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No. 293,

For the Week ending August 13, 1881.

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VENTILATION OF HALLS OF AUDIENCE.

An able and exhaustive paper has lately been presented to the American Society of Civil Engineers, on the ventilation of halls of audience, by Mr. Robert Briggs, C.E. It appears from this paper that a man in health and at rest requires for breathing 480 cubic inches of air per minute. The inhaled air, in American summer condition of 70° Fah. and 70 per cent of hygrometry, or about 1·7 per cent of its volume of aqueous vapor, and 0·04 per cent of carbonic acid, will, when exhaled, be found to contain nearly three times as much vapor and nearly 100 times as much carbonic acid, and to have lost one-fifth of the oxygen inhaled, while the temperature will have risen to 90° Fah. But, contrary to the teaching of some authors, the exhaled air will be about 3 per cent lighter than it was before being breathed. The carbonic acid does not, as some believe, separate and fall to the ground, but it is inseparably mixed with the breath.

Breathing is not the only means through which inhabited air is vitiated; insensible perspiration adds one-fifth or more to the carbonic acid sent out with the breath, while an average of about two pounds of water per day evaporates from an adult man at rest and awake, and both add to the contamination of exhaled air.

Now, if it be accepted that air is unfit for breathing after having once been in the lungs, it seems that about one-third of a cubic foot of air per minute is required by each person. The internal temperature of the body being nearly 100° Fah., it is essential that the surface should radiate heat, and that the air thus heated should pass off. Small portions of ammonia and gases, with floating organic matter, dust, and smoke in the air, with the probability that the origin of disease is only found in the germs of living organisms that subsist on the decomposing organic matter suspended in the atmosphere, are important facts in estimating the quantity of air required for perfect ventilation. It seems, therefore, that at least four cubic feet per minute are required, and that this quantity would amply ventilate a single person if it could all be devoted to his use exclusively.

Passing now to the subject of practical ventilation of halls of audience, it appears that each individual of an audience cannot, by known means, be supplied with his quota of four cubic feet per minute, which would, if made to pass upward along his person while standing, serve to perfectly ventilate him; it further appears that in a room continuously occupied by persons in health, or at least not affected with offensive diseases, as much as 30 cubic feet of air per minute must be properly introduced for each individual. A desirable capacity for the chamber seems to be 1,000 cubic feet of room for each person, but audience halls average no more than 200 to 300 cubic feet to the person, and therefore contain only about six to ten minutes' supply of air. This smaller capacity does not seem to be a very important defect, provided a systematic supply of air, at a proper temperature and in a desirable state of humidity, is properly introduced and distributed. The last part of the problem, as here stated, is the important difficulty to be overcome.

The system of air introduction through perforated floorings is in operation, and has been for twenty-four years, at the Houses of Parliament, London, although it is thought to be "embarrassed in its action by singularly unmechanical and insufficient apparatus for warming and supplying the air."

In other systems the standing difficulty is the establishment of local currents which produce unpleasant sensations in those persons who are exposed to them, and the desideratum has been and still is to supply an effective quantity of agreeably tempered air in such a way as to be imperceptible to the audience.

As regards the comparative effects of gas and electric lighting we are told that "the vitiation of air by electric light, arising from the slow combustion of the carbon, is too insignificant to form any element in considering the ventilation." The ventilation of churches that are heated by furnaces in the cellars beneath the audience can be partially done by removal of air at or near the floor, but no large ventilating shaft from the upper part of the room is admissible as a means of natural ventilation.

Natural processes can be only partially successful in ventilating codience rooms. Success "can only follow the complete adaptation of mechanical appliances and apparatus, as well as of structural arrangements, to the ascertained wants and requirements of the individual composing an audience."

Fans of the disk pattern are recommended as being from 10 to 15 per cent more effective than the common incased fan. The speed of the fan should be such as to impel the air in the ducts at the rate of 600 feet per minute, while the ends of the ducts should be fitted with baffling boxes so that the air may leave the box at a velocity not exceeding 120 feet per minute at a distance of one foot above it.

Box coils, as they are called, consisting of horizontal pipes inclosed in a chamber, are best for indirect heating (ventilation); while vertical coils, though less efficient by 20 per cent, are preferable for office heating.

The efficiency of well exposed steam pipes with steam at 36 to 40 pounds pressure is given as 3 cubic feet of air heated from zero to 100° Fah. per square foot of surface, or 5 cubic feet from 50° to 70° or 80°

For direct heating by coils placed in the rooms to be heated one square foot for each 80 cubic feet of space within the walls of an exposed room, but special provision must be made for doorways and open passages.

