# An Expansion Tank Story

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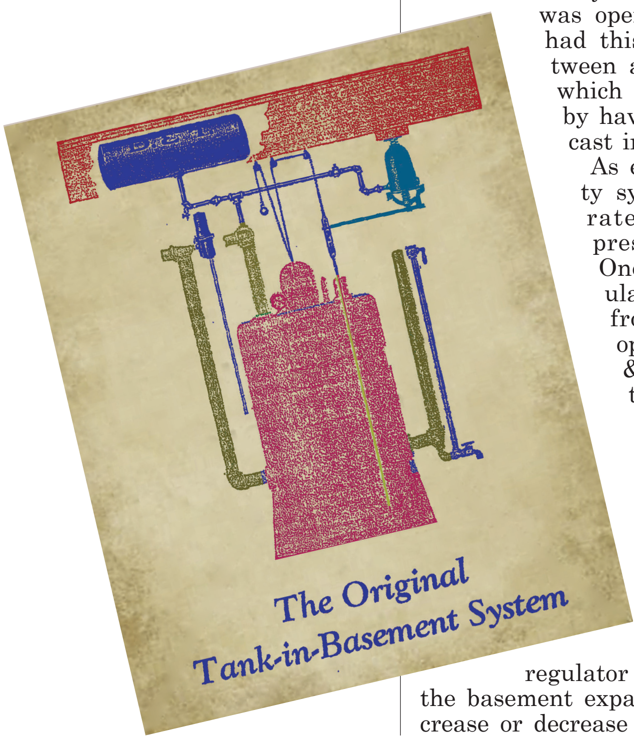
One of the most common components used in every hydronic heating system is also one of the least understood. I am referring to the expansion tank…I mean compression tank…I mean steel expansion tank…I mean the diaphragm compression tank…I mean the precharged expansion tank…see what I mean? It is called so many different names and each one of them can be correct, depending upon the tank. Years ago, when gravity hot water was king of the heating systems, there truly was an expansion tank that was located at the highest point in the system (usually in the attic) and was open to the atmosphere (there was no top on it or if there was, it had a vent pipe that was piped out through the roof). As the coal fired boiler heated the water, the molecules would start to get all excited and move around faster, causing the water to expand. Since water is not compressible, the old-timers knew they needed a place to put this "expanding" water so as to not create a pressure problem. So they would install this tank at the highest point in the system and as the water heated/expanded, it would move into the expansion tank. The tank thus gave the water a place to expand into and consequently would prevent the system from over-pressurizing. One of the negatives to having an open expansion tank was evaporation and the potential increase for corrosion through iron oxidation. Because the system would have to replenish the missing water with fresh-oxygenated street water, once heated, it released oxygen into the system. Also because the tank was open to the atmosphere, you had this constant interaction between air and the system water, which could accelerate corrosion by having the oxygen attack the cast iron and black steel piping.




As early as 1911, some gravity systems started to incorporate a closed and thus pressurized expansion tank. One manufacturer in particular, D & T Manufacturing from St Louis, MO developed a system called The D & T Tank in Basement System. Interestingly enough, the reason they went to a pressurized tank in the basement was to better control the firing of the coal boiler. By using a set of pulleys and chains that were connected to the draft damper and check damper, and a diaphragm regulator piped into the bottom of the basement expansion tank, they could increase or decrease the firing rate of the coal boiler and thus regulate the corresponding temperature supplied to the system. As mentioned earlier, as water is heated, the molecules expand causing an increase in the volume of system water.

With a pressurized tank, there is a volume of air that is maintained in the tank; it is there to act as a cushion or a spring on the water in the system. Since gases are compressible and water is NOT, when heated, the water squeezes into the tank by compressing the air in the tank. And like all gases, when you squeeze or compress the volume of air in the tank, its pressure increases. Well the D & T Tank company used this changing of pressures to influence the diaphragm regulator which in turn re-positioned the check and draft dampers, thereby increasing or decreasing the fire in the boiler. Pretty ingenious!

