

L 100

Bubble-Tube Level System

Installation, Operation and Maintenance Instructions

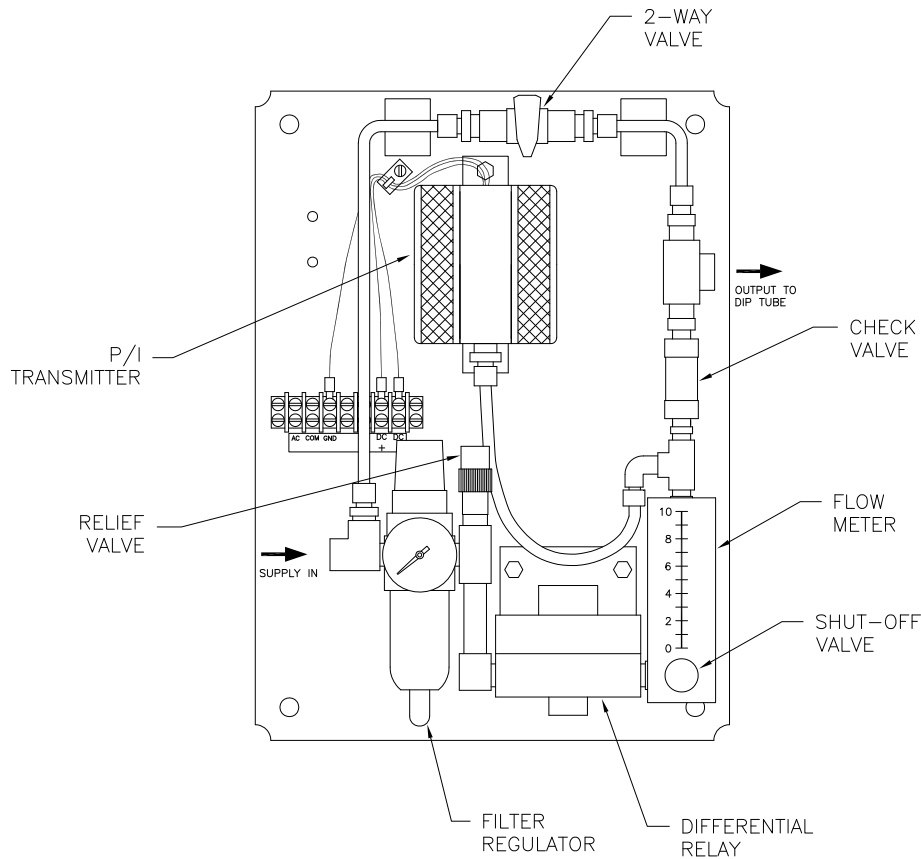


Figure 1

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1.0 INTRODUCTION

1.1 Scope

The L100 Bubble-Tube Level System is comprised of fully self-contained instruments requiring only connections to air or gas supply, dip tube and electrical power source to provide precise level indication. Because only the stationary dip tube and the purged gas come in contact with the liquid, these systems are ideal for applications involving hazardous locations or strict liquid in an open tank including those which are highly corrosive, viscous, hot (molten metal), explosive, slurry type or foodstuff. In addition, the electronic output from the L100 is compatible with almost all analog instrumentation, including local and remotely-located indicators, computers, data loggers, recorders and controllers.

1.2 Functional Description

In the L100 Bubble-Tube Liquid Level System, the level is measured in a vented vessel by measuring the pressure required to force a gas into the liquid at a point beneath the surface. This method allows for level measurement without liquid entering the piping or the instrument.

A pressure regulator and constant-flow regulator combine to establish a consistent flow of clean air or gas to a bubble pipe immersed a fixed distance in the tank. The flow is regulated to a very low level, building up pressure in the end of the bubble pipe. Thereafter, pressure is kept at this value by the escape of air bubbles through the liquid. Changes in the measured level cause the gas pressure to build or drop. An integral P200 is then used at this point to measure the back pressure and transmit an electrical signal proportional to the level or volume of liquid.

The presence of the high-quality, industry-leading P/I Transmitter in the L100 Bubble-Tube Level System provides the user with an established and recognized electronic interface. Since the totally solid-state P200 transmitter is typically capable of accuracies of 0.10% of span, the entire L100 System may be expected to maintain a 0.25% accuracy. Additionally the L100 may be used in indoor or outdoor hazardous areas due to the NEMA 4 design and the FM & CSA explosion-proof and FM & CSA intrinsically safe certifications of the P200.

The L100 provides for a variety of features which simplify the application of bubble-tube techniques to liquid level. Over-pressure relief and back-flow check valves are used to protect the P200 and are supplied as standard equipment in every system along with a flowmeter to read purge flow. Provision for manual blow-down of the bubble pipe by high pressure air is included to allow the user to clear any obstructions from the bubble pipe. Figure 1 shows a labeled drawing of the L100 System, and Figures 2 through 4 give functional representations of the technique. Note in Figure 5 the small V-notch in the bottom of the pipe which allows the air to exit in a steady stream rather than in intermittent large bubbles.

