1. Introduction.

The presence of uncontrolled amounts of air in a water supply system can seriously reduce its performance. In extreme cases, the flow can even be stopped. Excess air in the system is the direct cause of the section reduction and therefore of its carrying capacity. Another inconvenience of an excesive amount of air in the system is that it may lead to errors in the measuring elements of the system.

During the draining of the system vacuum is generated inside the pipes, and if it is not well managed may result in the collapse and crushing of them.

Air control within a piping system is performed with the proper placement of air valves.

2. Origins of air in networks and pipes.

Water contains dissolved air in varying amounts, depending on pressure and temperature.

At 20°C and atmospheric pressure, the dissolved air content in the water is about 20 liters per m^3 .

Temperature rise and pressure drop will reduce the dissolved air content in the water.

In a pipe that carries 100 m^3 per hour at a constant pressure and at a temperature varying from 15 to 30°C, they will detach from the water, approximately 500 liters of air per hour, and remain trapped in the pipe.

Air can enter the system from the atmosphere in the following cases:

- When a pump is started, the air is compressed from the pump to the network.
- Pumping itself can create a vortex action at suction points. This will result in an air aspiration to be fed into the system.
- When a drive passes from a partially filled section to a fully filled section, it will draw air from the partially filled section to the fully filled section.

3. Problems related to the presence of air in pipe networks.

3.1. Cessation of water Flow.

In pipes with slope variation and low speeds (0.6 m/sec), the free air inside the system will be concentrated in the form of bags. These air pockets are usually located at the slope change points of the pipe. They reduce the passage and transport capacity of the pipe. In this scenario if the system is powered by a pump, higher pressure will be needed to cope with the airbags and the efficiency will be reduced. In extreme cases, the pump will not be able to supply the extra pressure required to overcome the airbags and the system flow will stop completely. (Fig. 1). In gravity networks, the influence of airbags on flow characteristics is greater than in pressurized networks, as there is no pressure to force the outflow of airbags. The cessation of flow in the gravity system due to airbags is shown in Fig. 2. Adequate drainage of the airbags will ensure normal flow conditions.

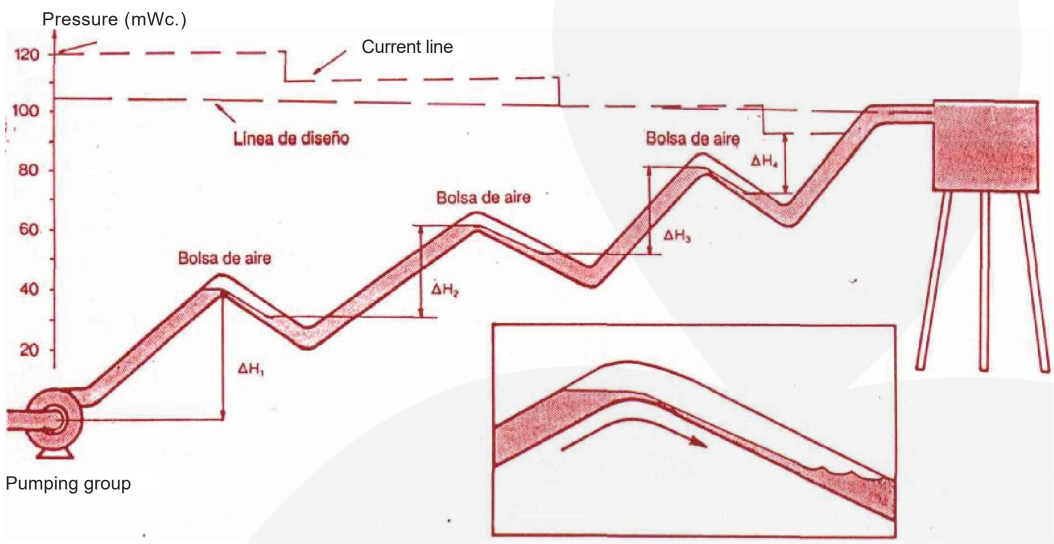
3.2. Cavitation.

