Controlled Air Venting

of one-pipe steam systems

By A. F. H. SCOTT

IT is often stated that very little practical information on venting air from one pipe steam heating units is available for the guidance of heating contractors and automatic heating dealers. This is all the more surprising because the efficiency of such heating units is directly proportional to the accuracy with which vent valve equipment can be adjusted so that all radiators, convectors or unit heaters, regardless of their distance from the boiler or of their size, shall heat up at the same rate and time.

However, through our technical research and continuous study of the basic problem, a complete and no-technical understanding can now be presented here to those heating contractors who seek practical information on controlled venting.

For instance, it has been found that air bound radiators may lose up to 50 per cent or more of their heating effectiveness. The condition of air bound radiators may be caused by air valves that either close prematurely, i.e., at too low a temperature, or that require too great a temperature drop to open them and thereby resume venting, or that vent TOO fast, allowing the radiator to become water-logged and the valve to close by flotation of the thermostatic float when water of condensation is presented within.

A thermostatic float is charged with a heat sensitive liquid which changes to a gas when heated by steam temperature and expands creating an internal pressure inside the float, thereby causing a flexible diaphragm to expand with snap action, thus raising the valve pin to its seat which closes against steam and water.

The heat sensitive fluid used has a pressure-temperature curve that will parallel the pressure-temperature curve to steam (see Hoffman Data Book page 293) so that the increase in internal pressure within the float will be the same as the increase in steam pressure for each degree of temperature added to it.

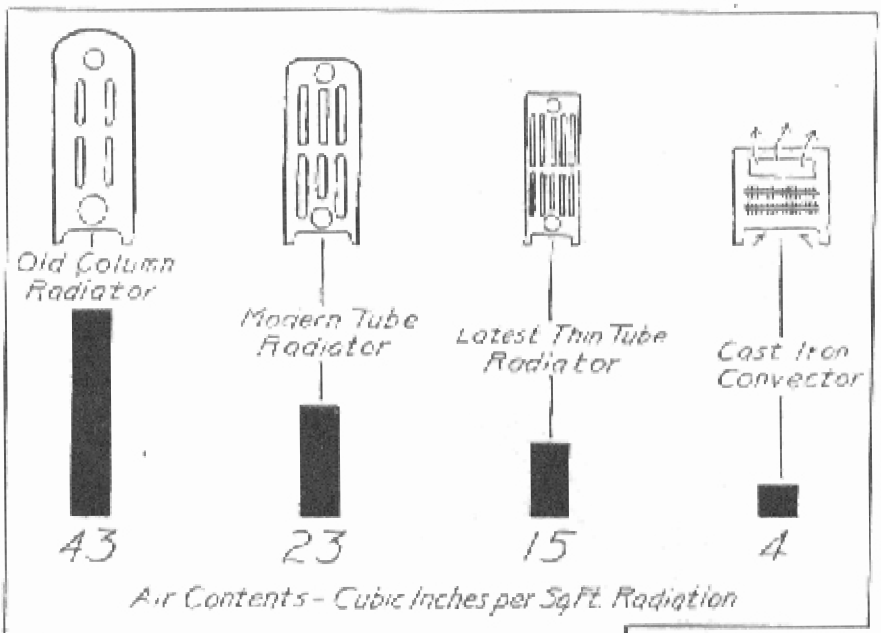
Thus vent valves were devised because air, steam and water will not mix. Consequently, the air must be expelled yet the steam heating unit must be closed against and hold the steam and water inside to provide the desired heating comfort and economical operation of the system.

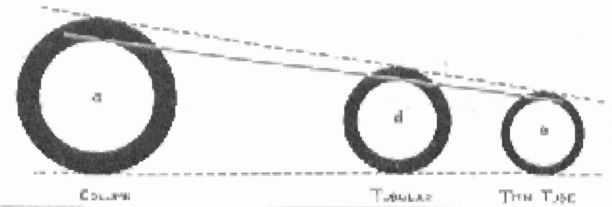
Accordingly, each radiator, in a single pipe system, must be provided with a vent valve and in addition the end of each steam main should be provided with a main vent valve. This vent valve at the end of the main should have a considerably larger venting capacity than the air vents used on the individual radiator. A properly functioning main vent at this point means that in the shortest possible time the mains will be full of steam and distribution to the radiators can be more easily balanced.

Now a word about fast venting and a caution about **extremely** fast venting. There is a wide difference between venting air from a radiator at an **extremely** fast rate and completely heating a radiator in the shortest length of time by venting at the proper rate.

Many important factors must be considered in order to accomplish this most desirable result of complete heating up in shortest length of time such as:

(a) weight of radiator
(b) amount of air contained in the radiator
(c) size of the supply valve
(d) rate at which air is vented





Left: Inside areas of circle represent air capacities; wall thicknesses show relative weights

(e) velocity of steam entering the radiator

(f) the type, the internal construction, and length of the radiator itself

With these details in mind, next consider the prime source of heating—the boiler. In the days of hand-fired coal systems, a considerable pressure in the boiler was available. However, the advent of automatic heating with oil or gas-fired boilers, operated intermittently by thermostat control, brought with it belief in the necessity of quicker venting as compared with the air valves used on coal-fired installations, as well as in controlled venting of air in the system.

