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# VENTILATION IN FIRE FIGHTING

By DANIEL H. SHIRE

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THIS publication contains one of the papers presented at the first Short Course for Fire Fighters, held at Iowa State College on October 13 to 16, 1925, under the auspices of the Engineering Extension Department. While it will not be possible to issue all the valuable material presented at this meeting, certain of the other papers will probably be published.

It is planned to hold short courses on fire fighting annually. The names of those who apply will be placed on a mailing list to receive full information concerning future courses.

# VENTILATION IN FIRE FIGHTING

By Daniel H. Shire

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The importance of proper ventilation in fire-extinguishing operations warrants designating it "the strategy of fire fighting." Certainly it constitutes one of the most important and necessary duties carried on by a fire department in extinguishing fires in structures.

## Differences of Opinion

In many fire departments there are, among the higher ranking officers, many who are opposed to the theory of ventilation and who, in actual practice, will not permit their subordinates to operate in such a manner on a structure that is on fire as will partially or wholly relieve it of the accumulated smoke, gas, and heat that is produced by the burning of the contents or the structural parts of the building. Some fire chiefs even go so far as to hold that a structure in which a fire occurs should remain closed tight until the fire is under control, except as it may be necessary to open it up for the admission of hose lines. Most fire chiefs, however, advocate prompt and thorough ventilating.

Nothing in this article, however, should be taken as a reflection upon any fire department, its officers, or its men. Fire fighters, as a class, at all times do their best, never shirking their duty as they see it. But times change, and so it is with fire fighting. It takes more than a blue flannel shirt to make a fireman these days.

The conflicting and confusing differences of opinion that prevail among our fire officers upon this subject, as upon every other question of strategy or modern methods, can in nearly every case be traced to the conditions under which these officers have learned their business.

In departments where no special effort has been made to school or to drill the men, the following conditions will usually be found: (a) Officers who have served for the greater part of their lives in districts in which frame residence buildings abound, when placed in command of a department, will fight against the venting of a structure, while (b) officers who have served for the most part in a district in which brick residence and apartment houses prevail, when

placed in command of a department, will maintain an intermediate attitude upon the question of the venting of a structure.

In fact, men who have been placed in command of a fire department without much experience hardly understand what venting means. In contrast to this, men who have served for the greater part of their lives in high-value and commercial districts, when placed in command of a department, will favor prompt ventilation.

### The Old School

Some fire officers are indifferent; they make no special study of their work, either along the line of fire fighting or of fire prevention. Often such an officer has had no special training to fit him for his job. Investigation and experience have shown that this way of building up fire departments is wrong, and it is safe to believe that every conscientious fireman knows that it is wrong. This condition, however, is what retards our educational development and makes the opinions of fire officers less authoritative than they should be.

### Modern Training Methods

Today, thanks to the department's drill school and its fire college, no such chances are taken as of old. It may be said that firemen are now being trained to fight fire by not fighting it.

This sounds absurd, but it is not so at all. The modern fireman learns to fight a blaze at close range. He runs into the fire, not from it. The theory is explained to him, and then practice demonstrates the value of the method. He memorizes the procedure, and then gets his hands and feet to do it.

### Why Ventilation is Needed

There are thousands and thousands of fires occurring every year throughout this country, incipient, of course, at the moment of their origin—even incipient when the alarm is sent in, and still incipient when the fire department arrives—that could be extinguished very quickly and with little damage to the contents or the structure but for the fact that something had accumulated that frequently delays, and occasionally prevents, the fire department from reaching the seat of the fire.

Now, what had accumulated? Nothing but gases, heat, and smoke, the most powerful barriers the fire department knows.

Some fire departments depend entirely on the strong physique, grit, and stamina of the firemen engaged in fighting such fires. These



men cheerfully assume the risk of death by suffocation, or permanent disability, or at least of severe physical suffering in their efforts to overcome it.

The records of many fire departments will prove the accuracy of this statement. They will show that firemen have lost their lives at a considerable number of fires of insignificant proportions, while firemen in large numbers have received permanent or temporary injuries in their efforts to overcome the heat and smoke barrier in order to extinguish the fire. The proper venting of the structures involved in these fires would have saved nearly all of this.

This statement is not exaggerated. For confirmation as to its accuracy, let each fireman give thought to the fires on which he has operated during his service in the fire-fighting game, recalling the frequency with which he came into contact with heat and smoke at fires of trivial proportions, when, if it were not for the presence of this heat and smoke, these fires would, in the language of the fireman, have been extinguished with "a dash of water."

The objects of ventilation are two-fold: (1) to release the pressure and heat caused by the fire, so that hose streams can get to work at the proper range to kill the fire quickly, and (2) to draw the fire up through one channel and thus prevent its mushrooming into larger areas or its extending.

