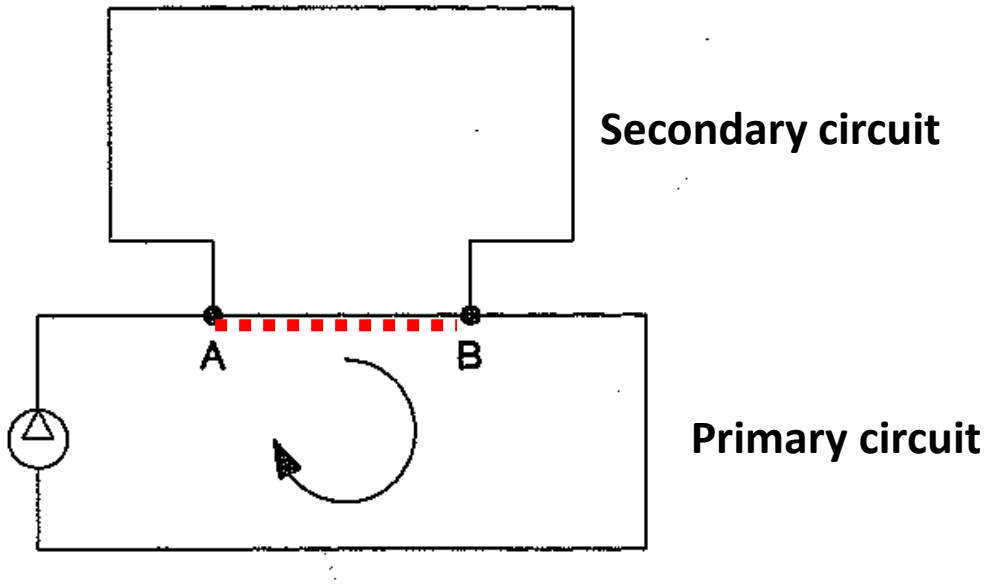
Hydronic systems - circuits

J. Vivian

Hydronic circuits

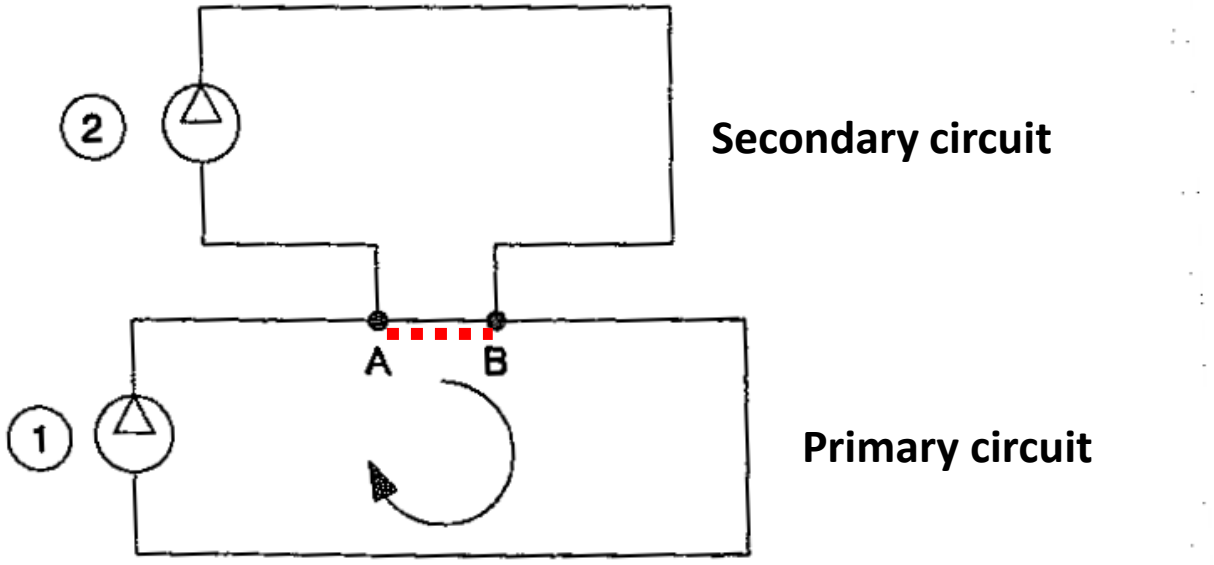
When there are two circuits, the primary and secondary flow rates depend on the pressure drop in the common section (e.g. AB)



The greater the pressure drop in the section A-B, the greater the circulating flow rate in the secondary circuit

If in the common section (red dotted line AB) the pressure drop is null (or if the length is very limited) there is no circulation of water in the secondary circuit. Hence it is necessary a pump for circulating water in the secondary circuit.

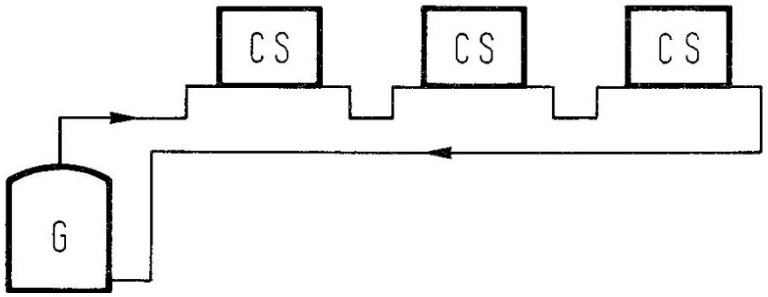
If the pump 2 stops there is only water circulation in the circuit 1.



It is possible to connect to a primary circuit with a set of different secondary circuits by installing in each circuit a circulation pump.

One-pipe circuit with in-series connection

The terminal units are connected **in series**.



