SIX KINDS OF STEAM HEAT

or, six ways to recapture the residential heating market*

TRADE DISCUSSIONS on the subject of steam heat are commonly characterized by considerable confusion—for three principal reasons.

First, there are so many different ways in which steam may be used to heat buildings that people—even contractors who make a living selling and installing steam heat—are prone to get mixed up; second, the growth of numerous proprietary systems or steam heating devices and specialties is continually bringing new terms into the industry and giving old terms new shades of meaning; and finally, many contractors still judge steam heat on the basis of information which is out-of-date.

For instance, many objections to steam heating are connected with systems no longer being installed—or old systems which have since been improved and perfected. Yet people do not scorn the Ford automobile because the old Model T had to be cranked with the front wheel against a curbstone! When faced with such generalized adverse criticism of steam heating, it is always well to ask: "Do you mean *modern* steam heat, or do you mean *Model T* steam heating systems?"

For another illustration, consider the terms "vapor" and "vacuum." According to commonly accepted terminology, a vapor heating system is a steam system operating at low pressure or at negative pressure—at a vacuum. Yet a vacuum system is the same thing! In fact, if someone mentions "vacuum system" you have to investigate what he means before knowing whether he's referring to a one-pipe steam system with vacuum air valves, or a two pipe vapor steam system with a vacuum pump.

WHAT "VAPOR" MEANS

The facts are that vapor, as used in connection with steam heating, simply means steam at very low pressures, usually ranging from two to six ounces positive pressure down to 10 to 25 inches of negative pressure or vacuum. (The term vacuum simply means pressure below atmospheric, and is measured in inches of mercury instead of pounds per square inch.)

Practically all residential steam heating systems today are vapor systems in which low pressures are maintained and in which vacuum is not created mechanically by a pump or other vacuum producer, but automatically, through—or as a by-product of—the condensation of steam in a closed system.

LIMITING THE SUBJECT

In this article, we hope to present a comparative picture, and a brief but clear picture, of the six ways in which steam can be used for heating low-cost and medium cost residences, in order to help eliminate some of the confusion surrounding this important subject.

But first let us narrow the subject.

All heating consists of three basic elements:

(*a*) *COMBUSTION transforms fuel into a form of heat energy capable of being distributed to a point of use—the form being steam, hot water, or hot air;*

(*b*) *DISTRIBUTION of the heat from point of generation to point of use;*

(*c*) *TRANSFER of the heat from a "delivery platform" (radiator or register) to the objects to be heated.*

In this article we are not concerned with combustion—the type of boiler, the nature of the controls, nor the kind of automatic firing device, if any. Neither are we concerned with whether standing radiation, or convectors, or radiant panels, or registers, or unit heaters are the delivery agents. All we care about is *moving* the heat, because that is what distinguishes the six kinds of steam heat from one another.

STEAM'S EXCLUSIVE POINTS

Obviously, we are not concerned here with the movement of hot water or hot air heat.

There are, however, certain characteristics involved in moving steam heat which can only be considered in contrast with the methods involved in moving hot air or hot water. For instance, steam is the only modern form of heat which requires no artificial circulating mechanism. Of course, there are gravity water and gravity air, but neither supplies either the comfort or the economy to be called "modern heating" when used with modern automatic firing devices. That gives steam one big ad-

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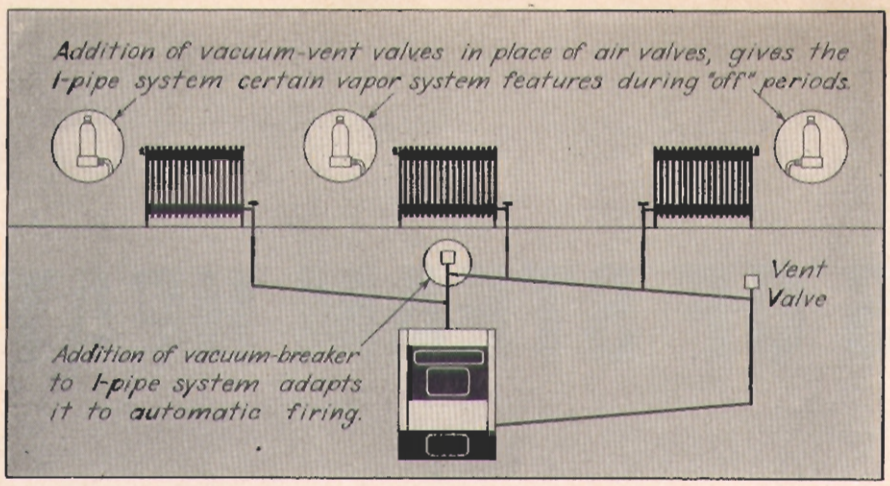
* *In addition to the various forms of hot water heating, which will be described in a later issue.—Ed.*

THE ONE-PIPE STEAM SYSTEM



vantage over other heating methods—operating economy.

