Primary/Secondary Pumping...Low Loss Headers

(Are they the same thing?)

By George Carey

Even though it has been around since 1954, Primary/Secondary Pumping has become increasingly popular over the last five years or so. The applications for this piping technique are numerous but first, let's look at the basic premise.

The Essence of Primary/ Secondary Pumping

When two piping circuits are connected, flow in one circuit will cause flow to occur in the other circuit based upon the pressure drop in the piping common to both circuits. This describes exactly how a mono-flo system is supposed to operate. Flow in the primary main will cause some flow to occur in the mono-flo circuit due to the pressure drop of the mono-flo fittings in the piping common to both circuits. What Gil Carlson (engineer from Bell & Gossett) discovered some 50 years ago, was if the pressure drop in the piping common to both circuits was eliminated, flow in one circuit will not necessarily cause flow to occur in the other circuit.

That is the basis for Primary/Secondary Pumping; the pressure drop in the common pipe *has* to be designed for a minimum amount of resistance. By keeping the pressure drop very low, you have hydraulically isolated one loop from the other. Therefore, each loop's circulator can operate as if the other circulator does not exist. The benefit of this is you can have different size circulators co-existing without pumping problems. You can isolate flow through the off circuits by simply turning off that particular circuit's pump. You also can prevent heat from traveling into off circuits (boilers, radiation zones, etc...). The spacing of the supply and return tees for each secondary circuit is critical. By keeping the tees close together (maximum 3-4 pipe diameters apart), the pressure drop between the tees is almost negligible.

Therefore, as the primary pump is circulating water along the main, the water will not flow through the secondary circuit if its circulator is off. You have successfully isolated one circuit from the other.

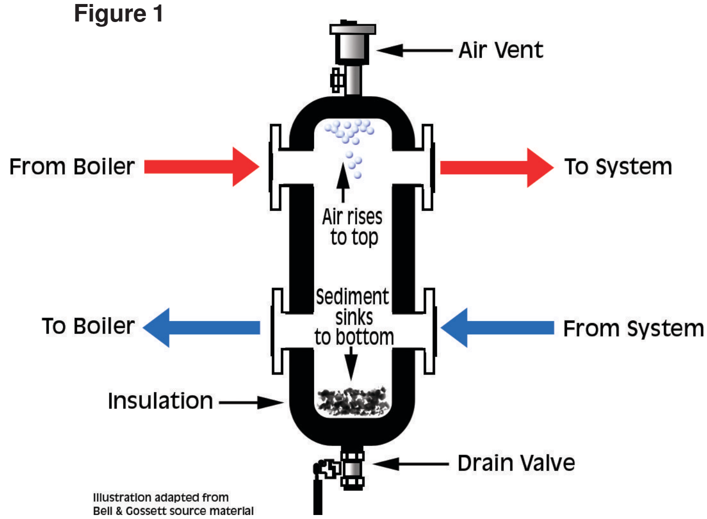
Law of the TEE

Gil use to say that to fully understand primary/secondary pumping, you had to understand the concept of "*the law of the tee*". What he was referring to is what happens in the common piping. The flow rate and the direction of the flow rate that occurs in the common pipe needs to be discussed. Because we have hydraulically isolated one circuit from the other, we can have different flow rates occurring in each circuit. These different flow rates will meet in the common piping. What occurs there can be very interesting. The flow in the primary piping can be greater than the flow in the secondary circuit, the flow rates can be equal or the secondary flow rate may be greater than the primary.

What is the significance of all this? Well, with different flow rates coming together in this "common pipe", mixing of water temperatures is going to occur. And depending upon the flow rates of the primary circuit versus the secondary flow rate, you can mix down supply water temperatures that are going to the secondary circuit. Or you can elevate the return water's temperature going back to the primary main. The possibilities are endless—and that is one of the reasons why a system designed with primary/ secondary pumping can achieve what other more traditional systems cannot.

Fast forward to today's modern hydronic heating systems. These systems can have multiple boilers, multiple

Figure 1



water temperatures, different types of heating terminal units in the same heating system (fan coils, baseboard, panel radiators and radiant heating). All of these applications can and do incorporate some form of primary/secondary pumping. To keep up with these modern systems, a few manufacturers have introduced a modern primary/secondary arrangement called a *"Low loss Header"*. This new device simplifies the P/S piping circuit and also eliminates a few other necessary components. (See Figure 1 on page 12)

These low-loss headers (meaning these very low pressure drop devices) have become a combination air separator, dirt collector and most importantly, a manifold that creates standalone primary and secondary circuits.

How do they Work?

These primary/secondary headers efficiently separate the primary and secondary circuits by acting as a set of "closely spaced tees", the piping arrangement you would normally see in a traditional primary/secondary piping system. In addition to that, these engineered devices also act like air and dirt separators. Its design is to create a low velocity area that allows:

1) Independent operation of primary and secondary circulators without "bumping" into each other.
2) Air bubbles to rise to the top and vent out through the float vent
3) Any sediment floating around in the piping system to sink to the bottom and be blown out through the drain-off valve.