Pros

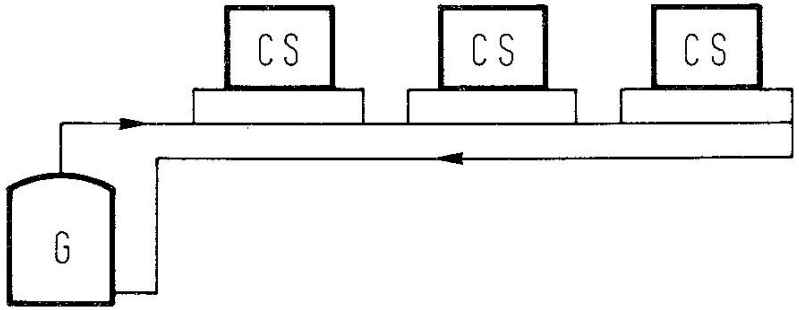
- Limited installation costs
- Simple sizing

Cons

- Supply temperature decreasing with distance from generator → last units need to be oversized to compensate for lower average temperature
- Heat emitters with high flow resistance limit the total heat output
- No individual flow control, which is limited to control features on heat emitters (e.g. blower speed in fan-coils)
- Noise due to excessive flow velocity through small tubes / valves in heat emitters

One-pipe circuit with in-parallel connection

The terminal units are connected **in parallel**.



Pros

- Limited installation costs
- Lower pressure drop
- Individual flow control

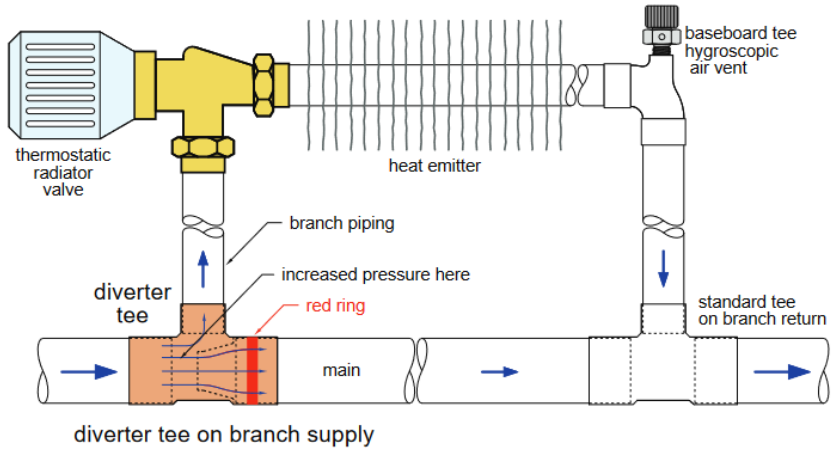
Cons

- Supply temperature decreasing with distance from generator → last units need to be oversized to compensate for lower average temperature

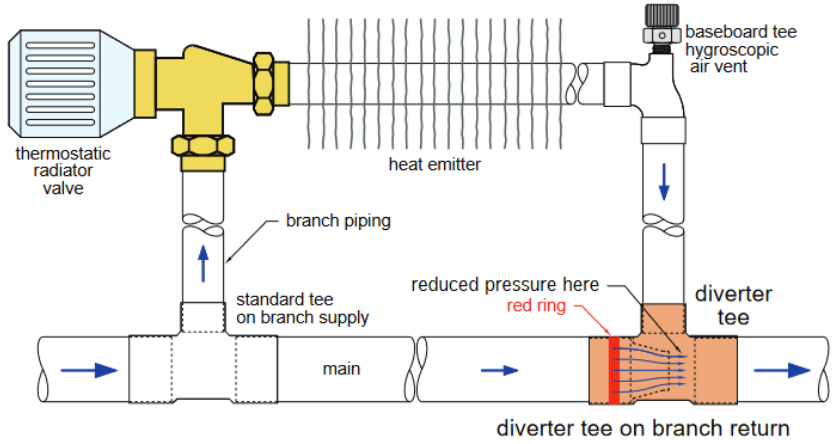
One-pipe circuit with in-parallel connection

Diverter tees are fittings specially designed to divert a portion of the water flowing in the main piping circuit through a branch circuit that includes at least one heat emitter.

- They can be installed on the supply, on the return, or on both branches.
- Each branch includes a thermostatic radiator valve that can modulate flow through that branch based on the set room temperature. Flow through a given branch can be completely stopped if necessary.