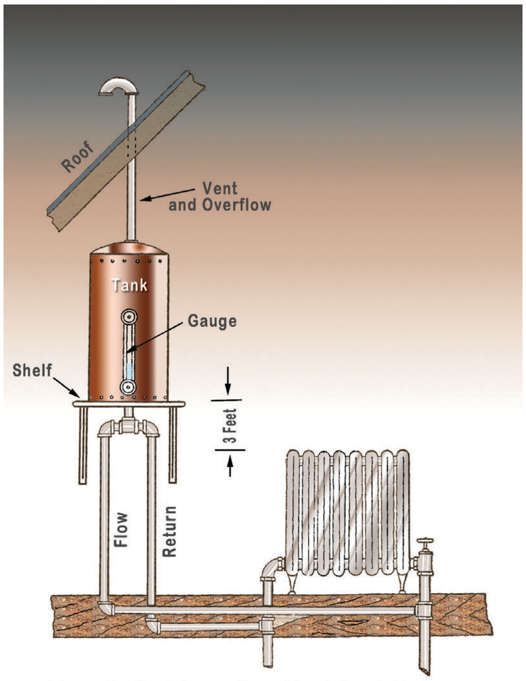
Eventually the "Booster" pump was developed and gravity hot water systems gave way to forced hot water circulation systems. In fact the term "Booster" was a marketing term from Bell & Gossett in their efforts to show how adding a pump to a gravity hot water system you could "boost" the heat faster throughout the system. Of course the expansion tank was needed even more than before because now the tank performed two functions:

- It was still the only place for the expanded volume of water to be accepted while keeping the pressure within the system below the boiler relief valve setting.
- It became the only place where any air in the system was directed to…the development of what became known as an Air Control System. And at the heart of this system was the Compression/Expansion Tank.

It was at this point that the industry starting referring to the tank as a *compression tank*. Their reasoning was for the expanding water to enter into the tank, it was now necessary to squeeze or "compress" the body of air in the tank. And in doing so, the pressure in the system would start to increase. It quickly became apparent that the size of the tank was important if they did not want the system pressure to increase to the boiler's relief valve setting. They did not want to dump water all over the floor and they also did not want to introduce large amounts of fresh water that would attack the boiler, pumps and piping.

So they had to come up with a method to size the compression tank for any and all hot water systems. They determined that to properly size a compression tank, you need to know:

- The volume of water in the system.
- The operating temperature range (How hot will the water operate up to?)
- What is the acceptable pressure range (Start with the system's fill pressure when cold and then as the water is heated, the




**Expansion Tank Connection—Circulation to Tank**

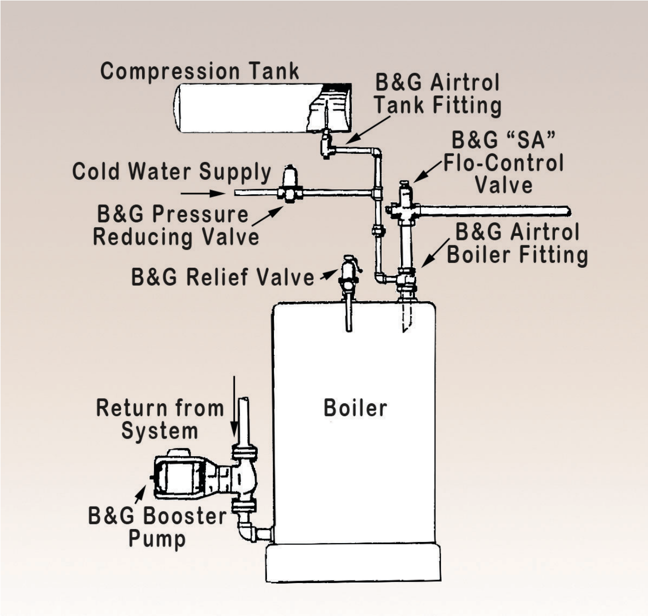
pressure can rise to a point close to but below the boiler relief valve setting.)

What the manufacturers quickly realized that although it was easy to establish the temperature range and the system's operating pressure range, it was very difficult in establishing the water content of a system. Unfortunately, that was also a very important piece of information to successfully size a compression tank. Eventually, they came up with sizing charts that included system water content for the various pieces of equipment including boilers, different forms of radiation and piping systems. All the charts had a column that listed the BTUs and then they calculated the water content accordingly. They put a lot of time, behind the scenes, to come up with these sizing charts. Unfortunately, the industry mistook the BTU/H capacity of a boiler as the definitive piece of information needed to size a tank, when in fact it has nothing to do with it; the engineers just calculated water content based upon standard conditions of such and such BTU boiler and its corresponding radiation and piping.

The other important role the steel compression tank played was in controlling any oxygen in the form of air bubbles that could be floating around in a hydronic system.