Quicker venting was thought desirable because of the relatively low pressures of an ounce or two generated on each ON cycle of the oil burner, which may be attributed to various causes like improper adjustment, too small an oil nozzle or gas-control valve, or improper type or size of burner. Obviously controlled air venting was considered paramount in order to insure even distribution of steam to each radiator or steam heating unit regardless of its location or distance from the boiler. Even though fast venting may appear desirable, improved burner-boiler efficiency will always continue to pay the owner dividends in fuel saving as well as in heating comfort.

In line with "taking care" of this desire for quicker-venting situation, some air valve manufacturers began competing with each other to make the fastest venting air valves possible without due regard to other troubles that might result when attempting to correct ONE stated condition due to the very low steam pressures above referred to. Obviously but little trouble will be encountered by water-logging of a radiator at the extremely low vapor pressures due to the absence of high velocity steam entering the radiator but at slightly higher steam pressures, say from 3 ounces up to 8 ounces, the critical velocity point will be passed and water-logging and accompanying rumbling will occur in the customary long section low type radiators in use today, on the ON or heating up period.

When the modern slenderized type of thin tube radiation is used, more trouble is likely to be encountered due to the small amount of air volume which they contain, and the further fact that these thin tube sections are connected with only 1" nipples instead of the usual 1½" nipples used in the standard tubular type of radiator.

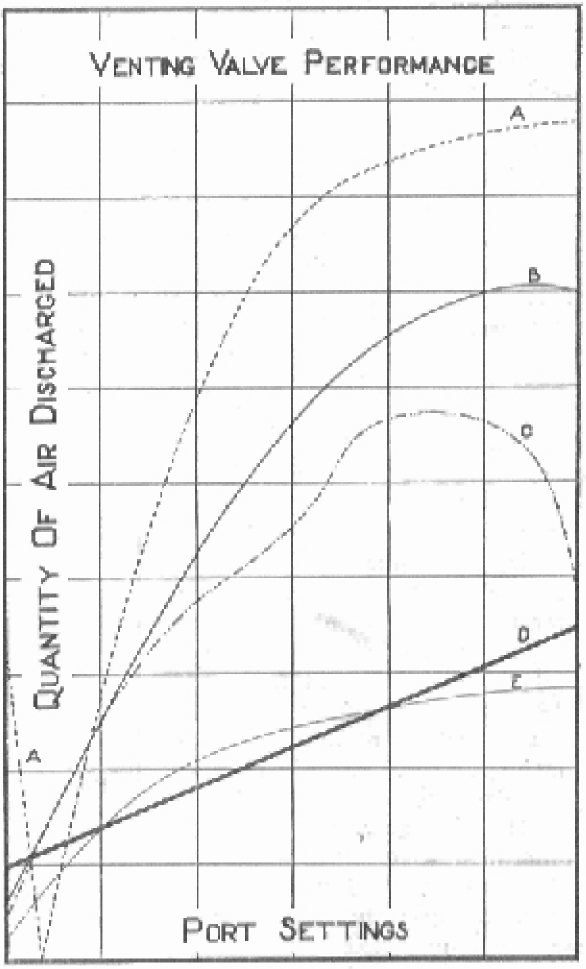
Since automatic heating operates intermittently, naturally the radiator cools down during the OFF period which, if prolonged, means cooling down to room temperature. Now when the thermostat calls for heat and the next ON period cycle begins, the metal in the radiator or other steam heating unit must be raised from room to steam temperature.

Thus while some air valve manufacturers have been busy designing and building air valves to vent MORE rapidly—that is **extremely** FAST—the radiator manufacturers, by the same token, have gone modern and are designing and building radiators that contain LESS air volume. Accordingly, we must consider seriously these recent design trends as they may be most illuminating in establishing more practical information for you on this vital subject of controlled venting. Since it is obviously much more important to vent the different radiators in the system at their proper relative speeds than to actually vent each individual radiator as **extremely** FAST as possible, the venting rate of the different radiators should be such that they ALL HEAT UP AT THE SAME TIME regardless of their size or distance from the boiler. In order to control this change in the rate of venting, radiator valves are equipped with an adjustment. The radiator far removed from the boiler should have its valve adjusted to a larger opening or port size than the one which is close to the boiler. Similarly, a smaller radiator should be equipped with an air vent valve with a smaller port adjustment than is used on a larger capacity radiator.

