



Spitfire VSR

Variable rotation speed, governed, travelling irrigator

Operator's Manual Version 2.01

Version: VSR 201 September 2011



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Operating specifications

Description and features

The **Spitfire Intelligent Irrigator, Model VSR 201** is a travelling irrigator with electronic application depth control (governing) and an especially uniform spread pattern. It is capable of irrigating water, and dilute liquid manures containing particles smaller than a 14 mm diameter sphere.

Electronic governing of the speed allows the irrigator to apply consistent amounts of liquid along the run. The governor compensates for the differing flow rates and wetted widths that result from different or changing supply pressures or changing hose loads.

VSR (Variable Speed Rotary) indicates a departure from the previous oscillating style of machine.

Wetted widths

Wetted widths depend on pressure and rotational speed. Higher pressures give greater broadcast ranges, while faster rotational and travel speeds reduce wetted widths.

Operating pressures are between 2.4 and 3.5 bar. The machine won't run outside of these pressures.

At 3 bar (44 psi) and when applying 20 mm liquid, the maximum *wetted* width in calm conditions will be around 50 metres. For practical purposes, lane spacings should be about 40 metres to evenly distribute the water. (That is, some overlap is necessary to compensate for the lighter application at the extremes of the thrown jet.)

Travel distances

The standard rope (and travel) length is 250 metres, but 350 can be accommodated in the rope canister.

Application depths

The equivalent rainfall (application depths) for this new rotary irrigator are:

8, 10, 12, 15, 20, 25 mm with the standard 18 mm diameter nozzle and long boom.

10, 15, 20, 30, 35, 40 with the 20 mm nozzle and shortened boom option.

These depths are pre-selected by means of two switches on the irrigator control box. Once selected, the irrigator regulates (governs) its own speed to deliver the required amount of liquid, and it compensates for varying supply pressures along the run or different pressures at different hydrants.

Application rates

Application rates are **not** *application depths*.

Application **depths** are the amounts (depths or “thickness” of the liquid “layer”) that is applied to the land

Application **rates** are the speed at which the liquid “layer” is applied to the land

For example, you may apply a 20 mm depth of liquid to the land and take ½ an hour to do it. (The application *rate* is therefore 20 mm in ½ an hour or 40 mm in one hour) If you applied this 20 mm of liquid over 2 hours then the *rate* would be 10 mm per hour.

The soil also has a rate at which water will infiltrate. E.g. In sandy loam, water will soak in at an infiltration rate of 14 mm every (per) hour. If you used the first of the two application **rates** mentioned above, you would apply liquid faster than it could soak in. Thus it would pond on the surface until it such time as it vanished. (The application rate is 40 mm per hour while the infiltration rate of the soil is 14 mm per hour) In the second case, the application rate is 10 mm per hour while the soil infiltration rate is 14 mm per hour. In this case the liquid will be absorbed faster than it is being applied.

In both cases 20 mm was the applied **depth**, but the **application rates** were different.

It is recommended that liquid is applied at close to the rate at which the soil can absorb it, otherwise liquid ponds can arise. The water then starts to travel over the surface of the land to places where it may not be wanted. The amount delivered to the target zone will be reduced.

We understand that some “shallow puddling” is inevitable, but it is desirable that it is not evident after 15 – 20 minutes. And its average depth over the target zone should not be greater than the amount of liquid being applied.

Drag hose

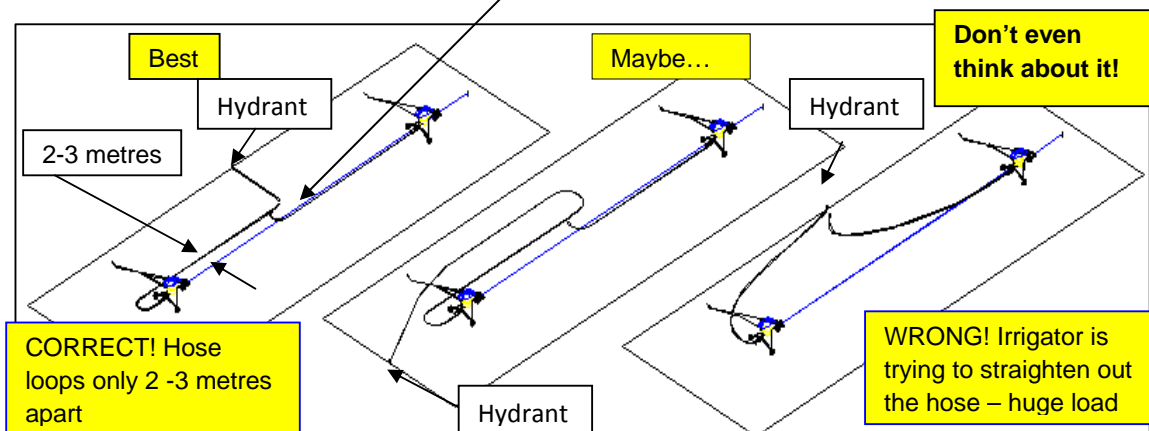
Small diameter drag hoses are easy to move, but need more pressure to carry the desired flow rate of fluid. Large hoses need less pressure but are much heavier and stiffer, and tougher to move.

