All Mechanical Automatic Tray Filling System

Designed by Eng. João Roberto Gabbardo Ms.C gabbardo@yahoo.com
Text revision by Steven Jones stdojo@gmail.com

Introduction

Some time ago I developed a circuit to help CP growers to avoid the cumbersome task of filling the trays were the pots are resting. All of us know the problem of keeping the trays filled when we want go to a vacations trip. Frequently we must ask a parent, neighbor or friend to do the task so we can be gone on a vacation. We think all the time how the plants are going and the vacation can be a nightmare. When we return we have a surprise – but a bad one! The hard to grow *Drosophyllum lusitanicum* or the most beautiful *Heliamphora* is in a poor condition or worse: the plant died! Because I suffered this trauma I projected and built a circuit capable of monitoring the water level and automatically filling the trays. The circuit was thought to be simple and cheap, but most growers aren't skilled in electronics and never encourage themselves to learn electronics and assemble circuits. So I thought how to make a system without using electrical or electronics parts. The result was an all mechanical, easy to assembly and low cost sprinkler system.

How it works

The heart of the system is the flush tank valve. These valves are simple but with a smart assembly. The buoy – a plastic hollow sphere or cylinder – is fixed at the extremity of a stick or arm (usually made of aluminum). The other extremity has a kind of lever coupled to what is actually the valve. This valve is composed by a cylinder with a small sliding piston inside where the stick is coupled and when the valve moves up and down this piston moves horizontally closing or opening a small hole from where the water can flows. Please refer to **Figure 1** and **Figure 2**. **Figure 1** shows high water level forcing the buoy/arm upward and moving the piston to left side closing the hole. **Figure 2** shows what happens when the water level decreases. The buoy/arm goes down so the piston moves to the right, *thus* opening the hole letting the water flow.