Reference to the chart (Figure 1) will be of interest. These curves are based on actual test results of different air vent valves, all of which had some means of adjusting for the rate of venting or air discharge. All of the curves, except D, show that the entire adjustment of the various valves is not used. Curve A is at one-half of its discharge rate at approximately ¼ of the setting between the

FIGURE 1

Venting rates of five adjustable venting valves at different port settings, from actual tests of the valves



smallest and the largest port. Curves B & C are about the same, while the performance on curve E is not at all desirable. Curve D alone has a venting capacity proportional to its setting and although its maximum capacity is not by any means the highest as shown on the chart, it will, without question, result in a better

Many conditions govern proper air venting

balanced single pipe steam system provided, of course, it is used in connection with end of main vents of proper capacity. Curve A is of particular interest inasmuch as it shows that the smallest setting permits initially of a considerable discharge of air, then as the setting is moved slightly towards the largest, the valve seals off entirely and then opens and continues from there on up to its maximum venting capacity.

This comparative study of open vent capacities with adjustable settings leads one to the conclusion that **extreme** FAST venting is NOT necessary and in fact is unwise due to the inevitable water-logging of the radiator and the attendant noise of the rumbling that follows quite apart from the difficulties entailed from balancing the system.

Here is yet another approach to a better understanding of the importance of controlled venting. For sometime past, the ASH & VE has made a very thorough study of the critical velocities of steam flowing in mains, in risers, and in radiator branches and new tables published in the 1941 Guide show considerable reduction in such velocities which now guides all of us to figure lower velocities of steam entering the radiator, thereby facilitating better drainage of the condensate. The supply of steam, being limited, it is useless to increase the venting rate possibilities of the air exit. Such advanced thinking further supports similar conclusions discussed.

For instance, these newest velocities of steam are specified on the basis of the amount of radiation after the iron of the radiator is heated up to a steam temperature. However, during the heating up period—that is as steam enters the cold radiator—the velocity of steam will greatly exceed the above mentioned new table specifications and condensate will be retained in the radiator due to its inability to flow out against this initial high velocity.

After a study of all these additional factors, some interesting comparisons were obtained showing the difference in heating up effect for the three types of standard radiators, column, tubular and slenderized, when using an air valve or open vent with a venting rate capacity of 250 cubic inches per minute.

In order to assist in visualizing the amount of air content in the different types of radiators under consideration, Table 1 gives the amount of air content per square foot radiation in cubic inches, as well as the amount of air contained in a comparable steel or wrought iron pipe from ½″ to 1¼″ size. For instance, it will be noted that the old style cast iron column radiation is practically the same in cubic inch capacity as a 1¼″ pipe. Tubular radiation is the same in capacity as ¾″ pipe, and a slenderized radiator approximately has the same volume capacity as a ½″ pipe.

The table will be helpful in visualizing the problem of comparing the difference in heating up of the three distinct types of radiators listed as "a, d and e" of the same square feet of radiation capacity.

You will recall that previously in this article were listed certain important factors to consider in the complete heating of a radiator in the shortest time.

Assuming a 50 ft. section cast iron radiator (of types a, d and e) the approximate weights vary as follows: (a) 350# cast iron, (d) 275# cast iron, and (e) 210# cast iron. Similarly, the air content varies as follows: (a) 2150 cu. in. approximately, (d) 1150 cu. in. approximately, and (e) 750 cu. in. approximately. Since each radiator is to be completely heated from room temperature to steam temperature, there is approximately 66% more pounds of cast iron to heat up and almost three times as much air to expel from a column type radiator than from an equivalent 50 sq. ft. thin tube type. Again there is over 30% more cast iron to heat up with over 50% more air to expel from a tubular type radiator than the thin tube type on the same basis.

Conversely the conclusion is obvious. With only 70% as much cast iron to heat up in the thin tube type, and less than half the air content of an equivalent tubular type to expel for complete heating, the modern slenderized radiator does NOT require FAST venting—but it does require controlled air venting by individual air valve adjustment for balanced heat distribution at the same time throughout the system.

TABLE 1

EQUIVALENT AIR CONTENTS—RADIATORS, CONVECTORS, UNIT HEATERS AND PIPE

(a) Cast Iron Column (old style)	—43 cubic inches per sq. ft. radiation (approx)
(b) Cast Iron wall	—48 cubic inches per sq. ft. radiation
(c) Cast Iron flue	—50 cubic inches per sq. ft. radiation
(d) Cast Iron tube	—23 cubic inches per sq. ft. radiation
(e) Cast Iron thin tube	—15 cubic inches per sq. ft. radiation
(f) Cast Iron convector	—3 to 4 av. inches per sq. ft. radiation
(g) Copper convector	—½ per sq. ft.
(h) Unit Heaters 100 to 200 EDR	.30 to .40 per sq. ft.
300 to 500 EDR	.25 to .30 per sq. ft.
600 to 900 EDR	.20 to .25 per sq. ft.
900 to 1400 EDR	.15 to .20 per sq. ft.

Pipe:

½″ steel or wrought iron pipe	17 cu. in. per sq. ft.
¾″ steel or wrought iron pipe	23 cu. in. per sq. ft.
1″ steel or wrought iron pipe	30 cu in. per sq. ft.
1¼″ steel or wrought iron pipe	41 cu. in. per sq. ft.

(Note: the capacities for the various sizes of pipe are given per square foot of pipe surface rather than per lineal foot for easy comparison).