

HYD 377

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THE STUDY OF STORMPROOF LOUVERS  
FOR VENTILATING SYSTEMS

Hydraulic Laboratory Report No. Hyd-377

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ENGINEERING LABORATORIES BRANCH



DESIGN AND CONSTRUCTION DIVISION  
DENVER, COLORADO

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January 11, 1954

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Design and Construction Division  
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Denver, Colorado  
January 11, 1954

Laboratory Report No. Hyd-377  
Hydraulic Laboratory Section  
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Checked by: J. W. Ball  
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Subject: The study of stormproof louvers for ventilating systems

PURPOSE

To determine the operational characteristics of stormproof louvers for ventilating systems.

SCOPE

Two louvers were tested: A design from Davis Dam (referred to in this report as Louver Design No. 1) and a louver constructed commercially (Louver Design No. 2), Figure 4A. Tests included measurement of head losses and a determination of the stormproof qualities of each louver. No attempt was made to improve or alter the louvers.

CONCLUSIONS

1. The head loss due to the louvers, with an average air velocity in the duct of 1,000 feet per minute, is:

1.16 inches of water for Louver No. 1 and  
5.06 inches of water for Louver No. 2

2. Water dripping down from an upper louver vane will be drawn into the duct through the opening below the vane at an average air velocity in the duct of about:

400 feet per minute for Louver No. 1 and  
220 feet per minute for Louver No. 2

3. Distribution of flow in the duct just downstream from the louver is not uniform. Air entering through the louver is concentrated in a stream near the top of the duct and there is a large eddy at the bottom near the entrance, Figure 5. Maximum pressure head recovery, indicating uniform flow to be established, occurred about 14 feet downstream from each louver.

4. Water collecting on the louver vanes will run down between the louver frame and the ends of the vanes unless the ends of the vanes are made watertight. The ends of the bottom vane must be sealed to prevent this water from entering the duct.

## THE INVESTIGATION

### Laboratory Installation and Equipment

The exposed face of each louver was mounted flush in a 4-foot-square panel which represented the outside wall of a building, Figures 1 and 4A. The air duct downstream was represented by a plywood conduit 17-1/2 inches square (inside measurements) and 20 feet 6 inches long. A viewing window made up part of one side of the duct starting at the louver and extending 4 feet downstream. This window enabled the observation of smoke or water drawn through the louver and into the duct. A 9-inch orifice was installed at the downstream end of the duct to measure the air flow.

Air was drawn through the duct and the 9-inch orifice by a blower with a capacity of about 55 cubic feet per second and a shut-off suction head of 8-1/2 inches of water. Flow was controlled with a cut-off board clamped on the blower discharge pipe.

Pressures were measured at various stations in the duct. At each station one piezometer hole was drilled in each of the four wall surfaces, except holes were not drilled through the viewing window.

Suction heads and differentials were measured by using water-filled "U" tubes on a slanting gage board which could be adjusted to give readings from 5 to 100 times the actual head.

Water was supplied from a 2-gallon reservoir through a 1/4-inch rubber tube and an eight-hole manifold for the stormproof tests concerning water running down the louver vanes. A single nozzle was used in place of the manifold for the tests concerning water drops being drawn into the vanes from a fixed distance out. Smoke for flow pattern observation was supplied to the louver by forcing air through a can of smoldering oakum placed near the louver entrance.

### Head Loss

Curves of head loss versus average air velocity in the duct were drawn for the head loss tests. The curves were described by the general equation:

$$H_L = KV^2$$

Where

$H_L$  = head loss in inches of water

K = a constant determined by test for each entrance condition

V = average air velocity, feet per minute, in the 17-1/2-inch-square duct

Duct entrance and screen loss. Tests were made to determine the head loss for the unobstructed 17-1/2-inch-square duct entrance and for the opening covered with 2- and 4-mesh hardware cloth to separate these losses from those due to the louver. The coefficient "K" in the head loss formula for each entrance condition is as follows:

Unobstructed 17-1/2-inch-square entrance

$$0.0512 \times 10^{-6}$$

Entrance covered with 2-mesh hardware cloth

$$0.0615 \times 10^{-6}$$

Entrance covered with 4-mesh hardware cloth

$$0.0646 \times 10^{-6}$$

Louver loss. The loss equations for the louvers without screens are:

$$H_L = (1.160 \times 10^{-6})(V^2) \text{ for Louver No. 1}$$

$$H_L = (5.055 \times 10^{-6})(V^2) \text{ for Louver No. 2}$$

The ratio of open area through the louver to duct area is quite small, being 0.385 for Louver No. 1 and 0.211 for Louver No. 2. The above loss equations are based on the air velocity in the duct which is the principal factor contributing to the difference in loss coefficients. Computations based on the velocity of the air passing through the louvers indicated that, considering the shape factor only, the loss coefficient for Louver No. 2 is 1.30 times that for Louver No. 1.

