SELF – ADJUSTING SLOT AIR INLETS

COMPLETE INSTRUCTIONS

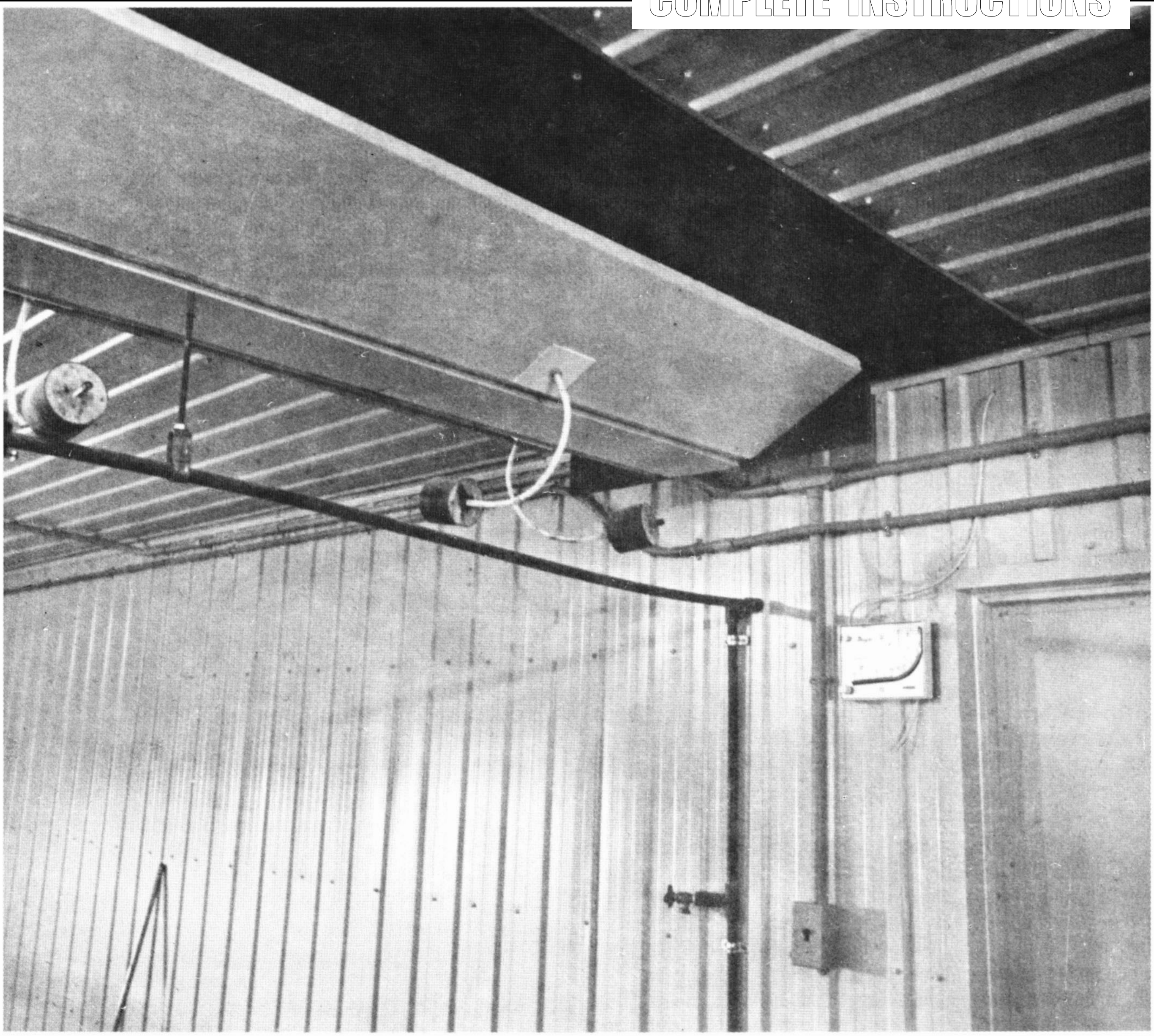

Figure 1 **Double-slot self-adjusting air inlet with a prepainted steel ceiling. Note the static pressure manometer on the endwall, for calibrating the inlet (photo courtesy of Ontario Ministry of Agriculture and Food).**

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With a conventional negative-pressure ventilation system, fans pull stale air from the animal room, switching on and off according to the thermostat temperature settings. The fresh air inlet is the other main part of the ventilation system; its task is to distribute the fresh air and mix it with the room air so that all the animals get enough fresh air without feeling drafts.

