

United States Patent

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[54] INLET CONTROL

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98/38

[51] Int. Cl. F24f 7/00

[58] **Field of Search** 98/41 SV, 41 R, 41 AV, 38 E,
98/38 B, 38 A, 38, 37, 33 R, 33 A

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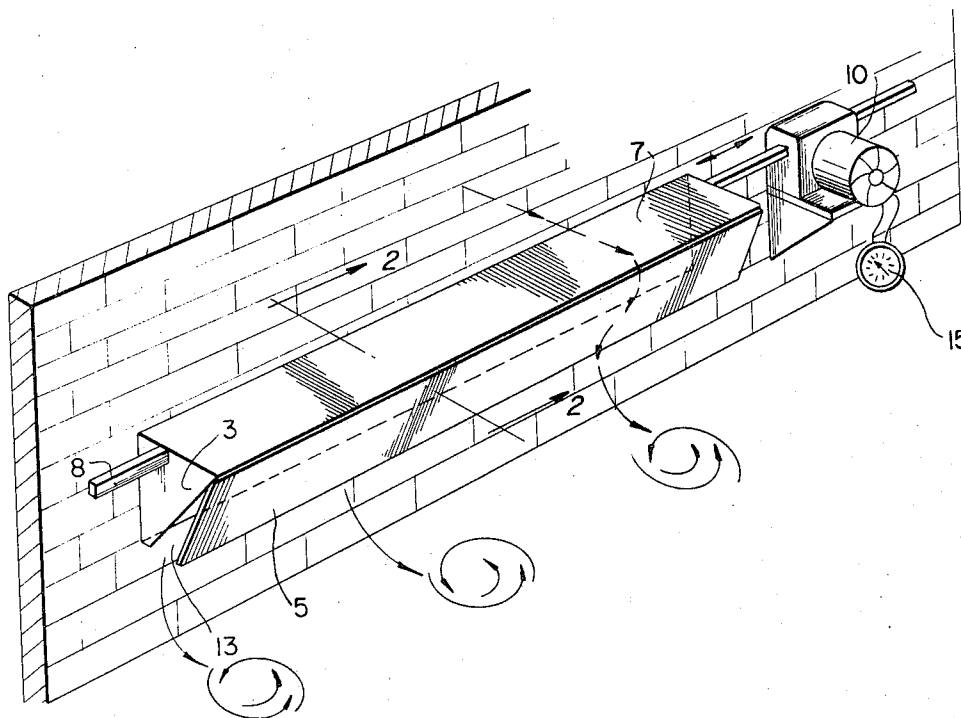
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[57] **ABSTRACT**

As auxiliary in a ventilating system, a control unit mountable against an air inlet contains a sloping face and means to adjust the face to control a throat for air flow at given pressure differentials of inside and outside air.