The best compromise for this machine is a **63** millimetre Outer Diameter (OD) Medium density Polyethylene (MDPE) hose no more than 200 metres long, rated at 6 bar. (PN 6)

However, you can use a 75 OD hose of MDPE about 140 metres long, but then the travel distance reduces to about 200 metres.

Divide the drag hose into four equal 50 metre lengths with a 50 mm male and female Camlock coupling at each end, **double clamped!** The hose must have a working pressure rating of at least 6 bar.

See the diagram below. **The drag hose should be laid out about 2-3 metres from the cable.** At the end of the run there should be a small residual loop in the hose. Irrigators will stall if the water pressure is too low to give the jet thrust that pulls the hose. And if the hose is laid out **incorrectly**, it can easily treble the pull required and almost guarantee stalling in the paddock.



New features

This **VSR 201** model incorporates a number of new features as **standard**:

Motion detection: If the irrigator has not moved but the boom has rotated 20 revolutions, then the valve at the rear of the machine will close. This creates a pressure rise at the pump which can be used to turn the pump off.

Absence of rotation: If the boom has not begun to rotate within 3 minutes of pressure being applied to the machine, the valve at the rear of the machine will close, so as to prevent a puddle in the paddock.

When the machine stops for any reason (such as: Pump stops pumping, low pressure, excessive pressure, reaches its stopping point, no travel when it should be travelling) the valve at the rear of the machine closes. This prevents the contents of the main line from draining.

When this valve is closed, pressure in the line may build up as a result of bacterial gas generation in the supply line. In this case, the valve will open for a few seconds to release the excessive pressure. It will then close again when the pressure has dropped.

If the machine has stopped, it can be **reset by depressing the rope stop switch** actuator at the front of the machine. There are two states of stoppage (See also p. 15): **Normal stoppage** (such as when the pump stopped pumping; irrigator has reached the end of its rope or rope setting) and **Lock-out stoppage** (where some undesirable condition causes the irrigator to stop. E.g: The machine stopped travelling for some reason; pressure was too low or too high, there was a nozzle blockage)

In the case of **Normal stoppage**, the machine resets itself and waits for the pump to start up again or, if it has reached the end of its rope it waits to be shifted to the next run.

In the case of a Lock-out stoppage, the machine waits until someone has visited it and determined what caused it to stop. A switch position can be selected, and the irrigator will give “beeps” which indicate the reason for the stoppage. The code for the “beep’ is on the side of the machine.

Self steering: The irrigator now has a steering drawbar so that if it drifts off course it will steer itself back on course. A bias causing the machine to steer to the right is deliberate, and is in-built to counteract the boom torque (turning effect) along with the hose offset at the rear of the machine.

Brake: On downhill slopes when there is little hose to pull, the machine can run down the slope. A spade is fitted to the drawbar, which is usually raised by tension in the rope. If the rope becomes slack, the spade contacts the ground and digs in a little. When rope tension returns, the spade is pulled clear of the ground.

Wheel track: This has been increased by 400 mm to ensure even better stability.

Pressure requirements

The **maximum desirable** operating pressure is when the gauge on the machine reads about 3.0 bar = 43 psi = 310 kPa. The machine will function best at pressures between 2.4 bar (35 psi) and 2.9 bar (42 psi). Higher pressures produce more aerosols and spray drift and waste water. Lower pressures reduce the pulling force of the irrigator and reduce the wetted width. **The machine will turn itself off if the operating pressure is less than 2.4 bar (35 psi) or greater than 3.5 bar (50 psi).** In the first case, there may be insufficient pulling power, and in the second case, the power available will be excessive and the machine may damage itself.

Progressive cavity pumps for this machine should be rated at 5 to 5.2 litres per second for best performance.

With centrifugal pumps, it may be desirable to fit a valve at the rear of the machine and adjust the pressure to around 2.9 bar in each paddock.