The cross section of steam supply pipes should have one circular inch area for every 500 feet of effective heating surface, enlarged $\frac{1}{100}$ for each foot from the point of first distribution or branch from the main. The condense water or return requires one half as much. Flow mains should rise vertically to some point where they can be drained or trapped, and then descend half an inch in 10 feet to the end.

Boilers of the common tubular form require one square foot of heating surface to each 9 square feet of coil surface or radiators, or one square foot of grate surface to 270 of radiating surface, the grate and heating surface of the boiler being as 1 to 30.

Chimney flues 50 feet high should have an area one-tenth of the grate surface, and 100 feet high one-twelfth. The maximum quantity of coal consumed will not exceed 8 pounds per square foot per hour, while for six months in the year 20 to 30 pounds per 24 hours per square foot will suffice.

A fan delivering 20,000 to 40,000 cubic feet of air per minute will require from 20 to 60 pounds of coal per hour. No allowance need be made for steam to drive the fan where buildings are warmed and ventilated, as the exhaust steam will be utilized for heating purposes.

The author says, "steam heating apparatus in all its details, as used in America, is peculiarly American," and "as practiced here, is not fully known or used in England or France, and but little more known in Germany."

BUTTON-SET RIVETING FOR BOILERS.

"Button-set riveting," which means forming the zone of a globe on the rivet by means of a concave "set" and a sledge, has been generally regarded with disfavor by boiler makers, but it has been long used by oil tank builders, enabling them to erect large tanks with astonishing rapidity and at correspondingly low cost for labor. The fine appearance and general good character of this work led enterprising boiler makers, who were not in condition to warrant the expense of steam riveting machines, to clandestinely try this method on steam boiler shells, and it has at last found favor among reputable makers, who now employ it openly, and they are supported in it by most people who understand the difference, except perhaps professional hand riveters, whose occupation is injured by its adoption.

We take the following from an interesting report by Mr. Wells to the recent convention of Railroad Master Mechanics at Providence, on the subject of "set riveting," as compared with "steam" and "hand riveting" of locomotive boilers. The plan of "set" riveting consists in placing upon the inserted hot rivet a set, mounted upon a handle, as smiths' sets, flatters, and hot chisels are, and having a cavity of the shape and dimensions of the desired head in its lower end, and "driving" the rivet by strokes from one or more sledges upon the other end of the set, a heavy holding iron being used to meet by its inertia the force of the sledges. The weight of the set described is $2\frac{1}{2}$ to 3 pounds, of the sledges 9 to 10 pounds, while the holder or anvil placed upon the other end or head of the rivet is about 60 pounds, and held firmly against the work by the short arm of a stiff lever of the first order.

The skill required for this work is readily acquired by laborers of ordinary intelligence, and consists merely in properly placing the holder, holding the set squarely on the rivet, and delivering fair blows upon its upper end. The first blows serve to upset the body of the rivet in the hole more effectually than blows struck with light hammers directly on the rivet point, and 24 blows in all, at the rate of about 80 per minute, finish the "setting" of the rivet, and half a dozen blows upon a "flatter" placed on the lap near the rivet completes one rivet, except a few blows more on the set to give the head a nice finish according to the taste of the workman.

Thus are driven on the shell of a boiler 30 rivets per hour, or an average of 22 on all parts, including changing bolts, drifting holes, and adjusting the work. Hand riveters average about 125 rivets per day of twelve hours and a half, or 10 per hour, under similar conditions. The report shows that the riveting of a locomotive boiler containing 1,722 rivets will occupy 65·85 hours, at a total cost for labor of $44.77, or an average of 2·64 cents each rivet, against which stands 5·84 cents each for rivets driven by hand at the rate of 10 per hour. The difference in favor of set riveting is shown to be 54 per cent in cost and 51 per cent in time. From the drawings exhibited, showing sections of laps riveted by the two methods as well as by steam riveter, it appears that "set" riveting is the most perfect in the matter of the rivet filling the hole. The remarks by members that followed the report indicated that no discussion was possible, since all seemed to think favorably of this method, and the president of the convention thought, that being the case, it ought to be adopted at once.

THE TORPEDO STEAM ALARM.

For several days the torpedo steamer Alarm has been stationed at Yonkers, on the Hudson, where trial has been made of the new propelling and steering machinery with which she has been fitted.

This vessel, and the novel system of torpedo warfare provided for in her construction and equipment, were described and illustrated in detail in the SCIENTIFIC AMERICAN of March 17, 1877. The Fowler wheel, which had been adopted to fill the double office of propelling and steering, did not prove entirely satisfactory. It enabled the boat to turn quickly in small space, but it did not give speed enough.