With the passage of water through different accessories, the speed of the water increases due to the reduction of the section. This causes a drop in local pressure and the formation of vapor bubbles. When flow conditions return to normal, the bubbles will collapse, releasing large amounts of energy, causing significant erosion. By removing air from the cavitation zone, this destructive action can be contained.

3.3. Accuracy of measurements and counters.

At equal pressure and temperature, the air velocity is 29 times higher than the water velocity. As many measuring instruments are based on the velocity of the fluid, the presence of air inside the pipes will give erroneous readings and possibly, if the velocity reaches high values, it can damage the instruments. In instruments measuring volumes, both air and water shall be recorded, resulting in inaccurate measurements.

By evacuating the air in the vicinity of the measuring instruments, the accuracy of the reading shall be ensured while extending the life of the meters.



$AH_1+AH_2+AH_3+AH_4$ = Cutting pressure = 120 m.c.a.

Fig. 1.- The pump is not capable of supplying the necessary pressure to overcome the air pockets.

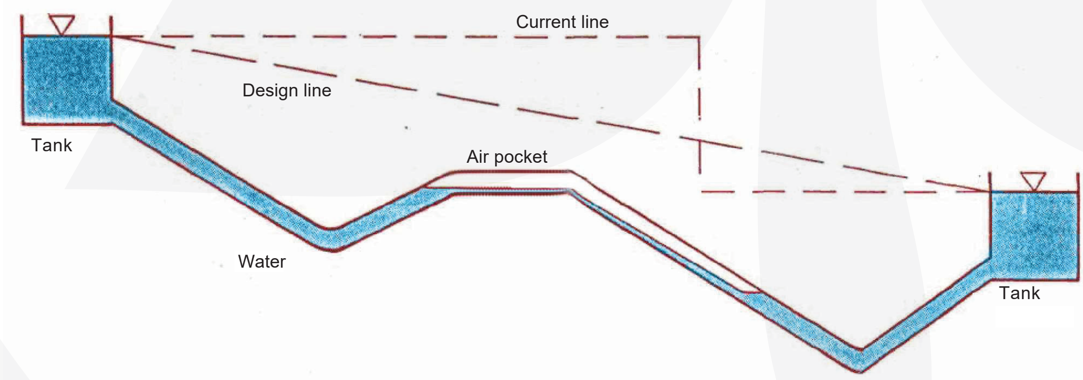


Fig. 2.- Flow stoppage due to air pockets in a low pressure pipe

3.4. Suction.

Quick emptying of a pipe, intentionally or accidentally (breakage, etc.), can create suction and vacuum within the line. This can result in the collapse of the pipes.

The differential pressure limit, above which a pipe collapses, can be determined by the following formula:

$Ap=3.5x10^6\ (T/D)^3$(iron pipes).
$Ap=1.1x10^6\ (T/D)^3$(aluminium pipes).
where: T = Wall thickness.
D = Pipe diameter.
Ap = Differential pressure (Kg/cm^2).

By introducing air through anti-suction valves into areas where suction is expected to occur, the collapse of the pipes will be avoided. Suction in buried systems can introduce dirt into the system.

4. Location of the air release valves.

4.1. In pipelines where the slope varies in relation to the hydraulic gradient.

a) Peak.
Point where (a) the pipe rises to become parallel to the hydraulic gradient or (b) the pipe moves from being parallel to the hydraulic gradient to descending. A double-acting air release valve should be placed at each peak (Fig. 3).