9 Claims, 7 Drawing Figures



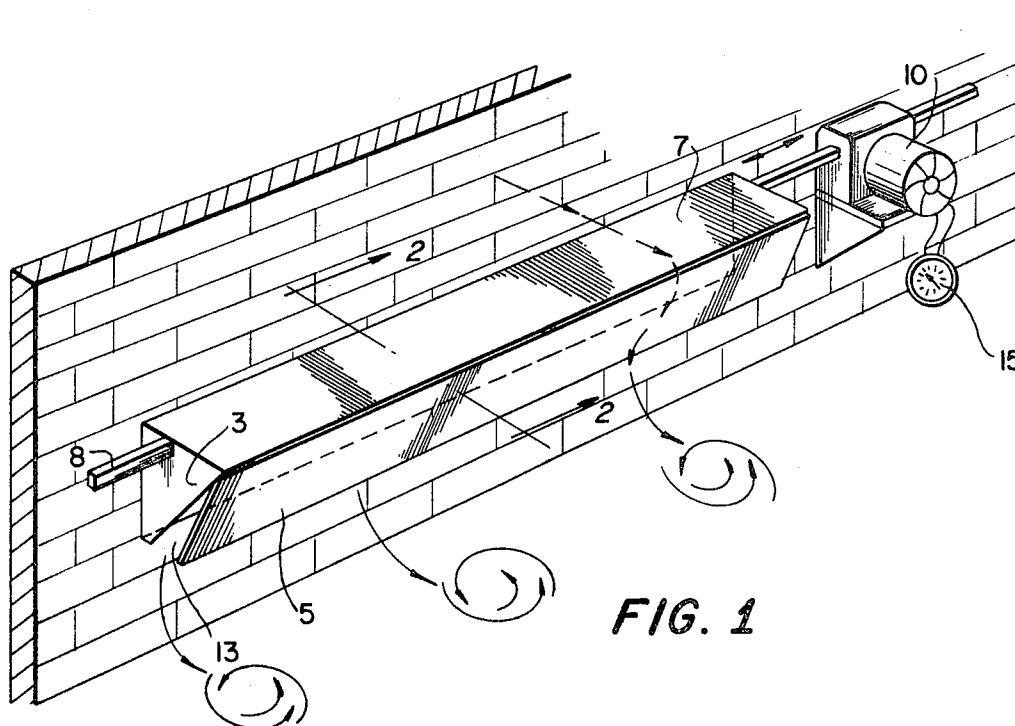


FIG. 1

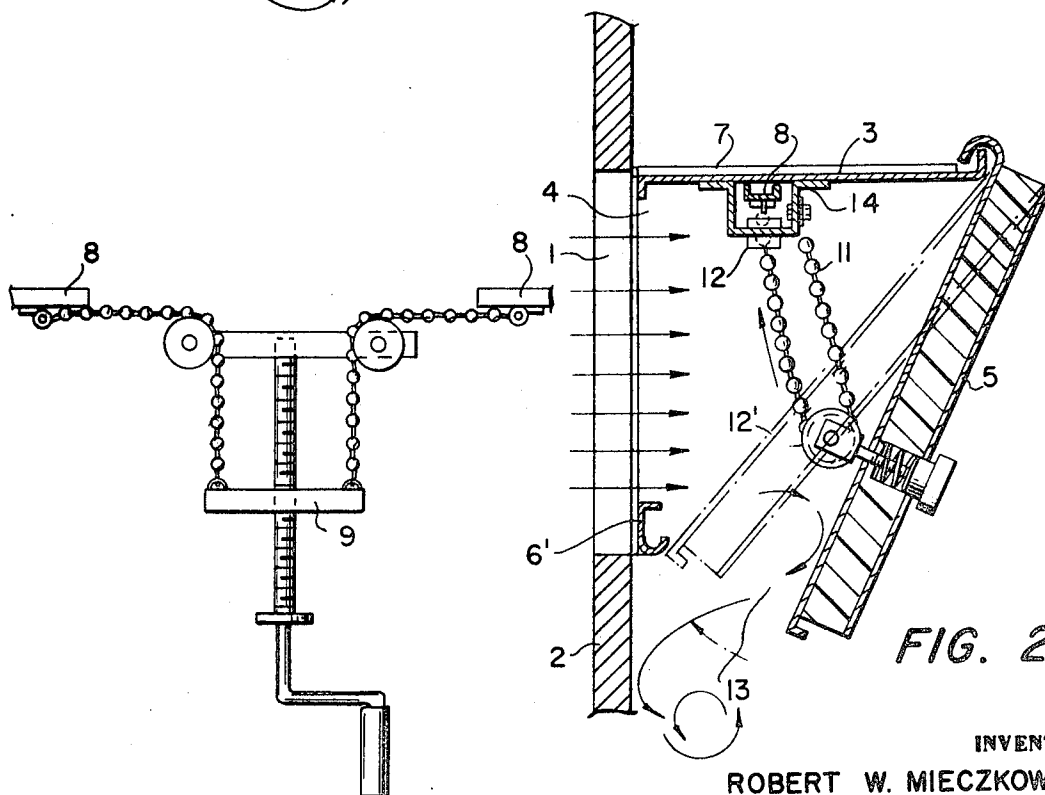


