CONSTRUCTION OBSERVATION REPORT

Leachate Head Reduction System Upgrade

Refuse Hideaway Landfill
Town of Middleton
Dane County, Wisconsin

Prepared for:

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August 9, 1996

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ATTACHMENTS

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INTRODUCTION

This report describes the construction activities performed during the installation of the upgraded leachate extraction system.

The leachate extraction system upgrade consisted of the following:

- Installation of 1-inch High Density Polyethylene (HDPE) air supply line from the air compressor to each of the eight (8) gas extraction wells.
- Installation of eight (8) Solo II air driven pumps and down well tubing.
- Gas Extraction wellhead retrofit.
- Air Regulator and Cycle counter installation at eight (8) existing pump control enclosures.
- Installation of a 10' x 10' prefabricated building.
- Equipment installation, wiring and plumbing.
- Control wiring.

SITE DESCRIPTION

The Refuse Hideaway Landfill is located in the NW 1/4 of Sec 8 T7N-R8E in Dane County and is currently closed.

There are thirteen (13) existing landfill gas extraction wells located on the site. The wells were installed in 1991 in order to control off-site migration of landfill gas. Vacuum to the wells is provided by a blower located in the Blower House. The landfill gas is piped via a 6" HDPE header pipe, to an enclosed flare where it is burned.

There are permanent electrical leachate extraction pumps located in eight (8) gas wells. The leachate is discharged from the wells, into a leachate conveyance system which consists of approximately 800 lineal feet of piping. The leachate is collected in a buried 25,000 gallon collection tank. The conveyance piping also transports condensate which accumulates with-in the active header piping. The condensate is transferred to the conveyance pipe through four (4) driplegs located along the header piping.

The conveyance system was not affected by the leachate extraction system upgrade.

BACKGROUND

The previous leachate extraction system, which utilized submersible electric pumps, was unable to provide continuous, reliable pumping and required high maintenance or replacement of various components of the system (Refer to the Annual Report 1995 for Maintenance History). Without reliable, effective leachate pumping, the leachate levels rose in the landfill.

Monthly leachate level readings indicated that on May 10, 1996, the combined leachate head in the eight (8) gas wells with pumps was 125.9 feet. The total length of screen in the same eight (8) gas wells is 373 feet, leaving an effective total screen length of 247.1 feet. The elevated leachate levels in the eight (8) wells decreased the effective screen length by one-third. This could limit the flow of landfill gas to the flare and possibly lead to blower/flare shut downs.

PURPOSE AND SCOPE

In an effort to provide continuous, reliable leachate head reduction, an air driven pump system was proposed and accepted by the Wisconsin Department of Natural Resources (WDNR).

The air driven pump system consists of an electric powered air compressor with an air drier, buried 1-inch air supply line, regulators at each well, a retrofitted wellhead flange, down well tubing and pumps.

The air compressor and an drier are located in a 10'x 10' prefabricated building located within the blower/flare system enclosure.

The existing electrical service was to be used to supply power to the compressor, air drier as well as the landfill gas extraction blower. The existing service was not large enough to provide power to the blower/flare and to the compressor.

In order to provide the necessary service, three (3) buck booster transformers were required as well as 475 feet of larger direct burial cable. A change order was issued and OK'd by the state.

Construction Activities Observed

Work began on April 16, 1996 with the removal of the eight (8) submersible electric pumps. The electronic components at each pump control panel were left intact and the lead wires to the pumps were terminated at the junction box located on the gas wells.

Excavation of the 2-foot deep trench began on April 17, 1996, and continued through April 19, 1996. The main trench began at gas well GW-13 and continued to gas well GW-12. From there, the trench was excavated along side of the existing access road with branches trenched to gas wells GW-11, GW-9, GW-5, GW-4 and GW-8. The main trench continued along the access road into the blower flare area. The trench to GW-7 was excavated off of the branch to GW-8 (Refer to the trench layout plan attached as Appendix 2).

Approximately 2,400 linear feet of 1-inch high density polyethylene (HDPE) pipe was installed in the trenches. Following the HDPE pipe installation, locator ribbon was placed in the trenches. The trenches were then backfilled with the excavated material and compacted with equipment tires.

The HDPE line was pressure tested at 25 psi for 24 hours with no loss of pressure observed.

The pumps with modified well flanges and down well tubing were assembled at the site May 1 through May 3, 1996. Each gas well was measured for depth and the down well tubing cut to length such that the pumps were set 2.0 feet above the bottom of the well. Appendix 1 contains a table indicating the measured well depth from the top of the well, the depth to the bottom of the extraction pump and the serial number of the pump installed. A "reference" air line was attached to the pump approximately 1 foot above the bottom of the pump. This line is used to determine the amount of leachate head in each gas well.

Following the pump installation the concrete slab for the prefabricated building was formed and poured.

The air compressor and air drier were set on the slab and the prefabricated building was set and anchored. The 1-inch HDPE air line enters the building through the floor slab.

At each gas well with a pump, the existing control panel was used to house the individual pump air regulators and cycle counters. Plumbing from the 1-inch HDPE to the control panel consists of a 1-inch HDPE to coated steel transition fitting, a ball valve to control air flow to the regulator and reducer fittings to adapt to 1/4-inch air line hose. The 1/4-inch air line hose enters the control panel and is attached to the regulator with a quick disconnect coupling. Compressed air is then plumbed through the regulator and cycle counter. The down well tubing providing air to the pumps is continuous line through the wellhead flange. The air line is run from the flange, into the control panel and connects to the cycle counter via a quick disconnect.

The existing leachate conveyance system was utilized to transport leachate to the storage tank. The pump discharge line exits the well flange and connects to the existing 1-inch HDPE leachate conveyance line at the wells. A ball valve is located on the discharge line at the wellhead flange to control flow. This should be left open when the pump is operating.

The plumbing inside the compressor building consists of 1-inch galvanized iron pipe from the air compressor to the air drier and from the air drier to the 1-inch HDPE air line.

Two (2) filters were installed in the air line between the compressor and the field. The first filter is an oil coalescing filter which removes any oil that may be in the compressed air. Oil particulates will destroy the desiccant material in the air drier. The second filter is installed down stream of the air drier and removes any particulates from the air direr prior to entering the air regulator to the field.

The interior plumbing also includes a solenoid valve which is connected to the control panel such that when a tank full condition is alerted, power to the compressor will be turned off, the air in the compressor tank will be shut off from the field and the air pressure in the field will be released, this will prevent further pumping following a tank full alarm.

SYSTEM START-UP

Following the electrical system upgrade, the compressor was started and the pumps were observed to check their working condition. Following some minor adjustments to the well flanges, all pumps were observed to be working, pumping an average of 0.095 gallons per cycle*. (*Volume average provided by pump supplier)

A problem was immediately discovered as the blower for the gas extraction system would shut down whenever the air compressor was cycled on. This was due to the high starting amps required to start the compressor. The solution was to install a "Soft Start" motor starter which starts the compressor slowly and reduces the amperage draw. Once installed both the compressor and the blower could run simultaneously.

Once re-started, the compressor was observed to run continuously. The cause for this was a faulty solenoid on the compressor. A replacement was ordered and installed. The compressor may run continuously as long as there is leachate to pump out of the wells however the faulty solenoid valve was preventing the air tank from filling properly.

An hour meter was installed in the compressor to track run time, and the pressure switch on the compressor was adjusted. The pressure switch was originally set so that the compressor would shut off when the tank pressure reached 125 psi. The compressor would then turn on when the air pressure in the tank dropped to 100 psi. The adjustment was made to turn the compressor off at 100 psi and on at 70 psi. The solenoid replacement and adjustments allowed the compressor to cycle on and off and reduced compressor run time.

STARTING PROCEDURES

Prior to starting the compressor, the oil level in the compressor should be observed to be between the high and the low in the sight glass. Refer to attached Operation and Maintenance Manuals.

The two (2) ball values at each gas well (one for compressed air, one for leachate discharge) should be opened.

The regulator at the gas wells should be open.

The air drier unit is to be turned on such that the drying columns can be cycled.

The ball valve from the tank to the field should be closed, the regulator to the field should be full open. The auto tank drain is to be energized via the 100v outlet in the building. The ventilation fan should be turned on (A thermostat will regulate the fan).

The compressor is started by switching from "off" to "auto". Allow the pressure to build up in the tank. Once the compressor shuts off (100 psi in tank) open the ball valve to the field slowly. Observe the pipes for leaks and observe the filter indicators located on the filters. The indicator arrow should settle on green, meaning the filter is clean, yellow indicates that the filter is in need of changing/cleaning and red indicates that the filter is dirty and oil or particulates may not be filtered out completely, in which case the system should be shut down until filters can be changed. Following a system start-up, each well with a pump should be visited to observe if the pump is operational.

If pumps are not operating, make sure that ball valves are open, the regulator is open and adjust the air vent valve on the wellhead flange. If the pump still does not operate, check the liquid level in the well as the pump will not pump if the well is dry. If leachate exists in the well above the pump and no pumping occurs, then the pump will need to be removed for visual inspection. Once the pump is out of the well, turn on the air and tip pump upside down and make sure the ball valve in the pump is not stuck. If the ball valve is stuck, the pump can not operate. Refer to manufacture operation and maintenance for the SOLO II pump.

A special portable liquid level gauge was purchased with the pumps to obtain liquid levels at gas wells with pumps.

The liquid level gauge consists of a 0 to 150 inch water column (in W.C.) magnehelic gauge and a compressed air tank. The tank can be filled from the air supply lines at any of the eight (8) gas wells with pumps.

The gauge has two (2) air line ports. A reference air line port (red) and a bubbler air line port (blue).

The bubble line port is for the blue bubbler air line at the wellhead. The bubbler air line is a ¼-inch plastic tube which extends from the wellhead down to a level approximately 3-feet from the bottom of the well. The bubble line air is tied to the side of the Solo II pump.

The reference air line port is for the red reference air line at the wellhead. The reference air line terminates inside the well at the wellhead flange.

With the air lines connected to the appropriate ports, the bubble line is charged with compressed air by pushing a button locate on the gauge panel. A reading is obtained from the magnehelic gauge which corresponds to the inches of water column above the bubble line. From this, a liquid level is determined. Please see Appendix 3 for manufacturers instructions.

MAINTENANCE

Refer to the attached manufacturer operation and maintenance for the required maintenance.

At a minimum, the compressor oil should be a changed every 1,000 hours of operation.

The indicator arrows on the filters should be monitored and if less than clean conditions are indicated, steps should be take to clean or replace the filters.

The desiccant material in the air drier is checked through a sight window on the unit. If the desiccant becomes contaminated with oil, the material will need to be changed. (Refer to Manufacturer Operation & Maintenance).

APPENDIX 1

PUMP DEPTH DATA

GAS WELL	MEASURED DEPTH *	DEPTH TO BOTTOM OF PUMP	PUMP SERIAL NUMBER
GW-4	63' - 0"	61' - 0"	5150
GW-5	67' - 1"	65' - 1"	5136
GW-7	61' - 10"	59' - 10"	5153
GW-8	67' - 3"	65' - 3"	5149
GW-9	68' - 1"	66' - 1"	5134
GW-11	66' - 9"	64' - 9"	5152
GW-12	79' - 6"	77' - 6"	5151
GW-13	70' - 3"	68' - 3"	5135

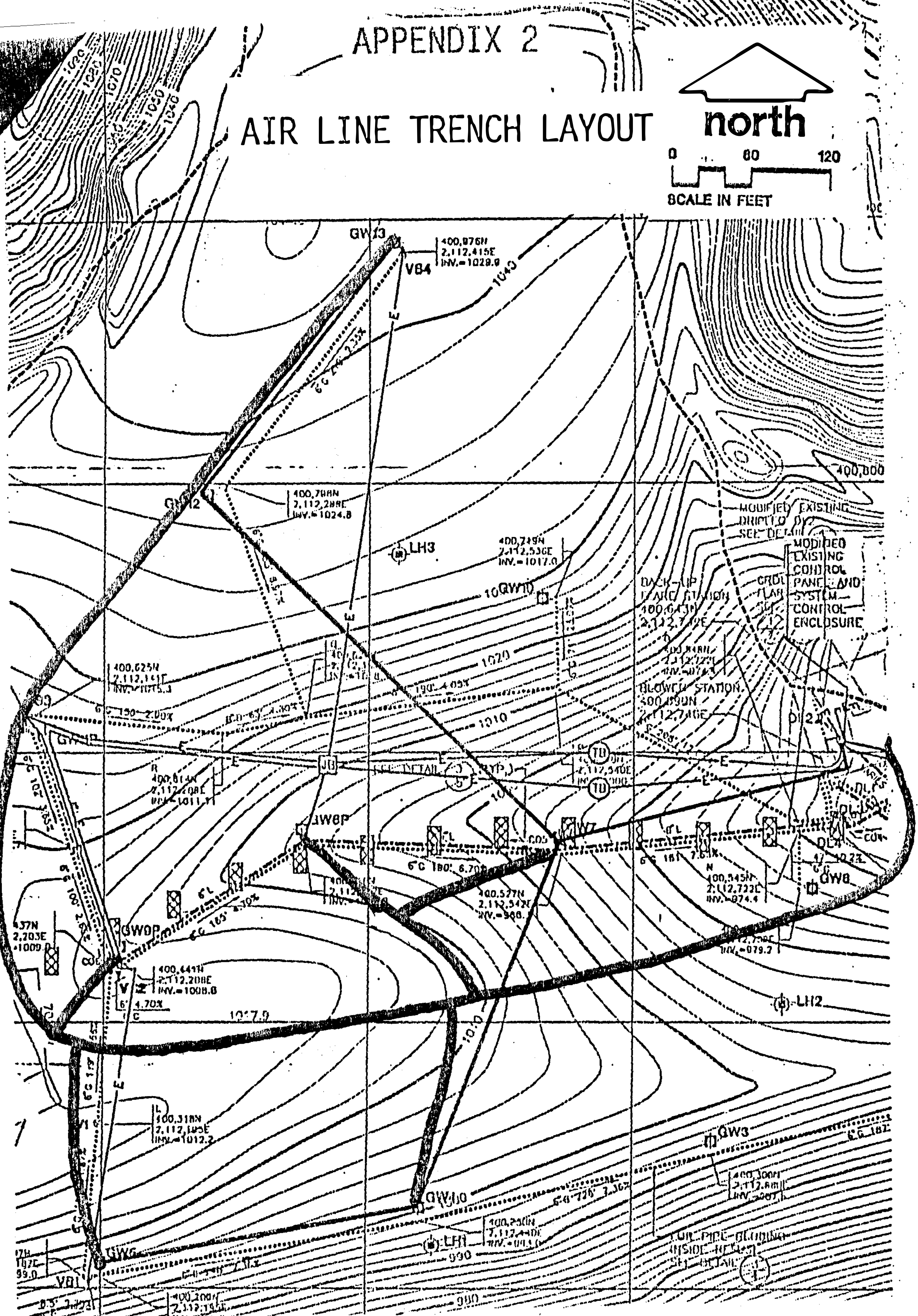
* DEPTH MEASURED FROM TOP OF WELL FLANGE

APPENDIX 2

AIR LINE TRENCH LAYOUT

APPENDIX 2

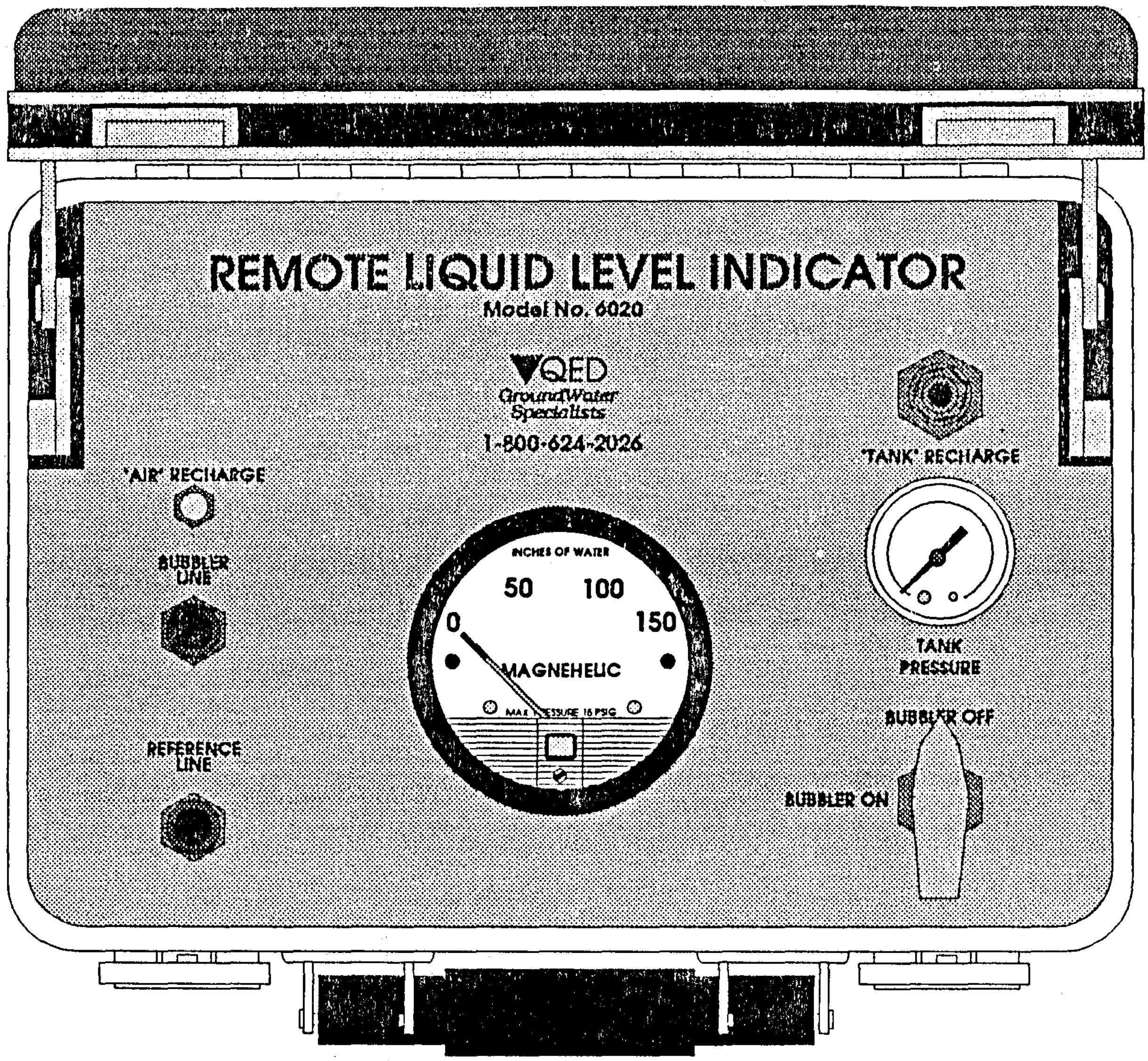
AIR LINE TRENCH LAYOUT



APPENDIX 3

LIQUID LEVEL INDICATOR INSTRUCTIONS

Model 6020 Remote Liquid Level Indicator



Operating Instructions

1. Disconnect the airline from the filter/regulator, (located on the MS1050), and connect it to the 'TANK RECHARGE'. NOTE: Bubbler on/off valve should be in the 'off' position.
2. Charge tank to 100 P.S.I., (indicated by the 'TANK PRESSURE' gauge). Remove air line once gauge reaches 100 P.S.I. and re-attach the airline back into the filter/regulator of the MS1050.
3. Connect bubbler and reference lines to the 6020, (blue hose=bubbler line and red hose=reference line).
4. Turn bubbler valve to the'BUBBLER ON' position.
5. Press and hold the 'AIR RECHARGE' button until you start to see a stabilized reading on the water level gauge.
6. Release the 'AIR RECHARGE' button and wait until the water level gauge Indicator has stabilized.
7. Take reading.
8. Turn the bubbler valve to the 'BUBBLER OFF' position and disconnect all lines from the 6020.

NOTE: When the 6020's tank has been fully charged to 100 P.S.I. It should have the capacity to do approximately 4-6 wells, (depending on length of tubing runs and well conditions).

P/N 96066 12-6-93

PHOTOGRAPHS

TYPICAL WELL HEAD

AIR DRIER AND INTERIOR PIPING

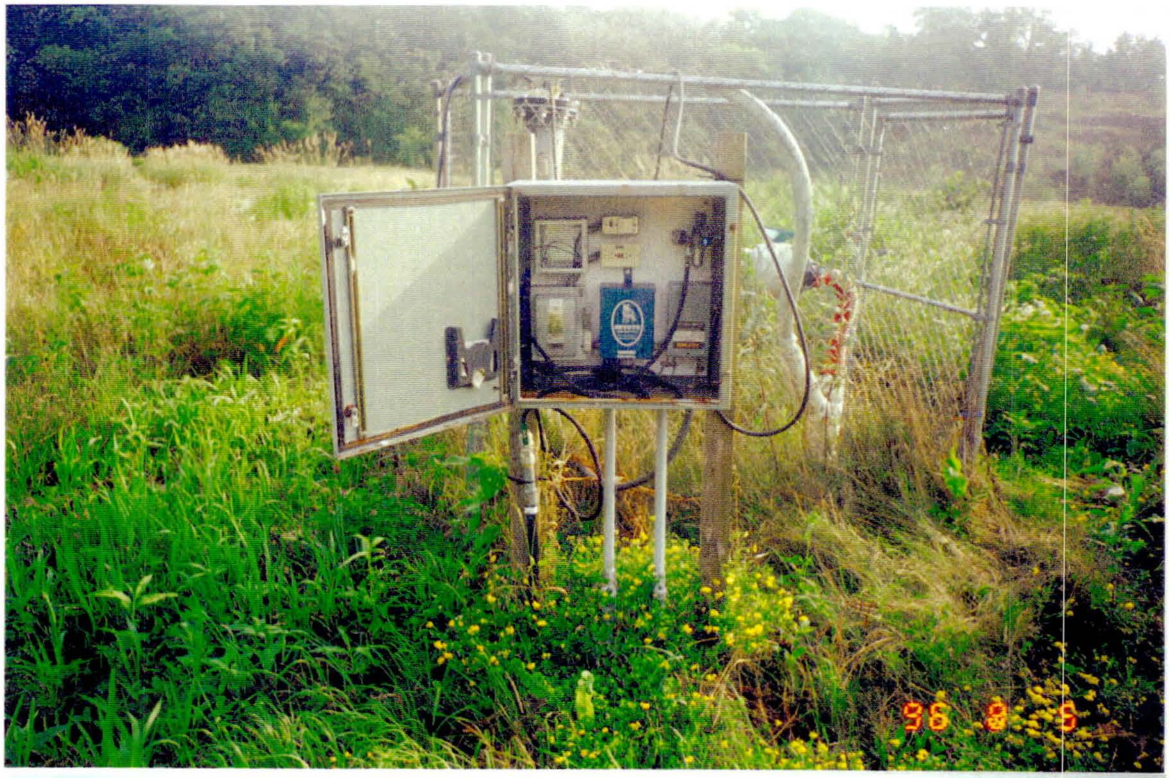
TRENCH FOR ELECTRICAL SERVICE UPGRADE

AIR LINE TRENCH ALONG ACCESS ROAD

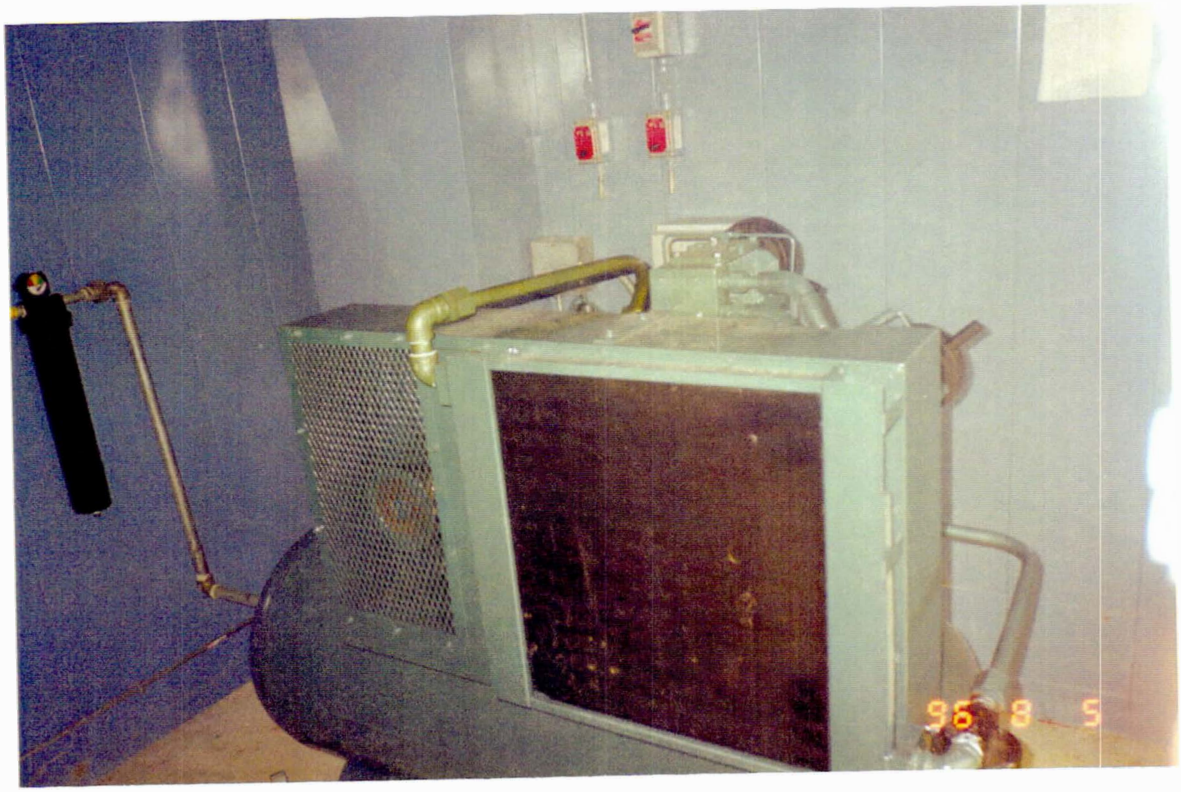
10' X 10' PREFABRICATED BUILDING ON SLAB

REGULATOR AND CYCLE COUNTER MOUNTED IN

EXISTING PUMP CONTROL PANEL



AIR COMPRESSOR



OPERATION AND MAINTENANCE MATERIALS

CAP-600L
December, 1994

ChallengeAIR

air compressor

INSTALLATION AND OPERATING INSTRUCTION MANUAL

CURTIS

WARNING

Before installing and operating this compressor, read and understand the safety precautions contained in LV-474 supplement to and part of CAP-600

460/3

IMPORTANT

Make a permanent record of the Model and Serial numbers of your machine here. You'll save time and expense by including this reference identification on replacement parts orders.

ChallengeAIR
CURTIS-TOLEDO, INC.
1905 Kienlen Avenue
St. Louis, MO 63133

REFER TO MODEL & SERIAL NUMBER.
READ INSTAL. & OPERATION INSTR.
DO NOT OPERATE LOWER THAN 500
R.P.M. OR ABOVE MAX. AS STIPULATED
BY PERFORMANCE DATA SHEET.

MODEL NO.	SERIAL NO.
E15	860125

A60125

*CONSULT FACTORY FOR SPECIAL APPLICATIONS

CURTIS-TOLEDO, INC.

1905 Kienlen Avenue, St. Louis, Missouri 63133, (314)383-1300
FAX (314)381-1439

Sales representatives in principal cities

INSTALLATION

CONGRATULATIONS on your new Curtis ChallengeAir Compressor. Please examine the compressor for shipping damage(s) and if any are found report it immediately to the carrier.

Select a clean dry location with a rigid floor strong enough to support the compressor. If the compressor is to be located in an area where vibration is critical, properly engineered vibration mounts and flexible piping should be used. Remove the skid. **NOTE: The compressor should never be operated on the shipping skid.** Level the compressor so it can be bolted down securely. Before tightening the bolts, check to see that all four feet are resting on the foundation. Shim up if necessary to eliminate stress on the receiver or base when the bolts are tightened. We suggest using a level for proper alignment.

Maximum ambient temperature in which the compressor and motor should be operated is 104°F. Therefore, adequate ventilation must be provided.

The suction openings of the compressor are equipped with a combination air filter-muffler to protect the compressor from normal dust and other harmful substances. If the air around the compressor is excessively hot, dusty, humid or contaminated with foreign gases (such as ammonia or acid fumes) move the filter-muffler to a remote point where the air is clean, cool and dry. Run a pipe to the compressor suction opening. If the run is over 50 feet in length, use a larger pipe to avoid excessive pressure drop. In order to fit the filter to the compressor, push down the connections. Be sure piping and fittings are clean and free from dirt and chips. If the filter is installed outside, check to insure that it is located above the normal outside dust level, and that rain cannot enter the filter element. Where the relocation of the filter-muffler is not possible or feasible, an oil bath filter is recommended and is available from Curtis.

On basic or base mounted compressors run a discharge pipe to the receiver or optional aftercooler and push up or down as necessary. The pipe should enter near the top of the receiver. Keep in mind that condensate may form in the discharge line, therefore, the lines should always be pitched to drain condensate away from the compressor. Always provide a safety relief valve in the discharge line between the compressor and in-line shutoff valves. If more than one compressor pumps into a common system, a check valve in the discharge line of each compressor is recommended to prevent moisture from entering the cylinder head when one compressor is idle. A globe on gate valve installed in the discharge line will allow compressor isolation from plant air system for compressor maintenance. (Note: A safety relief valve should be located between the compressor and the globe/gate valve.

Check the electrical supply for voltage, phase, and frequency to see that they match the nameplate stampings on the motor, magnetic starter, solenoids, and other controls. Use electrical wires of adequate size to carry the full load current of the motor without excessive voltage drop. Charts are available from Curtis (upon request) to provide information on this. The motor must always be protected by a starter with properly sized thermal overload(s). The starter should protect the motor from overheating and burn-out due to an overload, low voltage or single phasing of a 3-phase circuit. **Failure to install the proper starter and overloads will void the motor manufacturers warranty.** Follow the National Electric Code or local electric code in providing wiring, fusing and disconnect switches. **NOTE: Do not close the disconnect switch to start the compressor until the procedures outlined under "Startup Procedures" have been completed.**

LIMITED SAFETY PRECAUTIONS
(Also see supplement LV-474)

The following safety precautions are recommended in the use of this compressor:

1. Use a totally enclosed OSHA-approved belt guard to cover the drive assembly. Where possible, place the flywheel toward the wall, and mount the unit a minimum distance of 2 feet from the wall for maintenance convenience.
2. Turn off & lock out the electrical disconnect switch before working on the unit to prevent the unit from starting unexpectedly.
3. Release all air pressure from the system before working on the unit and red tag all electrical control switches, for safety precaution.
4. Do not by-pass motor overcurrent protection.
5. Do not change the setting or in any way affect the operation of the safety valve.
6. Keep unit securely anchored so that movement will not put a strain on piping, wiring, or air receiver.

WARNING: Read and understand supplement LV-474 before installing and operating the compresssor.

START-UP PROCEDURES

OIL RECOMMENDATION

Use a good grade of industrial compressor oil (non-detergent) with foam, rust and oxidation inhibitors and a minimum life of 1500 hours in the ASTM D 943 test for oxidation stability.

Ambient Temperatures:

0-32°F - Viscosity 180 to 240 SUS at 100°F.
- Minimum pour point of −20°F.
- Grade ISO 46.
- Approved listing:
  - Chevron-Turban GST Oil 46.
  - Amoco-Amokon Oil 46.
  - Conoco-Turban Oil 46.
  - Shell-Turbo Oil T-46.
  - Texaco-Regal R & O Oil 46.

32-100°F - Viscosity 300 to 350 SUS at 100°F.
- Grade ISO 68.
- Approved listing:
  - Chevron-Turban GST Oil 68.
  - Amoco-Amokon Oil 68.
  - Conoco-Turban Oil 68.
  - Shell-Turbo Oil T-68.
  - Texaco-Regal R & O Oil 68.

100-110°F - Viscosity 450-550 SUS at 100°F.
- Grade ISO 100.
- Approved listing:
  - Chevron-Turban GST Oil 100.
  - Amoco-Amokon Oil 100.
  - Conoco-Turban Oil 100.
  - Shell-Turbo Oil T-100.
  - Texaco-Regal R & O Oil 100.

If the compressor is equipped with an automatic start-stop control (with pressure switch unloading), it is automatically unloaded upon starting, and will automatically load after attaining running speed. If the compressor is equipped with a constant speed control (pilot valve unloading), it is necessary to manually unload the compressor, if there is pressure in the discharge line, in order to achieve an unloaded start. The compressor must be manually loaded after the compressor has attained full running speed; thereafter, it functions automatically to maintain operating pressure until the unit is shut off.

Close the disconnect switch and start the compressor. Observe the direction of rotation, which should be counterclockwise when viewed from the flywheel side of the compressor on all models. For single-phase units, the direction of rotation is determined by the motor nameplate instructions, and is adjusted at the factory. For three-phase units, if the rotation is incorrect, stop the unit and interchange any two of the three wires to the motor at the disconnect switch. This will reverse the direction of rotation of the motor and compressor.

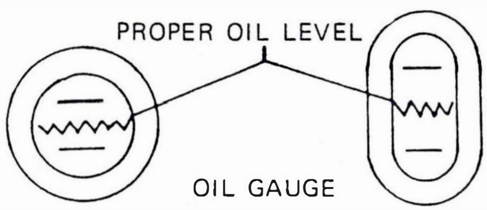
PREVENTIVE MAINTENANCE

A good maintenance program will add years of service to your air compressor. The following is recommended as a minimum maintenance program. (TURN OFF POWER BEFORE SERVICING.)

LUBRICATION

1. For proper lubrication the compressor shall not be operated below the minimum or above the maximum R.P.M. recommended for the various models.
2. Maintain oil level mid-way between the upper and lower lines of the crankcase sight gage.

NOTE ILLUSTRATION



3. Stop compressor to add and gauge oil.
4. Do not fill above the upper line and do not operate compressor with oil level below the lower line.

DO NOT OVER FILL

5. Change oil at the first 100 hours of operation and 1000 hours there-after, or as required. It may be necessary to change oil more frequent due to abnormal humid and containated conditions.

DAILY MAINTENANCE

1. Check and maintain oil level at centerline of sight glass and add oil as necessary.
2. Drain condensate from receiver unless it is equipped with an automatic tank drain, in which case the drain should be checked weekly to see that it is operating. See automatic tank drain instructions.
3. Check for unusual noise or vibration (See "Trouble Shooting".)

WEEKLY MAINTENANCE

1. Clean the air filters. A clogged air filter can seriously affect the efficiency of the compressor and cause overheating and oil usage.
2. Clean all external parts of the compressor and driver. Be sure to clean the intercooler finned surface on two-stage compressors. A dirty compressor will cause abnormally high discharge temperature and resulting oil carbonization on internal valve components.
3. Check the safety valve manually (by pulling ring or lever) to see that it is not stuck.

MONTHLY MAINTENANCE

1. Inspect the entire air system for leaks.
2. Inspect condition of oil and change if necessary.
3. Check drive belt tension and tighten if needed.

EVERY 3 MOS. OR 1,000 HRS. OF OPERATION

1. Change oil.
2. Inspect valves. Clean the carbon from valves and head if necessary.
3. Check and tighten if necessary all bolts, nuts, etc.
4. Check unloader operation.

*CHECKING BELT TENSION

The v-belt(s) should be so adjusted that a declination of about 3/8 - 1/2 inch will be obtained when it is pushed by a finger at the middle point as shown in Figure 1.

CAUTION: Over tightening the v-belt(s) will result in overloading of the motor and belt failure, while a loose belt will be slipping and resulting in an unstable speed and overheating the belt.

WARNING: Read and understand supplement LV-474 before installing and operating the compresssor.

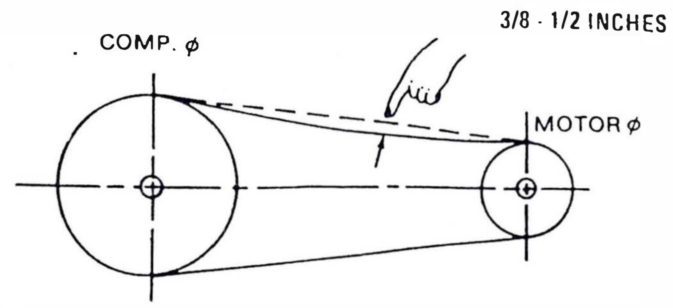


Figure 1

To change tension, loosen the motor hold-down bolts and slide the motor on the base, using a lever if necessary, or by turning the adjusting bolt at the end of the base.

Retighten motor hold-down bolts.

NOTE: Do not overtighten belts.

ELECTRIC MOTOR

Grease once a year with a good grade of lithium ball bearing grease, or as directed by the motor manufacturer.

VALVE INSPECTION AND MAINTENANCE

Valves should be inspected at regular intervals as recommended under "Maintenance" and cleaned or replaced when necessary. The valve can be serviced without disconnecting air piping or removing the head. **(Be sure the power to the motor is disconnected and all pressure released before starting to work on the compressor.)**

On constant run models, it is necessary to remove the unloader piping before the valve plugs can be removed.

MODELS E-11 AND E-23 (Figures 2 and 3)

A. Disassembly:

1. Unbolt the outlet valve push cover (70112-11450).
2. Remove the outlet valve push cover packing (70112-11460), spring (70112-41070) and valve plate (70112-31030). **CAUTION: Steps 1 and 2 are for outlet valve.**
3. Remove the unloading connecting tube for Models E-11 and E-23.
4. Untighten four cylinder head fixed bolts.
5. Remove cylinder head carefully and turn it over.
6. Unbolt inlet valve receiver (70112-31020).
7. Remove valve spring (70112-31070) and valve plate (70112-31030).

   Valves should be inspected approximately every 1,000 hours of operation. Inspect the valve seats on cylinder head for dents, cracks or wear. Replace all defective parts. Remove carbon deposits and wash all valve components in a suitable non-flammable cleaning fluid.

B. Assembly:

1. Place outlet valve plate (70112-31030) in position.
2. Place the outlet valve push cover packing (70112-11460) in position.
3. Insert the spring (70112-41070) into outlet valve push cover (70112-11450).
4. Turn outlet valve push cover (70112-11450) in position carefully.
5. Check the valves to see if they can move freely in their guides.
6. Turn over the cylinder head (70112-11012).
7. Place the inlet valve plate (70112-31030) in position.
8. Insert the small end of inlet valve spring (70112-31070) into position of valve receiver (70112-31020).
9. Screw inlet valve receiver in position.
10. Check the valves to see if they can move freely in their guides and do not pinch or bind between the seat and guard legs.

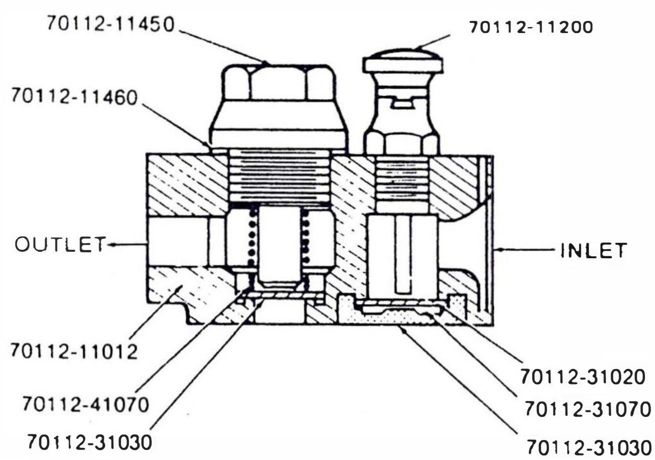


Figure 2

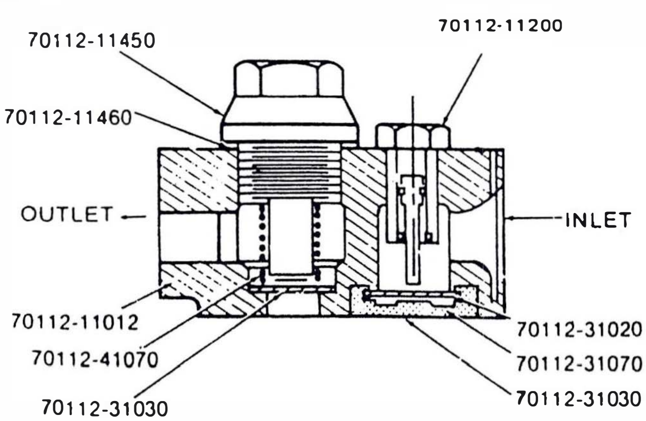


Figure 3

WARNING: Read and understand supplement LV-474 before installing and operating the compresssor.

MODELS E-50, E-71 AND E-15 (Figures 4 and 5)

A. Disassembly of Inlet Valve Assembly (Figure 4)

1. Remove the cotter pin.
2. Untighten the hex nut.
3. Remove unloading fork (70123-31080), unloading fork guide (70123-31090), unloading spring (70123-11230) and valve seat (70123-31010).

CAUTION:

1. **If a vise is used to hold the valve assembly, be careful not to clamp the assembly too tight.**
2. **Valve assembly should be inspected approximately every 1,000 hours of operation.**
3. **Inspect the valve seat for dents, cracks or wear.**
4. **Replace all defective parts.**
5. **Valve seats might be worn after years of operation which can be re-lapped or re-ground, in this case the recess in which the valve guard legs fit must also be cut down accordingly to ensure a same valve lift.**
6. **Remove carbon deposits and wash all valve components in a suitable non-flammable cleaning fluid.**

B. Reassembly of Inlet Valve Assembly

1. Place valve spring (70123-31070) and valve plate (70123-31030) on valve receiver (70123-31020).
2. Place valve seat (70123-31010), unloading fork guide 70123-31090), unloading spring (70123-11230) and unloading fork (70123-31080) respectively.
3. Tighten the valve assembly by tightening the hex nut.
4. Check the valves to see if they can move freely in their guides and do not pinch or bind between the seat and guard legs.
5. Insert the cotter pin.

C. Disassembly of Outlet Valve Assembly (Figure 5)

1. Remove the cotter pin.
2. Untighten the hex nut.
3. Remove valve receiver (70123-41020), valve spring (70123-41070) and valve plate (70123-31030).

CAUTION: Refer to disassembly of inlet valve assembly (paragraph B).

D. Reassembly of Outlet Valve Assembly

1. Place valve spring (70123-41070) in valve receiver 70123-71020).
2. Place valve plate (70123-31030) in valve receiver. (70123-41020).
3. Insert the sub-assembled part (assembled in step 1 and 2) into valve seat (70123-41010).
4. Tighten the hex nut.
5. Check the valves to see if they can move freely in their guides and do not pinch or bind between the seat and guard legs.

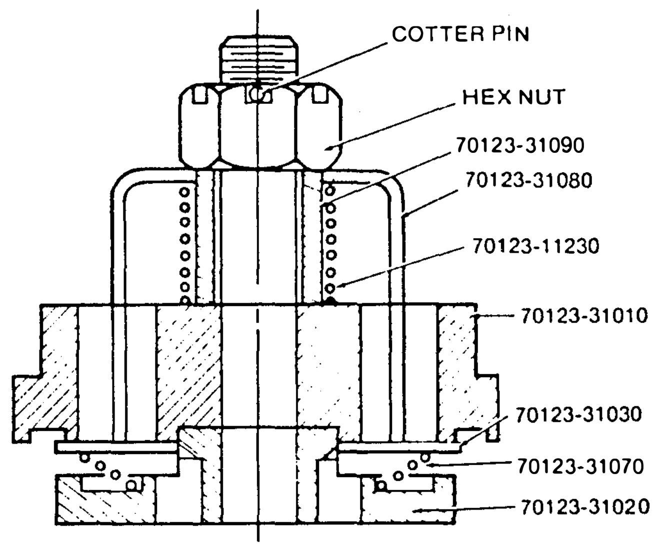


Figure 4

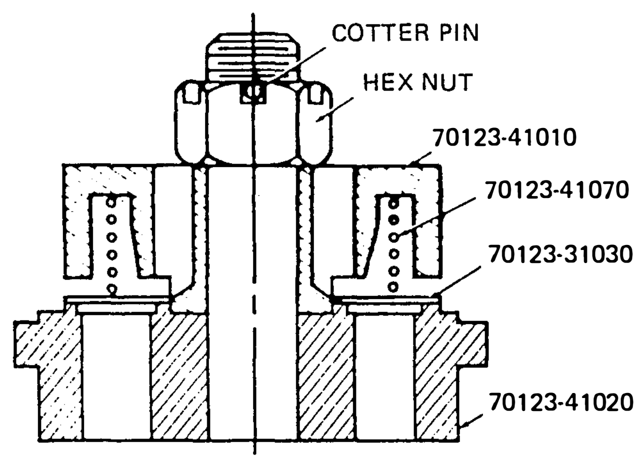


Figure 5

WARNING: Read and understand supplement LV-474 before installing and operating the compresssor.

VALVE ASSEMBLY INSTALLATION—MODEL E-50 (Figures 6 and 7)

1. Install valve assembly gasket (70123-11110).
2. Install valve assembly (70123-31001).
3. Install valve push cover (70123-11151).
4. Install head bolt and tighten evenly and securely.

It is strongly recommended that a Preventative Maintenance Kit & Valve/Gasket Maintenance Kit be kept on hand. In this manner, the valves can be used in turn to keep the compressor always in good condition and a minimum down-time.

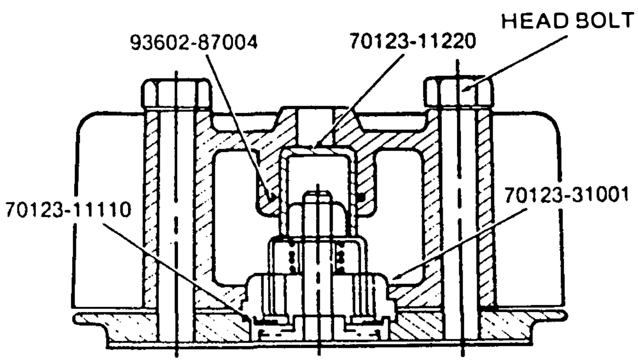


FIGURE 6

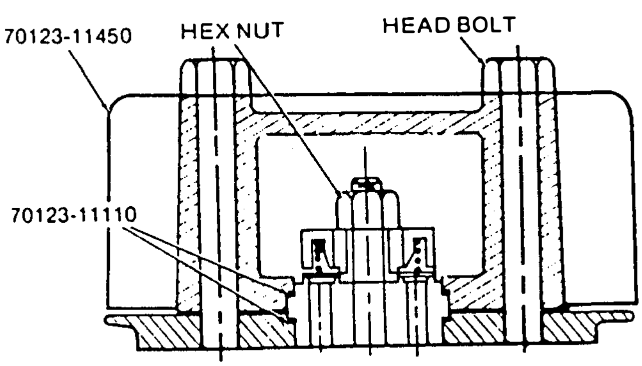


FIGURE 7

PISTON RINGS (Rebuild Kit)

To inspect or replace piston rings as follows:

1. Remove cylinder head.
2. Remove cylinder.
3. Loosen the connecting rod bolts.
4. Push out the piston with piston rings and connecting rod.
5. To remove the old rings, pry them out of their grooves and slide them over the piston. Care should be taken not to damage the piston.
6. Inspect the ring grooves for nicks and carbon deposits. Clean the ring grooves and remove the obstructions which might prevent the rings from moving freely.

To install new rings on the piston as follows: (Be careful not to damage the piston and rings).

1. Install the oil control ring (70123-61050) first. Rotate ring in groove to make sure it is free.
2. Install the Compression ring (70123-61030). Make sure the "top" or "R" make is exactly on top. If not, it might cause excessive oil consumption.
3. Repeat the process with other rings, if any.
4. Assemble connecting rod into the crankshaft. Be sure that the connecting rod and its cap are in original pair and position, since the connecting rod cap and crankshaft pin bushing are selected fitted and are not interchangeable.
5. Check if the ring cuts are in proper positions (Figure 8).

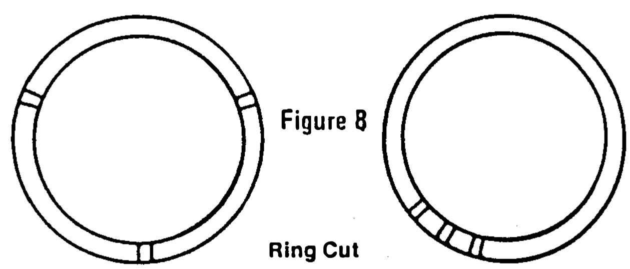


Figure 8

A—CORRECT
The ring cuts are evenly apart from each other

B—INCORRECT
The ring cuts are approximately concentric in one direction

WARNING: Read and understand supplement LV-474 before installing and operating the compresssor.

REBUILD KITS

AIR COOLED SINGLE STAGE MODELS

ES03

PART NO.	CONSISTS OF
CF1299	1-70111-66140 Filter Element 2-70111-31030 Valve Disc 1-70111-31070 Spring 1-70111-41070 Spring 1-70111-11650 Gasket 1-70111-11610 Head Gasket 2-70111-6130 Comp. Ring 1-70111-61050 Oil Ring 1-70111-57230 Bottom Cover Gasket 1-70111-57080 Front Oil Seal 1-70111-57960 Rear Cover Gasket 10-92521-190600 Copper Washer

ES05

PART NO.	CONSISTS OF
CF1237	1-70111-66140 Filter Element 2-70112-31030 Valve Disc 1-70112-31070 Spring 1-70112-41070 Spring 2-70112-61030 Comp. Ring 1-70112-61050 Oil Ring 1-70112-11610 Head Gasket 1-70112-51610 Crankcase Gasket 1-70112-57950 Front Cover Gasket 1-70112-57960 Rear Cover Gasket 1-70112-57060 Oil Seal 12-92521-190800 Copper Washer

ES06

PART NO.	CONSISTS OF
CF1302	2-70111-66140 Filter Element 4-70111-31030 Valve Disc 2-70111-31070 Spring 2-70111-41070 Spring 2-70111-11650 Gasket 2-70111-11610 Head Gasket 2-70121-51610 Crankcase Gasket 4-70111-61030 Comp. Ring 2-70111-61050 Oil Ring 1-70121-57950 Front Cover Gasket 1-70111-57960 Rear Cover Gasket 1-70121-57970 Bottom Cover Gasket 1-70121-57080 Front Oil Seal 24-92521-190800 Copper Washer

ES10

PART NO.	CONSISTS OF
CF1238	2-70111-66140 Filter Element 4-70112-31030 Disc 2-70112-31070 Spring 2-70112-41070 Spring 4-70112-61030 Compression Ring 2-70112-61050 Oil Ring 2-70112-11610 Head Gasket 2-70112-51610 Crankcase Gasket 1-70122-57950 Front Cover Gasket 1-7-122-57960 Rear Cover Gasket 1-70122-57060 Front Oil Seal 24-92521-190800 Copper Washer 1-70111-57700 Oil Level Gauge & Cover 1-70111-57730 Oil Level Gauge Cover Seal

ES20

PART NO.	CONSISTS OF
CF1239	3-70111-66140 Filter Element 6-70112-31030 Disc 2-70112-31070 Spring 3-70112-41070 Spring 6-70112-61030 Compression Ring 3-70112-61050 Oil Ring 3-70112-11610 Head Gasket 3-70112-51610 Crankcase Gasket 1-70122-57950 Front Cover Gasket 1-70122-57960 Rear Cover Gasket 1-70122-57080 Front Oil Seal 26-92521-190800 Copper Washer 1-70111-57700 Oil Level Gauge & Cover 1-70111-57730 Oil Level Gauge Cover Seal

ES-30

PART NO.	CONSIST OF:
CF1246	REBUILD KIT INCLUDES: 2-70123-66140 Filter Element 4-70123-31030 Disc 2-70123-31070 Spring 2-70123-41070 Spring 4-70123-61030 Compression Ring 4-70123-61050 Oil Ring 4-70123-11110 Seat Gasket 2-70123-11610 Head Gasket 2-70123-51610 Crankcase Gasket 1-70123-57950 Front Cover Gasket 1-70123-57960 Rear Cover Gasket 1-70123-57080 Front Oil Seal *2-70123-61081 Bushing 4-70123-61090 Rod Bearing (Halves) 26-92521-191000 Copper Washer

ES-50

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES: 3-70123-66140 Element
CF1245	VALVE/GASKET MAINT. KIT INCLUDES. 6-70123-31030 Disc 3-70123-31070 Spring 3-70123-41070 Spring 6-70123-11110 Seat Gasket 3-70123-11610 Head Gasket
CF1244	REBUILD KIT INCLUDES: 1-70123-57080 Front Oil Seal 6-70123-61030 Compression Ring 6-70123-61050 Oil Ring *3-70123-61081 Bushing 6-70123-61090 Rod Bearing (Halves) 3-70123-51610 Crankcase Gasket 1-70123-57850 Front Brg. Cover Gasket 1-70133-57960 Rear Brg. Cover Gasket 34-92521-191000 Copper Washer

ES-100

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES: 3-70123-66140 Element
CF1243	VALVE/GASKET MAINT. KIT INCLUDES. 6-70124-31030 Disc 3-70124-31070 Spring 3-70124-41070 Spring 6-70124-11110 Seat Gasket 3-70124-11610 Head Gasket
CF1242	REBUILD KIT INCLUDES: 1-70124-57950 Front Brg. Cover Gasket 6-70124-61030 Compression Ring 6-70124-61050 Oil Ring 3-70124-61080 Bushing 6-70124-61090 Rod Bearing (Halves) 3-70124-51610 Crankcase Gasket 1-70134-57080 Front Oil Seal 1-70134-57960 Rear Brg. Cover Gasket 34-92521-191000 Copper Washer

ES-150

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES: 3-70123-66140 Element
CF1241 **CF1312	VALVE/GASKET MAINT KIT INCLUDES. 6-70125-31030 Disc 3-70125-31070 Spring 9-70125-41070 Spring 6-70125-11110 Seat Gasket 3-70125-87510 Manifold Gasket 3-70125-11610 Head Gasket **70135-11610 Head Gasket
CF1240	REBUILD KIT INCLUDES: 1-70134-57080 Front Oil Seal 6-70125-61030 Compression Ring 6-70125-61050 Oil Ring *3-70125-61081 Bushing 6-70125-61090 Bearing (Halves) *3-70135-51610 Crankcase Gasket 1-70135-57950 Front Brg. Cover Gasket 1-70134-57960 Rear Brg. Cover Gasket 24-92521-191200 Copper Washer

* WARNING — THESE ITEMS INTERCHANGE WITH PARTS ON SERIAL #3020000 & HIGHER ONLY. CONTACT FACTORY FOR EARLIER SERIES.