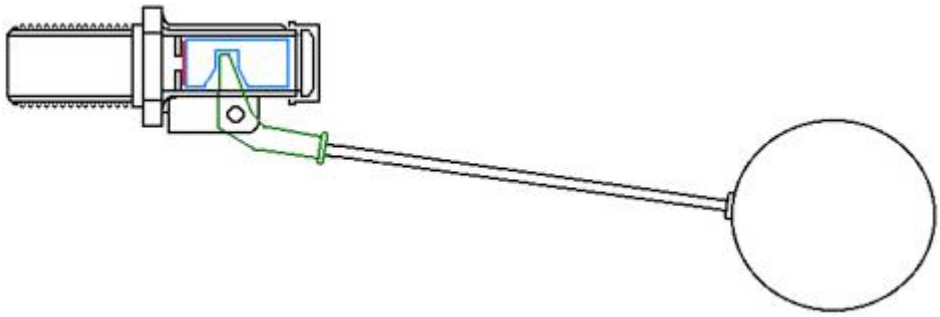

Figure 1: Valve closed

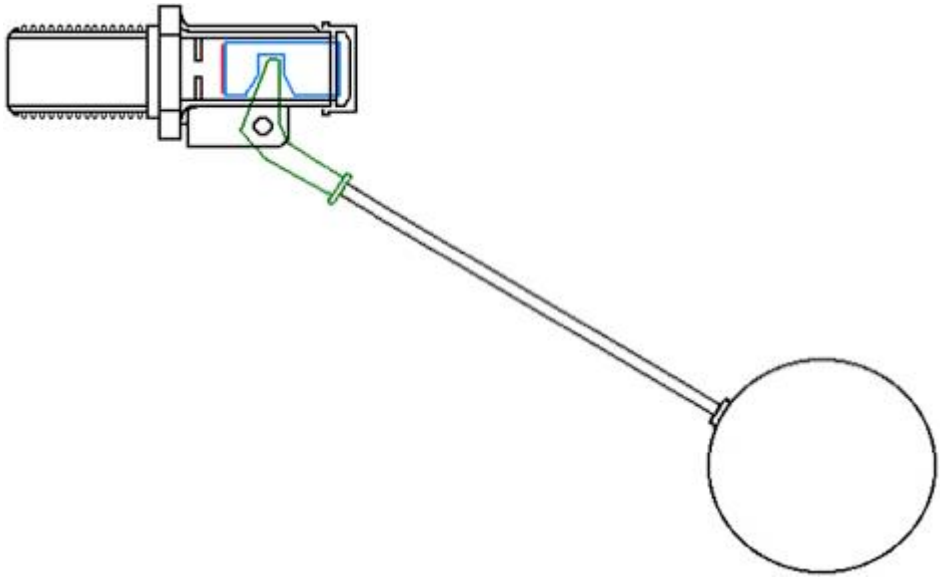

Figure 2: Valve opened

When the water will flow filling the tray the buoy/arm rises making the piston moves horizontally closing the hole and stopping the water flow. The water level can be easily adjusted by the user folding the arm.

Photo 1 shows the 2 kinds of flush tank valves used on the present system disassembled.

Photo 1: Valve disassembled

Top: the buoy and arm. Bottom from left to right: locking nut, valve body, piston, fixing pin, body cap.

The general idea is to use the fluid level changes in the trays as a triggering mechanism to keep optimum water levels in the tanks. If you put the all the trays at the same height and connect them by some way close to the bottom when you put water in one tray the water will flows from one tray to other until the water level be the same in all trays. In the present system the flush tank valve will serve to fill the trays up to a desired water level maintaining the upper level automatically.

What you will need

- Flush tank valves. The kind of valve will depend of the trays size.
- Hose, hose clamps, proper hose terminals.
- Plumbing hardware like knees, nipples, T junctions etc.
- Plastic water taps.
- Teflon tape.
- Drilling machine and drills or even a rotary toll like a Dremel.
- Round file.

Photo 2 depicts the plumbing hardware.

Photo 2 - Basic material to the sprinkler system

Of course the kind of materials will vary according to the grower conditions i.e. kind and number of trays and the available material on local hardware suppliers.

Assembling the system

There are two ways to mount the valves. The first is to fix the valve in one of the trays and the other is use a separate tray or box with size to fit the valve inside. The first method is preferable if you have a very limited space for the trays but the valve will rob precious space inside tray. Of course the trays should be sufficiently tall to allow for free movement to the buoy and a good degree of water level adjustment so the second method is indicated if your trays are shallow. In my first attempt I installed one valve inside each tray. At this time I just wanted to evaluate the system and if it had not worked as I was expecting the valves should be simply removed from the trays. Also I did not want to drill extra holes and had leakage troubles. When the number of species grew I decided to use only one valve and interconnects between the trays by using small taps and pieces of hose because the rack I built to grow my plants was completely occupied by 3 big trays and as a result lacked enough space for even a small tray. It worked well until I needed more and more space for other species and I finally put one box with a cover outside the rack. This box is 35cm tall, 36cm wide and 72cm long and the valve fitted nicely inside. As the box is taller than the trays the water level adjustment is easier. The cover is desirable since it prevents the valve from being damaged by UV rays. I also substituted the small taps for others for the same reason. More later.

The first step is to drill the hole to attach the valve. If you want to mount the valve inside the tray keep the buoy 1cm apart from the side inner wall. Here I'm describing how to install the valve in a separate box. Align the valve in the center of the wall that you want to fix it and draw a line marking the water entering center hole outside tray/box border. Use the valve plastic nut as a gauge valve pattern to mark the valve fixing hole in the tray. Align the plastic nut center with the line previously made and draw a circle having the inner nut diameter. Draw this circle as near as possible the upper edge to allow the widest possible up/down movement to the buoy. Drill a small hole in the center of the marked circle and enlarge it using a round file *until the valve can be firmly attached*. **Photo 3** shows the hole drilled in the box as described later. Doing so will allow for easy water level adjustment after the valve is attached to the tray. Why am I saying it several times? Please handle the valve and you will see that the piston of the valve can moves few millimeters inside the valve body cylinder. **Photo 4** shows the small gap between the piston and the water output hole when the buoy valve is completely moved downside.