FIG. 2

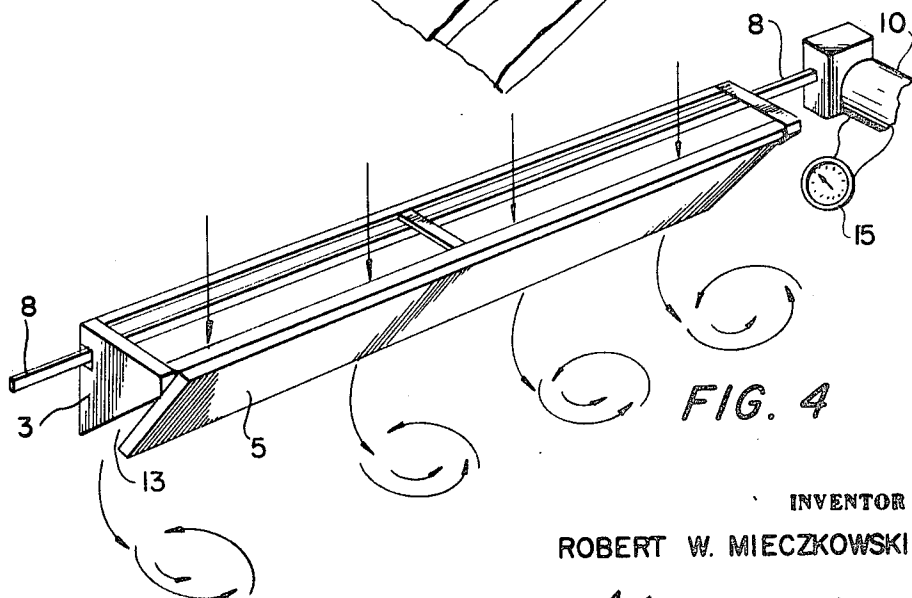
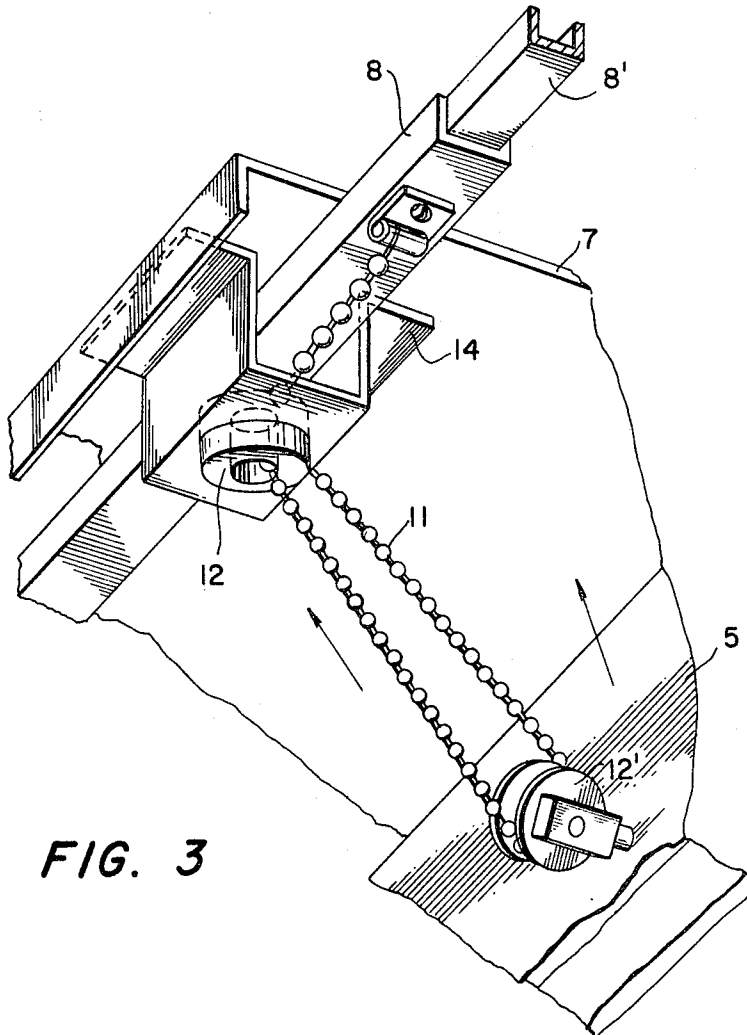
FIG. 5