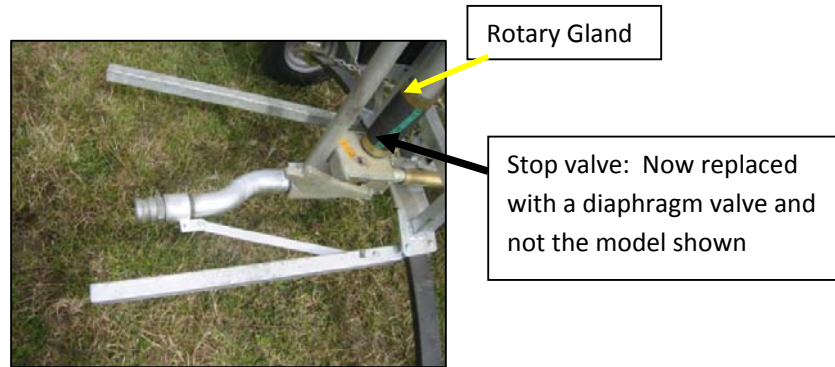
Ground anchor details

This machine can generate up to 600 kilogrammes of tension in the rope. You should anchor the rope to a stout strainer post with the wraps around the post being at ground level.

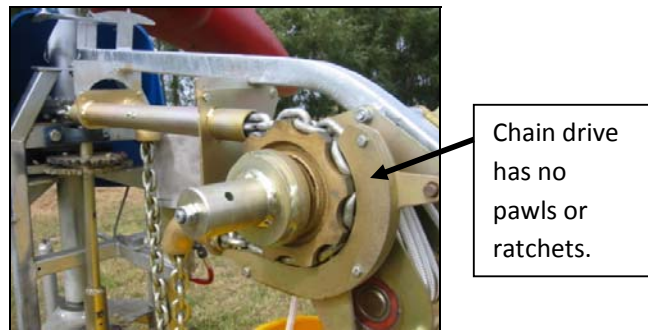
Components of the irrigator

This “VSR” model irrigator has a rotating boom with a single counterbalanced nozzle supplied via by a hose to a special stop valve at its base and which is connected to a rotary gland.

The rotary gland allows the boom to turn while sealing the liquid at the joint between the fixed part and rotating part of the machine.

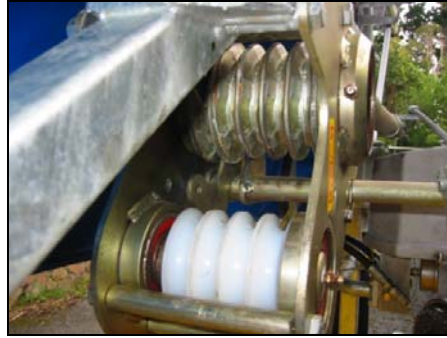


The stop valve is tripped when the irrigator reaches the end of its run, and it closes slowly so as to stop the liquid flow relatively gently. The boom rotation then stops and so does the travel of the irrigator.



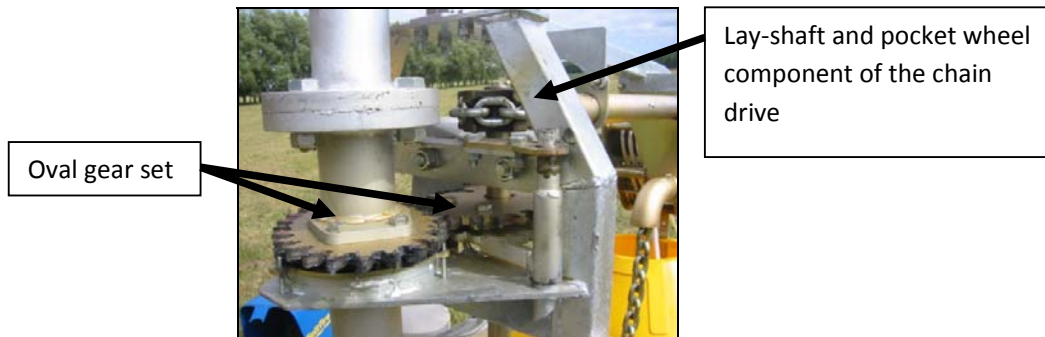
The rotating boom drives the capstan (winch) via a unique chain drive (see above) and it also drives another shaft to which the governor is attached – the lay-shaft.

The capstan winds up the rope and deposits it into the canister. It has a clutch that allows the rope to be pulled out to the field anchor. The clutch consists of a large hexagonal socket which engages a hexagonal nut, with a freewheel. Even when the clutch is engaged, the freewheel still allows the hand wheel to be wound up to recover slack rope. When the clutch is disengaged, the rope can be pulled out to the field anchor.



Capstan without the rope

The boom drives the lay-shaft via oval gears. The lay-shaft is attached to a gearbox and hydraulic pump, which maintain the layshaft speed constant. But the oval gears then enable the acceleration and deceleration of the boom, twice per rotation. Traditional rotary irrigators apply heavy amounts of liquid at the outer limits of the wetted width and reduced amounts of liquid on the centre of the run. The oval gears allow this machine to speed up when liquid is being applied to the outer edges of the run and to slow down across the centre of the run. This enables a more uniform application of liquid across the wetted width.



