YOUR CHOICE OF HEATING SYSTEMS

THE CHOICE OF A HEATING SYSTEM FOR YOUR HOME: BY CHARLES HART NICHOLS, CONSULTING MECHANICAL ENGINEER

WHEN planning to build a house, it is advisable to have some idea of the advantages and disadvantages of the various systems of heating. For a system that gives satisfaction in one house often proves unsatisfactory in another, owing to different conditions. The size, location and exposure of the house and its various rooms, and the requirements of the occupants, are all determining factors.

When laying out a heating system, the amount of heat required must be figured after the kind of system has been determined; but in order that a better understanding of the different systems may be had, the conditions which govern the amount of heat required will be considered here first.

THE AMOUNT OF HEAT REQUIRED.

The amount of heat required in any room is exactly the amount which is being lost from that room, by radiation through windows and walls, and by leakage of air, either in or out, around the windows, through flues, opened doors, etc. A certain amount of leakage is essential for ventilation, and is also necessary to make hot-air heating systems operate.

The amount of heat lost by radiation depends upon the area of the windows; thickness of the glass, whether single or double sash; area of doors, whether solid or sash; area, thickness, material and construction of exposed walls; area, material and construction of exposed roofs, ceilings and floors; points of the compass, and difference in temperature of the air on both sides of the walls, floors, doors and windows.

The amount of heat lost by leakage depends upon the area of clearance around windows and doors, the size and height of fireplace flues, size and location of other openings, points of the compass, velocity of the wind, and location as regards proximity to other buildings, etc.

In other words, the amount of heat required depends upon the exposure, and not upon the volume of the room. It is desirable, therefore, that a house be built with heat-resisting material and methods of construction, as heat saved means less heat to be supplied, not once, but every day.

THREE MAIN HEATING SYSTEMS.

There are three main systems of heating—by means of hot air, steam and hot water. These can be combined or modified into several other systems, more or less distinct. In a hot air system the air may be heated in a furnace, direct from the fuel, or may be heated by passing over radiators or coils containing steam or hot water. The air may enter the room because of the tendency of heated air to rise—that is, by gravity; or it may be forced or drawn into the room by a fan. The air may be taken entirely from outdoors, or may be partly or entirely recirculated from the rooms being heated.

HEATING BY STEAM.

In a steam system, the steam may be circulated through the piping and radiators at approximately atmospheric pressure, or may be circulated at a pressure below or above atmosphere. When below atmosphere, it is called a vapor, a vacuum, or a vapor-vacuum system, and the radiators may be placed in the rooms (direct radiation), or they may be placed in the cellar, and connected by ducts so that fresh air may be heated and then conveyed to the rooms (indirect radiation); or they may be placed in the rooms and so arranged that air from outdoors may pass over them also and become heated (direct-indirect radiation).

THE HOT-WATER SYSTEM.

In a hot water system the water may flow by gravity or be forced through the piping by a pump. In either case the radiators may be placed as direct, indirect, or direct-indirect radiation, the same as with steam.

As before stated, a certain amount of fresh air for ventilation is necessary, and in most cases the leakage around windows and doors will be sufficient, with occasional opening of doors and windows. In a hot air system, either by means of a furnace or indirect steam or hot water radiation, ventilation in a large quantity is obtained, provided that the air already in the rooms can escape. A fireplace flue is the best means of obtaining this result, but loose or slightly opened windows will also do.
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Hot-Air System.

The gravity furnace hot air system has as the principal advantage, besides the ventilation, a low cost of installation, and as disadvantages, a greater cost of operation than with steam or hot water, and an uncertainty in the heating of rooms on the windward side of the house. The low cost of installation is due to the simplicity of the furnace and flues. The high cost of operation is due to the fact that enough heat must be supplied to raise the temperature of the fresh air used from that of outdoors to the temperature of the rooms, besides supplying enough additional heat to make up the losses from the rooms. This cost of operation will be lowered from 10 per cent. to 30 per cent., if part of the air delivered to the rooms is recirculated to the furnace at the room temperature, thereby saving the cost of heating that amount of outside air to the temperature of the room. This will, however, increase the cost of installation from 10 per cent. to 30 per cent.

The greatest disadvantage of this system is the uncertain heating due to the direction of the wind, which will blow into the rooms on the windward side and prevent the heated air from entering, while on the leeward side the wind will cause an excessive amount of the heated air to enter the rooms and pass out of the windows, before being cooled to the room temperature. This uneven heating can be partially overcome by the use of tight storm sash on the windward side, with the doors between the rooms open, so that the heated air, after being cooled, will pass through the windows of the rooms on the leeward side. On this account, it is better to locate the furnace near the windward side of the building, as the shorter lengths of the flues will favor these colder windward rooms.

