

lines. In countries where the fire-place has been depended upon for heat, many very ingenious grates have been invented with the object of warming the air in the rooms by passing it around the fire and discharging it back into the room, or for taking fresh air from the outside of the house and discharging it into the room after passing it around the back of the fire-place. Grates of this description have not come into use in this climate as they would not be able to warm the rooms properly, and consequently some other means of heating must be adopted which is generally sufficient without the assistance of the fire-place. We thus lose the benefits of the ventilation which always results from the use of a fire-place, even though it has no special arrangements for supplying fresh, warm air.

Very little can be said in favour of the method of heating by stoves, except that it is capable of economically heating rooms to a very high temperature. A stove heats a room slightly by radiation, but principally by convection, as already stated. The walls and floors remain comparatively cold as they receive no radiated heat, and the contact of the warm air does not warm them in any degree equal to that radiated from a fire. The reverse is the case—the walls through being colder chill the air of the room. There is a slight amount of ventilation caused by the withdrawal of the necessary amount of air to support combustion in the stove. Fresh air, as in the case of a fire-place, comes in through cracks and crevices in the windows, doors, etc. A great number of arrangements have been made whereby ventilation may be secured with the use of stoves. The stove pipe has been placed within a second pipe so that the heat from it would induce an outward current between the two pipes, thus ventilating the room. Casings have been constructed around stoves, so that the air to be warmed was made to pass up between the stove and the lining. This was first done with the object of drawing the cold air from the floor and warming it. After a time the casing was carried down to the floor with a number of holes near the base, through which the cold air might be drawn, and at the same time a pipe was put in which connected with the outside air. The fresh cold air entered through this pipe, and was discharged under or at one side of the stove in such manner that it was warmed between the stove and the casing. With slides covering the openings into the room at the bottom of casing and with the dampers in the pipe supplying fresh air, it was possible to regulate the temperature of the room to a nicety, for if the room got too warm, by closing the slides at the bottom of casing and opening the damper in the fresh air pipe the temperature could be lowered very rapidly, or if the room got too cold, by closing the dampers and opening the slides the temperature could be raised very quickly. Many modifications of the above arrangements were brought into use, and in the majority of cases were found to be satisfactory. Having adopted the casing around a stove, placed in the room to be warmed, it was but a short step to place a stove with this casing in the space adjoining the room to be warmed or below it. Thus by degrees the hot air furnace became a reality. An ordinary stove with casing was placed in the basement, and as it was found to be satisfactory for the heating of one room, it gradually came into use for the purpose of heating a number of rooms. As a result, the small stove gave place to a larger one and the large stove to the furnace, which is really nothing more than a stove specially designed for the work which it has to do.

The principal benefits to be derived from the use of a hot air furnace are the doing away with a number of fires placed in stoves for one large fire, with a consequent reduction in attendance, and the bringing of fresh air into the house, which provision is always made in the erection of a furnace. If the furnace is of ample size and the fresh air opening left open, a house warmed by the means of a hot air furnace will be reasonably well ventilated. The air in a house heated by a hot air furnace may be very impure, not because the house is so heated, but because the apparatus is improperly managed or is defective. If the occupant objects to burning the necessary fuel, closes the fresh air inlets and draws the furnace supply of air from the house, he cannot expect very pure air. He is simply making his heating system correspond to a stove in his room without a supply of fresh air. The air of the house is carried through the furnace over and over again. When it becomes cold it drops to the floor and from the floor is carried through the furnace, where it is warmed and again discharged to the different rooms to be warmed.

The principal point to be observed in setting up a hot air furnace in a house is to put in a furnace of large size—the larger the better. A large furnace will be more economical than a small one; even an excessively large furnace will not burn any more fuel than a small one. If a small furnace is put in it will be possible to keep the house warm in mild weather by ordinary fires, but in cold weather the furnace will have to be driven beyond its capacity. This driving of the furnace means that it becomes over-heated and possibly red hot, and the air passing over it is heated to a temperature far too high. If air is heated much beyond 140° F., it is positively not in a proper condition for breathing. All its vitality has been abstracted, and it is so dry as to absorb moisture from any and every substance in the house, thus causing the woodwork to shrink to an extent which one would not think possible, besides abstracting moisture from the occupants of the house to their serious injury.