#### Stormproof Characteristics

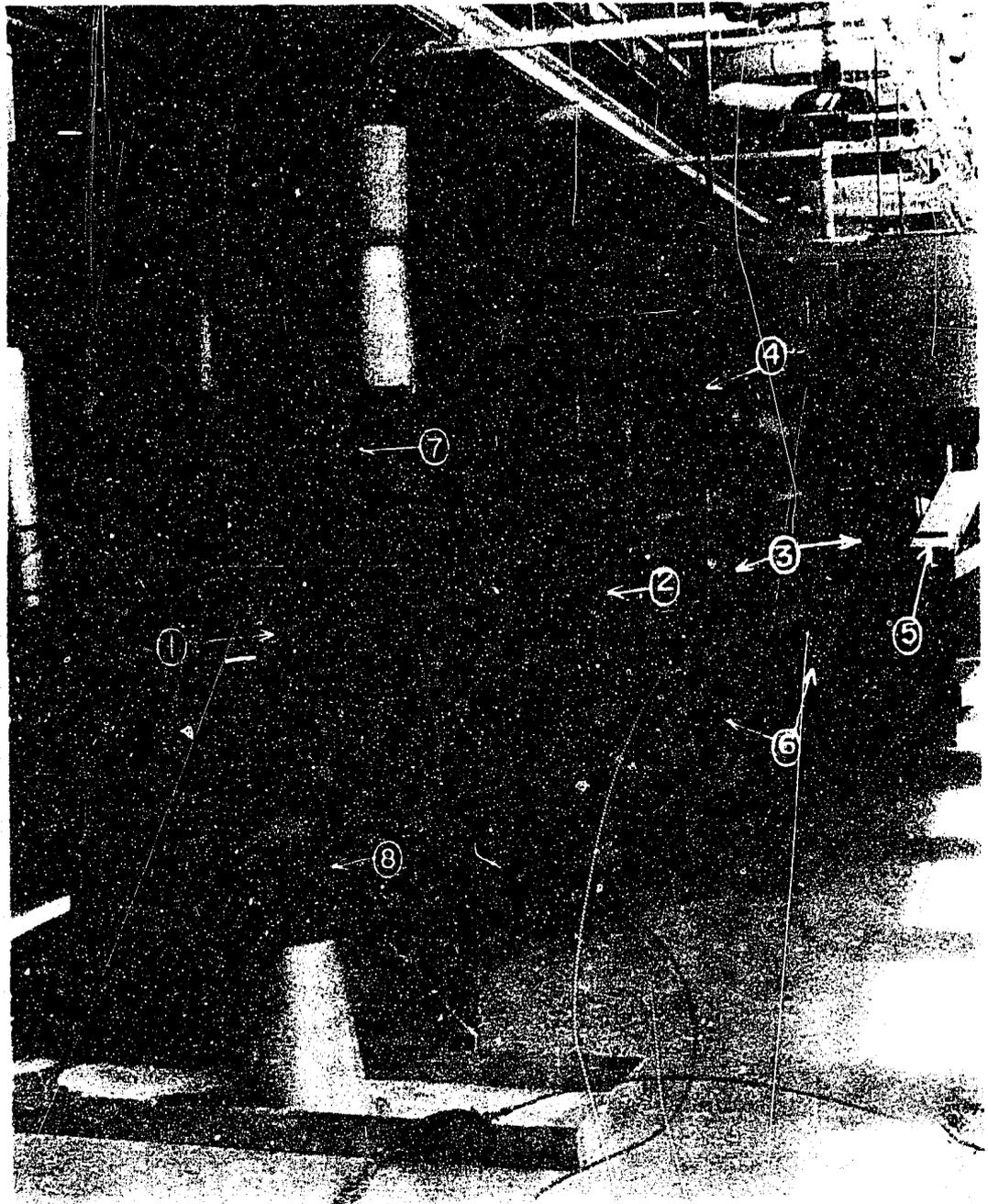
Water dripping down from one louver vane to another will be drawn into the duct at some minimum duct velocity depending on the shape and spacing of the vanes. For Louver No. 1 without a screen this minimum

average air velocity in the duct is about 400 feet per minute and for Louver No. 2 is about 220 feet per minute. Drops being drawn into the duct through Louver No. 1 are shown on Figure 3A.