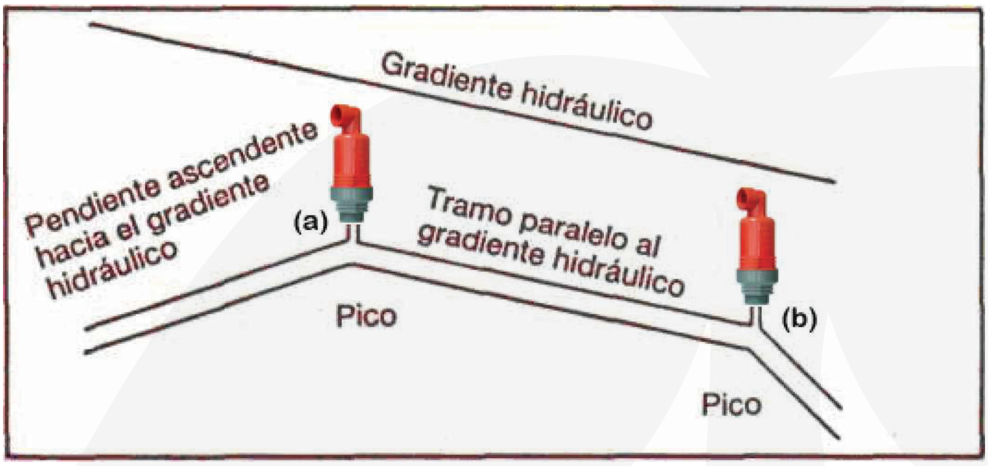


Fig. 3.

b) Increased slope in the pipe.

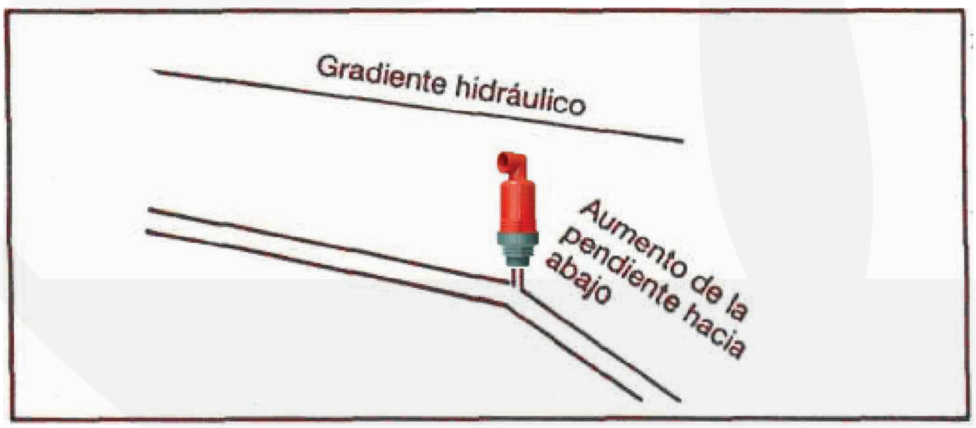


Fig. 4.

c) Reduction of the slope in the pipe.

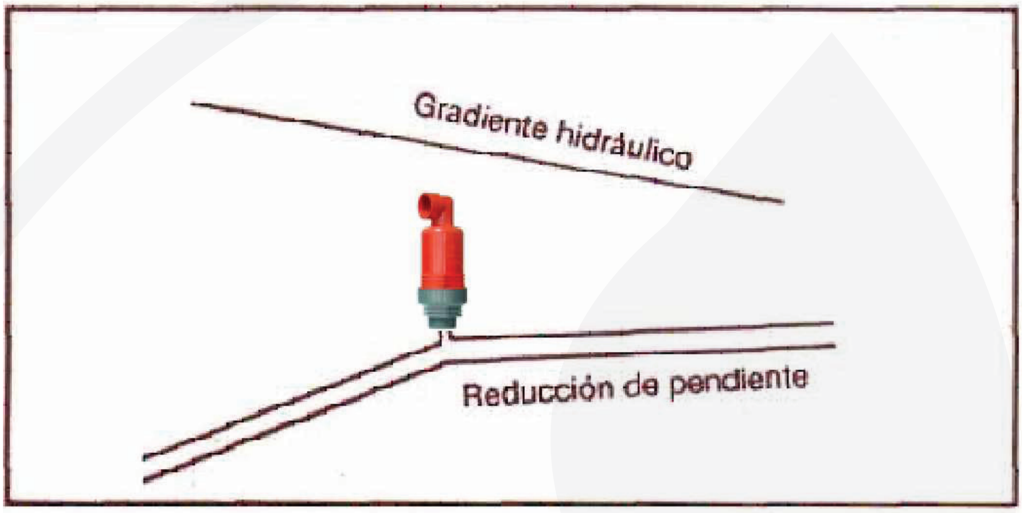


Fig. 5.