Some previous air inlets have used complicated cable-and-winch systems to adjust the size of the openings for the wide range of ventilation rates required (summer maximum 10 to 20 times winter minimum!). However, these manual adjustments could not handle frequent ventilation changes, particularly in spring and fall when the fans must respond to wide daily temperature fluctuations. Several ventilation equipment manufacturers have developed pressure-sensing air inlet controllers, but they are expensive and not always reliable.

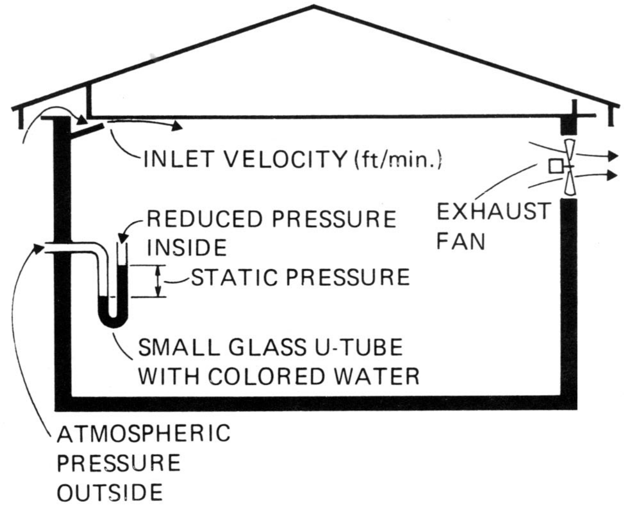
OPERATING PRINCIPLES

This leaflet describes a simple counterbalanced inlet baffle. Outside air applies pressure to the top of the baffle; this pressure, and the mass of the baffle itself, are continuously balanced by counterweights hung on the other side of the hinge. Whenever the thermostats and fans call for a change in ventilation rate, a slight change in room-air pressure opens or closes the baffles accordingly.

Figure 2 shows how the inlet airspeed is related to the static pressure difference that pulls air through the inlet slot. For any desired inlet airspeed, a simple adjustment of the length of the counterweight arms will set the static pressure required to hold the baffle open, and once set, the baffle will automatically open and close the slot to maintain almost constant airspeed over a wide range of ventilation rates.

WINTER VENTILATION For cold weather, airspeed at the inlet slot is very critical. Below 1000 ft/min, cold winter air, being much denser than the warm room air, will sink rapidly down from the inlet and cause drafts in the pens below. Above 1000 ft/min the incoming air jet has enough energy to help it cling to a discharge surface (such as the ceiling) while it picks up and mixes with the room air. Smoke tests easily demonstrate this.

Figure 2 shows that 1000 ft/min airspeed corresponds to about 0.06 in. (water column) static pressure. For winter, the counterweight arms should be extended to hold about 0.06 in. static pressure. It is easier to measure the static pressure with a manometer than to measure the velocity (see Figure 2).