**USE WITH SERIAL #A311XXXX AND LATER. 70135-11610 REPLACES 70125-11610

REBUILD KITS
AIR COOLED TWO STAGE MODELS

E-35

PART NO.	DESCRIPTION
CF1306	PREVENTATIVE MAINTENANCE KIT INCLUDES:
	1-70152-66140 Element
CF1307	GASKET/VALVE MAINT. KIT INCLUDES:
	4-70152-31030 Disc
	2-70152-32030 Disc
	4-70152-31071 Spring
	2-70152-32071 Spring
	1-70152-11610 Head Gasket
	1-70152-31120 Seat Gasket
	1-70152-11620 Seat Gasket
CF1308	REBUILD KIT INCLUDES:
	1-70152-51610 Case Gasket
	1-70152-57960 Rear Cov.Gkt.
	2-70152-61030 Comp. Ring
	1-70152-61050 Oil Ring
	1-70152-61060 Bushing (L.P.)
	1-70152-62060 Bushing (H.P.)
	2-70152-61090 Rod Brg. Set
	3-70152-62030 Comp. Ring
	1-70152-62050 Oil Ring
	1-70152-57950 Frt. Cov. Gkt.
	1-70127-57060 Frt. Oil Seal
	6-92521-190600 Copper Washer

E-11

PART NO.	CONSISTS OF:
CF1250	1-70111-66140 Filter Element
	2-70112-31030 Disc
	2-70162-32030 Disc
	1-70112-31070 Spring
	1-70162-42070 Spring
	1-70112-41070 Spring
	1-70162-32070 Spring
	2-70112-61030 Compression Ring
	1-70112-61050 Oil Ring
	2-70162-62030 Compression Ring
	2-70162-62050 Oil Ring
	1-70112-11610 Head Gasket (1st)
	1-70162-12610 Head Gasket (2nd)
	2-70112-51610 Crankcase Gasket
	1-70122-57950 Front Cover Gasket
	1-70122-57960 Rear Cover Gasket
	1-70122-57080 Front Oil Seal
	24-92521-190600 Copper Washer

E-23

PART NO.	CONSISTS OF:
CF1251	2-70111-66140 Filter Element
	4-70112-31030 Disc
	2-70111-31030 Disc
	2-70112-31070 Spring.
	2-70112-41070 Spring
	1-70172-32070 Spring
	1-70172-42070 Spring
	4-70112-61030 Compression Ring
	2-70112-61050 Oil Ring
	2-70111-61030 Compression Ring
	2-70111-61050 Oil Ring
	2-70112-11610 Head Gasket (1st)
	1-70111-11610 Head Gasket (2nd)
	3-70112-51610 Crankcase Gasket
	1-70122-57950 Front Cover Gasket
	1-70122-57960 Rear Cover Gasket
	1-70122-57080 Front Oil Seal
	32-92521-190600 Copper Washer

E-57

PART NO.	
CF1291	PREVENTATIVE MAINTENANCE KIT INCLUDES:
	1-70153-66142 Element
CF1292	GASKET/VALVE MAINT. KIT INCLUDES:
	4-70153-31031 Disc
	2-70153-32031 Disc
	4-70153-31071 Spring
	2-70153-32071 Spring
	1-70153-31120 Seat Gasket
	1-70153-11610 Head Gasket
	1-70153-11620 Seat Gasket
CF1293	REBUILD KIT INCLUDES:
	1-70153-57950 Front Brg. Gasket
	2-70124-61030 Comp. Ring
	1-70124-61050 Oil Ring
	3-70153-62030 Comp. Ring
	1-70153-62050 Oil Ring*
	1-70153-61081 Bushing (L.P.)
	1-70153-62081 Bushing (H.P.)
	4-70153-61090 Rod Brd. (Halves)
	1-70153-51610 Case Gasket
	1-70123-57080 Oil Seat
	1-70153-57960 Rear Brg. Gasket
	6-92521-191000 Copper Washer

E-50

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES:
	2-70123-66140 Element
CF1253	GASKET/VALVE MAINT. KIT INCLUDES:
	6-70123-31030 Disc
	3-70123-31070 Spring
	3-70123-41070 Spring
	6-70123-11110 Seat Gasket
	3-70123-11610 Head Gasket
CF1254	REBUILD KIT INCLUDES:
	1-70123-57960 Fr. Brg. Gasket
	4-70123-61030 Comp. Ring
	4-70123-61050 Oil Rings
	3-70112-61030 Comp. Ring
	1-70112-61050 Oil Ring
	2-70123-61081 Bushing
	1-70173-62080 Bushing
	6-70123-61090 Rod Brg. (Halves)
	3-70123-51610 Crank Case Gasket
	1-70123-57080 Oil Seal
	1-70133-57960 Rear Brg. Gasket
	34-92521-191000 Copper Washer

E-71

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES:
	2-70123-66140 Element
CF1255	GASKET/VALVE MAINT. KIT INCLUDES:
	4-70124-31030 Disc
	2-70123-31030 Disc
	2-70124-31070 Spring
	1-70123-31070 Spring
	2-70124-41070 Spring
	1-70123-41070 Spring
	4-70124-11110 Seat Gasket
	2-70123-11110 Seat Gasket
	2-70124-11610 Head Gasket
	1-70123-11610 Head Gasket
CF1256	REBUILD KIT INCLUDES:
	1-70124-57950 Front Brg. Gkt.
	4-70124-61030 Comp. Ring
	4-70124-61050 Oil Ring
	3-70123-61030 Comp. Ring
	2-70123-61050 Oil Ring
	2-70124-61060 Bushing
	1-70174-62060 Bushing
	3-70124-51610 Gasket
	1-70134-67080 Oil Seal
	6-70124-61090 Bearing (Halves)
	1-70134-57960 Rear Brg. Gkt.
	34-92521-191000 Copper Washer

E-15

PART NO.	DESCRIPTION
CF1252	PREVENTATIVE MAINTENANCE KIT INCLUDES:
	2-70123-66140 Element
CF1257	**CF1314 GASKET/VALVE MAINT. KIT INCLUDES:
	4-70125-31030 Disc
	2-70124-31030 Disc
	2-70125-31070 Spring
	1-70124-31070 Spring
	6-70125-41070 Spring
	1-70124-41070 Spring
	4-70125-11110 Seat gasket
	2-70124-11110 Seat gasket
	4-70125-87510 Manifold gasket
	2-70125-11610 Head gasket
	1-70124-11610 Head gasket
	**70135-11610 Head gasket
CF1258	REBUILD KIT INCLUDES:
	4-70125-61030 Comp. Ring
	4-70125-61050 Oil Ring
	3-70124-61030 Comp. Ring
	2-70124-61050 Oil Ring
	*3-70125-61081 Bushing
	6-70125-61090 Rod Bearing (Halves)
	3-70135-51610 Gasket
	1-70134-57080 Oil Seal
	1-70135-57950 Fr. Brg. Gkt.
	1-70134-57960 Rear Brg. Gkt.
	24-92521-191200 Copper Washer

* **WARNING** – THESE ITEMS INTERCHANGE WITH PARTS ON SERIAL #3020000 & HIGHER ONLY. CONTACT FACTORY FOR EARLIER SERIES.

**USE WITH SERIAL #A311XXXX AND LATER.
70135-11610 REPLACES 70125-11610

RING SETS & GASKET SETS

SINGLE STAGE

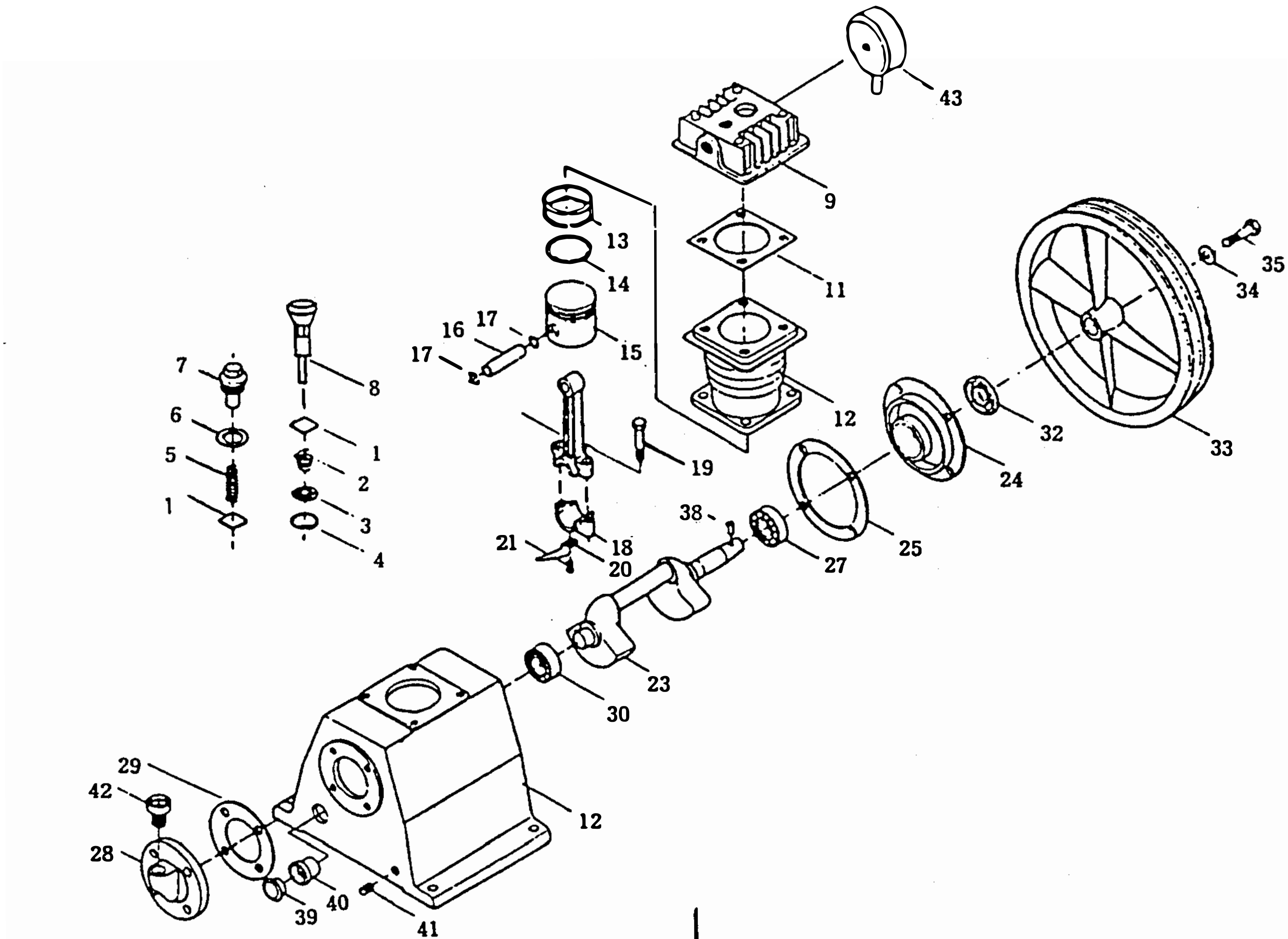
MODEL	PART NO.	DESCRIPTION	QUANTITY REQ'D.
ES03	CF1297 CF1298	Ring Set Gasket Set	1 1
ES05	CF1259 CF1276	Ring Set Gasket Set	1 1
ES06	CF1300 CF1301	Ring Set Gasket Set	2 1
ES10	CF1260 CF1277	Ring Set Gasket Set	2 1
ES20	CF1261 CF1278	Ring Set Gasket Set	3 1
ES30	CF1262 CF1279	Ring Set Gasket Set	2 1
ES50	CF1263 CF1280	Ring Set Gasket Set	3 1
ES100	CF1264 CF1281	Ring Set Gasket Set	3 1
ES150	CF1265 CF1282 *CF1311	Ring Set Gasket Set *Gasket Set	3 1 1

TWO-STAGE

MODEL	PART NO.	DESCRIPTION	QUANTITY REQ'D.
E11	CF1266 CF1267 CF1283	Ring Set (LP) Ring Set (HP) Gasket Set	1 1 1
E23	CF1268 CF1269 CF1284	Ring Set (LP) Ring Set (HP) Gasket Set	2 1 1
E35	CF1303 CF1304 CF1305	Ring Set (LP) Ring Set (HP) Gasket Set	1 1 1
E50	CF1270 CF1271 CF1285	Ring Set (LP) Ring Set (HP1 Gasket Set	2 1 1
E57	CF1288 CF1289 CF1290	Ring Set (LP) Ring Set (HP) Gasket Set	1 1 1
E71	CF1272 CF1273 CF1286	Ring Set (LP) Ring Set (HP) Gasket Set	2 1 1
E15	CF1274 CF1275 CF1287 *CF1313	Ring Set (LP) Ring Set (HP) Gasket Set *Gasket Set	2 1 1 1

*USE WITH SERIAL #A311XXXX AND LATER.

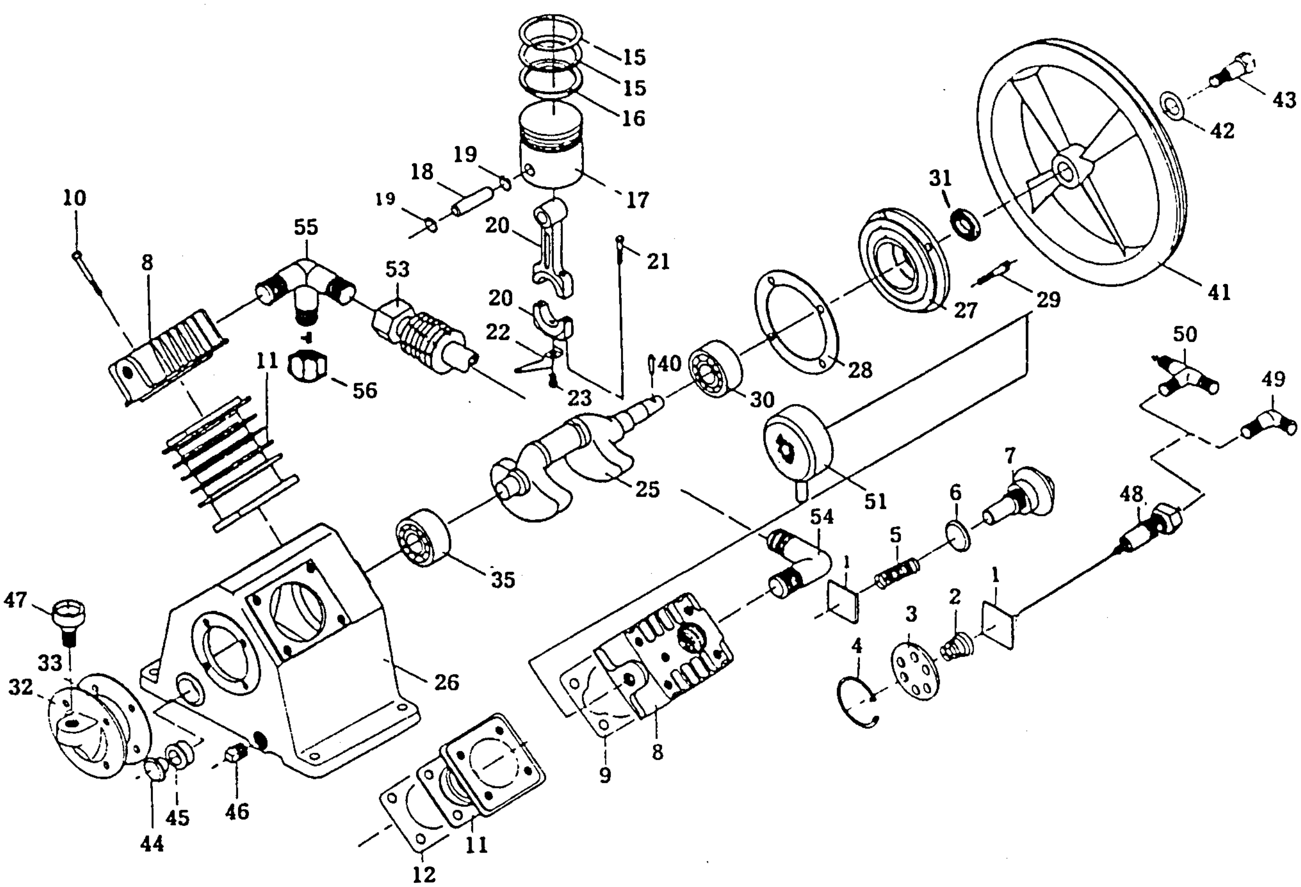
MODEL ES03
AIR COOLED, SINGLE STAGE, SINGLE CYLINDER



DESCRIPTION	QTY.	PART NO.
VALVES		
1. Inlet & Outlet Valve Plate	2	70111-31030
2. Inlet Valve Spring	1	70111-31070
3. Inlet Valve Receiver	1	70111-31020
4. Inlet Valve Snap Ring	1	93610-130025
5. Outlet Valve Spring	1	70111-41070
6. Outlet Valve Push Cover Gasket	1	70111-11650
7. Outlet Valve Push Cover	1	70111-11450
8. Manual Unloader Asm.	1	70111-11300
9.		
CYLINDERS		
9A. Cylinder Head Asm. (Includes Valves)	1	70111-11000
9B. Cylinder Head (Bare Casting)	1	70111-11010
10. Cylinder Head Bolt (Not Shown)	4	(Hardware Item)
11. Cylinder Head Gasket	1	70111-11610
12. Cylinder & Crankcase	1	70111-57010
13. Compression Ring	2	70111-61030
14. Oil Control Ring	1	70111-61050
15. Piston	1	70111-61010
16. Piston Pin	1	70111-61120
17. Piston Pin Snap Ring	2	70111-61070
18. Connecting Rod Asm.	1	70111-61200
19 Connecting Rod Bolt	2	(Furnished on Conn. Rod Only)
20. Oil Splash Dipper	1	70111-61282
21. Oil Splash Dipper Bolt	1	91507-2304010
22. Oil Splash Dipper Bolt Washer (Not Shown)	1	92522-130400

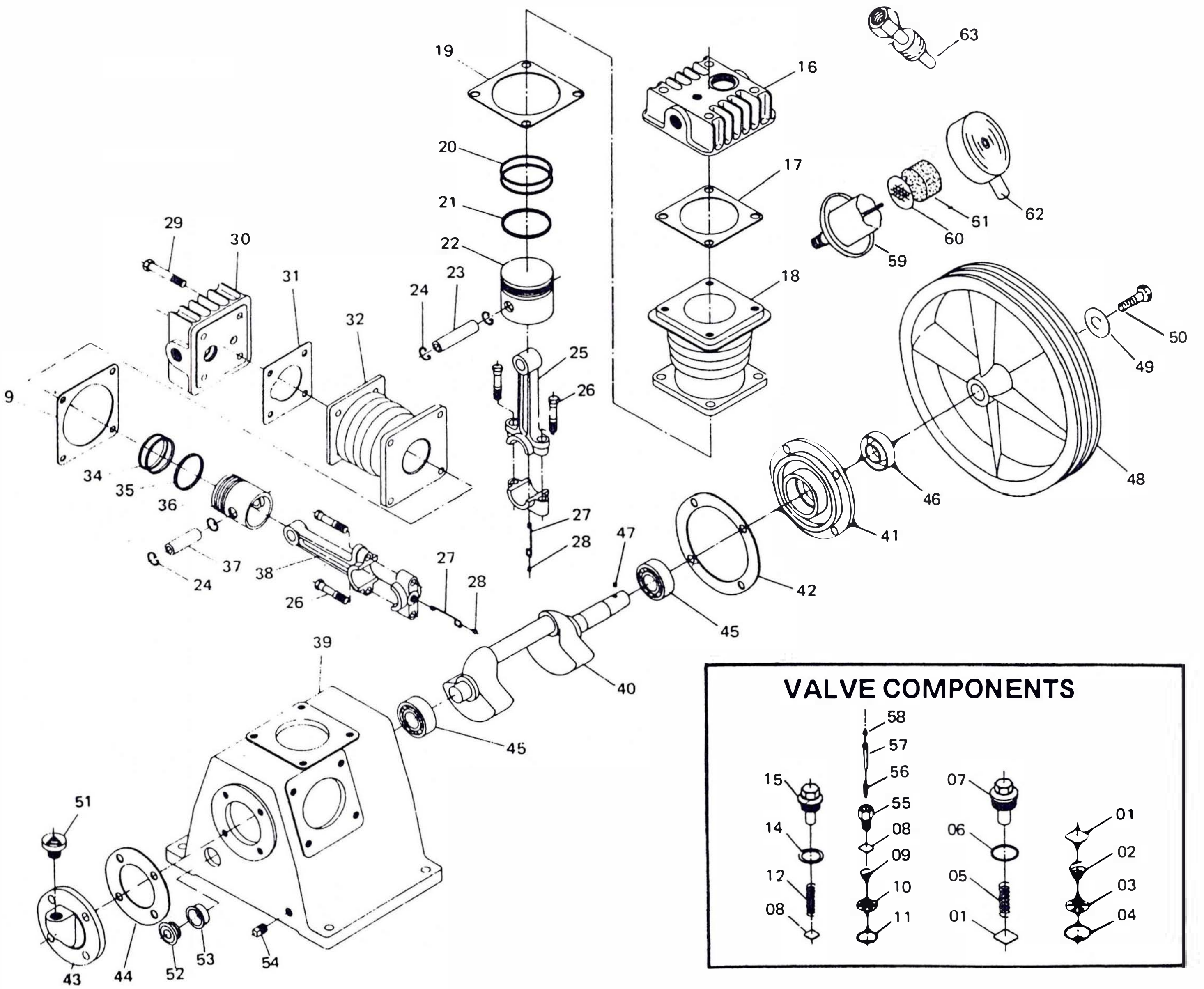
DESCRIPTION	QTY.	PART NO.
CRANKCASE AND CRANK ASSY.		
23. Crankshaft	1	70111-56010
24. Front Bearing Cover	1	70111-57030
25. Front Bkg. Cover Gasket	1	70111-57040
26. Front Cover Bolts (Not Shown)	4	91501-1306015
27. Front Bearing #6203	1	93501-62030
28. Rear Bearing Cover	1	70111-57060
29. Rear Bearing Cover Gasket	1	70111-57960
30. Rear Bearing #6201	1	93501-62010
31. Rear Brg. Cover Bolt (Not Shown)	3	93501-1306015
32. Front Oil Seal	1	70111-57080
33. Compressor Pulley	1	70111-76010
34. Comp. Pulley Thrust Washer	1	70111-76210
35. Comp. Pulley Thrust Bolt	1	91501-1306020
36. Crankcase Bottom Cover (Not Shown)	1	70111-57220
37. Crankcase Bottom Cover Gasket (Not Shown)	1	70111-57230
38. Compressor Pulley Pin	NA	(Not Required)
39. Oil Level Gauge & Cover	1	70111-57700
40. Gauge Cover Seal	1	70111-57730
41. Crankcase Oil Plug (1/4" PT)	1	90112-100202
42. Breather Asm.	1	70103-57600
AIR STRAINER ELEMENT		
43. Air Strainer Asm.	1	70109-66000
44. Air Strainer Element (Not Shown)	1	70111-66140

MODEL ES06
AIR COOLED, SINGLE STAGE, TWO CYLINDER



DESCRIPTION	QTY.	PART NO.
VALVES		
1. Inlet and Outlet Valve Plate	4	70111-31030
2. Inlet Valve Spring	2	70111-31070
3. Inlet Valve Receiver	2	70111-31020
4. Inlet Valve Snap Ring	2	93610-130025
5. Outlet Valve Spring	2	70111-41070
6. Outlet Valve Push Cover Gasket	2	70111-11650
7. Outlet Valve Push Cover	2	70111-11450
CYLINDERS, CRANKCASE AND CRANK ASSY.		
8a. Cylinder Head Assy. (Includes Valve)	2	70111-11000
8b. Cylinder Head (Bare Casting)	2	70111-11010
9. Cylinder Head Gasket	2	70111-11610
10. Cylinder Head Bolt	8	(Hardware Item)
11. Cylinder	2	70121-51010
12. Cylinder to Case Gasket	2	70121-51610
13. Cylinder to Case Bolt (Not Shown)	8	91501-1306015
14. Cylinder to Case Bolt Washer (Not Shown)	16	92521-190600
15. Compression Ring	4	70111-61030
16. Oil Control Ring	2	70111-61050
17. Piston	2	70111-61010
18. Piston Pin	2	70111-61120
19. Piston Pin Snap Ring	4	70111-61070
20. Connecting Rod Assy.	2	70111-61200
21. Connecting Rod Bolt	4	(Furnished on Conn. Rod Only)
22. Oil Splash Dipper	2	70121-61282
23. Oil Splash Dipper Bolt	2	91507-2304010
24. Oil Splash Dipper Lockwasher (Not Shown)	2	92522-130400
25. Crankshaft	1	70121-56010
26. Crankcase	1	70121-57010
27. Front Bearing Cover	1	70121-57030
28. Front Bearing Cover Gasket	1	70121-57950
29. Front Bearing Cover Bolt	4	91501-1306015
30. Front Bearing #6204	1	93501-62040
31. Front Oil Seal	1	70121-57080
32. Rear Bearing Cover	1	70111-57060
33. Rear Bearing Cover Gasket	1	70111-57960
34. Rear Bearing Cover Bolt (Not Shown)	3	91501-1306015
35. Rear Bearing #6203	1	93501-62030
36. Crankcase Bottom Cover (Not Shown)	1	70121-57220
37. Crankcase Bottom Cover Gasket (Not Shown)	1	70121-57230
38. Crankcase Bottom Cover Bolt (Not Shown)	4	(Hardware Item)
39. Front & Rear Cover Bolt Washer (Not Shown)	10	92521-190600
40. Compressor Pulley Pin	1	70112-56060
41. Compresssor Pulley	1	70121-76010
42. Compressor Pulley Thrust Washer	1	70112-76210
43. Compressor Pulley Thrust Bolt	1	91501-1308025
44. Oil Level Gauge & Gauge Cover	1	70111-57700
45. Oil Level Gauge Cover Seal	1	70111-57730
46. Crankcase Oil Plug (1/4" NPT)	1	90112-100202
47. Breather Assy.	1	70103-57600
UNLOADERS (•Indicates Not Included On Basics)		
48. Auto – Unloader Assembly	2	70112-11200
49. Unloading Elbow• (Includes Nut & Sleeve)	1	VA786
50. Unloading Tee• (Includes Nut & Sleeve)	1	VA787
AIR STRAINER ASSY. & DISCHARGE PIPING		
51. Air Strainer Assy.	2	70109-66000
52. Air Strainer Element (Not Shown)	2	70111-66140
53. Compr. Body Discharge Pipe Assy	1	70121-87100
54. Outlet Pipe Elbow	1	70121-87010
55. Outlet Pipe Tee	1	70121-87020
56. Outlet Pipe Tee Nut	1	79922-130404

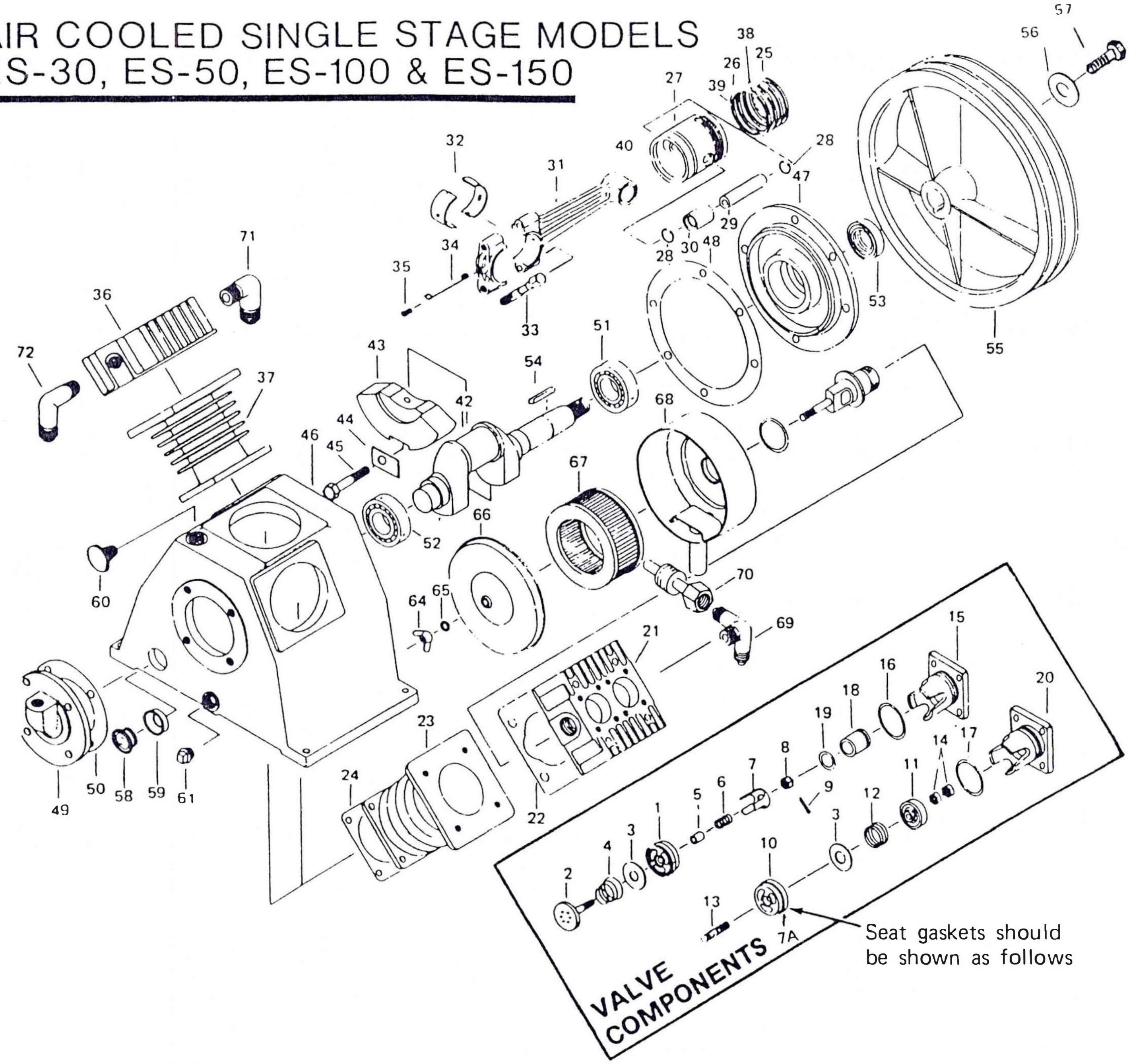
AIR COOLED SINGLE STAGE MODELS
ES-05, ES-10 & ES- 20



MAIN PARTS LISTING FOR SINGLE STAGE MODELS ES-05, ES-10 & ES-20

		MODEL ES05		MODEL ES10		MODEL ES20	
		Qty. Req.		Qty. Req.		Qty. Req.	
VALVES							
1.	Inlet & outlet valve plate	2	70112-31030	4	70112-31030	6	70112-31030
2.	Inlet valve spring	1	70112-31070	2	70112-31070	3	70112-31070
3.	Inlet valve receiver	1	70112-31020	2	70112-31020	3	70112-31020
4.	Inlet valve snap ring	1	93610-130032	2	93610-130032	3	93610-130032
5.	Outlet valve spring	1	70112-41070	2	70112-41070	3	70112-41070
6.	Outlet valve push cover gasket	1	70112-11650	2	70112-11650	3	70112-11650
7.	Outlet valve push cover	1	70112-11460	2	70112-11450	3	70112-11450
CYLINDERS & CYL HEADS							
16A	Cylinder head assembly	1	70112-11000	2	70112-11000	3	70112-11000
16B	Cylinder head	1	70112-11010	2	70112-11010	3	70112-11010
17.	Cylinder & head gasket	1	70112-11610	2	70112-11610	3	70112-11610
18.	Cylinder	1	70112-51010	2	70112-51010	3	70112-51010
19	Cylinder & case gasket	1	70112-51610	2	70112-51610	3	70112-51610
20.	Compression ring	2	70112-61030	4	70112-61030	6	70112-61030
21	Oil control ring	1	70112-61050	2	70112-61050	3	70112-61050
22.	Piston	1	70112-61010	2	70112-61010	3	70112-61010
23.	Piston pin	1	70112-61120	2	70112-61120	3	70112-61120
24.	Piston pin snap ring	2	70112-61070	4	70112-61070	6	70112-61070
25.	Connecting rod assembly	1	70112-61200	2	70112-61200	3	70112-61200
26.	Connecting rod bolt	1	70112-61250	4	70112-61250	6	70112-61250
27.	Oil splash dipper	1	70111-61282	2	70122-61282	2	70122-61282
27A	Oil splash dipper					1	70132-61290
28.	Oil splash dipper bolt	1	91607-2304010	2	91507-2304010	3	91507-2304010
29.	Cylinder head bolt	4	(Hardware Item)	8	(Hardware Item)	12	(Hardware Item)
CRANK ASSEMBLY							
39.	Crankcase	1	70112-57010	1	70122-57010	1	70132-57010
40.	Crankshaft	1	70112-56010	1	70122-66010	1	70132-56010
41.	Front bearing cover	1	70112-57030	1	70122-57030	1	70122-57030
42.	Front bearing cover gasket	1	70112-57950	1	70122-57950	1	70122-57950
43.	Rear bearing cover	1	70112-57060	1	70122-57060	1	70122-57060
44.	Rear bearing cover gasket	1	70112-57960	1	70122-57960	1	70122-57960
45A	Bearing - Front	1	93501-62050	1	93501-62050	1	93501-62050
45B	Bearing - Rear	1	93501-62040	1	93501-62050	1	93501-62050
46.	Front oil seal	1	70112-57080	1	70122-57080	1	70122-57080
47.	V-pulley pin	1	70112-56060	1	70112-56060	1	70112-56060
48.	Compressor pulley	1	70112-76010	1	70122-76010	1	70132-76010
49.	Compressor pulley thrust washer	1	70112-76210	1	70112-76210	1	70112-76210
50.	Compressor pulley thrust bolt	1	91501-1308025	1	91501-1308025	1	91501-1308025
51.	Breather Assy.	1	70103-57600	1	70103-57600	1	70103-57600
52-	Oil gauge & gauge cover	1	70111-57700	1	70111-57700	1	70111-57700
53.	Gauge cover seal	1	70111-57730	1	70111-57730	1	70111-57730
54.	Crankcase oil plug	1	90112-100202	1	90112-100202	1	90112-100202
UNLOADERS							
55.	Auto-unloader assembly	1	70112-11200	2	70112-11200	3	70112-11200
56.	Auto-unloader spring	1	(Assy. only)	2	(Assy. only)	3	(Assy. only)
57.	Auto-unloader piston	1	(Assy. only)	2	(Assy. only)	3	(Assy. only)
58.	O-ring (unloader)	1	93601-810004	2	93601-810004	3	93601-810004
AIR STRAINER							
61.	Air strainer element	1	70111-66140	2	70111-66140	3	70111-66140
62.	Air strainer assembly	1	70109-66000	2	70109-66000	2	70109-66000
63.	Discharge piping assembly	1	(Not Req'd)	2	70122-87100	2	70132-87100
64.	Outlet Pipe Joint A		–	1	70122-87010		–
65.	Outlet Pipe Joint B		–	1	70122-87020		–

AIR COOLED SINGLE STAGE MODELS
ES-30, ES-50, ES-100 & ES-150



		Qty. Req.	ES30	Qty. Req.	ES50	Qty. Req.	ES100	Qty. Req.	ES150
VALVE ASSEMBLIES	Inlet valve assy. 1st stage	2	70123-31001	3	70123-31001	3	70124-31000	3	70125-31001
	Outlet valve assy. 1st stage	2	70123-41001	3	70123-41001	3	70124-41000	3	70125-41001
	Air strainer assy	2	70123-66001	3	70123-66001	3	70123-66001	3	70123-66001
	Breather assy	1	70103-57600	1	70103-57600	1	70124-57600	1	70124-57600

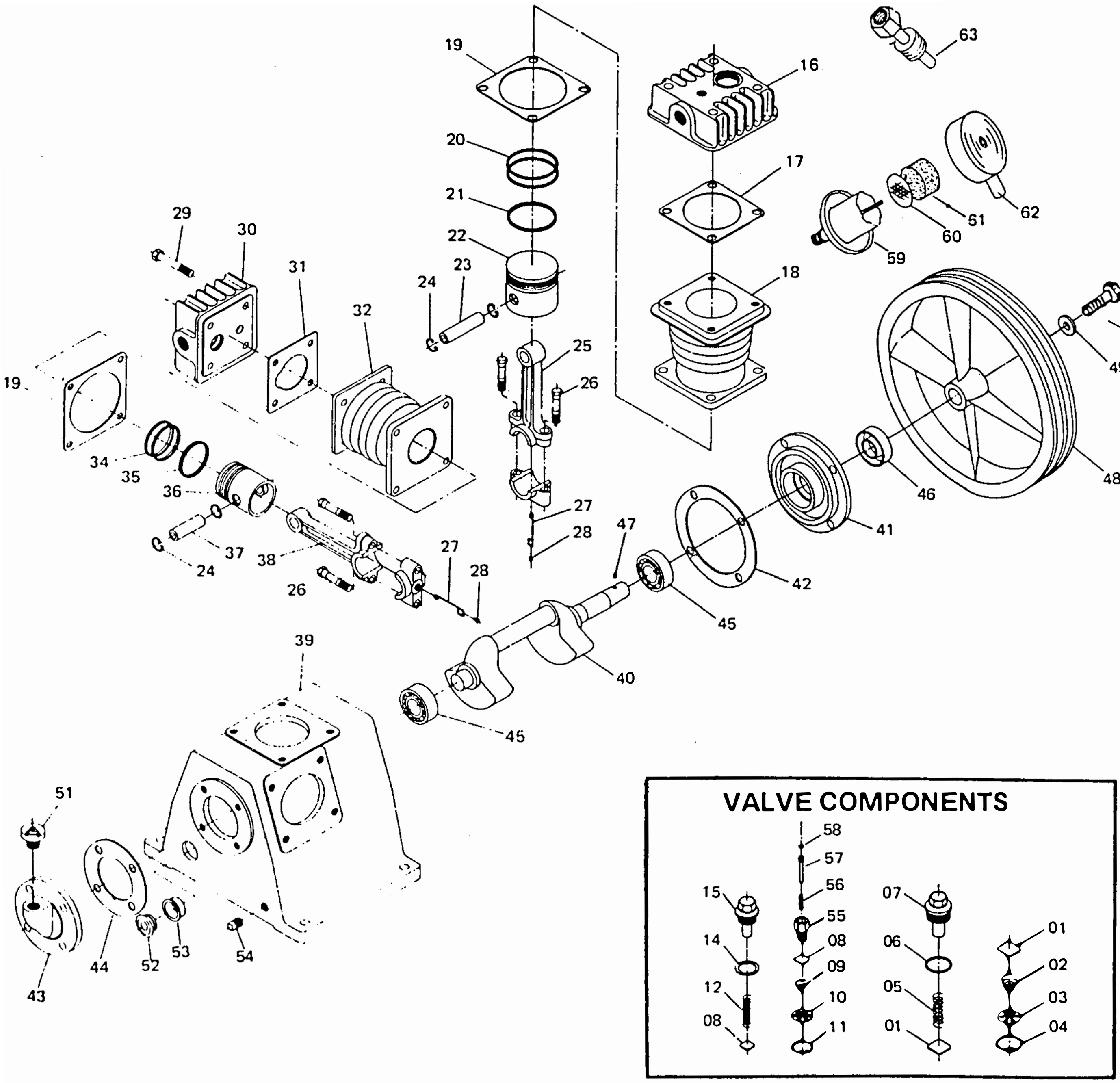
MAIN PARTS LISTING FOR MODELS
ES-30, ES-50, ES-100 & ES-150

			Qty. Req.	ES30	Qty. Req.	ES50	Qty. Req.	ES100	Qty. Req.	ES150
VALVES & UNLOADERS	1.	Inlet valve seat	2	70123-31010	3	70123-31010	3	70124-31010	3	70125-31010
	2.	Inlet valve receiver	2	70123-31020	3	70123-31020	3	70124-31020	3	70125-31020
	3.	Inlet & outlet valve plate	4	70123-31030	6	70123-31030	6	70124-31030	6	70125-31030
	4.	Inlet valve spring	2	70123-31070	3	70123-31070	3	70124-31070	3	70125-31070
	5.	Inlet valve unloading fork guide	2	70123-31090	3	70123-31090	3	70124-31090	3	70125-31090
	6.	Unloading spring	2	70123-11230	3	70123-11230	3	70124-11230	3	70125-11230
	7A	Valve Gasket	4	70123-11110	6	70123-11110	6	70124-11110	6	70125-11110

MAIN PARTS LISTING FOR MODELS ES-30, ES-50, ES-100 & ES-150 (Continued)

			Qty. Req.	MODEL ES30	Qty. Req.	MODEL ES50	Qty. Req.	MODEL ES100	Qty. Req.	MODEL ES150
VALVES & UNLOADERS (Cont'd)	78	Inlet valve unloading fork	2	70123-31080	3	70123-31080	3	70124-31080	3	70125-31080
	8.	Locknut	2	92517-230800	3	92517-230800	3	92517-231000	3	92517-231200
	10.	Outlet valve seat	2	70123-41010	3	70123-41010	3	70124-41010	3	70125-41010
	11.	Outlet valve receiver	2	70123-41020	3	70123-41020	3	70124-41020	3	70125-41020
	12.	Outlet valve spring	2	70123-41070	3	70123-41070	3	70124-41070	3	70125-41070
	13.	Outlet valve bolt	2	70123-41810	3	70123-41810	3	70124-41810	3	70125-41810
	14.	Nut (Outlet valve)	4	92502-130800	6	92502-130800	6	92502-130800	6	92502-131000
	15.	Inlet valve push cover. 1st stage	2	70123-11150	3	70123-11150	3	70124-11150	3	70125-11150
	16.	O-ring G 40	2	93602-810040	3	93602-810040	3	93602-810055	3	93602-810065
	17.	Viton O-ring G 40 (Outlet valve)	2	93602-870040	3	93602-870040	3	93602-870055	3	93602-870065
	18.	Unloading piston, 1st. stage	2	70123-11220	3	70123-11220	3	70124-11220	3	70125-11220
	19.	O-ring P 20	2	93601-810020	3	93601-810020	1	93601-810020	3	93601-810022A
	20.	Outlet valve push cover, 1st stage	2	70123-11450	3	70123-11450	3	70124-11450	3	70125-11450
CYLINDERS	21A.	Cylinder head assembly	2	70123-11000	3	70123-11000				
	21.	Cylinder head (1st)	2	70123-11010	3	70123-11010	3	70124-11010	3	70125-11010
	21B.	S/N A311XXXX AND LATER		–		–		–	3	70135-11010
	22.	Cylinder & head gasket, 1st stage	2	70123-11610	3	70123-11610	3	70124-11610	3	70125-11610
	22A.	S/N A311XXXX AND LATER		–		–		–	3	70135-11610
	23.	Cylinder (1st)	2	70123-51010	3	70123-51010	3	70124-51010	3	70135-51010
	23A.	S/N 3020000 THRU A311XXXX	2	70123-51011	3	70123-51011	3	70124-51011	3	70135-51010
	23B.	S/N A311XXXX AND LATER		–		–		–	3	70135-51011
	24.	Cylinder & case gasket	2	70123-51610	3	70123-51610	3	70124-51610	3	70135-51610
	25.	Compression ring (1st)	4	70123-61030	6	70123-61030	6	70124-61030	6	70125-61030
	26.	Oil control ring (1st)	4	70123-61050	6	70123-61050	6	70124-61050	6	70125-61050
	27.	Piston (1st)	2	70123-61010	3	70123-61010	3	70124-61010	3	70125-61010
	27A	S/N 3020000 & Later Use	2	70123-61011	3	70123-61011	3	70124-61011	3	70135-61011
	28.	Piston pin snap ring	4	70123-61070	6	70123-61070	6	70124-61070	6	70125-61070
	29.	Piston pin (1st)	2	70123-61120	3	70123-61120	3	70124-61120	3	70125-61120
	30.	Connecting rod piston pin bush (1st)	2	70123-61081	3	70123-61081	3	70124-61080	3	70125-61081
	31.	Connecting rod assembly, 1st stage	2	70123-61200	3	70123-61200	3	70124-61200	3	70125-61200
	31A	S/N 3020000 & Later Use	2	70123-61201	3	70123-61201	3	70124-61201	3	70125-61200
	32.	Connecting rod crank pin metal	4	70123-61090	6	70123-61090	6	70124-61090	6	70125-61090
	33.	Connecting rod bolt	4	70123-61250	6	70123-61250	6	70125-61250	6	70125-61250
	33A	Oil splash dipper H.P.		–	1	70123-61290	1	70134-62290		–
	34.	Oil splash dipper	2	70122-61280	2	70122-61280	2	70134-61281	3	70135-61281
	35.	Oil splash dipper bolt	2	91507-2304012	3	91507-2304012	3	91507-2304012	3	92501-130800
CRANKCASE & CRANK ASSEMBLY	42.	Crankshaft	1	70123-56010	1	70133-56010	1	70134-56010	1	70135-56010
	46.	Crankcase	1	70123-57010	1	70133-57010	1	70134-57010	1	70135-57010
	47.	Front bearing cover	1	70123-57030	1	70133-57030	1	70134-57030	1	70135-57030
	48.	Front bearing cover gasket	1	70123-57950	1	70123-57950	1	70124-57950	1	70135 57950
	49.	Rear bearing cover	1	70123-57060	1	70133-57060	1	70134-57060	1	70134-57060
	49A	S/N 3020000 & Later Use	1	70123-57061	1	70133-57061	1	70134-57061	1	70134-57061
	50.	Rear bearing cover gasket	1	70123-57960	1	70133-57960	1	70134-57960	1	70134-57960
	51.	Front bearing	1	93501-62060	1	93501-63060	1	93502-32210	1	93502-30310
	52.	Rear bearing	1	93501-62060	1	93501-63060	1	93502-32210	1	93502-32210
	53.	Front oil seal	1	70123-57080	1	70123-57080	1	70134-57080	1	70134-57080
	54.	V-pulley pin	1	70123-56061	1	70123-56061	1	70134-56060	1	70134-56060
	55A	Compressor Fan	1	(Not Req'd)	1	(Not Req'd)	1	70124-76310	1	70135-76310
	55B	Compressor pulley	1	70123-76010	1	70133-76010	1	70134-76011	1	70135-76011
	56.	Compressor pulley washer	1	70123-76210	1	70124-76210	1	70124-76210	1	70124-76210
	57.	Compressor pulley set bolt	1	91501-1312030	1	91501-1312030	1	91601-1312040	1	91501-1312050
	58.	Gauge cover	1	70111-57700	1	70111-57700	1	70124-57700	1	70124-57700
	59.	Gauge cover seal	1	70111-57730	1	70111-57730	1	70124-57730	1	70124-57730
	60.	Crankcase oil cap	1	70123-57190	1	70123-57190	1	70123-57190	1	70123-57190
	61.	Crankcase oil plug	1	90112-100404	1	90112-100404	1	90112-100404	1	90112-100404
	67.	Air strainer filter	2	70123-66140	3	70123-66140	3	70123-66140	3	70123-66140
	69.	Outlet pipe joint 8	1	70123-87020	1	70133-87020	1	70134-87020	1	70135-87020
	70.	Compressor body discharge piping ass'y	1	70123-87100	2	70133-87100	2	70134-87100	2	70135-87100 (short)
	70A	S/N 3020000 & Later Use	1	70123-87101	2	70133-87101	2	70134-87101	2	70135-87200 (long)
	71.	Outlet pipe joint A	1	70123-87010	1	70123-87010	1	70124-87010	1	70135-87010
	73	Outlet pipe joint C		–	1	70133-87030	1	70134-87030	1	70135-87030
	74.	Gasket (Manifold)		–		–		–	3	70125 87510