Photo 3 – Hole to fix the valve in the box

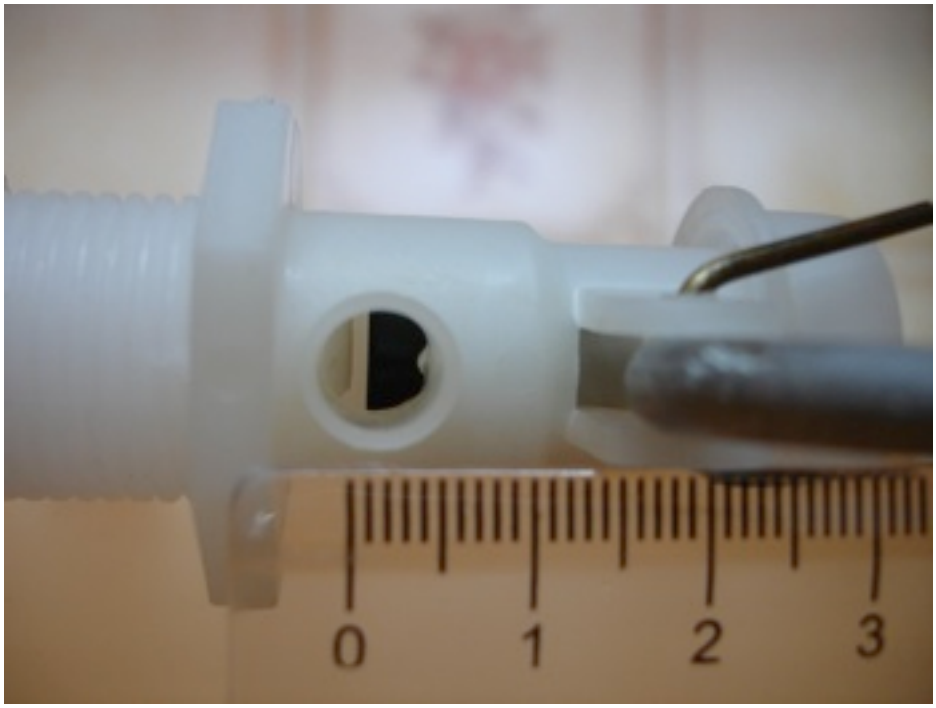

Photo 4 - Valve opened

If the tray is too shallow the adjustment can be very difficult so attempt to not install the valve in a flat one! Even with a deep box I need to fold the buoy arm to fit the valve inside the box as the **Photo 5** depicts.