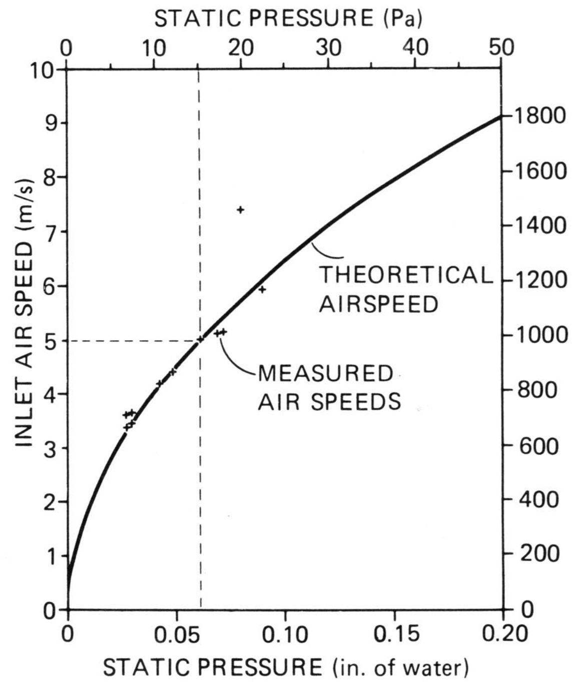


Figure 2 Static pressure and its relation to the airspeed at the inlet slots

SUMMER VENTILATION In hot summer weather it is more important to maximize the fan capacity than to keep the fresh air mixing at the ceiling. Therefore the counterweight arms can be shortened, reducing the static pressure and increasing the slot opening. A jet velocity of about 800 ft/min is suggested for summer, corresponding to 0.04 in. static pressure.

FEATURES AND LIMITATIONS

WIND These pressure-sensing inlets respond quickly to slight pressure changes due to fans starting or stopping. But they also respond to external wind pressures. In cold weather the fresh air supply must be taken from a space uneffected by wind pressure, such as the attic or a hallway ventilated from both sides of the building. Where inlets are located along the walls (Figure 3, detail [1]) provide fresh summer air from wide soffit openings, screened to keep out birds, rats and squirrels. But for cold weather, almost close the soffit and draw air from a perimeter-ventilated attic.

ATTIC AIR SUPPLY Where the attic is used as a winter air supply plenum, it should be ventilated all around the perimeter (both eaves, both gables) to sense the average atmospheric pressure, regardless of wind strength or direction. Design the attic vents to keep out birds, rodents, snow and rain.

If the attic is used for summer air supply as well, be sure to open bigger attic doors to provide the increased airflows needed in hot weather. These summer openings may be at the soffits or at the gable ends, with soffit flaps being preferred (Figure 5). Provide at least 3 sq ft of attic air inlet area for each 1000 cfm total ventilation fan capacity. Shield the attic against solar heat gain by using a white reflective roofing, or add some insulation between the roofing and the attic space. Plain galvanized steel roofing is quite reflective when new, but when weathered to its natural grey, absorbs a lot of heat and should be painted white. White asphalt shingles on a plywood or flakeboard decking will also reduce solar heat gain effectively.

BACKDRAFTING THROUGH INLETS With conventional air inlets adjusted manually, any interruption of the normal negative pressure in the animal room (fan failure, a door left open, etc.) lets warm moist room air drift up into the cold attic. In winter this can lead to massive frosting and condensation in the attic. With automatic inlets, the problem is partly solved because the inlet simply closes until negative room pressure is restored.

UNIFORM AIR FLOW Inlet baffle dimensions and adjustment of the counterweight arms must be uniform throughout the room. For example, if part of the air inlets are set with shorter arms (lower pressure) than the rest, most of the air will come in through the low pressure part, the rest of the flaps remaining closed.

CONDENSATION FROM INLETS Condensation is bound to occur wherever warm, moist room air contacts a cold surface. An example is at the plastic hinge (7), Figure 3 , where the "attic" side of the plastic is at outdoor temperature. It is a good idea to locate the inlets over a part of the floor where some dripping can be accepted (for example, over a slotted floor). The dripping can be reduced by adding a vertical stop of polystyrene board (11) at the plastic hinge, Figure 3 [2].

CONSTRUCTING THE INLETS

These inlets may be made continuous or intermittent; in either case, end-stops will be required at both ends of each inlet unit.

BAFFLE AND HINGE ASSEMBLY High-density extruded polystyrene board is an ideal material for the baffles; it is light, smooth, warp-free, moisture-resistant and insulating. Cut two baffles 1 ft wide by 8 ft long from each 1 1/2 in. board. Woven-reinforced plastic tarpaulin material makes an ideal, airtight hinge. Staple the plastic hinge to straight wood strapping, wrap it around three sides of the strapping and clamp it on the workbench to the upside-down baffle with stove bolts and galvanized sheet steel angle. Adjust the hinge space between baffle and strapping precisely to suit the final arrangement of the inlet when turned over and screwed up into place (see Figure 3 (10), or Figure 4 (10). The objective is to mount the baffle assembly so that the baffle edge is exactly parallel to the ceiling surface where the air jet develops its "throw". If the plastic hinge should tear (or simply need adjustment), unscrew the wood strapping, re-staple the hinge and screw the whole baffle assembly back in place.