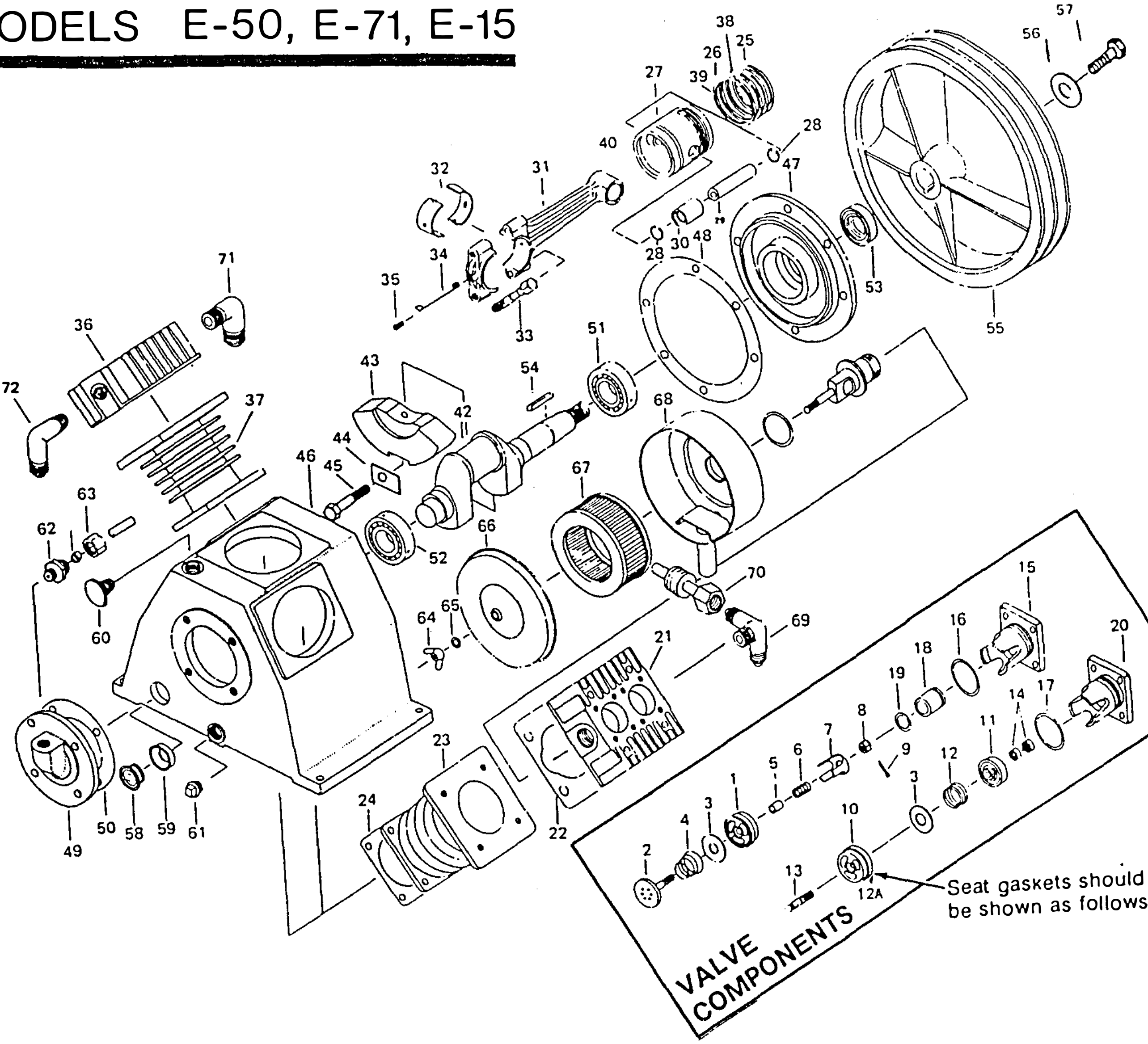
AIR COOLED
TWO STAGE MODELS E-11 & E-23



MAIN PARTS LISTING FOR
TWO STAGE MODELS E-11 & E-23

No.	Part	Qty. Req.	MODEL E11	Qty. Req.	MODEL E23
VALVES					
1.	Inlet & outlet valve plate (1st)	2	70112-31030	4	70112-31030
2.	Inlet valve spring (1st)	1	70112-31070	2	70112-31070
3.	Inlet valve receiver (1st)	1	70112-31020	2	70112-31020
4.	Inlet valve snap ring (1st)	1	93610-130032	2	93610-130032
5.	Outlet valve spring (1st)	1	70112-41070	2	70112-41070
6.	Outlet valva push cover gasket	1	70112-11650	2	70112-11650
7.	Outlet valve push cover (1st)	1	70112-11450	2	70112-11450
8.	Inlet & outlet valve plate (2nd)	2	70162-32030	2	70111-31030
9.	Inlet valve spring (2nd)	1	70162-32070	2	70172-32070
10.	Inlet valve receiver (2nd)	1	70162-32020	1	70111-31020
11.	Inlet valve snap ring (2nd)	1	93610-130022	1	93610-130025
12.	Outlet valve spring (2nd)	1	70162-42070	1	70172-42070
14.	Outlet valve push cover gasket (2nd)	1	70162-12650	1	70111-11650
15.	Outlet valve push cover (2nd)	1	70162-12450	1	70111-11450
CYLINDERS					
16.	Cylinder head (1st)	1	70112-11010	2	70112-11010
17.	Cylinder & head gasket (1st)	1	70112-11610	2	70112-11610
18.	Cylinder (1st)	1	70112-51010	2	70112-51010
19.	Cylinder & case gasket	2	70112-51610	3	70112-51610
20.	Compression ring (1st)	2	70112-61030	4	70112-61030
21.	Oil control ring (1st)	1	70112-61050	2	70112-61050
22.	Piston (1st)	1	70112-61010	2	70112-61010
23.	Piston pin (1st)	1	70112-61120	2	70112-61120
24.	Piston pin snap ring	4	70112-61070	6	70112-61070
25.	Connecting rod assembly (1st)	2	70112-61200	2	70112-61200
26.	Connecting rod bolt	2	70112-61250	3	70112-61250
27.	Oil splash dipper		70122-61282	2	70122-61282
27A.	Oil splash dipper		-	1	70132-61290
28.	Oil splash dipper bolt	2	91507-2304010	3	91507-2304010
29.	Cylinder head bolt	8	91505-230409	12	91505-230409
30.	Cylinder head (2nd)	1	70162-12010	1	70172-12010
31.	Cylinder & head gasket (2nd)	1	70162-12610	1	70111-11610
32.	Cylinder (2nd)	1	70162-52010	1	70172-52010
34.	Compression ring (2nd)	2	70162-62030	2	70111-61030
35.	Oil control ring (2nd)	2	70162-62050	2	70111-61050
36.	Piston (2nd)	1	70162-62010	1	70172-62010
37.	Piston pin (2nd)	1	70162-62120	1	70172-62120
38.	Connecting rod assembly (2nd)		-	1	70182-62200
CRANK ASSEMBLY					
39.	Crankcase	1	70122-57010	1	70132-57010
40.	Crankshaft	1	70122-56010	1	70132-56010
41.	Front bearing cover	1	70122-57030	1	70122-57030
42.	Front bearing cover gasket	1	70122-57950	1	70122-57950
43.	Rear bearing cover	1	70122-57060	1	70122-57060
44.	Rear bearing cover gasket	1	70122-57960	1	70122-57960
45.	Bearing	2	93501-62050	2	93501-62050
46.	Front oil seal	1	70122-57080	1	70122-57080
47.	V-pulley pin	1	70112-56060	1	70112-56060
48.	Compressor pulley	1	70112-76010	1	70132-76010
49.	Compressor pulley thrust washer	1	70112-76210	1	70112-76210
50.	Compressor pulley thrust bolt	1	91601-1308026	1	91501-1308025
51.	Breather Assy.	1	70103-67600	1	70103-67600
52.	Oil gauge & gauge cover	1	70111-57700	1	70111-57700
53.	Gauge cover seal	1	70111-57730	1	70111-57730
54.	Crankcase oil plug	1	90112-100202		90112-100202
UNLOADERS					
55.	Auto-unloader assembly	2	70112-11200	3	70112-11200
56.	Auto-unloader spring	2	(Assy. only)	3	(Assy. only)
57.	Auto-unloader piston	2	(Assy. only)	3	(Assy. only)
58.	O-ring (unloader)	2	93601-810004	3	93601-81004
AIR STRAINER ASSEMBLY					
61.	Air strainer filter	1	70111-66140	2	70111-66140
63A	Discharge Piping Assembly	-	—	1	70132-87100
63B	Discharge Piping Assembly	1	70172-87300	1	70172-87300
64.	Air Strainer Assembly	1	70109-66000	2	70109-66000
65.	Outlet pipe joint #A	3	70122-87010	3	70122-87010
65A.	Outlet pipe joint #B			1	70132-87030

AIR-COOLED TWO STAGE MODELS E-50, E-71, E-15



		Qty. Req.	MODEL E50	Qty. Req.	MODEL E71	Qty. Req.	MODEL E15
VALVE ASSEMBLIES	Inlet valve assy, 1st stage	2	70123-31000	2	70124-31000	2	70125-31000
	Inlet valve assy, 2nd stage	1	70173-32000	1	70173-32000	1	70175-32000
	Outlet valve assy, 1st stage	2	70123-41000	2	70124-41000	2	70125-41000
	Outlet valve assy, 2nd stage	1	70123-41000	1	70123-41000	1	70124-41000
	Air strainer assy	2	70123-66001	2	70123-66001	2	70123-66001
	Breather assy	1	70103-57600	1	70124-57600	1	70124-57600

MAIN PARTS LISTING FOR TWO STAGE MODELS E-50, E-71 & E-15

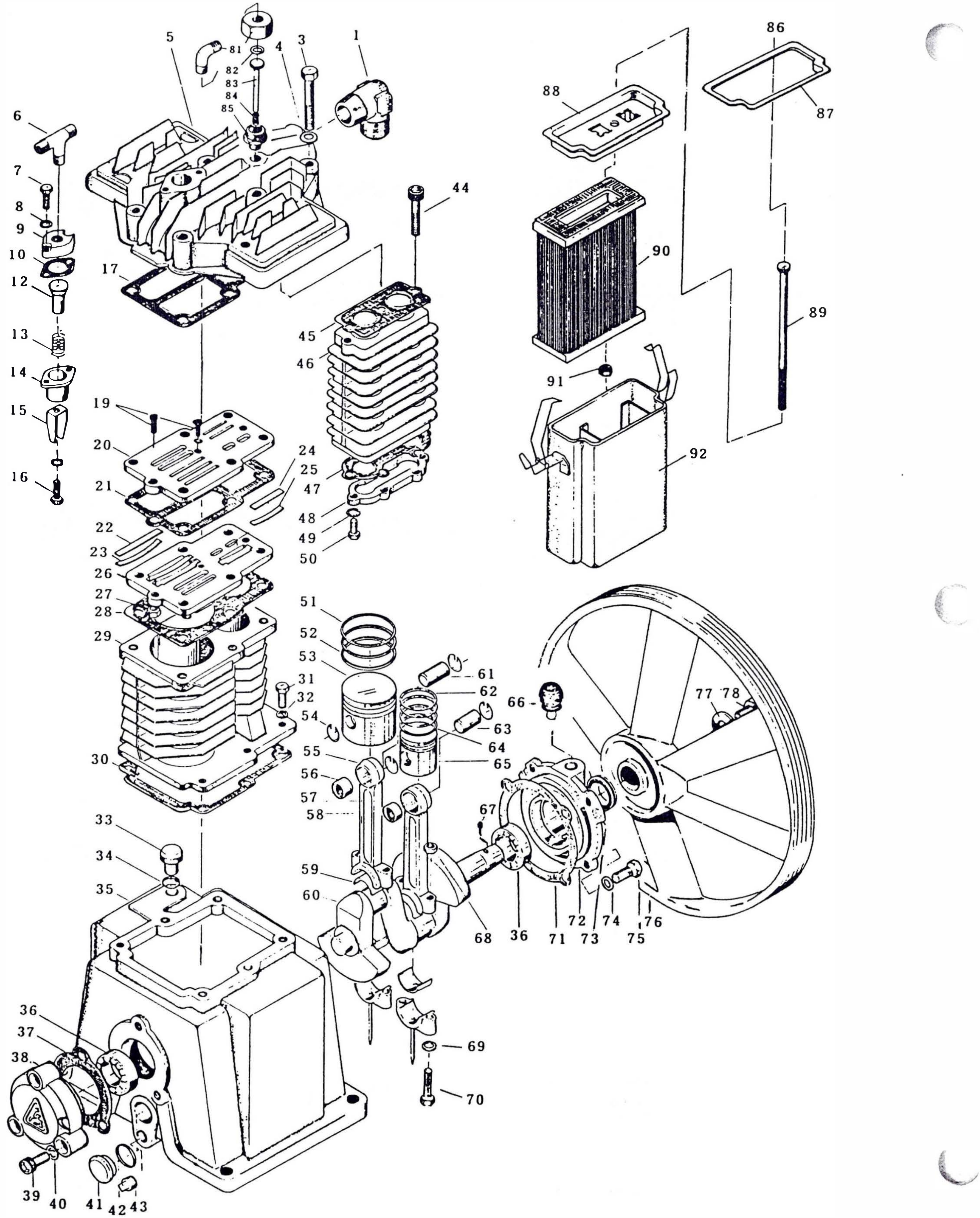
VALVES & UNLOADERS

Quantity Required E50	E71	E15		MODEL E50	MODEL E71	MODEL E15
3	2-1	2-1	1. Inlet valve seat	70123-31010	(1st.) 70124-31010 (2nd.) 70123-31010	(1st.) 70125-31010 (2nd.) 70124-31010
3	2-1	2-1	2. Inlet valve receiver	70123-31020	(1st.) 70124-31020 (2nd.) 70123-31020	(1st.) 70125-31020 (2nd.) 70124-31020
6	4-2	4-2	3. Inlet & outlet valve plate	70123-31030	(1st.) 70124-31030 (2nd.) 70123-31030	(1st.) 70125-31030 (2nd.) 70124-31030
3	2-1	2-1	4. Inlet valve spring	70123-31070	(1st.) 70124-31070 (2nd.) 70123-31070	(1st.) 70125-31070 (2nd.) 70124-31070
2	2-1	2-1	5. Inlet valve unloading fork guide	70123-31090	(1st.) 70124-31090 (2nd.) 70123-31090	(1st.) 70125-31090 (2nd.) 70124-31090
2	2-1	2-1	6. Unloading spring	70123-11230	(1st.) 70124-11230 (2nd.) 70123-11230	(1st.) 70125-11230 (2nd.) 70124-11230
2	2-1	2-1	7. Inlet valve unloading fork	70123-31080	(1st.) 70124-31080 (2nd.) 70123-31080	(1st.) 70125-31080 (2nd.) 70124-31080
3	3	3	8. Slotted nut	92506-130800	92506-130800	92506-130800
3	3	3	9. Cotter pin	93701-232018	93701-232018	93701-232018
3	2	2-1	10. Outlet valve seat	70123-41010	(1st.) 70124-41010 (2nd.) 70123-41010	(1st.) 70125-41010 (2nd.) 70124-41010
3	2-1	2-1	11. Outlet valve receiver	70123-41020	(1st.) 70124-41020 (2nd.) 70123-41020	(1st.) 70125-41020 (2nd.) 70124-41020
6	4-2	4-2	12A Seat Gaskets	70123-11110	(1st.) 70124-11110 (2nd.) 70123-11110	(1st.) 70125-11110 (2nd.) 70124-11110

MAIN PARTS LISTING FOR
TWO-STAGE MODELS E-50, E-71 & E-15 (Continued)

	No.	Part	Qty. Req.	MODEL E50	Qty. Req.	MODEL E71	Qty. Req.	MODEL E15
	128	Outlet valve spring	3	70123-41070	2-1	70124-41070(1st.)	6	70125-41070(1st.)
				–		70123-41070(2nd.)		70124-41070(2nd.)
	13.	Outlet valve bolt	1	70123-41811	1	70124-41810(1st.)	1	70124-41810 (1st)
				–		70123-41811(2nd.)		70124-41070 (2nd)
VALVES & UNLOADERS	14.	Nut (Outlet valve)	1	93502-130800	1	93502-130800	1	92502-13100
	15.	Inlet valve push cover, 1st stage	2	70123-11150	2	70124-11150	2	70125-11150
	15.	Inlet valve push cover, 2nd stage	1	70123-11150	1	70123-11150	1	70175-12150
	16.	O-ring G-40 (Inlet valve)	3	93602-810040	2	93602-810055 (1st)	2	93602-810065 (1st)
				–		–	1	93601-870055 (2nd)
	17.	Viton O-ring G-40 (Outlet valve)	3	93602-870040	2	93602-870055(1st)	2	93602-870065 (1st)
				–	2	93602-870040(2nd)	1	93601-870055 (2nd)
	18.	Unloading piston, 1st stage	2	70123-11220	2	70124-11220	2	70125-11220
	18.	Unloading piston, 2nd stage	1	70123-11220	1	70123-11220	1	70124-11220
	19.	O-ring P-20	2	93601-810020 (1st)	2	93601-810021(1st)	2	93601-810022A (1st)
			1	93601-870020 (2nd)	1	93601-870020(2nd)	1	93601-870021 (2nd)
	20.	Outlet valve push cover, 1st stage	2	70123-11450	2	70124-11450	2	70125-11450
	20.	Outlet valve push cover, 2nd stage	1	70123-11450	1	70123-11450	1	70175-12450
	20A	Outlet valve push cover push pipe		–		–	1	70124-11120
CYLINDERS	21.	Cylinder head (1st)	2	70123-11010	2	70124-11010	2	70125-11010
	21A.	S/N A31XXXX & LATER USE		-		–	2	70135-11010
	22.	Cylinder & head gasket, 1st stage	2	70123-11610	2	70124-11610	2	70125-11610
	22A.	S/N A311XXXX & LATER USE		-		-	2	70135-11610
	22.	Cylinder & head gasket, 2nd stage	1	70123-11610	1	70123-11610	1	70124-11610
	23.	Cylinder (1st)	2	70123-51010	2	70124-51011	2	70125-51010
	23A.	S/N A311XXXX & LATER USE	3	70123-51610	3	70124-51610	3	70135-51610
	24.	Cylinder & case gasket	3	70123-51610	3	70124-51610	3	70135-51011
	25.	Compression ring (1st)	4	70123-61030	4	70124-61030	4	70125-61030
	26.	Oil control ring (1st)	4	70123-61050	4	70124-61050	4	70125-61050
	27.	Piston (1st)	2	70123-61010	2	70124-61010	2	70125-61010
	27A	S/N 3020000 & Later Use	2	70123-61011	2	70124-61011	2	70135-61010
	28.	Piston pin snap ring	6	70123-61070	6	70124-61070	6	70125-61070
	29.	Piston pin (1st)	2	70123-61120	2	70124-61120	2	70125-61120
	30.	Connecting rod piston pin bush (1st)	2	70123-61080 (1st)	2	70124-61080 (1st.)	2	70125-61081 (1st)
			1	70173-62080 (2nd)	1	70174-62080 (2nd.)	1	70175-62080 (2nd)
	30A.	S/N 302000 & Later Use	2	70123-61081 (1st)		-	2	70125-61081 (1st)
	30B.	S/N A303XXXX & LATER USE			1	93503-RNA6903R(2nd)		-
	31.	Connecting rod assembly, 1st stage	2	70123-61200	1	70124-61200	2	70125-61200
	31.	Connecting rod assembly, 2nd stage	1	70173-62200	1	70174-62202	1	70175-62200
	32.	Connecting rod crank pin metal	6	70123-61090	6	70124-61090	6	70125-61090
	33.	Connecting rod bolt	6	70125-61250	6	70125-61250	6	70125-61250
	34.	Oil splash dipper	2	70122-61282	2	70134-61281	3	70135-61281
	34A	Oil splash dipper	1	70132-61290	1	70134-61290		—
	35.	Oil splash dipper bolt	3	91507-2305010	3	91507-1305012	3	92501-1308001
	36.	Cylinder head (2nd)	1	70123-11010	1	70174-12010	1	70175-12010
	37.	Cylinder (2nd)	1	70173-52010	1	70174-52010	1	70175-52010
	37A	S/N 3020000 Later Use		–	1	70174-52011		-
	38.	Compression ring (2nd)	3	70112-61030	3	70123-61030	3	70124-61030
	39.	Oil control ring (2nd)	1	70112-61050	2	70123 61050	2	70124-61050
	40.	Piston (2nd)	1	70173-62010	1	70174-62010	1	70175-62010
	41.	Piston pin (2nd)	1	70173-62120	1	70174-62120	1	70175-62120
CRANKCASE AND CRANK ASSEMBLY	42.	Crankshaft	1	70133-56010	1	70134-56010	1	70135-56010
	43.	Crankshaft counterweight		–	1	70134-56030	1	70135-56030
	44.	Counterweight lock washer		–	2	70124-56830	2	70124-56830
	45.	Counterweight mounting bolt		–	2	70124-56810	2	70135-56810
	46.	Crankcase	1	70133-57010	1	70134-57010	1	70135-57010
	47.	Front bearing cover	1	70133-57030	1	70134-57030	1	70135-57030
	48.	Front bearing cover gasket	1	70123-57950	1	70124-57950	1	70135-57950
	49.	Rear bearing cover	1	70133-57060	1	70134-57060	1	70134-57060
	49A	S/N 3020000 & Later Use	1	70133-57061	1	70134-57061	1	70134-57061
	50.	Rear bearing cover gasket	1	70133-57960	1	70134-57960	1	70134-57960
	51.	Front bearing	1	93501-63060	1	93502-32210	1	93502 30310
	52.	Rear bearing	1	93501-63060	1	93502-32210	1	93502-32210
	53.	Front oil seal	1	70123-57080	1	70134-57080	1	70134-57080
	54.	V-pulley pin	1	70123-56060	1	70134-56060	1	70134-56060
	55A	Compressor fan		–	1	70124-76310	1	70135-76310
	55B	Compressor pulley	1	70133-76010	1	70134-76011	1	70135-76011
	56.	Compressor pulley washer	1	92521-232000	1	70124-76210	1	70135-76210
	57.	Compressor pulley set bolt	1	91501-1312030	1	91501-1312040	1	91501-1312050
	58.	Gauge cover	1	70111-57700	1	70124-57700	1	70124-57700
	59.	Gauge cover seal	1	70111-57730	1	70124-57730	1	70124-57730
	60.	Crankcase oil cap	1	70123-57190	1	70123-57190	1	70123-57190
	61.	Crankcase oil plug	1	90112-100404	1	90112-100404	1	90112 100303
	62.	Breather Assembly	1	70103-57600	1	70124-57600	1	70124-57600
	67.	Air strainer filter	2	70123-66140	2	70123-66140	2	70123-66140
	69.	Outlet pipe joint B	1	70163-87020	1	70174-87020	1	70175 87020
	70.A	Compressor body discharge piping ass'y 1st	1	70133-87101 (short)	1	70134-87101 (short)	1	70135-87100(short)
	70.B	Compressor body discharge piping ass'y 1st		–		–	1	70135-87200(long)
	70.C	Compressor body discharge piping ass'y 2nd		–		–	1	70175 87400(short)
	70.D	Compressor body discharge piping ass'y 2nd	1	70173-87300 (long)	1	70174-87300 (long)	1	70175 87300(long)
	71.	Outlet pipe joint A	2	70123-87010	3	70124 87010	1	70135 87010
	72.	Outlet pipe joint D	1	70173-87010		–	1	70125-87010(2nd Out
	73.	Outlet pipe joint C		–		–	1	70175-87030
	74.	Gasket manifold		–		–	4	70125-87510

AIR COOLED TWO STAGE MODEL E-35



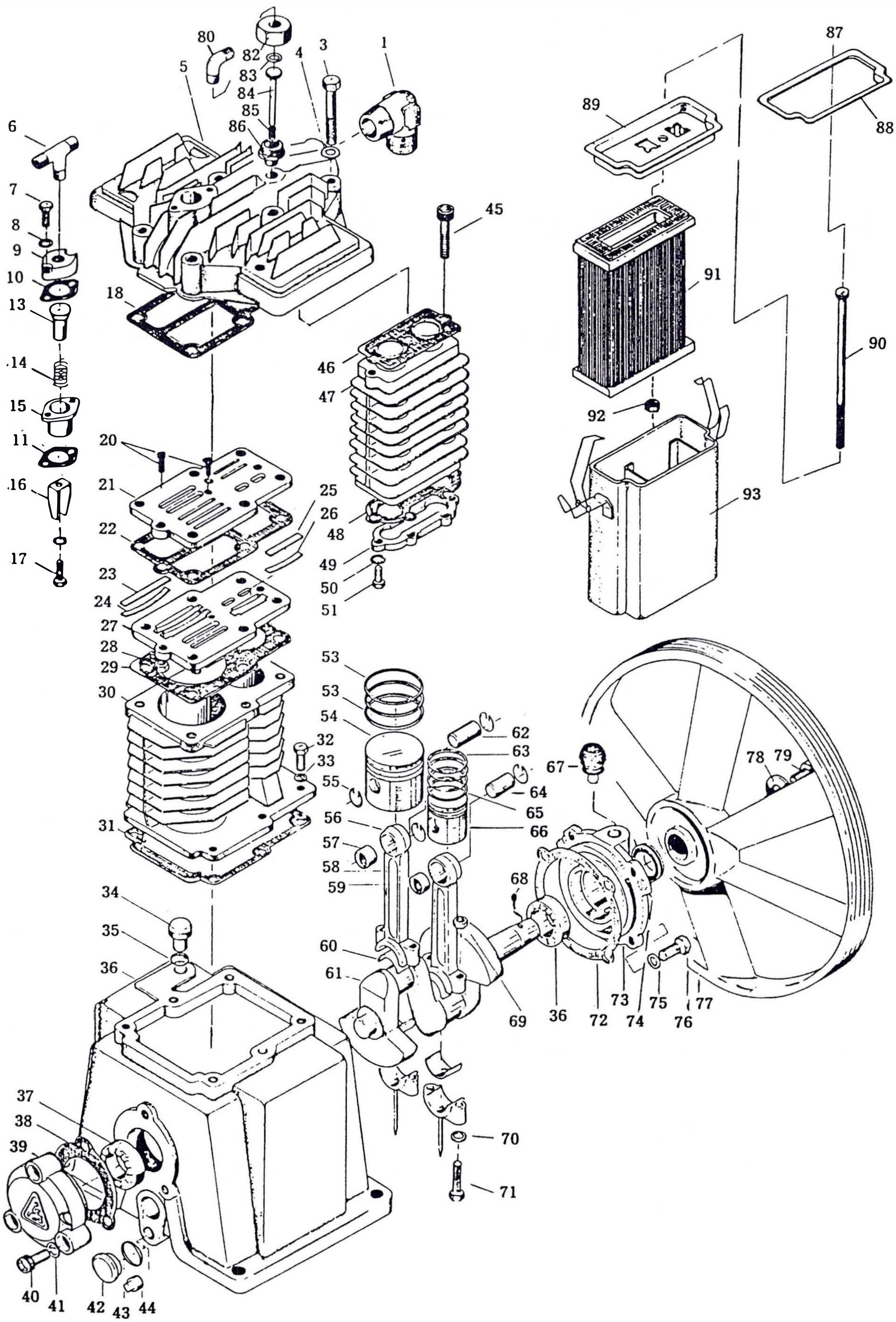
MAIN PARTS LISTING FOR AIR COOLED TWO STAGE MODEL E-35

(FORMERLY B-1)

	DESCRIPTION	QTY.	PART NO.
1.	Discharge Elbow	1	70123-87050
2.	Discharge Elbow Nut (Not Shown)	1	79922-130606
3.	Cylinder Head Bolt	6	(Hardware Item)
4.	Spring Washer	6	92522-130800
5.	Cylinder Head	1	70152-11010
6.	Unloading Tee •#	1	VA787
7.	Bolt	2	91521-1306025
8.	Spring Washer	2	92522-130600
9.	Upper Cover	1	70153-11270
10.	Upper Cover Gasket	1	70153-11640
11.	Unloader Ass'y (1st) (Includes 12-16)	1	70152-11200
12.	Unloading Piston	1	70153-11220
13.	Unloading Spring	1	70153-11230
14.	Unloading Cylinder	1	70153-11210
15.	Unloading Fork (1st)	1	70152-31080
16.	Bolt	1	91501-1306015
17.	Cylinder Head Valve Seat Gasket	1	70152-11610
18.	Valve Plate Ass'y (Includes 19-27)	1	70152-31000
19.	Valve Seat Bolt	3	91521-1305012
20.	Valve Seat (Upper)	1	70152-31010
21.	Valve Seat Gasket	1	70152-31120
22.	Valve Plate (1st)	4	70152-31030
23.	Valve Plate Spring (1st)	4	70152-31071
24.	Valve Plate (2nd)	2	70152-32030
25.	Valve Plate Spring (2nd)	2	70152-32071
26.	Valve Seat (Bottom)	1	70152-31020
27.	Nut	1	92501-230500
28.	Cylinder-Valve Seat Gasket	1	70152-11620
29.	Cylinder	1	70152-51010
30.	Cylinder Crankcase Gasket	1	70152-51610
31.	Bolt	11	91501-1308030
32.	Copper Washer	6	92521-190800
33.	Crankcase Oil Cap	1	70101-57190
34.	Oil Cap O–Ring	1	93601-810016
35.	Crankcase	1	70152-57010
36.	Bearing #6205 (Front & Rear)	2	93501-62050
37.	Rear Cover Gasket	1	70152-57960
38.	Rear Cover	1	70152-57060
39.	Rear Cover Bolt	3	91521-1308030
40.	Copper Washer	7	92521-190800
41.	Oil Level Gauge & Gauge Cover	1	70111-57700
42.	Gauge Cover Seal	1	70111-57730
43.	Crankcase Oil Plug (1/4" NPT)	1	90112-100202
44.	Inter-Cooler Bolt	3	91521-1308045
45.	Gasket	1	70152-71610
46.	Inter-Cooler Body	1	70152-71110
47.	Inter-Cooler Body Gasket	1	70152-71620
48.	Inter-Cooler Cover	1	70152-71160
49.	Spring Washer	4	92522-130600
50.	Bolt	4	91501-1306015
51.	Compression Ring (1st)	2	70152-61030
52.	Oil Control Ring (1st)	1	70152-61050
53.	Piston (1st)	1	70152-61010
54.	Piston Snap Ring	4	70152-61070
55.	Connection Rod Ass'y (1st)	1	70152-61200
56.	Piston Pin Bush (1st)	1	70152-61080
57.	Connecting Rod Ass'y (2nd)	1	70152-62200
58.	Piston Pin Bush (2nd)	1	70152-62080
59.	Crank Pin Metal (Rod Brg 2-Halves)	2	70152-61090
60.	Crankshaft	1	70152-56010
61.	Piston Pin (1st)	1	70152-61120
62.	Compressions Ring (2nd)	3	70152-62030
63.	Piston Pin (2nd)	1	70152-62120
64.	Oil Control Ring (2nd)	1	70152-62050
65.	Piston (2nd)	1	70152-62010
66.	Breather Ass'y	1	70103-57600
67.	V-Pulley Pin	1	70112-56060
68.	Nut (Connecting Rod)	4	(Ass'y Only)
69.	Spring Washer (Connecting Rod)	4	(Ass'y Only)
70.	Bolt (Connecting Rod)	4	(Ass'y Only)
71.	Front Cover Gasket	1	70152-57950
72.	Front Cover	1	70152-57030
73.	Front Oil Seal	1	70127-57080
74.	Copper Washer	7	92521-190800
75.	Bolt	4	91501-1308030
76.	Compressor Pulley	1	70152-76010
77.	Compressor Pulley Thrust Washer	1	70112-76210
78.	Bolt	1	91501-1308025
79.	Unloading Elbow •#	1	VA786
80.	Unloader Ass'y (2nd) (Includes 81-85)	1	70152-12200
81.	Unloader Cover (2nd)	1	70103-11270
82.	Viton O-Ring Unloader (2nd)	1	93601-870009
83.	Unloading Piston (2nd)	1	70153-12220
84.	Unloading Spring (2nd)	1	70103-11230
85.	Unloader Body	1	70103-11210
86.	Air Strainer Ass'y (Includes 87-92)	1	70152-66000
87.	Air Strainer Cover Gasket	1	(Ass'y Only)
88.	Air Strainer Cover	1	(Ass'y Only)
89.	Air Strainer Bolt	1	(Ass'y Only)
90.	Air Strainer Element	1	70152-66141
91.	Nut (Self Lock) Air Strainer	1	(Ass'y Only)
92.	Air Strainer Body	1	(Ass'y Only)
93.	Intercooler Safety Valve (Not Shown)	1	VV431

•Includes Nut(s) and Sleeve(s) #Not Supplied on Basics

AIR COOLED TWO STAGE MODEL E-57



MAIN PARTS LISTING FOR AIR COOLED TWO STAGE MODEL E-57

(FORMERLY B-2)

DESCRIPTION	QTY.	PART NO.
1. Discharge Elbow	1	70124-87010
2. Discharge Elbow Nut (Not Shown)	1	79922-130707
3. Cylinder Head Bolt	6	(Hardware Item)
4. Spring Washer	6	92522-131000
5. Cylinder Head	1	70153-11011
6. Unloading Tee*#	1	VA787
7. Bolt	2	91521-1306025
8. Spring Washer	2	92522-130600
9. Upper Cover	1	70153-11270
10. Upper Cover Gasket	1	70153-11630
11. Lower Unloader Gasket	1	70153-11640
12. Unloader Assy (1st) **(Includes 13-17)**	1	70153-11200
13. Unloading Piston	1	70153-11220
14. Unloading Spring	1	70153-11230
15. Unloading Cylinder	1	70153-11210
16. Unloading Fork	1	70153-31080
17. Bolt	1	91501-1306015
18. Cylinder Head Valve Seat Gasket	1	70153-11610
19. Valve Plate Assy **(Includes 20-28)**	1	70153-31001
20. Valve Seat Bolt	3	91521-1305012
21. Valve Seat (Upper)	1	70153-31011
22. Valve Seat Gasket	1	70153-31120
23. Valve Plate (1st)	4	70153-31031
24. Valve Plate Spring (1st)	4	70153-31071
25. Valve Plate (2nd)	2	70153-32031
26. Valve Plate Spring (2nd)	2	70153-32072
27. Valve Seat (Bottom)	1	70153-31021
28. Nut	2	92501-230500
29. Cylinder-Valve Seat Gasket	1	70153-11620
30. Cylinder	1	70153-51011
31. Cylinder-Crankcase Gasket	1	70153-51610
32. Bolt	6	91501-1310030
33. Copper Washer	6	92521-191000
34. Crankcase Oil Cap	1	70123-57190
35. Oil Cap O-Ring	1	93601-810018
36. Crankcase	1	70153-57011
37. Bearing #6206 (Front & Rear)	2	93501-62060
38. Rear Cover Gasket	1	70153-57960
39. Rear Cover	1	70153-57061
40. Rear Cover Bolt	3	91521-1308030
41. Copper Washer	3	92521-190800
42. Oil Level Gauge & Gauge Cover	1	70111-57700
43. Gauge Cover Seal	1	70111-57730
44. Crankcase Oil Plug (1/4" NPT)	1	90112-100202
45. Inter-Cooler Bolt	3	91521-1308055
46. Gasket	1	70153-71181
47. Inter-Cooler Body	1	70153-71111
48. Inter-Cooler Body Gasket	1	70153-71620
49. Inter-Cooler Cover	1	70153-71161
50. Spring Washer	6	92522-130600
51. Bolt	6	91501-1306015
52. Compression Ring (1st)	2	70124-61030
53. Oil Control Ring (1st)	1	70124-61050
54. Piston (1st)	1	70153-61011
55. Piston Pin Snap-Ring	4	70124-61071
56. Connection Rod Assy (1st)	1	70153-61201
57. Piston Pin Bushing (1st)	1	70153-61081
58. Connecting Rod Assy (2nd)	1	70153-62201
59. Piston Pin Bushing (2nd)	1	70153-62081
59A. Piston Pin Needle Bearing (2nd) **	1	93503-TA2420
60. Connecting Rod Brg (2 Halves)	2	70153-61090
61. Crankshaft	1	70153-56011
62. Piston Pin (1st)	1	70153-61121
63. Compression Ring (2nd)	3	70153-62030
64. Piston Pin (2nd)	1	70153-62121
65. Oil Control Ring (2nd)	1	70153-62050
66. Piston (2nd)	1	70153-62011
67. Breather Assy	1	70124-57600
68. V-Pulley Pin	1	70123-56060
69. Nut (Connecting Rod)	4	(Assy Only)
70. Spring Washer (Connecting Rod)	4	(Assy Only)
71. Bolt (Connecting Rod)	4	(Assy Only)
72. Front Cover Gasket	1	70153-57950
73. Front Cover	1	70153-57030
74. Front Oil Seal	1	70123-57080
75. Copper Washer	4	92521-190800
76A Bolt (Front Cover)	4	91501-1310030
76B Compressor Pulley (1-Piece)	1	70153-76010-402
76C Compressor Pulley (2-Piece)	1	70153-76011
77. Compressor Fan (2-Piece)	1	70153-76310
78. Compressor Pulley Washer	1	70123-76210
79. Compressor Pulley Bolt	1	91501-1310030
80. Unloading Elbow *#	1	VA786
81. Unloader Assy (2nd) **(Includes 82-86)**	1	70153-12200
82. Unloader Cover (2nd)	1	70103-11270
83. Viton O-Ring Unloader (2nd)	1	93601-870009
84. Unloading Piston (2nd)	1	70153-12220
85. Unloading Spring (2nd)	1	70103-11230
86. Unloader Body (2nd)	1	70103-11210
87. Air Strainer Assy **(Includes 88-93)**	1	70153-66002
88. Air Strainer Cover Gasket	1	(Assy Only)
89. Air Strainer Cover	1	(Assy Only)
90. Air Strainer Bolt	1	(Assy Only)
91. Air Strainer Element	1	70153-66142
92. Nut (Self Lock) Air Strainer	1	(Assy Only)
93. Air Strainer Body	1	(Assy Only)
94. Intercooler Safety Valve (Not Shown)	1	VV431

*Includes Nut(s) and Sleeve(s) # Not Supplied on Basics

**S/N A4081331 & Later

INSPECTION & MAINTENANCE
OF E-57 VALVE ASS'Y

INSTRUCTION FOR E-57 COMPRESSOR MODEL HEAD VALVE ASSEMBLY INSPECTION AND MAINTENANCE.

Model E-57 valve assembly inspection and maintenance instruction.

1. Inspect valve assemblies every 1000 hours of operation or as necessary to maintain efficient operation.
2. Turn off power, red tag power supply switch (caution: Maintenance in process — DO NOT START). Drain all air pressure from system before starting work.
3. Disconnect air piping from head.

Remove valve package.

A1. Loosen and remove head bolts. On constant run models, remove copper tubing from unloader cylinder.

A2. Remove cylinder head to expose valve assembly.

A3. Remove valve assembly, head to valve package gasket and valve package to cylinder gasket. Use new gaskets in re-assembly. Note conditions of cylinders, clean out any foreign material and cover with clean shop cloth while open.

A4. Refer to parts breakdown for description of valve packages.

A5. Secure valve assembly package, loosen and remove socket head bolts to separate the upper and lower valve seats. This will expose the valve springs and valve plates.
CAUTION: Do not interchange upper and lower valve seats.

A6. Thoroughly clean and wash all valve seats and parts with a suitable non-flammable cleaning fluid.
CAUTION: Use care to not scratch or deform valve parts in the cleaning.

A7. Carefully inspect the valve seats, plates and springs for dents, cracks, wear, and any reasons to prevent proper and efficient operation.

A8. Replace all parts not in proper condition.

Assemble valve assembly package.

B1. Secure lower valve plate in flat position with spring slots "up".

B2. Refer to parts breakdown for valve package breakdown.

B3. Place valve springs and valve plates in proper positions over slots in seat. Use tag wire or string for tie to hold in position for completing assembly.

B4. Secure upper valve seat in flat position with spring slots up.

B5. Use new valve seat gasket.

B6. Place valve seat gasket in position on lower valve plate.

B7. Place upper valve seat with valve springs and valve plates tied in position on top of lower valve seat with new valve seat gasket in place between the two seats.

B8. Start center and then the two end valve plates socket head bolts, tighten finger tight being careful not to damage seat gasket, use socket head wrench to torque the three bolts uniformly to secure the top valve seat to the lower valve seat using care to avoid damage to the gasket, and valve springs and plates from moving out of position.

B9. Remove ties to free valve springs and plates.

B10. Check to be sure valve springs and valve plates are in proper position and the plates are free to flex when manually touched with blunt instrument.

Assemble valve assembly package into compressor.

C1. Use new gaskets, valve package to cylinder and cylinder head to valve package. Select gaskets by part numbers from parts breakdown.

C2. Remove shop cloth to expose open cylinder bores. Remove any foreign matter from cylinder bores and top of cylinder.

C3. Place gasket on top of cylinder, place and align valve package, place gasket on top of valve package and align holes for head bolts.

C4. Place clean head on top of valve package with gasket and align with cylinder bolt holes.

C5. Insert cylinder head bolts using care to avoid damage to the gaskets, start each bolt threading evenly to contact head surfaces.

C6. Torque head bolts homogeneously, follow torque specifications on page 20.

C7. Attach and tighten copper tubing of constant running compressors.

C8. Assemble and tighten discharge tubing.

C9. Check oil level in crank case.

C10. Close and tighten valve or the connections used to drain air pressure from system.

C11. Remove all tools and make area safe to start compressor.

C12. Turn on power at main switch and inspect to see that unit is operating properly.

C13. Stay with unit for normal pump up to cut out pressure.

C14. If unit has performed through a running cycle properly put on line for duties and remove red tag from power supply switch.

C15. Make entry in equipment maintenance log.

VALVE PLATES DESIGNS FOR E-57 COMPRESSOR

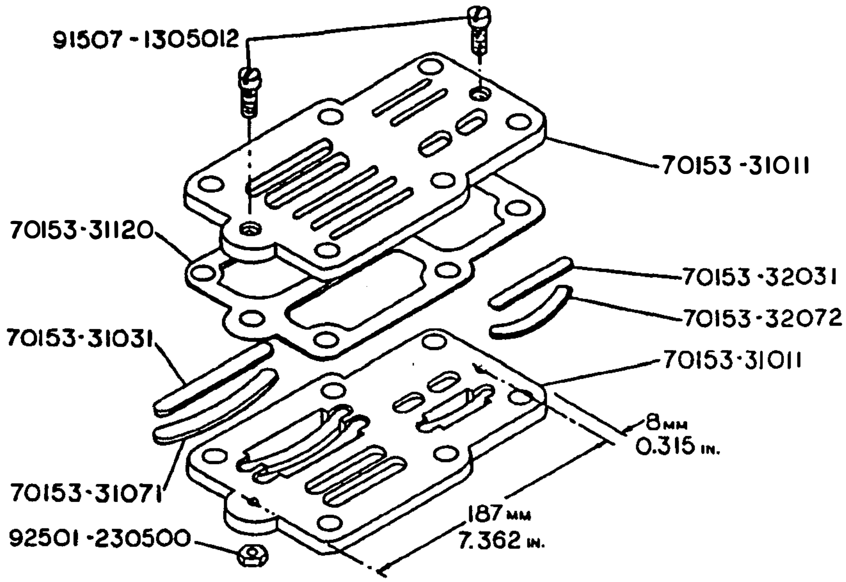


FIG. 1

SERIAL NUMBER 6107030 THROUGH 6116445

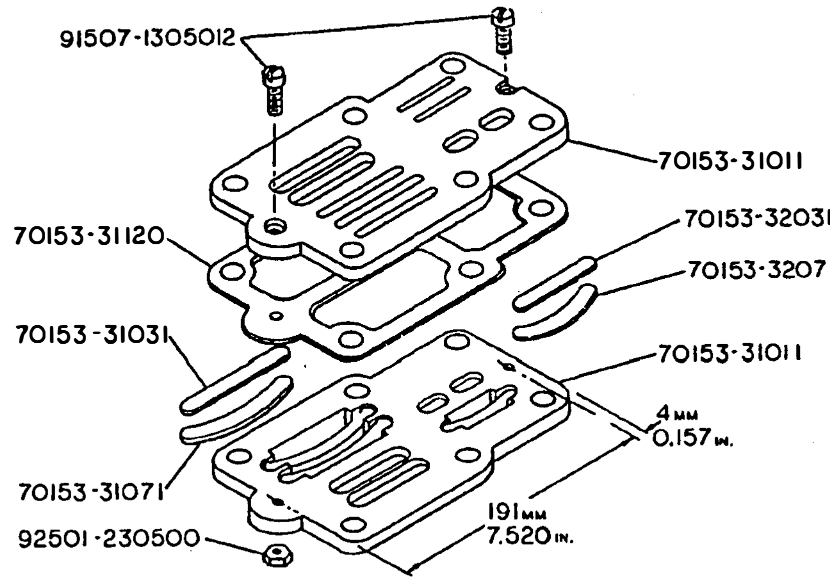


FIG. 2

SERIAL NUMBER 7010603 THROUGH 7043734

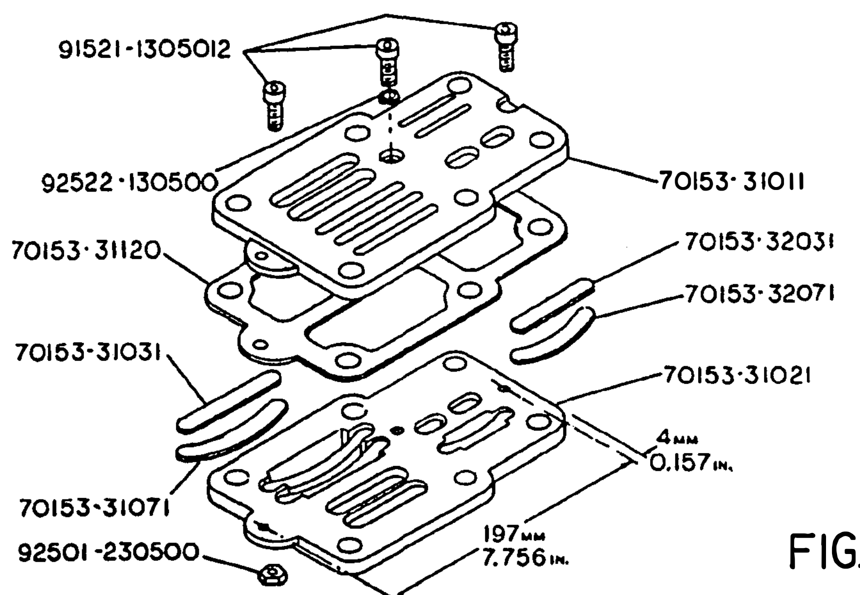


FIG. 4

SERIAL NUMBER 7043735 AND LATER

BOLT TORQUES FOR CHALLENGEAIR COMPRESSORS

	HEAD BOLTS		CYLINDER-CASE		ROD BOLTS		FRONT COVER		REAR COVER		INLET & OUTLET VALVE PUSH COVER	
	SIZE BOLT	TORQUE CM–FT.	SIZE BOLT	TORQUE CM–FT.	SIZE BOLT	TORQUE CM–FT.	SIZE BOLT	TORQUE CM–FT.	SIZE BOLT	TORQUE CM–FT.	SIZE BOLT	TORQUE CM–FT.
ES03	M6=1	120-8.7			M6=1	135-9.7	M6-1	100-6.8	M6-1	100-6.8		
ES05	M8=1.25	200-14.5	M8=1.25	200-14.5	M8=1.25	180-13.0	M8-1.25	180-13.0	M6-1	100-6.8		
ES06	M6=1	120-8.7	M6=1	120-8.7	M6=1	135-9.7	M6-1	100-6.8	M6-1	100-6.8		
ES10	M8=1.25	200-14.5	M8-14.5	200-14.5	M8=1.25	180-13.0	M8-1.25	180-13.0	M8-1.25	180-13.0		
E11	M8=1.25	200-14.5	M8-1.25	200-14.5	M8-1.25	180-13.0	M8-1.25	180-13.0	M8-12.5	180-13.0		
ES20	M8=1.25	200-14.5	M8-1.25	200-14.5	M8=1.25	180-13.0	M8-1.25	180-13.0	M8-1.25	180-18.0		
E23	M8=1.25	200-14.5	M8-1.25	200-14.5	M8=1.25	180-13.0	M8-1.25	180-13.0	M8-1.25	180-13.0		
ES30	M10=1.5	300-21.7	M10-1.5	280-20.25	M10=1.5	280-20.25	M10-1.5	280-20.25	M10-1.5	280-20.25	M8=1.25	225-16.3
E35	M8=1.25	200-14.5	M8-1.25	200-14.5	M8=1.25	180-13	M8-1.25	180-13	M8-1.25	300-21.7		
ES50	M10=1.5	300-21.7	M10-1.5	280-20.25	M8=1.5	280-20.25	M8-1.5	280-20.25	M10-1.5	280-20.25	M8-1.25	225-16.3
E50	M10=1.5	300-21.7	M10-1.5	280-20.25	M8=1.5	280-20.25	M8=1.5	280-20.25	M10-1.5	280-20.25	M8-1.25	225-16.3
E57	M10=1.5	320-23.1	M10-1.5	280-20.25	M8=1.25	280-20.25	M10=1.5	300=21.7	M8-1.25	300-21.7		
ES100	M10=1.5	320-23.1	M10-1.5	280-20.25	M8-1.5	300-21.7	M8-1.5	300-21.7	M10-1.5	280-20.25	M8-1.25	225-16.3
E71	M10=1.5	320-231	M10-1.5	280-20.25	M8-1.5	300-21.7	M8-1.5	300-21.7	M10-1.5	280-20.25	M8-1.25	225-16.3
ES150	M10=1.5	320-23 1	M10-1.75	350-25.3	M10-1.5	320-23.1	M10-1.5	320-23.11	M10-1.5	28-120.25	M10-1.5	320-23.1
E15	M10-1.5	320-231	M10-1.75	350-25.3	M10-1.5	320-23.1	M10-1.5	320-23.1	M10-1.5	280-20.25	L M10-1.5 H M8-1.25	320-23.1 225-16.3

BOLT TORQUES

MODEL NO.	FLYWHEEL BOLTS		FAN BOLTS	
	TORQUE FT.-LBS.	TORQUE IN.-LBS.	TORQUE FT.-LBS.	TORQUE IN.-LBS.
ES03	8	96	—	—
ES05 ES06 ES10 E11 ES20 E23 E35	12	144	—	—
E57	23	276	—	—
ES30	30	360	—	—
ES50 E50	40	480	—	—
E71 ES100	45	540	24	288
E15 ES150	50	600	24	288

OIL CAPACITIES

MODEL NUMBER	HORSEPOWER	MIN RPM	OIL CAPACITY
ES03	1/4 - 1/2	500	1/2 PINTS
ES05	1/2	500	1/2 PINTS
ES06	3/4	500	10 OUNCES
ES10	1	500	1¼ PINTS
ES20	2 - 3	500	1¾ PINTS
ES30	3 - 5	500	1¼ PINTS
ES50	5 - 7½	500	1½ QUARTS
ES100	7½ - 10	500	2½ QUARTS
ES150	15	500	5 QUARTS
E11	1	500	1¼ PINTS
E23	2 - 3	500	1¾ PINTS
E35	3 - 5	500	2½ PINTS
E50	5	500	1½ QUARTS
E57	5 - 7½	500	2 QUARTS
E71	10	500	2½ QUARTS
E15	15	500	5 QUARTS

TROUBLE - SHOOTING

	SYMPTOMS	CAUSES	REMEDIES
WHEN COMPRESSOR CAN BE STARTED	Flywheel revolves in wrong direction	Incorrect connection of motor terminal.	Re-arrange terminal connection.
	Overheating of bearings	1. Insufficient lubrication. 2. Bad lubrication system. 3. Crankshaft placed improperly.	1. Add lubrication oil. 2. Remove and examine the system. 3. Remove and put it in place.
	Revolution slows down	1. Heavy lubrication oil. 2. Drop of voltage. 3. Worn motor condenser.	1. Refill with lighter lubrication oil. 2. Contact power company or install a transformer. 3. Replace motor condenser.
	Severe vibration	Bent crankshaft	Send to factory for repair
	Abnormal noise	1. Loose valve assembly. 2. Piston hits cylinder cover. 3. Loose bearing metals.	1. Tighten valve bolt and lock nut. 2. Put on an additional cylinder head gasket. 3. Repair or replace bearing metals.
	Pressure cannot be built up or only up to a certain extent	1. Worn valve plate. 2. Valve springs have lost their temper. 3. Dirt on the valve plate. 4. Leaks from safety valve. 5. Leaks from bolt holes. 6. Uneven valve seat surface. 7. Leaks from piston rings. 8. Bad packing (gasket too thick) 9. Leaks of air lock or drain cock.	1. Repair or replace valve plate. 2. Replace valve springs. 3. Remove and clean it. 4. Repair or replace safety valve. 5. Tighten the nuts even with packing. 6. Remove and lap the surface. 7. Replace with new ones. 8. Replace packing (gasket). 9. Replace with new ones.
	Inaccuracy of pressure gauge	Pressure gauge damaged.	Replace with new ones
	Excessive consumption of lubrication oil	1. Worn piston ring. 2. Worn piston. 3. Worn cylinder.	1. Replace with new ones. 2. Replace with new ones. 3. Replace with new ones.
	Slipping of belts	1. Working pressure too high. 2. Improper belt tension. 3. Worn belt.	1. Lower working pressure. 2. Adjust belt tension. 3. Replace with new ones.
	Overheating of electric motor	1. Overloading of motor due to excessive working pressure (higher than the stipulated pressure). 2. Burnt piston. 3. Burnt bearing metals. 4. Drop of voltage.	1. Lower working pressure. 2. Rebuild compressor. 3. Rebuild compressor. 4. Contact power company or install a transformer.
WHEN COMPRESSOR CANNOT BE STARTED	No sound	1. Breakdown of electric current. 2. Line failure. 3. Malfunction of motor.	1. Contact power company. 2. Examine the line. Replace with new wiring. 3. Contact Motor Mfg.
	Fuse tends to blow	1. Fuse too fine. 2. Wrong connections. 3. Overloading of motor. 4. Overloading of motor due to leaks of outlet valve. 5. Crankshaft too tight.	1. Replace with heavy ones. 2. Change connections. 3. Eliminate the loading. 4. Remove and repair outlet valve. 5. Remove crankshaft and examine it.

RECOMMENDED STATEMENT ON DRYERS AND FILTERS

Liquid water occurs naturally in air lines as a result of compression. Moisture vapor in ambient air is concentrated when pressurized and condenses when cooled in downstream air piping. Compressed air dryers reduce water vapor concentration and prevent liquid water formation in compressed air lines. Dryers are necessary companion to filters, aftercoolers, and automatic tank drains for improving the productivity of compressed air systems.