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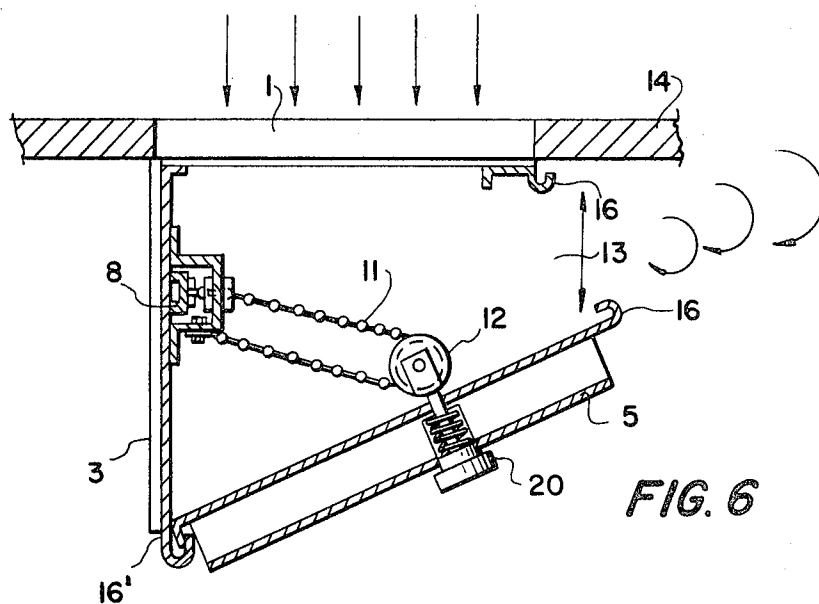


FIG. 6

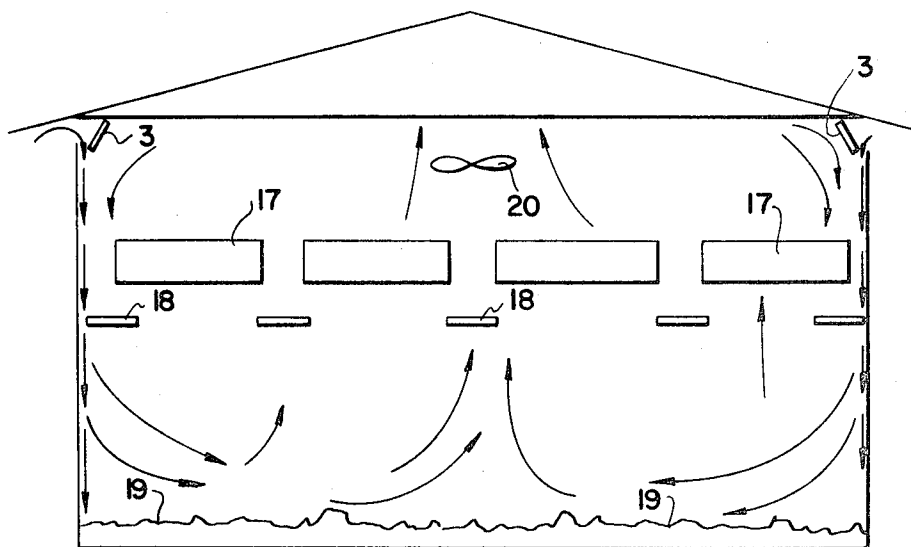


FIG. 7

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INLET CONTROL

This invention relates to ventilation; especially to auxiliary means to improve the effectiveness of primary ventilating systems. The invention relates to control of air inlets to a ventilated space. The control not only regulates replacement air but directs the air to perform certain scavenging functions. The invention provides a control unit that after adjustment operates without requiring power components in the unit.

