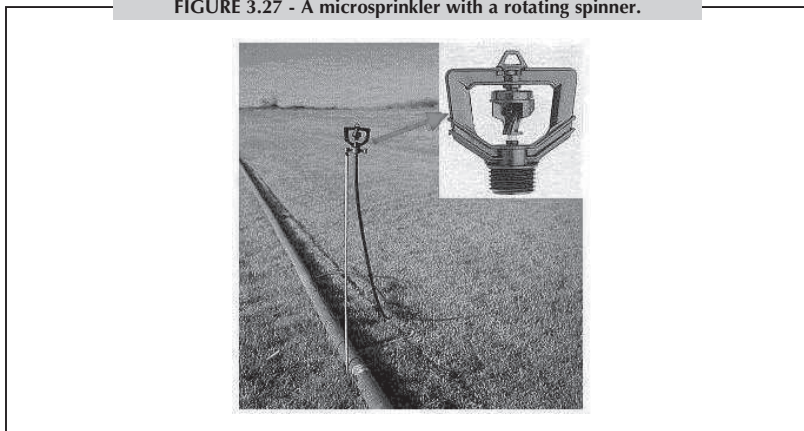


**Microsprinklers.** These water emitters are small plastic sprinklers of low capacity with flow rates less than 300 litres/h. Their main characteristics are their rapid rotation/whirling, less than a minute per rotation, the very small size of the water drops and the low angle of the water jet above nozzle. They have only one nozzle, of about 2.0 mm. They discharge 150–250 litres/h at 2.0 bars operating pressure. They are full circle and the wetted diameter is only 10–12 m. Mounted at a height of 60 cm on metallic or plastic rods inserted into the ground, they are connected to PE laterals (25 or 32 mm) through small flexible tubes 7 mm in diameter and 80 cm long. The spacing arrangement in the field is the same as for conventional sprinklers. The spacing does not exceed 6.0 m, i.e. 50 percent of the wetting diameter. The filtration requirements are about 60 mesh (300 microns) (Figure 3.27).

FIGURE 3.27 - A microsprinkler with a rotating spinner.



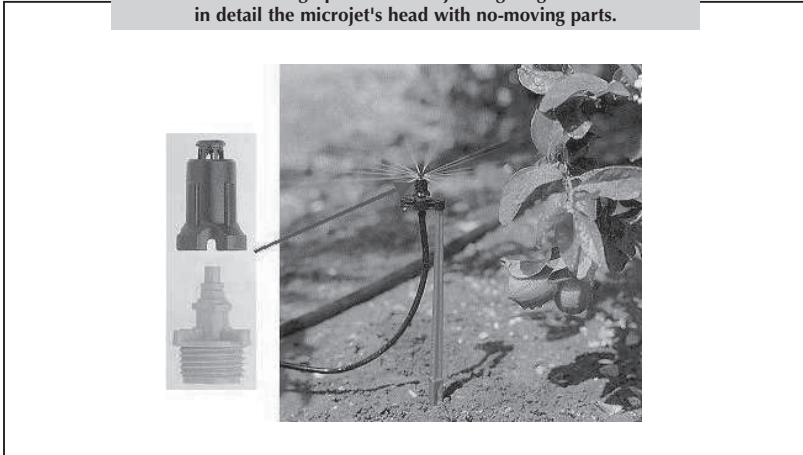
**Spitters, micro-jets and sprayers.** These are small plastic emitters with a low water discharge at a low angle in the form of fine drops in a sectorial or full circle pattern. They are mainly used for tree crops. They are of various mechanisms with a wide range of flow rates and water diameters. They have a small passage diameter, thus filtration of the water is essential. Their main performance characteristics are:

- operating pressure: 1.5–2.0 bars;
- flow rate: 35–250 litres/h (generally 150 litres/h);
- wetting diameter: 3–6 m;
- precipitation rate: 2–20 mm/h (generally 4–8 mm/h);
- filtration requirements: 60–80 mesh (250–200 microns).

