5. Typical system arrangements

5.0 Hydraulic interference in hydronic circuits

5.1 Direct return circuit

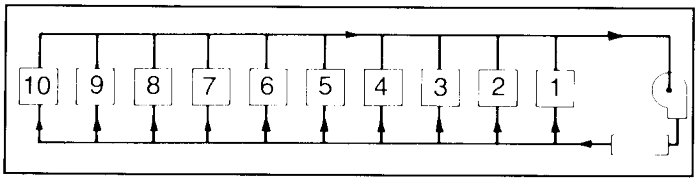


Fig. 23. Direct return example

Design A:
We will consider a typical direct return hydronic system comprised of 10 terminals each of 10 USGPM requirement and with each coil and subcircuit identical (Figure 23). In the initial design, if the system is balanced with a CBV on each terminal and the pump head needed is equal to 50 Ft, assume that the pressure drop in the equipment room equals 10 Ft for the 100 USGPM flow.

We will calculate the flow in each terminal with the following assumptions:

- Use a pumphead that = 50 Ft
- Increase the pump head to obtain the correct flow in terminal No. 10
- Consider that the design pressure drop in the coils and accessories divided by the pump head equals 0.2 for case "A" or 0.5 for case "B"
- Coils 2-4-6 have a smaller nominal pressure drop than other coils and create "favored circuits" or overflows.

We have for each terminal the actual differential pressure ΔP (Ft) compared with the theoretical values ΔPN (Ft) obtained assuming a pump head of 50 Ft. The system is balanced with a CBV in series with the unit coil, ΔPT in terminal and ΔPC for the CBV.

5.2 Reverse return circuit

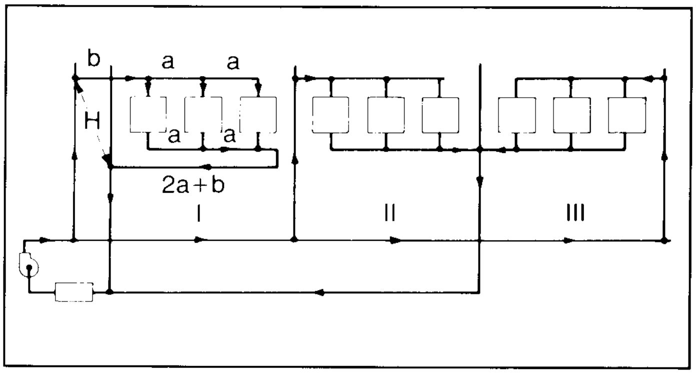


Fig. 24. Reverse return circuit

Figure 24 shows circuit 1 with three coils mounted with reverse return piping. If (a) and (b) represent the pressure drops in the pipes, we can easily see that each coil has the same differential pressure which is equal to H-(4a+2b). This result is valid if all flows correspond to values calculated.

This solution is interesting if those coils needed are the same differential pressure. If this is not the case, the coils will not receive the calculated flows and balancing valves are needed with or without reverse return circuit.

If the coils are identical, we have seen that the balancing problem is reduced in practice if a nominal pressure drop of each coil is large enough to reduce the influence of the pressure drops in the pipes.

Moreover, the reverse return circuit does not solve the question of overflowing or "favored circuits" which is the most serious problem.

5.3 Hydraulic interferences

Before balancing a system, you should verify that some fundamental mistakes do not exist in the piping which can disturb the general functions.

We will not study general questions such as:

- Pump cavitation and NPSH factor, or
- Position of expansion tank.

It may be of interest to examine some hydraulic interferences which can give the impression that the system is unbalanced or that some control valves are not closing properly. One example is related to some circuits in parallel with a common pipe.

On Figure 25a, we consider that the two-way control valve V1 is open, whereas V2 is closed. The water flow coming from coils 1 and 2 passes through section AB. The differential pressure between A and B can be sufficient to create a water flow through coils 3 and 4.

Let us consider that the calculated pressure drop in coil 3 equals 2 Ft and the differential pressure between A and B is equal to 0.01 Ft. The differential pressure applied on coil 3 is 0.005 Ft. The water flow through coil 3 depends on the square root of the differential pressure. This water flow equals:

$$100\% \times \sqrt{\frac{0.005}{2}}$$

= 5% of the calculated maximum value.