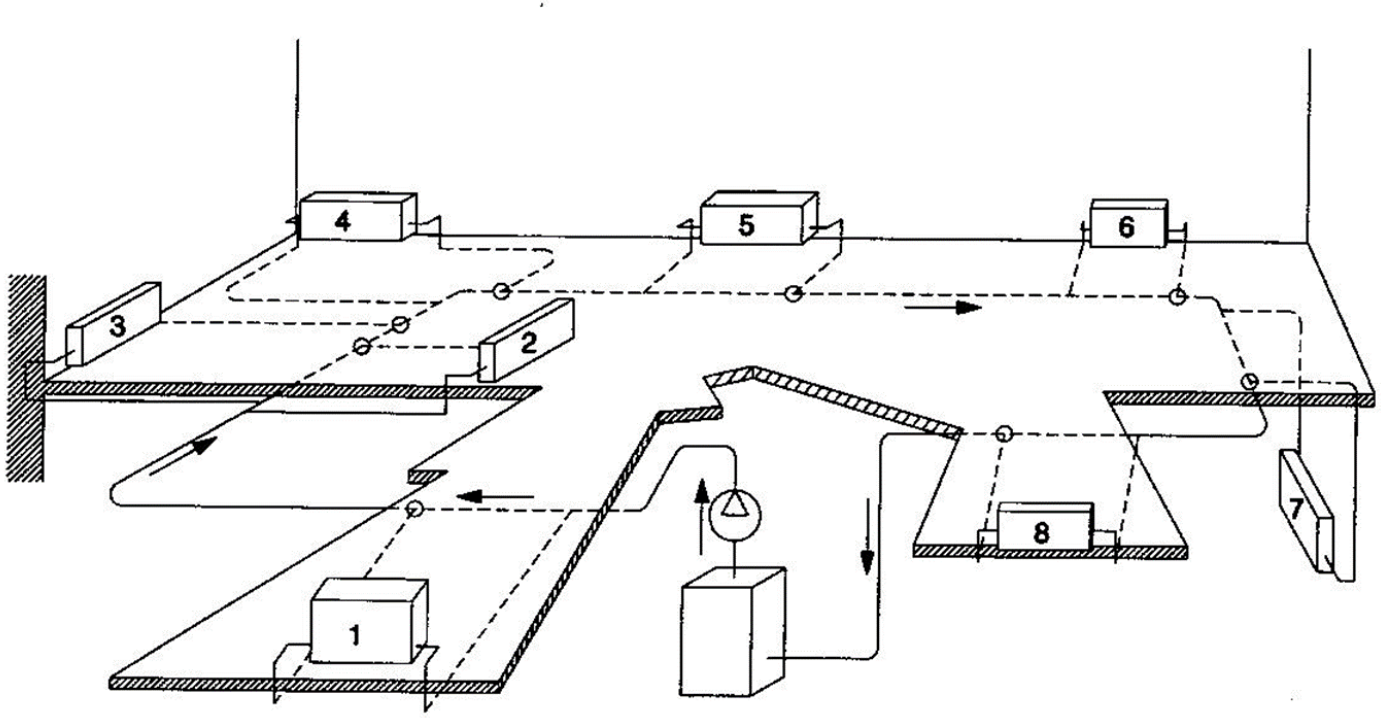
diverter tee on branch supply



diverter tee on branch return

One-pipe circuit with in-parallel connection

The terminal units are connected **in parallel**.



Two-pipe circuit with direct return

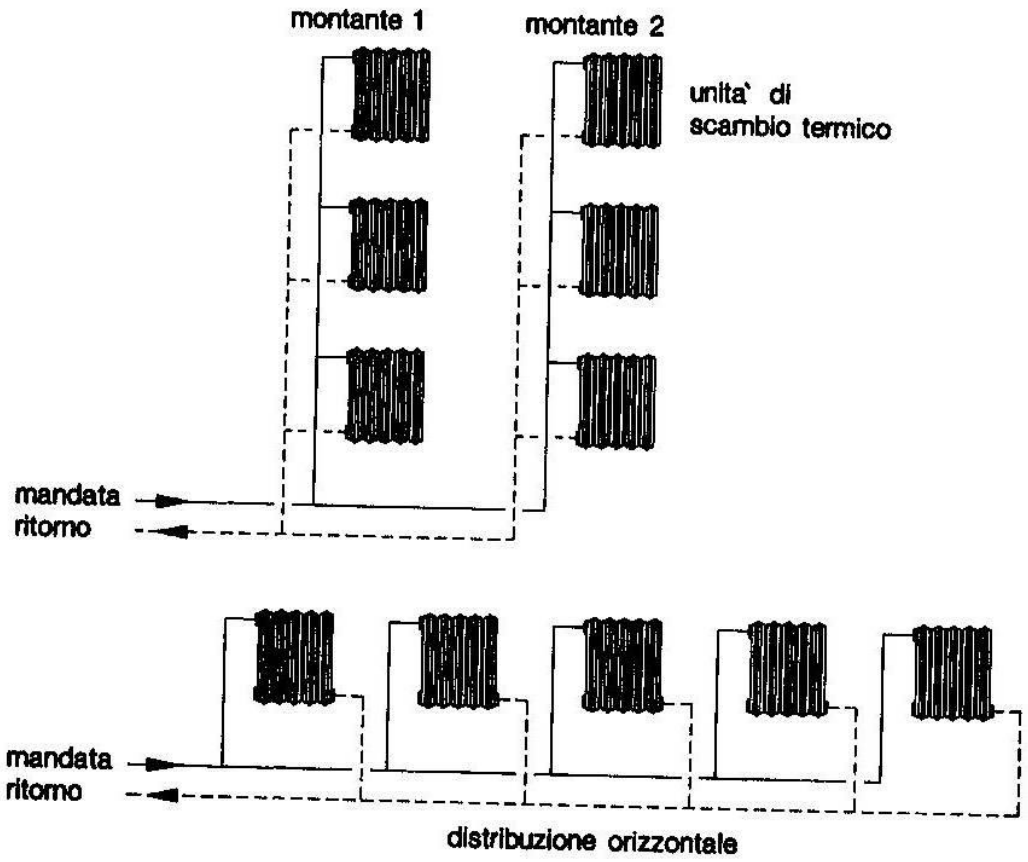
Double-pipe distribution with **direct return**

Pros

- Same supply temperature to all units (in contrast to single-pipe systems)

Cons

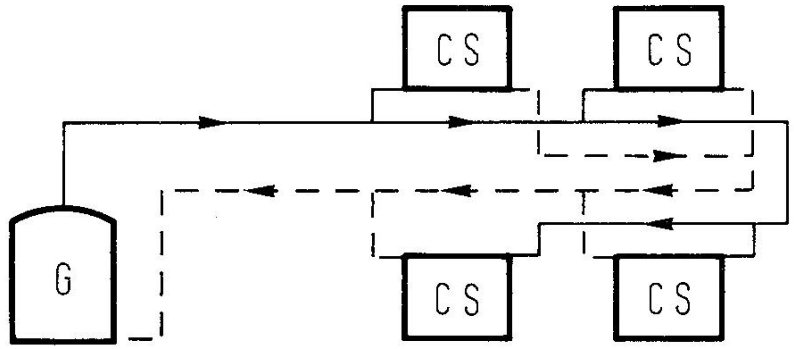
- Distribution system costs more than equivalent single-pipe due to longer piping
- Balancing needed to supply the design flow to all units because pressure differential decreases with distance from the pump(s)



Two-pipe circuit with reverse return

Double-pipe distribution with **reverse return**

(Tichelmann loop)



Pros

- Same supply temperature to all units (in contrast to single-pipe systems)
- Self-balanced system because the last terminal unit is «hydraulically» the closest to the pump on the return line