Steam heating systems may be generally classified by pressure: there are high pressure and low pressure systems. High pressure steam (over 15 pounds pressure) is necessary in ships, for instance, where 35 pounds pressure is generally used to assure distribution of heat regardless of the motion of the ships. But in the building field, on land, virtually all steam heating is by low pressure steam (under 15 pounds pressure). If steam from a high pressure source is used, it is first reduced to low pressure before entering the heating system. Therefore all that concerns us here is low pressure steam.

There is no reason for using high pressure steam in heating buildings. Low pressure reduces insurance costs, simplifies heating plant operation, makes skilled and licensed operators unnecessary, avoids high temperature surfaces, and assures maximum safety.

It is common knowledge among engineers that the higher the temperature and pressure the greater the strain on any physical material and therefore the greater the likelihood of failure and the shorter the life. For anything that must be as long-lived as a heating system, the advantage of low pressures is obvious.

Other advantages of steam center around the fact that it is the lightest heating medium known. Although hot water has lately been making some advances in the high building field, steam is almost exclusively used for that type of structure. In high buildings, of course, hot air is out of the question because of the difficulties involved in moving hot air for long distances, and the weight and bulk of the ducts. Hot water doesn't require space-consuming ducts *as does hot air*, but the weight of the water is a serious structural factor. Steam, on the other hand, weighs virtually nothing and losses in pressure through friction are comparatively small.

More significant for the small home owner or builder is the fact that modern steam may be kept at low temperatures and low absolute pressures and still efficiently heat the building—factors which add to personal comfort and at the same time stretch the life of the heating system.

And last, but not least, one-pipe steam (all three types as described below) is widely considered to be the best competitive tool for radiator heating contractors to use in outselling hot air jobs, where price is the first factor. One-pipe steam is the lowest-cost method of heating a house in the "wet heat" catalog. Good materials, of course, are essential.

JOINT ADVANTAGES OF ALL RADIATOR HEAT

But the characteristics of steam heating systems which are *shared* with hot water heating systems, and which contrast favorably with the characteristics of *hot air* heating, are probably most important of all from the consumer's standpoint. Some of these* are sustained heat, even heat, bathroom comfort, no drafts, safety from the fire standpoint, possibility of heating detached garages economically, no recirculation of disease germs, livable window areas, heat and hot water from one fire, long life, increased loan value of the building, lower maintenance costs, less noise, fewer odors, radiant heat may be combined with convected heat, comfort not affected by outside wind conditions—and many others.

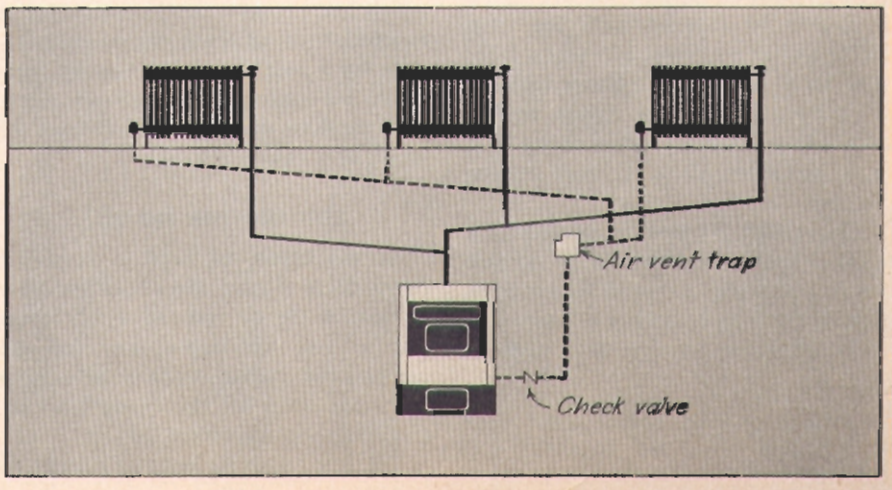
NOTE: In addition to the steam heating systems generally described below, there are others which are now either seldom used or outmoded. These include the one-pipe air line system—in which the vented air is returned to the basement through a separate small air tube, with or without a vacuum pump at the end of it; the gravity two-pipe air-vent system; the two-pipe open system which, for residential heating particularly, is no longer considered practical from the viewpoint of operating economy and personal comfort. Also, though most steam systems may be either up-feed or down-feed, no mention is made of the latter in order to simplify this presentation.—Ed.