If we refer to the curve of Figure 5, we see that the coil's emission for this water flow represents 30% of the maximum load when EWT = 200°F. Coil 3 has an EWT of 180°F and the water flow is going in the reverse direction to give a final emission of 20% of the maximum value; coil 4 gives 2.5% of its maximum. Connection AB, which does not seem important, can give the impression that the valve V2 is not tight and results in wasted energy and overheating from coils 3 and 4.

Figure 25b shows the solution to this problem by inserting a common return from coils 3 and 4 before connecting to the return riser.

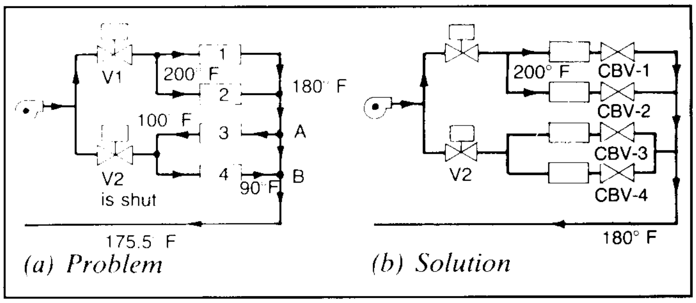
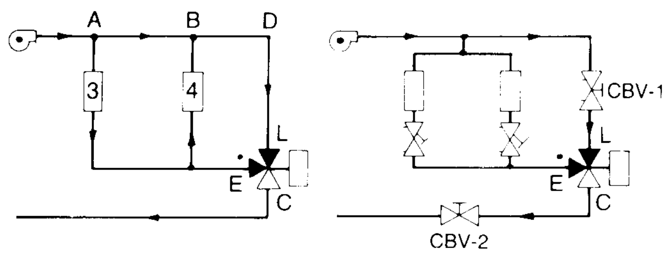


Fig. 25. Two-way valve circuit interference

Another example shows a three-way valve mounted in a mixing position to control two coils (3 and 4) (Figure 26).

When the "E" (Equal percentage) path is closed, the "L" (Linear) path is open. Since the branch DL has a low resistance, the flow through section AB is larger than calculated, and therefore generates a water flow across coils 3 and 4 for the same reasons as examined in Figure 25a.

This problem is eliminated in Figure 26b. The three-way valve is balanced on the bypass section with valve CBV 1 and balancing valve CBV 2 adjusted to the design water flow.

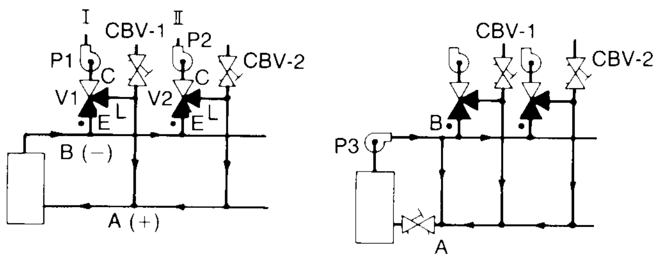


(a) Problem *(b) Solution*

Fig. 26. Three-way valve circuit interference

Two secondary circuits with three-way main valves are connected to a boiler with a large internal resistance, shown in Figure 27. In this example, P2 is a large pump which generates a large flow, whereas Pl has a low head for a small circuit. When the supply of V2 is fully open (E to C) a large flow is going through the return to the boiler and creates a big pressure drop.

If the different pressure between points A and B is larger than the head of pump Pl, we obtain a reverse water flow to circuit I (L to E, or C to E).



(a) Problem *(b) Solution*

Fig. 27.Three-way valve secondary interference

Without going to this limit, it is understandable that the flow in circuit I will be influenced by the opening of valve V2. In Figure 27, the pressure drop in the boiler is compensated with the addition of pump P3 and the equalizer bridge AB to avoid interference between the circuits.

If the equalizer circuit AB is forgotten, we do not have a constant water flow through the boiler or chiller and when a secondary three-way valve is open, the primary pump is put in series with the corresponding secondary pump.