Whisper Jet

2" Air Injector

Installation & Operation Manual

E-Zee Milking Equipment, llc & NuPulse

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PURPOSE

An air injector is used in conjunction with an automatic pipeline washer to create a slug of wash solution for the purpose of cleaning all interior surfaces of a pipeline. There are several important factors required for proper cleaning of a pipeline.

1) Wash solutions are at the proper concentrations and temperature.
2) All surfaces are contacted for a sufficient period of time.
3) The slug has enough velocity and density to provide scouring action.

The air injector must be adjusted correctly to aid in meeting these requirements.

COMPONENTS

DESCRIPTION	QTY
50 MM Valve assembly	1
2" End Cap, Sani Pro	1
4 way 120VAC Solenoid Valve	1
1/4" ID x 3/8" OD clear PVC tubing	15 ft.
Brass 1/4" NPT x 1/4" barb elbow	2
1/4" MNPT brass filter	1
Repeat cycle timer	1
2" Hycar Gasket	2
2" V Insert Clamp	2
Brass 1/4" NPT x 1/4" Barb—Straight	2

LOCALLY SOURCED ITEMS

- 1/4" ID x 1/2" OD single pulsation hose
- 2" x 1-1/2" reducer (if connecting to 1-1/2" pipeline)
- Tee or Wye for connecting into "Add water line"
- Enclosure to house repeat cycle timer and solenoid valve (if there is not ample room in washer control box)

SPECIAL TOOLS

1) 1/4" N.P.T. Tap & 27/64" drill bit
2) 3/16", 1/4", 5/16", 3/8", 7/16" & 1/2" drill bits

OPERATION

The air injector has three possible adjustments:

1) The amount of air admitted into the pipeline: controls velocity of slug.
2) The amount of time air is being admitted—referred to as "ON" time.
3) The amount of time between air blasts—referred to as "OFF" time.

When a system starts washing, vacuum is applied to the pipeline and wash solution is drawn in. The air injector is in the "OFF" time to allow wash solution to accumulate. The length of the "OFF" time is determined by the amount of wash solution flowing into the pipeline and the size of the pipeline to be washed. Enough water should be allowed to enter the pipeline to form a slug length of at least 10 feet. The "ON" time of the air injector needs to be long enough to allow the slug to travel the length of the pipeline and reach the receiver. The amount of air admitted into the pipeline determines the velocity of the slug. The velocity of the slug should be between 20 and 33 feet per second. If an insufficient amount of air is admitted into the pipeline, a slug may not form or the slug will not have enough velocity to make it to the receiver. If too much air is admitted, the air may break up the slug before it reaches the receiver .

INSTALLATION

1) Assemble the air injector as shown in **Figure 1.**
2) It is preferred that the air injector be installed in a clean environment such as the milk room to keep the filter cleaner. The air injector assembly can be mounted in either a horizontal or vertical position.
3) **Parlor Installation:** The air injector assembly is mounted to a Tee or Wye fitting on the "ADD WATER" pipeline running between the wash vat and the connection into the milk pipeline next to the receiver. A milk/wash valve or plug must be located between the "ADD WATER" line and the receiver to force the slug to travel around the pipeline. It is not recommended that the air injector be installed on the jetter supply line. It should be on a separate "ADD" water line from the wash vat to the pipeline. Refer to **Figure 8.**

1) **Around the barn pipeline:** Single loop or double loop with equal length loops. The air injector assembly is mounted to a Tee or Wye fitting on the wash pipeline running between the wash manifolds or wash vat and the connection into the milk pipeline next to the receiver. A milk/wash valve or plug should be located between the wash line and the receiver to force the slug to travel around the pipeline. Refer to **Figures 5 and 6**.

2) **Around the barn pipeline:** Unequal length loops. Two separate air injector valves will be needed but controlled from a common timer. The air injector assemblies are mounted to a Tee or Wye fitting on the wash pipeline running between the wash manifolds or wash vat and the connection into the milk pipeline next to the receiver. A milk/wash valve or plug should be located between the wash line and the receiver to force the slug to travel around the pipeline. Refer to **Figure 7.**

3) The three 1/4" brass fittings and the air filter must be assembled onto the 4 way solenoid, refer to **Figure 3** for proper location. Use Teflon tape on all threads.