Their heads are fixed to small plastic wedges 20–30 cm above ground and they are connected to the PE laterals with 7–9 mm flexible plastic

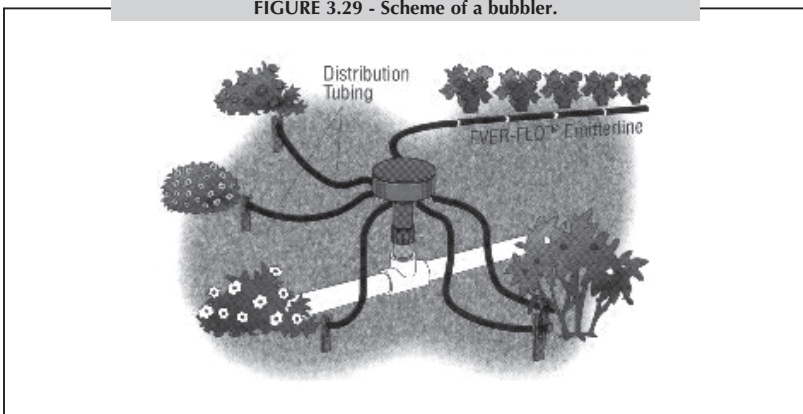
tubes 60–120 cm long and a barbed plunger. They are placed one per tree, 30–50 cm apart (Figure 3.28).

FIGURE 3.28 - Photograph of a micro-jet irrigating a citrus tree and in detail the microjet's head with no-moving parts.



**Bubblers.** Low pressure bubblers are small-sized water emitters designed for localized flood irrigation of small areas. They deliver water in bubbles or in a low stream on the same spot. The flow rate is adjusted by twisting the top and ranges from 110 to 250 litres/h at operating pressures of 1.0–3.0 bars. The bubbler heads are installed, as are the minisprinklers, on small plastic wedges inserted into the ground and connected to a PE lateral with a 7 mm flexible plastic tube 80 cm long. They are placed in a tree basin; one or two per tree. The basin is always needed to contain or control the water because the bubbler discharge usually exceeds the soil infiltration rate (Figure 3.29).

FIGURE 3.29 - Scheme of a bubbler.



**Drippers.** The drippers are small-sized emitters made of high quality plastics. They are mounted on small soft PE pipes (hoses) at frequent spaces. Water enters the dripper emitters at approximately 1.0 bar and is delivered at zero pressure in the form of continuous droplets at low rates of 1.0–24 litres/h. Drippers are divided into two main groups according to the way they dissipate energy (pressure):

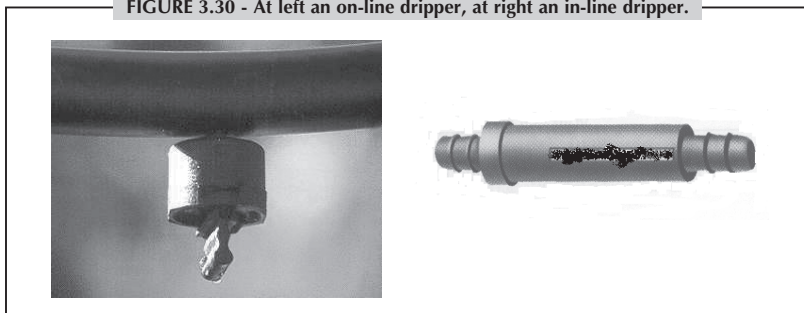
- orifice type, with flow areas of 0.2–0.35 mm<sup>2</sup>;
- long-path type, with relatively larger flow areas of 1–4.5 mm<sup>2</sup>.

Both types are manufactured with various mechanisms and principles of operation, such as a vortex diode, a diaphragm or a floating disc for the orifice drippers, and a labyrinthine path, of various shapes, for the long-path ones. All the drippers now available on the market are turbulent flow ones.

Drippers are also characterized by the type of connection to the lateral: on-line, i.e. inserted in the pipe wall by the aid of a punch; or in-line, where the pipe is cut to insert the dripper manually or with a machine (Figure 3.30).

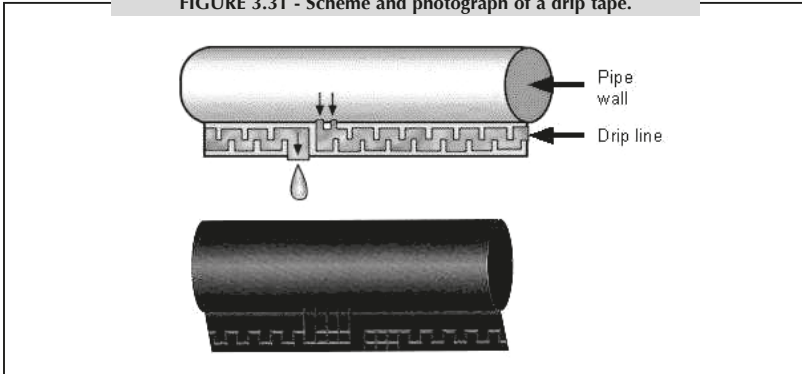
On-line multi-exit drippers are also available with four to six 'spaghetti' type tube outlets.

FIGURE 3.30 - At left an on-line dripper, at right an in-line dripper.