4.2. Point above ground.

An air release valve should be installed where the pipe rises above ground level (as in the case of valve installation (fig. 6). If the pipe, downstream of the valve, rises, an automatic air valve will suffice. In the event that it descends, a double-acting aire release valve will be required to ensure rapid drainage of the pipe.

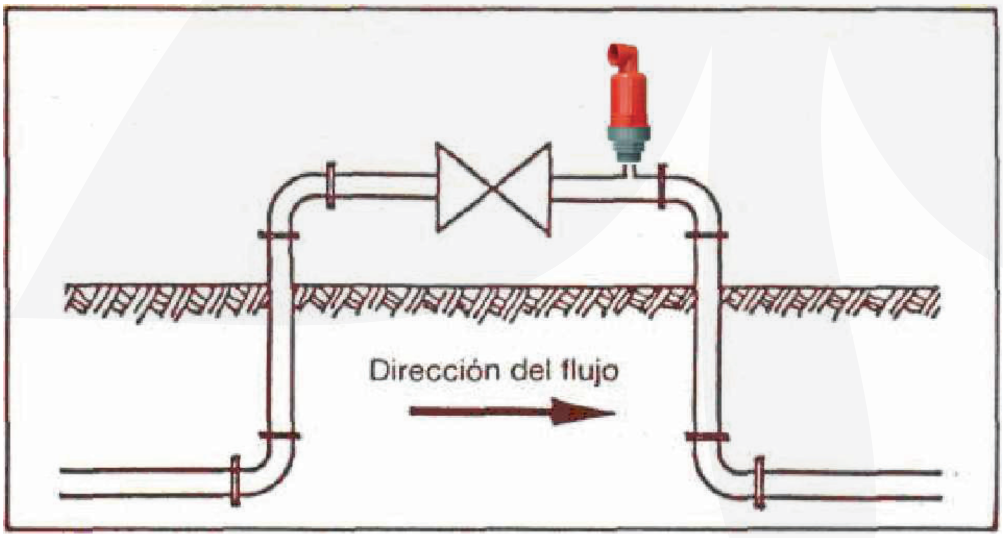


Fig. 6.

4.3. Large branches with uniform gradient.

In large branches with a uniform slope (ascending, descending or parallel to the hydraulic gradient), it is recommended to install a double-acting air relase valve every 500-1,000m. (Fig. 7).