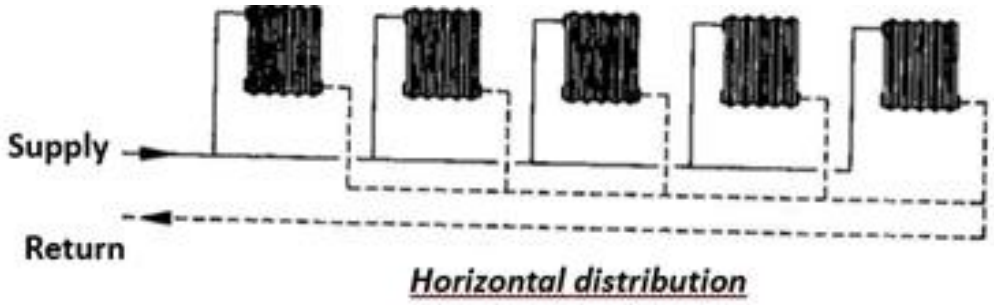
Cons

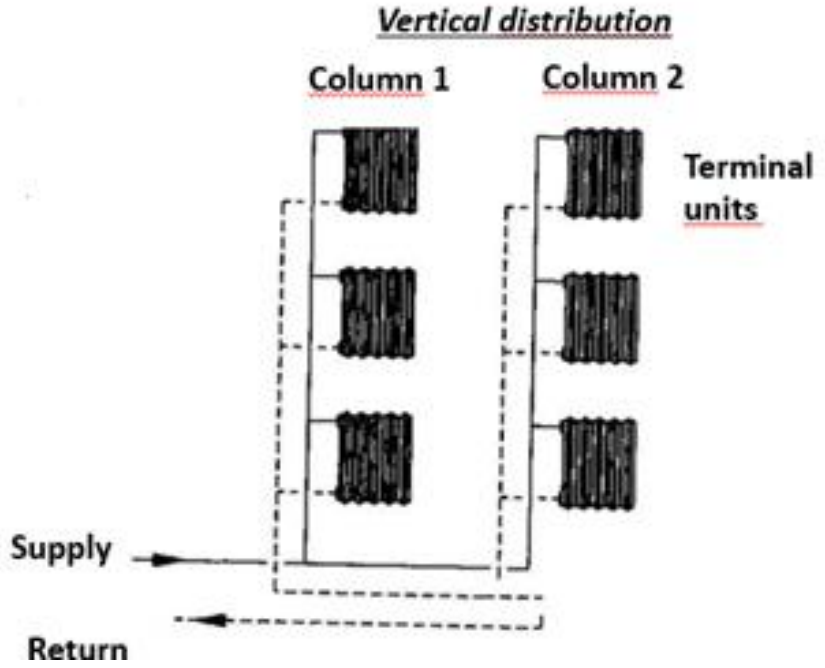
- Distribution system costs more than equivalent double-pipe system with direct return due to longer piping needed for the return line (installation of 3 pipes in parallel for part of the circuit).

Two-pipe circuit with reverse return

Double-pipe distribution with **reverse return**

(Tichelmann loop)