Illustrative use of the invention is in ventilating enclosed livestock buildings, such as today's large poultry house, swine nurseries, or calf barns. These need better ventilation. Poultry houses now contain 20,000 or more birds and are 4 or 500 feet long by some 40 feet wide. Birds in the houses are crowded. Caged birds may occupy only 0.6 sq. ft. each. They smother easily if ventilation is poor. They become ill if the air becomes contaminated. Moisture to be removed by scavenging air amounts to over 50 gallons (say 200 liters) of water a day from 1000 birds. Good moisture-retaining capacity of air requires maintaining adequate temperature; but ventilating systems to overcome temperature must avoid drafts and wet pockets. Besides moisture another contaminant is carbon dioxide, which the birds breathe off. This is heavier than air and settles to the floor. Another is ammonia. This rises from the droppings and is stifling. Also, effective air scavenging minimizes many communicable disease organisms.

Ventilating systems must be flexible, operating as they do through different seasons, in different climates, and particularly under extensive daily fluctuations of wind, rain and temperature. Some systems attempt to move large volumes of air, and install large fan capacity but do not overcome harmful drafts.

The present invention improves use of inlet air, with various primary outlet systems. This invention avoids uncontrolled inlet air leakage, since air expulsion from an enclosed space causes static pressure difference between inside and outside air. Inlet air is caused to flow into the space responsively to the static pressure difference. Preferably lower pressure inside causes inlet air to flow into the space in regulated response to this difference.

This invention directs air from an upper perimeter inlet to flow in an accelerated, rolling broad stream or sheet that gradually entrains air to be expelled from the space. The space is maintained under certain static pressure differentials. The invention provides inlet control units to mount against perimeter inlets, whether wall or ceiling, adapted to operate even as an extensive control line, auxiliary to any variety of ventilating outlet systems.

A practical arrangement will now be described as illustration of this invention, within the appended claims.

Having reference to the accompanying drawings:

FIG. 1 shows in perspective an air inlet control unit having a face hinged at its top, mounted against a side wall opening and connected to a motor controlled by differential pressure means.

FIG. 2 is a section across the unit, mounted against a side wall opening showing the outer face hinged at its top and connected to positioning means. FIG. 2 shows also an alternative hinge connection at the bottom of the outer face.

FIG. 3 shows schematically two interengaging rigid adjustment elements, as channels, connected by flexi-

ble positioning means to an outer face, as a means to connect individual control units in to a multiple inlet control line.

FIG. 4 shows the unit in perspective open at the top, suitably for mounting against a ceiling perimeter air inlet. The hinged outer face is connected to a retractable rod or channel controlled by differential pressure means.

FIG. 5 shows a simple illustrative structure to adjust a line of retractable baffle control means. This illustration is of a yoke connected to rigid retractable means, with stylized moving means.

FIG. 6 shows the unit in cross section, analogous to FIG. 2 but mounted against a ceiling perimeter opening. The outer face is shown hinged at its bottom and connected to positioning means. FIG. 6 shows also an alternative hinge connection at the top of the outer face.

FIG. 7 shows in schematic cross-section a tall enclosure, with this invention applied at the upper perimeter to scavenge air from the bottom.

The drawings show an air inlet 1 such as a perimeter slot at the ceiling 14 or at the upper part of a side wall 2. Both a wall opening or a ceiling opening are termed upper perimeter opening in this description and claims. Air inlet control unit 3 is an enclosure mounted with an open face 4 against wall opening 1 in FIG. 2 or against ceiling opening in FIG. 6. The unit 3 is an elongate box structure of triangular cross-section. A movable outer face or baffle 5 is hinged along its own edge so as to fall open, or in opposite direction to be drawn under the unit towards the wall. The hinge being along the edge also blocks leakage from the throat formed. As illustrated in FIGS. 2 and 6 the hinged edge may be connected either at the top or at the bottom since alternative hinge elements 6,6' or 16,16' are provided. Choice of one or the other will be explained later. A closed face, 7 at the top in FIG. 2, stabilizes the unit, assists in directing inlet air and carries retractable adjustment means 8 mounted lengthwise of the unit. Means 8 connects between positioning elements on movable face 5 and pulling means 9 shown generally in FIG. 5 or as motor means 10 shown under pressure-control in FIGS. 1 and 4.