Water drops falling vertically across the face of the louver will be drawn into the system by the air stream at certain combinations of drop distance from the louver and air velocity. When the drops fall  $3/4$  inch from the top edge of the louver face and the duct velocity is 1,225 feet per minute, the water accumulates on the lower vane as shown on Figure 3B. The results of the tests with water drops are shown graphically on Figure 2.

#### Downstream Flow Conditions

The flow in the duct became uniform about 14 feet downstream from the two louvers as shown by pressure head measurements on the walls of the duct, Figure 4B. This indicates that for best efficiency, a blower should not be placed less than 14 feet from these louvers. The flow pattern made visible by smoke entering the two lower openings of Louver No. 1 is shown on Figure 5.



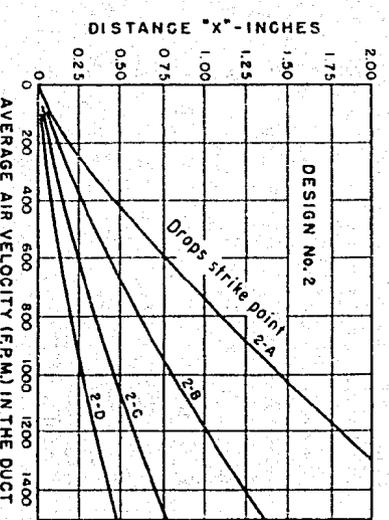
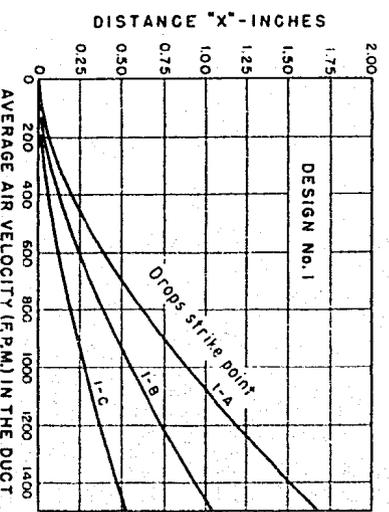
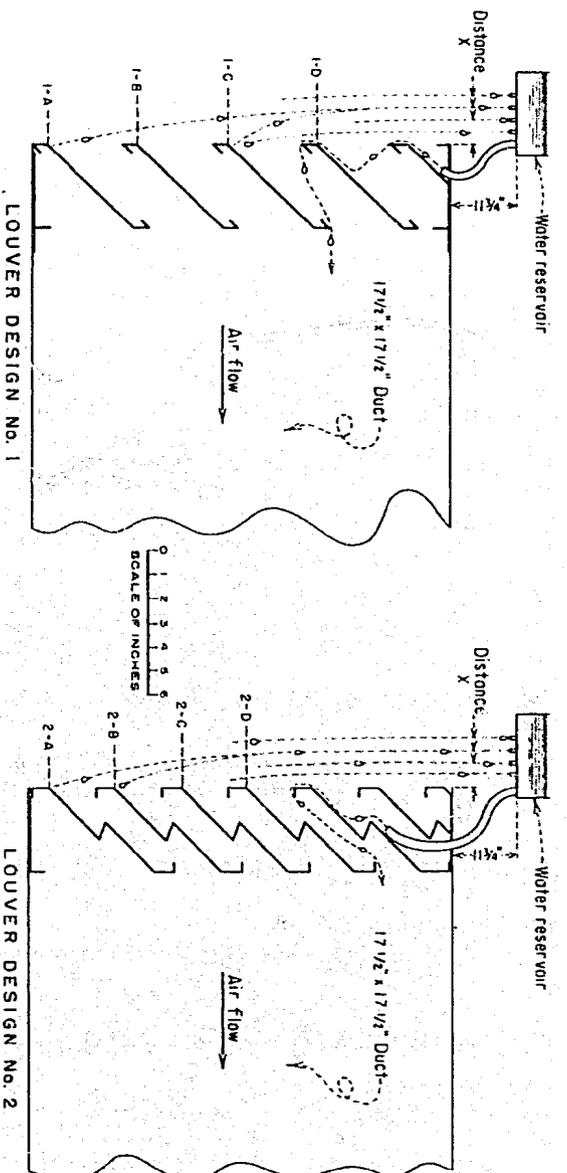
### LABORATORY TEST APPARATUS