Oval gear set

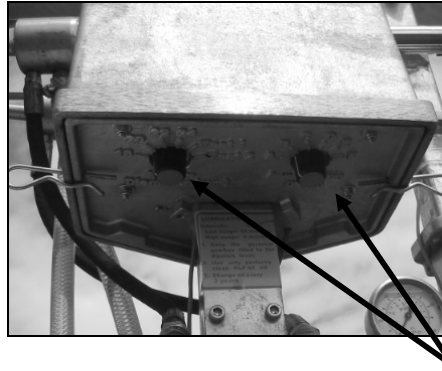
Lay-shaft and pocket wheel component of the chain drive

All of these items are grouped together on a chassis consisting of a mast, a spine, and chassis member. Various covers are used to protect the mechanisms. The cover on the boom also provides counter wind resistance in high winds.

Operating principle

Governing is a process whereby the control of machine function is regulated - with the aid of feedback - to produce the desired result.

This irrigator is fitted with a governor which is “told” how much water the machine must apply, and then adjusts the travel speed and makes allowance for changes in water pressure (as the machine climbs or descends valleys) or as the hose load alters.



The governor electronics are inside the controller box. Selector knobs shown.

In this case we use the two selector switches on the control box to “tell” the machine how much liquid we want to apply. Using information stored in the pre-programmed electronic module, it measures the liquid supply pressure at its pressure sensor, and measures the time of each boom rotation. (Each revolution of the boom means an increment of travel along the paddock) If the boom rotation speed is too low for the desired application depth, the governor oil flow adjustment motor opens a small valve which allows the machine to speed up. It may make 3 or four adjustments before it settles to its desired speed. When that speed is reached the governor may do nothing until it senses that the machine has slowed. (Perhaps the hose has become harder to pull.) It will then open the valve again to increase the speed, and may again need three or four adjustments to get it just right.

Resistance to slow the machine down is provided by the hydraulic pump on the bottom lay-shaft. It pumps oil through the small valve orifice attached to the governor. If the governor fully closes this valve orifice, the machine encounters huge resistance and locks up. As the valve orifice opens, the resistance drops and the boom can start to rotate. When the valve is completely open, there is very little resistance to rotation. Thus the governor opens and closes this valve orifice to add or remove resistance to motion, depending on the programmed parameters within the controller electronics.

A 12 Volt d.c. battery supplies energy to only the controller, and the controller uses only a tiny amount of battery energy to drive the flow adjustment motor. The main rotational thrust that rotates the boom (and which winds in the rope) is generated by the liquid jet rushing from the nozzle on the end on the boom. This jet is at the end of the boom arm (a lever) and the turning effect comes from the jet reaction. The rotating boom turns the lay-shaft – the lay-shaft turns the hydraulic pump and the capstan – the capstan winds in the rope – the rope pulls the irrigator and its hose over the ground.

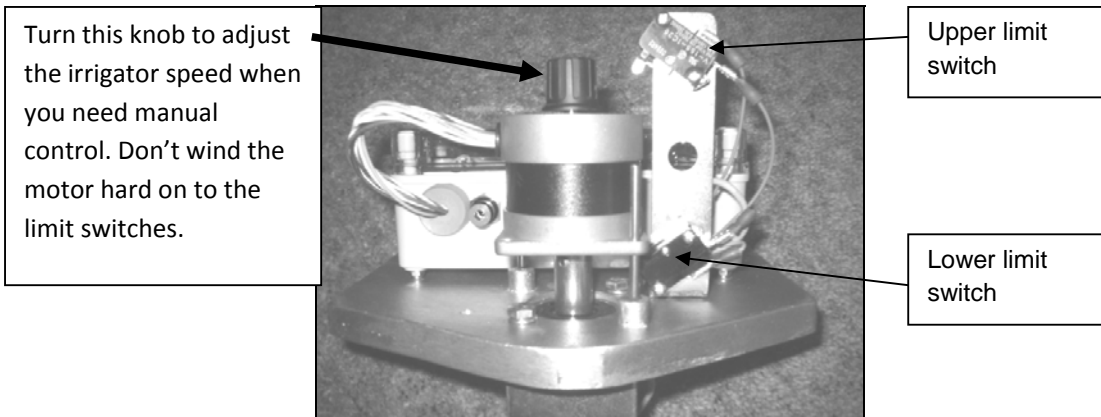
Variable speed rotation (VSR)

Previous models of our irrigator used an oscillating boom to achieve a uniform liquid distribution pattern. The VSR machine is a rotary machine with speed variation during the full rotation. The special oval gears which are fitted to the boom and the lay-shaft provide a variable gear ratio as the boom rotates. Since the lay-shaft is attached to the governor, the lay-shaft’s speed is kept relatively constant and appropriate to the desired travel speed. But since the gear ratio is changing, while the

lay-shaft speed is maintained constant, the boom speed must rise and fall twice during each rotation. Thus across the middle of the run, the liquid is applied by a slower running boom, which then accelerates to a higher speed while it applies liquid at the outer edges of the wetted swathe. This evens out the non-uniform application found in traditional travelling irrigators. The ratio between the highest and lowest speeds is 2:1.