Adjustment means are shown with flexible element 11 joining retractable means 8 with the movable face 5 through directing guides as bushing 12 and pulley 12'. This connection is to pull hinged face 5 into one position or another when suitably drawn. It may move back again by gravity action of face 5. This may be arranged so the apparatus will "fail safe" to some open position if appropriate retaining means is not operative. As shown in FIGS. 2 and 6, fine adjustment means 20 are provided as a take-up screw and knob 20 through baffle 5 connected to position pulley 12' toward or away from baffle 5. This is useful for close adjustment of the closure or throat opening 13, for example, when wind or warpage might alter a base value of the opening. The adjustment element shown as flexible bead chain 11 may be in other forms; for example, folding arm connections to give more rigidity.

Means 8 to adjust the slope of face 5 establishes a throat 13 along an edge of face 5. Means 8 preferable is a rigid tension member so as over a long line of inlet units to avoid cumulative flexing or stretching with

maladjustment of more distant units. A rod is suitable, especially with inter-fitting end connections; but a channel form of pulling element 8 provides rigidity with ease of interconnection by slidable fit to a similar channel from one unit to another, with economy and availability. In some cases a double-acting rigid adjustment means 8 is desirable, suitable for tension or compression, to give positive adjustment of face 5 in either direction, such as by a reversible motor 10. Here rigid channel or rod is especially desirable. The element 8 is shown in FIG. 3 slidably mounted by bracket 14 against fixed face 7. Also in FIG. 3 channel 8 is shown in somewhat exaggerated form joined by slidable fit to a neighboring channel 8'.

In operation, as outlet fans, expel air from the enclosure outside, air flows in through perimeter inlets along the upper part of the building. With the inlet control described, this entering air reflects from the sloping adjustable face 5. As in FIG. 1, this air then moves down along the side wall, or as in FIG. 6 moves along the ceiling.

Under this invention, a static pressure difference between inside and outside air of about 0.01 to 0.20 inches of water in the space is developed to accomplish desired action. Preferably pressure difference of about 0.04 to 0.10 inches of water is sought and obtained under this invention with a mean of the order of 0.05 inches.

Considering FIGS. 1, 2 and 4 and 7 movement of elements 8 tilts face 5 to provide a suitable throat 13 between the wall 2 and the bottom of face 5. The throat accelerates movement of the incoming broad sheet or stream of air as it flows and discharges through the throat. Air velocity necessarily resulting carries the air sheet well to the floor, with curling or rolling movements that gradually entrain or engulf inside air to be expelled. The two gradually merge and move out into the space, drifting toward the outlet fans (not shown). The velocity of air discharging through and out of throat 13 is something of a venturi effect in which velocity is accompanied by diminished local pressure that tends to draw air into the sheet from the space. This entrainment action of gentle, gradual, swirling intermingling of incoming air with inner or space air may be visualized by admitting smoke or the like to the inlet air. The gradual merging action down the wall and into lower regions of the ventilated space is readily shown and is something of a control for adjustment of throat 13. It is found that as this occurs with a given setting the pressure differential mentioned attains a substantially steady condition. In other terms, a differential pressure reading of about the stated value is a guide for operating the control. A higher static pressure difference indicates that more air, by larger throat, should be admitted by opening face 5; at a lower static pressure difference, the throat should be narrowed by closing face 5 to restrict the inlet air stream.

As shown in FIG. 5 adjustment of throat 13 through movement of adjustment members 8 may be by a yoke and crank or equivalent pulling means to shorten adjustment means 11 and raise face 5 as in FIG. 2. Release permits gravity to lower face 5, or rigid members 8 may be pushed back toward the unit to lower face 5 if friction requires. Adjustment to open or close throat 13 automatically is obtained by driving channel

members 8 one way or the other from a reversible motor controlled for forward or reverse drive by a differential static pressure switch. Such are indicated in FIGS. 1 and 4 by numerals 10 and 15 respectively. Such switch preferably is set at a midpoint of about 0.05 inches of water differential air pressure. Such motors and pressure controls are well known of themselves.

In some cases it is desirable for units in a line of FIGS. 1, 2 and 4 to swing face 5 from bottom hinge connection 6', 6' 16', 16' to be open at the top. This projects air out horizontally at an upper level. Entraining, rolling air movement is obtained to an effective degree even though outer air may be relatively cooler than inside. If desired some control units in a line may still be open at the bottom, for inlet air from them to curl along the wall into the lower areas, as previously described.