The L100 System provides two possible means of accurate measurement. Although a very well-regulated constant air flow is provided by the L100, the following formula and table show that a significant pressure drop may occur in long lengths of tubing between the bubble system and the tank:

$$P_D = (K \times A \times L) \div 1000$$

Where: P_D = Pressure drop in inches of water.
K = Coefficient which is a function of the tubing. See table.
A = Air flow in standard cubic feet per hour.
L = Length of tubing in feet.

| Size Pipe | K | Size Tubing | K |
|-----------------|-------|-------------|-------|
| 1/8" (0.269 ID) | 3.0 | 1/8" ID | 70.0 |
| 1/4" (0.364 ID) | 0.9 | 3/16" ID | 12.5 |
| 3/8" (0.493 ID) | 0.27 | 1/4" ID | 4.0 |
| 1/2" (0.622 ID) | 0.105 | 1/2" ID | 0.245 |
| 1/4" (0.824 ID) | 0.035 | 3/4" ID | 0.050 |

If the pressure instrument (P200) is connected to the purge tubing near the flow regulator, a pressure drop in the tubing can introduce appreciable error in the instrument reading, see Figure 2. If the purge flow is precisely constant for all level, environmental and operating conditions; the fixed inaccuracy due to the pressure drop in the tubing may be calibrated out by an appropriate zero readjustment. However, in high accuracy situations a large pressure drop, subject to even small operational variations eliminate this error, the air purge can be decreased, the tubing size increased, or a separate sense/return tube can be run back to the P200 from the open tank. See Figure 3. This latter solution provides a zero pressure drop as sensed by the P200 because the P200 does not consume air. Upon request the L100 can provide the proper connections for this remote sensing.

Aside from the many standard features of the L100 Bubble-Tube Level System, there are numerous standard options which are listed in the Specifications section. The factory can be contacted at any time to handle specific requests.

2.0 SPECIFICATIONS

| | |
|------------------------------|--|
| Range | 0-30 psi or 0-69 feet water column or equivalent, full scale. |
| Gas Input | 1.0 to 7.0 SCFH, regulated on-board to a pressure between 120% or 3 psi, whichever is greater, and 200% of full scale liquid head. Maximum blow-down pressure is 150 psi. Maximum on-board regulated pressure is 60 psi. |
| Electrical Input | Using P200: 10-42 VDC. Autoblow-down and digital readout options also require 120 VDC. |
| Electrical Output | P200: 2-wire, 4-20 mA into 700 Ohms at 24 VDC or 2-wire, 10-50 mA into 280 Ohms at 24 VDC |
| Accuracy | 0.25% of span; 0.2% of span typical. Includes linearity, hysteresis and repeatability errors. |
| Sensitivity | 0.02% of span |
| Repeatability | 0.1% of span; 0.05% of span typical. |
| Operating Temperature | 30 ⁰ F to 161 ⁰ F |
| Thermal Sensitivity | 0.007% of span per ⁰ F for zero and span. |
| RFI/EMI Effect | Meets or exceeds SAMA PMC 33.1, 1978, 2-abc: 0.1% of span at 10 volts/meter |
| Environmental | P/I is NEMA 4X and explosion-proof, standard. Entire plate assembly fits in an optional NEMA 4 enclosure for further protection. |
| Available Options | NEMA 4X enclosure with or without digital readout, remote analog readout, auto purge. |

3.0 INSTALLATION

3.1 Dip Tube Considerations

A poorly constructed or mounted Dip Tube will impair the accuracy and reliability of the Bubble-Tube Liquid Level System. Some problems and causes are on the following page.

| Problem | Cause |
|--------------------------------------|---|
| Fluctuating Transducer Output Signal | <ol style="list-style-type: none"> 1. Poorly supported Dip Tube, (tube allowed to move). 2. V-notch omitted from tube opening, See Figure 5 3. Turbulence within tank, (not related to dip tube design). |
| Transmitter Zero Shift | <ol style="list-style-type: none"> 1. Changes in pressure drop due to long length of tube before dip tube or other restriction. 2. Narrowing of dip tube air passage, due to corrosion. |

3.2 Calibration

The L100 Bubble-Tube Liquid Level System has been calibrated at the factory for the service and column height specified on the customers purchase order. Calibration can be affected by restrictions in the piping system due to the length of piping before the bubble-tube or the size of the piping as well as volume of gas being forced down the bubble-tube. It is important to keep the size of the piping as large as economically feasible and the length as short as possible while reducing the gas flow to that which will still provide accurate readings; approx. 1.5 SCFH.