4) The repeat cycle timer and the solenoid valve must be mounted in an enclosure. Typically there is ample room in the automatic washer control box for these items, however if there is not room, an enclosure will need to be supplied locally. The timer must be provided with 120 V AC power from the washer. If the washer control does not have a location to wire in an air injector, it can be wired to the output that powers the vacuum pump. Use 18 ga wire to make the connection to the timer and solenoid. Refer to **Figure 4** for wiring schematic.

5) One 1/2" and one 3/8" hole will need to be drilled in the enclosure for the vacuum supply tubing coming from the vacuum source and going to the 50mm air injector valve.

6) Locate a vacuum line close to the solenoid valve and drill (27/64" bit) and tap a 1/4" NPT hole into the line. It is recommended that the hole be on the side or top of the pipe but not the bottom as moisture may accumulate there which can lead to premature failure of the solenoid valve. Thread the supplied 1/4" brass elbow fitting into this hole using Teflon tape on the threads.

7) Route the dealer supplied 1/4" ID x 1/2" OD vacuum tubing from the vacuum source to the solenoid valve. Route the supplied 1/4" ID x 3/8" OD clear PVC tubing from the solenoid valve to the 50 mm valve. Secure the tubing and be careful not to kink or make sharp bends while routing the tubing which could restrict air flow.

ADJUSTMENTS

Air Admission Rate

The air admission rate controls the velocity of the slug and varies depending on the pipeline diameter. Research by the University of Wisconsin has found that the velocity of the slug should be between 20 and 33 feet per second to get the required cleaning action. When slug velocities are too low, it is difficult to maintain a slug. When velocities are too high, excessive air is mixed with the slug causing the slug to break apart or provide inadequate shear action for cleaning. The table below gives the recommended air admission rate range for standard pipeline sizes. The low value reflects a 20 ft/sec. velocity while the high value reflects a 33 ft/sec. velocity.

Table #1 - Recommend Air Flow Rates

Pipeline Size	Air Flow Rate
2”	12 – 25 scfm*
2.5”	18 – 39 scfm*
3”	27 – 58 scfm*
4”	48 – 104 scfm*
*scfm – standard cubic feet per minute	

The NuPulse air injector assembly has a plastic end cap that will need a hole drilled in it to admit the proper amount of air. The Table #2 lists the common hole diameters and the approximate air flow the hole will admit. In some cases it may be necessary to drill multiple holes to achieve the desired air admission. Start with a hole size that will admit an air flow rate on the lower end of the recommended range and then test the system to see that the desired slug velocity was achieved. It is better to error on a smaller size hole -they are easy to make larger but difficult to make smaller.

Table #2- Hole Size Admission Rate

Hole Size	Air Admission Rate
¼”	14 cfm
5/16”	21 cfm
3/8”	28 cfm
7/16”	38 cfm
½”	52 cfm

Air Injector timer -"OFF" length

While the air injector is off or closed, wash solution is being drawn into the system. It is necessary to provide enough water to develop a minimum 10 foot long slug. Water is drawn into the system through milk units and, in parlor systems, an "add water" line. The table below is the approximate amount of water needed to develop and maintain a slug in a pipeline.

The amount of water entering the system can be estimated several different ways.

Pipeline Size	Wash Solution Volume
2”	3 gallons
2.5”	5 gallons
3”	7 gallons
4”	13 gallons

1. Cylindrical Vertical Wash Vat

Measure the wash vat's inside diameter in inches (D) and record. As the wash cycle starts, measure the drop in the wash solution level during each air injector cycle until the milk pump starts. Determine the average in inches (Y) and use the following equation to determine the gallons of wash solution.

Gallons of wash solution per cycle = $Y*D^2$ 0.0034 (Y, D must be in units of inches)

2. Horizontal Wash Vat

Measure the inside dimensions for the top of the wash vat in inches (L & W). The assumption is that during the first few cycles, the wash solution level will be in the straight side section of the sink. Measure the wash solution level drop per air injector cycle in inches (H) during several cycles before the milk pump returns wash solution to the sink. Determine the wash solution use per cycle by the following equation:

Gallons of wash solution per cycle = (L x W x H) / 231 (L, W & H must be in inches)

3. System with Milk Meters

Put milk meters and/or detachers in attach & manual mode and read the amount of solution going through each unit as the wash cycle progresses. This method is also helpful in balancing the wash solution flow through individual milking units.