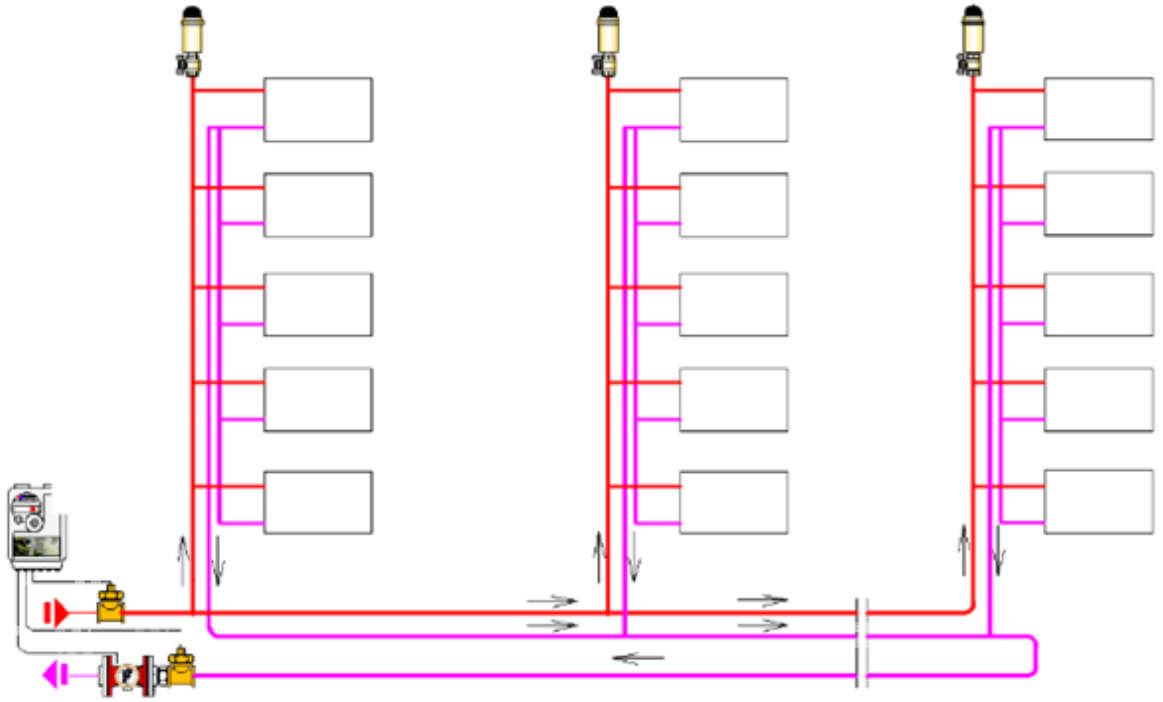




Two-pipe circuit with reverse return

Double-pipe distribution with **reverse return**

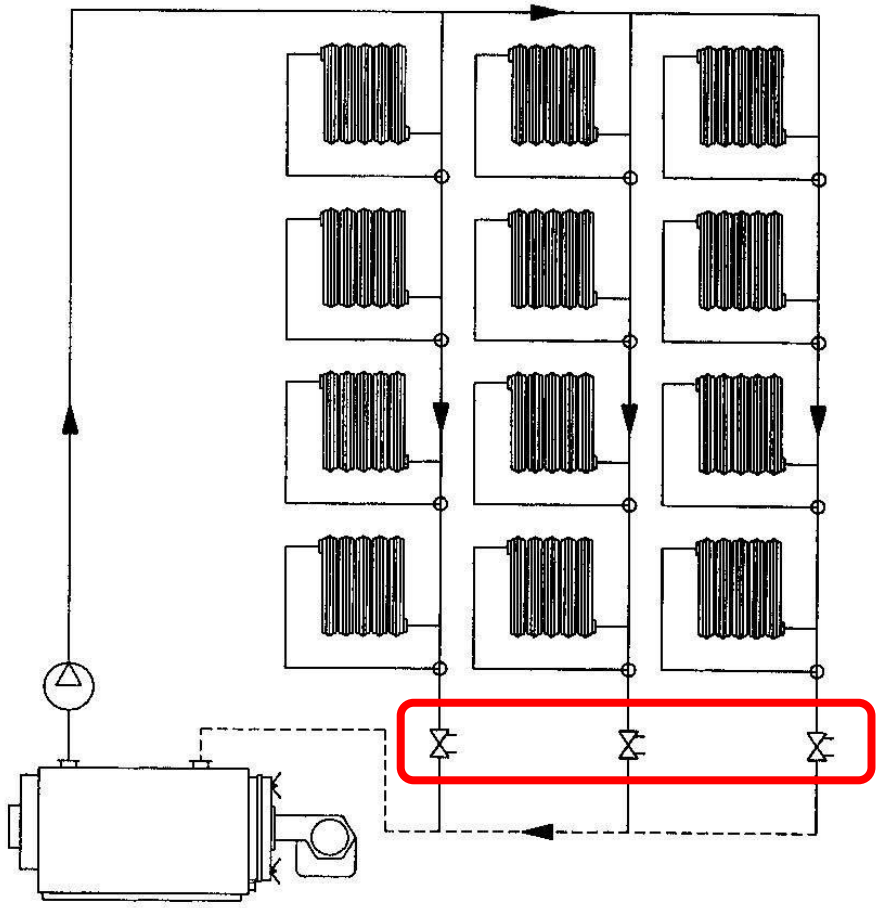
(Tichelmann loop)



[source: www.ctenergia.it]

One-pipe vertical circuit with direct return

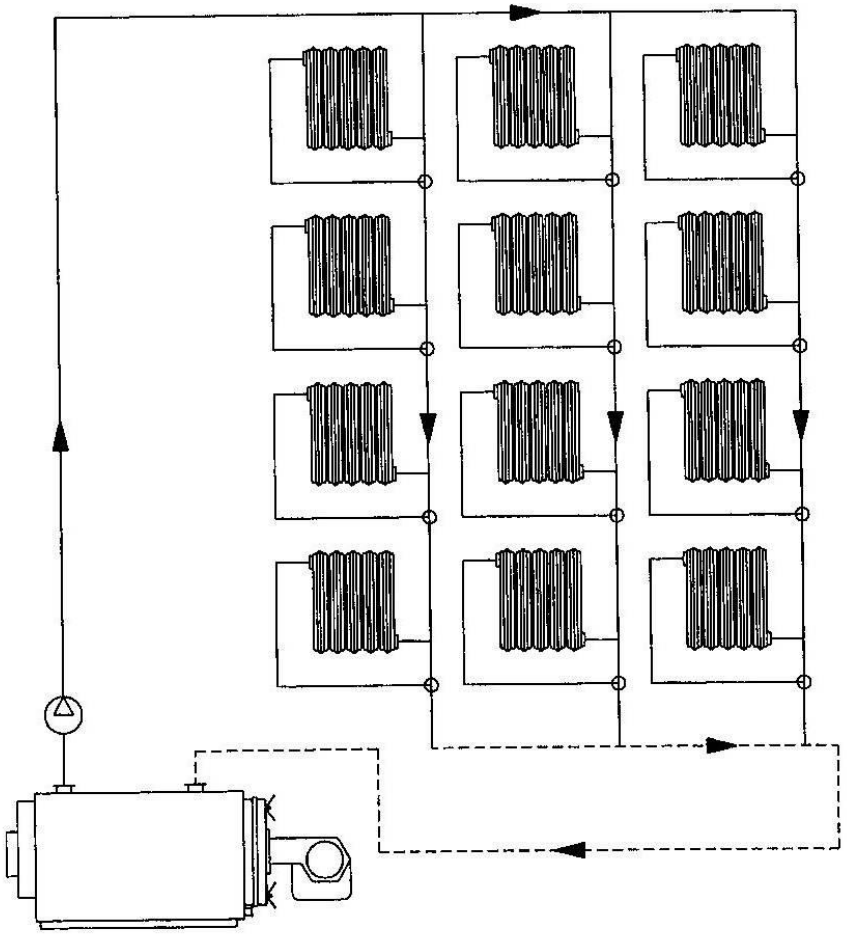
Single-pipe vertical circuit with **direct return**



Balancing valves

One-pipe vertical circuit with reverse return

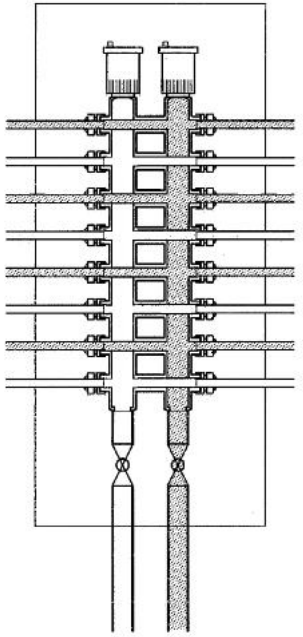
Single-pipe vertical circuit with **reverse return**



Two-pipe distribution with manifolds

Pros

- Possibility of realizing zone-based systems. Different zones of the building have same supply temperature, pressure difference and independent heat metering.
- Ease of installation because connections are pre-assembled.
- Working well with thermostatic valves on the terminal units.
- Uniform heat output during system start ups.