CEILING SURFACE The ceiling where the airstream is discharged must be smooth; any ridges (such as electrical conduit or corrugated steel) running across the direct path of this fast airstream will deflect air downwards, spoiling the distribution. Figure 1 and Figure 3 (17) both show ceiling panels of rigid polystyrene insulation added to make the nearby part of the ceiling level and smooth. Set these panels into a bead of caulking compound (15) to handle slight ceiling irregularities and to seal them airtight.

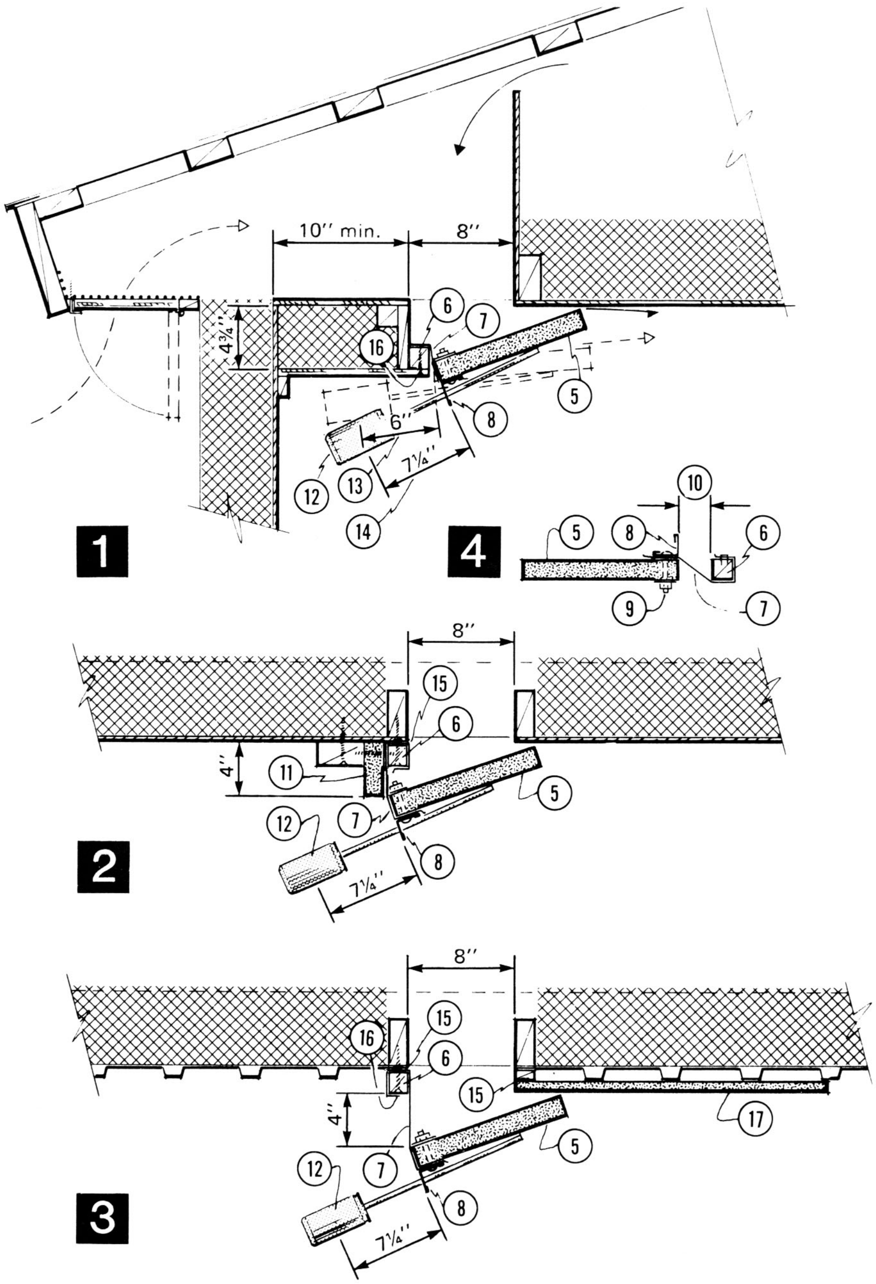
COUNTERWEIGHTS Make these from any heavy material such as concrete, steel bar, etc. Counterweight lever arm dimensions in Figures 2 and 3 are based on two weights per 8-ft length of baffle, 2 ft from each end. We used 355 mL aluminum beer cans, with tops cut off, then filled with concrete (Figure 6). Others (Figure 1) have used short lengths of waxed cardboard tubes, also concrete-filled. Soft drink cans (280 mL) are a little too small; they would need longer counterweight arms and more room to swing.