ONE-PIPE STEAM

The one-pipe steam system is the most widely used and lowest cost steam heating system, and probably requires little explanation here. As its name indicates, there is one pipe circuit, and one service to each radiator, this pipe serving both for the flow of steam from the boiler

** All the advantages of radiator heating over hot air heating have been summed up in a PLUMBING & HEATING BUSINESS reprint entitled "40 Points for Home Comfort," copies of which are still available to contractors for consumer distribution, at 3¢ per copy paid in advance, at the office of this publication.—Ed.*

THE BASIC TWO-PIPE VAPOR SYSTEM



into the radiator and for the return of water from the radiator back to the boiler.

Air, which is always present inside radiators and piping (just as it is always present outside them) is pushed out of each radiator through an air valve by the pressure of steam coming into the radiator. In the one-pipe system, it is necessary to connect the piping at the bottom of the radiator, so that the water (condensate) in it may drain out. It is also necessary to use rather large-size supply valves and piping, since flow must occur in two directions—steam forward and condensate back.

The air valve, distinguishing mark of the one-pipe steam system, is a device which contains a thermostatic mechanism of some sort, the designed purpose of which is to close the valve's vent port when all air has been exhausted from the radiator. Then the steam warms the radiator and the radiator's radiant and convected heat warm the room. The air valve also contains a float, the function of which is to close the valve and prevent water spillage if conditions arise causing water to accumulate in the radiator from condensation.

In a large proportion of air valves sold today, the venting ports may be adjusted according to the distance of the radiator from the boiler—larger ports being provided for the more distant radiators, and smaller ports for the nearer ones, in order to balance the system by eliminating all air from all points at approximately the same time. It is claimed that this avoids uneven heating and "cold rooms," formerly a disadvantage of one-pipe steam. Today the satisfactory performance of one-pipe steam systems it substantially improved through this improvement in venting valves, both air and vacuum types.

ADVANTAGES

The advantage of the one-pipe steam system is, above all, low first cost. It is the most elementary form of radiator heating. One other advantage is that knowledge of the installation method is very widespread, so that a reasonably good installation may be obtained often without special design and drawings.

DISADVANTAGES

The main disadvantage of the one-pipe steam system is the difficulty of controlling it. In general, the system has only two speeds: full on and full off. Other minor disadvantages are the tendency of air valves to clog up, and (for sensitive persons) the slight noise and smell of air vented from the radiators.

Often residents will try to modulate the heat output of a radiator by partially shutting off the supply valve; or will fail to shut the valve tightly. At such times steam enters the radiator through a relatively constricted opening at a velocity much greater than usual. This prevents the condensate from flowing back and soon the radiator fills with water. Water-hammer results. When the radiator is turned on again, there is difficulty in re-establishing proper circulation temporarily. The gathering of water in the radiators under such conditions diminishes the amount of water in the boiler, thus interfering with the efficiency of its operation.

A disadvantage of the adjustable ports on some air valves is that the range of possible orifices is limited because the float — or thermostat-operated valve within the air valve—is itself an orifice. This limits the upward range of useful orifice settings.

TRADE NAMES

There are no trade names by which the one-pipe steam system is known, though it is sometimes referred to according to the make of air valves used.

RANGE OF UTILITY

Wherever cost is the controlling factor, one-pipe steam is used for a wide range of purposes, from the smallest residences to multi-storied apartment houses.

ONE-PIPE VAPOR

By simply installing vacuum air valves on the radiators of a one-pipe gravity steam system, the characteristics of the system are changed and during the "off" periods it acquires some of the characteristics of a two-pipe vapor system (see below).

Ordinary air valves close against steam and water, but when the cooling steam condenses and the radiators grow colder, the valves reopen and admit atmospheric air. Vacuum valves, on the other hand, are so designed that after the air is expelled from the system, the valves shut tight and do not reopen until ordinary system leaks or excessive pressure at the boiler break the vacuum and bring the system back to atmospheric pressure.

The existence of the vacuum within the system permits the generation of steam at relatively low temperatures, and this steam or "vapor" circulates throughout the system. Use of vacuum valves requires a tight piping installation, and therefore is favored by the FHA.

