A Mechanism for Automatic and Manual Control of the Air Velocity at the Window Opening of Fume Hoods

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A MECHANISM FOR AUTOMATIC AND MANUAL CONTROL
OF THE AIR VELOCITY AT THE WINDOW OPENING OF FUME HOODS

Definition of Purpose

The purpose of the following research concerned an effort to develop a control on the air velocity at the door opening of a fume hood. It was felt necessary that this control, acting through a damper, must maintain positive action and must be automatic as well as manual, and purely mechanical in nature. Considerations of the use of electrical or pneumatic devices in any portion of the mechanism were rejected in order to maintain as simple and direct a mechanism as possible avoiding as much maintenance and breakdown as could reasonably be foreseen.

Problems Involved

The first problem was that of developing a positive controlled velocity action through the face opening of the hood without causing turbulence or other air action sufficient to cause eddy currents, back drafts, etc. of such a nature as to provoke any danger from toxic or radio-active materials as regards the operator of the hood. It was felt that in order to safe guard against possible back drafts, eddy currents, etc., it was necessary to develop a control mechanism to satisfy the following conditions:

1. The establishment of constant velocity through the face of the hood.
2. The development of a true automatic control to insure the above constant velocity at any position of the door of the hood.
3. To develop in addition the possibility of manual control to provide increased velocity when needed.
within the discretion of the operator of the hood.

4. The establishment of an emergency release of the door of the hood by the operator with the additional provision that the damper must be re-set to automatic position before the operator can resume operation of the hood.

Development

As a first problem, it was felt necessary that direct linkages were necessary between the door of the hood and the damper.

In addition, it was also felt necessary to develop a condition in the mechanism whereby the sash could be operated independent of the damper.

It was also felt expedient that under conditions whereby the mechanism is being used in manual operation, a locking device was necessary by which the sash could be moved in the direction of a closed position only in order to insure positive increasing velocity at a time. In connection with this, it was also considered necessary that the door of the hood could be closed rapidly by the operator as an emergency arose.

With the above conditions the relation between velocity and the door action depends upon the linear cam profile established. This is explained in the drawing. The position of the mechanism was also considered carefully and it was ultimately established on the right side of the face of the hood for operation in that position. In considering the material for the building of the mechanism, every effort was made to develop the various parts of the mechanism from standard turned stock eliminating any castings as far as possible. The weight of the mechanism is also a consideration as well as the fact that it must be resistant to corrosion actions of any sort. For this reason, stainless steel was chosen in the main.
The damper itself was designed to be inserted where the exhaust duct leaves the hood proper. As was mentioned above, direct linkages connect the damper and the control mechanism. The damper is designed as a unit and may be removed from the hood in a simple manner by a plate opening to which it is attached and fastened against the exhaust duct.

The considerations in this problem were restricted to a non-air-conditioned situation in the area in which such a hood is to be used. In an additional investigation, the development of mechanism to be used under air conditioning will be considered.
A DESCRIPTION OF THE CONTROL MECHANISM

This device is designed to link kinematically the window sash of a fume hood with the damper in the stack of said hood. There are two operating positions as illustrated in Figure 1, automatic \( Y_1 \) and manual \( Y_2 \). When in an automatic position \( Y_1 \), any relationship of air velocity and opening may be obtained. This relationship is established by the use of a linear cam \( F \) which is fastened to the sash \( E \) of the hood. The roller \( L \) of the mechanism is fastened to the frame of the hood, and it follows the contour of the cam \( F \) held in this constrained position by the spring \( Q \). As the sash \( E \) is raised and lowered, the cam \( F \) causes the link \( M \) to travel through an arc of 90°. The link \( M \) is fastened rigidly to the shaft \( S \).

The sleeve \( T \) with its circular rings \( Y_1 \) and \( Y_2 \) and conical inclined plane \( T^1 \) is free to move with respect to the casing \( N \), and it is also free to move laterally with respect to the shaft \( S \) for positioning. When the sleeve \( T \) is in manual position \( Y_2 \), it is free to rotate about the shaft \( S \).

Referring to Figure 1 again, the sleeve \( T \) is in its extreme right automatic position \( Y_1 \) and is held in this position by the spring \( R \) along with the indexing device \( V \). The spring \( R \) also forces the sleeve \( T \) back into automatic position \( Y_1 \) when the sleeve has been used in the extreme left manual position \( Y_2 \). This position is held by the constraining spring \( R \) and the indexing device \( V \). In this automatic position \( Y_1 \) the shaft \( S \) with its corresponding locking bar \( S^1 \) is engaged in a slot in the sleeve \( T \). Thus the roller \( L \), fastened to the shaft \( S \), is constrained to move the sleeve \( T \) which in turn transmits the rotary displacement of link \( M \) through to link \( I \) which then follows link \( M \). The link \( I \)
extends through the sleeve (T) and supports the round knob (K) for manual operation. The rotary motion of the link (I), which has been caused to follow the roller (L) and the link (M), transmits this same rotary motion through the links (D) and (C) to the damper (B) as shown in Figure 4 of the small assembly drawing. It may be seen from Figure 3 that the sleeve (T) is still in automatic position. A small round link (Z1) is at the high point of the conical inclined plane (T1). The round link (Z1) in turn engages the dog (Z2) which, seen in Figure 2, holds the dog (Z2) in a horizontal position. This dog (Z2) is constrained to this position by the spring (Z3). Thus it will be seen that the dog is disengaged from the ratchet (G) which is also fastened to the sash (E) of the hood. The position of the ratchet (G) may be seen in Figure 4. By way of repetition, the sash (E) is free to be raised and lowered at will when the mechanism is in the automatic position (Y1). As the sash (E) is raised and lowered, this constrained condition causes the damper (B) to follow accordingly.

When manual operation is desired, the indexing device (V) as illustrated in Figure 1 is pulled out to the position as shown. Pressure is then applied at the right end of the sleeve (T) forcing the sleeve (T) to the extreme left. The indexing device (V) will now engage the sleeve (T) at the manual position (Y2). Since the sleeve (T) is free to move laterally with respect to the link (S), the locking bar (S1) becomes disengaged from the sleeve (T). In this manual position (Y2), the constrained condition between the sleeve (T) and the link (S) no longer exists. Thus it may be seen that by operating the knob (K), any position of the link (I) may be obtained thus controlling the damper (B) through the links (D) and (C). In this same manual position (Y2), it may be seen from Figure 3 that the conical inclined plane (T1) of the
sleeve (T) is moved to the left. The link (Z1) is in the top or narrow position of the inclined plane having been forced up by way of the spring (Z3) through the link (Z2). As shown in Figure 2, the spring (Z3) will have caused the dog (Z2) to rotate clockwise thus engaging the ratchet (G). The sash (E) is thus locked in this position with respect to any upward movement.

As it is seen, however, should an emergency arise within the hood and it becomes desirable to lower the sash (E) in a hurry, the operator is free to do so since the dog (Z) does not constrain the lowering of the hood (E). The purpose of this locking device is to prevent the hood from again being opened while in the manual position. In order to open the hood (E) the indexing device (V) is merely released from the sleeve (T) by pulling it out. The compressed spring (R) thus forces the sleeve (T) to the extreme right automatic position (Y1). The operator then rotates the knob (K) slightly in order to bring the bar (S1) and the slot in the sleeve (T) into an engaging position. This again engages the link (S) and its bar (S1) with the sleeve (T) at the same time the dog (Z2) is disengaged from the ratchet (G). Now the sash (E) is free to operate as before in the automatic position (Y1).
Figure 4. Automatic control, damper and hood