Key to numbers:

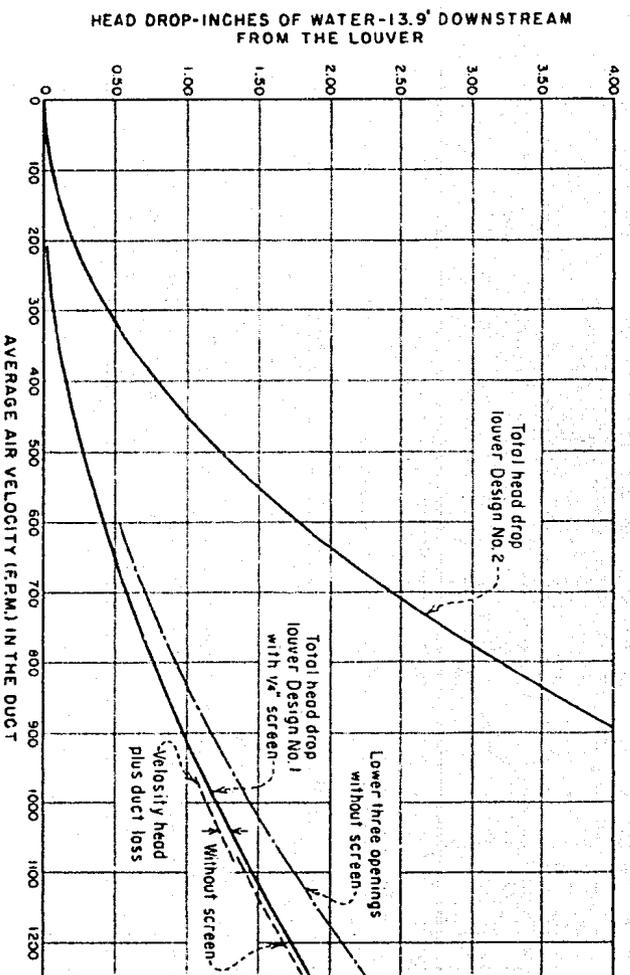
- |                                     |                     |
|-------------------------------------|---------------------|
| 1. Louver                           | 5. Slanting gage    |
| 2. Viewing window                   | 6. Piezometer leads |
| 3. 17-1/2" X 17-1/2" X 20-1/2' duct | 7. Water supply     |
| 4. Control valve                    | 8. Smoke generator  |

### STORMPROOF LOUVERS FOR VENTILATING SYSTEMS

Test apparatus



Minimum average air velocity in the duct of which water will be drawn through the louver and into the duct is 400 f.p.m. for Design No. 1, and 220 f.p.m. for Design No. 2