Water and water vapor remloval increases the efficiency of air operated equipment, reduces contamination and rusting, increases the service life of pneumatic equipment and tools, prevents air line freeze ups, and reduces prodict rejects. The use of dryers filters are recommended when these moisture related problems are reported to our factory or disttributor service departments.

TROUBLE SHOOTING GUIDE

Symtom: Liquid water in compressed air lines.

Problem: Water vapor condendation from cooling and compredion occurs naturallly.

Solution: Remove the water vapor from compressed air prior to distribution through the air system. Check operation of aftercooler and moisture seperator. Install a compressed air dryer sized for the flow and dryness level required.

(Note: Filters may also be required to remove particulates, liquid oil aerosols, or for oil vapor removal. Change cartrides as recommended by filter manufacturer.)

Check all drain traps routinely to insure thier proper operation. Maintain them regularly.

COMPRESSOR PUMP-UP TIME

TWO STAGE

H.P. Size	Compressor Model No.	R.P.M.	Piston Displ. C.F.M.	Tank Size Size (in)	Tank Size Gal	Approx. Time Required To Pump From: 0 to 175 PSIG Min.-Sec.	Approx. Time Required To Pump From: 145-175 PSIG Min.-Sec.
3	3VT6	947	10.66	20 x 50	60	12' - 24"	2' - 8"
5	5E23VT6	1000	11.3	20 x 50	60	11' - 47"	2' - 1"
5	5E1HT6	1100	17.96	20 x 50	60	6' - 46"	1' - 10"
5	5E1VT6	1100	17.96	20 x 50	60	6' - 46"	1' - 10"
5	5E1HT8	1100	17.96	24 x 48	80	9' - 2"	9' - 2"
5	5E1VT8	1100	17.96	20 x 48	80	9' - 2"	9' - 2"
5	5HT6	968	20.58	20 x 50	60	5' - 56"	1' - 1"
5	5VT6	968	20.58	20 x 50	60	5' - 56"	1' - 1"
5	5HT8	968	20.58	20 x 66	80	7' - 54"	1' - 21"
5	5VT8	968	20.58	20 x 48	80	7' - 54"	1' - 21"
5	5E2HT6	900	21.47	20 x 50	60	5' - 25"	0' - 56"
5	5E2VT6	900	21.47	20 x 50	60	5' - 25"	0' - 56"
5	5E2HT8	900	21.47	20 x 66	80	7' - 14"	1' - 14"
5	5E2VT8	900	21.47	20 x 48	80	7' - 14"	1' - 14"
7 1/2	7E2HT8	1100	29.81	20 x 66	80	5' - 34"	0' - 57"
7 1/2	7E2VT8	1100	29.81	24 x 48	80	5' - 34"	0' - 57"
7 1/2	7HT8	764	29.57	20 x 66	80	5' - 22"	0' - 55
10	10HT8	977	37.81	20 x 66	80	4' - 11"	0' - 43"
10	10HT12	977	37.81	24 x 70	120	6' - 17"	1' - 5"
10	10VT12	977	37.81	30 x 47	120	6' - 17"	1' - 5"
15	15HT12	855	54.55	24 x 70	120	4' - 28'"	0' - 46"

TWO STAGE GASOLINE ENGINE DRIVEN

H.P. Size	Compressor Model No.	R.P.M.	Piston Displ. C.F.M.	Tank Size Size (in)	Tank Size Gal	Approx. Time Required To Pump From: 0 to 175 PSIG Min.-Sec.	Approx. Time Required To Pump From: 145-175 PSIG Min.-Sec.
11	11E2GT3	910	21.7	16 x 41	30	2' - 42"	0' - 28"
11	11GT3	950	20.2	16 x 41	30	3' - 1"	0' - 31"
11	11GT6	950	20.2	20.2	60	6' - 3"	1' - 2"
10	11E2GT3K	910	21.7	16 x 41	30	2' - 42"	0' - 28"
10	11GT3K	950	20.2	16 x 41	30	3' - 1"	0' - 31"
10	11GTGK	950	20.2	20.2	60	6' - 3"	1' - 2"
11	11E2GT3HE	910	21.7	16 x 41	30	2' - 42"	0' - 28"

CAT

COMPRESSOR PUMP-UP TIME

SINGLE STAGE

H.P. Size	Compressor Model No.	R.P.M.	Piston Displ. C.F.M.	Tank Size Size (in)	Tank Size Gal	Approx. Time Required To Pump From: 0 to 100 PSIG Min.-Sec.	Approx. Time Required To Pump From: 80-100 PSIG Min.-Sec.
3	3HS6	945	15.97	20 x 50	60	6' - 16"	1' - 15"
3	3VS6	945	15.97	20 x 50	60	6' - 16"	1' - 15"
5	5ES20VS6	1000	16.9	20 x 50	60	6' - 4"	1' - 13"
5	5EHS6	945	20.13	20 x 50	60	4' - 8"	0' - 50"
5	5VS6	945	20.13	20 x 50	60	4' - 8"	0' - 50"
5	5HS8	945	20.13	20 x 66	80	5' - 31"	1' - 6"
5	5VS8	945	20.13	24 x 48	80	5' - 31"	1' - 6"
7 1/2	7HS8	945	30.14	20 x 66	80	3' - 35"	0' - 43"
7 1/2	7VS8	945	30.14	24 x 48	80	3' - 35"	0' - 43"
10	10HS8	866	50.4	20 x 66	80	2' - 7"	0' - 25"
10	10HS12	866	50.4	24 x 70	120	3' - 10"	0' - 38"
10	10VS12	866	50.4	30 x 47	120	3' - 10"	0' - 38"
15	15HS12	855	81.74	24 x 70	120	2' - 2"	0' - 24"

JIM GRIEP

BURT UNLOAD COIL
ELECTRIC S.V.
230 VOLT
PPG
PETERPAUL

NEW STARTER

480 VOLT HOLDING COIL
230 V
STARTER OVERLOAD
LOOK AMP DIAL
SET AT OR
ABOVE FULL LOAD

460 VOLT

DIAL 25AM

Compresed Air Technolgies

CURTIS-TOLEDO INC. St. Louis, Missouri 63133

LIMITED WARRANTY

CURTIS-TOLEDO will, at its option, repair, replace, or refund the purchase price of any materials or parts of any new equipment manufactured by CURTIS-TOLEDO which, within the Applicable Warranty Period specified on the reverse side of this card, prove, upon examination by CURTIS-TOLEDO, to be defective in material and/or workmanship, provided that Buyer meets all of the applicable requirements of this Warranty and none of the exclusions apply.

To qualify for warranty service, Buyer must: (1) contact CURTIS-TOLEDO prior to returning any item and obtain a returned material authorization number; and (2) pay all transportation charges to CURTIS-TOLEDO and back to Buyer.

This warranty does not apply to and there is expressly EXCLUDED from coverage hereunder, the following: (1) equipment which has been installed improperly, or which has not been operated and maintained in accordance with CURTIS-TOLEDO'S ratings and instructions and in accordance with good industry practices; (2) equipment which has been damaged in transit or by misuse, neglect, or accident; (3) equipment which has been repaired or modified without authorization from CURTIS-TOLEDO; (4) the effects of normal wear and tear, and the effects of corrison and erosion due to the presence of substances in the environment in which the equipment is operated and/or in gases passing through the equipment; (5) labor charges incidental to the service, adjustment, removal, or repair of any materials or parts, or any other expenses incurred by Buyer (all such charges and expenses shall be paid by Buyer); and (6) equipment manufactured by others, such as dryers, electric motors, gasoline engines, starters, and controls (any claims with regard to such equipment must be made by the Buyer to the original manufacturer of same).

The Warranty provisions contained herein apply ONLY to buyers for purposes of resale and/or to commercial or industrial users. They do not apply to buyers or users of CURTIS-TOLEDO products for personal, family, or household purposes, for whom there is NO WARRANTY, but to whom the limitations and exclusions shown below nonetheless apply.

CURTIS-TOLEDO ASSUMES NO LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES UNDER ANY WARRANTY, EXPRESS OR IMPLIED AND ALL SUCH LIABILITY IS HEREBY EXPRESSLY EXCLUDED. THE TOTAL LIABILITY OF CURTIS-TOLEDO HEREUNDER FOR ANY AND ALL LOSSES AND DAMAGES ARISING OUT OF ANY CAUSE WHATSOEVER SHALL, IN NO EVENT, EXCEED THE PURCHASE PRICE OF THE GOODS WITH RESPECT TO WHICH SUCH CAUSE ARISES. THERE IS NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHICH EXTENDS BEYOND THE FACE HEREOF. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY EXPRESSLY EXCLUDED.

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D

NOTE: Warranty registration must be completed and returned to validate warranty.

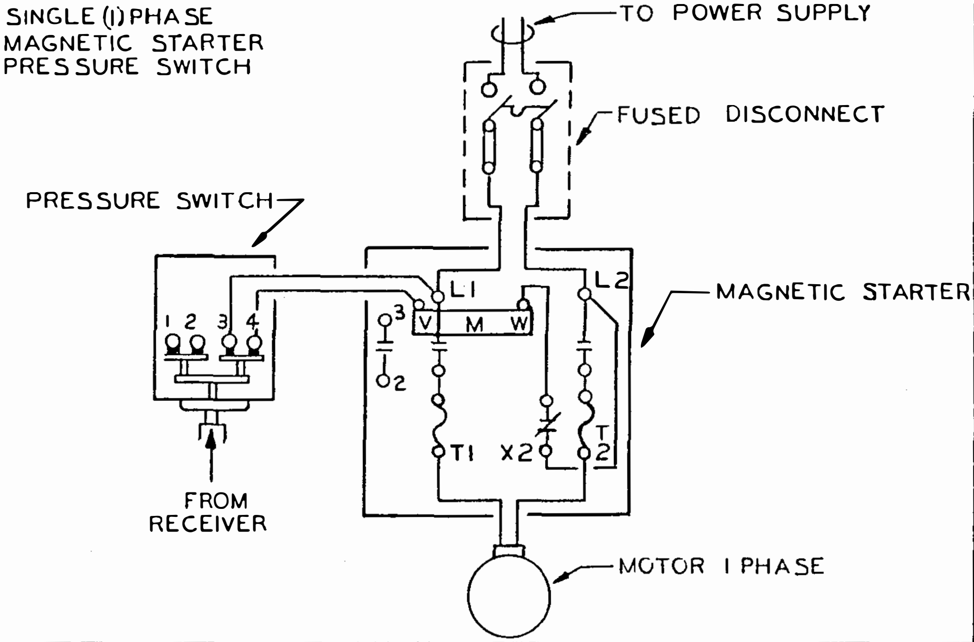
FORM QAB274 (1-95)

VIP PRINTING • (314) 426-5707

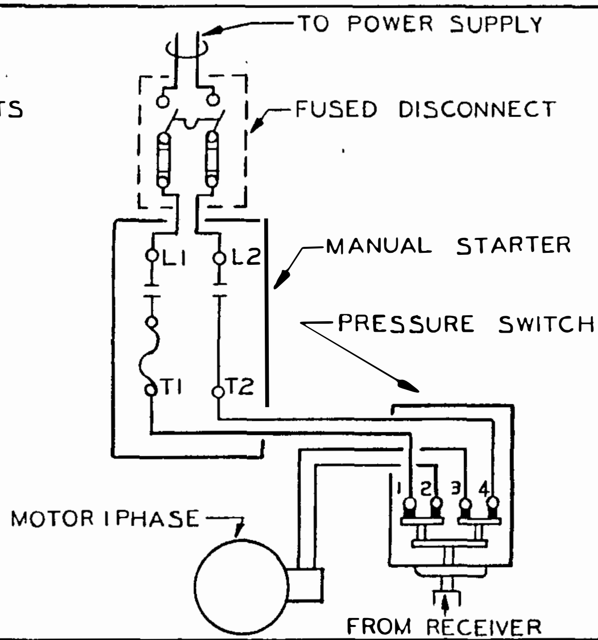
CURTIS-TOLEDO INC.

ST. LOUIS MO. 63133 U.S.A.

SINGLE (I) PHASE
MAGNETIC STARTER
PRESSURE SWITCH



SINGLE (I) PHASE
MANUAL STARTER
PRESSURE SWITCH
1 THRU 3 HP @ 230 VOLTS
1 & 1 1/2 HP @ 115 VOLTS



3-9-81 | A-CCA1495

CURTIS-TOLEDO INC.

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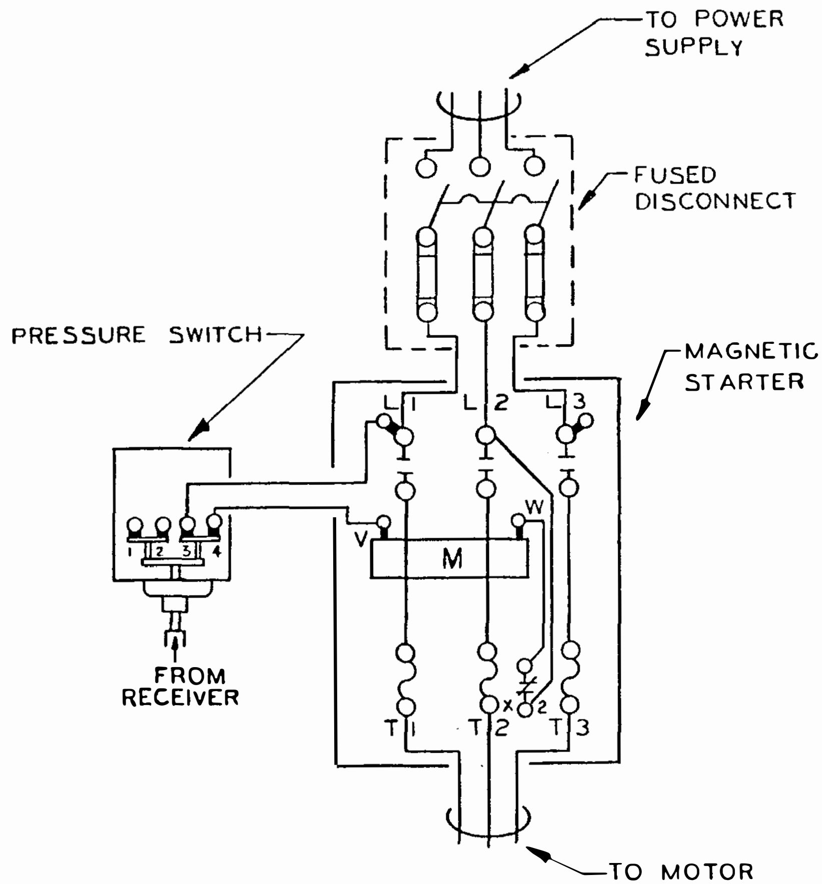


3 PHASE MOTOR
MAGNETIC STARTER
PRESSURE SWITCH
(S.S.) START STOP CONTROL

3 PHASE 60 HERTZ 200/240-480 VOLTS

3-6-81 | A-CCA1494

CAUTION

CHECK THE TIGHTNESS OF THE FLYWHEEL TO THE SHAFT

On ChallengeAir Models E11, E23, E35, E50, E57, ES03, ES05,ES06, ES10, ES20, ES30, and ES50, remove the flywheel washer and screw. Take a block of wood about 2 x 2 x 6, place at the hub of the flywheel and drive the flywheel home on the taper with a blow from a hammer. Then replace the washer and screw and tighten the screw to the torque shown in the tables.

The flywheel on the ChallengeAir Models E71, E15, ES100, and ES150 are shipped with the pulley portion of the flywheel mounted. Remove the screw or nut and washers from the shaft. With a wood block and hammer drive the flywheel home on the taper of the shaft. Place the washer and screw on the E71 and ES100, and the washer and nut on the E15 and ES150. Tighten the screw or nut to the torque shown in the tables. **(CAUTION ON THE E71 AND ES100: DO NOT ATTEMPT TO PULL FLYWHEEL OVER THE TAPER WITH THE FLYWHEEL SCREW. FOLLOW THE ABOVE INSTRUCTIONS.)**

The fan portion of the flywheel is shipped separately, packed with screws and lockwashers. Unpack and fit the fan to the pulley portion of the flywheel and attach with the screws and lockwashers furnished, and tighten to the torque shown in the tables.

ChallengeAir MODEL NO.	FLYWHEEL BOLTS		FAN BOLTS	
	TORQUE FT. - LBS.	TORQUE IN. - LBS.	TORQUE FT. - LBS.	TORQUE IN. - LBS.
ES03	8	96	—	—
ES05 ES06 ES10 E11 ES20 E23 E35	12	144	—	—
E57	23	276	—	—
ES30	30	360	—	—
ES50 E50	40	480	—	—
E71 ES100	45	540	24	288
E15 ES150	50	600	24	288

CURTIS-TOLEDO, INC.
1905 Kienlen Avenue, St. Louis, Missouri 63133
(314) 383-1300 FAX (314) 381-1439

CURTIS MANUFACTURING COMPANY
ST. LOUIS, MO. U.S.A.

OPERATION OF DUAL CONTROL, ASSD & CONSTANT SPEED CONTROL WITH 3 WAY SOLENOID VALVE

-Operation of the Selector Switch-

Dual control permits the compressor to automatically start and stop on pressure demand, or run continuously with a load and unload cycle based on pressure demand. Operation is chosen by a selector switch.

WITH THE SELECTOR SWITCH SET ON AUTO.

The Compressor stops when the cut-out pressure is reached and starts again when the pressure falls to the cut-in pressure setting of the pressure switch.

WITH THE SELECTOR SWITCH SET ON HAND.

The compressor continually runs, but unloads or stops pumping when the cut-out pressure is reached and loads or starts pumping again when the pressure falls to the cut-in pressure setting of the pressure switch.

WITH THE SELECTOR SWITCH SET ON OFF.

The compressor will immediately stop and remained stopped until the AUTO or HAND position is selected.

-Operation of 3 Way Solenoid Valve- *

When either the compressor stops or the pressure switch opens the solenoid valve is de-energized, opening port #3 to port #1. This permits high pressure air to flow via port #3 through the valve to the compressor unloader via port #1, thus unloading the compressor for either an unloaded start or constant running unloading. When the compressor starts or the pressure switch closes, the solenoid valve is energized which opens port #1 to port #2. The high pressure air in the unloader will now bleed via port #1 through the valve to atmosphere via port #2 and the restrictor plug. The compressor is now loaded and will pump. The purpose of the restrictor plug is to delay the loading action and allow the compressor to attain full speed on start-up before it starts pumping.

*On some valves, port "1" is marked "CYL," port "2" is marked "EXH," and port "3" is marked "IN"

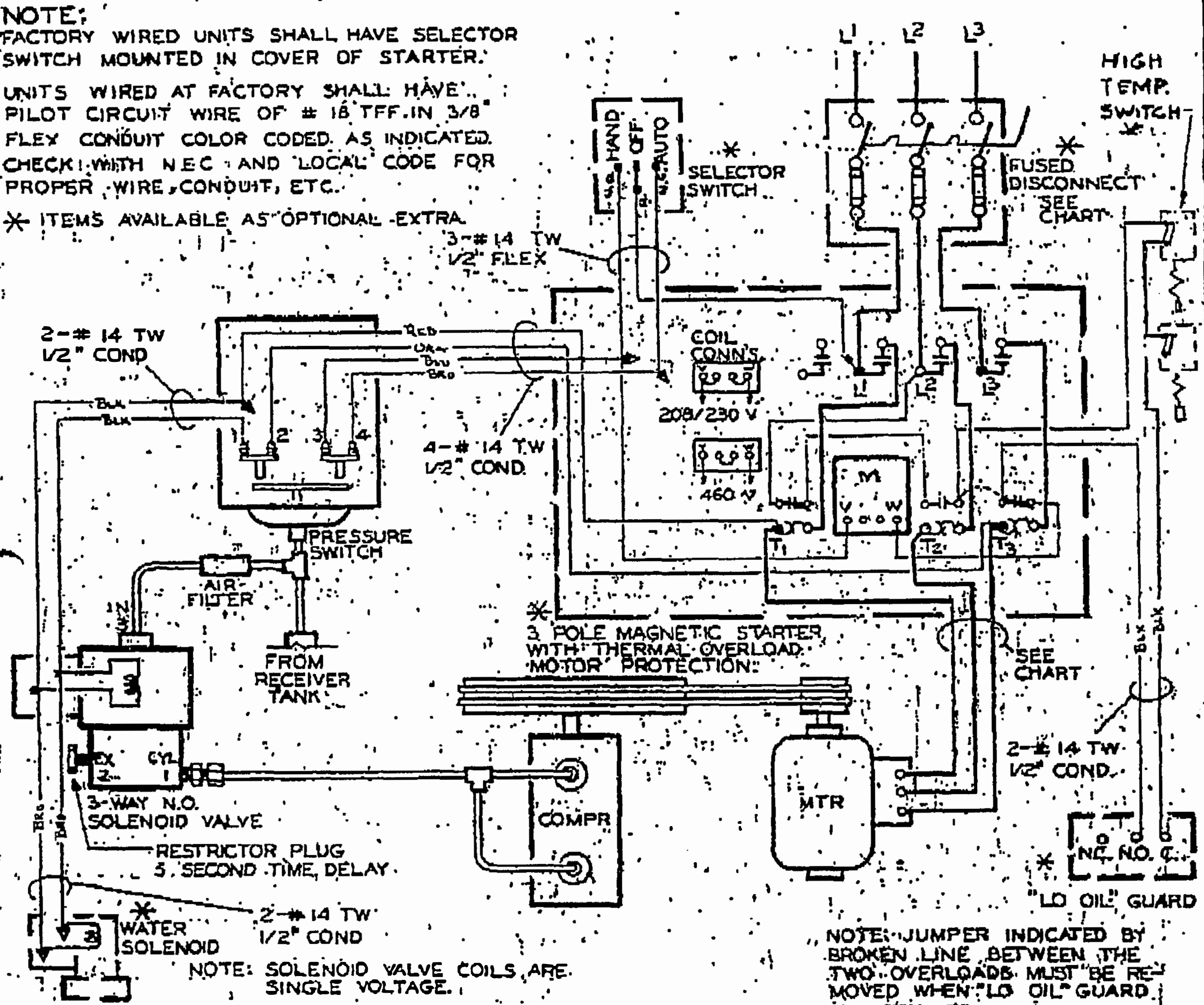
Piping Diagram For CW - Units	A-CAA-1440
Piping Diagram For CV-CQ Units	A-CAA-1463
Wiring Diagram For Dual Control (with options)	A-CA-1476
Wiring Diagram ASSD	A-CA-1497
Wiring Diagram For Dual Control With 120 Volt Pilot Control	A-CA-1485
Wiring Diagram For ASSD And Low Oil Level Cutout Device	A-CA-1497
Wiring Diagram For Dual Control With Low Oil Level Cutout Device With 120 Volt Pilot Control	A-CA-1498

DATE 5-16-73 / DRWN L.R.A.	OPERATION OF 3WAY UNLOADER SOLENOID	A-CA-1473

NOTE:
FACTORY WIRED UNITS SHALL HAVE SELECTOR SWITCH MOUNTED IN COVER OF STARTER.

UNITS WIRED AT FACTORY SHALL HAVE PILOT CIRCUIT WIRE OF # 18 TFF. IN 3/8" FLEX CONDUIT COLOR CODED AS INDICATED. CHECK WITH N.E.C. AND LOCAL CODE FOR PROPER WIRE, CONDUIT, ETC.

✳ ITEMS AVAILABLE AS OPTIONAL EXTRA.



NOTE: SOLENOID VALVE COILS ARE SINGLE VOLTAGE.

NOTE: JUMPER INDICATED BY BROKEN LINE BETWEEN THE TWO OVERLOADS MUST BE REMOVED WHEN "LO OIL" GUARD IS INSTALLED.

Curtis MFG. CO. ST LOUIS, MO.	WIRING DIAGRAM FOR DUAL CONTROL AND "LO OIL" GUARD (FURNAS STARTER)	GWB 8-23-69 DWG. NO. A-CA-1476

CURT S-TOLEDO, NC.

Supplement To:
CAP-200
CAP-600
CC/SM-1

Safety Precautions

Supplement LV-474

> **CAUTION**
>
> Before installing this compressor, read and understand the safety precautions contained within this manual!!

SAFETY

At Curtis-Toledo, Inc. safety is a primary concern. Beginning with the design stage, safety is built into every "Curtis Compressor". It is the purpose of this manual to pass along the "safety first" concept to you by providing safety precautions throughout its pages.

"WARNING!", **"CAUTION!"**, and **"DANGER!"** are displayed in large bold capital letters to call attention to areas of vital concern. They represent different degrees of hazard seriousness, as stated below. The safety precaution is spelled out in bold upper and lower case letters.

DANGER!

Immediate hazards which will result in severe personal injury or death.

WARNING!

Hazards or unsafe practices that could result in personal injury or death.

CAUTION!

Hazards or unsafe practices which could result in minor personal injury, product or property damage.

Each section of this safety manual and the company's operating instruction manual, as well as any instructions supplied by manufacturers of supporting equipment, should be read and understood prior to starting the compressor. If there are any questions regarding any part of the instructions, please call your local Curtis-Toledo Distributor, or the Curtis-Toledo factory before creating a potentially hazardous situation. Life, limb, or equipment could be saved with a simple phone call, (314) 383-1300.

CONTENTS OF SAFETY PRECAUTION MANUAL LV-474

SAFETY PRECAUTIONS

The owner, lessor or operator of any compressor unit manufactured by Curtis-Toledo, Inc. is hereby warned that failure to observe all safety precautions may result in serious injury to personnel and/or damage to property.

Curtis-Toledo, Inc. neither states as fact, nor in any way implies that this list of safety precautions is an all inclusive list, the observance of which will prevent all damage to property or injury to personnel.

Every reasonable effort has been taken to ensure that complete and correct instructions have been included in this manual. However, possible updates and changes may have occurred since this printing. Curtis-Toledo, Inc. reserves the right to change specifications, without incurring any obligation for equipment previously or subsequently sold.

Compressors and/or units are assembled to comply with the customer's purchase order and in compliance with Curtis-Toledo, Inc. specifications; alteration must not be made to the compressor or unit without Curtis-Toledo written approval.

Provisions must be made by the owner, lessor or operator to have a pressure reducing regulator valve with air gauge in each service line to supply safe and proper air pressure for the various use and applications.

When supplying air pressure direct from air compressor to a tire chuck for public or operator use to inflate tires and so forth, a safety precaution sign in large bold print must be posted in plain view at tire chuck location, **"DANGER, AIR PRESSURE FROM THIS CHUCK MAY EXCEED SAFE PRESSURE FOR TIRES AND SO FORTH"**. A hand operated gauge must be used to measure and not exceed safe inflated pressure.

Avoid discharge air temperatures from the compressor exceeding the flash temperature of the lubricating oil in the crankcase. Refer to the respective compressor installation and operating manual for lubricant recommendations.

A new or rebuilt reciprocating compressor should be run for 100 hours or as required at full discharge operating pressure to break-in the new piston rings. Until rings are seated, the compressor will discharge higher than normal amounts of oil. In light of this fact, the oil level should be checked more frequently during the 100 hour break-in period.

DANGER!

Air used for breathing or food processing must meet O.S.H.A. 29 C.F.R. 1910.134 or F.D.A. 21 C.F.R. 178.350 regulations. Failure to do so will cause severe injury or death.

WARNING!

Compressors are precision high speed mechanical equipment requiring caution in operation to minimize hazard to property and personnel. There are many obvious safety rules that must be observed in the operation of this type of equipment. Listed below (In no particular order) are some additional safety precautions that must be observed.

- **Transfer of toxic, dangerous, flammable or explosive substances using Curtis-Toledo products Is at the User's risk.**
- **Turn off and lockout/tagout the main power disconnect switch before attempting to work or perform any maintenance.**
- **Do not attempt to service any part of this unit while It Is running.**

WARNING!

- **Relieve the system of all pressure before attempting to service any part of the unit.**
- **Do not operate the unit with any of its safety guards, shields, or screens removed.**
- **Do not remove or paint over any DANGER!, WARNING!, CAUTION!, or Instructional materials attached to the compressor. Lack of Information regarding hazardous conditions can cause property damage or personal injury.**
- **Periodically check all pressure relief valves for proper operation.**
- **Do not change the pressure setting of the pressure relief valve, restrict the function of the pressure relief valve, or replace the pressure relief valve with a plug.**
- **Do not install a shutoff valve in the compressor discharge line without first installing a pressure relief valve of proper size and design between the shutoff valve and the compressor.**
- **Do not use plastic pipe, rubber hose, or lead-tin soldered joints in any part of the compressed air system.**
- **Alterations must not be made to this compressor without Curtis-Toledo's approval.**
- **Be sure that all tools, shipping and installation debris have been removed from the compressor and Installation site prior to starting the compressor.**
- **Do not operate the compressor in excess of the A.S.M.E. pressure vessel rating for the receiver or the service rating of the compressor, whichever is lower.**
- **Make a general overall inspection of the unit daily and correct any unsafe situations.**
- **"Horseplay" of any kind involving compressed air is dangerous and can cause very serious injury to the participants.**
- **Do not touch the compressor during or after operation—it may be HOT.**
- **Provisions should be made to have the instruction manual readily available to the operator and maintenance personnel. If for any reason any part of the manual becomes illegible or the manual Is lost, have it replaced immediately. The instruction manual should be read periodically to refresh one's memory. It may prevent a serious or fatal accident.**

RECEIVING DELIVERY

Immediately upon receipt of compressor equipment and prior to completely uncrating, the following steps should be taken:

1. Inspect compressor equipment for damage that may have occurred during shipment. If any damage is found, demand an inspection from the carrier. Ask the carrier how to file a claim for shipping damages. (Refer to **FREIGHT DAMAGE** for complete details.) Shipping damage is not covered by Curtis-Toledo's compressor warranty.

CAUTION!

Improper lifting can result In component or system damage or personal injury. Follow good shop practices and safety procedures when moving the unit.

2. Ensure that adequate lifting equipment is available for moving the compressor equipment.
3. Read the compressor nameplate to verify the model and size ordered.
4. Read the motor nameplate to be sure the motor is compatible with your electrical conditions (volts, phase, hertz).
5. Read the pressure relief valve nameplate to be sure it does not exceed the working pressure of the compressor or any other component in the system.
6 Read and understand the safety precautions contained within this manual. The successful and efficient operation of compressor equipment depends largely upon the amount of care taken to install and maintain the equipment. Curtis-Toledo strongly recommends that any or all person(s) in charge of installing, maintaining, or servicing one of our compressors read and understand entire contents of this manual and the respective compressor installation and operating instruction manual in order to perform such duties safely and efficiently.

FREIGHT DAMAGE

The transportation industry has adopted a modification with regard to the handling of obvious and concealed damage claims. Therefore, it is extremely important that you examine every carton and crate as soon as you receive it. If there is any obvious damage to the shipping container, have the delivering carrier sign the freight bill, noting the apparent damage, and request a damage report.

If concealed damage is discovered at a later date, the carrier must be notified within 15 days of initial receipt of freight. Contact the carrier as soon as possible, giving them an opportunity to inspect the shipment at the premises where the delivery was made. Do not move the damaged freight from the premises where the original delivery was made. Retain all containers and packing for inspection by the carrier.

INSTALLATION

Curtis-Toledo's air compressors should be installed in an area that is clean, well lighted, and adequately ventilated. Inspection and maintenance checks are required daily. Therefore, sufficient space needs to be provided around the compressor for safe and proper inspection, cleaning, and maintenance.

The compressor must not be installed closer than 15 inches to a wall, or 24 inches to another compressor. This allows ample circulation of air across the compressor cylinders, heads and cooler (if so equipped). If at all possible, the pulley drive system (i.e. motor pulley, compressor pulley, belts and guard) should be located next to a wall to minimize any danger created by the drive system while the compressor is operating.

Due to standard motor limitations, it is recommended that the compressor be operated in temperatures under 104°F. In cold climates, the compressor should be installed in a heated building.

CAUTION!

Do not operate this compressor in ambient temperatures lower than -15°F. A crankcase heater is recommended for a compressor that is to operate in temperatures under 32°F.

WARNING!

Under no circumstances should a compressor be used in an area that may be exposed to toxic, volatile, or corrosive atmosphere. Do not store toxic, volatile, or corrosive agents near the compressor.

MOUNTING

Proper mounting of Curtis-Toledo compressors is crucial to the safe operation and longevity of the equipment. The installation requires a flat and level concrete floor or pad. State or local codes may mandate that the compressor be bolted to the floor. The unit must be leveled and bolted making absolutely certain the feet are not stressed in any manner. Uneven feet drawn tightly to the concrete pad will cause severe vibrations resulting in cracked welds or fatigue failure. The customer is responsible for providing a suitable foundation.

MOUNTING MOBILE UNITS

Gas engine driven compressors mounted to truck beds should be fastened to the truck bed in such a way so as not to create any stress to the air receiver tank. Truck beds, characteristically, have a tendency to flex and could cause damage to the receiver tank if the tank is fastened directly to the truck bed. It is the User's responsibility to provide an adequate means of fastening the unit in these applications.

WARNING!

NOISE

Noise is a potential health hazard that must be considered. There are federal and local laws governing acceptable noise levels. Check with local officials for specifications.

Excessive noise can be effectively reduced through various methods. Ear plugs, total enclosures, intake silencers, baffle walls, relocating or isolating the compressor can reduce noise levels. Care must be taken when constructing total enclosures or baffle walls. If not properly constructed or positioned, they could contribute to unacceptable noise levels or overheating. If ear plugs effectively reduce the noise, the user should make available a supply of ear plugs near to noise source. Consult your local Curtis-Toledo Distributor if assistance is required.

WARNING!

Unusual noise or vibration indicates a problem. Do not operate the compressor until the source has been identified and corrected.

ELECTRICAL SUPPLY REQUIREMENTS

The electrical installation of this unit should be performed by a qualified electrician with knowledge of the National Electrical Code (N.E.C.), O.S.H.A. code and/or any local or state codes having precedence.

Before installation, the electrical supply should be checked for adequate wire size and transformer capacity. A suitable circuit breaker or fused disconnect switch should be provided. When a 3-phase motor is used to drive a compressor, any unreasonable voltage imbalance between the legs must be eliminated and any low voltage corrected to prevent excessive current draw. **Note**: This unit must be grounded.

The installation, electric motor, wiring, and all electrical controls must be in accordance with NFPA 70-1984 National Electric Code, National Electric Safety Code, state and local codes. Failure to abide by the national, state and local codes may result in physical harm and/or property damage. Do not by-pass motor overcurrent protection.

DANGER!

High voltage may cause personal Injury or death, per O.S.H.A. regulations 1910.137, disconnect and lockout/tagout all electrical power supplies before opening the electrical enclosure or servicing.

WARNING!

Never assume a compressor is safe to work on just because it is not operating. It could restart at any time. Follow all safety precautions outlined.

NEMA electrical enclosures and components must be appropriate to the area installed.

SYSTEM COMPONENTS

Efficiency and safety are the primary concerns when selecting components for compressed air systems. Products of inferior quality can not only hinder performance of the unit, but could cause system failures that result in bodily harm or even death. Select only top quality components for your system. Call your local Curtis-Toledo Distributor for quality parts and professional advise.

DRIVE PULLEYS

Drive pulleys must be properly aligned and drive belt tension set to specifications (refer to **PULLEY ALIGNMENT & BELT TENSION**). Improper pulley alignment and belt tension can cause motor overloading, excessive vibration, and premature belt and/or bearing failure.

DANGER!

Excessive compressor RPM's (speed) could cause a pulley to burst. In an instant, the pulley could separate Into fragments capable of penetrating the belt guard and causing bodily harm or death. Do not operate the compressor above the recommended RPM.

GUARDS

All mechanical action or motion is hazardous in varying degrees and needs to be guarded. Guards should be designed to achieve the required degree of protection and still allow full air flow from the compressor sheave across the unit. Guards shall be in compliance with OSHA safety and health standards 29 CFR 1910.219 in OSHA manual 2206 and any state or local codes.

WARNING!

Guards must be fastened in place before starting the compressor and never removed before cutting off and locking out the main power supply.

CHECK VALVES

Check valves are designed to prevent back-flow of air pressure in the compressed air system (air flows freely in one direction only). The check valve must be properly sized for air flow and temperature. Do not rely upon a check valve to isolate a compressor from a pressurized tank or compressed air delivery system during maintenance procedures!

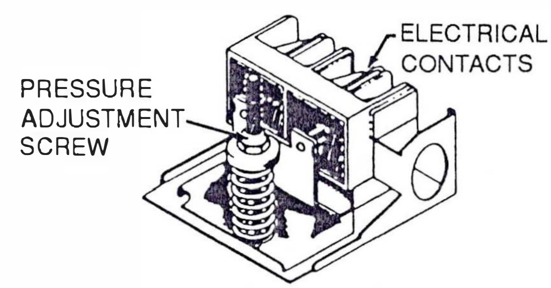
MANUAL SHUTOFF VALVES
Manual shutoff valves block the flow of air pressure in either direction. This type of valve can be used to isolate a compressor from pressurized system, provided the system is equipped with a pressure relief valve capable of being manually released. The pressure relief valve should be installed between the manual shutoff valve and the compressor.

PRESSURE RELIEF VALVES
Pressure relief valves aid in preventing system failures by relieving system pressure when compressed air reaches a determined level. They are available in various pressure settings to accommodate a range of applications. A check valve and pressure relief valve are required in all compressor discharge lines. Pressure relief valves are preset by the manufacturer and under no circumstances should the setting be changed by anyone other than the manufacturer.

DANGER!

Pressure relief valves are designed to protect compressed air systems in accordance with ASME B19 safety standards. Failure to provide properly sized pressure relief valves may cause property damage, severe personal injury or even death.

PRESSURE SWITCH
The pressure switch detects the demand for compressed air and allows the motor to start. When the demand is satisfied, the unit stops. Pressure switches provided by Curtis-Toledo are pre-set at the factory and usually do not require adjustment. However, if adjustment is required (by qualified electrician) refer to instructions inside cover of switch housing,



WARNING!

The maximum discharge pressure for the various models are established by the Curtis performance data. Do not set the pressure switch or regulators to exceed the design limit.

WARNING!

Electric power always exists inside the pressure switch whenever the compressor package is connected to a power supply. Be careful not to touch any electrical leads when setting the pressure switch.

WARNING!

Never exceed the designed pressure for the system or overload the motor beyond its Maximum Amp Draw.

- **Full Load Amps x Service Factor = Maximum Amp Draw.**
- **Full Load Amps (FLA) & Service Factor can normally be found on motor nameplate.**

WARNING!

Never assume a compressor is safe to work on just because it is not operating. It may be in the automatic stand-by mode and may restart any time. Follow all safety precautions outlined in STOPPING FOR MAINTENANCE.

AIR INLET SYSTEM

AIR INTAKE
A clean, cool and dry air supply is essential to the satisfactory operation of your Curtis-Toledo air compressor. The standard air filter that the compressor is equipped with when leaving the factory is of sufficient size and design to meet normal conditions, when properly serviced, in accordance with the maintenance section of this manual.

If, however. the compressor is to be installed in a location where considerable dust, dirt and other contaminants are prevalent, consult your Curtis-Toledo Distributor for advice and optional filters. It is the User's responsibility to provide adequate filtration for those conditions. Oil bath filters are not to be used. Warranty will be void if a failure is determined to be caused by inadequate filtration.

REMOTE INLET FILTERS
Depending on the size of the compressor and the size and construction of the room in which the unit operates, the air inlet may have to be located outside of the room. If it is necessary to remotely

install the air filter, make the inlet piping as short and direct as possible. Remotely installed air filters can lead to vibrations in the inlet piping. These vibrations can be minimized by adding a pulsation dampener in the inlet piping between the remote inlet filter(s) and the compressor.

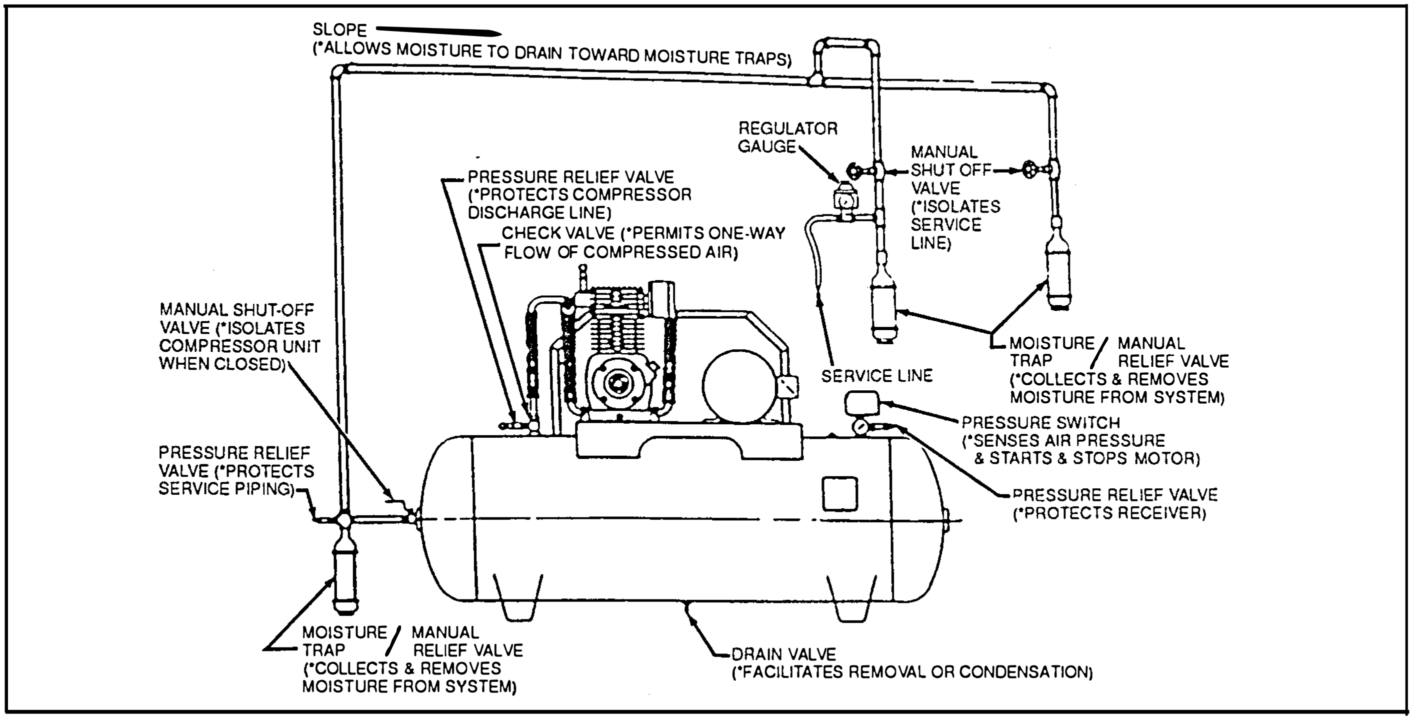
If the Intake is piped to outside atmosphere, a hooded filter should be installed to prevent water or snow from being ingested into the compressor.

All inlet piping should be at least the same size (or larger) in diameter as the inlet connection to the compressor. For every 10 feet of inlet piping or every 90° bend, increase the inlet piping diameter by one pipe size. The inlet piping must be thoroughly clean inside. Remove all weld slag, rust or dirt. Galvanized pipe with threaded or flanged fittings is preferred.

CAUTION!

Never locate the compressor air inlet system where toxic, volatile or corrosive vapors, air temperatures exceeding 104°F., water, or extremely dirty air could be ingested. These types of atmospheres could adversely affect the performance of the compressor system.

COMPRESSED AIR DISCHARGE SYSTEM



Typical Drop Leg & Component Location

The discharge piping should be of the same diameter as the compressor discharge connection, or sized so that the pressure drop at any point in the system does not exceed 10% of the air receiver pressure. Install auxiliary air receivers near heavy loads or at the far end of a long system. This will insure sufficient pressure if the use is intermittent, or sudden large demands are placed on the system.

Discharge piping should slope to a drop leg (refer to **TYPICAL DROP LEG & COMPONENT LOCATION**) or moisture trap to provide a collection point where moisture can be easily removed. All service line outlets should be installed above the moisture traps to prevent moisture from entering the tool or device using the air. Manual shutoff valves, protected by pressure relief valves, should be installed at all service line outlets to eliminate leakage while the tools are not in use.

As with any piping, all parts of the discharge piping should fit so as not to create any stress between the piping and components.

WARNING!

Never join pipes or fittings with lead-tin soldering. Welded or threaded steel pipes and cast iron fittings, designed for the pressures and temperatures, are recommended.

WARNING!

PRESSURE VESSELS
Air receiver tanks and other pressure containing vessels such as (but not limited to) pulsation bottles, heat exchangers, moisture separators and traps, shall be in accordance with ASME Boiler and Pressure Vessel Code Section VIII and ANSI B19.3 safety standards. They should be equipped with a pressure relief valve, pressure gauge, tank drain, and manual shutoff valve.

ASME coded pressure vessels must not be modified, welded, repaired, reworked or subjected to operating conditions outside the nameplate ratings. Such actions will negate code status, effect Insurance status and may cause property damage, severe Injury or even death.

Condensate must be drained from receiver daily. An automatic drain valve is recommended. Check weekly to see that the automatic drain is operating properly, see automatic receiver drain Instruction. Extend piping from receiver drain away from unit to provide safe and convenient removal of the moisture.

If the air receiver is going to be subjected to temperatures of 32°F or below, provisions must be made to guard against freezing of the pressure relief valves, pressure gauge, and moisture drain.

PRESTARTING CHECKLIST

WARNING!

Never assume a compressor is safe to work on just because It is not operating. It could restart at any time. Follow all safety precautions outlined in STOPPING FOR MAINTENANCE.

WARNING!

Failure to perform the pre-starting checklist may result in mechanical failure, property damage, serious injury or even death.

Steps 1 through 12 should be performed prior to connecting the unit to a power source.If any condition of the checklist is not satisfied, make the necessary adjustments or corrections before starting the compressor.

1. Remove all installation tools from the compressor and check for installation debris.
2. Curtis-Toledo compressors are normally shipped without lubricant in the crankcase. Before starting this compressor, add enough lubricant to the crankcase to register between the high and low marks. Use a non-detergent oil or consult the Curtis-Toledo factory for recommendations! Refer to the respective compressor operating manual to determine the correct amount and type of lubricant to use for your model and application.
3. Check motor and compressor pulleys for alignment and tightness on shaft (refer to **PULLEY ALIGNMENT & BELT TENSION**), as specified in the respective compressor installation and operation instruction manual.
4. Manually rotate the compressor pulley several rotations to be sure there are no mechanical interferences.
5. Check inlet piping installation.
6. Check belt tension. (Refer to **PULLEY ALIGNMENT & BELT TENSION**.) Refer to the respective compressor installation and operating instruction manual.
7. Check all pressure connections for tightness.
8. Make sure all pressure relief valves are correctly installed.
9. Be sure all guards are in place and securely mounted.
10. Check fuses, circuit breakers, and thermal overloads for proper size. (Refer to **ELECTRICAL SUPPLY REQUIREMENTS**.)
11. Open all manual shutoff valves at and beyond the compressor discharge.
12. After all the above conditions have been satisfied, the unit can be connected to the proper power source.
13. Jog the starter switch to check the rotational direction of the compressor. It should agree with the rotation arrow on the compressor pulley.
14. Check for proper rotation of the cylinder cooling fan (fins inside pulley). The fan should blow cooling air across the cylinder.

INITIAL STARTING & OPERATING

This instruction manual, as well as any instructions supplied by manufacturers of supporting equipment, should be read and understood prior to starting the compressor. If there are any questions regarding any part of the instructions, please call your local Curtis-Toledo Distributor, or the Curtis-Toledo factory, (314) 383-1300 ext. 285.

With the pre-starting checklist completed and satisfied, start the compressor. Watch and listen for excessive vibration and strange noises. If either exist, stop the compressor, look for and correct the problem before re-starting.

Torque cylinder to head capscrews, refer to torque specifications in the respective compressor installation and operating instruction manual. Then, run the compressor for at least 30 minutes. Shut the unit off and follow precautions outlined in **STOPPING FOR MAINTENANCE**. Retorque the head capscrews to the same specifications while the unit is still hot.

Observe compressor operation closely for the first hour of operation and then frequently for the next seven hours. After the first eight hours, monitor the compressor at least once every eight hours. If any abnormal conditions are witnessed, stop the compressor and correct the problem. After two days of operation check belt tension, oil level, and inspect the system for leaks.

DAILY STARTING CHECKLIST

WARNING!

Do not proceed until the PRE-STARTING CHECKLIST and INITIAL STARTING & OPERATING sub-sections have been read and are thoroughly understood.

1. Check oil level in crankcase.
2. Drain liquid from the air receiver and moisture trap (if so equipped).
3. Jog the starter button and check compressor rotations.
4. Start compressor per factory instructions; refer to the respective compressor installation and operating instruction manual.
5. Check system pressure. Do not operate the compressor in excess of the A.S.M.E. pressure vessel rating for the receiver or the service rating of the compressor, whichever is lower. Refer to the respective compressor installation and operating instruction manual.
6. Check cooling fan rotation. Fan blades of the compressor flywheel force ambient air across fins of the intercooler and cylinder heads.
7. Check all pressure relief valves for proper operation.
8. Check control system for proper operation.

STOPPING FOR MAINTENANCE

The following procedures should be followed when stopping the compressor for maintenance or service.

WARNING!

Never assume a compressor is safe to work on just because it is not operating. It could start at any time.

1. Per O.S.H.A. regulation 1910.147: The Control of Hazardous Energy Source (Lockout/Tagout), disconnect and lockout the main power source. Display a sign in clear view at the main power switch that the compressor is being serviced.
2. Isolate the compressor from the compressed air supply by closing a manual shutoff valve upstream and downstream from the compressor. Display a sign in clear view at the shutoff valve stating that the compressor is being serviced.
3. Lock open a pressure relief valve within the pressurized system to allow the system to be completely de-pressurized. **NEVER** remove a plug to relieve the pressure!
4. Open all manual drain valves within the area to be serviced.
5. Wait for the unit to cool before starting to service. (Temperatures of 125°F can burn skin. Some surface temperatures exceed 350°F when the compressor is operating.)

SERVICING VALVES

Compressor valve plates and valves should be inspected and cleaned on a regular basis. The valves are made of stainless steel and can be cleaned with a stiff bristle brush (not a wire brush!). A clean safety solvent may also be used to loosen carbon deposits on the valve plates and valves. Handle all parts with care; do not bend, mar or scratch any sealing surfaces.

WARNING!

Never use gasoline, thinners, or other flammable solutions to clean valves or related parts.

Always replace gaskets with-new ones when servicing the valves. Check to be sure the valves are seated perfectly flat against the sealing surface around each port. Damaged or improperly seated valves will cause lower than normal discharge pressure, excessive heat, and carbon build up.

MAINTENANCE SCHEDULE

To assure maximum performance and service life of your compressor, a routine maintenance schedule should be developed. A sample schedule has been included here to help you develop a maintenance schedule designed for your particular application. Time frames may need to be shortened in harsher environments.

The envelope shipped with the compressor contains a manual for the respective compressor model which includes a preventative maintenance checklist. Make copies of this checklist and retain the master to make more copies as needed. On a copy of the checklist, enter dates and maintenance person's initials in the appropriate spaces. Keep the checklist and this Instruction Manual readily available near the compressor.

EVERY 8 HOURS (OR DAILY)

- Maintain oil level between high and low level marks. (Discoloration or a higher oil level reading may indicate the presence of condensed liquids.) Drain and replace.
- Drain drop legs and traps in air distribution system.
- Give compressor an overall visual inspection and be sure safety guards are in place.
- Check for unusual noise or vibration.
- Check for oil leaks.

EVERY 40 HOURS (OR WEEKLY)

- Manually operate the pressure relief valves to be certain they are working.
- Clean the cooling surfaces of the intercooler and compressor.
- Check the compressor for air leaks.
- Check the compressor air distribution system for leaks.
- Inspect oil for contamination. Change more often under humid or dirty conditions.

EVERY 160 HOURS (OR MONTHLY)

- Check belt tension.
- Torque pulley clamp screws or jamnut.

EVERY 1000 HOURS (OR EVERY 3 MONTHS)

- Change oil (more frequently in harsher environments).