The counterweight arms shown in Figures 3, 4 and 5 were bright-plated, 5/16 in. threaded steel rod, set into the soft concrete. For adjustment, these rods slide easily through 5/16-in. holes drilled in the sheet steel angle clamp (8) . The threads keep the rods in place. If the counterweights are made heavier, the rods can be adjusted shorter, and vice versa; you can use any combination of counterweight mass and arm length that maintains the same supporting moment.

Build and mount one 8-ft length of inlet complete with two counterweights before proceeding. Check to make sure the baffle will swing from closed to fully open (at least 2 in.) without any hangups.

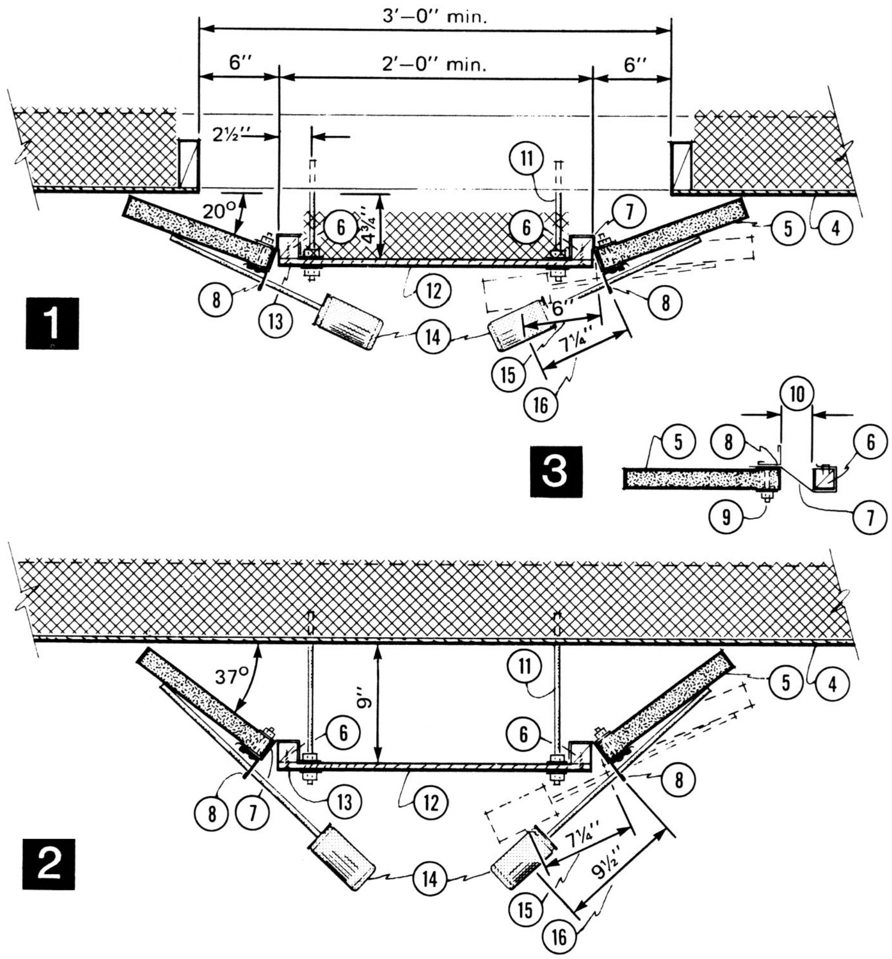
DOUBLE AIR INLETS

Figure 4 shows two similar designs for double inlets, usually located near the center of the ceiling span in rooms up to 40 ft wide. Design [1] draws fresh air from