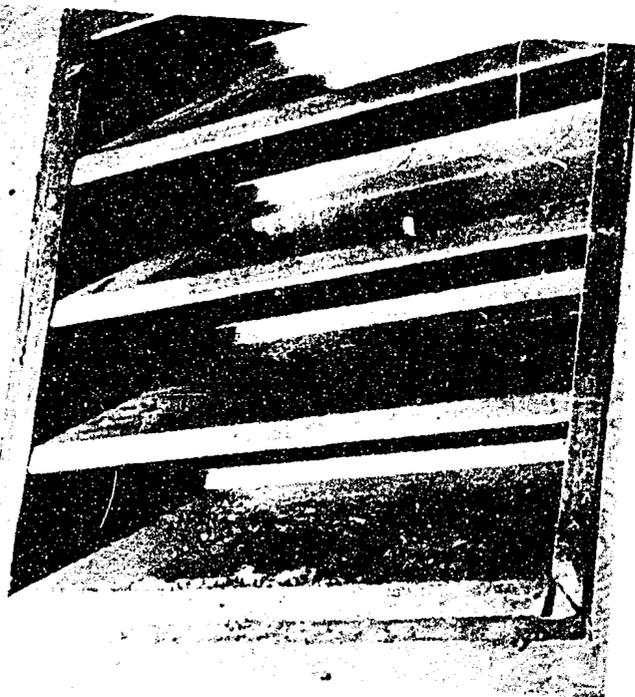


STORMPROOF LOUVERS FOR VENTILATING SYSTEMS  
HEAD LOSS AND STORMPROOF QUALITIES

Figure 3  
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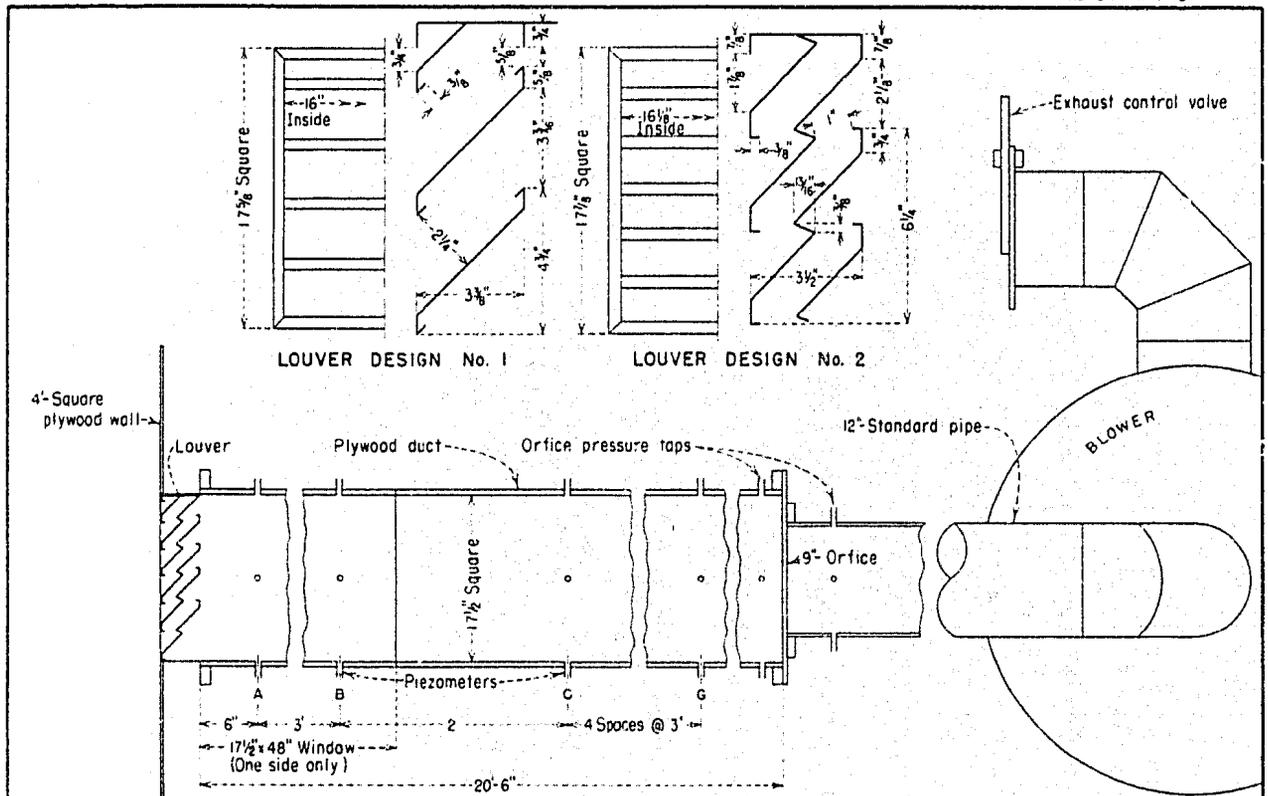
A. View of water drops being drawn into the duct through the upper full opening. Average air velocity in the duct = 500fpm