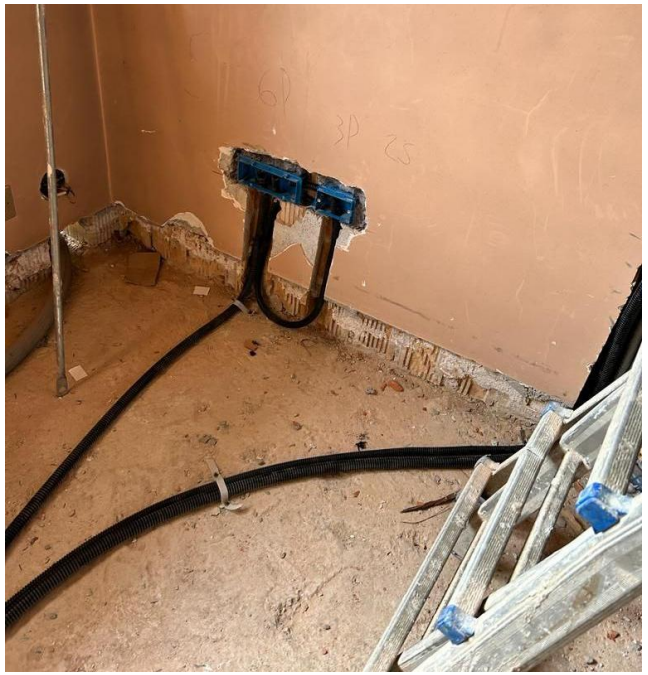
Rappresentazione di un collettore tipo

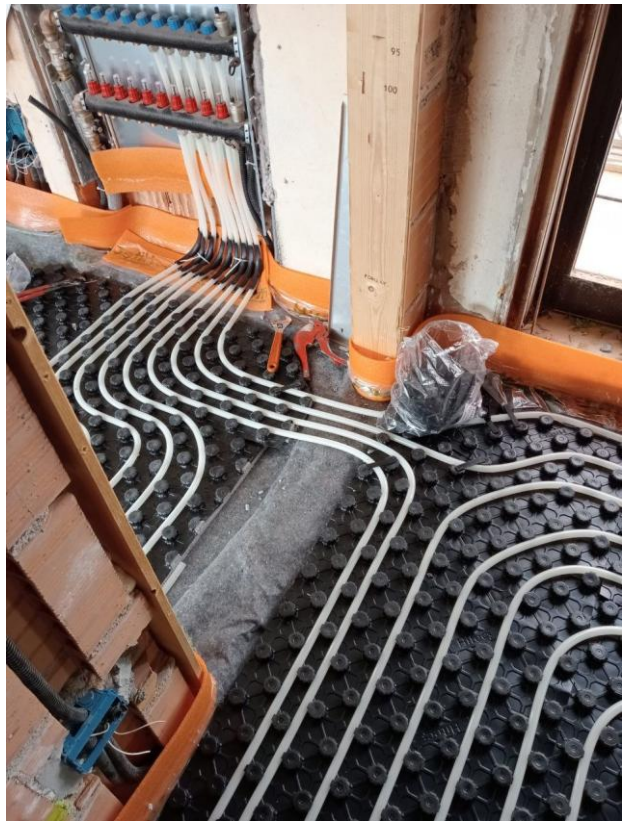
Two-pipe distribution with manifolds

Cons

- Each terminal unit needs a separate distribution line.

As a consequence, the floor has to be demolished in case of building retrofits.





Two-pipe distribution with manifolds

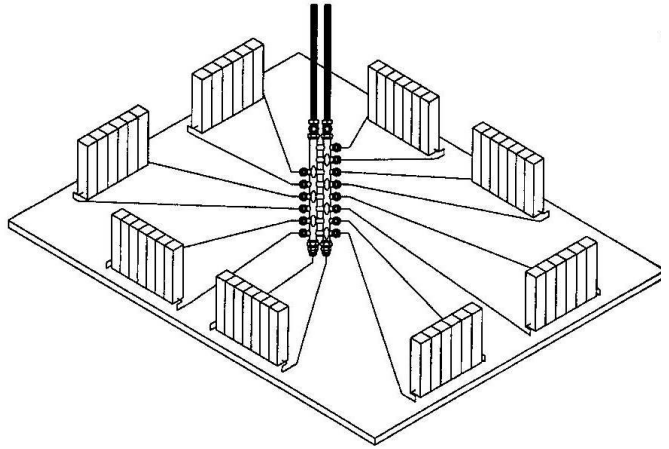
Where

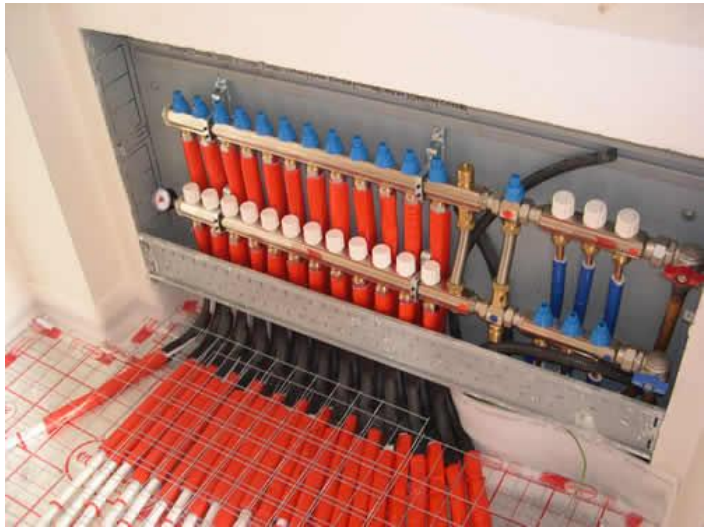
- **main manifold**: they are located in the heat supply station, downstream the heat generators.
- **zone manifold:** they receive the heat carrier fluid from the main manifold and distribute it locally to all the terminal units in the corresponding zone.

Two-pipe distribution with manifolds

Where

- To limit the development of internal circuits, manifolds are usually installed in a **barycentric position** with respect to the terminals to be served.
- It may also be convenient (especially in centralized systems) to place manifolds in **accessible cavities** (inspectable wall boxes, stairwells, cavediums).