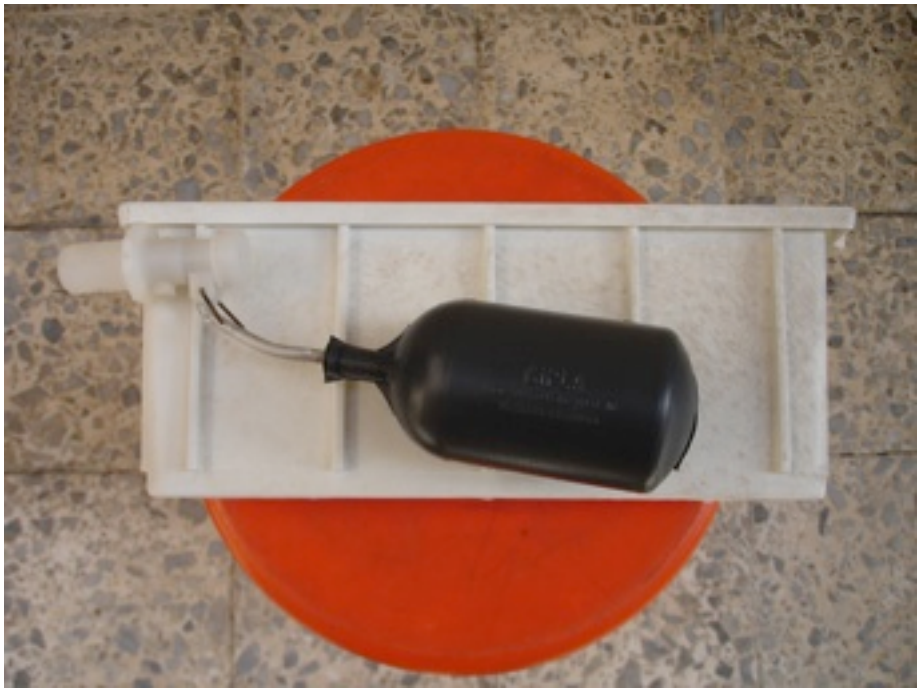

Photo 5 – Buoy arm folded to the valve fit inside box

Now insert the valve, lock the nut and cover the treads with some layers of Teflon tape to prevent any water leakage after connecting the hose tip. **Photo 6** shows the valve fixed inside the box.

Photo 6 – Valve fixed inside box

To connect the trays I first used small plastic taps and sections of a kind of plastic hose used in hot showers. These taps are intended to be use with water filters having a large front lip and are fixed in the filter by a large plastic nut and washers. **Photo 7** shows the tap and **Photo 8** the interconnection between trays.

Photo 7 – Small plastic filter tap

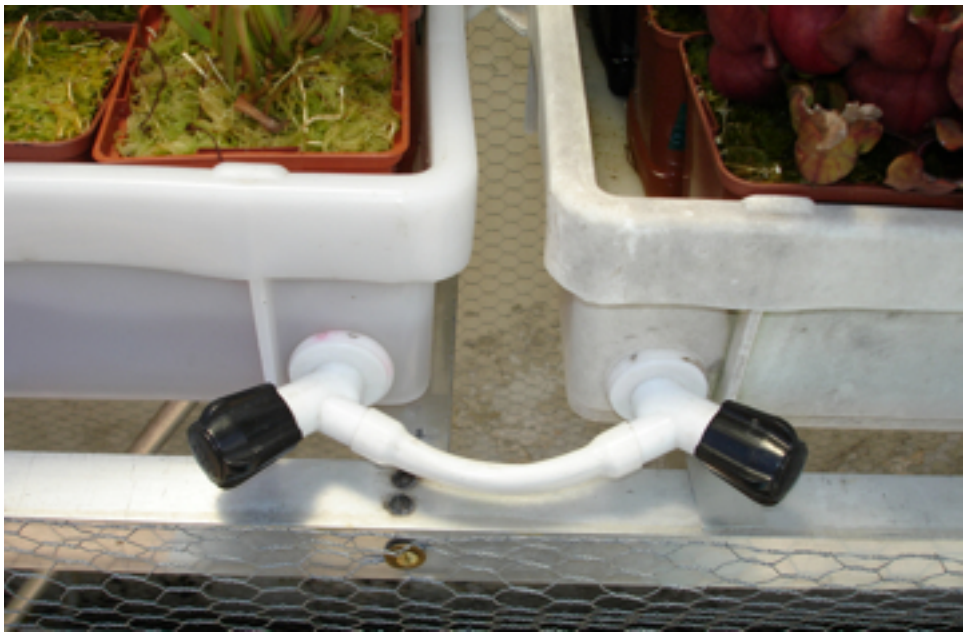

Photo 8 – Connection using small taps and sections of hot shower hose

The font large lip and plastic nut/washer assembly had worked very good to impede water leakage but soon I noticed a big problem with these small taps: they were not resistant to UV rays and I frequently needed to change them. Note how the taps are close to the tray bottom.