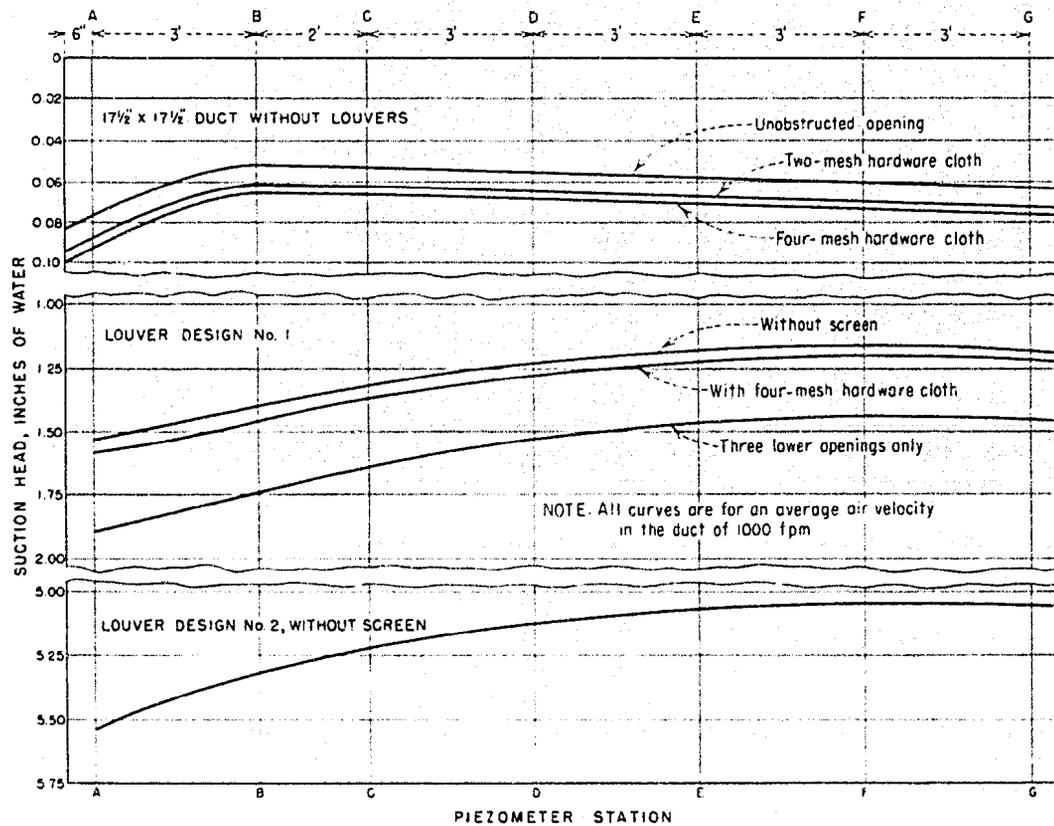
B. View of water being held on the two lower louver vanes by the air stream. Average air velocity in the duct = 650fpm

STORMPROOF LOUVERS FOR VENTILATING SYSTEMS

Stormproof tests of Louver No. 1



ELEVATION ON CENTER LINE  
A. LABORATORY INSTALLATION



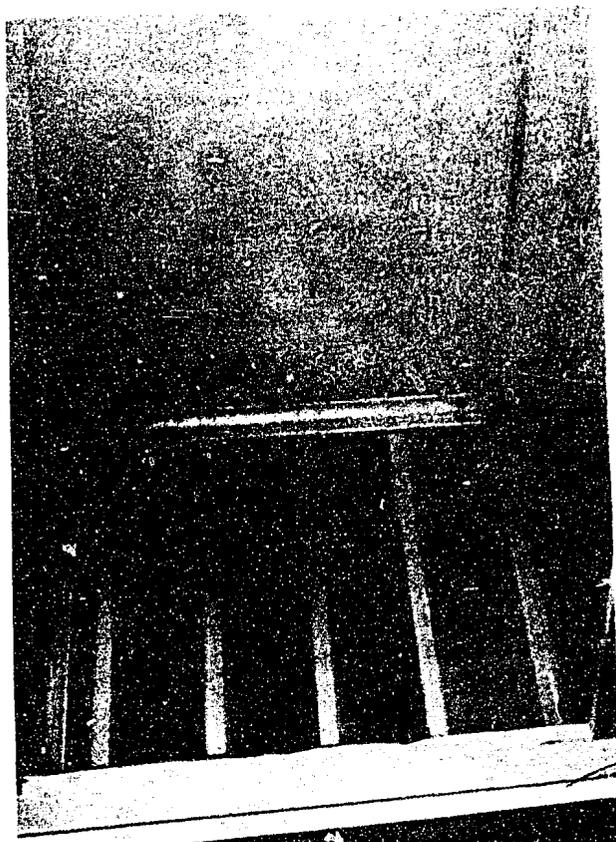
B. PRESSURE GRADIENT CURVES

STORMPROOF LOUVERS FOR VENTILATING SYSTEMS  
LABORATORY INSTALLATION AND PRESSURE GRADIENTS



Above-- Smoke entering the two louver openings of Louver No. 1. Viewing window is 17-1/2" high and 48" long.

Left---- Louver No. 1 as seen through the viewing window.



STORMPROOF LOUVERS FOR VENTILATING SYSTEMS

Smoke pattern downstream from Louver No. 1