Manual override of speed control

Even if the battery goes flat (less than 11.6 Volts), speed can still be controlled, by referring to this manual override feature. The battery leads are disconnected at the battery, and boom rotational speed is regulated by adjusting the black knob on the top of the electric motor located under the aluminium controller cover. There is no compensation for hydrant pressure when you use this mode, so the application amount is “nominal” – that is, close to the target amount but not under such fine control. Further, the valve at the rear of the machine won’t operate.



The rotation speeds for manual setting are:

18 mm nozzle (2.75 bar = 40 psi)

Nominally applied depth	8 mm	10 mm	12 mm	15 mm	20 mm	25 mm
Time for one boom rotation	9 sec	11 sec	14 sec	17 sec	23 sec	31 sec

20 mm nozzle (2.75 bar = 40 psi)

Nominally applied depth	10 mm	15 mm	20 mm	30 mm	35 mm	40 mm
Time for one boom rotation	9 sec	13 sec	18 sec	27 sec	32 sec	36 sec

Rope type

The rope is 10 mm diameter polyester braid with a breaking strain of 2500 kgf.

Stability

Caution: In high winds in exposed locations, gusts may topple this machine.

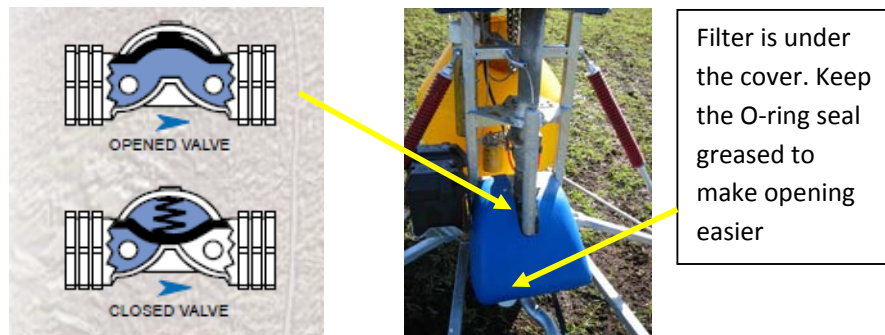
Caution: Running the machine on slopes may also lead to a capsize.

Tracking

The front wheel is self steering. The torque of this machine inclines it to steer a curved path along the paddock when the front wheel is pointed directly ahead. However, if it is set to steer the machine to the “right” it will manage an almost straight path along the paddock. The hose fitting at the rear of the machine is offset to assist with this characteristic.

Stop valve

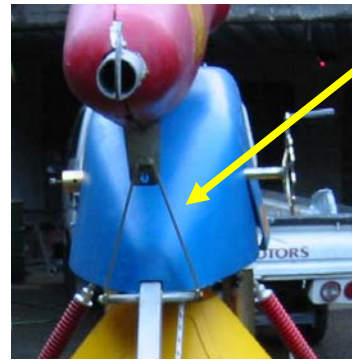
The stop valve at the rear of the machine is a diaphragm type. It uses water pressure to open or close. The water pressure which controls the valve is filtered to 50 microns **via a filter on the rear of the machine**. A 12 Volt d.c. Dorot solenoid valve, operated by the main controller causes this diaphragm valve to open or close. The filter cartridge is washable (in clean water) and should be washed every 2nd month, or earlier if valve operation becomes erratic.



The **air-bell** on the inlet pipe contains compressed air, which is led to the controller pressure sensor. This enables the governor to know what pressure is being applied to the machine. Each time the drag hose is disconnected, liquid drains from the air bell and a fresh charge of air enters the air bell.

Moving the irrigator

- When the irrigator has completed its run, **turn off the hydrant valve first**. Then go to the machine and unfasten each Camlock coupling in the drag hose. This allows the drag hose segments to drain while you shift the machine.
- Release the rope from the field anchor and carry the end back to the irrigator.
- Rotate the boom until it is aligned down the centreline of the machine, nozzle aft. Latch the boom and then loop the rope end over the hook on the end of the boom. **DO NOT ROTATE THE BOOM IN THE WRONG DIRECTION**. There is a backstop preventer which should lock the machine if you try to rotate the boom the wrong way. Find the easy way to rotate the boom. If you overshoot the mark during rotation, then go around again.