**Drip tapes.** These are thin-walled integral drip lines with emission points spaced 10, 20, 30, 45 cm or any other distance apart, delivering lower quantities of water than the usual drippers at very low pressures, i.e. 0.4–1.0 litres/h at 0.6–1.0 bar. They are integrated drip lines where the drippers are built in the pipe walls at the desired spacing during the manufacturing process. They are ready-made dripper laterals with a very high uniformity of application. Drip tapes are made of LDPE or other soft PE materials in various diameters from 12 to 20 mm and in several wall thicknesses (0.10–1.25 mm). Thanks to a filtration system incorporated inside the tubing, they are less susceptible to mechanical and biological blockages than conventional drippers are (Figure 3.31).

FIGURE 3.31 - Scheme and photograph of a drip tape.



**Pressure compensated (PC) emitters.** Several sprinklers, drippers and other water micro-emitters are available with built-in flow regulators. These emitters deliver a constant flow of water at any pressure exceeding the fixed operating one. Uniform rates of discharge are achieved along the laterals regardless of the number of emitters, spacing, length of line or elevation, where excessive pressure is available. Therefore, pressure variations in the laterals due to friction losses can exceed 20 percent. Thus, less expensive smaller diameter pipes can be installed in certain cases. However, the self-regulated emitters, called pressure compensated, are normally operated under pressures exceeding the fixed operational pressures and cost more than the conventional ones (Figures 3.32 and 3.33).

FIGURE 3.32 - Differences in discharge between a normal emitter and an ideal and a real pressure compensated emitters.

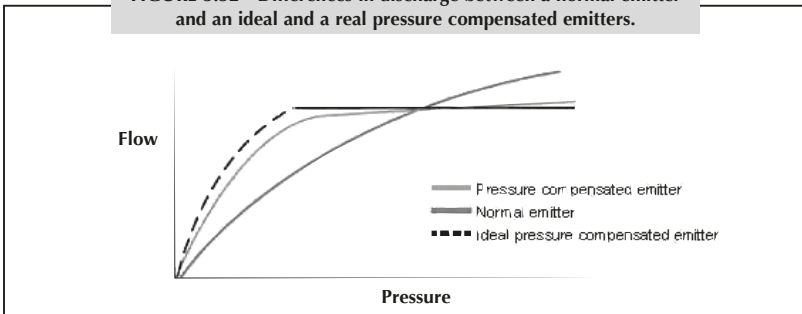
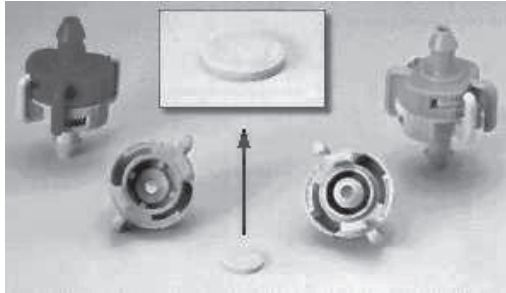
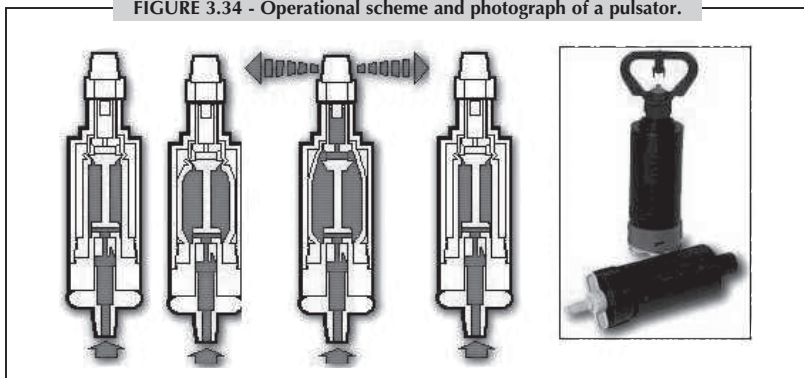


FIGURE 3.33 - Picture of a pressure compensated emitter showing the membrane that is used as flow-regulator.