ADVANTAGES

Advantages of this system, in comparison with one-pipe steam systems, are that it permits longer intervals between firing, enables the radiator to hold heat longer and at lower temperatures, and is reported to save fuel.

DISADVANTAGES

In general, though in a lesser degree, the same as for one-pipe steam. Trouble has been experienced in obtaining distribution of steam when vacuum air valves are used in automatically fired systems (see explanation below, under "One-Pipe Intermittent Vapor.")

TRADE NAMES

Same as for one-pipe steam.

RANGE OF UTILITY

Same as for one-pipe steam.

ONE-PIPE INTERMITTENT VAPOR

This system consists of a one-pipe installation with vacuum air valves (see

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above), plus an additional valve on the main line especially designed to "break the vacuum" at a predetermined point.

When the one-pipe vapor system, described above, is operating, the water in the boiler gives off vapors which are drawn into the various radiators in proportion to their rate of cooling—the radiator giving off most heat will condense most steam and the resulting vacuum tends to draw up an adequate supply of steam from the boiler. In this way, heat continues to be evenly distributed even though the variable venting feature of the air valve is not being used.

With a coal fire this could go on indefinitely. With automatic firing by gas or oil, however, there are intensive "on" periods followed by a total absence of fire in the boiler. When the thermostat calls for heat, steam is generated in large quantities for distribution to the radiators. Obviously, if the system is under vacuum, the air valves are not venting and therefore uniform distribution of steam to all radiators cannot be secured.

The intermittent vapor system gets around that obstacle with its electrical or mechanical valve situated near the boiler. One valve of this type is a solenoid valve, actuated by the thermostat. As soon as the thermostat calls for heat, the vacuum is broken, and the heating-up cycle starts.

The other type is a mechanical vacuum breaker set for about 11 inches of vacuum. When condensing steam and cooling radiators raise the vacuum within the closed system beyond that setting, the relief side of this dual-purpose valve opens and prevents the forming of a greater vacuum. As the vacuum within the system decreases below this setting, either through system leakage or the commencement of a firing cycle, the valve remains closed until the vacuum side adjustment is met, at which time the valve opens and returns the system to atmospheric pressure. Thereafter, the system being at atmospheric pressure, steam will be distributed uniformly to all radiators.

ADVANTAGES

Same as for one-pipe steam. Also this system offers a correction of one drawback of automatically-fired vapor installation, as described above.

DISADVANTAGES

The very advantage of the vacuum-breaking feature contains one disadvantage. It accentuates the familiar disadvantage of oil-burner firing whereby heat is delivered in great quantities for short periods, followed by long "off" periods.

TRADE NAMES

Vent-Vac System.
Bal-Vac System.

RANGE OF UTILITY

Same as for one-pipe steam.

THE 2-PIPE VAPOR SYSTEMS

NOTE: The following three systems all employ roughly the same style of piping for delivery of steam to radiators, and the three are distinguished from each other by their various methods of returning condensed steam (water) from the radiators to the boiler and of exhausting air from the radiators to the atmosphere.

At the supply connection to the radiators on each of these systems, an orifice can be installed if required to assure proper distribution of steam. This orifice may be a plug, sleeve, cone or plate with an opening properly sized, allowing for the heat requirements of each radiator and for the pressure drop in the supply line.

Some orifice valves are so situated as to permit the steam to enter at the top of the radiator instead of the bottom, so that by venturi action the new steam is mixed with the air-steam mixture within the radiator, and thus gives the radiator a uniform, moderate heat—or in any case a heat which is not stratified at the top of the radiator.

However, some of these systems are installed without orifice valves, with the result that a predetermined distribution of steam is not attained.

TWO-PIPE VAPOR

In the basic two-pipe vapor system, steam from the boiler flows upward through inclined mains and risers to the radiators. A small amount of steam condenses in the mains and risers, and so the pipes must be of sufficient size to permit its return to the boiler by gravity flow.

Two factors limit the flow of steam: (1) the pressure difference between the supply pipe and the radiator; (2) the size of the orifice opening.

At each radiator, air and water of condensation are discharged through a thermostatic trap containing a diaphragm or bellows. This diaphragm or bellows is charged in such a manner as to close against the flow of steam while permitting air and water of condensation to pass into the return line. The return piping runs alongside the supply piping back to the boiler.

The lowest point of the return main must be at sufficient elevation to allow a head of water to build up to overcome the pressure drop from the supply header to the return piping—so that water may be returned to the boiler by gravity flow.