Having arranged to put in a large furnace, in what portion of the house should it be placed to give the greatest satisfaction? In this climate where the prevailing winds are from the north-west, the furnace should be placed towards that side of the house. If it is not so placed it will be found very difficult to get any warm air into the rooms which lie north-west of the furnace, the warm air going almost entirely to the rooms on the opposite side. The furnace should not be placed too far from the centre of the rooms to be warmed, as it is possible to go to the opposite extreme and find that the rooms to the south-west of the furnace cannot be heated, because the air has to be carried through too great a length of horizontal pipe. At times we have very cold east winds, which makes it difficult to warm rooms with an easterly exposure, and if the furnace is placed too far from these rooms it will be impossible to heat them under such conditions. A hot air furnace requires for its satisfactory working that there should be some means of withdrawing air from the house. In the ordinary house a very large amount of air escapes by means of cracks and crevices around windows and doors, about the base boards, and also to some extent through the walls. The best way to arrange for the discharge of impure air is by the means of a fire-place which will withdraw the cold air from the floor, which is the proper point at which ventilation should be sought in a furnace heated house. Those fire-places which have flues in inside walls will nearly always be found to be withdrawing air from the room in which they are placed. A fire-place with a flue in the outside wall cannot be depended upon to withdraw air except a fire is burning therein. For a compactly built house of ordinary size, a hot air furnace is a very satisfactory means of warming, provided it is of ample size and there is a proper number of fire-places in the house. Of course it is to be understood that the furnace, hot air pipes, ducts, etc., have been put in by a man who thoroughly understands hot air heating.

The hot air furnace has been modified to some extent by the addition of hot water or steam heating in combination. This was first brought about by hot air furnaces being placed in houses having rooms so situated that it was impossible to heat them from the furnace. It occurred to some one that if a coil of pipe were placed within the fire pot of the furnace and connected to several radiators placed in those rooms which could not be heated by hot air, the difficulty would be solved. This arrangement was adopted in its crude form, but was not considered satisfactory by those who understood its drawbacks. The principal and most serious objection was that two openings had to be cut in the furnace which could not be closed tightly and which consequently allowed the gases of combustion to escape from the fire pot into the space surrounding the furnace and from that space into the house. It was also necessary to put on considerable amount of radiating surface, for if such was not done and the furnace was fired hard, trouble was almost sure to arise through the over-heating of the water in the coil and pipes. The idea was taken up, but instead of having a hot air furnace with combination hot water heating, a hot air and steam combination furnace resulted. This furnace was made of wrought iron with a steam generating chamber at the top of furnace. The air was warmed in the usual way by being passed over the outside surfaces of the furnace, and the steam was generated in the chamber above the furnace by passing the hot gases through vertical tubes as in a vertical steam boiler before allowing them to escape into the main flue. The central rooms were heated by hot air, and the rooms at a distance on the exposed sides of the house by radiators, which were supplied with steam from the chamber at the top of the furnace. This style of furnace is very satisfactory, provided it is properly put in and too much work is not expected of it. Lately a hot air and hot water combination boiler has been invented. It is really a hot water boiler, as it does nearly all the heating by means of hot water, the warm air being auxiliary to the hot water. The fresh air is made to pass around and over the boiler and is then allowed to escape into those portions of the house which are deemed to require plenty of fresh air. This form of boiler is not able to heat more air than is absolutely necessary to keep a house supplied with sufficient fresh air to maintain a reasonably healthy condition.

The next method of heating with which we will deal, is that of hot water as it has been practised for several years past. The boiler is placed in the basement, and flow and return pipes are run to radiators placed in the different rooms to be heated. The pressure on the system is that due to the head of water given by the height at which the expansion tank may be placed. The pressure at the tank, of course, will be that of the atmosphere. The pressure at the boiler may be 15 or 20 lbs., or even higher, in the case of a very high building. With this system it is practically impossible to get the water at any time much above 212 degrees, for if it should be heated higher than that it will change into steam at the expansion tank and blow off to the atmosphere, having its place taken by fresh cold water which will lower the atmosphere of that in the boiler and pipes very quickly. Some years ago nearly every radiator had its independent supply and return mains, or at the most there were not more than two or three radiators fed from the same main, and they were invariably placed at the same level, so that they would feed equally well. Of late years the tendency has been to place more radiators on