4. System where Solution is Drawn through Milker Units Only

Fill a bucket with a predetermined amount of solution and allow a milking unit to draw the solution out of the pail. Count the number of air injector cycles to empty the pail. The total amount of solution entering the system would then be estimated as the amount of solution drawn through one unit per cycle multiplied by the number of milking units.

Adjust the air injector "OFF" time until the desired amount of wash solution is entering the system. The recommended amount of wash solution per cycle should be about one third the capacity of receiver. Greater amounts can cause flooding of the trap. Lesser amounts may not provide adequate coverage to clean the receiver.

Air Injector Timer -"ON" length

The air injector needs to be open enough time for the slug to form and travel the total length of the pipeline and empty into the receiver. Measure the length of pipeline in feet (Lp) that the slug must travel. The pipe length will include the length from the air injector to the receiver. Determine the desired slug velocity in feet per second (V). Use the following equation to estimate the "ON" time of the air injector:

ON Time = Lp / V

If the air admission rate is set in the middle of the suggested range, use a velocity of 26 feet per second.

Special System Considerations

1. Around the barn (RTB) pipeline - single loop

   Refer to Figure 5. This system can be setup and adjusted with no special considerations.

2. Around the barn pipeline - double loops, equal length

   Refer to Figure 6. This system is typical of barns with the milk house in the middle. This configuration only works if the loops are of equal length. If the sides are different lengths the longer loop will typically experience cleaning problems. The connections to the looped line from the receiver should be done with “Y” fittings not a "T". The air admission rate and slug volume will need to be doubled because the slug will be split at the first “Y” and travel in two direction and then recombine at the second “Y” in route to the receiver. It is recommended that the air admission rate be adjusted for a velocity 40 ft/sec so it will be 20 ft/sec in each direction.

3. Around the barn pipeline - double loops, unequal length Refer to Figure 7. This pipeline configuration has a “Y” connection on the return line to the receiver. An air injector is required on each loop controlled by a common timer. The water volume is adjusted per the above recommendation for the pipeline size being used. The air admission rate is adjusted differently for each loop. The slug velocity in the longer loop needs to be higher than the shorter side so the slug from the longer side reaches the “Y” before the slug from the shorter side enters the receiver.

4. Parlor System Parlor systems are cleaned similarly to a single loop RTB pipeline except that a large portion of the wash solution typically enters the system through the milking units and is distributed over the length of the pipeline rather than a single point like the RTB pipeline. An important issue in parlor systems is the even distribution of wash solution through the jetters so the milker units are properly cleaned. One way to control solution distribution is with the use of restrictors in the jetters or their supply hoses. If the parlor has milk meters or other specialized automation, refer to the manufacturers requirements for washing otherwise the wash system should be set up as described in this manual. Refer to **Figure 8.**

Fine Tuning Adjustments

Visually observe the following during several wash cycles and make necessary adjustments.

1) The air injector should close just as the slug is entering the receiver.
2) The slug should have enough volume and velocity to coat all surfaces inside the receiver.
3) Ideally the trap should be filled to 1/4 capacity at the end of each wash cycle in order to clean the elbow between the receiver and the sanitary trap.
4) Milk pump capacity should be adequate to keep up with washing.
5) Vacuum level should recover between air injector cycles.

It is important to take some vacuum reading at different points on the pipeline to ensure the slug is covering the entire pipeline. Refer to reference 3 for information on using a vacuum meter to take readings.

Troubleshooting

1. A slug does not enter the receiver during each air injector cycle.
   a) "ON" time not long enough -slug does not reach receiver.
   b) Slug Velocity too high -reduce air admission rate.
   c) Milk/wash valve leaks too much.
   d) Not enough wash solution to form a slug - increase "OFF" time or wash solution.

2. Sanitary trap filling up.

   a) Too much water per cycle -check wash solution draw rate. It may be necessary to install a restrictor between the wash vat/sink and the air injector to reduce wash solution flow rate if the "OFF" time cannot be reduced.

   b) Milk pump not keeping up - refer to #3 below.