Some Items of Expense.

A steam direct radiation system will cost about 25 per cent. more to install, and about 35 per cent. less to operate, than a hot air furnace system, and a hot water direct radiation system will cost about 30 per cent. more to install, and about 25 per cent. less to operate, than a steam direct radiation system, or about 65 per cent. more to install and 50 per cent. less to operate than a hot air furnace system. Both of these systems consist of radiators and pipes, but, as the temperature of the hot water is less than that of the steam, the radiators for hot water must be larger than for steam, and therefore the piping must also be larger. Separate supply and return pipes to the radiators are required for hot water, and are sometimes desirable for steam, but usually one pipe is used for both supply and return between the mains in the cellar and the radiators. The two-pipe system will increase the cost of installation about 5 per cent. over the cost of the one-pipe system, or about 30 per cent. more than a furnace system.

In a steam system the temperature of the water in the boiler must be raised to 212 degrees before the steam is formed and begins to circulate; whereas in a hot water system the water will begin to circulate after a small rise in temperature, and, as the temperature rises higher, will circulate faster. For this reason the cost of operation in mild weather is less with hot water than with steam, but there is no difference in the cost of operation in cold weather, when either system must be operated at practically full capacity. This also gives the advantage that, in mild weather, a small amount of heat may be obtained from hot water, but not from steam when at atmospheric pressure or above, as the steam, when condensed to water, is still at 212 degrees.

The Vapor Vacuum.

To overcome this disadvantage of the steam system, a vapor or vacuum system is used, which circulates the steam at less than atmospheric pressure. The advantage is a slightly lower temperature of steam and therefore less heat, when desired in mild weather, at a less cost of operation. The disadvantage is increased cost of installation, due to special valves and air exhausters, and larger radiators, due to the lower temperature of the steam, unless the system is designed to be operated at atmospheric or higher pressure instead of a lower than atmospheric pressure, during the extreme cold weather. The increase in the cost of installation will be about 10 per cent. more than the cost of an ordinary steam system, or about 40 per cent. more than for a hot air furnace system, and the cost of operation will be about 15 per cent. less than an ordinary steam system, or about 45 per cent. less than a hot air furnace system.

When outdoor air is allowed to pass over either steam or hot water indirect radiat-
ors, before entering the room, the advantage of ventilation is obtained, but at the disadvantage of increased cost of installation and operation. This system is usually installed for the principal rooms, in connection with direct radiation in the other parts of the house, when the amount of ventilation desired is not sufficient for a separate hot air furnace. Another disadvantage of the indirect system is the danger that, when the radiator valves are closed, or, with hot water, when the boiler fire is banked at night with the resultant slow circulation of the water, if the cold air is not shut off also, the water in the radiators may freeze. The increase in cost will be about 35 per cent. for installation, and about 85 per cent. for operation, over direct radiation, whether steam, hot water or vapor, when all the heating is done by indirect, and a proportional percentage when part of the heating is done by direct radiation. Indirect radiation is a good system, but not an economical one, except when used for only one or two rooms.

Direct-Indirect Radiators.

Direct-indirect radiators have the advantage that in mild weather some ventilation may be obtained with the radiator that is only large enough to heat the room in cold weather without ventilation. But this means an increase in cost of installation of about 4 per cent., and an increase in the cost of operation of about 50 per cent., over the costs of direct radiation, except when used as direct radiation only, in very cold weather, when there will be no increase in the cost of operation.

If radiators, either steam or hot water, are placed behind grills or registers, or under seats or window sills, the efficiency of the radiators will be reduced, and larger radiators must be used in order to obtain the same amount of heat. If all the radiators are concealed behind grills or registers, the increase in cost of installation will be about 20 per cent. If under sills or seats, but not enclosed by grills, it will be increased about 6 per cent. over the cost of radiators set exposed in the room in the usual way—and a proportional amount if only part of the radiators are concealed. The cost of operation will be the same as though the radiators were not concealed.

Position of Radiators.

The best position for radiators in the rooms is beneath the windows, which is the cold side of the rooms. Then the air, warmed by the radiators, will rise and mix with the air cooled by the windows, which will fall, the two making a mixture at approximately the temperature of the rooms. When it is not desirable to locate the radiators under the windows, on account of interference with long curtains, they should still be located on the exposed or cold side of the rooms, because of the loss of heat through the exposed walls and windows.