Two-pipe distribution with manifolds

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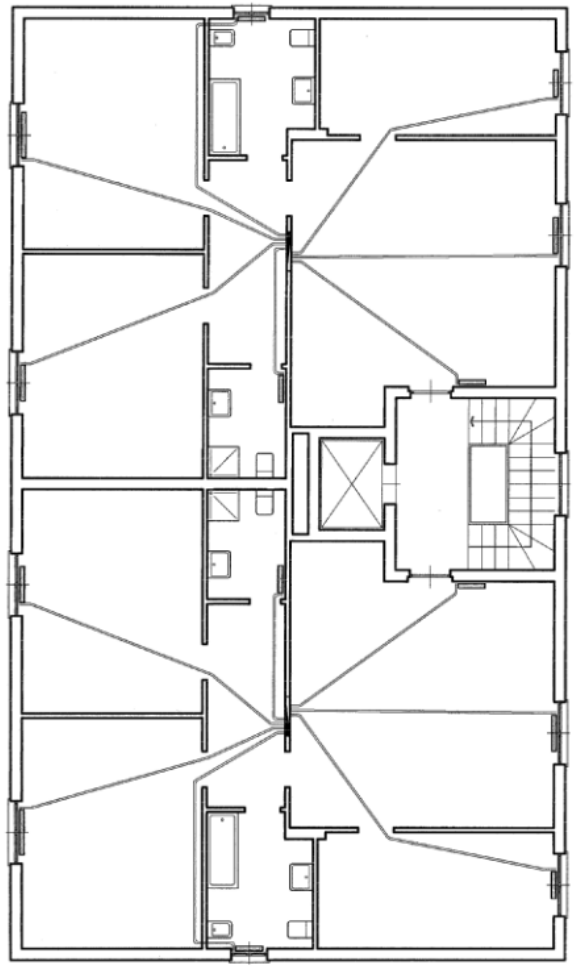
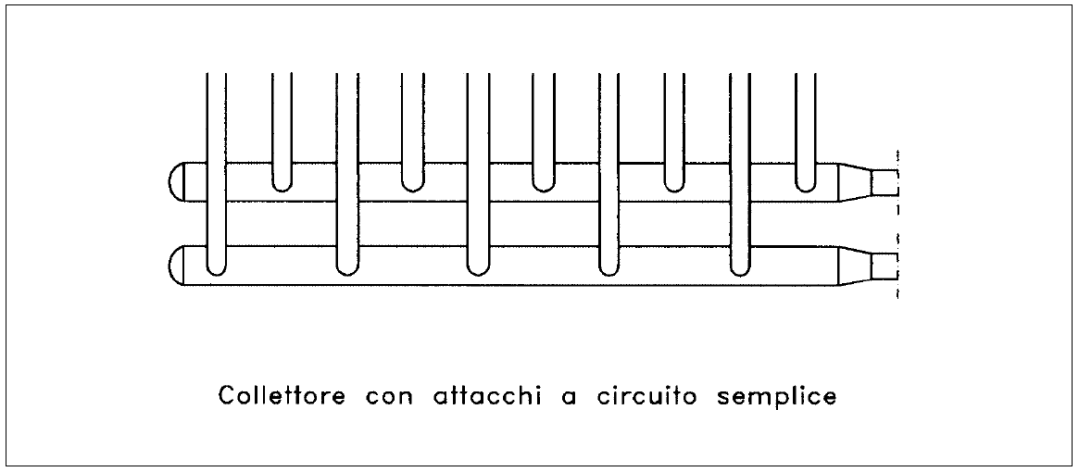
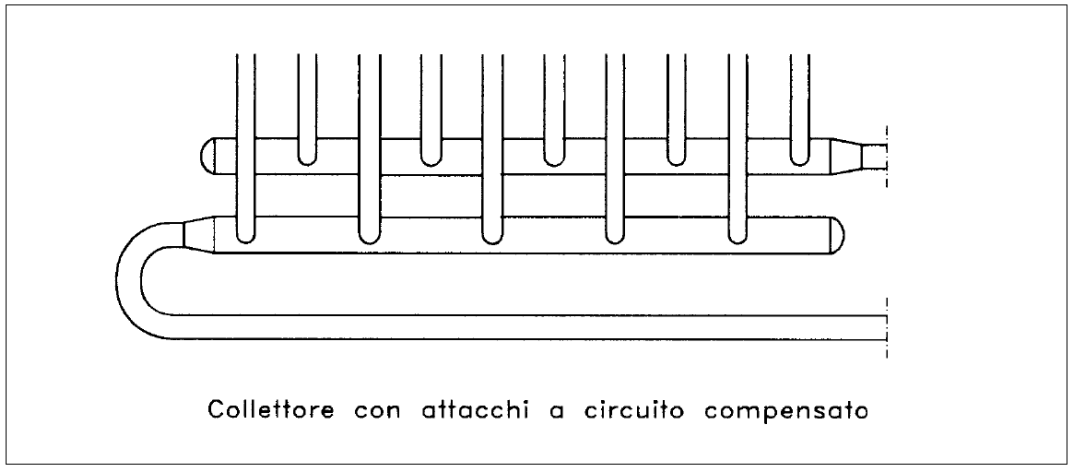


