Boiler Facts

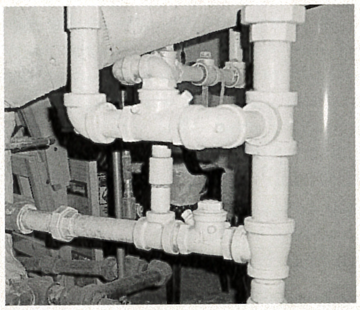
Vapor-vacuum devices...

(Those things that sit high above that old steam boiler and make you scratch your head!)

by George Carey

As this new heating season comes to life, you will probably have the opportunity to look at an old steam heating system. If you are lucky, it will be a crazy old two-pipe system that has some type of "wacky" looking device hanging from the ceiling. Be careful! Just because you don't know what it is or what it does, do not assume that it can't possibly be important! Also, do not try to replace this "wacky" device with something that "looks a lot like" what you just smashed out! Believe me, these crazy devices haven't been made for a long time. The device I am talking about is called a boiler return trap, a condensator or sometimes, an alternating receiver.

The function of this device is simple, but very important for the system to operate properly. Its sole purpose is to help the condensate that is coming back from the radiation to get back into the boiler. That's it! (It is not a steam trap so don't try to replace it with a bucket trap or F&T trap! I've seen the results when someone does this and it ain't pretty!)



Checkvalves of babcock return trap

Before getting into the explanation of how it works, let's talk about why it's needed in the first place. In the beginning, when steam was being introduced as a form of heating residential homes, the types of systems being installed were the one-pipe style. That is, the pipe that delivered the steam to the radiator was also the same pipe that returned the condensate from the radiator. There was an air vent on the opposite side of the radiator that would let the air out so the steam could enter. Remember, every time the boiler is off, all the piping and radiation above the boiler's water line is filled with air. Steam and air are both gases but with different densities so one won't go where the other is. This is why you have to get rid of the air from a radiator—so that the steam will be able to enter it and heat the room. The problem years ago was that this steam air vent wasn't working, shall we say, "up to the standards" of today's vent. In fact, it wasn't uncommon for those vents to spit water or even steam all over the floors, rugs, walls, etc. The heating engineers of the time knew that velocity was the problem. In a normally operating system, steam can travel at speeds up to 30 MPH in a riser. This velocity (wind) can prevent the condensate from draining back down the riser. For example, if the pipe is undersized for the amount of radiation that is connected to it or if the horizontal run-outs to the riser are pitched incorrectly, condensate will not be able to return down against the oncoming steam. If the condensate can't drain down, it will be held in suspension or more likely be driven towards the steam vent.

TWO PIPES ARE BETTER!

The "steam men" of the time experimented with different types of two-pipe systems. That is, one pipe for the steam and one pipe for the condensate. They were trying to minimize the velocity problem. Most of these systems had limited success due to either poor system performance or the cost of the installation was prohibitive. Then someone invented the thermostatic trap in the early 1900's, which completely changed the steam heating industry. Now you could use two pipes; one for the steam supply and one for the condensate. And with this new trap, the steam would never pass into the returns. Which is also why the boiler return trap was developed.

In a one-pipe system, when the steam travels to the end of the main after feeding all the risers, there is still leftover steam pressure that sits directly on top of the vertical column of condensate. This pressure helps the returning condensate get back into the boiler. Remember, the boiler is under pressure when it is producing steam. You need a pressure greater than what is inside the boiler to get the condensate back in. What happens is the condensate coming back from the radiation stacks up in the vertical portion of the return piping. As you know, water can exert pressure as it stacks up in a column. For every 28", water will exert one pound of pressure per square inch. What normally happens in a one-pipe system is, the returning condensate stacks up and combined with the leftover steam pressure develops a pressure greater than what is in the boiler. Naturally, the condensate can slide back into the boiler.