1	inlet along a side wall (summer air from screened soffit, winter air from attic)	10	2 3/8" for option 1 5" for option 2 6 7/8" for option 3
2	single inlet through a smooth ceiling (air from attic)	11	1 1/2" x 4: extruded polystyrene board
3	single inlet through a ribbed or uneven ceiling (air from attic)	12	counterweight, 1.9 lb on 5/16 x 18" threaded rod, spaced at 4' (2' from each end)
4	pre-assemble (5), (6), (7) & (8) upside down; staple (7) to (6) and bolt (8) to (5)	13	hot weather setting, for 800 ft/min air velocity; threaded rod on counterweight, adjust through hole in (8)
5	baffle, 1" x 12" extruded polystyrene board (Dow SM or equal), 8'-0" lengths butted end to end	14	mild to cold weather setting, for 1000 ft/min air velocity
6	strapping, 1 1/2" x 1 1/2" x 8' straight wood	15	caulk airtight
7	hinge, woven-reinforced polyethylene plastic tarpaulin (Dupont Fabrene STPNN, or equal)	16	screw assembled baffle and hinge assembly in place with No. 8 flat head wood screws
8	steel angle clamp 1 1/2" x 1 1/2", bent from (26) ga. galv. steel 4" wide	17	for rough or irregular ceilings add smooth 1" x 24" polystyrene board
9	plated stove bolts and oversized washers spaced at 12"		

Figure 3 Automatic single-slot air inlet details



1 double air inlet from attic

2 double air inlet and recirculation duct

3 pre-assemble ⑤, ⑥, ⑦ & ⑧ upside down; staple ⑦ to ⑥ and bolt ⑧ to ⑤

4 ceiling, smooth plywood or equal (if rough or irregular, add flat panels, see ⑯, Fig. 3)

5 baffles, 1 1/2" x 12" extruded polystyrene board (Dow SM or equal), 8' lengths butted end to end

6 strapping, 1 1/2" x 1 1/2" x 8' straight wood

7 hinge, woven-reinforced polyethylene plastic tarpaulin (Dupont Fabrene STPNN, or equal)

8 steel angle clamp 1 1/2: x 1 1/2: x 8', bent from 26 ga. galv. steel 4" wide

9 planted stove bolts with oversized washers 12" spacings

10 2 3/8" for option [1]
3/8" for option [2]

11 5/16" threaded rods screwed tight into 1/4" holes drilled in ceiling framing, spaced not over 4'

12 5/8" plywood duct bottom; adjust nuts and washers on ⑪ to hold baffles parallel to ceiling ④

13 screw assembled baffle and hinge assembly in place with No. 8 flat head wood screws

14 counterweight, 1.9 lb on 5/16" threaded rod, spaced at 4' (2' from each end)

15 hot weather setting, for 800 ft/min air velocity; threaded rod adjusts through hole in ⑧

16 mild to cold weather setting, for 1000 ft/min air velocity

Figure 4 Automatic double-slot air inlet details

the attic space; in this case the bottom panel ⑫ is insulated to prevent condensation where the warm, moist room air contacts the cold panel. A strong plywood bottom panel is suggested, mounted for vertical adjustment on threaded steel rods ⑪ in case you need to run electric lighting circuits, heating pipes, etc., underneath. Drill undersized holes into the ceiling joists or trusses, then screw the threaded rods into the holes with vise-grip pliers. At the end joints of the bottom panels, first add a splice-block of plywood drilled for the rods. Then install the bottom panels, screw the panel ends to the splice-block, and tighten the nuts and washers to adjust level and secure the connected bottom.