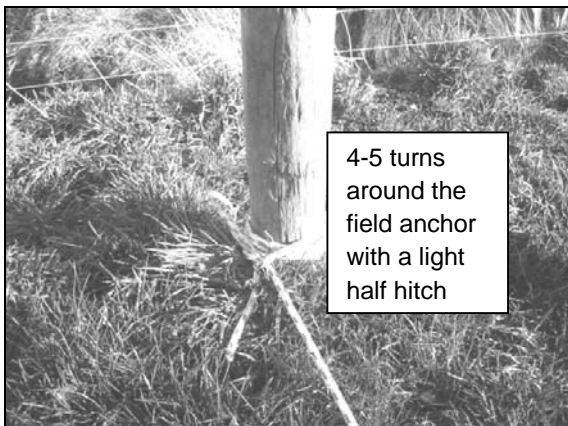
Boom latch

- d) Use the hand-wheel to wind the remaining slack rope into the canister. This will also wind slack rope on to the capstan drum and release the tight coils of rope wedged into the drum grooves. The first turn or so of the handwheel might be rather tight. **Do not undo the clutch yet.**

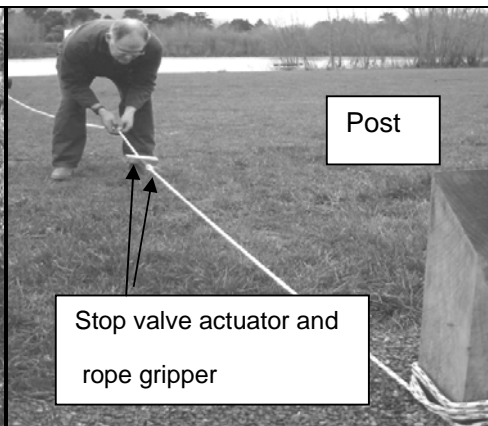
- e) Latch the irrigator to your ATV, quad-bike or ute and tow it (at a crisp walking speed - no more than 10kph) to the next site and point it in the right direction for travel.

- f) **Undo the clutch.** To do this, hold the rope near the capstan drum with your left hand, and rotate the hand wheel anti-clockwise. If you pull the rope as you do this you will feel the rope come free as the clutch disengages. Give the handwheel another turn **anti-clockwise** until you just feel resistance to the turning.

- g) Unhook the rope and take the rope, the friction grip and the striker to the field anchor at the end of the run. Wrap the rope end about 4 times around the post, tie a half hitch and then slide the friction grip and striker so that they are at least 5 metres from the post.



4-5 turns around the field anchor with a light half hitch



Post

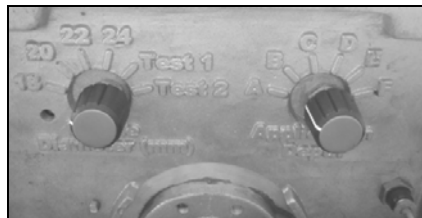
Stop valve actuator and rope gripper

- h) Now go to the drag hose segments, and snig (the end with the female Camlock) with a rope loop which will also loop over the drawbar of the ATV. Tow this line over to the irrigator. Set up the lines as shown on page 5. The drag hose should be about 2-3 metres from the irrigator rope with the loops as shown in the earlier diagram.

Clutch engagement/disengagement

When the hose is coupled, go to the irrigator and start to turn the handwheel, clockwise. This will cause the socket to engage a nut. It takes about 10 turns to fully engage the clutch, so if you turn the hand wheel only 3-4 turns and it seems to stop, then the nut probably hasn't entered the socket. Undo the handwheel about $\frac{1}{4}$ turn, pull gently on the rope or wiggle the boom left or right, and try to tighten the clutch again. Repeat this until you feel the nut enter the socket, after which time you keep winding the hand wheel to take all the slack out of the rope.

Set the **selector switches** for the fitted nozzle size and the desired application **depth**. (See the chart on the side of the machine) The switches are on the underside of the controller under the cover. This keeps them out of the weather. (**Don't ever direct a high pressure hose stream on the undersides of this controller if you clean the machine! You may ruin the controller.**)



You may now turn on the liquid supply

Safety

If you are near the machine while it is working, NEVER put your hands under the covers which act also as guards. You may switch the selector switches while the machine is running but do nothing else.

BE AWARE that as the boom rotates and it may come up behind you and strike your head!

Battery installation

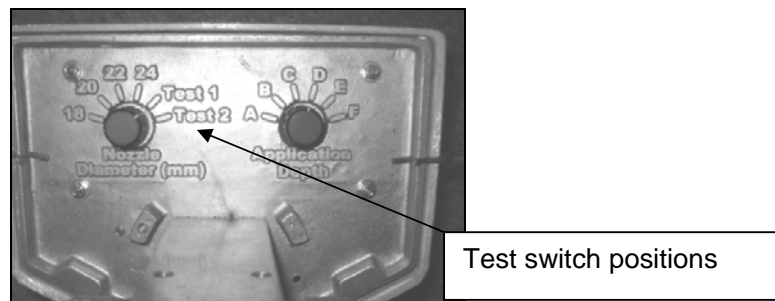
The battery is housed in the large black weather-proof box on the right hand lower side of the machine. If you ever have to remove it, the red or red-and-black wire should be attached to the **red** or positive battery terminal. When you connect the black wire to the negative battery pillar, you should hear the oil flow adjustment motor in the governor start and stop. There is a spade fuse in the cables (1 Amp)