As described later, these small plastic taps are not resistant to UV rays and to avoid this problem I substituted them for regular plastic water taps like the one in **Photo 9**. The tap fixing screw is 1/2 inches and I didn't found suitable nuts to fix it on the tray the first time. My first idea was made the nuts by myself cutting sections of plumbing plastic PVC sleeves. I used the ones to couple 3/4 to 1/2 inches diameter PVC plumbing pipes.

Later I found some 3/4 to 1/2 inches a plastic reduction to be used with garden hoses that have proven to be excellent nuts. **Photo 10** shows the nuts made from PVC sleeves and the reductions.

Photo 9 – Plastic water tap

Photo 10 – Nuts made from PVC sleeves and reductions

The holes in the trays should be made as close as possible of the tray bottom. To drill the holes use the tap plastic/PVC nut as gauge like described later to the valve.

Photo 11 shows one tap fixed using the nut made from PVC sleeve and **Photo 12** one tap fixed using the plastic reduction.

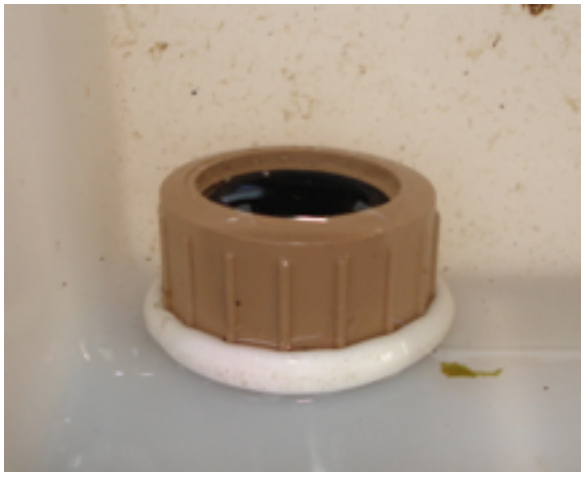

Photo 11 – Tap fixed using the PVC nut

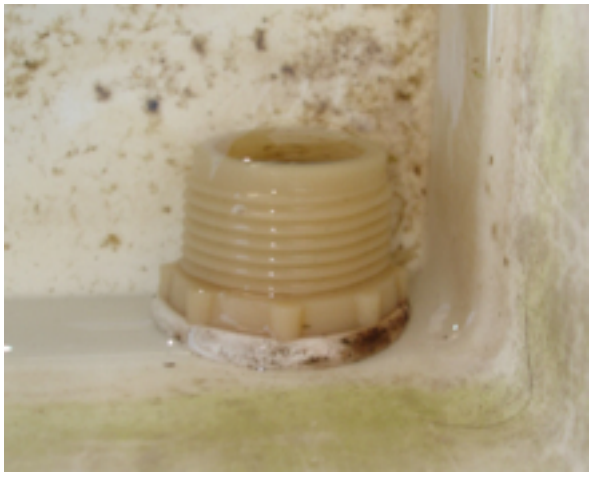

Photo 12 – Tap fixed using the reduction

These regular plastic taps with threaded tip allows you make the interconnection between the trays very smooth using pieces of garden hose and corresponding connectors. **Photo 13-a** and **Photo 13-b** shows how the box and trays are interconnected by this way.