3. Milk Pump not keeping up.

   a) Check that there are no air leaks between gaskets and check the condition of the milk pump check valve. Reduce vacuum level during washing. Milk pump capacity is affected by the vacuum level. Reducing the vacuum level during washing will increase pump capacity and decrease the flow rate of solution into the system.

   b) Reduce amount of wash solution per cycle -may require restrictor between wash vat and air injector.

   c) Increase time for pumping -Increase "OFF" time and decrease wash solution flow rate.

If you have a 2 channel vacuum recorder, it can be used to determine slug velocity, slug length and vacuum drop. Refer to Reference #3 and fax U of Wisconsin for a reprint.

Maintenance	
Daily	Check to see that air injector is working properly
Monthly	Wash air filter in mild detergent and replace. If dirty, clean more frequently.
	Check tubing for leaks and restrictions
Yearly	Replace all rubber seals in diaphragm valve
Every 2 years	Replace valve and stem in diaphragm valve
	Replace foam air filter
Every 3 years	Replace bearing in diaphragm valve

References

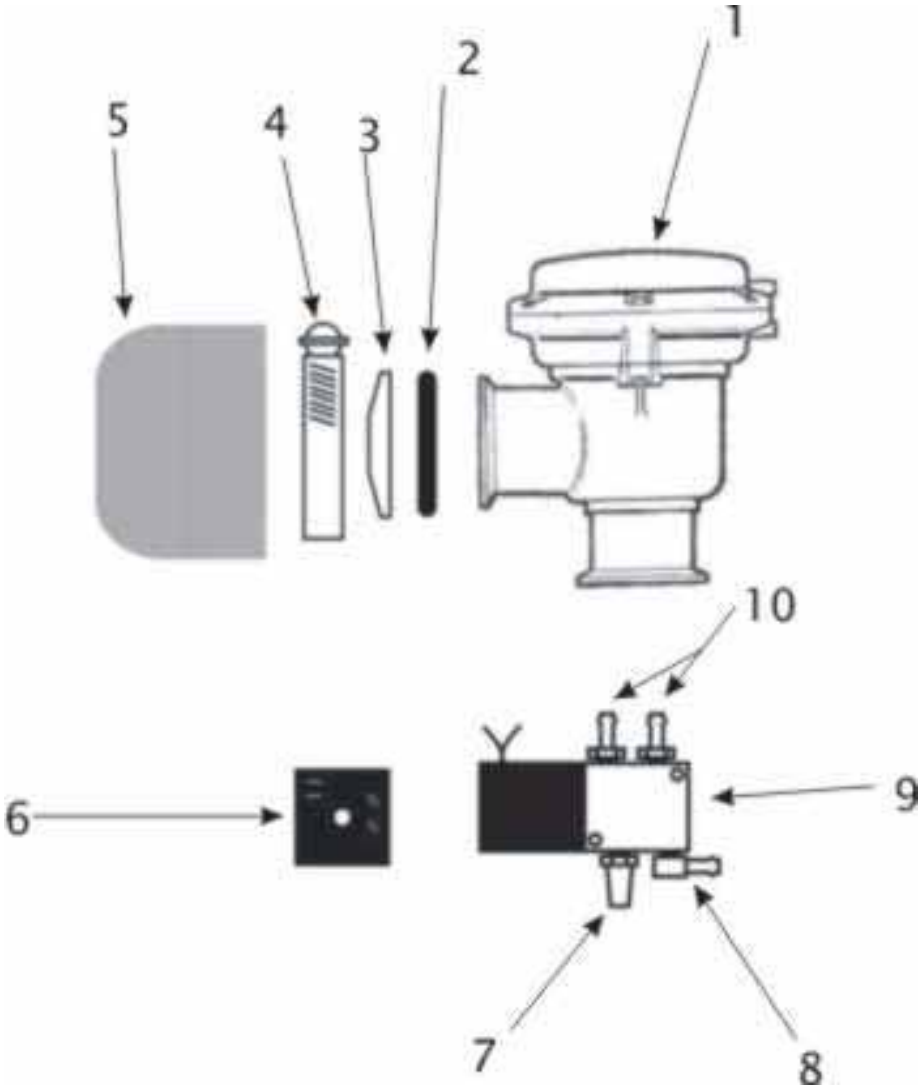
1) Reinemann, D.J., and A. Grasshoff, 1993. Milkline cleaning dynamics: design guidelines and troubleshooting. Proc National Mastitis Council 32nd Annual Meeting, Kansas City, MO.