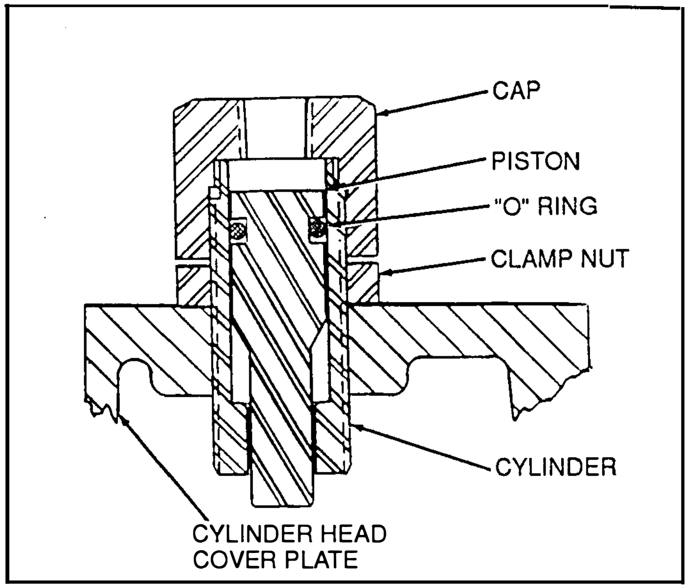
EVERY 1000 HOURS (OR EVERY 6 MONTHS)

- Inspect compressor valves for leakage and/or carbon build-up.
- Inspect piston unloader assembly, clean and repair as necessary. Refer to LV-473 herewith included.

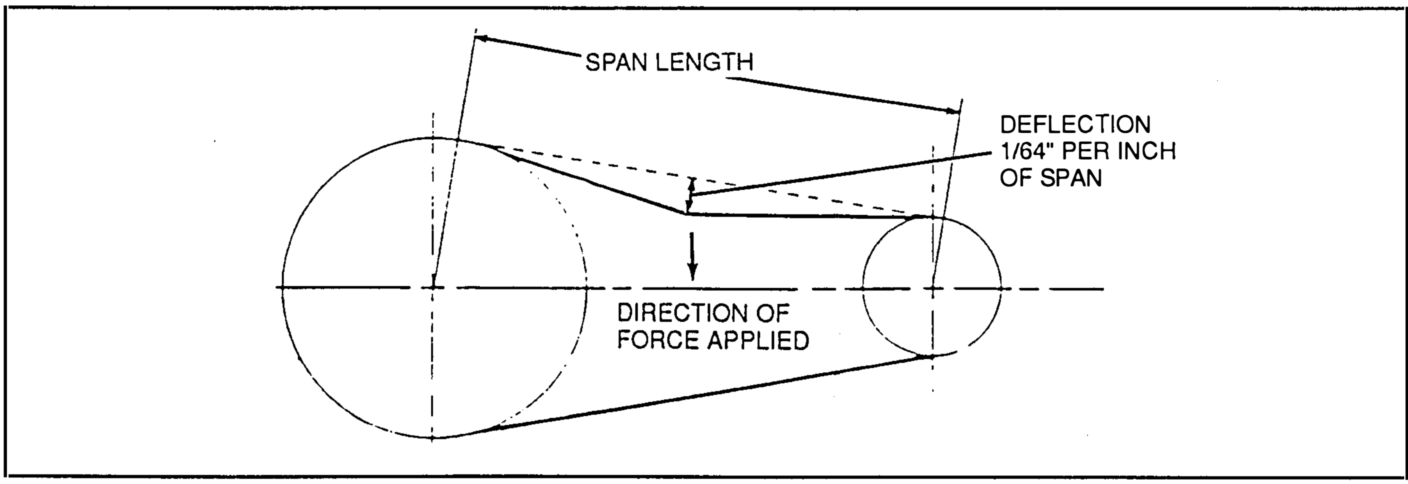
PISTON UNLOADER ASSEMBLY INSPECTION & MAINENANCE

1. Remove unloader cap and unloader piston only.
2. Inspect "O" Ring for deterioration or cracking, replace as required (refer to Parts List).
3. Inspect for contamination and corrosion on unloader piston and unloader cylinder I.D. Clean or replace as required.
4. Lubricate piston "O" Ring and cylinder I.D. with Lithium High Temperature Grease (thin coating). Reassemble piston and cap.
5. If unloader piston and cylinder are both removed, unloader adjustment will be required after reassembly.

Note: Air to unloader shall be free of moisture and contamination. If necessary, a filter addition is required.



PULLEY ALIGNMENT & BELT TENSION



Setting Belt Tension

Improper pulley alignment and belt tension are causes for motor overloading, excessive vibration and premature belt and/or bearing failure. To prevent this from happening, check the pulley alignment and belt tension on a regular basis.

At this time, inspect both the motor and compressor pulleys for oil, grease, nicks or burrs. Clean or replace pulleys if necessary. Make sure the pulleys are securely fastened. Align the compressor pulley with the motor or engine pulley. Drive belt grooves of both pulleys should be in line with each other.

Belt tension should be measured and adjusted to provide smooth operation. Step-by-step procedures are provided here to correctly measure and set the drive belt tension:

1. Measure the span length of the drive. (Refer to **MAINTENANCE SCHEDULE.**) See instructions in the respective model manual.
2. Determine the amount of deflection (in inches) required to measure deflection force (in pounds) by multiplying the span length x 1/64 (i.e. 32" span length x 1/64 = 1/2" of deflection required to measure deflection force).
3. Lay a straightedge across the top outer surface of a drive belt from pulley to pulley.
4. At the center of the span, perpendicular to the belt, apply pressure to the outer surface of the belt with a belt tension gauge. Force the belt to the predetermined deflection (refer to Step 2). Record the reading on the belt tension gauge and compare to the chart. The deflection force

reading should be within the minimum and maximum values shown. Adjust belt(s) accordingly. A new belt (or new belt set) should be initially tensioned 1/3 greater than the maximum valve.

5. Recheck the tension of the new belts several times in the first 50 hours of operation and adjust if necessary. Thereafter, check belt tension on a regular basis.

TROUBLESHOOTING

Trouble	Probable Cause
Low discharge pressure	• Restricted inlet • Defective compressor valves • Leaks in the compressed air distribution system at fittings, connections, etc. • Pressure switch defective or set wrong • Drive belt slipping • Incorrect speed • Worn piston rings or loose piston • Leaking head gasket • Drain valve open • Defective pressure gauge • Pressure relief valve leaking • Clogged intercooler • Loose compressor valves or leaking at valve gaskets • Compressor incorrectly sized for the altitude at the operating location • Piston rings not seated; allow 100 hour at full pressure
Water in the crankcase (lubricant appears milky)	• Compressor does not run long enough to get hot and vaporize the liquids squeezed out of the air during compression • Incorrect or inferior grade of lubricant • System pressure leaking back through discharge valve
Rusty valves and/or cylinders	• Compressor operated too infrequently • Compressor does not run long enough to get hot and vaporize the liquids squeezed out of the air during compression (compressor may be too large for application) • Compressor not properly prepared for storage • Discharge line from compressor head is pointed upward allowing condensation to drain back at shutdown

TROUBLESHOOTING (cont.)

Trouble	Probable Cause
Excessive vibration	• Incorrect speed • Compressor valves not functioning properly • Loose pulley • Motor or engine out of balance • Compressor, motor or engine not secured tightly, or tightened into a bind • Foundation or frame inadequate • Piping inadequately supported or tightened into a bind • Excessive discharge pressure • Compressor feet may need to be leveled with shims
Excessive drive belt wear	• Pulleys out of alignment • Belt too loose or too tight • Belt slipping • Pulley wobbling • Pulley groove damaged or rough • Incorrect belts
Compressor overheats	• Clogged intake system • Defective compressor valves • Pressure setting too high • Clogged intercooler, internally or externally • Inadequate ventilation, or recirculation of hot air • Pulley rotation wrong • Incorrect speed • Running clearances insufficient (piston to cylinder wall or running gear) • Lubrication inadequate • Compressor incorrectly sized
High discharge temperature	• Compressor valve assemblies defective • Discharge pressure too high • Inadequate ventilation or hot air recirculating • Cooling surfaces of compressor or intercooler excessively dirty • Internal surface of heat exchanger fouled • Ambient temperature too high • Scored or excessively worn cylinder walls

TROUBLESHOOTING (cont.)

Trouble	Probable Cause
Compressor knocks	• Head clearance insufficient • Piston loose in cylinder bore, cylinder bore worn, piston or piston rings worn • Worn rods • Wrong pressure setting, discharge pressure excessive • Crankcase lubrication inadequate • Loose pulley • Compressor valve assemblies loose
Excessive oil consumption	• Worn piston rings • Restricted intake system • Compressor running too hot • Breather valve not functioning properly • Oil level in crankcase too high • Oil viscosity wrong for the application • Connecting rod out of alignment, bent or twisted • Leaking oil seal • Piston rings not seated (allow 100 hours for seating) • Wrong oil (may be a detergent oil with a tendency to foam) • Inferior grade of oil
Excessive current draw (To determine maximum amperage allowed, multiply the FLA on the motor nameplate by the service factor.) **CAUTION!** **Motor surface temperature normally exceeds 170°F.**	• Low voltage (must be within 10% of nameplate voltage) • Loose electrical connection • Wire size too small • Incorrect oil • Discharge pressure too high • Intercooler plugging • Bearings tight or seizing • No crankshaft endplay • Motor sized incorrectly • Motor defective • Drive belts too tight

TROUBLESHOOTING (cont.)

Trouble	Probable Cause
Compressor knocks	• Head clearance insufficient • Piston loose in cylinder bore, cylinder bore worn, piston or piston rings worn • Worn rods • Wrong pressure setting, discharge pressure excessive • Crankcase lubrication inadequate • Loose pulley • Compressor valve assemblies loose
Excessive oil consumption	• Worn piston rings • Restricted intake system • Compressor running too hot • Breather valve not functioning properly • Oil level in crankcase too high • Oil viscosity wrong for the application • Connecting rod out of alignment, bent or twisted • Leaking oil seal • Piston rings not seated (allow 100 hours for seating) • Wrong oil (may be a detergent oil with a tendency to foam) • Inferior grade of oil
Excessive current draw (To determine maximum amperage allowed, multiply the FLA on the motor nameplate by the service factor.) **CAUTION!** **Motor surface temperature normally exceeds 170°F.**	• Low voltage (must be within 10% of nameplate voltage) • Loose electrical connection • Wire size too small • Incorrect oil • Discharge pressure too high • Intercooler plugging • Bearings tight or seizing • No crankshaft endplay • Motor sized incorrectly • Motor defective • Drive belts too tight

TROUBLESHOOTING (cont.)

Trouble	Probable Cause
Failure to start	• Power not on • Blown circuit fuse • Thermal overload fuses tripped • Low voltage • Faulty start switch • Power failure • Pressure switch incorrectly adjusted or faulty • Loose or broken wire • Motor defective • Compressor seized
Motor stalls	• Motor overloaded (refer to Excessive current draw)

CURTIS-TOLEDO, INC.

1905 Kienlen Avenue, St. Louis, Missouri 63133
(314) 383-1300
FAX (314) 381-1439 TELEX 44-7610

NORGREN

Régulateur u usage général
R74★ - ★★★ - ★★★

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et d'entretien
AM-246

Type	Port	Filatage	Type de soupape	Ressort (plage de réglage de pression de sortie)*
G ..Usage général	3...3/8"	A... PTF (1/4 sorties de jauge PTF)	R ..soupape de dépression	F...0,3 à 4 bar (5 à 60 psig)
R ..Usage général, débit inverse	4...1/2"	B ..ISO incliné Rc (1/4 sorties de jauge ISO R_c)	N ..autre type desoupape	M..0,3 à 10 bar (5 à 150 psig)
	6...3/4"	G ..ISO parallèle G (1/8 sorties de jauge ISO R_c)		S ..0,7 à 16 bar (10 à 250 psig)

* N'utilisez pas ces régulateurs pour contrôler des pressions en dehors des plages spécifiées.

SPECIFICATIONS
Liquide: air comprimé.
Pression d'entrée maximale: 300 psig (20.7 bar)
Plage de température:-18°C à 79°C (0 à 175 F).
L'air d'alimentation doit être suffisamment sec pour éviter la formation de glace à des températures inférieures à 2° C (35°F).

MATERIAUX DE CONSTRUCTION
Corps: Aluminium
Couvercle: Aluminium
Soupape: Laiton
Elastomères: Nitrile
Bouchon inférieur : Acétal

PIECES DE RECHANGE
Kit d'entretien (13, 15, 16, 17, 18)
Régulateurs de dépression 4381-700
Régulateurs d'autre type 4381-701
Couvercle protecteur anti-manipulations (bouton de réglage seulement) 4355-51

DIMENSIONS POUR LE MONTAGE DES PANNEAUX
Diamètre des orifices de montage des panneaux: 52mm (2.06")
Epaisseur des panneaux: 2 à 6 mm (0,06" à 0,25")

INSTALLATION
1. Installez le régulateur dans la conduite d'air à tout angle -
   - R74G - en aval des soupapes de contrôle de cycles,
   - R74R - en amont ou en aval des soupapes de contrôle de cycle,
   - avec débit d'air en direction de la flèche indiquée sur le corps,
   - aussi près que possible de l'appareil à lubrifier.
2. Branchez les tubes sur les ports appropriés en utilisant de la pâte isolante pour pas de vis sur les filets mâles uniquement. Evitez de mettre de la pâte à l'intérieur du lubrificateur.
3. Installez une jauge de pression ou bouchez les sorties de jauge. Les sorties de jauge peuvent aussi être utilisées comme sorties supplémentaires pour air régulé.
4. Installez un filtre en amont du régulateur.

REGLAGE
1. Tournez le bouton de réglage dans le sens des aiguilles d'une montre pour augmenter la pression. Tournez dans le sens inverse pour diminuer la pression.
2. Approchez toujours la pression désirée à partir d'une pression inférieure. Lors d'une diminution d'une pression haute vers une pression basse, réduisez d'abord à une pression inférieure à celle souhaitée et élevez ensuite à la pression souhaitée.
3. REGLAGE DE BOUTON. Déplacez le bouton vers le bas pour verrouiller le réglage de pression. Déplacez le bouton vers le haut pour déverrouiller. Installez un couvercle de protection contre les manipulations (reportez-vous à la section Pièces de rechange) pour protéger le réglage.
4. REGLAGE DE LA POIGNEE EN T. Serrez l'écrou de blocage (8) pour verrouiller le réglage de pression.

DEMONTAGE
1. Fermez la pression d'alimentation. Réduisez la pression d'alimentation et de sortie à zéro. Tournez le bouton de réglage (1 ou 7) complètement dans le sens inverse des aiguilles d'une montre.
2. Le régulateur peut être désassemblé sans qu'il ne soit nécessaire de le déposer de la conduite d'air. Désassemblez de la manière illustrée sur la vue explosée.

NETTOYAGE
1. Nettoyez les pièces à l'eau tiède savonneuse.
2. Faites sécher les pièces. Séchez les conduits internes avec de l'air comprimé propre et sec.
3. Vérifiez les pièces. Remplacez les pièces qui se révèlent endommagées.

MONTAGE
1. Lubrifiez les joints toriques, la tige de soupape (17), l'extrémité de la vis de réglage (7), et les circonférences extérieures et les deux côtés de la rondelle de blocage (4) avec de la graisse à joints toriques.
2. Montez le régulateur ainsi qu'indiqué sur la vue explosée.
3. Table de couples

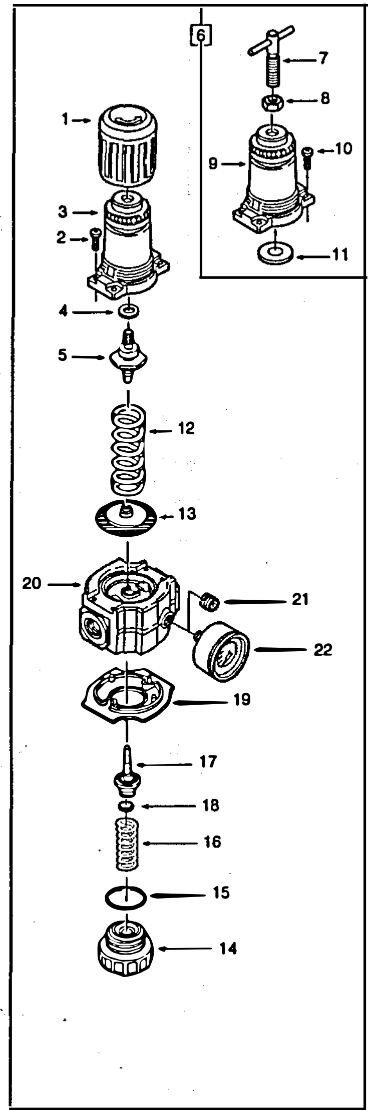
Elément	Couple en nanomètre (Pouce-livres)
2, 10 (vis)	2,8 à 3,9 (25 à 35)
14 (bouchon inférieur)	2,3 à 3,4 (20 à 30)

MISE EN GARDE
Ces produits sont conçus pour être utilisés dans des systèmes industriels à air comprimé. N'utilisez pas ces produits lorsque les pressions et températures dépassent celles qui sont indiquées dans la rubrique SPECIFICATIONS.

Si une pression de sortie dépassant le réglage de pression du filtre/régulateur peut provoquer une rupture ou une défaillance des appareils situés en aval, installez une soupape de dépression en aval du filtre/régulateur. La pression de décharge et la capacité de débit de la soupape de dépression doivent satisfaire les exigences du système.

La précision des indications des jauges de pression peut changer à la fois lors de l'expédition (malgré une mise en boîte soignée) et pendant la durée d'utilisation. Si une jauge de pression doit être utilisée avec ces appareils et si des indications erronées peuvent affecter la sécurité du personnel ou de toute propriété, la jauge devra être calibrée avant d'être installée et à des intervalles réguliers par la suite. En ce qui concerne les normes de jauges, veuillez vous reporter aux normes ANSI 840.8

Veuillez consulter Norgren avant d'utiliser ces produits avec des liquides autres que de l'air, dans le cas d'applications non industrielles, ou dans le cas d'applications de support vital.



NORGREN

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R74★ - ★★★ - ★★★
AM-246

Tipo	Puerto	Tipo De Rosca	Tipo De Diafragma	Resorte (Rango De Ajuste)*
G ..Uso general	3...3/8"	A ..PTF(1/4 PTF puertos para manometro)	R ..Con relieve	F...5 A 60 psig (0.3 a 4 bar)
R Uso general, flujo inverso	4...1/2"	B ..ISO R_c conica (1/4 ISO R_c puertos para manometro)	N ..Sin relieve	M..5 A 150 psig (0.3 a 10 bar)
	6...3/4"	G ..ISO G paralela (1/8 ISO R_c puertos para manometro)		S ..10 A 250 psig (0.7 a 17.2 bar)

* No usar estos reguladores para controlar presiones fuera de los rangos especificados.

ESPECIFICACIONES
Fluido: Aire comprimido
Presion maxima de entrada: 300 psig (20.7 bar)
Rangos de temperatura: 0 a 175°F (-18° a +79°C)
El suministro de aire debera ser lo suficientemente seco para evitar la formacion de hielo a temperaturas por debajo de 35°F (2°C)

MATERIALES DE CONSTRUCCION
Cuerop: Aluminio
Bonet: Aluminio
Valvua: Bronce
Elastomeros: Nitrilo
Tapón Inferior: Acetal

PARTES DE REEMPLAZO
Kit de servicio (13,15,16,17,18,)
Regulador con relieve 4381-700
Regulador sin relieve............................4381-701
Cable sellador de seguridad (Solo para perilla de ajuste)......................................4355-51

DIMENSIONES PARA MONTAJE EN PANEL
Diametro para orificio de montaje: 2.06" (52mm)
Espesor de montaje para panel: 0.06" a 0.25" (2 a 6 mm)

INSTALACION
1. Instale el regulador en la línea de aire en cualquier ángulo -
   - R74G - antes de valvulas de operacoin ciclica.
   - R74R - antes o después de las válvulas cíclicas
   - Siga la direccion de la flecha sobre el cuerpo.
   - Tan cerca como sea posible del dispositivo en servicio.
2. Conecte la tuberia utilizando sellador para cuerdas, soso sobre las cuerdas macho. No permita que el sellador entre a la unidad.
3. Instale un manometro de presion o bien un tapon en los puertos, estos puedden ser usados como salidas auxiliares de presion regulada.
4. Instale un filtro antes del regulador.

AJUSTE
1. Gire de Izquierda a derecha para aumentar la presion y de derecha a izquierda para reducirla.
2. Ajuste siempre la presion desde un rango menor al deseado. Cuando ajuste la presion desde un rango mayor, reduscala a un rango menor al deseado, entonces aumente la presion hasta el rango adecuado a la aplicacion.
3. PERILLA DE AJUSTE. Presione la perilla hacia abajo para asegurar el rango de ajuste. Jalela para liberarla. Instale un cable sellador de seguridad (Vea Partes de Reemplazo) para evitar desajustes.
4. MANIJA DE AJUSTE TIPO T. Apriete la contratuerca para asegurar el rango de ajuste.

DESENSAMBLE
1. Cierre la presion de entrada. reduzca la presion de las lineas de entrada y salida a cero. Gire la perilla de ajuste de derecha a izquierda pro completo (1 a 7 vueltas).
2. Los reguladores pueden ser desensamblados sin removerlos de la línea de aire. Desensamble como se muestra en la vista esquemática.

LIMPIEZA
1. Limpie las partes con agua tibia y jabón.
2. Seque las partes. Sopletee los pasajes internos del cuerpo con aire limpio y seco.
3. Inspeccione las partes y reemplace aquellas que se encuentren deterioradas.

ENSAMBLE
1. Lubrique los empaques,vastago de la válvula (17), la punta del tornillo de ajuste (7), la circunferencia exterior y ambos lados de la arandela (4) con grasa.
2. Ensamble el regulador como se muestra en el diagrama de despiece.
3. Tabla de torques

Articulo	Torque en Libras-Pulgada (Nm)
2,10 (tornillo)	25 a 35 (2.8 a 3.9)
14 (Tapón inferior)	20 to 30 (2.3 a 3.4)

ADVERTENCIA
Estos productos son manufacturados solo para ser usados en sistemas de aire comprimido. No use estos productos en donde las presiones o temperaturas excedan las ***Especificaciones.***

Si la presion de salida del regulador excede la ajustada puede ocasionar al dispositivo alimentado, rupturas o falias en el funcionamiento, instale un dispositivo de alivio despues del filtro/regulador. La presion de alivio y capacidad de flujo de este dispositivo deben satisfaces las necesidades del sistema.

La exactitud de un manometro de presion puede variar ya sea en el embarque (a pesar del cuidado al empacarlo), o bien durante la vida util de servicio. Si un manometro de presion va a ser utilizado con estos productos y una lectura incorrecta puede ocasionar riezgo para el personal o al proceso, el manometro debera ser calibrado antes de su instalacion y ser revisado a intervalos regulares durante su uso. Para estandares sobre manometros, refierase a ANSI B40 S.

Antes de usar estos productos con fluidos diferentes aire comprimido,para usos no industriales o sistemas mantenedores de vida, consulte a Norgren.

NORGREN Littleton, CO USA Phone 303-794-2611 Fax 303-795-9487 IMI

NORGREN

Regulador para Aplicações Gerais

R74★ - ★★★ - ★★★

Instruções de Instalação e Manutenção

AM-246

Tipo
G..Aplicações Gerais
R..Aplicações Gerais, fluxo reverso

Orifício
3.....1/8"
4 .....1/4"
6 .... 3/4"

Rosca
A ..NPT (Orifícios para manômetros: 1/8 NPT)
B ..ISO Rc Cônica (Orifícios para manômetros: Rc 1/8)
G ..ISO G Paralela (Orifícios para manômetros: ISO Rc)

Diafragma
R ..Com alívio
N ..Sem alívio

Mola (Faixa Pressão Secundária) *
F...0.3 a 4 bar (5 a 60 psig)
M..0.3 a 10 bar (5 a 150 psig)
S ..0.7 a 16 bar (10 a 250 psig)

* Não use esses reguladores para controlar pressões fora das faixas especificadas.

ESPECIFICAÇÕES
Fluido: Ar comprimido
Máxima pressão de entrada: 20.7 bar (300 psig)
Faixa de temperatura: -18°C a 79°C
O ar deve ser seco o suficiente para evitar formação de gelo em temperaturas abaixo de 2°C.

MATERIAIS
Corpo: Alumínio
Bonnet: Alumínio
Válvula: Latão
Elastômeros: Nitrílico
Tampa inferior: Acetal

PEÇAS DE REPOSIÇÃO
Kit de Reparo (13, 15, 16, 17, 18)
Reguladores com alívio 4381-700
Reguladores sem alívio 4381-701
Tampa do parafuso de trava (somente botão de ajuste) 4355-51

DIMENSÕES PARA MONTAGEM EM PAINEL
Diâmetro orifício do painel de montagem: 52 mm
Espessura do painel: de 2 a 6 mm

INSTALAÇÃO
1. Instale o regulador na linha de ar em qualquer ângulo -
   - R74G - antes das válvulas cíclicas
   - R74R - antes ou depois das válvulas cíclicas
   - com fluxo de ar na direção da seta do corpo
   - tão próximo quanto possível do dispositivo que está sendo atendido
2. Conecte a tubulação nas roscas apropriadas usando selante somente nas roscas macho. Evite a entrada de selante no interior do regulador.
3. Adapte um manômetro ou plugue os orifícios de manômetros, os quais podem ser usados como saídas adicionais para o ar regulado.
4. Instale um filtro antes do regulador.

REGULAGEM
1. Gire no sentido horário para aumentar a pressão estabelecida. Gire no sentido anti-horário para diminuir a pressão estabelecida.
2. Sempre atinja a pressão desejada a partir de uma pressão mais baixa. Para se reduzir de uma pressão mais alta para uma inferior, primeiro reduza para um valor menor do que aquela desejada e posteriormente aumente a pressão final.
3. BOTÃO DE AJUSTE. Empurre o botão de ajuste para travar a pressão escolhida; puxe para liberar. Instale um parafuso de trava (veja *Peças de Reposição*) para fixá-lo.
4. AJUSTE DO MANÍPULO "T". Aperte a porca (8) para travar na pressão escolhida.

DESMONTAGEM
1. Desligue a pressão primária . Reduza a zero a pressão nas linhas de entrada e saída. Gire totalmente no sentido anti-horário o ajuste (1 ou 7).
2. O regulador pode ser desmontado sem removê-lo da linha de ar. Desmonte-o tal como na vista explodida.

LIMPEZA
1. Limpe as peças com água morna e sabão.
2. Seque-as, bem como as passagens internas do corpo usando ar comprimido seco e limpo.
3 Inspecione as peças. Substitua as danificadas.

MONTAGEM
1. Lubrifique os O'rings, haste da válvula (17), o parafuso de ajuste (7), a circunferência externa da arruela (4) com uma leve camada de graxa de boa qualidade.
2. Monte o regulador tal como na vista explodida.
3. Tabela de Torque

Item	Torque em N-m
2, 10 (parafuso)	2.8 a 3.9
14 (tampa inferior)	2.3 a 3.4

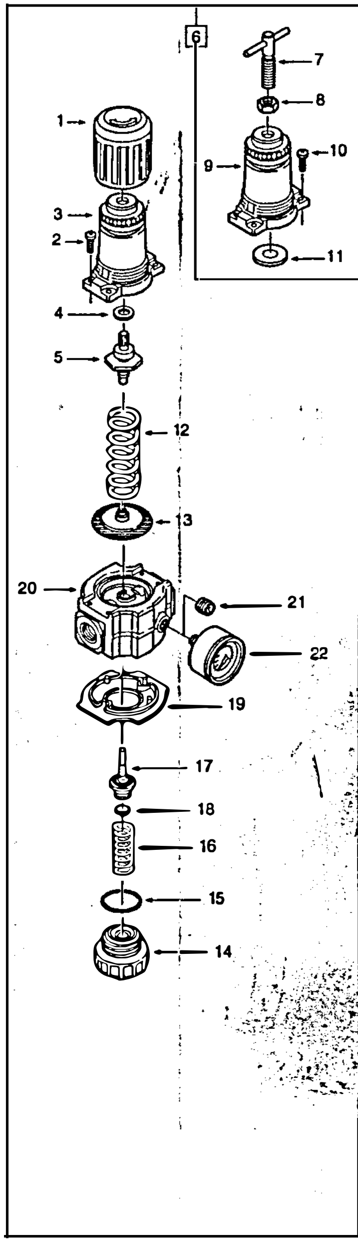
ADVERTÊNCIAS
Estes produtos devem ser usados somente em sistemas de ar comprimido industrial. Não os use onde pressões e temperaturas excedam os valores indicados nas ***Especificações.***

Se a pressão de saída for superior à estabelecida podendo causar danos ao equipamento, instale um dispositivo de alívio de pressão após o regulador, que atenda aos requisitos do sistema.

A precisão da indicação dos manômetros pode mudar, tanto durante o transporte (apesar dos cuidados na embalagem) como durante a vida útil.

Se um manômetro for usado com esses produtos e se indicações imprecisas puderem colocar em risco pessoas ou equipamentos, este deve ser calibrado antes da instalação inicial e a intervalos regulares durante o seu uso. Para manômetros standards refira-se à norma ANSI B40.1.

Antes de usar esses produtos com fluidos diferentes do especificado, para aplicações não industriais, ou para sistemas de suporte à saúde, consulte a Norgren.



NORGREN

General Purpose Regulator

R74★ - ★★★ - ★★★

Installation & Maintenance Instructions

AM-246 (4/95) Supersedes 9/94

Type
G..General purpose
R..General purpose, Reverse flow

Port
3...3/8"
4...1/2"
6...3/4"

Thread Form
A ..PTF(1/4 PTF guage ports)
B ..ISO R_c taper (1/4 ISO R_c guage ports)
G ..ISO G parallel (1/8 ISO R_c gauge ports)

Relief Type
R..Relieving
N ..Nonrelieving

Spring (Outlet pressure adjustment range) *
F...5 to 60 psig (0.3 to 4 bar)
M..5 to 150 psig (0.3 to 10 bar)
S ..10 to 250 psig (0.7 to 16 bar)

* Do not use these regulators to control pressures outside of the specified ranges.

SPECIFICATIONS
Fluid: Compressed air
Maximum inlet pressure: 300 psig (20.7 bar)
Temperature range: 0°to 175°F (-18° to 79°C). Air supply must be dry enough to avoid ice formation at temperatures below 35°F (2°C).

MATERIALS OF CONSTRUCTION
Body: Aluminum
Bonnet: Aluminum
Valve: Brass
Elastomers: Nitrile
Bottom Plug: Acetal

REPLACEMENT ITEMS
Service Kit (13, 15, 16, 17, 18)
Relieving regulators 4381-700
Nonrelieving regulators 4381-701
Tamper resistant cover (knob adjustment only) 4355-51

PANEL MOUNTING DIMENSIONS
Panel mounting hole diameter: 2.06" (52mm)
Panel thickness: 0.06" to 0.25" (2 to 6 mm)

INSTALLATION
1. Install regulator in air line at any angle -
   - R74G - upstream of cycling valves,
   - R74R - upstream or downstream of cycling valves,
   - with air flow in direction of arrow on body,
   - as close as possible to the device being serviced.
2. Connect piping to proper ports using pipe thread sealant on male threads only. Do not allow sealant to enter interior of regulator.
3. Install a pressure gauge or plug the gauge ports. Gauge ports can also be used as additional outlets for regulated air.
4. Install a filter upstream of the regulator.

ADJUSTMENT
1. Turn adjustment clockwise to increase pressure setting. Turn adjustment counterclockwise to decrease pressure setting.
2. Always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired pressure.
3. KNOB ADJUSTMENT. Push knob down to lock pressure setting. Pull knob up to release. Install tamper resistant cover (see ***Replacement items***) to make setting tamper resistant.
4. T-HANDLE ADJUSTMENT. Tighten jam nut (8) to lock pressure setting.

DISASSEMBLY
1. Shut off inlet pressure. Reduce pressure in inlet and outlet lines to zero. Turn adjustment (1 or 7) fully counterclockwise.
2. Regulator can be disassembled without removal from air line. Disassemble as shown on the exploded view.

CLEANING
1. Clean parts with warm water and soap.
2. Rinse and dry parts. Blow out internal passages in body with clean, dry compressed air.
3. Inspect parts. Replace those found to be damaged.

ASSEMBLY
1. Lubricate o-rings, valve stem (17), tip of adjusting screw (7), and the outer circumference and both sides of the thrust washer (4) with a light coat of good quality o-ring grease.
2. Assemble the regulator as shown on the exploded view.
3. Torque Table

Item	Torque in Inch-Pounds (N-m)
2, 10 (Screw)	25 to 35 (2.8 to 3.9)
14 (Bottom plug)	20 to 30 (2.3 to 3.4)

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 ***Specifications.***

If outlet pressure in excess of the regulator pressure setting could cause downstream equipment to rupture or malfunction, install a pressure relief device downstream of the regulator. The relief pressure and flow capacity of the relief device must satisfy system requirements.

The accuracy of the indication of pressure gauges can change, both during shipment (despite care in packaging) and during the service life. If a pressure gauge is to be used with these products and if inaccurate indications may be hazardous to personnel or property, the gauge should be calibrated before initial installation and at regular intervals during use. For gauge standards refer to ANSI B40.1.

Before using these products with fluids other than air, for nonindustrial applications, or for life-support systems consult Norgren.

7610.479.9 1/95

HANKiSON®

Instruction Manual
DH Series

PRESSURE-SWING DESICCANT TYPE COMPRESSED AIR DRYERS

GENERAL SAFETY INFORMATION

1. **Pressurized devices:** This equipment is a pressure containing device. Do not exceed maximum operating pressure as shown on equipment serial number tag. Make sure equipment is depressurized before working on or disassembling it for service.
2. **Electrical:** This equipment requires electricity to operate. Install equipment in compliance with national and local electrical codes. Standard equipment is supplied with NEMA 1 electrical enclosures and is not intended for installation in hazardous environments. Disconnect power supply to equipment when performing any electrical service work.
3. **Breathing Air:** Air treated by this equipment may not be suitable for breathing without further purification. Refer to OSHA standard 1910.134 for the requirements for breathing quality air.

IMPORTANT:
READ PRIOR TO STARTING THIS EQUIPMENT

A. *UNPACKING*

This shipment has been thoroughly checked, packed and inspected before leaving our plant. It was received in good condition by the carrier and was so acknowledged.

1. Check for Visible Loss or Damage. If this shipment shows evidence of loss or damage at time of delivery to you, insist that a notation of this loss or damage be made on the delivery receipt by the carrier's agent.
2. Check for Concealed Loss or Damage. When a shipment has been delivered to you in apparent good order, but concealed damage is found upon unpacking, notify the carrier immediately and insist on his agent inspecting the shipment. Fifteen days from receipt of shipment is the maximum time limit for requesting such inspection. Concealed damage claims are not our responsibility as our terms are F.O.B. point of shipment.

B. *MOVING CAUTION:*

Do not lift by piping. Use lifting lugs or fork lift.

MODEL	RATED FLOW	DESIGNATED AS MODELS
DH-25 DH-45 DH-60	25 SCFM 45 SCFM 60 SCFM	25 45 60
DH-80 DH-115 DH-165	80 SCFM 115 SCFM 165 SCFM	80 115 165
DH-260 DH-370 DH-450	260 SCFM 370 SCFM 450 SCFM	260 370 450
DH-590 DH-750 DH-930	590 SCFM 750 SCFM 930 SCFM	590 750 930
DH-1130 DH-1350 DH-1550	1130 SCFM 1350 SCFM 1550 SCFM	1130 1350 1550
DH-2100 DH-3000 DH-4100 DH-5400	2100 SCFM 3000 SCFM 4100 SCFM 5400 SCFM	2100 3000 4100 5400

FOR SERVICE INFORMATION CALL (412) 746-1100

HANKiSON INTERNATIONAL

CONTENTS

NOTE

Supplemental instructions for units supplied with the optional Automatic Purge Saving System are shown in italics.

MINI INSTRUCTIONS

For complete instructions on installation, operation, and maintenance, consult manual.

I. INSTALLATION

1. Install on level surface.
2. Ambient temperature range: 35 to 120°F (1.7 to 49°C) [if low ambient package supplied: -10 to 120°F (-23 to 49°C)]
3. Install purge mufflers if shipped separately.
4. Connect air from compressor to inlet.
   - Maximum compressed air temperature: 120°F (49°C)
   - Maximum compressed air pressure: Refer to serial number tag.
   - Minimum compressed air pressure: See section 2.2.1.2 .
5. Connect outlet to air system.
6. Refer to serial number tag for correct voltage. Connect to terminal strip in electrical enclosure. Standard units: connect wires to L1 and L2, and ground screw. *Automatic purge saving system: connect wires to positions 2 and 3; ground to position 1.*

II. START UP

1. Set or verify control board settings. See page 10.
2. SLOWLY pressurize unit.
3. Energize dryer by turning on/off switch on.
4. Adjust purge air flow rate. Turn purge rate valve until Purge Pressure Gauge reads as shown in following table.
   NOTE: One tower must be purging when setting purge pressure.

150 psig M.W.P. models

INLET PRESSURE (psig)		60-100	110	120	130	140	150
CYCLE TIME JUMPER SETTING	10 Min.	45	43	41	39	37	36
	4 Min.	70	66	63	60	58	56

250 psig M.W.P. models

INLET PRESSURE (psig)		125	130	135	140	145	150	175	200	225	250
CYCLE TIME JUMPER SETTING	10 Min.	91	87	84	81	78	75	64	55	48	43
	4 Min.	—	—	—	—	—	132	113	99	88	78

III. OPERATIONAL CHECKPOINTS

1. **POWER ON LIGHT -** Power on light is illuminated.
2. **MOISTURE INDICATOR -** Indicator should be green (Allow 4 hours after start up for indicator to turn green).
3. **TOWER PRESSURE GAUGES -**
   - Tower on line should read line pressure
   - Tower off line should read 2 psig or less while purging. If pressure exceeds 2 psig replace purge muffler elements.
     NOTE: An extra set of elements is shipped with dryer.
4. **PURGE PRESSURE GAUGE -** Verify proper setting.
5. **ON DRYERS SO EQUIPPED, CHECK FOR ALARM CONDITION.**

IV. DEPRESSURIZATION

Isolate dryer. Run timer until both tower pressure gauges read 0 psig.

1.0 DESCRIPTION

1.1 Function

1.1.1 Dryer Dual tower regenerative desiccant dryers are an economical and reliable way to dry compressed air to dew points below the freezing point of water (dew points as low as -150°F [1 ppb @ 100 psig] are possible) or reduce the moisture content of compressed air when used in critical process applications.

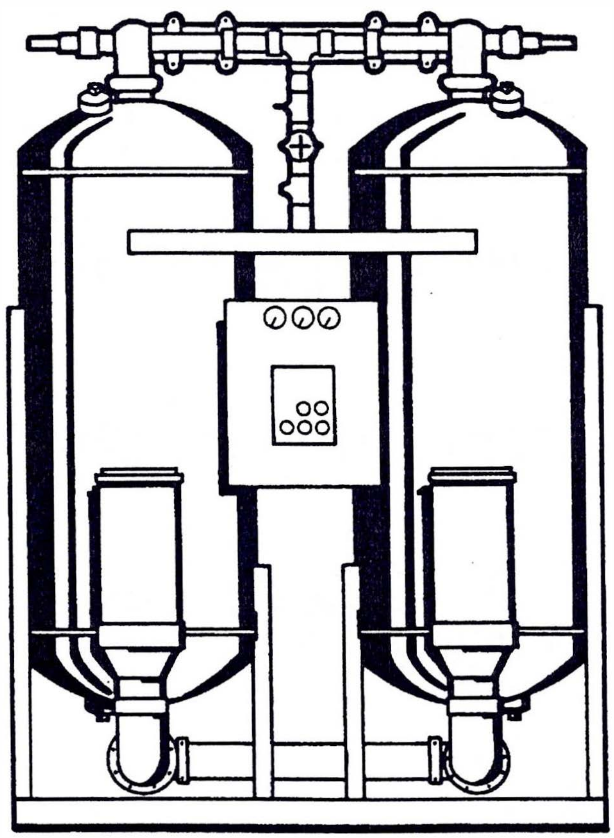
These dryers continuously dry compressed air by using two identical towers, each containing a desiccant bed. While one tower is on-stream drying the compressed air, the other tower is off-stream being regenerated (reactivated, i.e., dried out). The towers are alternated on- and off-stream so that dry desiccant is always in contact with the wet compressed air. In this way a continuous supply of dry air downstream is possible.

Desiccant dryers lower the dew point of compressed air by adsorbing the water vapor present in the compressed air onto the surface of the desiccant. Desiccant is a highly porous solid containing extensive surface area.

Adsorption occurs until the partial pressure of the water vapor in the air and that on the surface of the desiccant come into equilibrium. As adsorption occurs, heat is released (referred to as the heat of adsorption) and is stored in the bed for use during regeneration.

Desiccant is regenerated by driving off (desorbing) the water collected on its surface. Pressure-swing (also called heatless or heaterless because no outside heat is added) dryers regenerate by expanding a portion (approximately 14 - 15% at 100 psig) of the dried air to atmospheric pressure. This "swing in pressure" causes the expanded air to become very dry (have a very low vapor pressure). This very dry air (called purge air) plus the stored heat of adsorption allows the moisture to desorb from the desiccant. The purge air then carries the desorbed water out of the dryer.

1.1.2 Optional Automatic Purge Saving System
The Automatic Purge Saving System is designed to save energy (purge air) when pressure-swing dryers are operated at reduced loads.
The patented Purge Saving System operates by monitoring the changes in temperature within the desiccant beds. These changes in temperature are the result of heat (thermal energy) that is released when a bed is on-line drying (heat of adsorption), and the heat that is used when a bed is off-line being regenerated (heat of desorption).
The magnitude of these changes in temperature is an indirect measure of the water vapor content in the air being dried. This information is used to determine the time a tower stays on line during the drying cycle.



1.2 Operation

1.2.1 Dryer *(Refer to Figure 1A.)*

Compressed air flows through inlet switching valve (**3A**) to tower (**4A**) where the air is dried. After the air is dried it flows through check valve (**5A**) and then to the dryer outlet.

A portion of the dry air, the purge stream, branches off from the main air stream prior to the outlet. The purge stream flow rate is controlled by the adjustable purge rate valve (**6**) and the purge orifice (**7**).

The purge flow, which has been throttled to near atmospheric pressure, is directed through check valve (**5D**) to tower (**4B**). As the purge flow passes over the desiccant in tower (**4B**), it removes the water vapor which was deposited there while the tower was on-line drying. The purge air then passes through purge and repressurization valve (**9B**) and purge muffler (**10B**) to the atmosphere.

The dryer operates in this configuration for a period of time depending on whether the dryer is supplied with a standard or automatic control system, and on standard control systems, the cycle time chosen (4 or 10 minutes) and the Purge Economizer Switch setting.

After this time period, purge and repressurization valve (**9B**) closes allowing tower (**4B**) to repressurize slowly. Adequate repressurization time is allowed so that tower 4B is fully repressurized before switchover. On units with the standard control system, after 2 minutes on a 4 minute cycle or 5 minutes on a 10 minute cycle, or on units with the automatic purge saving system, after the sensing system determines that the desiccant bed is loaded, air inlet switching valve (**3B**) opens and inlet switching valve (**3A**) closes. After six seconds purge and repressurization valve (**9A**) opens.

(Refer to Figure 1B.) Tower (**4B**) is now drying the main air stream while tower (**4A**) is being regenerated by the purge air stream. The operation of the inlet switching and purge and repressurization valves is sequenced by the control system located in the electrical box.

1.2.2 Optional Automatic Purge Saving System (Refer to Figure 1C)

Assume Tower A is on-line drying the air while tower B has just gone off-line to be regenerated. At the beginning of tower B's regeneration cycle a temperature measurement is made at position B1. After the tower has been regenerated, another measurement is made at B1. The drop in temperature sensed during regeneration is an indirect measure of the water vapor content of the inlet air. The Purge Saving System's microprocessor then uses this information to calculate an allowable temperature rise in the bed during the drying cycle.

When tower B goes back on-line, a temperature probe at position B2 measures the initial bed temperature at this point and then monitors the bed until the calculated temperature rise occurs. The temperature rise occurs as heat of adsorption is released during the drying process. The time for the temperature rise to occur depends on flow rate. At 100% flow the temperature rise takes five minutes, at 17% flow it takes 30 minutes.

When the calculated temperature rise is reached, the towers switch with tower A now drying and tower B being regenerated. Tower B regenerates for 3.9 minutes, repressurizes, and remains idle until it is called upon for the next drying cycle.

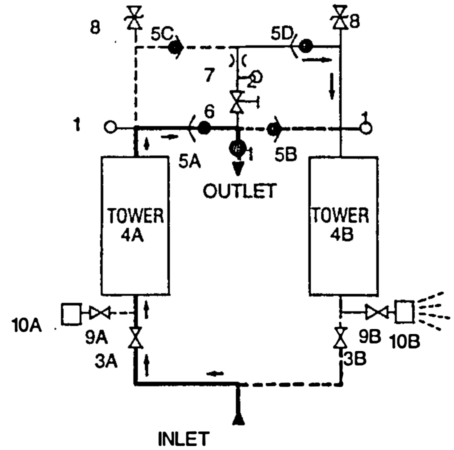


FIGURE 1A

TOWER 4A DRYING: TOWER 4B REGENERATING

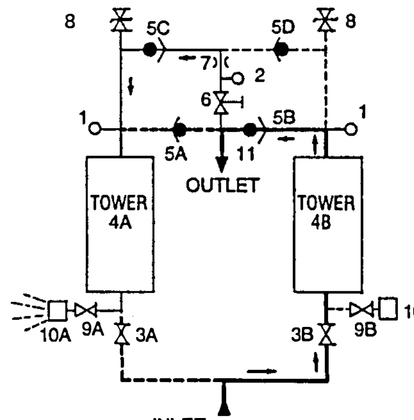


FIGURE 1B

TOWER 4B DRYING: TOWER 4A REGENERATING

1. Pressure Gauges (Desiccant Drying Towers)
2. Purge Pressure Gauge
3A. Left Air Inlet Switching Valve
3B. Right Inlet Switching Valve
4. Desiccant Drying Towers
5. Check Valves
6. Adjustable Purge Rate Valve
7. Purge Orifice
8. Pressure Relief Valves
9A. Left Purge / Repressurization Valve
9B. Right Purge / Repressurization Valve
10. Purge Mufflers
11. Moisture Indicator

LEGEND

Process Stream

Purge Stream

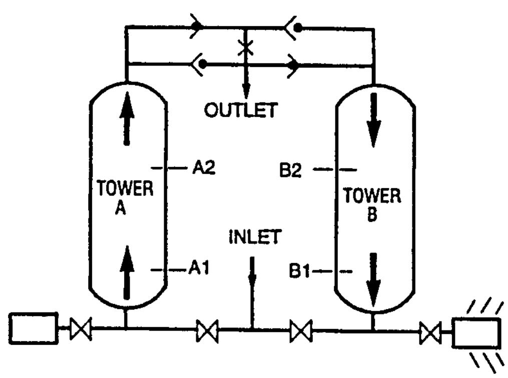


FIGURE 1C

2.0 INSTALLATION

2.1 Location in the compressed air system.

NOTE

Air Compressor should be adequately sized to handle air system demands as well as purge loss. Failure to take this into account could result in overloading air compressors and/or insufficient air supply downstream.

NOTE

It is desirable to install dryer where compressed air is at the lowest possible temperature (downstream of aftercoolers) and the highest possible pressure (upstream of pressure reducing valves) without exceeding the maximum working pressure. *(Refer to Figure 2A)*

(A) AFTERCOOLER/SEPARATOR - Compressed air entering dryer must be cooled to at least 120°F (49°C). Use aftercooler and separator if higher temperatures are present.

NOTE

Installation of a refrigerated dryer ahead of a pressure-swing desiccant dryer does not increase desiccant dryer capacity or reduce purge flow requirements. However a cooling unit installed ahead of the desiccant dryer reduces the inlet air

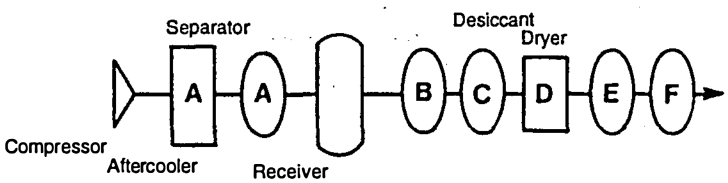


FIGURE 2A

(B & C) PREFILTERS - Adequate filtration is required upstream of the dryer in order to protect the desiccant bed from contamination. The following filters are recommended:
B - Air Line Filter - On compressed air systems utilizing non-lubricated (oil-free) air compressors, use to protect desiccant bed from solid and liquid contamination. On systems with lubricated compressors, use as a prefilter to the oil aerosol removal filter.
C - Oil Aerosol Removal Filter - On systems with lubricated compressors, use to remove oil aerosols and protect desiccant bed from oil contamination.

(D) DESICCANT DRYER
(E & F) AFTERFILTERS - To ensure downstream air purity (prevent desiccant dust from traveling downstream) adequate filtration downstream of the dryer is required. Depending on the degree of purity you require from your compressed air system, the following filters are recommended:
E - Air Line Filter - Use as an afterfilter to remove desiccant fines and protect downstream components from solid particles 1 micron and larger.
F - Oil Aerosol Removal Filter - Use as an afterfilter to filter out desiccant fines and protect downstream components from solid particles 0.025 micron and larger.

OR

Oil Vapor Adsorber - Use as an afterfilter to remove oil vapor and its subsequent taste and odor and to protect down-stream components from solid particles 0.025 micron and larger.

NOTE

By-pass lines and isolation valves are recommended so that maintenance work can be performed without shutting off the air supply.

2.2 Minimum & Maximum Operating Conditions

The compressed air supply inlet should be checked periodically to ensure that equipment design specifications are not exceeded. Normally the compressor installation includes inter-coolers, aftercoolers, separators, receivers, or similar equipment which adequately pretreat the compressed air supply in order to avoid excessively high air temperatures and liquid slugging of downstream equipment.

2.2.1 Compressed air conditions

2.2.1.1 Maximum working pressure:
Refer to dryer Serial Number Tag.

WARNING

Do not operate the dryer at pressures above the maximum pressure shown on the tag.

2.2.1.2 Minimum working pressures:

150 psig MWP models -
60 psig (4.1 bar) for dryers operated on a 10 minute cycle
80 psig (5.6 bar) for dryers operated on a 4 minute cycle

250 psig MWP models -
125 psig (8.6 bar) for dryers operated on a 10 minute cycle
150 psig (10.3 bar) for dryers operated on a 4 minute cycle.
If lower inlet pressures are encountered, consult factory.

2.2.1.3 Maximum Inlet compressed air temperature:
120°F (49°)

NOTE

If inlet air is higher than 120°F (49°C) the air must be precooled with an aftercooler.

2.2.2 Ambient temperatures:

Minimum:
Standard units: 35°F (1.7°C)
Units with optional low ambient package: - 10°F (-23°C)
Maximum: 120°F (49°C)

NOTE

If dryer is installed in ambients below 35°F (1.7°C) heat tracing of the prefilters and inlet piping and valves is necessary to prevent condensate from freezing. If installing heat tracing, observe electrical class code requirements for type of duty specified.

2.3 Mounting

Install dryer on a level pad on floor. Holes are provided in the floor stand base angles for floor anchors if desired.

NOTE

Floor anchors must be used if area is subject to vibrations.

2.4 Piping

2.4.1 Inlet and Outlet connections

Observe location of inlet and outlet connections as indicated in Figure 2B, 2C, or 2D and connect inlet and outlet piping.