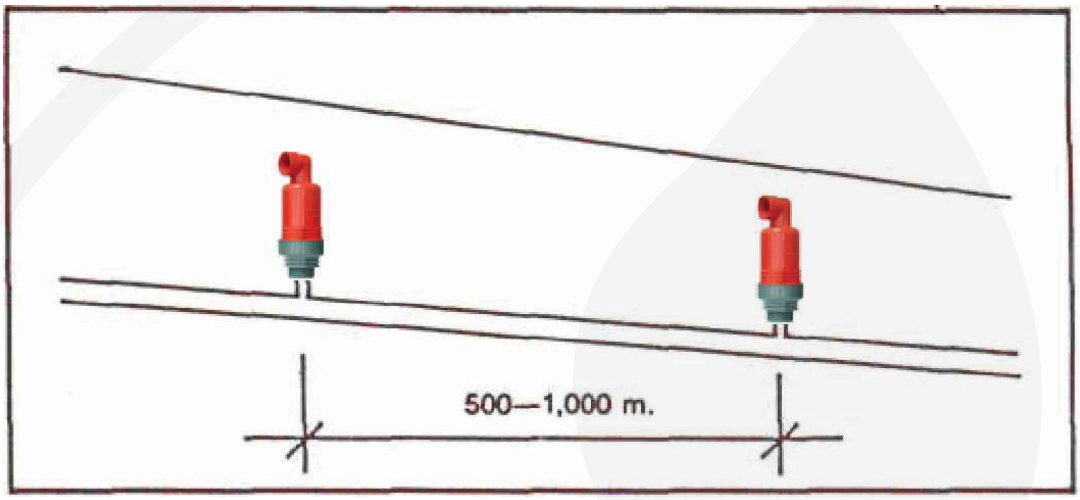


Fig. 7.

If automatic, double-acting air release valves are installed at both ends of the branch line, only kinetics within the branch line itself are required.

4.4. Pumps.

In order to evacuate the air that enters the system due to pumping, a kinetic air release valve must be installed at a high point before the check valve (fig. 8).

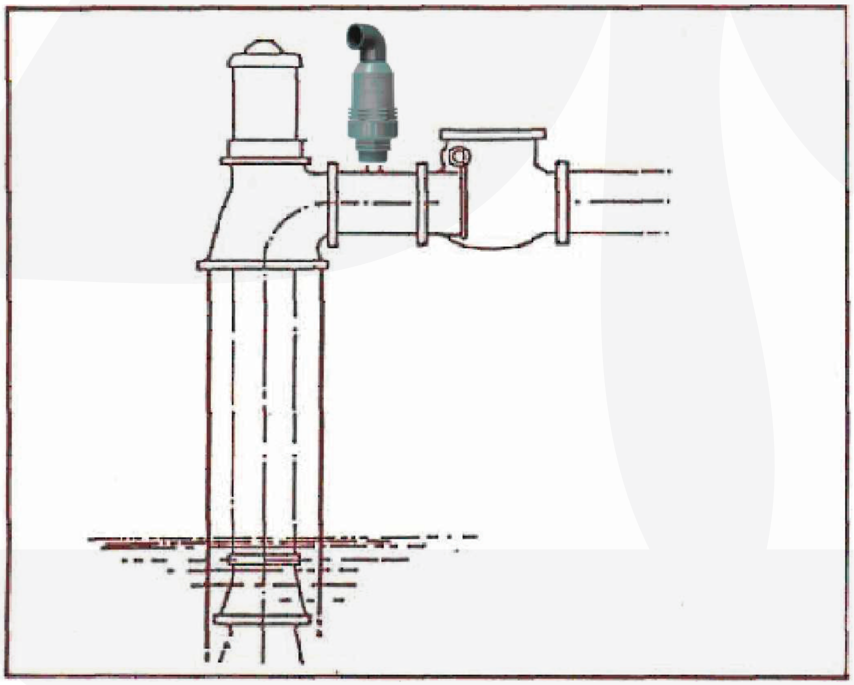


Fig. 8.

4.5. Measuring instruments.

In order to avoid the influence of air on the accuracy of the measurements and to avoid damage to the measuring instrumen ts, it is recommended to install a double-acting air valve at the inlet of the measuring instrument (fig. 9).