When you add thermostatic traps to the system, everything changes! The job of the trap is to stop the steam from passing beyond the piece of radiation. In doing so, there is no more steam pressure leftover to help the condensate get back into the boiler. Now all the condensate can do is stack in the vertical portion of the return line until it has enough static head from the column of water to overcome whatever pressure is inside the boiler. (Remember, 28" of a vertical column of water equals 1 pound of pressure psig.) If the boiler is operating at 2 psi, the condensate would have stack up almost 5' above the boiler's water line to be able to return to the boiler. The heating men of the time quickly figured this out! During this time, the fuel of choice was coal. The only way you could control the firing rate of the boiler (which controlled the steam pressure in the boiler) was by modulating the damper. This would either starve or feed the fire, thus controlling the steam pressure. Unfortunately, there was always a good chance the controls were operating exactly as intended and the boiler would build up in pressure. This created some problems, but first read on...

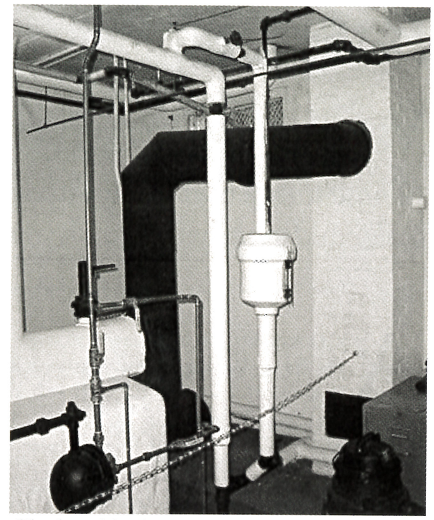
ONE VENT!

One other characteristic of a two-pipe vapor/vacuum system was that there was only one vent in the entire system. It was located down in the basement, so if there was any condensate spitting, it was in the cellar. No more wet floors, walls or curtains! The homeowners at the time loved it! The system worked great, until the boiler built up too much pressure. At that point, the returning condensate would back up, trying to develop enough static head to overcome the boiler's pressure. Since most basements don't have 8'-10' between the boiler's water line and the end of the dry return, the condensate would back up into the only vent in the system! The result was very inconsistent and uneven heating because of the trapped air in the system.

THE BOILER RETURN TRAP

The boiler return trap helped to return the condensate back into the boiler regardless of the boiler's pressure and here's how...

The return trap was always located near the boiler and at least 14-18½ above the boiler water line. (That dimension is very important so if you are replacing a boiler that has one of these, be sure to duplicate as best as possible the various dimensions from the original installation.) As the condensate makes its way back from the system, it starts collecting in the vertical pipes at the end of the dry returns. As long as the boiler is operating less than 8 ounces of pressure, the condensate will enter the boiler by gravity. (One ounce = 1.75½; therefore 8oz. x .75½ = 14½ which is the distance between the boiler's water line and the bottom of the boiler return trap.) When



Clarke oil boiler return trap

the boiler pressure increased, the return trap became necessary. At the base of the return trap there are two check valves—one on the boiler side and one on the system side. As the pressure built, the water in the boiler tried to back out, but the inboard check valve (the one closest to the boiler) snapped shut. This action prevented the boiler from experiencing a low water condition, but it also forced the returning condensate to stack up in the pipe connected to the bottom of the boiler return trap. Eventually, enough condensate backed up into the return trap. Inside this cast iron "ham", there was a float and lever attached to a valve mechanism. Also attached to the return trap was a small steam line that was supplied from somewhere off the boiler header piping. It was piped into the top of the return trap where the valve mechanism was located. The positioning of this valve was normally closed as long as the float was down. When the float started to lift (due to the condensate stacking up), the valve began to open. The steam was then allowed to enter into the return trap. At some point the steam pressure in the return trap was the same as the boiler's pressure. And because it was located 14-18½ above the boiler water line, the extra static column allowed the condensate to slide right back into the boiler. As the return trap became pressurized, the outboard check valve (the one on the system side) snapped shut, forcing the condensate back towards the boiler. As the condensate drained back into the boiler, the float would drop down, closing off the supply of steam. This cycle would repeat itself until the system was satisfied.

Basically this device was a steam driven condensate pump. When they fail, and eventually they will, you have a couple of options. You can attempt to rebuild it, replace it with a traditional condensate pump or you can install a boiler feed system. Each option has its positives and negatives. When the time comes, don't hesitate to call me at 1-800-423-7187 or email me at gcarey@fiainc.com.