This whole system, which was developed and promoted by Bell & Gossett around 1935 or so, became known as "Air Control" (drawing, right). The intent of this system is to "catch" any air found in the piping or radiation and direct it up into the compression tank. The air was the cushion that acted like a "spring" to maintain the appropriate pressures within the system. This type of system could never employ automatic air vents because if the vents vented air, the system pressure would drop, causing the automatic pressure-reducing valve to open, bringing in additional water to maintain the proper system fill pressure. And where would this new water go? The only place it could go…into the compression tank. Now you have changed the relationship between the volume of air and water in the tank. Without the proper amount of air in the tank, there wasn't enough "cushion" to accept the expanding water without causing an exorbitant pressure increase, thus causing the relief valve to open and dump gallons upon gallons of water onto the basement floor! The compression tank had to be mounted up in the ceiling, high above the boiler and its air separator. This was to allow "Mother Nature" to take over. Any air bubbles that were captured at the air separator would float up into the bottom of the compression tank. One last important characteristic about compression tanks is that the air in the tank was in constant contact with the system water—they were "touching" each other. So as the system water temperature changed, some of the air in the tank would go back into solution and then, as the system water was heated, this air would come back out of solution. It was critical to have a proper air separating device to "catch" any of these bubbles and put them back into the compression tank.

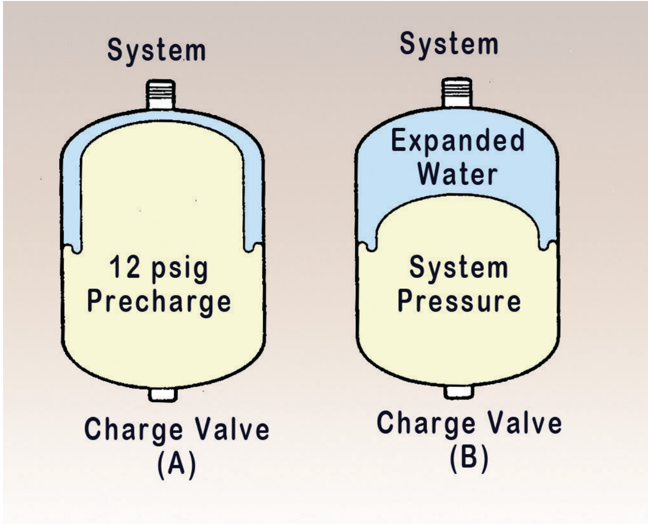
As early as 1954, a company in Warwick, RI named Amtrol patented a pre-pressurized diaphragm compression/expansion tank that would eventually change the hydronics industry when it came to expansion tanks. These diaphragm tanks are much smaller compared to the equivalent-in-size steel compression tank. And the main reason for that is the tank is pre-charged with the appropriate air pressure before it is connected to the system. Appropriate air pressure for what? For that particular system's required fill pressure (assuming the tank is installed in the basement with the boiler). See, the idea with these style tanks is there is no system water (theoreti-



cally) in the tank before the water is heated. Once the water starts expanding due to a temperature increase, it then "squeezes" into the tank, compressing the air. It is important to know what the system's required fill pressure is, because that becomes the pre-charged air setting in the diaphragm tank. Remember, there is no water into the tank until it is heated!

To calculate the required fill pressure, just measure from the boiler/fill valve to the highest piece of radiation in the house in feet. Divide that number by 2.31 to convert feet into psi. Now add 4 psi to that number (for positive pressure at the high point) and the total becomes the system's required fill pressure. We take that number and pre-charge the diaphragm tank to the same psi (before the tank is attached to the system) and the tank is ready to go. Another big difference with these tanks is they have a butyl diaphragm SEPARATING the air charge in the tank from the system water that enters the tank. Therefore we do not have to control the air in the system; rather we have to ELIMINATE it by venting any air found in the system out to the atmosphere. In this type of system you will typically see a large air separator with a large capacity vent located somewhere near the outlet of the boiler. Any air that passes through the separator will get "caught" and vented out through the air vent. Because the tanks have a pre-charge of air, they can be located almost anywhere, but the pipe connecting the tank to the system should come from the air separator or very close to it. They are subject to the same influences when it comes to sizing:

*Amtrol design*




- System volume
- Temperature (how hot will the water become)
- Pressure range (from the fill valve's setting to the pressure relief valve's setting)

Well, there you have a brief history of the evolution of The Expansion Tank.

*If you have any questions or comments, please call me at 1-800-423-7187 or email me at gcarey@fiainc.com*