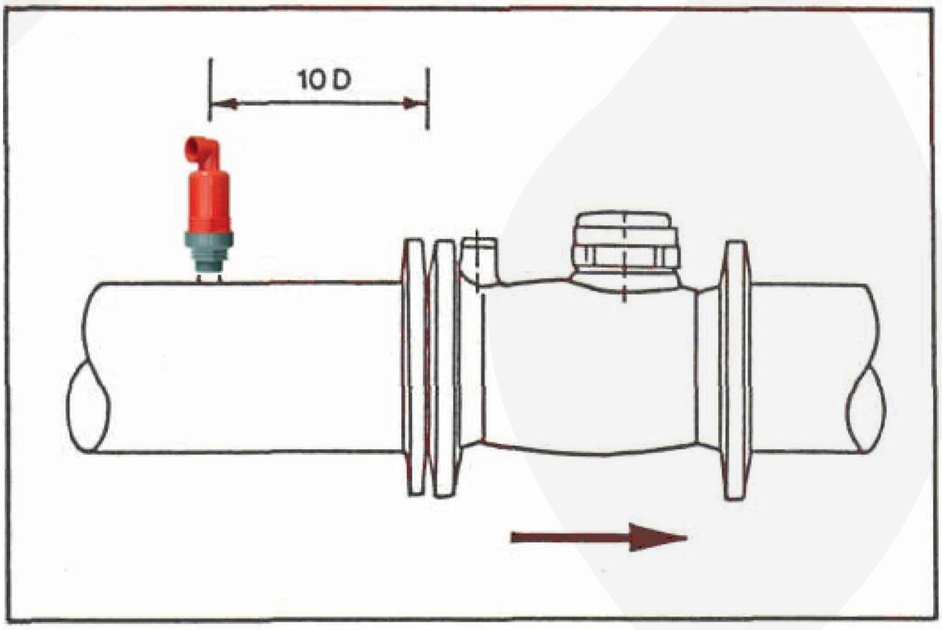


Fig. 9.

4.6. Pressure reducing valves.

The pressure reduction within the system causes the dissolved air to be released from the water. To evacuate this air, it is recommended to install an automatic air release valve downstream of the pressure reducing valve (fig. 10)

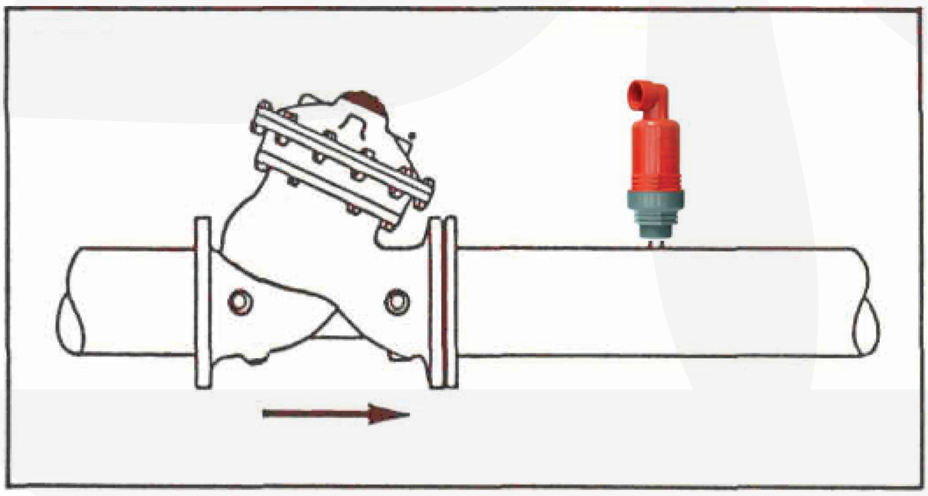


Fig. 10.

4.7. Diameter reduction.

When water enters a reduction cone, air bubbles can be released from the water. It is recommended to install an automatic air release valve as shown in Fig. 11.