Another option [2] (in Figure 4) is to use the space between the ceiling and the panel ⑫ as a fresh air distribution duct. In this case the ceiling is not cut open. The depth from ceiling to bottom is increased, also changing the angle of the baffles ⑤ and the length of the counterweights ⑭ . An effective arrangement is to pressurize short lengths of this duct space with prewarmed air from a recirculation fan that mixes some warm room air with the fresh air supply. For bigger airflows the “duct” capacity can be increased by making the bottom panel ⑫ wider than shown at [2] . Detailed design of these recirculation systems is beyond the scope of this leaflet.

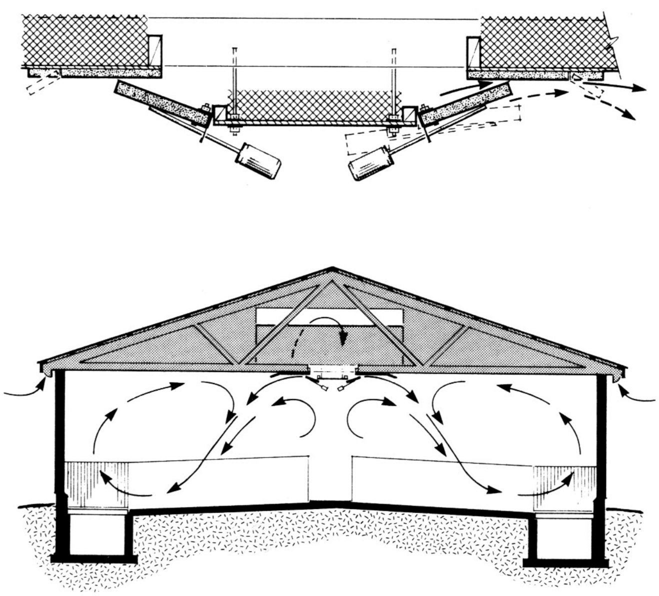


Figure 5 Deflector baffles can be added to relieve summer heat stress in swine growing and finishing barns.

For swine growing and finishing barns with center feed alleys, the double inlet arrangements shown in Figure 4 work very well except in very hot weather. When heat stress strikes, a pair of deflector baffles is useful to bend the airflows down into pens as shown in Figure 5. But make sure that the deflectors do not interfere with winter air flows when they are retracted to the ceiling.

FINAL ADJUSTMENTS

The success of these automatic inlets depends on achieving a uniform slot opening for any given ventilation rate. A simple manometer (Figure 1) is almost essential for making adjustments as it will show indirectly the inlet velocity achieved. It also indicates whether the room is airtight enough for negative-pressure ventilation to work (leaky structure, large gaps around doors, or air leaking in through untrapped manure openings will spoil the results). A Dwyer manometer like that shown in Figure 1 is quite suitable and is available from many ventilation equipment distributors. If the inlet slot is slightly uneven due to an irregular ceiling or inaccurate mounting of the baffle, work a sheet of coarse sandpaper mounted on a smooth board along the slot, sandpaper side down. This will remove some edge from the baffle, fitting it more closely to the ceiling line.

Smoke tests (Figure 6) also help to show if the fresh airflow is uniform and to verify that the air is moving as intended.

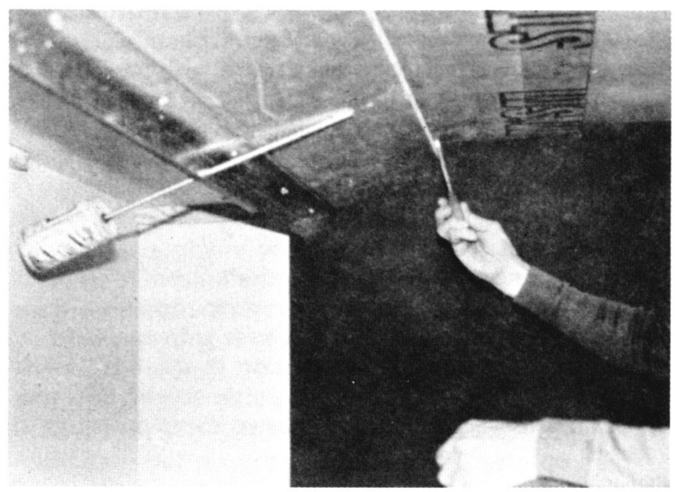


Figure 6 Smoke tests can be used to check the airflow from self-adjusting inlets.