### When Ventilation is Not Used

It does not require much knowledge of fire fighting to be able to appreciate the effect of proceeding upon the theory that there should be no opening up or ventilating until fire is under control, where it is applied to a fire in a heap of rubbish on the upper floor of a large six, eight, or even ten-story building, heavily stocked with silk or other expensive materials. What would be the damage, due to combustion, in comparison to the damage by water and smoke, if the officer in charge of fighting this fire cooled it down with hose lines in order to find his fire? Unless the structure is ventilated, a comparatively small fire in a pile of rubbish, or even in a metal receptacle such as is often used for holding clippings and combustible refuse, may generate sufficient smoke to charge a large floor area so heavily as to make it impossible for the firemen to remain on the floor long enough to locate the fire. The smoke or heat prohibits the advance of the first line of hose, so that its output of water cannot be distributed over the fire area, and other lines have to be stretched in and additional water thrown into the structure.

When the officer reaches the seat of such a fire after a prolonged battle, the smoke finally clears up and permits him to see how small

an area the fire had actually come into contact with. He can, at the same time, note the large area covered with valuable stock that has been damaged by water but not touched by the fire. Then he can go downstairs to the other floors, where he usually finds more valuable stock damaged by the water and smoke. If he meets the owner or the insurance men, he is apt to stop to tell them what a hard job the department had in stopping the fire.

Do not results of this kind justify the theory that a building involved with fire should be vented at this or that point where suitable openings will quickly liberate the gases, heat, and smoke confined in the structure, in order to assist the firemen working to get at the fire so that they can extinguish it? In thousands of fires the prompt liberation of the heat and smoke present permits a more speedy advance of the hose lines to the seat of the fire. Its extinguishment is prompter, therefore, and this is what we are all after.

Common sense shows that the prompt ventilation of large floor areas and of buildings is not only desirable but essential to efficiency in fire fighting. Buildings should be opened up at the top and the windows opened before the hose streams are brought into operation, except in cases where the heat is so great that firemen could not enter the floor even if the smoke were to lift sufficiently to permit them to crawl beneath it.

The term "open up," as it is used in the fire department, includes the opening of skylights, scuttles, doors, flooring, roofs, iron shutters, gratings, dead lights, windows, coverings over elevator shafts, stairways, and light and air shafts.

It should be clearly understood that it is not claimed that the venting of a structure is solely responsible for the extinguishment of a fire, or that it would have any great value in cases where, upon the arrival of the first officer, it was found that the fire had extended throughout the structure or nearly so. Such instances, however, constitute only a small percentage of the total number of fires, and they are referred to only for the purpose of bringing about a clearer understanding of the theory.

### Ventilation Applied to Business Districts

The great height of buildings in business or commercial districts is an additional reason for opening up suitable vents before using water. Not only is the water damage rendered less where ventilation is first accomplished, but the damage from smoke will not be so great when prompt ventilation is effected as where there is delay in this particular.



The large amount of merchandise in this district and the fact that this stock must be maintained in salable condition make the probable financial loss due to smoke and water greater, in proportion to the actual destruction by fire, than in the case of household goods.

Business houses are ordinarily provided with strong and securely-fastened doors, and are frequently fitted with shutters. This renders them more difficult to open than residence buildings, thus making it unlikely that they will be opened up before hose streams are available. The water supply in the business district is generally sufficient and reliable; hence, there is little likelihood of a failure of water that would result in great damage.

The central location of most business districts makes for boldness in fire-fighting operations, because of the rapidity with which the fire-fighting forces can be concentrated there. Then, too, owing to the design of business buildings, fires in them do not spread as rapidly as do fires in residences.

The foregoing statements explain some of the reasons why it is a safe and wise practice to ventilate in fighting fires in the business district.

### Ventilation of Shafts

Each fire chief should do his best to have every building, two or more stories high, equipped with automatic vents to check fire. In other words, shafts of any nature that extend through a building should at least be closed at their lower extremity and should not be roofed over with any material that will not readily vent the shaft in case of fire. Insufficient vent area at the top of a shaft invariably causes fire to mushroom and find its outlet at some lower point. The effectiveness of ventilation depends entirely upon the promptness with which it is provided. Once fire has mushroomed on the floors of a building due to absence of ventilation, the benefits from ventilation applied later are very much diminished. The providing of automatic vents should not be confined to taller structures, nor to those classed as fireproof or semi-fireproof. Ventilation is just as important from a property standpoint, and more so from a life-safety standpoint, in an old building.

Where such a building has a combustible stairway and an open stairwell from the ground floor to the roof, life is almost invariably lost on the top floor. This is due to the accumulation of heat trapped on the top floor. In order to do effective life-saving work, it is usually necessary to open up the roof at once to clear the halls of the intense heat and make it possible for firemen to enter, as well as for the occupants to live until rescued.