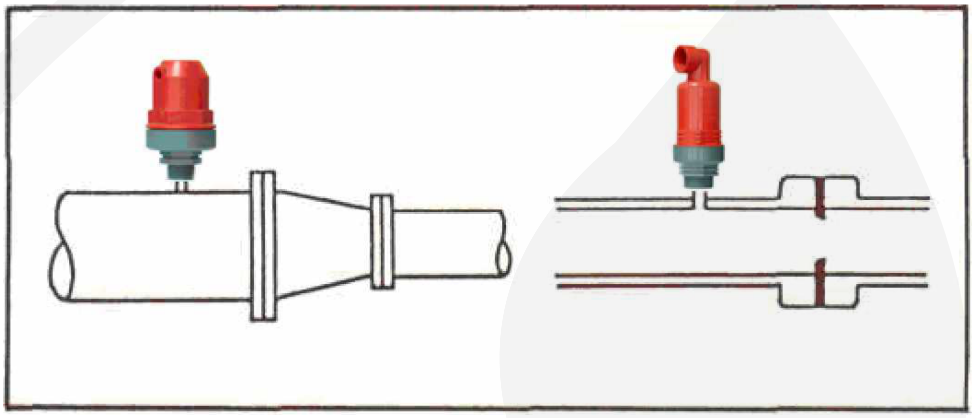


Fig. 11.

4.8. Filter system.

In the filtering system constructed on the basis of collectors, the air shall be accumulated in the upper part of the system.

In order to ensure the complete functioning of the filtering system, a double-acting air release valve must be installed (fig. 12).

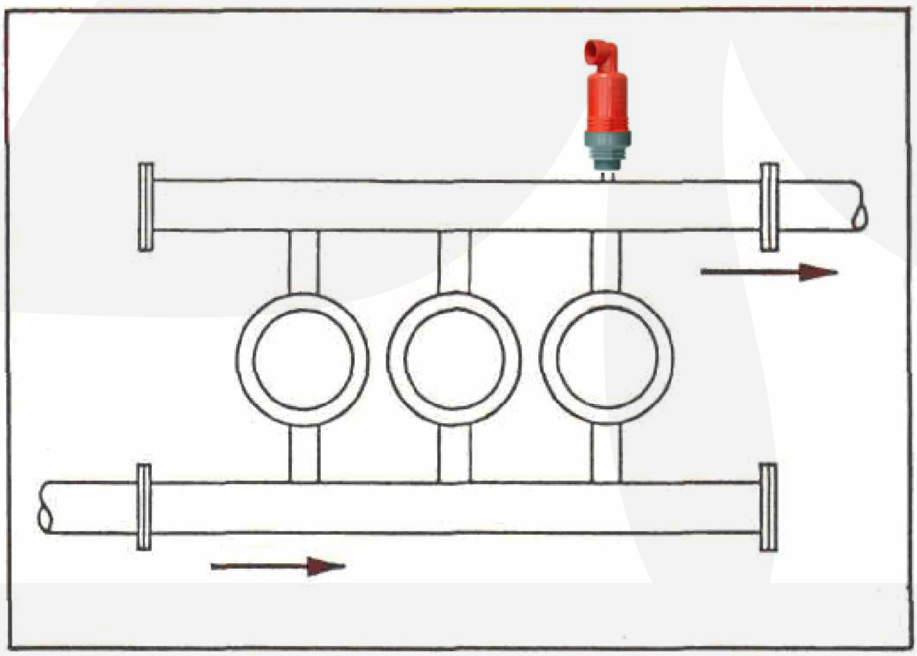


Fig. 12.

4.9. Road crossing.

Crossing under a road with a pipeline usually results in abrupt changes in the slope of the road. Therefore, a double-acting air release valve must be installed on each side of the road (fig. 13).

Fig. 10.

5. Failure.

(a) The air release valve leaks.

(1) Close the manual valve under the air release valve.

(2) Open the valve and clean the seal where the float closes. If it is free of dirt, replace it.

(3) Refit the air release valve and open the manual valve.

(b) The air release valve does not release air.

(1) Close the manual valve under the air release valve and clean the air outlet.

(2) Mount the air release valve and open the manual valve.

6. Installation and maintenance.

((a) It is recommended to install a manual isolation valve under the air release valve, in order to allow maintenance and repair operations without having to shut down the whole system.

(b) If there is a risk of freezing, the air release valve must be drained.

(c) It is recommended to perform, once a year, a routine check of air release valves, which should include:

- Unplugging the cover.

- Cleaning the orifice and outlets, also check the float seat tip.

- After the above operations have been carried out, open the manual seat valve.

Locating air and vacuum air release valves