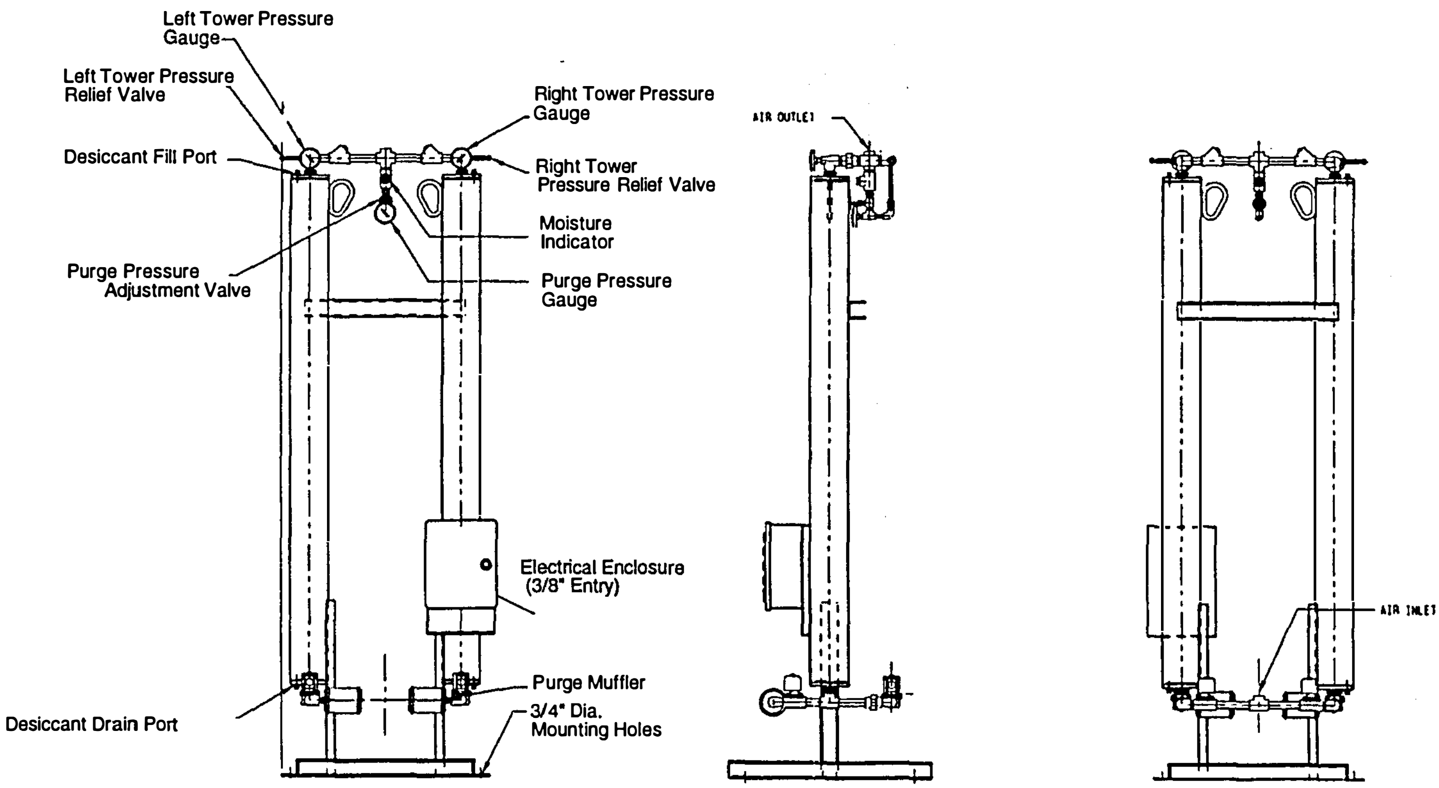
NOTE

All piping must be supported so as not to bear on the dryers or filters.

2.4.2 Isolation valves

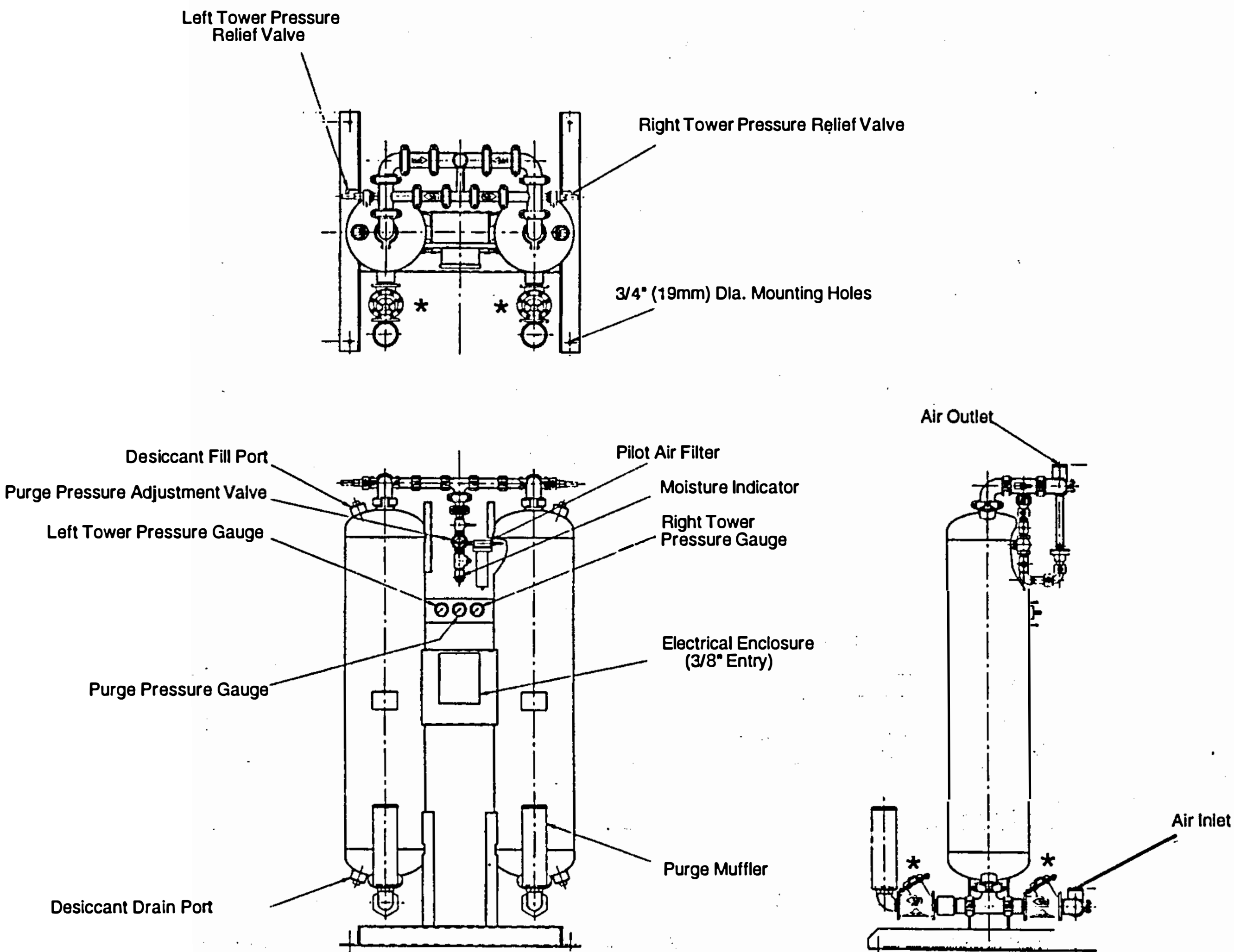
If isolation valves are installed, it is recommended that gate valves be used to ensure that dryer is pressurized slowly. This is particularly true if isolation valves are placed before and after pre- and after- filters where rapid pressurization could cause excessive pressure drop across filter cartridges.

FIGURE 2B Models 25 through 80



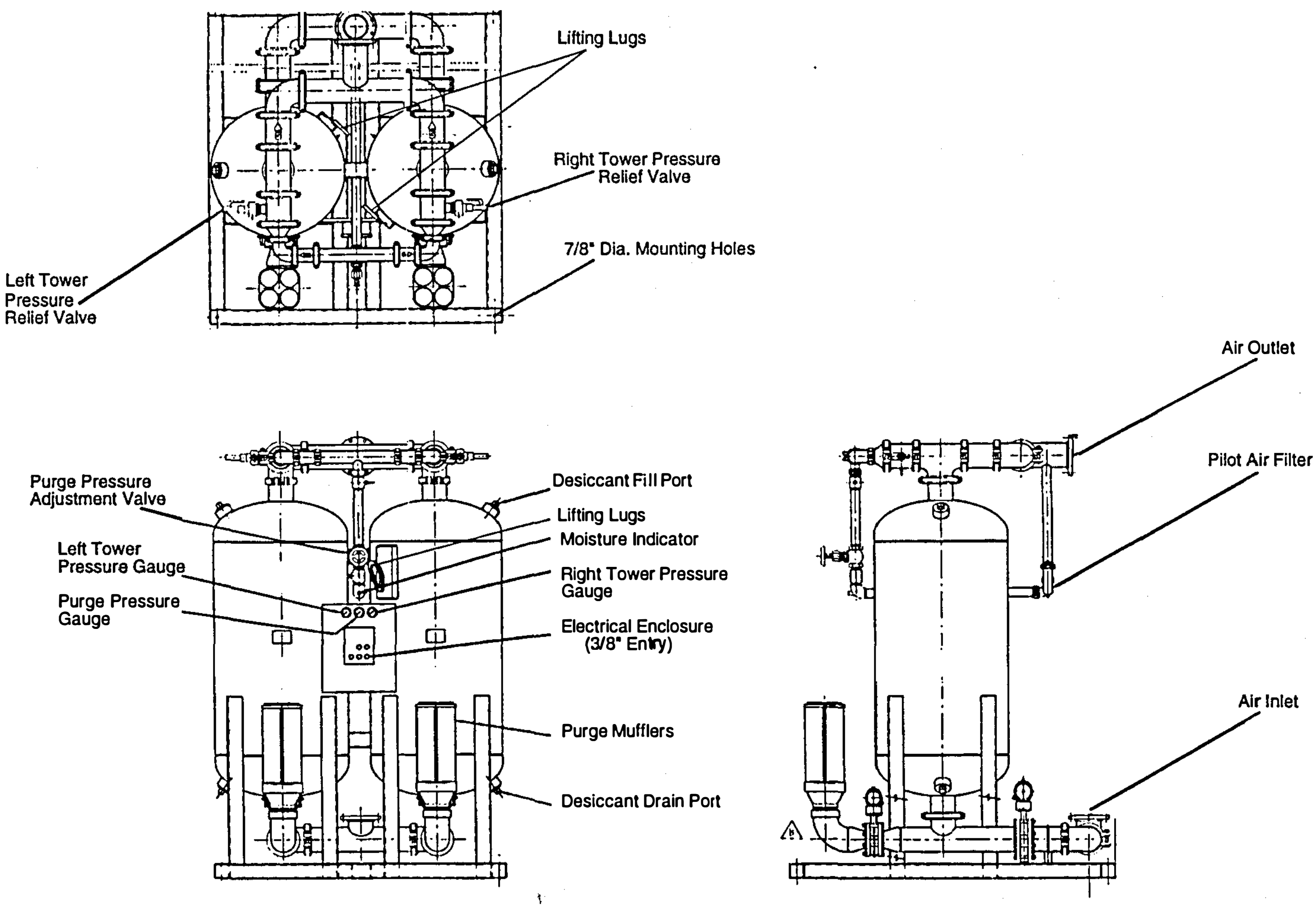
FRONT VIEW *RIGHTSIDE VIEW* *REAR VIEW*

FIGURE 2C Models 115 through 2100



*Models 115 through 260 use solenoid valves. Models 370 through 2100 use air operated butterfly valves.

FIGURE 2D Models 3000 thru 5400



2.5 Electrical Connections

· 2.5.1 Power to Unit

NOTE

Check Serial Number Tag for correct voltage.

2.5.1.1 Standard Unit

2.5.1.2 ***Automatic Purge Saving System****(Refer to Figure 2F)*

Connect wires to terminals at positions 2 and 3 on the terminal strip. Ground to position 1. Do not make connections to terminals labeled with grounding symbol or labeled with RS.

Set the voltage selection switch located at the lower edge of the control board for the proper supply voltage.

Electrical entry is 7/8"Dia. hole for 1/2" nominal conduit entry.

(Refer to Figure 2E)

Connect wires to terminals L1 and L2 and ground screw on mounting plate. Electrical entry is 3/8".

2.5.2 Connections for external alarm

2.5..2.1 Standard Unit

Switching Failure Alarm (optional) - Dry contacts for a remote alarm are supplied at terminals 11 and 12

Maximum contact rating is:

220 VAC - 0.15 amp

110 VAC - 0.3 amp

30 VDC - 1.0 amp

2.5.2.2 Automatic Purge Saving System

Dry contacts for a remote alarm are supplied at terminals 6 and 7. Maximum contact rating is:

230 VAC - 4.3 amp

115 VAC - 8.7 amp

200 VDC - 0.15 amp

100 VDC - 0.35 amp

50 VDC - 1.2 amp

30 VDC - 4.5 amp

25 VDC - 10 amp

10 VDC - 10 amp

2.6 Provisions for Purge Exhaust -Purge exhaust must be routed through the factory supplied mufflers or piped to a remote location.

2.6.1 Purge mufflers - If shipped separately, install purge exhaust mufflers in the locations shown in Figure 2B, 2C or 2D.

2.6.2 If purge exhaust is piped to a remote location, choose a pipe size large enough so that back pressure through the piping is not created.

WARNING

Do not operate dryer without one of the above measures. Exhausting air will result in noise levels above OSHA permissible levels and exhausting gas could potentially cause harm to persons or property.

2.7 Initial Desiccant Charge -The dryer is shipped complete with desiccant and ready to operate after piping and electrical connections are made.

POWER REQUIREMENTS

MODEL		WATTS	AMPS	
			HOLDING	INRUSH
STANDARD CONTROL BOARD				
25 THRU 60	120V - 60 Hz, 110V - 50 Hz	34.2	0.53	1.28
	240V - 60 Hz, 220V - 50 Hz	34.2	0.27	0.64
80	120V - 60 Hz, 110V - 50 Hz	44.1	0.68	2.70
	240V - 60 Hz, 220V - 50 Hz	44.1	0.34	1.35
115 THRU 260	120V - 60 Hz, 110V - 50 Hz	49.4	0.70	3.45
	240V - 60 Hz, 220V - 50 Hz	49.4	0.35	1.73
370 THRU 5400	120V - 60 Hz, 110V - 50 Hz	34.6	0.53	1.24
	240V - 60 Hz, 220V - 50 Hz	34.6	0.26	0.62
AUTOMATIC PURGE SAVING SYSTEM				
25 THRU 60	120V - 60 Hz, 110V - 50 Hz	44.2	0.62	1.37
	240V - 60 Hz, 220V - 50 Hz	44.2	0.31	0.68
80	120V - 60 Hz, 110V - 50 Hz	54.1	0.77	2.78
	240V - 60 Hz, 220V - 50 Hz	54.1	0.38	1.39
115 THRU 260	120V - 60 Hz, 110V - 50 Hz	59.4	0.78	3.53
	240V - 60 Hz, 220V - 50 Hz	59.4	0.39	1.77
370 THRU 5400	120V - 60 Hz, 110V - 50 Hz	44.6	0.61	1.33
	240V - 60 Hz, 220V - 50 Hz	44.6	0.30	0.66

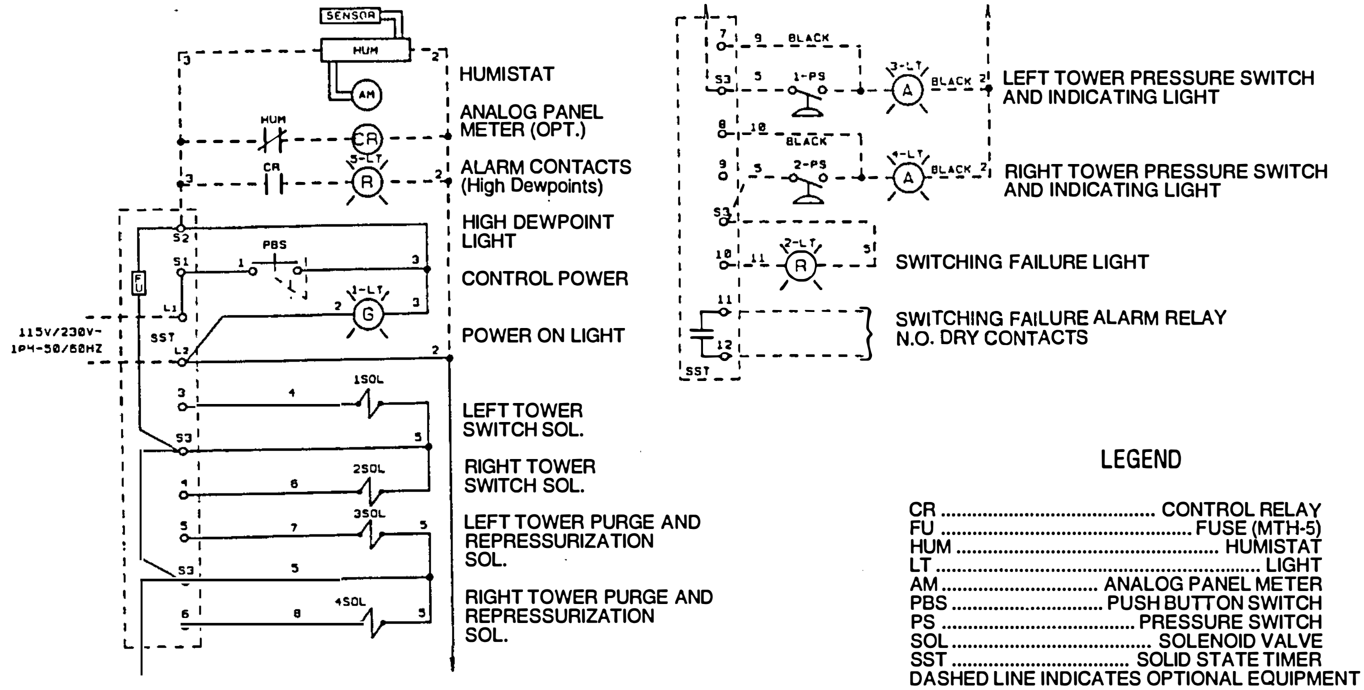


FIGURE 2E Electrical Schematic (Standard Dryers)

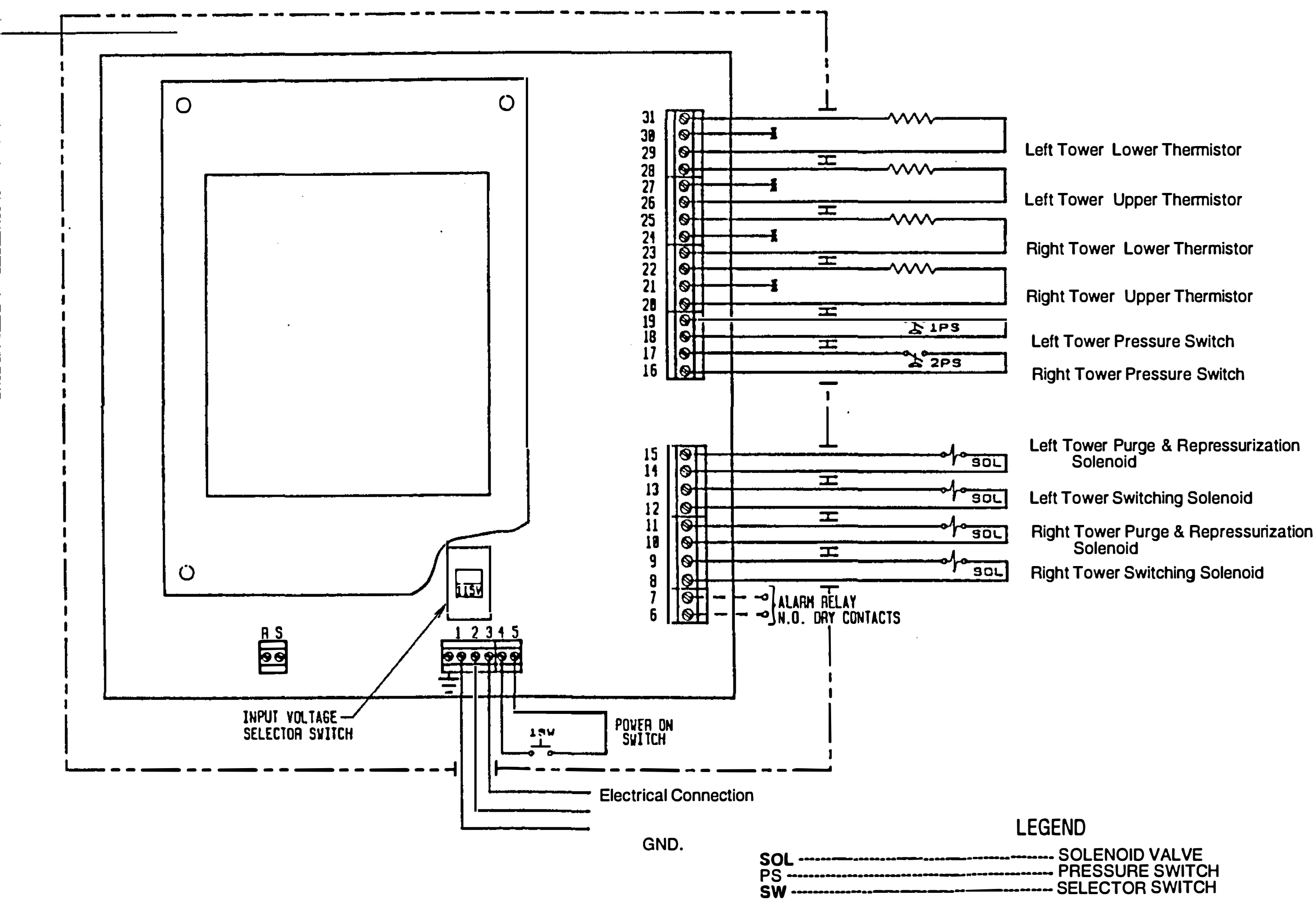


FIGURE 2F. ELECTRICAL SCHEMATIC (DRYERS WITH AUTOMATIC PURGE SAVING SYSTEM)

3.0 OPERATION

3.1 Start-up

3.1.1 Control board settings- Set or verify settings on control board (control board is found in electrical enclosure)

3.1.1.1 Standard Unit Control Board

NOTE

Make settings with dryer de-energized (Power-On light off).

3.1.1.1.1 Cycle Time Jumper- Determine if dryer is to operate on a 4 or 10 minute cycle time. Outlet dew points vary with inlet temperatures and cycle times. Refer to Table 9 to determine cycle time required to produce the desired dew point.

1)For a **10 minute cycle** - position jumper on top two terminals per Figure 3A1.

2) For a **4 minute cycle** - position jumper on bottom two terminals per Figure 3A2.

3.1.1.1.2Purge Economizer Switch- (DIP type switch) - Locate Purge Economizer Switch, Figure 3A3.

1)To set switch when dryer is operated at 100% of flow capacity, refer to Table 1.

NOTE

Switch positions vary depending on cycle time and MWP of dryer.

MWP of dryer is as indicated on Serial Number Tag.

2)To set switch for flows below 100% of flow capacity:

If dryer is operated at less than maximum flow capacity a reduction in purge air usage may be possible. Refer to Section 3.5.4 to determine maximum inlet flow capacity at operating pressure. Divide your actual flow by Maximum Flow to get % of Maximum Flow.

3) Refer to Table 8 and set DIP switches in Purge Economizer Switch (Figure 3A3) accordingly. Push switches up for ON. If actual flow rate through the dryer is unknown, set the switches for 100%.

EXAMPLE: A 60 scfm unit with 150 psig MWP operating on a 10 minute cycle has a Maximum Rated Inlet Flow of 60 scfm @ 100 psig. Currently only 30 scfm is used. 30/60 = .50 = 50%. To save purge air set Purge Economizer Switch for 50% as shown in Table 8: DIP switches 1 and 4 are OFF, DIP switches 2 and 3 are ON.

NOTE

If full flow is restored, Purge Economizer Switch must be reset for 100%.

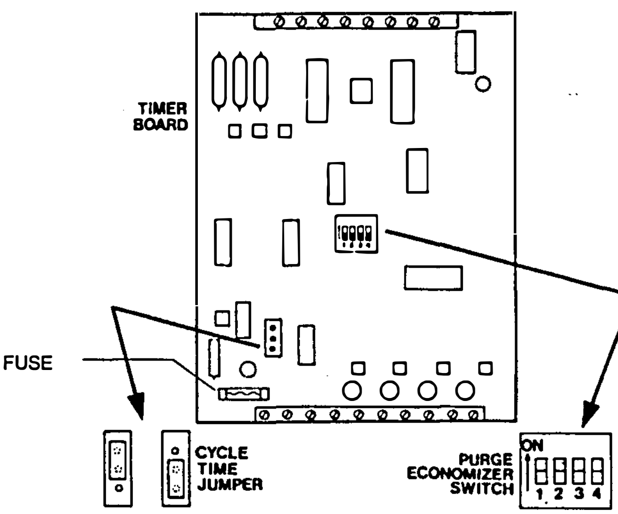


FIGURE 3A

TABLE 1 Purge Economizer Switch Setting For Maximum(100%)Flow

DRYER MWP		150 psig				250 psig			
DIP SWITCH NUMBER		1	2	3	4	1	2	3	4
CYCLE TIME JUMPER SETTING	10 Minute	Off	Off	Off	Off	Off	Off	On	Off
	4 Minute	Off	Off	On	Off	Off	On	On	Off

3.1.1.2 Automatic Purge Saving System Control Board

***3.1.1.2.1 Voltage selection** - Set the voltage selection switch located at the lower edge of the power board for the proper voltage.*

NOTE:

Make certain that paper insulation in front of battery has been removed.

3.1.1.2.2 Cycle selection

A cycle selector allows two choices in the fixed cycle mode and three in the demand cycle mode. Cycle selection is accomplished by depressing the cycle selector switch repeatedly until the light indicating the desired cycle model illuminates.

1) Fixed cycle mode

***10 minute** - in this mode the dryer switches towers every 5 minutes. With 100°F (38°C) inlet air, a -40°F (-40°C) pres sure dew point is produced.*

***4 minute** - In this mode the dryer switches towers every 2 minutes. With 100°F (38°C) inlet air, a -100°F (-73°C) pressure dew point is produced.*

(2) Demand Cycle Mode

In this mode the dryer switches when the desiccant bed is loaded as signalled by a calculated temperature rise. Unit can be set to produce three outlet dew points, -40°F (-40°C), 0°F (-17.8°C) and 40°F (4.4°C).

NOTE:

Automatic control will begin 1/2 cycle after start-up.

NOTE:

If a cycle change is made while dryer is operating, dryer will finish previous cycle (right tower drying terminates) before changing. Indicating light of newly selected mode will blink until changeover is complete. If it is necessary to begin a new selection immediately, shut unit off and on. (This is not recommended if either tower is in the regeneration mode since rapid repressurization could result.)

NOTE:

If switching to a cycle mode producing a lower dew point (e.g. 0°F to -40°F [-17.8 to -40°C]) while dryer is operating, one or two days of operation may possibly be needed before the new dew point is achieved.

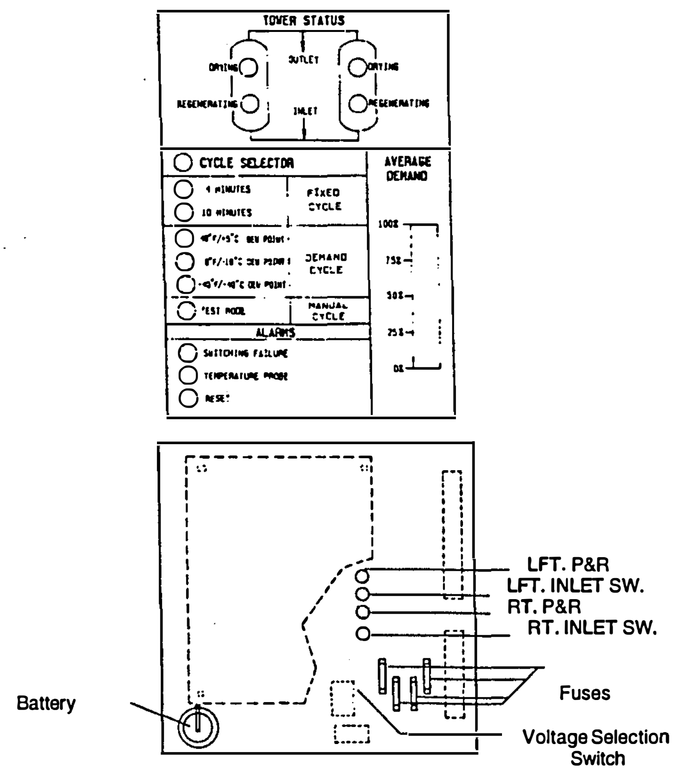


FIGURE3B

Models	750	930	1130	1350	1550	2100	3000	4100	5400
Purge/Repressurization Valve									
Complete Valve NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	4820.090.30	4820.090.31	4820.090.32	4820.090.32	4820.090.32	4820.090.33	4820.090.33	4820.090.34	4820.090.34
Repair Kit NEMA 1 NEMA 4,4X	4820.093.4	4820.093.5	4820.093.1	4820.093.1	4820.093.1	4820.093.2	4820.093.2	4820.093.3	4820.093.3
Coil 120-60/110-50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
240-60/220-50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inlet Switching Valve									
Complete Valve NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	4820.090.24	4820.090.24	4820.090.35	4820.090.35	4820.090.20	4820.090.20	4820.090.36	4820.090.36	4820.090.36
Repair Kit NEMA 1 NEMA 4,4X	4820.093.5	4820.093.5	4820.093.1	4820.093.1	4820.093.2	4820.093.2	4820.093.3	4820.093.3	4820.093.3
Coil 120-60/110-50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
240-60/220-50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pilot Valve for Purge/ Repressurization Valve									
Complete Valve 120-60/110-50	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29
240-60/220-50	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1
Repair Kit	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12
Coil 120-60/110-50	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1
240-60/220-50	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2
Pilot Valve for Inlet Switching Valve									
Complete Valve 120-60/110-50	4810.743.15	4810.743.15	4810.743.15	4810.743.15	4810.743.15	4810.743.15	4810.743.15	4810.743.15	4810.743.15
240-60/220-50	4810.739.2	4810.739.2	4810.739.2	4810.739.2	4810.739.2	4810.739.2	4810.739.2	4810.739.2	4810.739.2
Repair Kit	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26
Coil 120-60/110-50	4810.132.5	4810.132.5	4810.132.5	4810.132.5	4810.132.5	4810.132.5	4810.132.5	4810.132.5	4810.132.5
240-60/220-50	4810.132.6	4810.132.6	4810.132.6	4810.132.6	4810.132.6	4810.132.6	4810.132.6	4810.132.6	4810.132.6
Pilot Valve for Inlet Switching Valve (c/w Automatic Purge Saving System)*									
120-60/110-50	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29	4810.741.29
240-60/220-50	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1	4810.739.1
Repair Kit	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12
Coil 120-60/110-50	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1	4810.132.1
240-60/220-50	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2	4810.132.2
Purge Air Check Valve	4820.104.2	4820.104.2	4820.104.2	4820.104.2	4820.104.3	4820.104.3	4820.104.4	4820.104.5	4820.104.5
Outlet Air Check Valve	4820.104.7	4820.104.7	4820.104.4	4820.104.4	4820.104.5	4820.104.5	4820.104.6	4820.104.6	4820.104.6
Pressure Relief Valve	4820.658.6	4820.658.7	4820.658.7	4820.658.8	4820.658.8	4820.658.9	4820.658.9	4820.658.8	4820.658.9
Adjustable Purge Rate Valve	4820.283.5	4820.283.5	4820.283.5	4820.283.5	4820.283.4	4820.283.4	4820.283.4	4820.283.4	4820.283.10
Pilot Air Filter Cartridge	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3
Purge Muffler	3442.516.6	3442.516.6	3442.516.7	3442.516.7	3442.516.7	3442.516.8	3442.516.9	3442.516.9	3442.516.9
Muffler Insert	3442.101.5	3442.101.5	3442.101.6	3442.101.6	3442.101.6	3442.101.7	3442.101.8	3442.101.8	3442.101.8
Strainer	8835.739.2	8835.739.3	8835.739.3	8835.739.3	8835.739.3	8835.739.3	N/A	N/A	N/A
Timer (w/o Switching Failure Alarm)									
120-60/110-50	5945.690.8	5945.690.8	5945.690.8	5945.690.8	5945.690.8	5945.690.8	5945.690.8	5945.690.8	5945.690.8
240-60/220-50	5945.690.9	5945.690.9	5945.690.9	5945.690.9	5945.690.9	5945.690.9	5945.690.9	5945.690.9	5945.690.9
Timer (c/w Switching Failure Alarm)									
120-60/110-50	5945.690.10	5945.690.10	5945.690.10	5945.690.10	5945.690.10	5945.690.10	5945.690.10	5945.690.10	5945.690.10
240-60/220-50	5945.690.11	5945.690.11	5945.690.11	5945.690.11	5945.690.11	5945.690.11	5945.690.11	5945.690.11	5945.690.11
Timer/Automatic Purge Saving System* 120/240	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3
ON/Off Switch									
NEMA 1	6110.706.3	6110.706.3	6110.706.3	6110.706.3	6110.706.3	6110.706.3	6110.706.3	6110.706.3	6110.706.3
NEMA 4,4X	6110.729.11	6110.729.11	6110.729.11	6110.729.11	6110.729.11	6110.729.11	6110.729.11	6110.729.11	6110.729.11
Auto. Purge Saving System*	6110.729.20	6110.729.20	6110.729.20	6110.729.20	6110.729.20	6110.729.20	6110.729.20	6110.729.20	6110.729.20
Indicator Light (Green)									
NEMA 1: 120-60/110-50	6350.457.3	6350.457.3	6350.457.3	6350.457.3	6350.457.3	6350.457.3	6350.457.3	6350.457.3	6350.457.3
240-60/220-50	6350.457.8	6350.457.8	6350.457.8	6350.457.8	6350.457.8	6350.457.8	6350.457.8	6350.457.8	6350.457.8
NEMA 4,4X: 120-60/110-50	6350.448.6	6350.448.6	6350.448.6	6350.448.6	6350.448.6	6350.448.6	6350.448.6	6350.448.6	6350.448.6
240-60/220-50	6350.448.1	6350.448.1	6350.448.1	6350.448.1	6350.448.1	6350.448.1	6350.448.1	6350.448.1	6350.448.1
Indicator Light (Red)									
NEMA 1: 120-60/110-50	6350.457.2	6350.457.2	6350.457.2	6350.457.2	6350.457.2	6350.457.2	6350.457.2	6350.457.2	6350.457.2
240-60/220-50	6350.457.7	6350.457.7	6350.457.7	6350.457.7	6350.457.7	6350.457.7	6350.457.7	6350.457.7	6350.457.7
NEMA 4,4X: 120-60/110-50	6350.448.7	6350.448.7	6350.448.7	6350.448.7	6350.448.7	6350.448.7	6350.448.7	6350.448.7	6350.448.7
240-60/220-50	6350.448.2	6350.448.2	6350.448.2	6350.448.2	6350.448.2	6350.448.2	6350.448.2	6350.448.2	6350.448.2
Indicator Light (Amber)									
NEMA 1: 120-60/110-50	6350.457.1	6350.457.1	6350.457.1	6350.457.1	6350.457.1	6350.457.1	6350.457.1	6350.457.1	6350.457.1
240-60/220-50	6350.457.6	6350.457.6	6350.457.6	6350.457.6	6350.457.6	6350.457.6	6350.457.6	6350.457.6	6350.457.6
NEMA 4,4X: 120-60/110-50	6350.448.8	6350.448.8	6350.448.8	6350.448.8	6350.448.8	6350.448.8	6350.448.8	6350.448.8	6350.448.8
240-60/220-50	6350.448.3	6350.448.3	6350.448.3	6350.448.3	6350.448.3	6350.448.3	6350.448.3	6350.448.3	6350.448.3
Moisture Indicator	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1
Purge Orifice	33.1686-03	33.1687-03	33.1688-02	33.1689-02	33.1690-02	33.1691-02	33.1692-01	33.1693-01	33.1694-01
Tower Pressure Gauge	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1
Purge Flow Indicator Gauge	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1
Pressure Switch	4130.138.1	4130.138.1	4130.138.1	4130.138.1	4130.138.1	4130.138.1	4130.138.1	4130.138.1	4130.138.1
Pressure Switch Automatic Purge Saving System*	4130.138.12	4130.138.12	4130.138.12	4130.138.12	4130.138.12	4130.138.12	4130.138.12	4130.138.12	4130.138.12
Thermistor*	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1

* Items required for use with Automatic Purge Saving System

Models	750	930	1130	1350	1550	2100	3000	4100	5400
Purge/Repressurization Valve									
Complete Valve NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	4820.090.30	4820.090.31	4820.090.32	4820.090.32	4820.090.32	4820.090.33	4820.090.33	4820.090.34	4820.090.34
Repair Kit NEMA 1 NEMA 4,4X	4820.093.4	4820.093.5	4820.093.1	4820.093.1	4820.093.1	4820.093.2	4820.093.2	4820.093.3	4820.093.3
Coil 120-60/110-50 240-60/220-50	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
Inlet Switching Valve									
Complete Valve NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	4820.090.24	4820.090.24	4820.090.35	4820.090.35	4820.090.20	4820.090.20	4820.090.36	4820.090.36	4820.090.36
Repair Kit NEMA 1 NEMA 4,4X	4820.093.5	4820.093.5	4820.093.1	4820.093.1	4820.093.2	4820.093.2	4820.093.3	4820.093.3	4820.093.3
Coil 120-60/110-50 240-60/220-50	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
Pilot Valve for Purge/ Repressurization Valve									
Complete Valve 120-60/110-50 240-60/220-50	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1
Repair Kit	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12
Coil 120-60/110-50 240-60/220-50	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2
Pilot Valve for Inlet Switching Valve									
Complete Valve 120-60/110-50 240-60/220-50	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2	4810.743.15 4810.739.2
Repair Kit	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26	4810.443.26
Coil 120-60/110-50 240-60/220-50	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6	4810.132.5 4810.132.6
Pilot Valve for Inlet Switching Valve (c/w Automatic Purge Saving System)* 120-60/110-50 240-60/220-50	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1	4810.741.29 4810.739.1
Repair Kit	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12	4810.443.12
Coil 120-60/110-50 240-60/220-50	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2	4810.132.1 4810.132.2
Purge Air Check Valve	4820.104.2	4820.104.2	4820.104.2	4820.104.2	4820.104.3	4820.104.3	4820.104.4	4820.104.5	4820.104.5
Outlet Air Check Valve	4820.104.7	4820.104.7	4820.104.4	4820.104.4	4820.104.5	4820.104.5	4820.104.6	4820.104.6	4820.104.6
Pressure Relief Valve	4820.658.6	4820.658.7	4820.658.7	4820.658.8	4820.658.8	4820.658.9	4820.658.9	4820.658.8	4820.658.9
Adjustable Purge Rate Valve	4820.283.5	4820.283.5	4820.283.5	4820.283.5	4820.283.4	4820.283.4	4820.283.4	4820.283.4	4820.283.10
Pilot Air Filter Cartridge	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3	0731-3
Purge Muffler	3442.516.6	3442.516.6	3442.516.7	3442.516.7	3442.516.7	3442.516.8	3442.516.9	3442.516.9	3442.516.9
Muffler Insert	3442.101.5	3442.101.5	3442.101.6	3442.101.6	3442.101.6	3442.101.7	3442.101.8	3442.101.8	3442.101.8
Strainer	8835.739.2	8835.739.3	8835.739.3	8835.739.3	8835.739.3	8835.739.3	N/A	N/A	N/A
Timer (w/o Switching Failure Alarm) 120-60/110-50 240-60/220-50	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9	5945.690.8 5945.690.9
Timer (c/w Switching Failure Alarm) 120-60/110-50 240-60/220-50	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11	5945.690.10 5945.690.11
Timer/Automatic Purge Saving System* 120/240	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3	5945.694.3
ON/Off Switch NEMA 1 NEMA 4,4X Auto. Purge Saving System*	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20	6110.706.3 6110.729.11 6110.729.20
Indicator Light (Green) NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1	6350.457.3 6350.457.8 6350.448.6 6350.448.1
Indicator Light (Red) NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2	6350.457.2 6350.457.7 6350.448.7 6350.448.2
Indicator Light (Amber) NEMA 1: 120-60/110-50 240-60/220-50 NEMA 4,4X: 120-60/110-50 240-60/220-50	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3	6350.457.1 6350.457.6 6350.448.8 6350.448.3
Moisture Indicator	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1	3004-1
Purge Orifice	33.1686-03	33.1687-03	33.1688-02	33.1689-02	33.1690-02	33.1691-02	33.1692-01	33.1693-01	33.1694-01
Tower Pressure Gauge	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1
Purge Flow Indicator Gauge	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1	6685.279.1
Pressure Switch	4130.130.1	4130.130.1	4130.130.1	4130.130.1	4130.130.1	4130.130.1	4130.130.1	4130.130.1	4130.130.1
Pressure Switch Automatic Purge Saving System*	4130.130.12	4130.130.12	4130.130.12	4130.130.12	4130.130.12	4130.130.12	4130.130.12	4130.130.12	4130.130.12
Thermistor*	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1	6685.756.1

* Items required for use with Automatic Purge Saving System

DESICCANT ~~DRYER~~ PRODUCTION RECORD

RODUCTION ORDER NO. 534813

ODEL DH-60

ERIAL NUMBER 3332-1-9604-7D ES NO.

ANUFACTURE DATE 4-12-96 VOLTAGE 110/120-1-50/60HZ

ORKING PRESSURE: Minimum 50 PSIG Maximum 150 PSIG

ESICCANT: Type ACTIVATED ALUMINA Amount 72 lbs.

ESSEL INFORMATION
AT'L BD NO.: Left Tower N/A Right Tower N/A

NUFACTURE STANDARD

ECTRICAL INFORMATION

NEMA CLASS 1

NTROL BOARD TYPE: Standard ✓ SFA ___ Purge Saving System ___ TIL ___

VOLTAGE: 120 ✓ 240 ___ Other ___ WATTS 342 AMPS — Inrush 1.28 Holding .53

mments

SEMBLY SEQUENCE (*Initial upon completion*)

JS	PRODUCTION SEQUENCE	JS	INLET SWITCHING VALVE ASSY.	JS	AIR TEST OF PIPING
	PURGE REPRESSURIZATION VALVE ASSY.	JS	ALIGNMENT OF DRYER LINES		
EC	PAINT		PIPING BOM NO. REV		

ANUFACTURING AND QUALITY CONTROL (*initial upon completion*)

D	INLET SWITCHING VALVES	AKD	PURGE EP ESSURIZATION VALVES
D	TIMING SEQUENCE	AKD	PERFORMANCE TEST
AKD	APPEARANCE TAGGING	AKD	MOISTURE INDICATOR
	PACKAGING AND SHIPPING	AKD	FINAL APPEARANCE

610.ACC.1 is a complete listing of repair parts. Any deviation or additions to the repair parts list are ed below.

ART NUMBER	DESCRIPTION	QUANTITY

3.1.2 SLOWLY pressurize dryer to full line pressure (open inlet valve, outlet valve remains closed).

NOTE

During initial start-up check entire system for leaks. If necessary, depressurize and correct any leaks.

3.1.3 Energize dryer using the power switch located on the electrical box (power-on light illuminated).

NOTE

Standard control board - Units with switching failure alarm: alarm (light) may be activated if unit is energized before it is pressurized. To deactivate alarm, turn power switch off, then back on when both towers are at line pressure.

3.1.4 Adjust the purge rate valve.

3.1.4.1 Determine:

1)Maximum working pressure (MWP) of dryer from the dryer serial number tag 150 PSIG

2) Air pressure at inlet to dryer

3) Cycle time setting (4 or 10 minutes) For units with optional Automatic Purge Saving System in the demand cycle mode use the 10 minute setting.

3.1.4.2 Refer to *Table 2* for proper purge rate pressure setting at the conditions found in 3.1.4.1

3.1.4.3 Adjust purge rate valve until purge flow indicator reads required pressure setting.

NOTE

Adjustment must be made while a tower is purging (air exhausting from muffler).

NOTE

INSUFFICIENT PURGE AIR WILL EVENTUALLY RESULT IN SATURATION OF DESICCANT BED AND WET AIR DOWNSTREAM. MAKE CERTAIN THAT CYCLE TIME, PURGE ECONOMIZER SWITCH, AND PURGE PRESSURE ARE CORRECTLY SET.

3.1.5 Establish normal flow through dryer (open outlet isolation valve). Close air by-pass valve if present.

NOTE

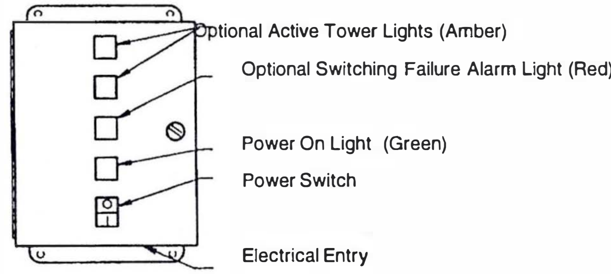
When dew points below -40°F (-40°C) are required, the dryer must be run with an inlet flow rate of less than 50% of maximum until the desired dew point is attained. Depending on the initial dryness of the desiccant, this can take as long as 2 to 3 days. This stabilization period is required on initial startup, after dryer has been shutdown for extended periods of time, or after dryer maintenance (desiccant change, etc.).

3.1.6 With the inlet pressure to the dryer at its minimum level, readjust the purge pressure as determined in 3.1.4.

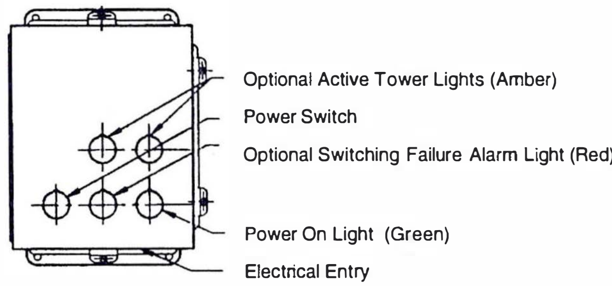
Purge Rate Pressure Setting (psig)

150 psig M.W.P. models

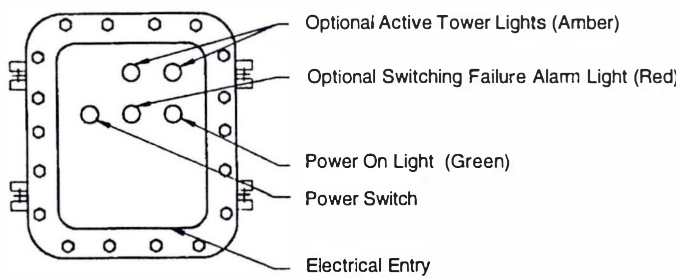
INLET PRESSURE (psig)		60-100	110	120	130	140	150
CYCLE TIME JUMPER SETTING	10 Min.	45	43	41	39	37	36
	4 Min.	70	66	63	60	58	56



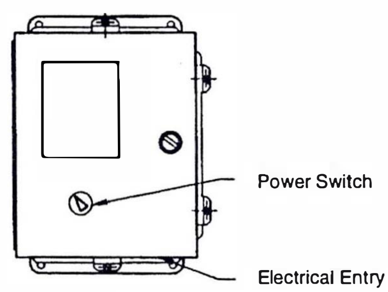
STANDARD ELECTRICAL ENCLOSURE
NEMA - 1



STANDARD ELECTRICAL ENCLOSURE
NEMA - 4, 4X



STANDARD ELECTRICAL ENCLOSURE
NEMA - 7



ELECTRICAL ENCLOSURE
Automatic Purge Saving System
NEMA - 4, 4X

FIGURE 3C Electrical Enclosures

250 psig M.W.P. models

INLET PRESSURE (psig)		125	130	135	140	145	150	175	200	225	250
CYCLE TIME JUMPER SETTING	10 Min.	91	87	84	81	78	75	64	55	48	43
	4 Min.	—	—	—	—	—	132	113	99	88	78

3.2 Operational Check Points

3.2.1 Standard Unit

3.2.1.1 Power to unit -Check periodically that there is power to the unit (power-on light illuminated).

3.2.1.2 Moisture Indicator- Every four hours check moisture indicator. Indicator should be green. Outlet relative humidity of the desiccant dryer is indicated by the color change humidity indicator. Green indicates a R.H. below 3% and yellow indicates a R.H. above 3%. Table 10 (page 15) indicates outlet dew point when moisture indicator changes from green to yellow at various inlet temperatures. During start-up the indicator may be yellow, however, it should begin to change to green within four hours.

3.2.1.3 Purge Flow Indicator -Every four hours check the purge pressure and adjust as required. Adjustment should be made when the inlet pressure to the dryer is at its minimum level.

NOTE

Adjustment must be made while a tower is purging (air exhausting from muffler).

3.2.1.4 Switching Failure Alarm (optional)

If unit is supplied with Switching Failure Alarm, periodically check for flashing red alarm light. Alarm light will flash if either tower fails to pressurize or depressurize to the required levels at the proper time.

NOTE

Alarm will activate if dryer is energized without being pressurized.

NOTE

If towers are switching properly and alarm light continues to operate, reset alarm by turning off power (power switch) for 30 seconds with both towers pressurized.

3.2.1.5 Tower Status Lights (optional) - dryers with optional active tower lights - illuminated light indicates which tower is on line (pressurized)

3.2.1.6 Tower pressure gauges

3.2.1.6.1 Periodically check tower pressure gauges to verify that tower pressure gauge of tower on line reads line pressure and tower pressure gauge of tower off line reads below 2 psig.

NOTE

Read off line tower gauge when tower is purging (air exhausting from muffler)

3.2.1.6.2 Check mufflers for back pressure

Excessive back pressure may result due to the accumulation of dust in the muffler. This sometimes occurs after start-up because of dusting of the desiccant during tower filling and dryer transport.

If the tower pressure gauge of the off-stream tower rises out of the black area on the gauge dial, muffler elements should be replaced. A set of purge exhaust muffler replacement elements is supplied with the dryer.

3.2.2. Units with Automatic Purge Saving System

3.2.21 Power to unit *- Check periodically that there is power to the unit (power-on light illuminated).*

3.2.2.2 Moisture Indicator *- Every four hours check moisture indicator. Indicator should be green. Outlet relative humidity of the desiccant dryer is indicated by the color change humidity indicator. Green indicates a R.H. below 3% and yellow indicates a R.H. above 3%. Table 10 (page 15) indicates outlet dew point when moisture indicator changes from green to yellow at various inlet temperatures. During start-up the indicator may be yellow, however, it should begin to change to green within four hours.*

3.2.2.3 Purge Flow Indicator *-Every four hours check the purge pressure and adjust as required. Adjustment should be made when the inlet pressure to the dryer is at its minimum level.*

NOTE

Adjustment must be made while a tower is purging (air exhausting from muffler).

3.2.2.4 Alarms

3.2.2.4.1 Switching Failure Alarm *- The switching failure alarm operates by sensing tower pressures after tower changeover. If towers have failed to pressurize or depressurize to the required levels, an alarm condition exists. The alarm light blinks while the alarm condition exists. If the alarm condition clears for two complete cycles, the light will switch to a steady glow. Depressing the reset switch will extinguish the light, but will not interrupt the drying cycle.*

If the tower being regenerated fails to repressurize, the dryer will not switch towers. The switching failure alarm will be activated and the dryer will remain in this mode until the tower repressurizes.

3.2.2.4.2 ***Temperature Probe Alarm*** *- (operates in a demand cycle mode only) This alarm is actuated by a short circuit, an open circuit, or temperatures below 40°F (4.4°C) or above 150°F (65.5°C). The alarm light blinks while the alarm condition exists. After the alarm condition clears for one complete cycle, the light will switch to a steady glow. Depressing the reset switch will extinguish the light, but will not interrupt the drying cycle.*

3.2.2.4.3 Dryer Cycle *(operates in demand cycle mode only) Either alarm will cause the controller to automatically switch to a fixed 10 minute cycle (cycle mode light will not indicate this).*

After the alarm condition clears and the light stops blinking, the controller will clear the internal information and switch back to a demand mode. It is not necessary to push the alarm reset for the dryer to return to the selected demand cycle mode. However, to extinguish the alarm light, press the alarm reset button.

NOTE

After an alarm condition clears, the dryer will not return to a demand cycle mode until the dryer completes two cycles if a switching failure alarm is experienced or one cycle if a temperature probe alarm is experienced. This occurs even if the alarm reset is depressed and the alarm light is extinguished.

3.2.2.4.4 ***Relay for Remote Alarm***

The remote alarm relay will close when an alarm occurs and remain closed until the alarm clears and is reset. The relay does not cycle as the lights blink.

3.2.2.5 ***Dryer status lights*** *- indicate when left and right towers are drying and regenerating.*

3.2.2.6 Valve energized lights

Four LEDs are furnished on controller to indicate which air control valves are energized at any particular time

3.2.2.7 Average Demand Meter

The demand meter displays the average demand on the dryer for the last 4 cycles. It is determined by dividing 40 (time to complete 4 cycles at full flow) by the actual time to complete the last 4 cycles.

3.2.2.8 Tower pressure gauges

3.2.2.8.1 Periodically check tower pressure gauges to verify that tower pressure gauge of tower on line reads line pressure and tower pressure gauge of tower off line reads below 2 psig.