Somewhere in the vicinity of the boiler, the return piping passes through a vent trap—which permits the air to escape to the atmosphere. And then the piping passes through a check valve—which simply prevents the flow of water back from the boiler into the return line.

ADVANTAGES

The advantages of this simple gravity system are perfect flexibility of circulation, low first cost and low maintenance cost due to simplicity of the apparatus.

DISADVANTAGES

Disadvantages are that the system must be operated at very low pressure to permit proper steam circulation and continuous return of condensate to the boiler. There must be available ample head room to permit proper grading of both supply and return piping. It is important that a workmanlike job be done in grading and hanging the piping, so that settlement of the house or slight pressure variations will not affect the operation of the system.

TRADE NAMES

Hoffman Two-Pipe Vapor System (Hoffman Specialty Co.)
Webster Vapor-Steam Heating System (Type V)
And others.

RANGE OF UTILITY

For smaller buildings having 1,000 square feet or less of installed EDR.

TWO-PIPE VAPOR WITH RETURN TRAP

The gravity system with return trap is an elaboration of the simple gravity system described immediately above. It includes an automatic device which will assure the return of water to the boiler regardless of pressure fluctuations.

Steam is supplied to this type of system through steam mains which are usually graded in the same direction as the flow of steam. The mains are dripped through steam traps to an overhead dry return. In this way, the water and air are taken back to the mechanical equipment for elimination of air from the system and the return of water to the boiler.

The automatic mechanism for the return of boiler water consists of a combination of boiler return trap and vent trap (with vent valve), plus two check valves, and the necessary connecting piping. The water of condensation and air from the radiators and piping flow back to the boiler return trap and vent trap, where the air is vented to the atmosphere through an air check valve. As a head of water builds up in the return piping, it also builds up in the boiler return trap, raising a float. At a certain point, the float opens a valve in the steam line from the boiler header to which it is connected, and thereupon the steam pressure in the boiler equalizes with the pressure on top of the water in the return trap. Therefore the head of water is forced back into the boiler through a check valve. At this operation the float lowers, closing the steam valve, and opening the air valve connecting with the dry return.

ADVANTAGES

The advantages of this system are its positive operation, its ability to regulate and vary heat output and room temperatures, and its complete safety from low water, plus the advantages of the basic two-pipe vapor system.

DISADVANTAGES

The cost of the boiler return trap, and the additional piping (and maintenance, which is very little), are the main disadvantages. Some small amount of additional basement space is required by the additional equipment, and occasionally there is some objection to the slight sound of the trap's operation.

TRADE NAMES

Sarco Vapor System.
Webster Type R System of Steam Heating.
Illinois Thermo-Modulating System.
Dunham Vapor System.
Hoffman Vapor Heating System with B.R.T.
And others.

RANGE OF UTILITY

While this type of system can be applied to any buildings requiring up to 16,000 square feet, it is generally applied to residences and commercial heating systems.

TWO-PIPE RETURN PUMP VAPOR SYSTEM

In this system, steam is supplied as in the system described immediately above.

Another name for the two-pipe return pump vapor system is "gravity steam system with condensation pump." It is a particularly useful system where it is not possible to arrange the boiler and other units of an installation so that gravity can be employed for the return of water to the boiler. It offers a mechanical means of returning condensate to the boiler.

This system is the same as the two-pipe vapor system, except that the return lines empty into a tank vented to the atmosphere through a non-return vent, from which it is then pumped to the boiler by a motor-driven condensation pump. It simply overcomes the gravity situation by pumping the condensate from a tank or a pit up to the boiler.

ADVANTAGES

Advantage of the return pump system is the positive return of water to the boiler, plus the other advantages of two-pipe vapor heating systems.

DISADVANTAGES

(1) Initial cost of the condensate pump, as well as the maintenance cost and the cost of current to run the pump; (2) sometimes the need for a pump pit; (3) the need for a regular attendant or other adequate protection (automatic water feeder) against low water in the boiler in case of pump failure.

TRADE NAMES

Trane Vapor System with Condensation Pump.
Hoffman Vapor System with Hoffman-Economy Condensation Pump.
Sarco Vapor System.
Illinois Thermo-Modulating System (Condensation Pump Type).
Webster Type PR System of Steam Heating.
And others.

RANGE OF UTILITY

This system can be applied to any type or size of building where a pump may be located in a spot to receive all condensate by gravity flow.

In addition to these six methods of steam heating, there are others, such as vacuum systems, sub-atmospheric steam systems, etc. These, however, are not described here because they are seldom if ever installed in residences—that is, seldom used in residences other than the museum or palace type.