2) Reinemann, D.J. and J.M. Book, 1994 Airflow requirements, design parameters and troubleshooting for cleaning milking systems. Proc ASAE / National Mastitis Council Dairy Housing Conference, 31 January – 4 February, 1994, Orlando, FL USA

3) Reinemann, D.J., June 1994. Testing Cleaning Performance of Milking Systems with a Vacuum Recorder. Wisconsin Center for Dairy Research, University of Wisconsin, Madison, WI. For a reprint, send fax to: WITEP, Wisconsin Center for Dairy Research at 608-262-1578. Include mailing address and number of reprints wanted.

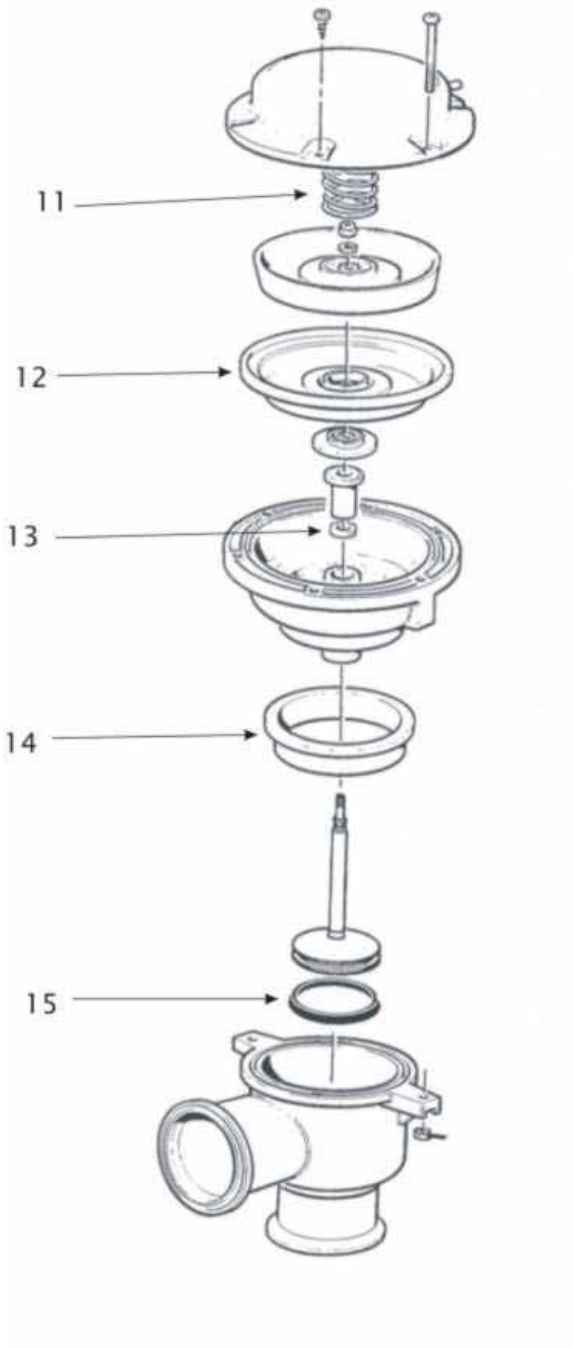
Figures & Drawings

Figure 1—Air Injector Assembly



For Part Numbers see page 17

Figure 2—Wash Valve Assembly



NO.	PART	DESCRIPTION
1	D498743	2" Valve Assembly—Clamp Fitting
2	F 30831	2" Hycar Gasket
3	A 03180	2" Sanipro End Cap
4	F 30721	2" V Insert Clamp
5	A 03185	Air Filter
6	A 03176	Cycle Timer
7	A 03171	1/4" Brass Filter
8	A 03170	1/4" Barb Fitting—Brass Elbow
9	A 31837	120VAC Solenoid Valve
10	A 03173	1/4" Barb Straight Fitting
11	D243721	Valve Spring
12	D381673	Diaphragm
13	D242738	Distributor Seal
14	D382756	Body Seal
15	D242740	Valve Seal