3.2 Checking for Leaks

Before the Bubble-Tube Liquid Level System can operate properly, all leaks must be eliminated. The test pressure must be conservatively selected to prevent damaging the P/I Transducer by over pressurizing the sensor. We suggest that the test pressure be no more than one and a half (1½) times the full scale operating pressure. The full scale operating pressure can be determined by showing the following equation:

$$\text{PRESSURE (PSIG)} = \text{COLUMN HEIGHT IN INCHES} \times (.036\text{PSIG} \div 1 \text{ IN. COLUMN}) \times \text{SG.}$$

$$\text{SG.} = \text{SPECIFIC GRAVITY; WATER} = 1$$

Example: What is the full scale operating pressure if a 75" water column is being measured?

$$\text{FULL SCALE OPERATING PRESSURE} = 75 \text{ IN. H}_2\text{O} \times (.036\text{PSIG} \div \text{IN. H}_2\text{O}) = 2.7\text{PSIG}$$

Apply (1½) one and a half times the full scale operating pressure to the bubble-tube system (1½ X 2.7 PSIG = 4.1 PSIG). A pressure increase can be accomplished by turning the knob of the pressure regulator clockwise. The pressure gauge mounted on the same pressure regulator will indicate regulator output. Should the tank be dry and the dip tube accessible, seal the end of the dip tube while checking the Air Rate Indicator for signs of air flow. A leak in the system will cause the black ball to float within the tube.

To inspect for leaks where the dip tube is not accessible or the tank partially full, a water-soap solution must be applied to all joints. All leaks must be eliminated before the system will operate correctly.

3.3 Correcting for Output Shifts

Unpredictable pressure drops caused by the configuration of the piping will cause both the zero and full scale readings to be higher than expected. To determine if an output shift has occurred, the tank will have to be empty or full, or the pipe carrying the pneumatic signal to the dip tube will have to be disconnected from the dip tube. With the tank empty or the supply pipe disconnected from the dip tube. With the tank empty or the supply pipe disconnected from the dip tube, the output of the P/I Transducer should be zero based or 4 mA on a 4-20 mA scale. If the zero or full scale reading is higher than 4 or 20 mA respectively, an output shift has occurred.

An output shift due to piping affects the zero and span calibration equally. For example, a system with a zero scale output of 4.23 mA will have a full scale output of 20.23 mA. Making an adjustment to the zero potentiometer of the P/I Transducer will cause both the zero and full scale readings to change simultaneously and equally. Do not adjust span potentiometer.

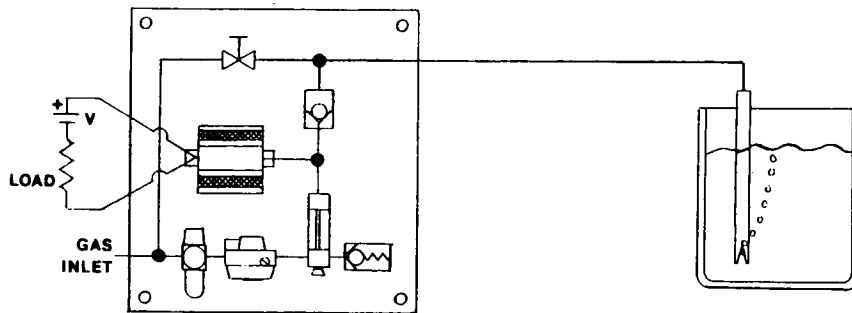
3.4 Blow-Down / Purging Options

A build up of contaminants at the end of a dip tube could cause a restriction that would create a false level signal. To overcome this problem, blow-down systems offered with bubble-type system. See Figures 2 through 4 inclusive.

Figure 2 shows our basic bubble-tube system, L100, which has dip tube blow-down feature. A counter-clockwise turn of the 2-way Valve will bypass the control portion of the circuit and blow full available air pressure through the dip tube.

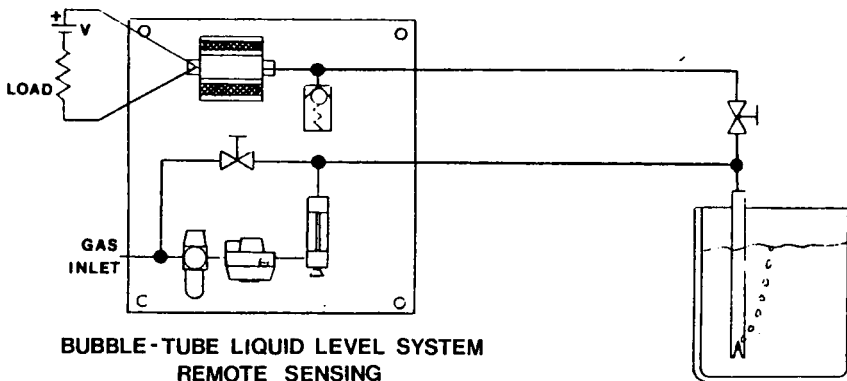
Figure 3 illustrates a remote sensing system which also offers a dip tube blow-down feature. When the control system bypass valve is opened, the maximum available system air pressure will force out any buildup of contaminants that may have accumulated in the dip tube. This system is equipped with a pressure relief valve that will limit the pressure to the P/I Transducer to under two (2) times full scale of the device (3 psig min.). If the transducer is exposed to (3) three times full scale pressure, recalibration of the transducer will become necessary. A shut-off valve shown in Figure 3 above the tee in the remote sensing line should be closed when air purging the dip tube. Closing this valve will ensure that the P/I Transducer will not be accidentally exposed to damaging pressures.