There are three possible flow paths which are all dependent on the flows within the primary and secondary circuits. Figure 2 depicts the three possibilities.

The top example shows where the flow in the primary circuit is equal to the flow in the secondary circuit. In this situation, the flow and temperature from the boiler become the flow and temperature to the distribution system. The hot water from the boiler remains at the top and exits from the top system-side port. A similar situation occurs at the bottom two ports. The flow rate and temperature from the system equal the flow and temperature back to the boiler…there is no mixing going on in this scenario.

The second example (middle) shows a system wherein the flow rate in the secondary circuit (blue arrows) is greater than the boiler/primary flow rate (red arrows). Because the flows are no longer balanced, the temperature of the water going to the secondary/system circuit is no longer the same as the boiler's temperature. This is because of the mixing that takes place within the primary/secondary header (just like in the common pipe of a traditional primary/secondary piping system).

Because the greater flow rate is coming from the secondary/system circuit, a portion of its return water blends with the flow and temperature coming from the primary/boiler circuit. This mixing creates a "mixed" supply temperature (lower than boiler water and warmer than the system's return temperature—arrow at T_2F_2).

The third and final example (at bottom) shows a system wherein the flow rate in the primary/boiler circuit (red arrows) is greater than the secondary/system circuit. This is another unbalanced flow rate example. This time, the flow rate in the system is less than the boiler's flow rate. Therefore, a portion of hot boiler water will "blend" with the cooler system return water, thus raising the temperature of the water entering the boiler(s)—arrow, T_3F_3. This can be a good thing when you are trying to protect the boiler from colder return temperatures; but it can also lead to boiler short cycling if the boiler output far exceeds the system's requirement. Proper controlling of the boiler firing is necessary for good efficient operation.

The next time you are faced with piping a multiple boiler application, and you want to pipe them correctly, you would be wise to at least consider trying one of these "low-loss" headers. They hydraulically isolate the boilers from the system conveniently, they separate and vent air from the system, they collect dirt and sediment from the system, they simplify what can be considered complicated piping, and they reduce installation and labor costs by reducing the number of fittings and piping required.

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

Figure 2

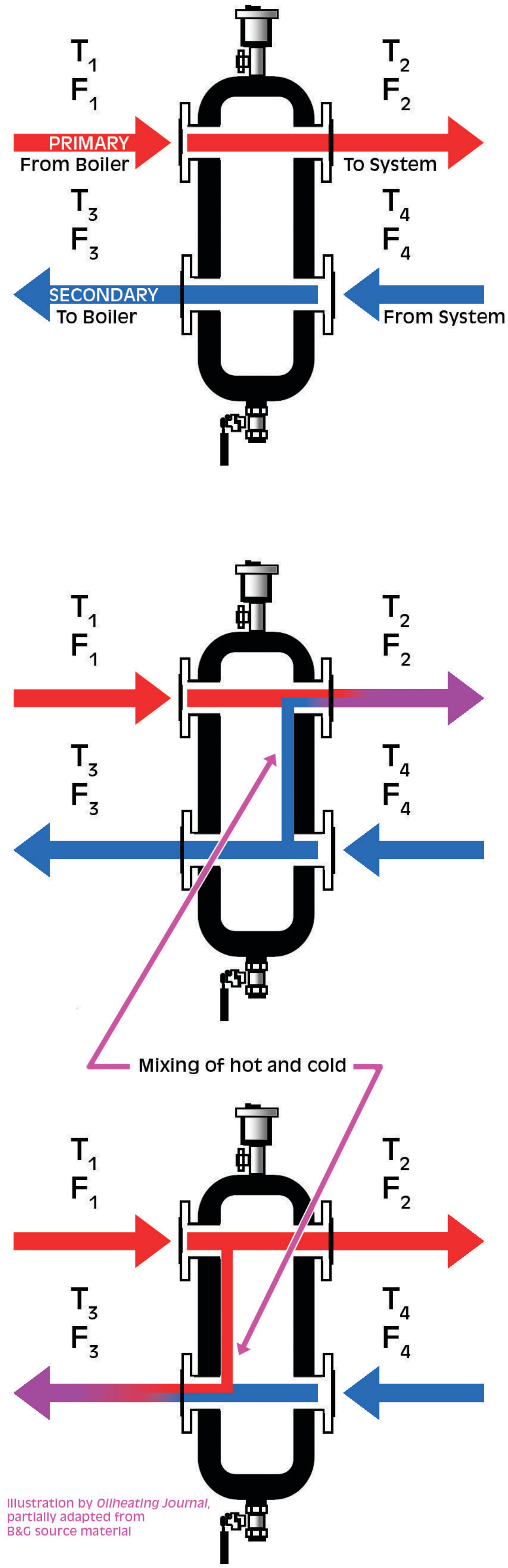


Illustration by *Oilheating Journal*, partially adapted from B&G source material