Battery management

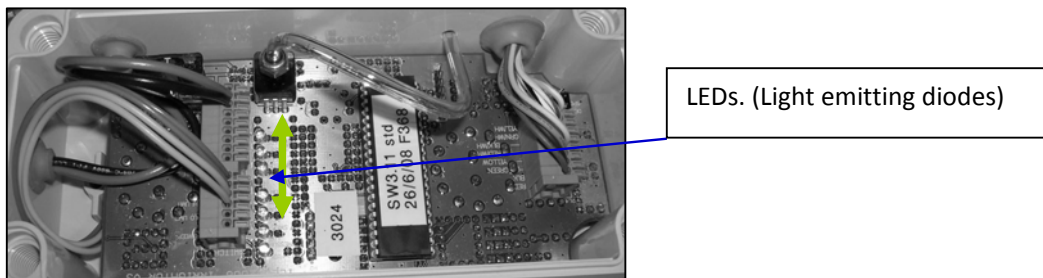
The battery should stay charged for about four months BUT you should place it on a charger overnight (10 hours) every second month so that it does not discharge. Tow the irrigator to a power point in a shed and hook up the charger. (Select the 12 Volt setting.) Leave the battery in its box, and remove the cover. Don't disconnect the wires. Just clip the charger on to the appropriate battery posts.

A fully charged battery will have a Voltage of about 12.6 volts. A discharged battery will be at about 11.6 volts.

The controller is fitted with a charge indicator. To view it, unhook and remove the blue cover. Then remove the R-pins from the aluminium controller cover lid, place it on the ground and put the pins into it. See p 16.



Now turn the Nozzle Diameter selector switch back to the "18" position, and replace both covers.



View into the control box with lid removed:

Nozzles

Two nozzle sizes are available to use with the irrigator. The standard size is 18 mm diameter. But, a 20 mm nozzle is available for either running at 2.5 bar maximum with the long boom, or at 50 psi max with the alternative shortened boom. The shortened boom is an optional extra.

Tests and checks

Quick checks

If you arrive at the machine and want to know why it has stopped, then switch the left hand switch on the controller underside to position "24". You now have 10 seconds to move around to the other side of the machine to listen to "beep" under the smaller blue cover near the back axle of the machine.

The "beeps" come in two groups, separated by 2 seconds. So if you hear 1 beep, then a pause, followed by 3 beeps (1+3) you look up the chart and it will say "insufficient pressure or pump stopped". If the first group is just one beep, even though it will be followed by more beeps, the first beep indicates that the machine has stopped normally. If the first group consisted of 2 beeps, then the machine has stopped and locked itself out until someone has come and attended to it and **RESET** it.

Here is the diagnostic code:

Left hand selector switch set to position "24"					
Normal stoppage			Lock-out stoppage		
First group	Second group	Reason for stoppage	First group	Second group	Reason for stoppage
1 beep	1 beep	1+1 = Relieving line pressure	2 beeps	1 beep	2+1= No boom rotation
1 beep	2 beeps	1+2 = Reserved for future use	2 beeps	2 beeps	2+2 = Irrigator not travelling
1 beep	3 beeps	1+3= Pump stopped or low pressure	2 beeps	3 beeps	2+3= Reserved for future use
1 beep	4 beeps	1+4= Reserved for future use	2 beeps	4 beeps	2+4= Excessive operating pressure
1 beep	5 beeps	1+5= Reached end of travel	2 beeps	5 beeps	2+5= Reserved for future use
1 beep	6 beeps	1+6= Switch turned to position "24"	2 beeps	6 beeps	1+6= Reserved for future use
1 beep	7 beeps	1+7= Reserved for future use	2 beeps	7 beeps	1+7= Resetting action or reconnected

REMEMBER TO TURN THE SWITCH BACK TO POSITION "18" WHEN YOU HAVE FINISHED

Further checks:

Battery check

To check battery charge level and sensors, rotate the boom until it points out the side, unhook and remove the large blue cover. Then remove the R-pins from the controller lid, place the cover on the ground and put the pins into it.

Reach under the controller and turn the “Nozzle Diameter” switch so that the white line on the knob stops at the “Test 1” position.

This is the battery check. If all the LEDs light up the battery is fully charged. If only one lights, then the battery needs charging. If half the LEDs are on, the battery is half charged and so on.

Wheel sensor switch check:

Turn the selector switch to “Test 2”. LED 7 should turn on and off if you move the machine so that the striker in the left hand wheel hub operates the switch finger.

Boom rotation sensor:

Turn the selector switch to “Test 2”. LED 6 and LED 2 should both turn on and off if you rotate the boom so that the striker under the oval gears operates the switch finger.