Figure 3 Connection to Solenoid Valve

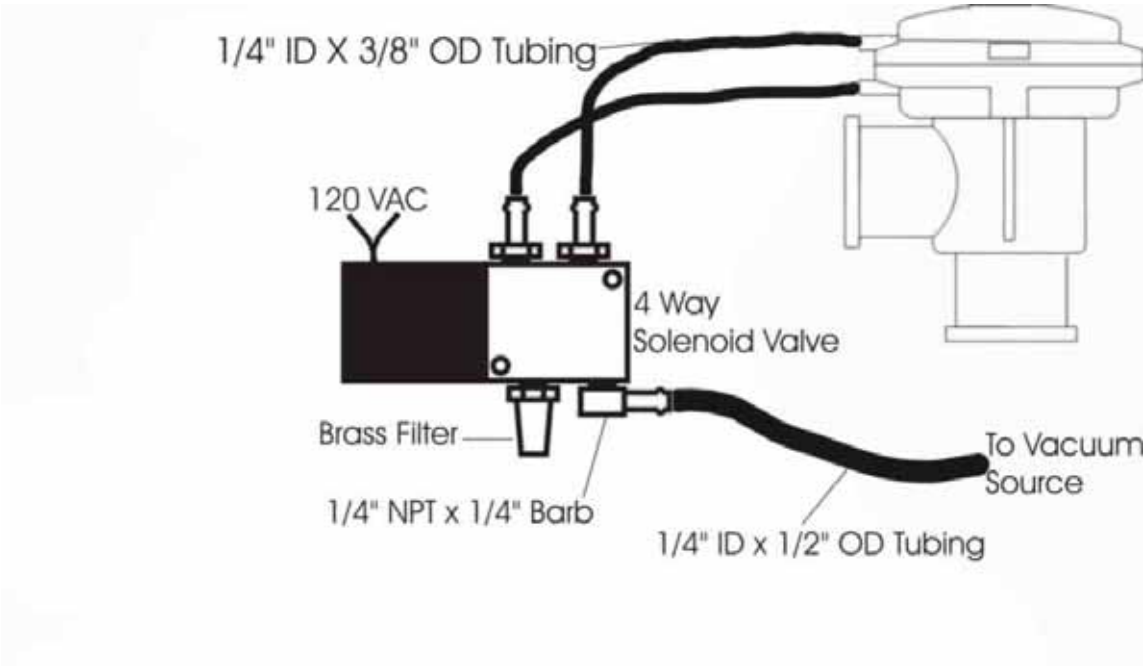


Figure 4 Wiring Diagram

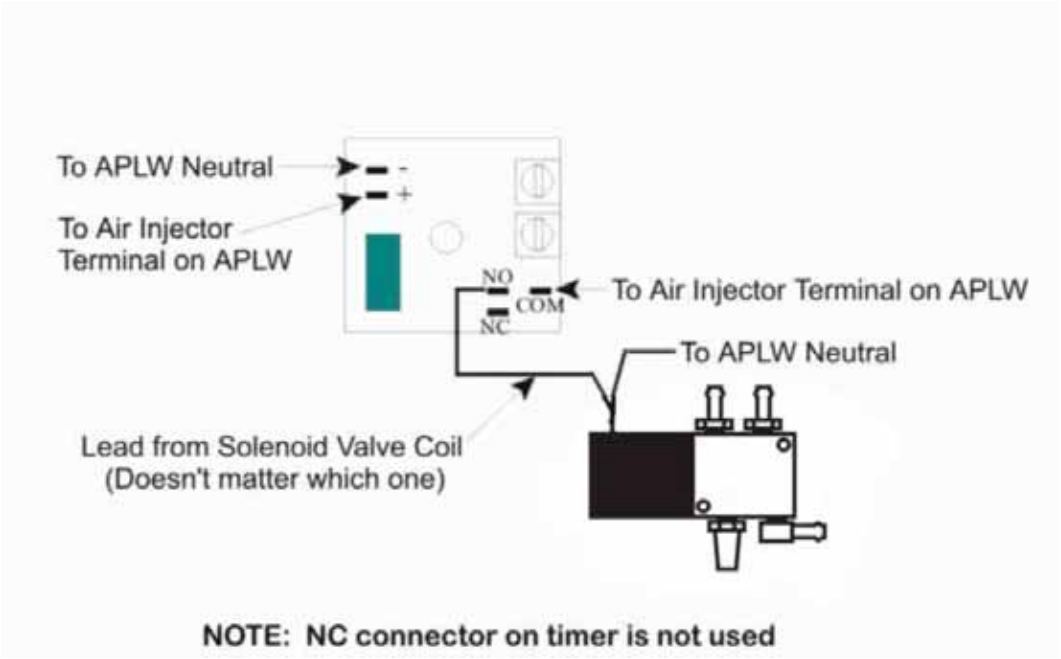


Figure 5 - Around the Barn Pipeline—Single Loop