In this type of structure a fire usually progresses in a typical way. Originating either in the basement or under the stairway on the ground floor, it quickly spreads up the stairwell, soon reaching the top floor. There it banks up, and the people on the top floor either hear the fire burning, or are awakened by the smoke or by the noise incident to the discovery of the fire from without. Immediately they step to their doors and open them. The pressure that exists in the pocketed space on the top floor in the stair hall causes a rush of flames into any room when a door leading into it is opened. A person arising at night, robed in thin garments and possibly but half awake, upon opening a door and being struck with a rush of flames is either panic-stricken or forced to retreat without closing the door. This is the way in which loss of life usually occurs.

Now, if these stairwells were properly vented with automatic ventilators, the pressure would not build up in the hall; instead, the heat, gases, and smoke would be drawn off to the atmosphere through a ventilator, so that opening a door would not immediately endanger the person as in the case where the heat is pocketed in the hallway.

One more point in connection with shafts is that they should extend through the roof to the atmosphere above, having a parapet wall sufficiently high to prevent the ignition of the roof from the heat passing through upon ventilating. In instances where there are cocklofts, the termination of a shaft at the ceiling of the top floor, while reducing the life hazard, does not reduce the property hazard as much as if the shaft passed through the cockloft to the atmosphere.

### Suggestions on Procedure

Immediately upon his arrival, the fire chief should be on the alert and should without a moment's delay give thought to the proper venting of the structure. He should consider the location of the fire and the line of its possible extension, opening up such portions of the structure as common sense and experience dictate. In certain special cases ventilation throughout a building is required, due to the presence of explosive or poisonous gases. In such a case, the largest possible area should be opened up for quick ventilation.

The speed with which the fire department works in extinguishing a fire depends primarily upon the speed with which the men can enter the burning building. This, in turn, usually depends directly upon the promptness and thoroughness with which proper ventilation is accomplished.

One of the precautions that must be observed in ventilating is not to open any door, window, or other opening that would directly endanger adjacent property. An indiscriminate opening of windows and doors on all floors is not always advisable. Take, for instance, a case where a fire is burning fiercely in the basement of a building near the elevator shaft or stairway. When the housing or roof covering directly over the shaft is opened up, the fire will sweep directly up the shaft and will be drawn toward the shaft in the basement. If the shaft were not properly enclosed, and especially if the windows on all the floors were opened, there would be a danger of the fire being drawn out onto the other floors and away from the channel from which it was intended to pass. Existing conditions will thus determine whether or not it is desirable to open the windows and doors.



In the case, however, of a building being completely filled with smoke, then ventilation by opening all the windows and doors is desirable, providing there is little danger of the fire being spread through the building by so doing.

The officer in charge of fighting a fire usually takes proper pride in having the operations so carried on under his direction that no unnecessary damage to property results from the work of the force engaged in extinguishing the fire. There are often occasions, in fact, when an officer will hesitate as to opening up this or that portion of a structure, when it requires that he order that plate glass or some other part of the structure be broken or damaged. He may not want to assume the responsibility as his own, or it may even be that there are standing orders from a superior that prevent his doing this or that thing vitally necessary in preventing the extension of the fire or of assistance in its quick extinguishment. If the principles of ventilation are understood, however, there need be no hesitancy whatever as to the venting of the structure; the small money value of the damage thus caused is as nothing compared to the value of the structure and its contents. Thousands of cases could be cited where conditions threatened the loss of the structure, but where prompt venting resulted in a comparatively small loss to the structure and its contents.

The direction of the wind must also be taken into account when a building is being ventilated. This is particularly true in cases where the roof is being opened up or where scuttles are being removed, for the fire may be driven to adjacent property. If the wind is in an unfavorable direction, even the opening of windows and doors may drive the fire toward exposed property and thereby increase the extent of the fire.

Atmospheric conditions have some effect upon good ventilation, but not much when the fire is a hot one. Where heavy and dense smoke and gases are present, a heavy atmosphere means that the smoke and gases will rise but slowly. They may, in fact, sink to the street around the burning structure and prove troublesome. A

cold and dry day is an ideal one for good ventilation, while a warm and humid day is rather unsatisfactory. In any case, however, ventilation must be resorted to where it will make it possible for the men to enter the burning structure.

### Summary of Principles

Good practice in ventilation can be summed up as follows:

1. Prompt venting in commercial or business districts.
2. Extreme caution in venting in frame-building districts.
3. Prompt venting of the tops of stairwells.
4. Cautious ventilating of all points in hotels, hospitals, tenements, apartment houses, and lodging houses.
5. For the liberation of heat and smoke, open up at the top.
6. For the liberation of carbon monoxide or other heavier-than-air gases or vapors, make the openings to the outer air at or near the floor level of the spaces where they are confined.

Life must receive first consideration upon arrival at the fire; ventilation should be next. Ventilation should not precede the getting of streams into operation; that is, it is dangerous to ventilate until the streams are ready to follow up immediately.

Proper ventilation depends upon the conditions encountered, but usually any part of a structure can be ventilated if good judgment is used.

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