NOTE

Read off line tower gauge when tower is purging (air exhausting from muffler)

3.2.2.8.2 Check mufflers for back pressure

Excessive back pressure may result due to the accumulation of dust in the muffler. This sometimes occurs after start-up because of dusting of the desiccant during tower filling and dryer transport.

If the tower pressure gauge of the off-stream tower rises out of the black area on the gauge dial, muffler elements should be replaced. A set of purge exhaust muffler replacement elements is supplied with the dryer.

3.2.3 All MODELS - Determine if air control valves are operating and sequencing correctly.

Refer to Section 1.2 and Figure 1A and 1B for a general description of operating sequence.

3.2.3.1 Inlet switching and purge/repressurization valves.

1) Tower pressure gauge of tower on line should read line pressure. No air should be leaking from purge/repressurization valve of the on line tower.

2) Tower pressure gauge of tower off line should read below 2 psig while tower is purging. If excessive purge air is exhausting during purge cycle, inlet valve may have failed to close or a check valve may be sticking.

3.2.3.2 Check valves

Check valve sticking will result in excessive air discharge through a muffler. If excessive air is discharged through the muffler on the left, check if valve 5a or 5d is sticking. If excessive air is discharged through the muffler on the right, check if valve 5b or 5c is sticking.

3.2.3.3 Operating Sequence

For dryers with standard control board and dryers with automatic purge saving system operating on a fixed time cycle-

Figure 3D and *Table 3A* show valve sequence times when dryer is operating on a 10 minute cycle. *Figure 3E* and *Table 3B* show sequence times when dryer is operating on a four minute cycle.

FIGURE 3D For dryers operating on a 10 minute cycle

VALVE	TIME (Min.) 0 1 2 3 4 5			6 7 8 9 10		
3A	OPEN			CLOSED		
3B	CLOSED			OPEN		
9B	Cl 6"	OPEN	Cl(1)	CLOSED		
9A	CLOSED			Cl 6"	OPEN (1)	CLOSED (1)

(1) Purge / repressurization Valve remains open and closed in any 5 minute period depending on the setting of the Economizer Switch. See table below for open and closed times.

TABLE 3A Purge valve open times for dryers operating on a 10 minute cycle.

MODEL	ECONOMIZER SWITCH SETTING	OPEN	CLOSED
150 MWP	100%	3' 54"	1'
	75%	2' 54"	2'
	50%	1' 54"	3'
	25%	54"	4'
250 MWP	100%	2' 54"	2'
	67%	1' 54"	3'
	33%	54'	4'

FIGURE 3E For dryers operating on a 4 minute cycle

VALVE	TIME (MIN) 0 1 2			3 4		
3A	OPEN			CLOSED		
3B	CLOSED			OPEN		
9B	Cl 6"	OPEN (2)	CLOSED (2)	CLOSED		
9A	CLOSED			Cl 6"	OPEN	CLOSED

(2) Purge / repressurization Valve remains open and closed in any 2 minute period depending on the setting of the Economizer Switch. See table below for open and closed times.

TABLE 3B Purge valve open times for dryers operating on a 4 minute cycle.

MODEL	ECONOMIZER SWITCH SETTING	OPEN	CLOSED
150 MWP	100%	1' 6"	48"
	67%	42"	1' 12"
250 MWP	100%	42"	1'12"

3.3 Shut Down

3.3.1 Depressurize dryer

3.3.1.1 Open by-pass valve (if one is installed) and close inlet and outlet isolation valves.

3.3.1.2 Run timer through a tower change cycle until pressure gauges on both towers read 0 psig.

3.3.2 De-energize dryer

Turn dryer off using on-off switch (Power-On light extinguished).

3.4 Loss of Power

Control valves are designed so that upon loss of power the air dryer is capable of drying air until the desiccant exposed to the air flow is saturated.

.5 Verify that dryer is operating within design parameters

3.5.1 Maximum working pressure:

Refer to Serial Number Tag to determine maximum working pressure of dryer.

WARNING

Do not operate dryer at pressures above the maximum pressure shown on the tag.

3.5.2 Minimum working pressures:

150 psig MWP models -

60 psig (4.1bar) for dryers operated on a 10 minute cycle

80 psig (5.6 bar) for dryers operated on a 4 minute cycle

250 psig MWP models

125 psig (8.6 bar) for dryers operated on a 10 minute cycle

150 psig (10.3 bar) for dryers operated on a 4 minute cycle.

If lower inlet pressures are encountered, consult factory.

3.5.3 Maximum operating temperature: 120°F (49°C).

3.5.4 Maximum Inlet Flow Capacity

3.5.4.1 At 100 psig (6.9 bar): For maximum inlet flow at 100 psig (6.9 bar) refer to *Table* 4

3.5.4.2 At pressures other than 100 psig (6.9 bar): Multiply inlet flow from *Table* 4 by multiplier from *Table* 5 that corresponds to system pressure at inlet to dryer.

3.6 Determining Purge and Outlet Flows:

3.6.1 Purge Flows

3.6.1.1 Maximum Purge Flow.- Maximum Purge Flow (MFP) is the amount of purge air flowing through the off-stream tower when the purge/repressurization valve is open. After the purge/repressurization valve closes, the purge flow will gradually decrease as the off-stream tower repressurizes to line pressure.

For maximum purge flow multiply inlet flow at rated conditions from *Table* 4 by Maximum Purge Flow Factor from *Table 6* that corresponds to the dryer MWP, Cycle Time Setting, and air pressure at inlet to dryer. For dryers supplied with the optional Automatic Purge Saving System operating in the Demand Cycle Mode, use 10 minutes as the cycle time.

3.6.1.2 Average Purge Flow - For dryers with the standard control board and dryers with the Automatic Purge Saving System operating in the fixed cycle mode:

The Average Purge Flow (APF) is the actual amount of flow used during the entire purge/repressurization cycle. It includes the maximum purge flow (MFP) for a portion of the purge/repressurization time and the volume of air used for repressurization, averaged over the cycle time.

To determine average purge flow, multiply maximum inlet flow at rated conditions from *Table* 4 by Average Purge/Repressurization Flow Factor from *Table 7* that corresponds to the dryer Maximum Working Pressure, Inlet Pressure, Cycle Time Setting, and Economizer Switch Setting.

3.6.2 Outlet Air Flow

3.6.2.1 Minimum Outlet Flow

Determine minimum outlet flow available from dryer by subtracting Maximum Purge Flow (MFP) found in 3.6.1.1 from inlet flow to the dryer.

3.6.2.2 Average Outlet Flow - For dryers with the standard control board and dryers with the Automatic Purge Saving System operating in the fixed cycle mode:

Determine average outlet flow available by subtracting Average Purge Flow (APF) found in 3.6.1.2 from the inlet flow to the dryer.

NOTE

Average outlet flow may be used to determine available downstream air supply if a storage vessel (e.g. receiver tank) of sufficient volume is available between dryer and point of air usage. Otherwise use minimum outlet flow to determine downstream air available.

EXAMPLE

Find maximum inlet flow, maximum and average purge flows, and minimum and average outlet flows for a 60 scfm unit with a MWP of 150 psig operated at 120 psig on a 10 minute cycle. Dryer will operate with an inlet air flow of 48 scfm.

Step 1: Find Maximum Inlet Flow by multiplying Maximum Inlet Flow at Rated Conditions from *Table* 4 by Inlet Pressure Correction Factor from *Table 5*: 60 x 1.08 = 64.8 scfm.

Step 2: Find Maximum Purge Flow by multiplying Inlet Flow at Rated Conditions from *Table 4* by Maximum Purge Flow Factor from *Table 6*: 60 x .162 = 9.7 scfm.

Step 3: Find Average Purge Flow by multiplying Maximum Inlet Flow at rated conditions from *Table 4* by Average Purge/Repressurization Flow Factor from *Table 7:* 60 x .103 = 6.2 scfm.

NOTE

A 48 scfm dryer is operating at 75% of maximum flow (@ 120 psig): 48/64.8 = 74%. Average purge flow is based on Economizer Switch setting of 75%.

Step 4: Find Minimum Outlet Flow available by subtracting Maximum Purge Flow (Step 2) from inlet flow: 48 - 9.7 = 38.3 scfm.

Step 5: Find Average Outlet Flow available by subtracting Average Purge Flow (Step 3) from inlet flow: 48 - 6.2 = 41.8 scfm.

3.7 Determining outlet pressure dew point at various inlet compressed air temperatures:

The outlet pressure dew point is determined by the compressed air temperature at the inlet to the dryer and cycle time selected (4 or 10 minutes). Use *Table 9* to determine outlet dew points at various inlet compressed air temperatures and cycle times.

TABLE 4 Maximum Inlet Flow at Rated Conditions

MODEL	25	45	60	80	115	165	260	370	450	590	750	930	1130	1350	1550	2100	3000	4100	5400
Inlet @ 100 psig (scfm) (1) (2)	25	45	60	80	115	165	260	370	450	590	750	930	1130	1350	1550	2100	3000	4100	5400

(1) Convert scfm to metric units as follows: 1 scfm = 1.717m³/h.
(2) "Performance data obtained and presented in accordance with ANSI/893.45M-1982. Pneumatic fluid power-Compressed air dryers-Methods for rating and testing." Conditions for rating air dryers are: 100 psig (6.9 bar) and 100°F (37.8°C) saturated inlet air, and a maximum 5 psi (.35 bar) pressure drop. Actual pressure drop for all units is less than 3 psi at rated conditions.

TABLE 5 Inlet Pressure Correction Factor

INLET PRESSURE	psig bar	60 4.1	70 4.8	80 5.5	90 6.2	100 6.9	110 7.6	120 8.3	125 3.6	140 9.7	150 10.3	175 12.1	200 13.8	225 15.5	250 17.3
MULTIPLIER		0.65	0.74	0.83	0.91	1.00	1.04	1.08	1.10	1.16	1.20	1.29	1.37	1.45	1.52

TABLE 6 Maximum Purge Flow Factor

DRYER MWP		150 psig						250 psig					
INLET PRESSURE (psig)		50-100	110	120	130	140	150	125	150	175	200	225	250
CYCLE TIME	10 minute	0.175	0.168	0.162	0.156	0.151	0.146	0.214	0.196	0.184	0.172	0.163	0.155
	4 minute	0.249	0.239	0.230	0.221	0.215	0.207	-	0.326	0.304	0.286	0.270	0.257

TABLE 7 Average Purge/Repressurization Flow Factor

DRYER MWP			150 psig										250 psig					
INLET PRESSURE (psig)			60	70	80	90	100	110	120	130	140	150	125	150	175	200	225	250
10 MINUTE CYCLE	ECONOMIZER SWITCH SETTING	25%	0.038	0.039	0.040	0.041	0.041	0.041	0.040	0.040	0.039	0.039						
		50%	0.073	0.073	0.074	0.075	0.076	0.074	0.072	0.070	0.069	0.068						
		75%	0.107	0.107	0.108	0.109	0.110	0.106	0.103	0.100	0.098	0.096						
		100%	0.141	0.142	0.143	0.143	0.144	0.139	0.134	0.131	0.128	0.125						
		33%											0.048	0.048	0.048	0.047	0.047	0.047
		67%											0.090	0.086	0.083	0.080	0.078	0.076
		100%											0.133	0.125	0.118	0.114	0.111	0.108
4 MINUTE CYCLE	ECONOMIZER SWITCH SETTING	67%	0.102	0.104	0.106	0.108	0.109	0.107	0.105	0.104	0.103	0.103						
		100%	0.147	0.149	0.151	0.152	0.155	0.151	0.147	0.146	0.143	0.140						
		100%											-	0.140	0.138	0.135	0.134	0.134

TABLE 8 Purge Economizer Switch Setting

DRYER MWP	% OF MAX. FLOW	10 MINUTE CYCLE DIP SWITCH POSITIONS 1	2	3	4	% OF MAX. FLOW	4 MINUTE CYCLE DIP SWITCH POSITIONS 1	2	3	4
150 psig	100	Off	Off	Off	Off	100	Off	Off	On	Off
	75	Off	Off	On	Off	67	Off	On	On	Off
	50	Off	On	On	Off					
	25	On	On	On	Off					
250 psig	100	Off	Off	On	Off	100	Off	On	On	Off
	67	Off	On	On	Off					
	33	On	On	On	Off					

TABLE 9 Outlet pressure dew points for dryers supplied with Activated Alumina Desiccant

INLET TEMP.	°F	35	40	50	60	70	80	90	100	110	120
	°C	1.7	4.4	10.1	15.6	21.1	26.7	32.2	37.8	43.3	48.9
OUTLET P.D.P. 10 MIN. CYCLE	°F	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30
	°C	-59.4	-56.7	-53.9	-51.1	-48.3	-45.6	-42.8	-40.0	-37.2	-34.4
OUTLET P.D.P. 4 MIN. CYCLE	°F	-149	-145	-138	-130	-122	-115	-108	-100	-92	-85
	°C	-100.6	-98.3	-94.4	-90.0	-85.6	-81.7	-77.8	-73.3	-68.9	-65.0

TABLE 10 Outlet pressure dew points at moisture indicator color change

INLET TEMP.	°F	35	40	50	60	70	80	90	100	110	120
	°C	1.7	4.4	10.1	15.6	21.1	26.7	32.2	37.8	43.3	48.9
OUTLET P.D.P.	°F	-34	-28	-22	-16	-10	-4	3	9	15	21
	°C	-36.7	-33.4	-30.0	-26.7	-23.4	-20.0	-16.1	-12.8	-9.5	-6.1

4.0 MAINTENANCE

WARNING

The heatless desiccant dryer is a pressure containing device. epressurize before servicing. (See Section 3.3)

4.1 Desiccant Replacement

NOTE

The use of the correct replacement desiccant is necessary for roper dryer operation. Never use hygroscopic salts of the type ommonly used in "deliquescent" type dryers.

4.1.1 Frequency of desiccant replacement

Desiccant should be replaced whenever the required dew point annot be maintained while the dryer is being operated within its lesign conditions and there are no mechanical malfunctions. Refer to section 5.0 for troubleshooting hints.

NOTE

Desiccant life is determined by the quality of the inlet air. Proper iltering of the inlet air will extend the life of the desiccant.

Typically desiccant life is 3 to 5 years.

4.1.2 Procedure for Desiccant Charge Replacement

4.1.2.1 Depressurize and de-energize the dryer. (See section 3.6)

4.1.2.2 Remove the fill and drain plugs from desiccant tower and drain the spent desiccant. Place a container at the base of the vessel to collect the desiccant. If necessary ap the sides of the vessels with a rubber mallet to loosen desiccant.

4.1.2.3 Replace the drain plug using teflon tape sealant or equivalent.

4.1.2.4 Fill the desiccant drying ower as full as possible with dry desiccant. Do not tamp desiccant.

4.1.2.5 Replace the fill plug using teflon tape sealant or equivalent.

4.1.2.6 Repeat this procedure for the other drying tower.

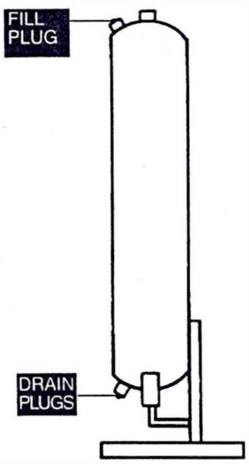


FIGURE 4A

4.1.3 Insuring desiccant dryness

4.1.3.1 Replacement desiccant is shipped in air tight containers. Keep the covers on these containers tightly closed until use to avoid moisture contamination. If desiccant is exposed to air it can be heated in an oven at 400°F (204°C) for four hours before use, or the procedure in 4.1.3.2 can be used.

4.1.3.2 If the dryer is not refilled with dry desiccant, it will be necessary to operate the dryer with an inlet flow rate of less than 50% of maximum to dry the desiccant. To do this, set the Economizer Switch for 100%, and the purge pressure for 45 psig. (3.1 bar)

4.2 Pilot Air Filter - Cartridge Replacement - Models 370 scfm and larger

4.2.1 Frequency of replacement - Pilot air filter contains a filter cartridge which should be changed yearly or sooner if pressure drop across cartridge prevents valves from actuating. Pilot air pressure must not drop below 60 psig (4.1 bar).

4.2.2 Procedure for cartridge replacement.

WARNING

THE FILTER IS A PRESSURE CONTAINING DEVICE. DEPRESSURIZE DRYER BEFORE SERVICING. (SEE SECTION 3.3)

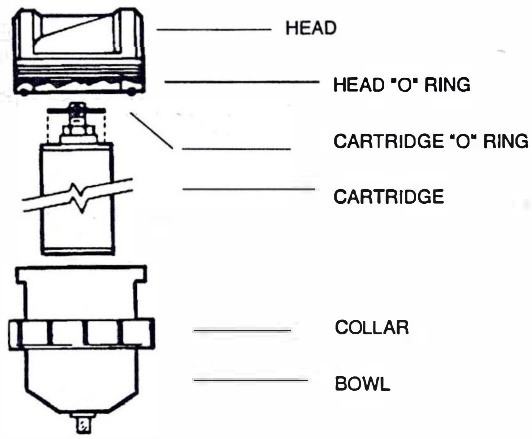


FIGURE 4B

NOTE

4.2.2.1 Unscrew the collar holding the filter bowl to head and remove the filter bowl and collar.

4.2.2.2 Clean the filter bowl.

4.2.2.3 Unscrew the old filter cartridge and discard. Also discard the small O-ring that seals the filter to the filter assembly head.**4.2.2.4** Insert small replacement O-ring on top of replacement filter cartridge and screw replacement filter cartridge into filter assembly head.

It is only necessary to finger tighten the filter cartridge into position to insure the seal. DO NOT WRENCH TIGHTEN.

4.2.2.5 After making sure large O-ring in filter is in place, reassemble filter bowl to filter head.

4.3 Fuse Replacement

4.3.1 Standard Units Only:

4.3.1.1 Fuse is located on board in electrical enclosure. Replace with 1/4 x 1 1/4", fast acting, 5 amp fuse (Bussmann AGC5).

TABLE 12 Amount of desiccant required for complete change (lb)

MODEL	25	40	60	80	115	165	260	370	450	590
ACTIVATED ALUMINA	48	48	72	106	182	182	316	452	528	710

MODEL	750	930	1130	1350	1550	2100	3000	4100	5400
ACTIVATED ALUMINA	926	1172	1468	1766	2064	2592	3930	4920	7750

4.3.2 Fuse Replacement

Only one of the "Valve Power" and one of the "Control Power" fuses should be installed at any time.

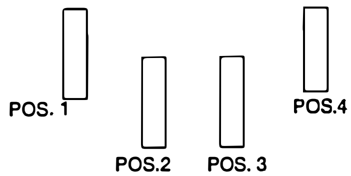
4.3.2.1 Use 1/8 amp fuse in positions 1 & 2

4.3.2.2 Use 1.6 amp fuse in positions 3 & 4.

4.3.2.3 Positions 1 & 4 take 5 mm x 20 mm size.

4.3.2.4 Positions 2 & 3 take 1/4" x 1 1/4" size.

4.3.2.5 Place fuses in positions 2 & 3 or 1 & 4 only. Do not place fuses in all four positions.



4.4 Battery replacement

Controller contains a battery which requires replacement every 3 to 4 years. If the battery is dead and the power is turned off and back on, a 10 minute fixed cycle will be selected by default.

4.5 Diagnostics

Manual Control

Press cycle selector switch until Test Mode Light illuminates. This change will not be acknowledged by the controller until the present cycle is completed (right tower drying terminates) or until the controller is de-energized and re-energized (not recommended when either tower is being regenerated since it will possibly cause a rapid repressurization).

In this mode the dryer is manually controlled and can be stepped through the cycle by depressing the alarm reset switch. At the same time, the average demand meter is functioning as a voltmeter monitoring the voltage from the thermistors. The dryer status and thermistor being monitored are indicated in the table below.

A 0% reading for a thermistor indicates a short circuit and a 100% reading, indicates an open circuit. A curve relating the demand meter reading to the thermistor temperature is shown in Figure 4C.

After the troubleshooting is completed, set the cycle selector to the desired position. Use the reset switch to manually step through the dryer operating sequence until the left tower drying light is illuminated and the reset switch cannot be used to step through the cycle. At this point, the dryer is on automatic control. Verify that the right tower depressurizes and repressurizes automatically before leaving the dryer.

If the dryer is switched from the manual mode and the cycle is not completed using the reset switch, the controller will automatically step through the test mode at a rate of one step every 50 seconds until the cycle is completed.

NOTE

Changes in the cycle selector are only acknowledged when the present cycle is completed. If in manual mode, continue to step through dryer operating sequence until left tower drying begins.

STEP NUMBER	WHAT OCCURS	TOWER STATUS				VALVE POSITION				SOLENOID/TERMINALS ENERGIZED (light illuminated)				FOR AIR-OPERATED VALVES: PILOT VALVE PORT PRESSURIZED				THERMISTOR BEING CHECKED			
		MODE		PRESSURE		L	L	R	R	L P/R	L IN	R P/R	R IN	L	L	R	R	T	T	B	B
		LT	RT	LT	RT	P/R	IN	P/R	IN	(15/14)	(13/12)	(1/10)	(9/8)	P/R	IN	P/R	IN	L	R	L	R
Start		D	D	LP	LP	C	O	C	O					A	A	A	A				
1	R IN closes	D	-	LP	LP	C	O	C	C				E	A	A	A	B	X			
2 (1)	R P/R opens	D	R	LP	<2	C	O	O	C			E	E	A	A	B	B				X
3	No change	D	R	LP	<2	C	O	O	C			E	E	A	A	B	B				X
4 (2) (3)	R P/R closes	D	-	LP	REP	C	O	C	C				E	A	A	A	B	X			
5	R IN opens	D	D	LP	LP	C	O	C	O					A	A	A	A				
6	L IN closes	-	D	LP	LP	C	C	C	O		E			A	B	A	A			X	
7 (1)	L P/R opens	R	D	<2	LP	O	C	C	O	E	E			B	B	A	A		X		
8	No change	R	D	<2	LP	O	C	C	O	E	E			B	B	A	A		X		
9 (2) (3)	L P/R closes	-	D	REP	LP	C	C	C	O		E			A	B	A	A			X	

NOTES:

(1) Close purge rate valve during this step to check for any valve leaks. No air should exhaust through the muffler. If air is exhausting through the muffler, check all valves for leaks. After testing for leaks or fixing any leaks, be sure to open the purge pressure valve and reset the purge pressure.

(2) Do not go to the next step until the tower is repressurized.

(3) Switching failure alarm circuit is energized during this step (alarm light should flash until pressure exceeds 40 psig).

CODES:

R IN - Right inlet valve
R P/R - Right purge/repressurization valve
L IN - Left inlet valve
L P/R - Left purge/repressurization valve
LT - Left tower
RT - Right tower

D - Drying
R - Regenerating
LP - Line Pressure
<2 - Less than 2 psig
REP - Repressurizing
C - Closed
O - Open

E - Energized
TL - Top left
TR - Top right
BL - Bottom left
BR - Bottom right

TEMPERATURE RANGE VERSUS AVERAGE DEMAND

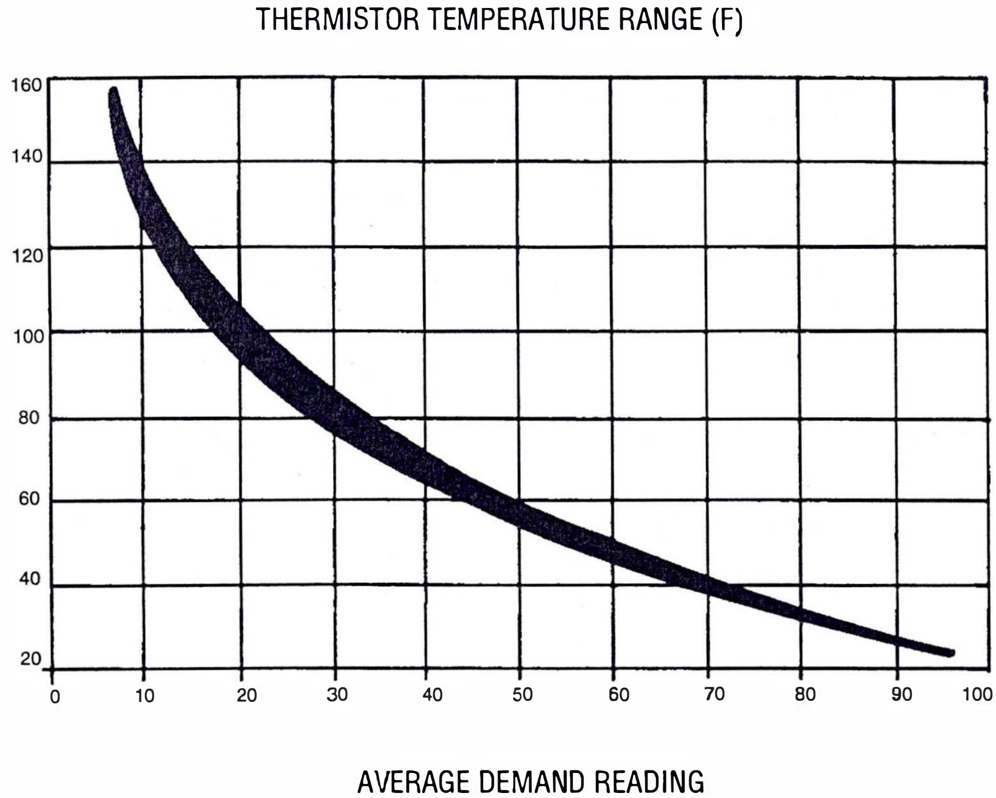


FIGURE 4C

5.0 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
5.1 Power-on light not lit	No power to unit	Check voltage at terminal board.
	On/Off Switch off	Turn on.
	Switch malfunctioning	Replace switch.
	Light burnt out	Replace light.
5.2 Moisture Indicatior	Maximum flow being exceeded	Refer to Section 3.5.4 to determine maximum flow.
Turns yellow (elevated outlet dew points)	Design conditions being exceeded	Refer to Section 3.5 to determine if dryer is being operated within its design limitations.
	Desiccant not adsorbing a. Useful service life has ended	Change desiccant.
	b. Desiccant is contaminated (e.g. with oil)	Take corrective action. Refer to Section 2.1 to determine proper prefiltration then change desiccant.
	c. Premature exhaustion (saturated with water)	Refer to 5.3for corrective action. Desiccant beds may be reactivated by running at reduced flow until desired outlet dewpoint is achieved.
5.3 Desiccant being exhausted prematurely	Insufficient purge rate a. Improper purge rate valve purge	Refer to Section 3.1.4 to determine correct Purge Pressure Indicator Setting.
	b. Tower not completely depressurized during purge cycle (Tower pressure gauge should read lower than 2 psig)	
	1. Clogged exhaust muffler	Replace muffler.
	2. Purge valve won't open	Check power to valve to determine if valve or timer at fault. On Models 370 and larger, check pilot air line for obstruction.
	3. Check valve stuck open	Repair valve.
	Insufficient purge time a. Improper set points	Refer to Section 3.1.1 to determine correct Economizer Switch and Cycle Time Jumper settings.
	b. Faulty Timer	Refer to Section 3.2.3 to verify proper time sequence.
5.4 Tower fails to pressurize to line pressure	Purge repressurization valve won't close	Check valve for obstruction. On Models 25 thru 260 this valve is normally closed. On Models 370 and larger, check pilot solenoid valve and pilot air line for obstruction.
	Excessive downsteam air demand	
5.5 Towerfails to depressurize to less than 2 psig	Purge rate valve open too far	Check Section 3.1.4 for purge rate indicator setting.
	Clogged muffler	Replace muffler.
	Check valve stuck open	Repair valve.
	Purge repressurization valve won't open	Check power to valve (pilot valve on Models 370 and larger) to determine if valve or timer is at fault.. Models 370 and larger: Check pilot valve, pilot air line, and purge repressurization valve for obstruction.
5.6 Excessive purge air is discharged during purge cycle	Inlet valve won't close	Check power to valve (pilot valve on Models 370 and larger) to determine if valve or timer iis at fault. Check valve for obstruction. Models 370 and larger: Check pilot valve and pilot air line for obstruction.
	Check valve sticking	Refer to Section 3.2.3.2
5.7 Excessive desiccant dust downstream	Faulty timer	Refer to Section 3.2.3 to verify proper time sequence.
	Purge rate valve closed	Refer to Section 3.1.4 to determine Correct Purge Pressure setting.

WARRANTY

The manufacturer warrants the product manufactured by it, when properly installed, operated, applied, and maintained in accordance with procedures and recommendations outlined in manufacturer's instruction manuals, to be free from defects in material or workmanship for a period of one (1) year from the date of shipment to the buyer by the manufacturer or manufacturer's authorized distributor, or eighteen months from the date of shipment from the factory, whichever occurs first, provided such defect is discovered and brought to the manufacturer's attention within the aforesaid warranty period. The manufacturer will repair or replace any product or part determined to be defective by the manufacturer within the warranty period, provided such defect occurred in normal service and not as a result of misuse, abuse, neglect or accident.

The warranty covers parts and labor for the warranty period. Repair or replacement shall be made at the factory or the installation site, at the sole option of the manufacturer. Any service performed on the product by anyone other than the manufacturer must first be authorized by the manufacturer. Normal maintenance items requiring routine replacement are not warranted. Unauthorized service voids the warranty and any resulting charge or subsequent claim will not be paid. Products repaired or replaced under warranty shall be warranted for the unexpired portion of the warranty applying to the original product. The foregoing is the exclusive remedy of any buyer of the manufacturer's product. The maximum damages liability of the manufacturer is the original purchase price of the product or part.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, OR STATUTORY, **AND IS EXPRESSED IN LIEU OF THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.** THE MANUFACTURER SHALL NOT BE LIABLE FOR LOSS OR DAMAGE BY REASON OF STRICT LIABILITY IN TORT OR ITS NEGLIGENCE IN WHATEVER MANNER INCLUDING DESIGN, MANUFACTURE OR INSPECTION OF THE EQUIPMENT OR ITS FAILURE TO DISCOVER, REPORT, REPAIR, OR MODIFY LATENT DEFECTS INHERENT THEREIN. THE MANUFACTURER, HIS REPRESENTATIVE OR DISTRIBUTOR SHALL NOT BE LIABLE FOR LOSS OF USE OF THE PRODUCT OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE BUYER, WHETHER ARISING FROM BREACH OF WARRANTY, NEGLIGENCE OR STRICT LIABILITY IN TORT.

The manufacturer does not warrant any product, part, material, component, or accessory manufactured by others and sold or supplied in connection with the sale of manufacturer's products. *8/94*

AUTHORIZATION FROM THE SERVICE DEPARTMENT IS NECESSARY BEFORE MATERIAL IS RETURNED TO THE FACTORY OR IN-WARRANTY REPAIRS ARE MADE.

FOR SERVICE INFORMATION CALL (412) 746-1100

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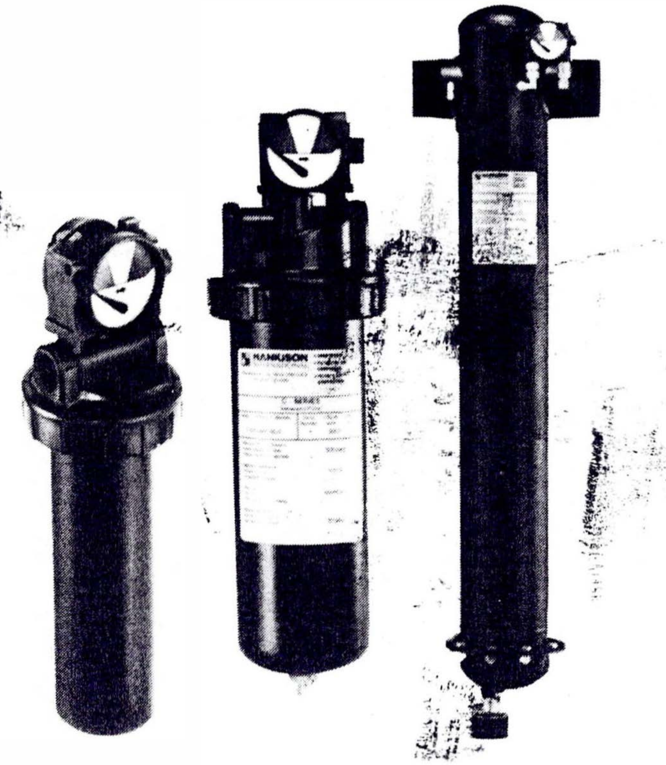


HANKiSON®
COMPRESSED AIR FILTERS
Instruction Manual

C Series Separator/Filter
C18 through C660
T Series Air Line Filter
T20 through T850
A Series Oil Removal Filter
A18 through A350
H Series Oil Vapor Removal Filter
H18 through H350

GENERAL DESCRIPTION

C Series Separator/Filter (Centriflex):
Removes solid particles, water droplets and oil aerosols three microns (mean diameter) and larger from compressed air and gas systems in order to protect downstream equipment from damage or malfunction. The Separator/Filter is designed for use at locations where large liquid loads are present (downstream of aftercoolers, etc.).

T Series Air Line Filter (3100 Series):
Removes solid particles, water droplets and oil aerosols one micron (mean diameter) and larger from compressed air and gas systems in order to protect downstream equipment from damage or malfunction and to prolong the life of finer filters. It is designed for use where bulk liquid has been removed from the system.

A Series Oil Removal Filter (Aerolescer):
Removes 99.999+% of liquid aerosols (specifically oil) 0.01 microns and larger from compressed air and gas systems in order to protect downstream equipment from damage and products and processes from oil aerosol contamination.

H Series Oil Vapor Removal Filter (Hypersorb):
Removes gaseous oil and various other hydrocarbon vapors from compressed air in order to remove offensive odors from the system and prevent contamination of products or processes. It is intended for use after an Oil Removal Filter.

CAUTION:
Pressurize and depressurize filters slowly.

GENERAL SAFETY INFORMATION
CAUTION

1. Pressurized devices-

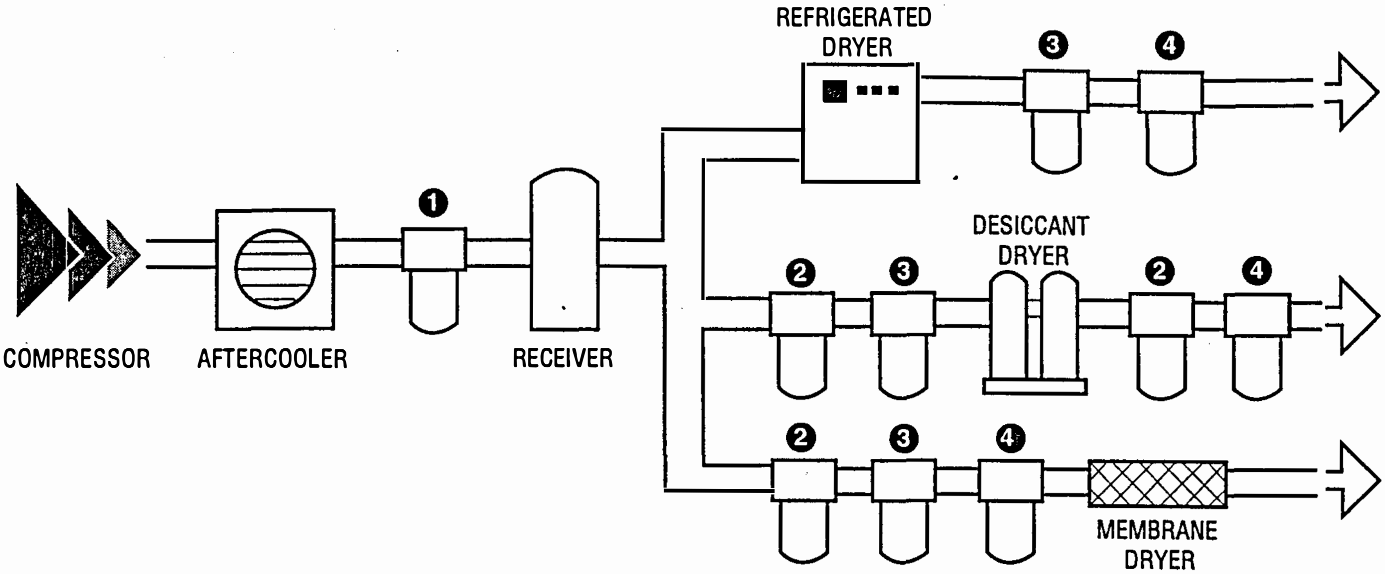
This equipment is a pressure containing device.
- Do not exceed maximum operating pressure as shown on equipment serial number tag.
- Make sure equipment is depressurized before working on or disassembling it for servicing.

2. Breathing air-
- Air treated by this equipment may not be suitable for breathing without further purification. Refer to OSHA standard 1910.134 for the requirements for breathing quality air.

3. Flammable gases-
WARNING:
- The materials of construction used in the this product are compatible physically with flammable gases, however, there are application limitations for this product *when used with flammable gases.*
- The heads of some filters are zinc die castings and can be slightly pourous and, therefore, not completely leak-resistant. *The product should be used in a well ventilated area* and in the absence of sparks or ignition sources. It should not be used within an environment requiring Class I, Division 1, Group D electrical equipment as defined by the National Electric Code.
- The type of area- forced exhaust system used, i.e., high or low level, would be dependant upon the gas involved.
- Each application (other than air or inert gas) should be carefully reviewed to minimze the chances of creating a fire or explosion hazard.

I. INSTALLATION

A. FILTER PLACEMENT IN A TYPICAL COMPRESSED AIR SYSTEM

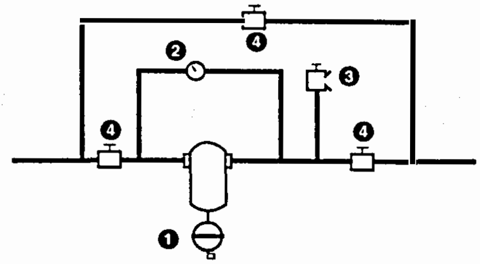


1. **Separator/Filter -**
   Use as a separator to handle the heavy liquid load from the aftercooler. Also provides 3 micron filtration.
2. **Air Line Filter -**
   A. Use as a prefilter ahead of desiccant and membrane dryers
      1) On systems supplied by oil-lubricated systems, use to remove liquid water (if present) and protect the Oil Removal Filter from gross contamination
      2) On oil-free systems - use alone to protect dryer from liquid and solid contaminants.
   B. Use as an afterfilter with pressure-swing (heatless) type desiccant dryers to collect desiccant fines
3. **Oil Removal Filter -**
   A. Use as a prefilter ahead of desiccant and membrane dryers on systems supplied by lubricated compressors to remove oil aerosols.
   B. Use as an afterfilter downstream of refrigerated dryers to remove liquid oil aerosols. (Downstream is the preferred location because of the additional aerosols formed in the dryer)
4. **Oil Vapor Removal Filter -**
   Use to remove oil vapor and its subsequent taste and odor.

IMPORTANT:
An Oil Vapor Removal Filter must always be installed downstream of an Oil Removal Filter.

IMPORTANT:
The compressed air supply at the inlet to the filter should be periodically checked to insure that equipment design specifications are not exceeded. Normally the compressor installation includes intercoolers, aftercoolers, separators, receivers, or similar equipment which adequately pretreat the compressed air supply in order to avoid excessively high air temperatures and liquid slugging of downstream equipment.

A typical installation will also include:



1. **Manual or automatic drains -**
   For draining collected liquids from the system (Separator/Filter, Air Line Filter, and Oil Removal Filter) and depressurizing filter for servicing (all).
2. **Differential Pressure Gauges -**
   For monitoring pressure drop across the filter in order to determine the need for filter cartridge replacement (Separator/Filter, Air Line Filter, and Oil Removal Filter)
3. **Air Sample Tap -**
   For determining when the adsorptive capacity of the Oil Vapor Removal Filter cartridge is exhausted.
4. **Isolation valves and by-pass piping -**
   For isolating and by-passing filters for servicing. In critical applications, two filters installed in parallel may be necessary so that one filter is in operation while the other filter is being serviced.

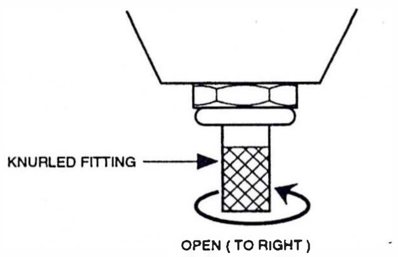
B. PIPING

1. **Mounting -**
   Separator/Filter, Air Line Filter, and Oil Removal Filter - Mount so that inlet and outlet connections are horizontal (filter bowl vertical). Separated and coalesced liquids drain by gravity downwardly through the cartridge and drop to and are collected in the filter sump. The vessel must be mounted nearly plumb vertically so that drainage will not be impeded and filtration efficiency reduced.
2. **Flow Direction -**
   Check to ensure that the air flow is in the proper direction as indicated on the filter head. Air flow direction through the filter cartridge must be from the inside out.
3. **Connection & Clearances -**
   See Dimensional Drawing, (page 6) for connection sizes and service clearances.

C. DRAIN PROVISIONS

1. Manual Drain -

Separator/Filter, Air Line Filter, and Oil Removal Filter- Collected liquids must be drained on a periodic basis. If equipped with a knurled fitting, turn the knurled fitting on the bottom of the bowl to your right (clockwise) to open and to your left (counterclockwise) to close. If equipped with a petcock, open in the normal fashion.

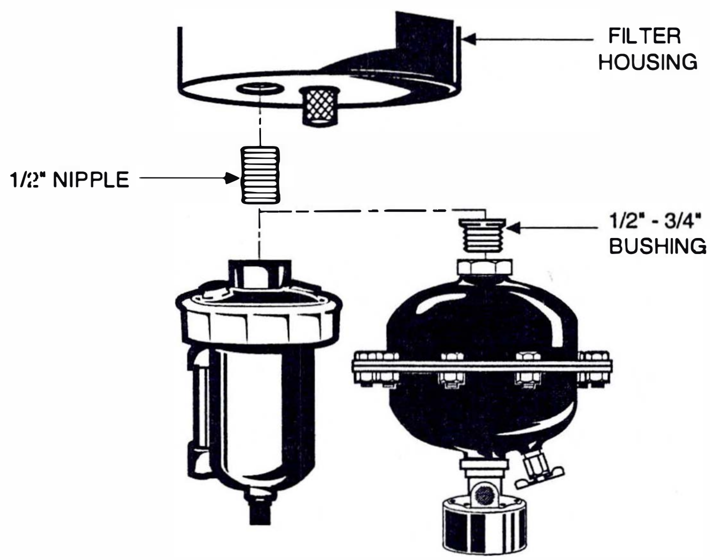


2. Auto Drain -

Units with auto drains will automatically discharge any water and oil collected in the bowl.

a. Filters with Internal Auto Drains - If your filter is equipped with an internal auto drain, "Auto" will appear on the serial number tag next to Drain Type.
Internal Auto Drains may be manually drained by turning the knurled fitting to your right (clockwise) to open.

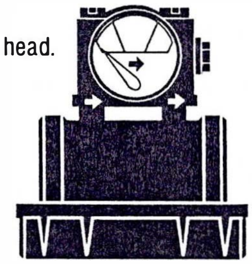
b. Filters with External Auto Drains - 100 ounce bowls and larger are provided with a 1/2" plug for installation of an external auto drain. To install an External Auto Drain, remove plug, attach nipple (and bushing if necessary) and Auto Drain.



D. DIFFERENTIAL PRESSURE GAUGE (DPG) -

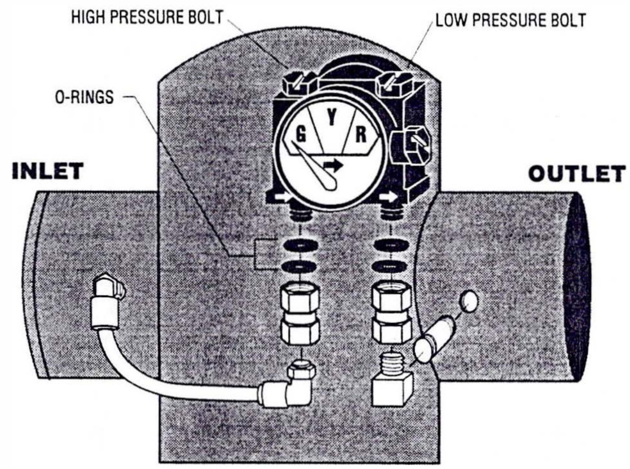
1. Filters with 3/8, 1/2, 3/4, 1, and 1 1/2" connections -

When supplied, the gauge comes preassembled in the filter housing head.

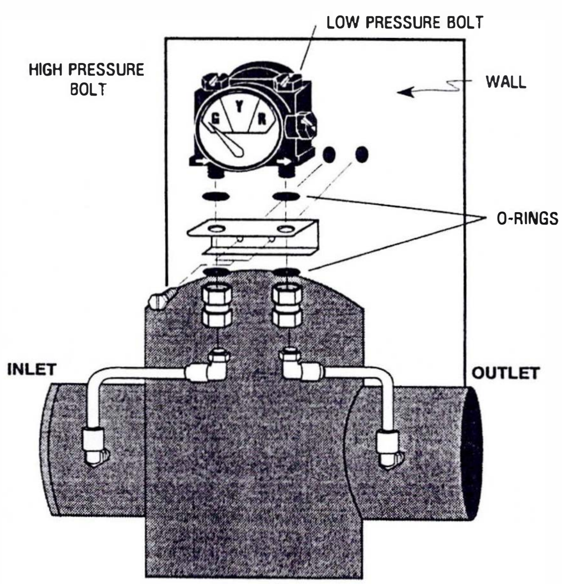


2. Filters with 2 and 3" connections -

When supplied, the gauge and installation kit are shipped separately packaged for field installation. Refer to diagram for proper installation. Gauge may be installed on filter housing with nipple supplied or on a nearby wall using the wall mounting bracket supplied.



NOTES: 1) Make certain O-rings are in place on the bottom of the gauge body.
2) Connect the low pressure transmission bolt (bolt next to RED band on gauge) to the gauge port at the filter outlet (downstream side of filter).
3) Connect the high pressure transmission bolt (bolt next to GREEN band on gauge) to the gauge port at the filter inlet (upstream side of filter).
4) Torque bolts to 25 +/- 5 inch oz. **DO NOT OVERTIGHTEN.**



WALL MOUNTED

E. OPERATING LIMITATIONS

1. **Maximum Working Pressure** - standard units

NOTE: Filter may have higher MWP. Check unit serial number tag to verify MWP.

a. Polycarbonate Bowls: 150 psig *(10 bar)*
b. 16 through 381 oz Metal Bowls-
With manual drain: 300 psig *(21 bar)*
With internal auto drain: 175 psig *(12 bar)*
c. 5" Pressure Vessel-
Standard models with or without internal drain: 300 psig *(21 bar)*

NOTE: If using external drain, do not exceed pressure rating of drain.

2. **Maximum Pressure Differential**

IMPORTANT:
Under normal circumstances the pressure differential across the filter should not exceed 30 psi *(2.1bar)*; excessive pressure drop may cause filter cartridge failure!

3. **Maximum Operating Temperature**
   a. When filtering liquids - Temperatures above 120°F *(49°C)* are not recommended since filtration efficiency may decrease and certain cartridge materials may be adversely affected.
   b. When filtering solids - Air Line Filter only: 200°F *(93.3°C)*. All others: 120°F (49°C).
4. **Maximum Liquid Loading**
   Maximum liquid concentrations at inlet to filters must not exceed:
   a. Separator/Filter: 25,000 ppm w/w
   b. Air Line Filter: 2000 ppm w/w
   c. Oil Removal Filter: 100 ppm w/w If inlet concentrations are greater than this, filter must be preceded by a Separator/Filter or Air Line Filter to remove bulk liquid loading.
   d. Oil Vapor Removal Filter: No liquids should be present at the inlet to this filter.
5. **Chemical Resistance -**
   Compressed air does not normally contain contaminants which will adversely affect the filter cartridge. However, some hydrocarbons, acids, bases and certain other chemicals can attack parts of the filter assembly. These contaminants are usually introduced through the compressor intake port under certain environmental conditions. Provision should be made to prevent this in order to protect the entire compressed air system. On questionable applications consult factory prior to installation.

CAUTION: Polycarbonate Bowls

In units where the separator bowl is constructed of polycarbonate, be aware that the following circumstances could adversely affect the polycarbonate material. Care should be taken to: AVOID installation areas where high temperatures (120°F/*49°C* or higher) exist or solvent fumes or chemical vapors (see Chemical Resistance table) with an adverse affect on polycarbonate are present in the atmosphere.
AVOID cleaning the polycarbonate bowl with solvents such as acetone, alcohols, ketones, esters or aromatic hydrocarbons such as benzene, toluene, xylene, etc. Clean with a mild household detergent only. AVOID adverse solvent fumes & chemical vapors (see Chemical Resistance table) being drawn into the compressed air system via the compressor intake. AVOID the use of polycarbonate bowls on air systems where synthetic compressor lubricants are transmitted downstream. AVOID compressed air temperatures above 120°F/*49°C* or pressures above 150 psig/*10 bar* at inlet to dryer.
Chemical and Solvent Resistance Table (Partial List)
LIMITED RESISTANCE: Cyclohexanol, Gasoline (High Aromatic) Hydrochloric Acid (Conc.), Milk of Lime (CaOh), Nitric Acid Conc.), Sulfuric Acid (Conc.)
NON RESISTANT: Acetaldehyde, Acetic Acid (Conc.), Acetone, Acrylonitrile, Ammonium Fluroide, Ammonium Sulfide, Benzene, Benzoic Acid, Benzyl Alcohol, Bromobenzene, Butyric Acid, Carbon Tetrachloride, Carbon Disulfide, Carbolic Acid, Caustic Potash Solution (5%). Caustic Soda Solution (5%), Chlorobenzene, Cyclo Hexanone, Cyclohexene, Dimethyl Formamide, Ethane Tetrachloride, Ethylamine, Ethyl Ether, Ethylene Chlorohydrin, Formic Acid (Conc.) Freon I(Refrigerant & Propellant)*, Nitrobenzene, Nitrocellulose Lacquer, Phenol, Phosphorous Hydroxy Chloride, Phosphorous Trichloride, Propionic Acid Sodium Sulfide, Styrene, Sulfuryl Chloride, Tetra Hydronaphthaiene, Thiophene, Toluene, Xylene, Synthetic Compressor Lubricants **
Dissolved by: Chloroform, Cresol, Dioxane, Ethylene Dichloride, Methylene Chloride, Pyridine.

* DuPont Trademark ** Phosphate Ester lubricants: where compressor lubricants other than normal mineral base lubricants are used, contact lubricant manufacturer.

CHEMICAL AND SOLVENT RESISTANCE TABLE FOR FILTER CARTRIDGES

OIL REMOVAL FILTER & OIL VAPOR REMOVAL FILTER - POLYURETHANE FOAM (FOAM SLEEVE)
RESISTANT: Not adversely affected chemically by water, soap or detergents; not affected chemically by oils, cleaning solvents, or greases at normal temperature. Heavy liquid loading may cause mechanical degradation.
LIMITED RESISTANCE: Aliphatic hydrocarbons cause slight swelling; aromatic cause considerable swelling; removal of these hydrocarbons allows restoration of original dimensions and strength.
NOT RESISTANT: Strong acids, caustics, chlorine or sulfur dioxide.
ALL MODELS - MINERAL FILLED NYLON (Filter Cartridge End Caps)
RESISTANT: Inert to most organic chemicals such as esters, ketones, alcohols, and hydrocarbons. Resists alkalis and salt solutions.
LIMITED RESISTANCE: Benzene Alcohol, Benzaldehyde, Benzoic, Citric Acid, Mercuric Chloride, Methylene Chloride, Oxalic Acid, and Potassium Bichromate.
NOT RESISTANT: Attacked by strong mineral acids and strong oxidizing agents. The following listed materials result in decomposition, and/or swelling, and/or loss of strength, etc. Aniline, Benzene-Sulphoric Acid, Boron Trifluoride, Bromine, Chloracetic Acid, Chloral Hydrate, Chlorine, Chloroform, Chlorosulfonic Acid, Chromic Acid, Cresols, Ethylene Chlorhydrin, Hydrochloric Acid (10%), Nitric Acid (10%), Phenol, Phosphoric Acid (25%), Potassium, Permaganate, Resorcinol, Sulfuric Acid (10%), Xylenol.
AIR LINE FILTER, AND OIL REMOVAL FILTER - POLYPROPYLENE (Filter Cartridge Inner Support Core Tube) RESISTANT TO: Alkalis, weal acids and saline solutions. Resistant to most organic solvents below 175°F. LIMITED RESISTANCE: Attacked slowly by oxidizing acids. NOT RESISTANT: Soluble in aromatic solvents such as toluene, xylene and chlorinated hydro-carbons at temperature above 175°F.