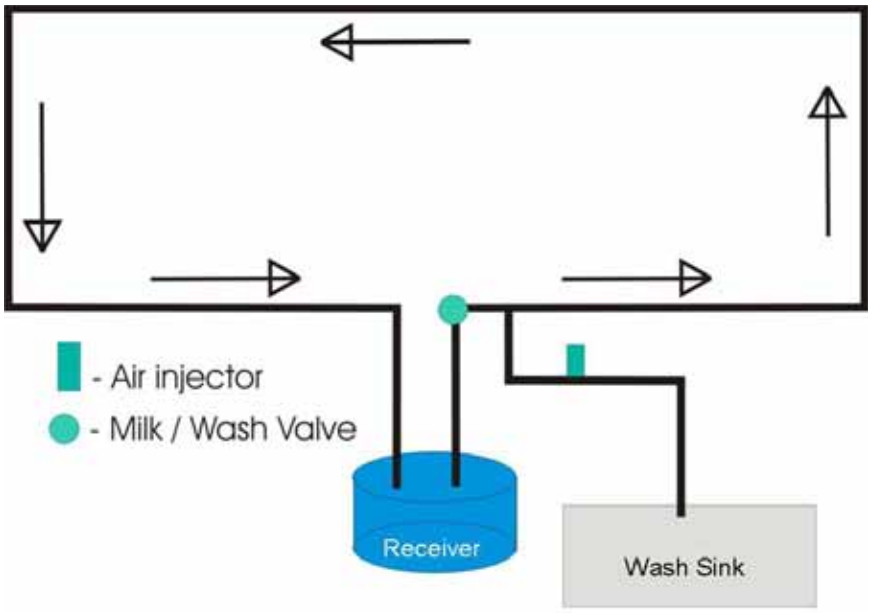


Figure 6 - Around the Barn Pipeline—2 Equal Loops

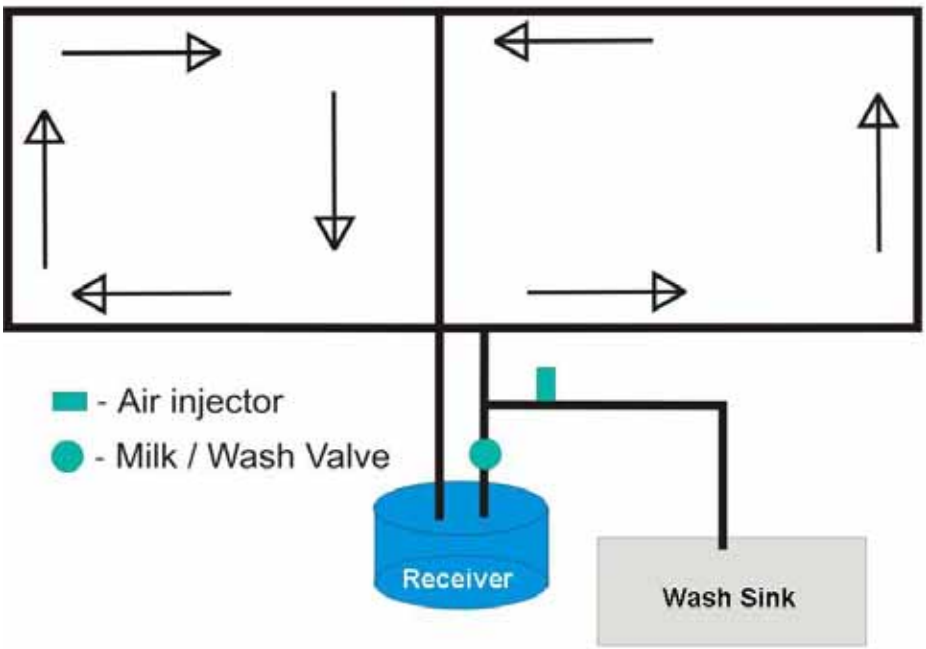


Figure 7 - Around the Barn Pipeline—2 Unequal Loops