Photo 13-a - Box and tray connected

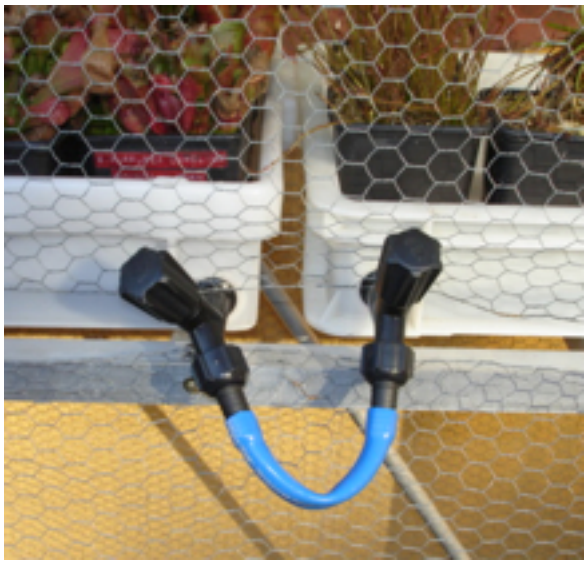

Photo 13-b – Trays connected

These plastic taps allows you easily clean the trays once a time very easy. You only need to close the taps of the other trays and unscrew the connections.

Let's connect the water to trays. Make sure to use a garden's hose resistant to UV rays and that doesn't became softened by the sun heat. The UV rays are harmful to some plastic and rubber and since the water will exercise pressure to the outside of the hose it will expand and explode in hot days. A good kind of hose is the type with twisted nylon inside the plastic. Depending of the number of trays and how they are disposed you will need some T junctions for hoses, knees and nipples to do it. The following pictures show my first attempt with separate valves. The quality of these pictures is not good (600 × 800 resolution) since I used a webcam this time. **Photo 14** shows how the water was distributed. Here 2 T junctions were joined using a nipple to distribute the water to 3 trays. All hoses were locked using hose clamps to avoid water leakage. **Photo 15-a, Photo 15-b** and **Photo 15-c** show the valves installed and the system working properly.

Photo 14 - Water distribution

Photo 15-a - Valve in the 1st tray

Photo 15-b -Valve in the 1st tray

Photo 15-c - Hoses connected

The **Photo 16** shows the remaining valve in only one tray and **Photo 17** the water connection to valve. Note the use of a knee in the connections.

Photo 16 - Remaining valve

Photo 17 - Water connection

The trays showed on the photos have the following dimensions: 68 cm length, 36 cm width and 9 cm depth. It is a good idea drill some drainage holes in the trays. If the valve remain locked in open position by some way the water will fill the tray flooding the small pots. The maximum water level can be adjusted just below the drainage holes by folding the buoy arm according.

If the place where you grow your plants is located close to a house wall the hoses can be squeezed. To overcome this problem you may use some additional plumbing. One knee with the same inner gauge of the valve water input and a nipple will do the job like in the previous photos. *Do not forget cover the treads with Teflon tape before attach the pieces!*

My box remained sufficiently far apart from the wall to dispense the extra nipple and knee. **Photo 18** shows how the hose is connected directly in the box.

Photo 18 – Hose connected directly to the valve

Improvements

A possible improvement to the system is the use of "quickly clamp" garden hardware. The "quickly clamp" connectors allow fast and easy disassemble/assembly of the system to clean the trays. On the other hand, this hardware is more expensive than ordinary plumbing hardware and is prone to be damaged when exposed to the sunlight for long periods of time because the UV rays.

Problems

The system is very simply and by this way the problems can be predicted. As the valve has moving parts they will wear with the age. The buoy also can be filled with water and sink so the valve never will close's. Since they are cheap devices it will be very difficult or perhaps impossible get spare parts for them and the entire valve should be replaced. Sometimes the valve can lock from dirt accumulated on the arm fixing pin. You will need to remove the valve, and then disassemble and clean it using a brush. These valves can be damaged by the UV arrays and the best is providing a cover to protect them from direct exposure to the sun.

Conclusions

The system is very easy to be assembled using cheap and easy to find parts. Anyone will be able to build such a system even without being skilled with mechanicals but if you had any doubt, critical or suggestion, please send an email to: gabbardo@yahoo.com

I hope you enjoy it!

Acknowledgements

I wish thanks so much Steven Jones a CP grower and friend who gently revised the text and without his work the text probably would be looking messy and unreadable.