Figure 4 illustrates a bubble-tube liquid level system with an automatic dip-tube blow down feature. Figure 4 and Figure 2 are similar systems with the exception that Figure 4 utilizes a timer and 2-way electrically operated valve to automatically air purge the system.



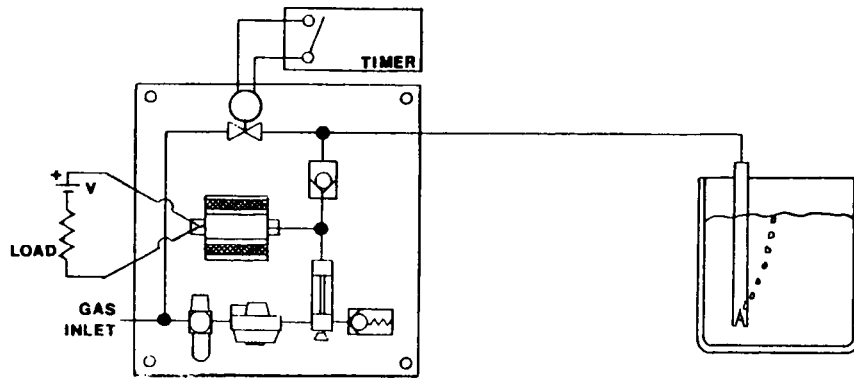
BUBBLE-TUBE LIQUID LEVEL SYSTEM
L100

FIG. 2



BUBBLE-TUBE LIQUID LEVEL SYSTEM
REMOTE SENSING
L100 R

FIG. 3



BUBBLE-TUBE LIQUID LEVEL SYSTEM
WITH AUTOMATIC PURGING
L100A **FIG.4**

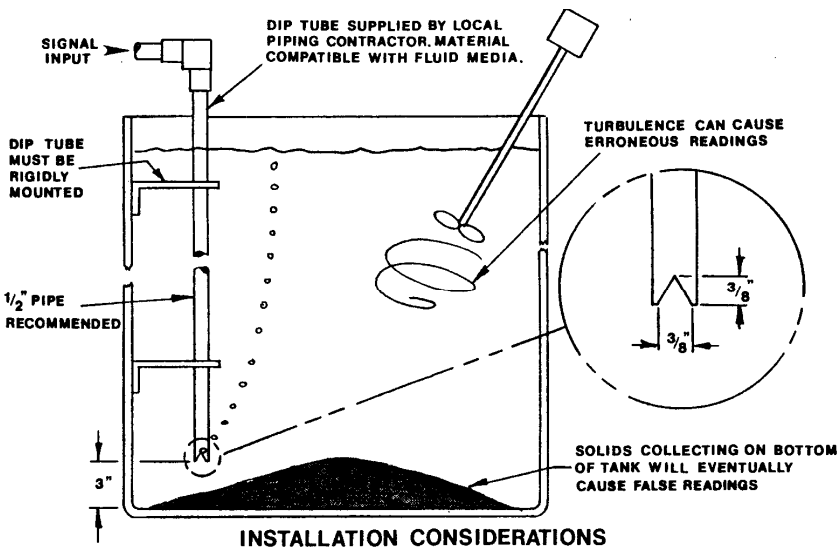


FIG. 5

4.0 WARRANTY & DISCLAIMER

ControlAir, Inc. products are warranted to be free from defects in materials and workmanship for a period of eighteen months from the date of sale, provided said products are used according to ControlAir, Inc. recommended usages. ControlAir, Inc.'s liability is limited to the repair, purchase price refund, or replacement in kind, at ControlAir, Inc.'s sole option, of any products proved defective. ControlAir, Inc. reserves the right to discontinue manufacture of any products or change products materials, designs or specifications without notice. Note: ControlAir does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for the proper selection, use, and maintenance of any ControlAir product remains solely with the purchaser and end user.

WARNING

These products are intended for use in industrial compressed-air systems only. Do not use these products where pressures and temperatures can exceed those listed under Specification