When the rooms are heated by hot air, from either a furnace or indirect radiators, the air should enter the rooms on the warm side, or farthest from the windows. A circulation will then be maintained by the warmed air rising from the registers, passing across the ceiling, and falling in front of the windows—some of it escaping through the windows, or through doors into adjoining rooms, and some of it passing across the floor to rise again by being mixed with the warmer entering air. The registers should not, however, be so placed that the entering air will escape through the fireplace flues before it has fallen past the cold windows, and given up its surplus heat.

Forced circulation of hot water, and forced ventilation, are not used in small or medium-sized houses, except where a number of houses are heated from one central plant, in which case forced circulation of hot water is frequently used instead of steam.

Automatic temperature control is sometimes used in house heating, as the operations necessary to maintain a given temperature, with the exception of putting coal on the fire, are automatically performed; but the cost of installation will be greatly increased, though the cost of operation will be slightly decreased. The boiler draft doors and dampers are sometimes automatically controlled by clock mechanism, so that the house may be warmed in the morning before the occupants arise.

Capacity of Boilers.

Boilers for both steam and hot water are usually rated by the number of square feet of direct radiation that the boilers are capable of supplying with steam at 218 degrees, or water at 180 degrees, when the temperature of the room is 70 degrees. This rated amount of radiation must include all piping as well as radiators, and should include also a small addition for inefficiency in the
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operation of the boiler. Allowance must also be made for the difference in efficiency between direct, indirect and direct-indirect radiation, and for all concealed radiators, etc., and for any other temperature of the steam, hot water, or the room. Additional allowance must be made if the boiler fire is to be used to supply domestic hot water, by the insertion of a water coil in the combustion chamber.

Most boilers are designed for large anthracite, the bigger boilers for egg size and the smaller boilers for stove size. There are also some boilers made for pea anthracite and for burning bituminous coal without smoke. The boilers for large coal are designed to hold enough to last seven or eight hours, with a thickness of coal of about 15 or 16 inches. If small coal is used, a smaller quantity only can be put in at one time, requiring more frequent firing, or a magazine holding eight hours' supply, which will feed the coal gradually to the fire bed, either automatically or by hand. The disadvantage of a magazine boiler for pea coal is that either the coal must be lifted to a magazine above the combustion chamber, to feed to the fire by gravity, or the coal must be pushed up into the fire from below by the attendant, at frequent intervals. The advantage of a boiler burning pea coal over a boiler burning stove or egg coal is the lower cost of the pea size, the amount of coal consumed being the same in both cases. Pea coal may be used in boilers without magazines if the proper grates have been provided, but the coal must be more frequently fired, and the bed of coal must be of less thickness, to permit sufficient air to pass through the coal for its combustion. Pea size cannot well be burned on a grate designed for large coal, on account of the wider spaces between the grate bars. In any boiler or furnace, the coal should never be above the bottom of the firing door, as a thicker bed of coal will prevent the air from passing through—in which case the boiler will not generate as much heat as when a smaller amount of coal is fired at one time, and fired more frequently.

It is economy to have all piping and hot air ducts in the cellar covered with a non-conducting covering, unless a warmed cellar is desired, as all heat thus saved means a corresponding saving of coal.

The percentages of increase or decrease in costs here given are approximate only, as prices will always vary with different houses, locations and contractors. It is always better to have the heating system designed by an engineer, who will figure all sizes of radiators, pipes and boiler, based upon the amount of heat lost, figured from the sizes of the exposed windows, walls, etc., so that all contractors will estimate upon the same basis. If this is not done, one contractor may estimate upon an installation larger than necessary, to be sure of the results in heating, and another may estimate upon an installation smaller than necessary, to be sure of getting the contract.


Name of Post-office address.

Editor, Gustav Stickley, Morris Plains, N. J.

Mng. Editor, Mary Fanton Roberts, 6 East 39th St., New York City.

Business Manager, Gustav Stickley, Morris Plains, N. J.

Publisher, Craftsman Publishing Co., 6 East 39th St., New York City.

Owner, Craftsman Publishing Co., 6 East 39th St., New York City.

Names and addresses of stockholders holding 1% or more of total amount of stock:

Gustav Stickley, The Craftsman, Inc. . . . . . . 6 East 39th St., New York City.

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Known bondholders, mortgagees and other security holders, holding 1% or more of total amount of bonds, mortgages or other securities: NONE.

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Sworn to and subscribed before me this 19th day of March, 1915.

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(Seal)

Notary Public, No. 69, New York County.
My commission expires March 30th, 1916.