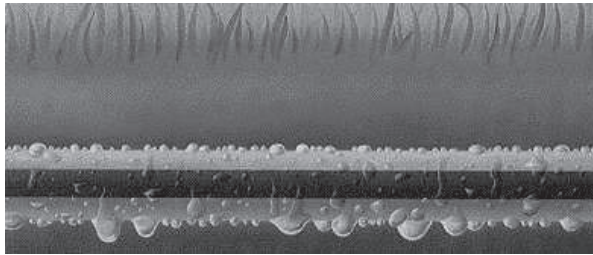
**Pulsators.** Pulsators are small plastic hydraulic devices used in micro-irrigation systems to reduce emitter and system flow rates to very low levels for higher efficiencies. The pulsators employ a built-in dripper with a discharge of 4–8 litres/h that feeds an integral silicone sleeve chamber. This in turn acts as a miniature pulsating pump generating hundreds of pulses per hour and so emitting the water. Thus, they can convert a low continuous flow into an instantaneous pressurized emission of water in short pulses. This process enables application rates of 0.3–0.8 mm/h with spitters, minisprinklers and sprayers, and 100–300 cm<sup>3</sup>/h with drippers. They are attached to the emitters, one for each minisprinkler or sprayer, and one for 20–70 drippers accordingly. The emitted water per pulse is roughly 0.5 cm<sup>3</sup>. The silicone sleeve remains closed when the water pressure drops with the termination of the irrigation and prevents the water in the system from draining. Pressure compensated pulsators are also available for use on mountains and sloping terrain (Figure 3.34).

FIGURE 3.34 - Operational scheme and photograph of a pulsator.



**Porous pipes.** These pipes are small-sized (about 16 mm) thin-walled porous flexible hoses made from PE fibres, PVC, ABS (Acrylonitrile Butadiene Styrene) or rubber. They permit water and nutrients under low pressure to pass from inside the tube, by transpiration, and irrigate the crops. The porous pipeline discharge is not accurate because the size of the pores varies and is not stable. They are used as lateral drip lines beneath the surface. Their application is limited although they do offer some advantages (Figure 3.35).

FIGURE 3.35 - Scheme of a porous pipe.



**Garden hoses.** Flexible garden hoses are made of various plastic materials, usually soft PVC, reinforced with textile or polyester yarn. They come in nominal diameters, the approximate inside diameter, of  $\frac{1}{2}$ – $1\frac{1}{2}$  inch (15, 19, 25, 32 and 38 mm) with plain ends. They have a wide range of water applications (Figure 3.36).

FIGURE 3.36 - Photograph of a garden hose with outlet.

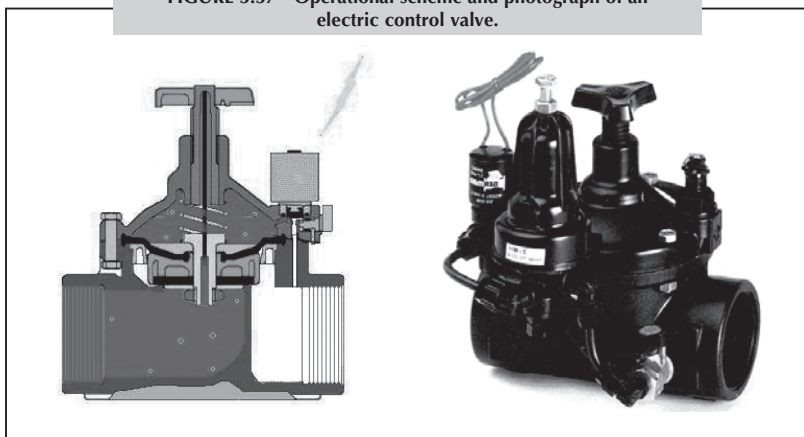


## AUTOMATION EQUIPMENT

The main component parts for automation in an irrigation system are the remote control (electric) valves, the controller and the field wiring, where electricity is the transmitting power.

**Electric (solenoid) valves.** These are automatic valves which can be commanded from a distant point to turn the water flow on and off. The body construction is based on the globe valve design. They open and close by means of a flexible diaphragm or a piston utilizing hydraulic pressure controlled by an electrically actuated solenoid valve mounted on top (Figure 3.37). Made of reinforced glass or plastic, the electric valves, normally closed, are in inches with screw-type connections, a working pressure of 10.0 or 14.0 bars, and with a handle for manual operation and flow control.

FIGURE 3.37 - Operational scheme and photograph of an electric control valve.



**Controllers.** These are automatic timing devices which supply the actuating power to operate the remote control (electric) valves, i.e. to open and close on a pre-set programme. They contain a transformer which reduces the standard voltage to 24–30 V. The power output from the electric controllers is transmitted to the electric valves through underground wiring. Their main features are the stations and the programmes. Each station usually operates one valve. The operation of the stations is sequential. There are many types of controllers available in many stations, up to 30, with dual or triple programmes for different scheduling and variable cycles of more than 14 days, and 0–12 hour station timing. Battery powered controllers are also available for independent stations (Figure 3.38).