Two-pipe distribution with manifolds

Types



Collettore con attacchi a circuito semplice



Collettore con attacchi a circuito compensato

Two-pipe distribution with manifolds

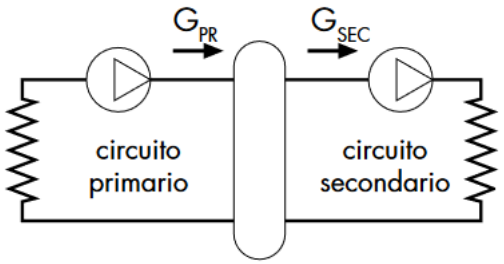
Core-Care Lab

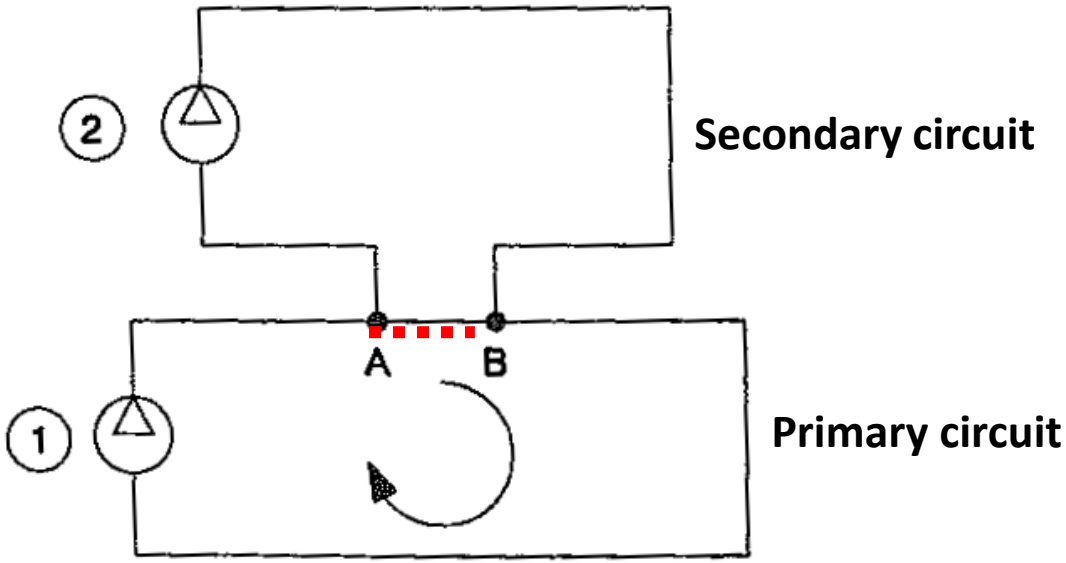
Heating and cooling manifolds supply the same radiant systems

Two-pipe distribution

Hydraulic separator

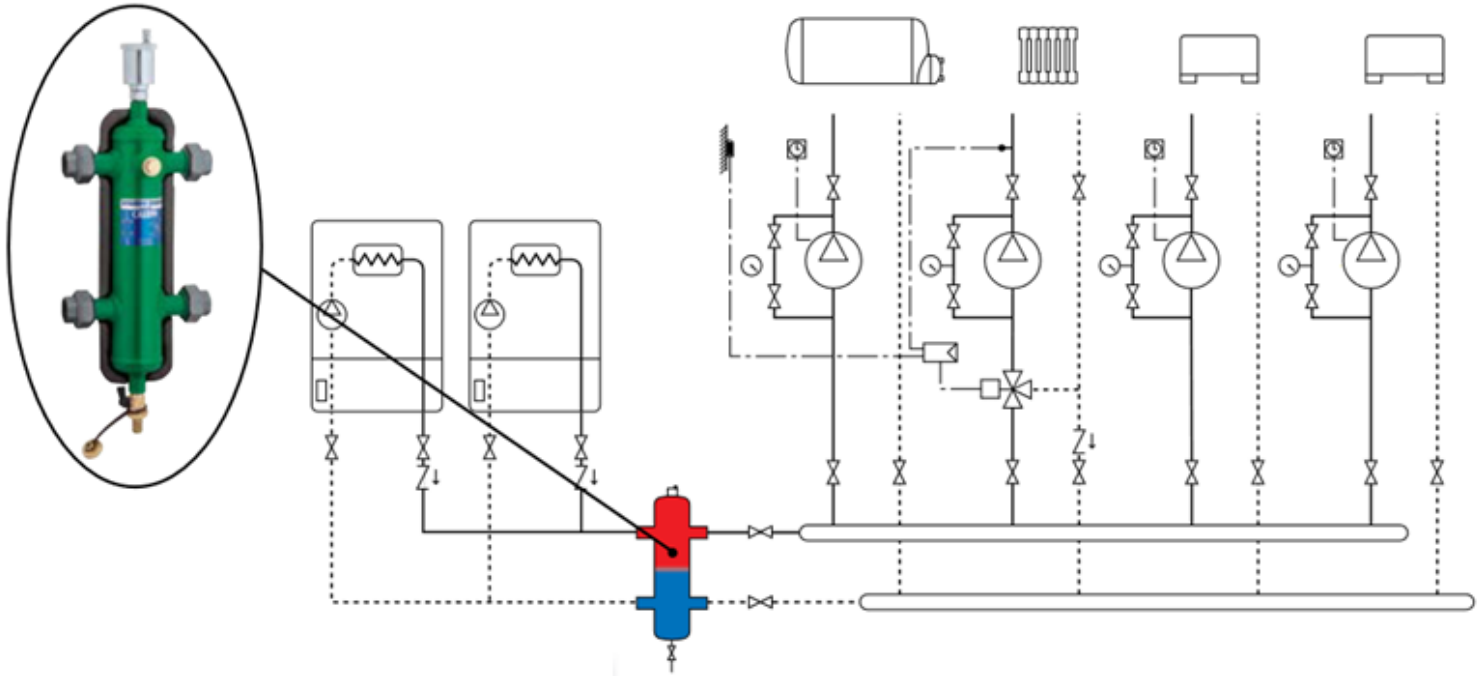
It is the easiest way to separate the pressure dynamics of the primary circuit from that of the secondary circuit.





Two-pipe distribution

Hydraulic separator

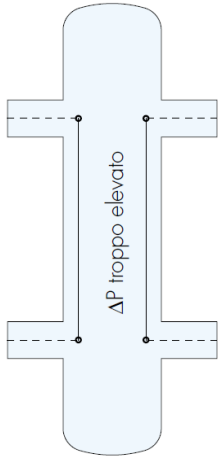


[source: www.caleffi.com]

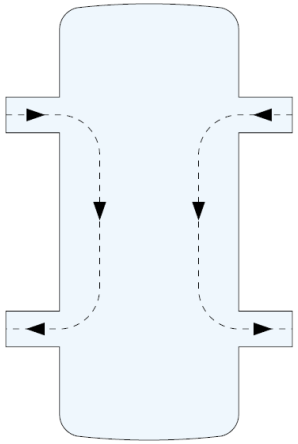
Two-pipe distribution

Hydraulic separator

A by-pass flow between supply and return pipe might occur if the separator is undersized (causing an excessive Δp) or not properly installed. It must be sized for the maximum overall flow among primary and secondary circuit.



Rappresentazione separatore troppo stretto



Rappresentazione separatore troppo largo