It is evident that the upper throat opening and control and action just described, with units mounted against a wall perimeter opening, may be obtained likewise with units mounted against a ceiling perimeter opening as in FIG. 4 or as mounted in FIG. 6.

With reference to FIG. 7, a type of deep enclosure is illustrated that with poultry is sometimes termed a "deep pit" house. Typically such have lines of poultry cages 17 spaced across the building with head room of about 8 feet and about 8 feet from the floor. Catwalks 18 are provided between cages for service attendants. Droppings 19 accumulate on the floor. Often excessive moisture accumulates also on the floor. FIG. 7 shows air inlet units 3 of this invention in upper perimeter installation at opposite sides of the enclosure. Catwalks 18 are spaced away from the building side walls so that air streams from the units 3 may flow down along the walls. With adjusted differential air pressure, for example, of the order of 0.10 to 0.20 in some instances, the air streams flow well to the floor area with their entraining, scavenging action. Opposed streams from opposite walls rolling toward each other over the floor and accumulations rise at various areas, as determined by their individual controls and burdens, and drift to the air outlet means. Such outlets are not shown as they involve their own known and varied installations, but are indicated by symbol 20 in FIG. 7. Utilizing this invention, one may provide downward-moving, entraining currents of fresh air to ventilate a floor and accumulations a considerable distance below entrance and exit levels for the air. This air flow cleanses and dries the floor levels and then rises through the poultry cages without drafts in a gentle drift toward operating outlets.

In this operation, as in other operations under this invention, aside from adjustments of inlets, actual control of the airflow action requires no propelling drive nor power consumption of its own. Advantage is taken of the existing air outlet means already normally present in a given installation. That is, intake or inlet fans, are absent.

This invention has been illustrated by reference to ventilating animal shelters, but certain benefits can be obtained also with other delicate objects, such, without limitation, as greenhouses, culture caves, laboratories and the like.

In accordance with the Patent Statutes I have set forth my best mode of application of this invention.

However, those skilled in the art can now perceive modifications and equivalents within the scope of the appended claims.

What is claimed is:

1. An air inlet control unit, adapted for auxiliary control in a ventilating system having means to expel air from an enclosed space, the unit being an enclosure having an open face adapted for mounting against a perimeter air inlet, having a closed face, and having a movable face member and hinge means at top and bottom edges of the movable member to swing the member to various open and closed positions to form a throat with respect to one of the faces to afford an opening from the air inlet, and control means to swing the movable face to various throat-forming upper or lower positions.

2. An air inlet control unit as set forth in claim 1, the means to swing the throat-forming face comprising a pull element mounted on the unit and adapted to connect to similar elements of neighboring units to form a control line through a series of the units.

3. An air inlet control unit as set forth in claim 2, in which the pull element is a channel bar adapted for slidable fit with a similar channel bar of a neighboring unit.

4. An air inlet control unit as set forth in claim 2 in which the means to swing the throat-forming face comprises motor means connected to a rigid positioning element and control means therefor responsive to static

air pressure differentials between inside and outside the ventilated space.

5. An air inlet control unit as set forth in claim 1 in which the control means is responsive to air pressure differentials of the order of 0.01 to 0.20 inches of water.

6. An air inlet control unit as set forth in claim 1 in which the open face is adapted to mount against a side wall air inlet and the movable face member has hinged connection at its upper edge, to form a throat adjacent the side wall below the air inlet, and means to adjust the movable face member and throat to various throat openings at various positions.

7. A process of ventilating an enclosed space comprising expelling air therefrom, thereby causing a static pressure difference between air inside and outside the enclosed space, causing a sheet of inlet air to flow into the space, responsively to the static pressure difference, accelerating the air flow and directing the inlet air flow downward in an accelerated rolling stream gradually entraining air to be expelled from the space.

8. A process of ventilating an enclosed space as set forth in claim 7 in which inlet air flow is controlled to maintain static air pressure differential between inside and outside to 0.01 to 0.20 inches of water.

9. An air inlet control unit as claimed in claim 1 with upper and lower hinge member means along the edge of the movable face member.

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