End of travel rope switch:

Turn the selector switch to “Test 2”. LED 5 should turn on and off if you depress the hinged eye at the front of the machine.

Motor upper limit switch:

Turn the selector switch to “Test 2”. LED 4 should turn on and off if you depress the roller on the upper limit switch.

Motor lower limit switch:

Turn the selector switch to “Test 2”. LED 3 should turn on and off if you depress the roller on the lower limit switch.

Pressure sensor:

If water pressure is present at the machine between 2.4 bar and 3.5 bar, LED 1 will light up.

Turn the Nozzle Diameter selector switch back to the “18” position, and replace both covers.

ALWAYS reset the selector switch to the correct “18” nozzle size or else the machine will not be able to govern its speed. If the switch has been left in either “Test” position, then after 3 minutes the motor will close the valve to its starting position, but it will not regulate the travel speed.

Motor and flow control valve tests

The electric motor drives a pressure compensated hydraulic flow valve. When you use the hand wheel on the motor to close the valve (turn it clockwise, when viewed from the top) until the motor just makes contact with the lower limit switch (you will hear a very faint “click” when the switch

operates) then the valve should lock the machine from rotating. Make sure the clutch is undone, and then try to rotate the boom - clockwise when viewed from the top - and if you feel significant resistance the valve is doing its job at the shut-off point. Now open the valve one half a turn, by turning the knob on top of the electric motor. There should be obvious resistance, but you should be able to rotate the boom. Finally, open the valve until the motor just touches the upper limit switch. There should be minimal resistance to you attempt to rotate the boom.

If there is no resistance to boom rotation during any of these tests, it is possible that there is no hydraulic fluid in the system. Usually you will see red fluid in the hoses. If there is none, top up the fluid. (Caltex Automatic Transmission Fluid.) Fill the reservoir to within 100 mm of the top.

Maintenance

Physical checks

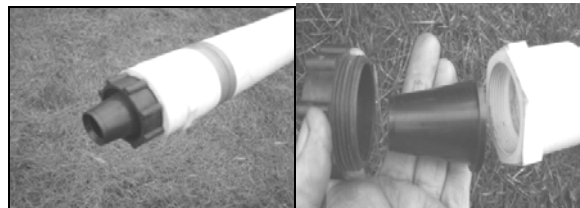
Tyres should be inflated to about 1.5 bar = 15 kPa = 22 psi

All nuts and bolts should be tight.

Check that the oval gears are intact **and well greased**.

Remove bird's nests which may interfere with the mechanisms, especially the limit switch that contacts the layshaft.

Is the nozzle cracked or blocked?



Is the boom straight?

Lubrication

Oval gears and chain drive

Use a water proof grease liberally on the gears and chain drive. Place grease in the pockets between the gear teeth

Latch the boom while you are applying the grease. Gears can trap hands. Use a paint brush in the grease pot to transfer grease to the gears and chain.

Smear the chain drive liberally with grease every 3 months. Make sure that the grease gets deep into all the chain links..

Hydraulic fluid

Top up the reservoir with Caltex Automatic Transmission Fluid to within 100 mm of the top of the reservoir.

Front wheel:

Grease the king pin and drawbar hinges.

Grease the nylon idler wheel at the front of the machine. Do not allow grease to get on the rope. Do not over-grease.

Capstan layshaft:

Grease the layshaft in the capstan at the grease nipple once a year. Do not allow grease to get on the rope. Do not over-grease.

Oil filter

The filter is a 10 micron, 20 mm thread spin on filter, 100mm diameter. This will only need changing if water has got into the hydraulic circuit, or after 5 years of use.

Rotary gland

There is a grease nipple on this gland. Grease the gland monthly, but watch the gap between the flanges in the gland as you pump grease into the gland. If the flanges begin to separate, stop greasing.

Warranty

General

The irrigator consists of exchangeable modules. Each module can be removed from the irrigator and replaced with a reconditioned or new module.

Our warranty guarantees each modular component to be free of defects in workmanship or materials for a period of **twelve months** from the date of purchase. In the event that a component fails within the warranty period, we undertake to provide a reconditioned component to you, free of freight charges, and we will reimburse the freight charge of the unit that you must return to us. **You** (or a competent person) will then fit the exchange component we supply, according to the simple fitting instructions and illustrations. Only a limited range of spanners, screwdrivers and Allen keys are required.

What to do if you have a warranty claim

Call your supplier first (or us on **++64 4 586 3411 if he is unavailable**) and describe the symptoms. We will then decide which items appear to be defective and we will dispatch to you an exchange module within three **working** days of your call, subject to all components being available. (This allows for weekends).

Note that we can usually tell why components have failed, and if we can show that the failure was caused or contributed to by misuse, then we reserve the right to charge our costs to your account. We will discuss this with you.

Intellectual Property

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