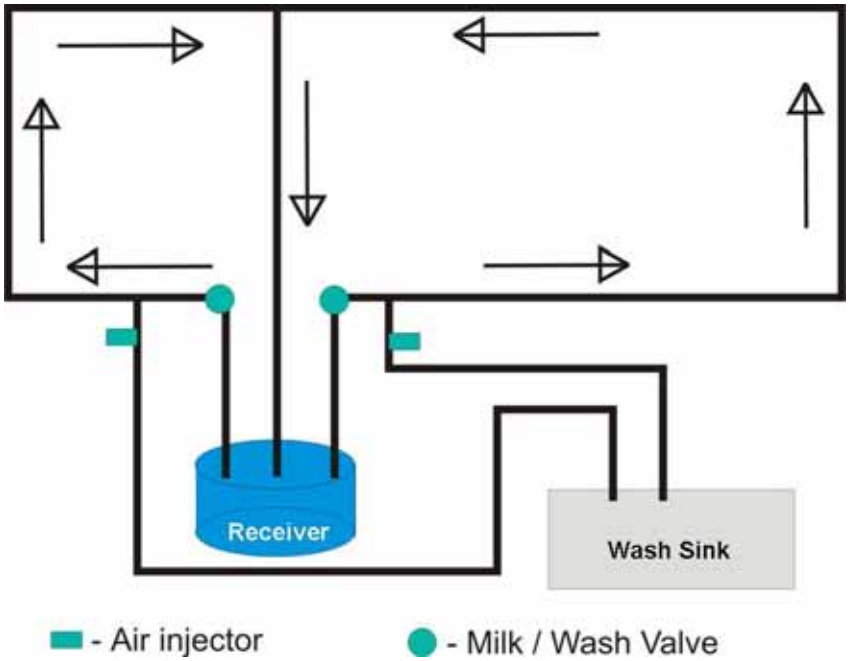
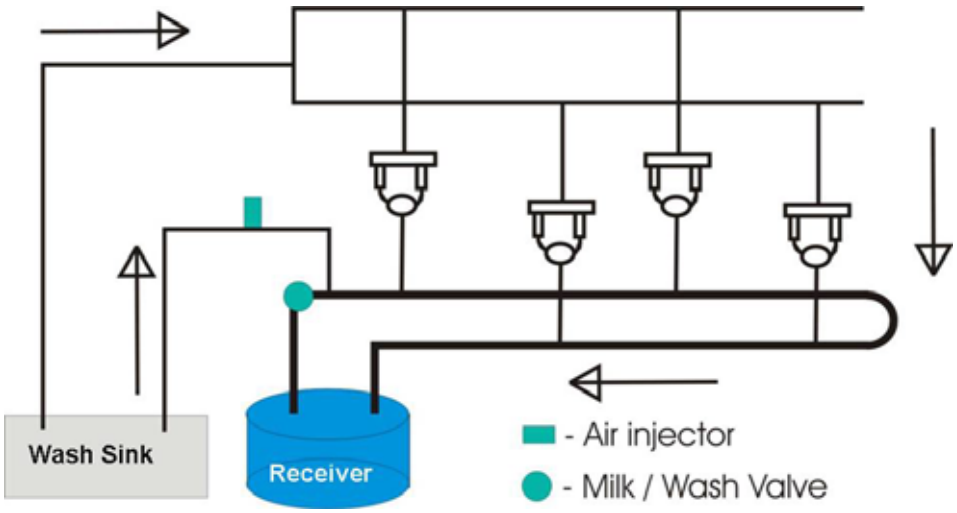


Figure 8 Parlor System



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