II. OPERATION

Periodic checks are recommended to insure continuous separation and filtration efficiency.

A. Operational checkpoints for Separator/Filters, Air Line Filters, and Oil Removal Filters

1. Check pressure drop across the filter:
   a. Check for excessive pressure drop. Pressure drop in excess of 10 psi (0.7 bar) indicates that the filter sleeve or cartridge should be replaced. (See Section III.A.)

NOTE: Pressure drop may temporarily increase after flow stoppage: Refer to section III. A.I.C.
NOTE: On filters supplied with Differential pressure Gauges, when indicator enters red area, the element should be replaced.

IMPORTANT:
Pressure drop should never exceed 30 psi *(2.1 bar)*.

   b. Check for sudden reduction in pressure drop. This might indicate:
   (1) Possible leak across O-ring seal between top cap of cartridge and filter head assembly.
   (2) Leak through the filter cartridge due to damage from chemical attack or excessive pressure drop.
2. Check the flow, pressure, and temperature to make sure that the filter is not being operated beyond its rated capacity. See Section II.C. to determine maximum flow capacity.
3. Check to see that filter is installed level (filter bowl plumb vertically). This is necessary to insure adequate drainage of the cartridge.
4. Check for proper drainage. See that manual drains are drained periodically and that automatic drains are functioning. The liquid level must always be kept below the cartridge bottom cap to insure proper operation.
5. Check to see that downstream air lines are clean. Occasionally old air lines or even newly installed air lines contain residual contaminants which could show up at the point of use.

B. Operational Checkpoints for Oil Vapor Removal Filters

1. Check for an oily smell by opening the manual valve. If an oily smell exists the following should be checked:
   a. Filter cartridge adsorptive capacity exhausted. Replace cartridge. (See Section III.A.)
   b. Leak across O-ring seal between cartridge top cap and filter head assembly - seal improperly seated.
   c. Leak through filter cartridge due to damage from chemical attack or excessive pressure drop.
   d. Presence of liquids - failure of upstream filter cartridge.
   e. Flow and pressure conditions in excess of rated capacity. See Section II.C. to determine maximum flow capacity.
   f. Presence of gaseous impurities which cannot be adsorbed.

CAUTION:
Methane, carbon monoxide, carbon dioxide and various inorganic gases cannot be removed by the Oil Vapor Removal filter. The factory should be contacted for special applications.

2. Check for excessive pressure drop. Pressure drops much in excess of 1 psi might indicate:
   a. Filter being operated beyond its rated capacity.
   b. Filter is being overloaded with bulk liquids - Check that filters upstream of the Oil Vapor Removal Filter are properly installed and working correctly.

C. FLOW CAPACITY

Maximum air flow for the various filters at 100 psig is indicated in Table 1. To determine maximum air flows at inlet pressures other than 100 psig, multiply flow from Table 1 by multiplier from Table 2 that corresponds to the minimum operating pressure at the inlet of the filter.

CAUTION:
Do not select filters by pipe size. Make selection by flow rate and operating pressure only.

TABLE 1.
Maximum Air Flow (scfm*) @ 100 psig

C SERIES		T SERIES		A SERIES		H SERIES	
SIZE	FLOW	SIZE	FLOW	SIZE	FLOW	SIZE	FLOW
C18	18	T20	20	A18	18	H18	18
C35	35	T40	40	A35	35	H35	35
C55	55	T110	110	A55	55	H55	55
C110	110	T220	220	A110	110	H110	110
C165	165	T330	330	A220	220	H220	220
C220	220	T400	400	A275	275	H275	275
C330	330	T850	850	A330	330	H330	330
C400	400			A350	350	H350	350
C660	660						

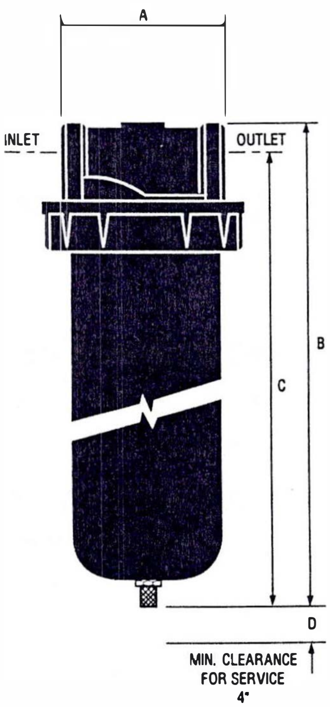
* Convert scfm to metric units as follows: 1 scfm = 1.736 m^3n/h

TABLE 2.
Air Flow Correction Factor

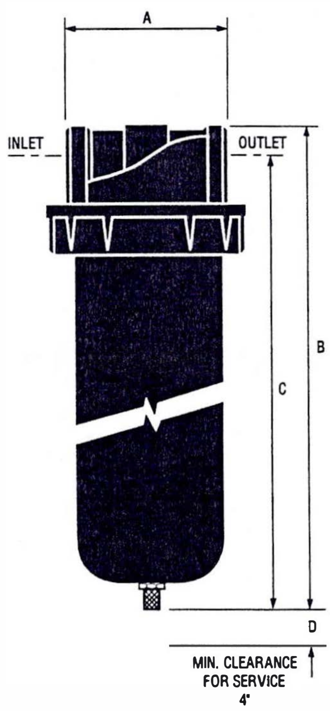
MINIMUM INLET PRESSURE (PSIG)	20	30	40	60	80	100	120	150	200	250	300
MULTIPLIER	0.30	0.39	0.48	0.65	0.82	1.00	1.17	1.43	1.87	2.31	2.74

MODELS				IN/OUT CONNECTION *	BOWL TYPE	DIMENSIONS inches (mm)				WTS. LBS KG
C SERIES Separator/ Filter	T SERIES Air line Filter	A SERIES Oil Removal Filter	H SERIES Oil Vapor Removal Filter			A	B	C	D	
C18 C35	T20 T40	A18 A35	H18 H35	**03** 3/8"	**8 P** 8 oz.Poly	3-3/16 (81)	6-7/16 (164)	5-13/16 (148)	4 (102)	1-5/8 (0.74)
				03 or 04 3/8"or 1/2"	**16 P** 16 oz.Poly	3-3/16 (81)	10-9/16 (268)	9-15/16 (238)	4 (102)	2-1/2 (1.13)
				03 or 04 3/8"or 1/2"	**16** 16 oz.Metal	3-3/16 (81)	10 (254)	9-3/8 (238)	4 (102)	2-3/4 (1.24)
C55 C110	T110	A55	H55	**06 or 08** 3/4"or 1"	**48** 48 0z. Metal	4 (102)	16 (406)	12-3/4 (324)	6 (152)	6 (2.7)
		A110	H110	**06 or 08** 3/4"or 1"	**100** 100 oz.Metal	4 (102)	25-1/8 (638)	21-5/8 (549)	14 (356)	13-1/4 (6.0)
C165	T220			**12** 1-1/2"	**100** 100 oz.Metal	5-1/8 (130)	25-5/8 (651)	22-1/8 (562)	14 (365)	19 (18.9)
C220 C330	T330	A220	H220	**12** 1-1/2"	**205** 205 oz.Metal	5-1/8 (130)	32-7/16 (824)	28-15/16 (735)	16 (406)	21 (9.5)
		A330	H330	**12** 1-1/2"	**381** 381 oz.Metal	5-1/8 (130)	38-1/2 (978)	34-3/4 (883)	26 (660)	30 (13.6)
C400	T400	A275 A350	H275 H350	**16** 2"	**5L** 5" PV	10-1/4 (260)	40-7/8 (1038)	4-7/8 (124)	24 (610)	37 (17)
C660	T850			**24** 3"	**5L** 5" PV	10-1/4 (260)	40-7/8 (1038)	4-7/8 (124)	24 (610)	37 (17)

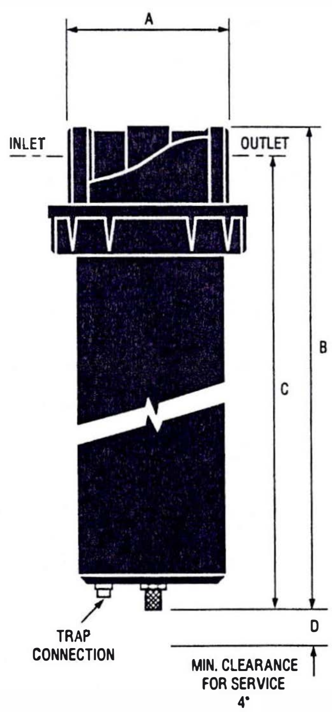
** 03, 04, 06, 08 and 12 NPT Female, 16 and 24 NPT Male; B after number denotes BSP threads supplied.*



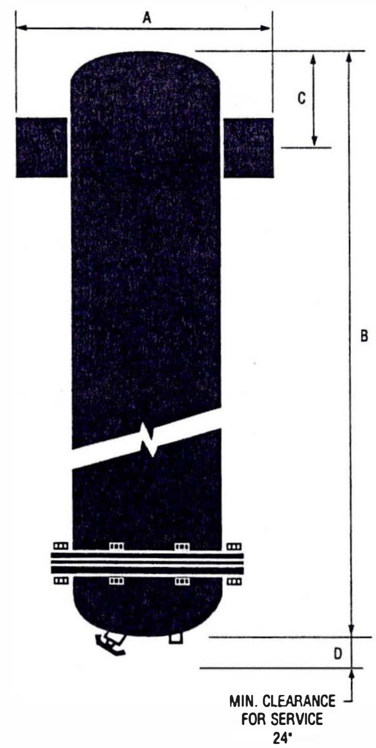
C18 and C35
T20 and T40
A18 and A35
H18 and H35



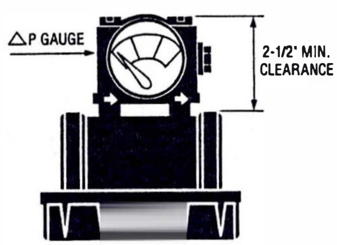
C55 and C110
T110
A55
H55



C165 THRU C330
T220 THRU T330
A110 THRU A330
H110 THRU H330



C400 and C660
T400 and T850
A275 and A350
H275 and H350



Differential Pressure Gauge Specifications:

Maximum working pressure: 300 psig
Maximum operating temperature: 150°F
Inert glass filled Acetal housing

Optional reed switch:
Maximum voltage switching: 100 AC/DC
Maximum switch current: 0.30 AMPS
Maximum carrying current: 1 amp
Contact rating: 10 VA

III. MAINTENANCE:

A. WHEN TO REPLACE FILTER ELEMENT:

NOTE: Air Line Filter, Oil Removal Filter and Oil Vapor Removal Filter - complete cartridge is replaced; Separator/Filter - unless separator core is damaged only outer sleeve needs replaced.

1. Separator/Filter, Air Line Filter, Oil Removal Filter:
   a. Initial (dry) pressure drop: 1 psi *(.07 bar)* nominal.
   b. Operating pressure drop: During operation the filter cartridge becomes liquid loaded (wetted). At rated flow conditions, operating pressure drop will normally be: 3 to 4 psi for light liquid loading, 4 to 5 psi for moderate liquid loading, and 5 to 6 psi for heavy liquid loading. Further pressure drop will occur only as the cartridge becomes contaminated with solid particles.

IT IS RECOMMENDED THAT THE FILTER CARTRIDGE OR SLEEVE BE REPLACED FOR MAXIMUM FILTRATION EFFICIENCY WHEN PRESSURE DROP EXCEEDS 10 PSI (0.7 BAR) (INDICATOR IN RED AREA).

   c. Pressure drop after flow interruption: When flow is interrupted for several hours, the pressure drop may temporarily increase upon the resumption of flow. Normally, within one hour, the pressure drop should return to where it was prior to stopping the flow. This phenomenon is not cause for filter cartridge replacement. It is due both to residual liquids contained within the cartridge "pooling" and a change in the viscosity of these liquids due to a temporary temperature change.

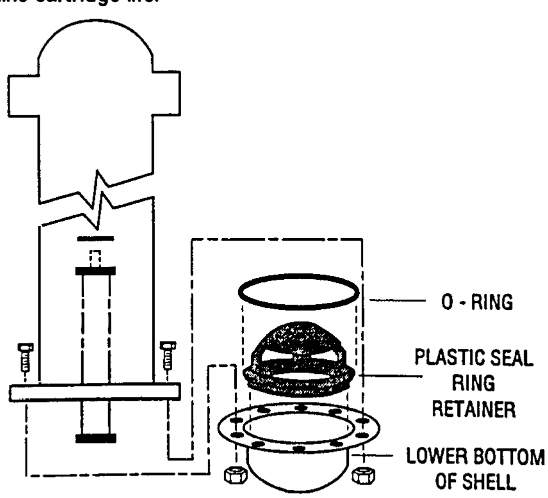
NOTE: Oil Removal Filter only - In operation, the outer foam cover will show evidence of liquid discoloration on a band on the lower portion of the foam cover. This is normal. Spotting above the band indicates that the foam is accumulating liquids faster than it can be drained and that an excessive amount of liquid is present in the incoming air. This may be corrected by installing an air line filter upstream of the filter or by using two filters in series.

2. Oil Vapor Removal Filter: When used after a high efficiency coalescing filter, the Oil Vapor Removal Filter should provide a minimum life of approximately 1500 hours of continuous operation at rated capacity. The pressure drop across the Oil Vapor Removal Filter cartridge remains essentially constant throughout its effective life and cannot be used as an indicator for cartridge replacement. Cartridge life is terminated when the adsorptive capacity of the cartridge is used up. It is recommended that periodic odor tests be conducted to determine cartridge life.

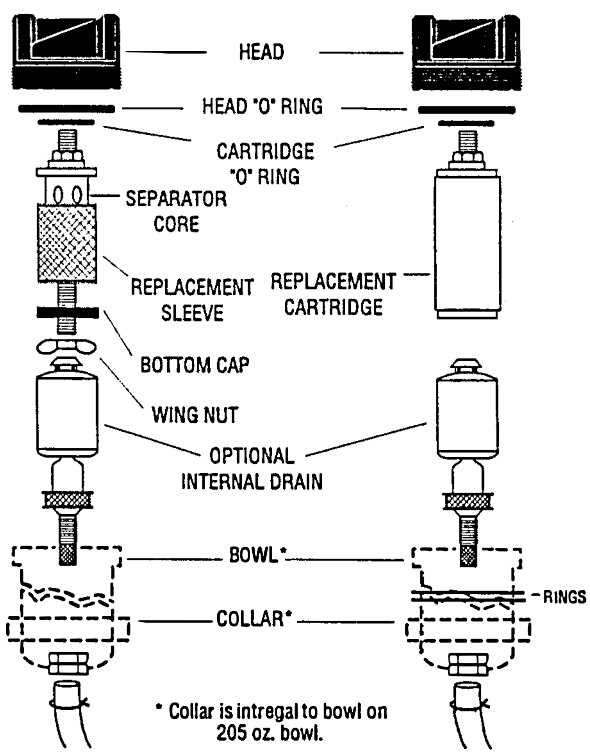
B. PROCEDURE FOR FILTER CARTRIDGE REPLACEMENT:

CAUTION:
THIS FILTER IS A PRESSURE CONTAINING DEVICE. DEPRESSURIZE BEFORE SERVICING.

1. Isolate filter assembly from system by opening by-pass valve (if one is installed) and closing inlet and outlet valves.
2. Depressurize the filter by slowly opening manual drain valve.
3. Disassemble filter housing
   a. For models with 8, 16, 48, and 100 oz bowls - Unscrew the collar holding the filter bowl to the head and remove the filter bowl and collar.
   b. For models with 205 and 381 oz bowls - Remove the filter bowl, unscrewing it from the filter head by hand or strap wrench.
   c. For models with 5" pressure vessel - Remove flange bolts. Lower bottom shell, O-ring, and seal ring retainer.
4. Clean the filter bowl.
5. Remove and replace complete cartridge (all models) or sleeve only (Separator/Filter)
   a. Removing and replacing complete cartridge
      1) Unscrew the old filter cartridge and discard. Also discard the small O-ring that seals the filter to the filter assembly head.
      2) Insert small replacement O-ring on top of replacement filter cartridge and screw replacement filter into filter assembly head.
   b. Removing and replacing sleeve only (Separator/Filter)
      1) Remove wing nut and bottom cap.
      2) Slide disposable filter sleeve down over separator core.
      3) If necessary, unscrew separator core from filter head and clean with soap and water.
      4) Reassemble separator core to head. (Use new O-ring supplied with replacement sleeve.)
      5) Slide new filter sleeve over separator core.
      6) Replace bottom cap and wing nut.



5" Pressure Vessel



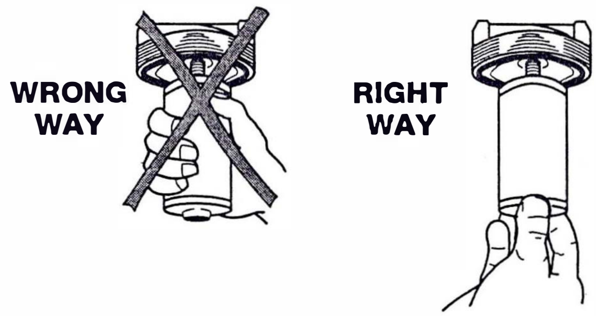
C Series *T, A and H Series*

IMPORTANT:

Oil Removal Filters and Oil Vapor Removal Filters-
The filter cartridges should never be handled by the outside foam cover...damage could result. When installing a replacement cartridge, handle by the bottom end cap only. (See Drawing)

IMPORTANT:

It is only necessary to finger tighten the filter cartridge into position to insure the seal. DO NOT WRENCH TIGHTEN.



6. Reassemble filter housing
  a. Models with bowls - After making sure that large O-ring in filter head is in place, reassemble filter bowl to filter head.
  b. Models with 5" pressure vessel - Reassemble bottom shell, O-ring and seal-ring retainer to housing. Make sure seal-ring retainer provides a backup for the O-ring as shown in drawing.

7. After making sure that the manual valve is closed, repressurize unit by slowly opening the inlet valve, then opening the outlet valve, and finally closing the by-pass valve.

REPLACEMENT CARTRIDGE/SLEEVE

C SERIES		T SERIES		A SERIES		H SERIES	
MODEL	REPLACEMENT SLEEVE	MODEL	REPLACEMENT CARTRIDGE	MODEL	REPLACEMENT CARTRIDGE	MODEL	REPLACEMENT CARTRIDGE
C18	0734-1	T20	0731-3	A18	0713-2	H18	0715-2
C35	0734-2	T40	0731-4	A35	0713-3	H35	0715-3
C55	0734-3	T110	0731-5	A55	0713-4	H55	0715-4
C110	0734-3	T220	0731-6	A110	0713-5	H110	0715-5
C165	0734-4	T330	0731-7	A220	0713-6	H220	0715-6
C220	0734-5	T400	0731-8	A275	0713-12	H275	0715-12
C330	0734-6	T850	0731-9	A330	0713-7	H330	0715-7
C400	0734-7			A350	0713-11	H350	0715-11
C660	0734-7						

WARRANTY

The manufacturer warrants the product manufactured by it, when properly installed, operated, applied, and maintained in accordance with procedures and recommendations outlined in manufacturer's instruction manuals, to be free from defects in material or workmanship for a period of one (1) year from the date of shipment to the buyer by the manufacturer or manufacturer's authorized distributor, or eighteen months from the date of shipment from the factory, whichever occurs first, provided such defect is discovered and brought to the manufacturer's attention within the aforesaid warranty period. The manufacturer will repair or replace any product or part determined to be defective by the manufacturer within the warranty period, provided such defect occurred in normal service and not as a result of misuse, abuse, neglect or accident.

The warranty covers parts and labor for the warranty period. Repair or replacement shall be made at the factory or the installation site, at the sole option of the manufacturer. Any service performed on the product by anyone other than the manufacturer must first be authorized by the manufacturer. Normal maintenance items requiring routine replacement are not warranted. Unauthorized service voids the warranty and any resulting charge or subsequent claim will not be paid. Products repaired or replaced under warranty shall be warranted for the unexpired portion of the warranty applying to the original product. The foregoing is the exclusive remedy of any buyer of the manufacturer's product. The maximum damages liability of the manufacturer is the original purchase price of the product or part.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, OR STATUTORY, **AND IS EXPRESSED IN LIEU OF THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.** THE MANUFACTURER SHALL NOT BE LIABLE FOR LOSS OR DAMAGE BY REASON OF STRICT LIABILITY IN TORT OR ITS NEGLIGENCE IN WHATEVER MANNER INCLUDING DESIGN, MANUFACTURE OR INSPECTION OF THE EQUIPMENT OR ITS FAILURE TO DISCOVER, REPORT, REPAIR, OR MODIFY LATENT DEFECTS INHERENT THEREIN. THE MANUFACTURER, HIS REPRESENTATIVE OR DISTRIBUTOR SHALL NOT BE LIABLE FOR LOSS OF USE OF THE PRODUCT OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE BUYER, WHETHER ARISING FROM BREACH OF WARRANTY, NEGLIGENCE OR STRICT LIABILITY IN TORT.

The manufacturer does not warrant any product, part, material, component, or accessory manufactured by others and sold or supplied in connection with the sale of manufacturer's products.

01/01/93

AUTHORIZATION FROM THE SERVICE DEPARTMENT IS NECESSARY BEFORE MATERIAL IS RETURNED TO THE FACTORY OR IN-WARRANTY REPAIRS ARE MADE.

HANKiSON INTERNATIONAL
CANONSBURG, PA 15317-1700 U.S.A.
TEL (412) 745-1555 • FAX (412) 745- 6040

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SOLO™

CONTROLLERLESS PNEUMATIC PUMP

MANUAL P/N 36226 REV. 2-22-94

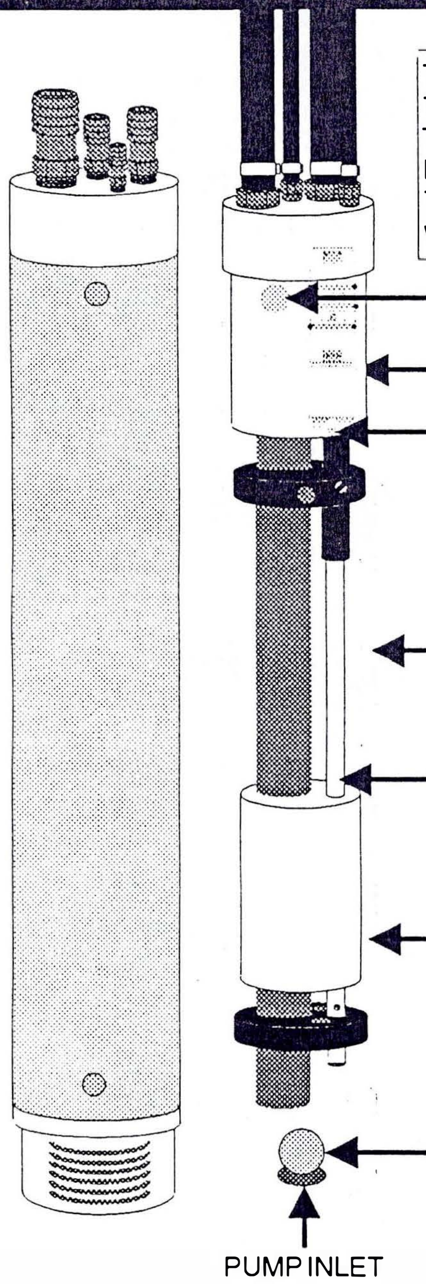
SOLO

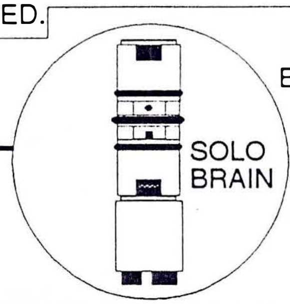
SOLO is an intelligent, high-rate pneumatic pump for total fluids applications. It runs itself, with an internal float system and a magnetic "brain" cartridge. The brain senses liquid level in the pump, turning the air supply on when the pump is full, and turning it off as soon as the pump empties. With its built- in brain, SOLO doesn't require air cycle or on-off level control at the well head, simplifying system design. All you need above the well cap is a compact air filter/speed control. SOLO is easy to install-just run air to each well. Continued operation is truly hands-off. SOLO constantly reacts to changes in well recovery rate, so it's always pumping at the highest rate possible. It also shuts down automatically if water in the well drops below pumping level. (NOTE: SP4000 requires a minimum of 3.5 feet of liquid in order to pump and the SP2000 requires a minimum of 1 foot of liquid in order to pump) Because cycling is controlled at the pump, SOLO is either refilling or discharging 100% of the time. There's no waiting between active phases of the cycle for the entire length of air supply tubing to re-pressurize. This operating efficiency enables SOLO to deliver pumping rates of up to 4.5 gallons per minute while also saving on air supply requirements. The mechanism in SOLO uses the same high-clearance design that has made PULSE PUMP the standard for field performance without clogging or breakdowns.

TABLE OF CONTENTS

HOW THE SOLO PUMP WORKS

THE SP4000 REQUIRES A MINIMUM OF 3.5' OF LIQUID TO PUMP.
THE SP2000 REQUIRES A MINIMUM OF 1' OF LIQUID TO PUMP.
THE SOLO PUMP AUTOMATICALLY SHUTS OFF WHEN THE LIQUID LEVEL IS PUMPED DOWN.
THE SOLO PUMP WILL AUTOMATICALLY BEGIN PUMPING AGAIN ONCE WELL LEVEL HAS RECOVERED.





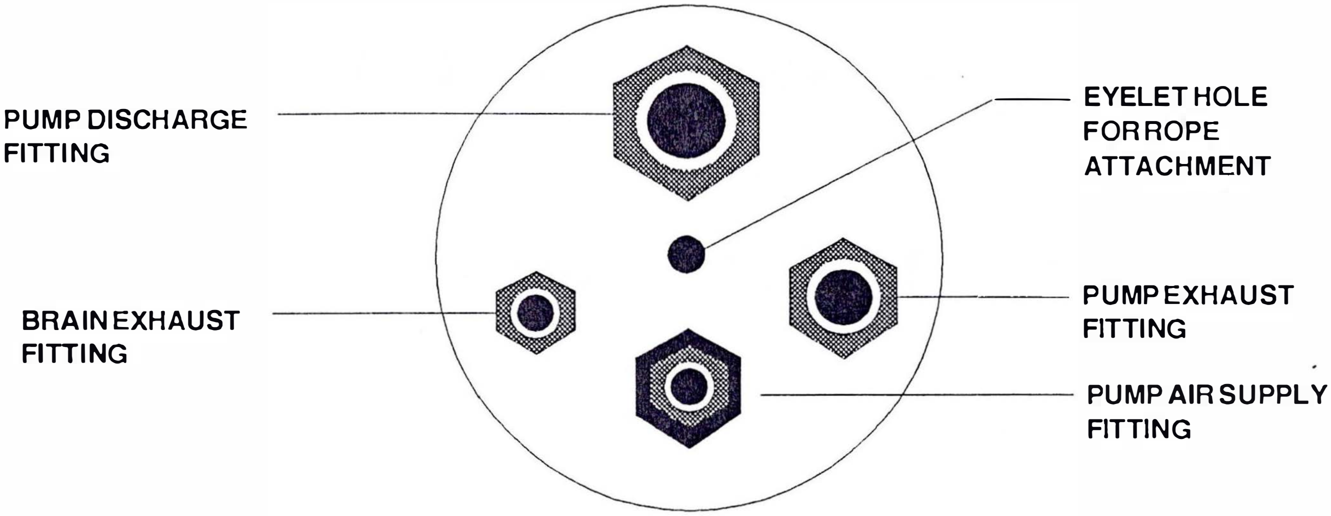
FLOAT WITH PUMP FULL

FLOAT IN THIS POSITION SLIDES THE ACTUATOR ROD UPWARD CAUSING AIR TO ENTER THE PUMP. THE AIR PRESSURE FORCES THE INLET CHECK BALL TO SEAT, PREVENTING WATER FROM ESCAPING OUT THE INLET. THE LIQUID IN THE PUMP'S BODY IS THEN FORCED INTO THE PUMP'S FILL TUBE AND UP THE DISCHARGE LINE TO THE SURFACE. THE TOP CHECK BALL IS UNSEATED BY THE UPWARD FORCE OF THE DISCHARGED LIQUID.

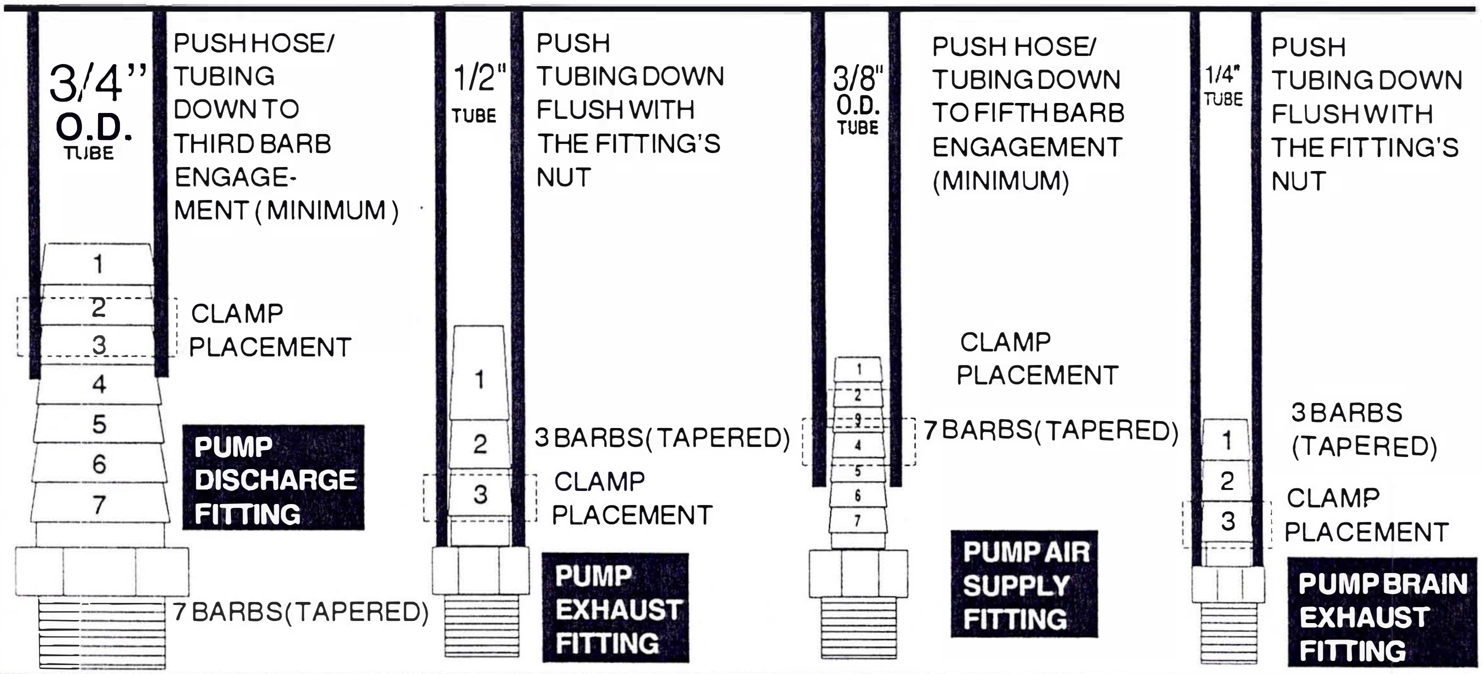
FLOAT WITH PUMP EMPTY

FLOAT IN THIS POSITION SLIDES ACTUATOR ROD DOWNWARD ALLOWING THE COMPRESSED AIR IN THE PUMP TO VENT. THE INLET CHECK BALL UNSEATS (NO LONGER HAVING ANY AIR AIR PRESSURE HOLDING IT DOWN) WHICH ALLOWS THE NEXT VOLUME OF LIQUID FROM THE WELL INTO THE PUMP. AS THE LIQUID REFILLS THE PUMP, THE FLOAT RISES BACK UP INTO THE POSITION MENTIONED ABOVE AND THE PUMPING PROCESS IS REPEATED. THE TOP CHECK BALL IS SEATED BY THE WEIGHT OF ANY LIQUID IN THE DISCHARGE LINE ABOVE IT PREVENTING THAT LIQUID FROM RE-ENTERING THE PUMP BODY.

HOSE/TUBING ATTACHMENTS TO TOP OF SOLO PUMP

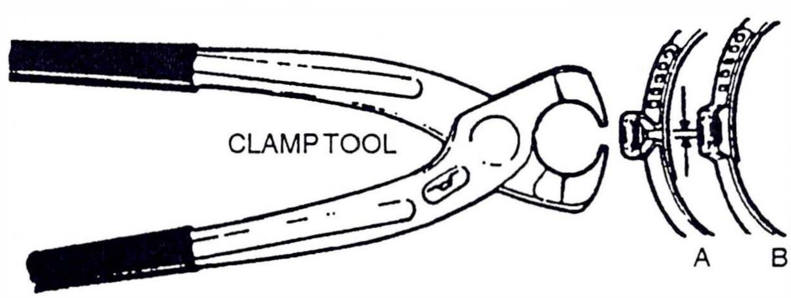


TOP VIEW OF SOLO PUMP



TIGHTENING THE CLAMPS

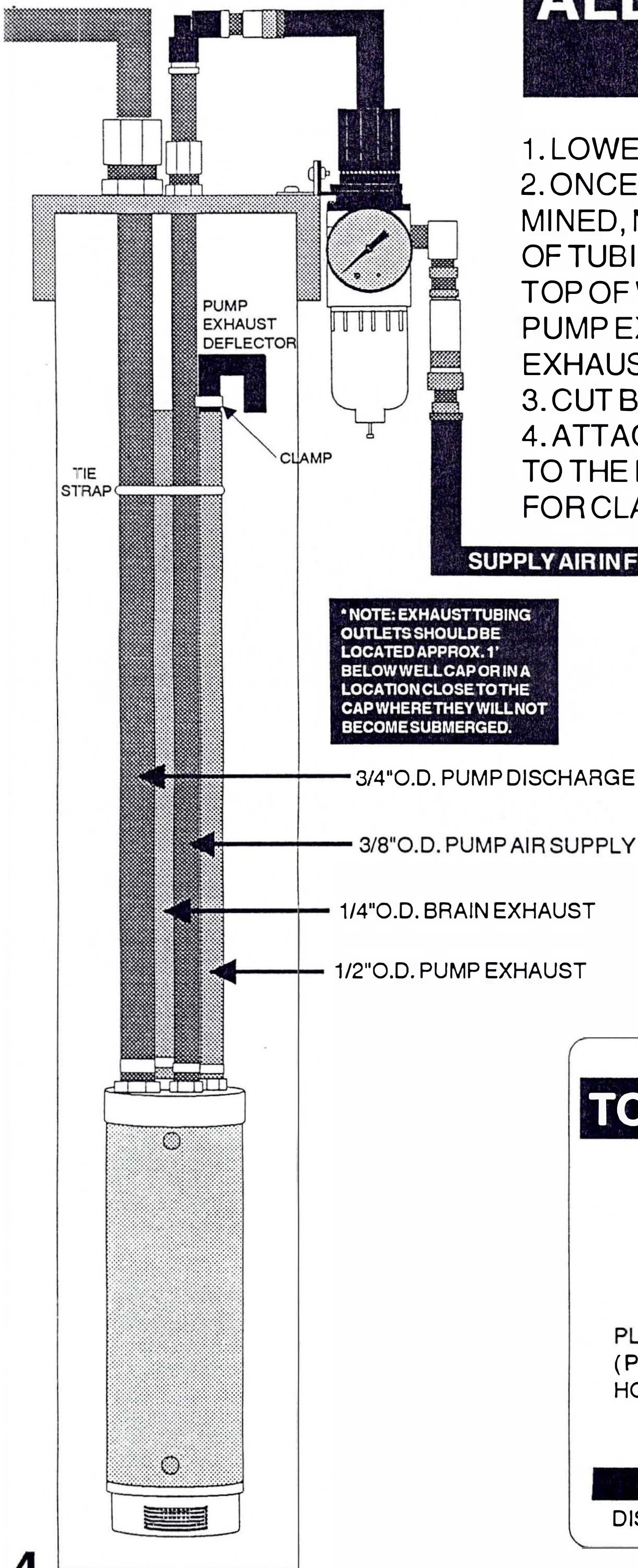
PLACE CLAMP TOOL OVER THE DIMPLED EAR PORTION OF THE CLAMP AND SQUEEZE EAR TOGETHER (AS SHOWN BELOW).



A. CLAMP IN CLOSED POSITION
B. CLAMP IN OPEN POSITION

ALL NYLON TUBING 4, 6, 8" CAPS

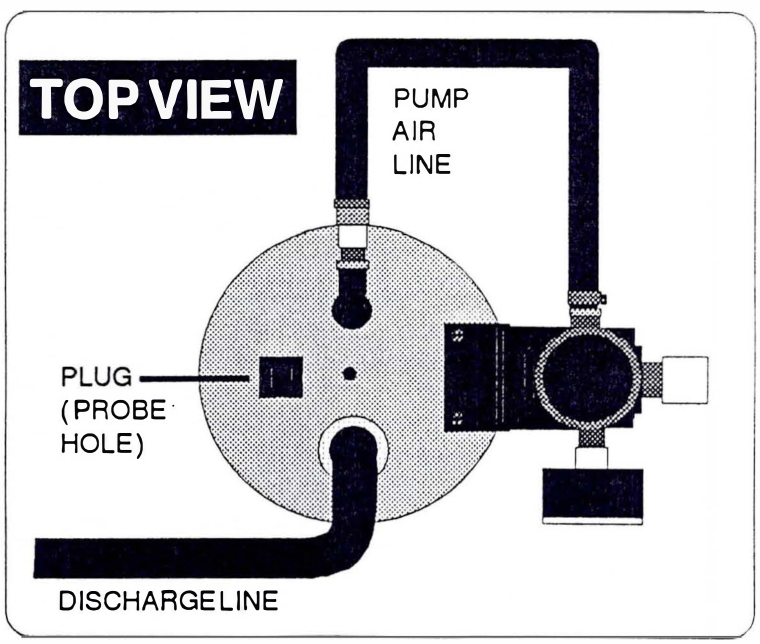
1. LOWER PUMP TO DESIRED DEPTH.
2. ONCE PUMP DEPTH HAS BEEN DETERMINED, MEASURE OFF APPROXIMATELY 1 FT. OF TUBING LENGTH (MEASURED FROM THE TOP OF WELL CASING) FROM BOTH THE PUMP EXHAUST LINE AND THE BRAIN EXHAUST LINE.*
3. CUT BOTH EXHAUST LINES.
4. ATTACH THE PUMP EXHAUST DEFLECTOR TO THE PUMP EXHAUST LINE. (SEE PAGE 3 FOR CLAMP INSTRUCTIONS)



*** NOTE: EXHAUST TUBING OUTLETS SHOULD BE LOCATED APPROX. 1' BELOW WELL CAP OR IN A LOCATION CLOSE TO THE CAP WHERE THEY WILL NOT BECOME SUBMERGED.**

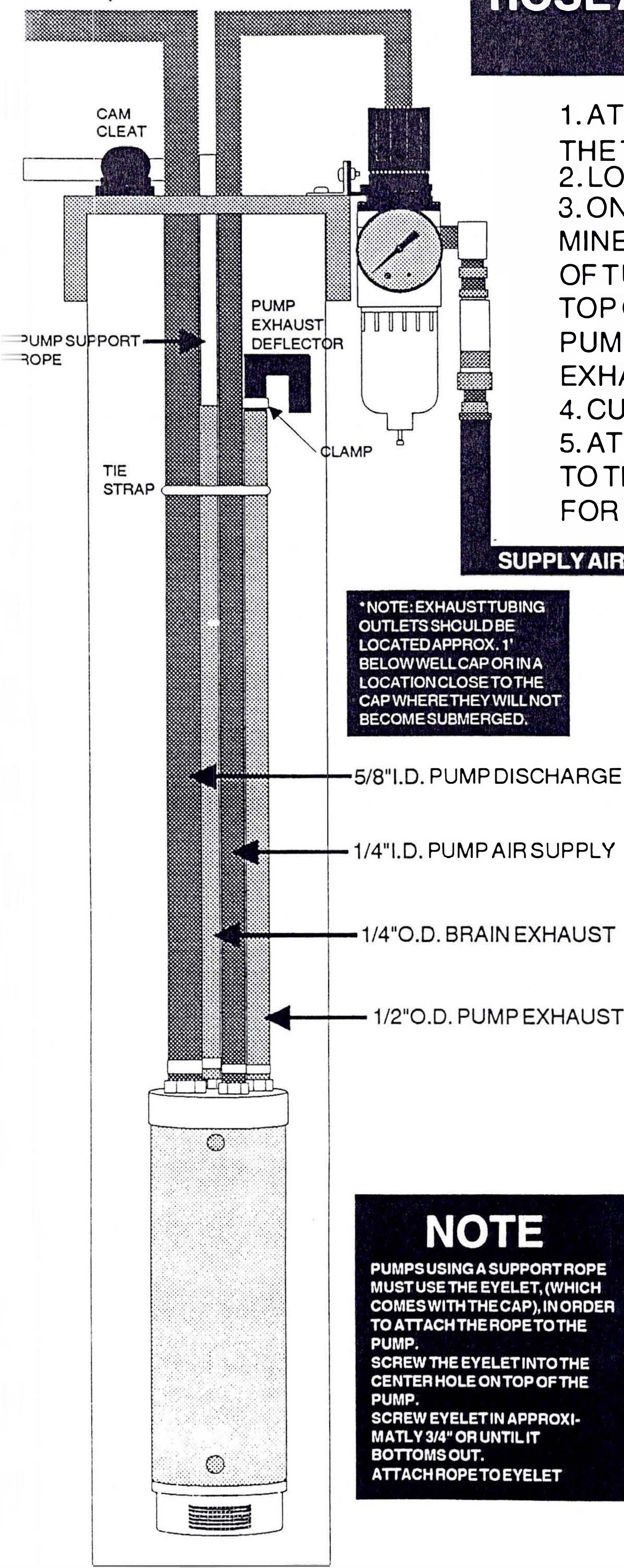
5. TIE STRAP ALL TUBING INTO ONE BUNDLE APPROXIMATELY 4-6" BELOW WHERE YOU CUT OFF YOUR EXHAUST LINES.
6. PASS PUMP DISCHARGE AND AIR SUPPLY LINES THROUGH THE WELL CAP.
7. RE-ADJUST PUMP TO DESIRED DEPTH .
8. TIGHTEN WELL CAP FITTINGS DOWN ONTO AIR/DISCHARGE LINES.

TOP VIEW



HOSE AND TUBING COMBINATION 4, 6, 8" CAPS

1. ATTACH EYELET FOR SUPPORT ROPE TO THE TOP OF THE SOLO PUMP. ATTACH ROPE.
2. LOWER PUMP TO DESIRED DEPTH.
3. ONCE PUMP DEPTH HAS BEEN DETERMINED, MEASURE OFF APPROXIMATELY 1 FT. OF TUBING LENGTH (MEASURED FROM THE TOP OF WELL CASING) FROM BOTH THE PUMP EXHAUST LINE AND THE BRAIN EXHAUST LINE.*
4. CUT BOTH EXHAUST LINES.
5. ATTACH THE PUMP EXHAUST DEFLECTOR TO THE PUMP EXHAUST LINE. (SEE PAGE 3 FOR CLAMP INSTRUCTIONS)

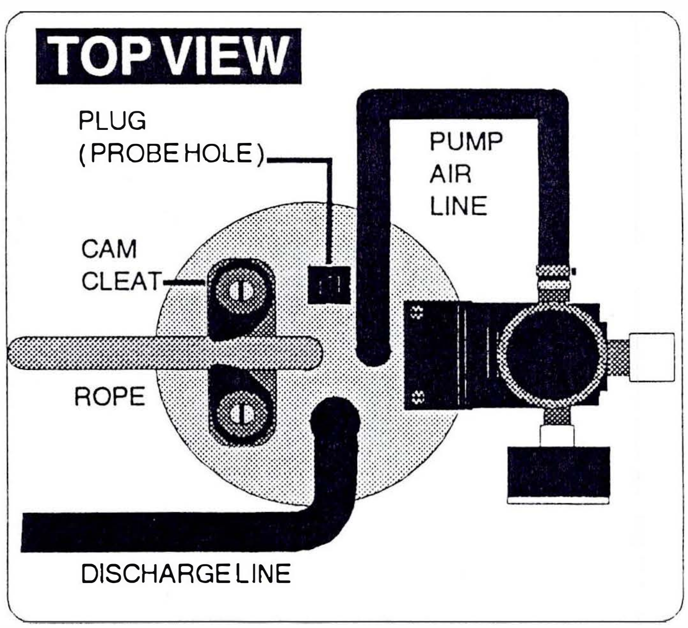


*NOTE: EXHAUST TUBING OUTLETS SHOULD BE LOCATED APPROX. 1' BELOW WELL CAP OR IN A LOCATION CLOSE TO THE CAP WHERE THEY WILL NOT BECOME SUBMERGED.

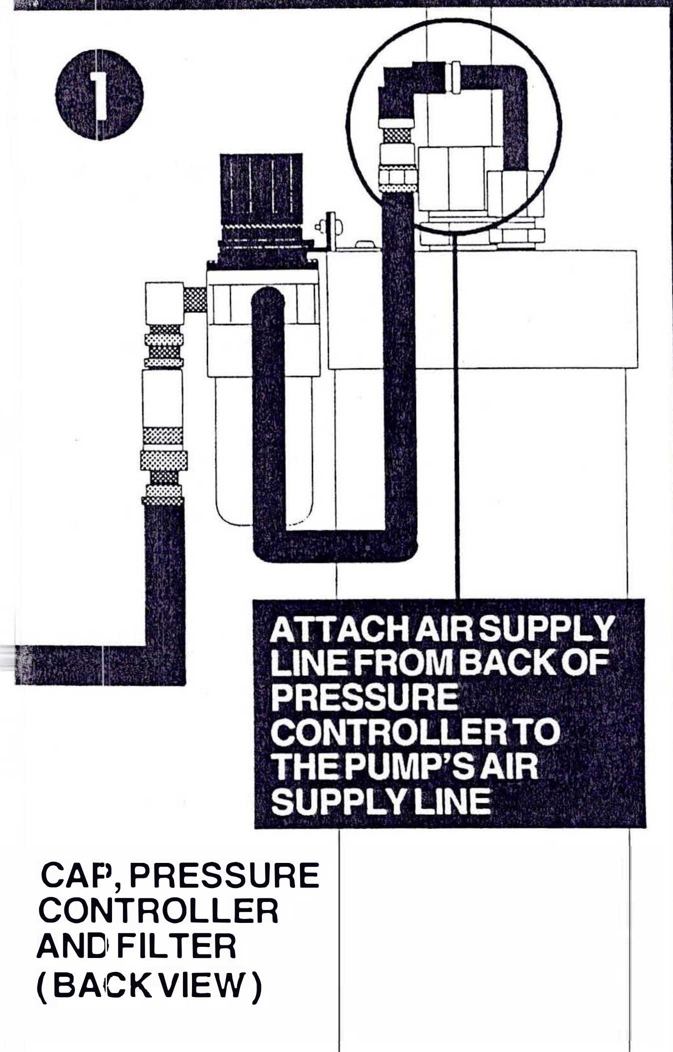
6. TIE STRAP ALL TUBING INTO ONE BUNDLE APPROXIMATELY 4-6" BELOW WHERE YOU CUT OFF YOUR EXHAUST LINES.
7. PASS PUMP DISCHARGE AND AIR SUPPLY LINES THROUGH THE WELL CAP.
8. RE-ADJUST PUMP TO DESIRED DEPTH.
9. PASS PUMP SUPPORT ROPE THROUGH CAM CLEAT TO HOLD PUMP INTO POSITION.

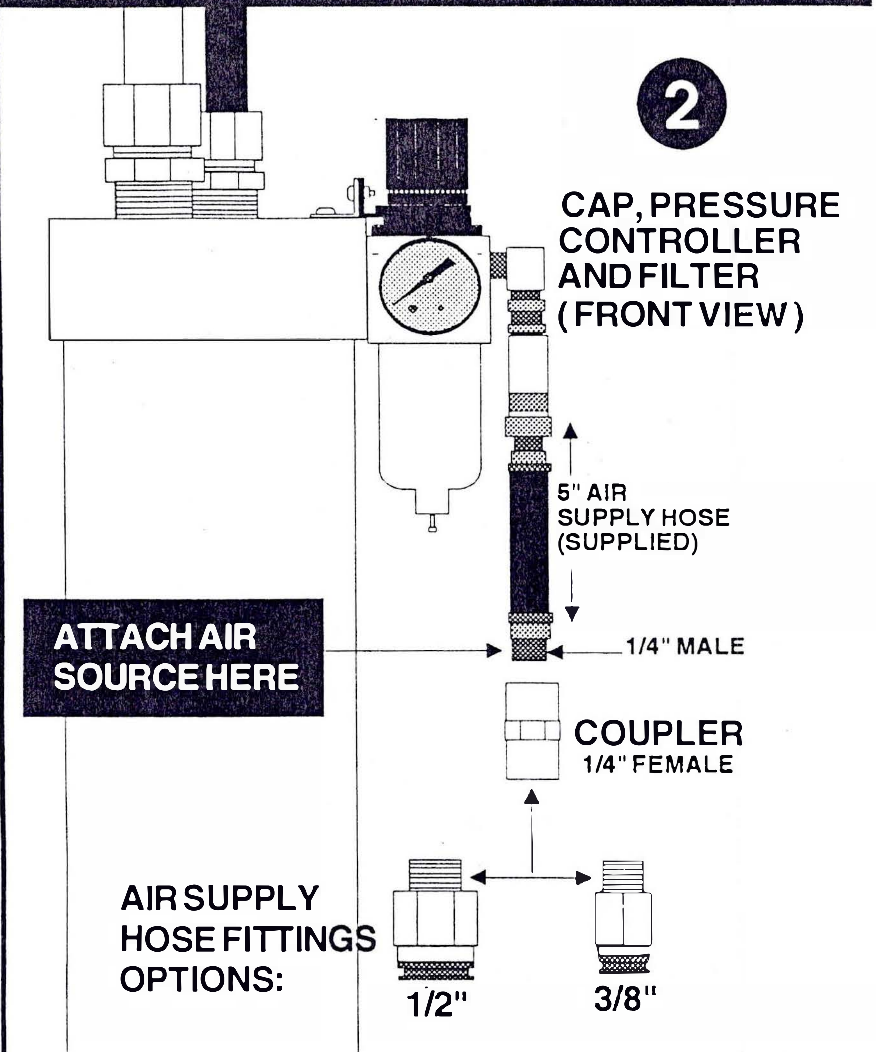
NOTE

PUMPS USING A SUPPORT ROPE MUST USE THE EYELET, (WHICH COMES WITH THE CAP), IN ORDER TO ATTACH THE ROPE TO THE PUMP.
SCREW THE EYELET INTO THE CENTER HOLE ON TOP OF THE PUMP.
SCREW EYELET IN APPROXIMATLY 3/4" OR UNTIL IT BOTTOMS OUT.
ATTACH ROPE TO EYELET

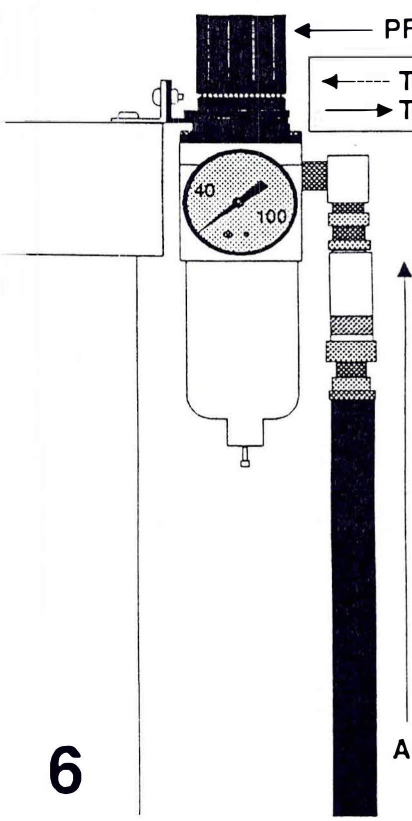


PUMP OPERATION AND ATTACHMENTS





PRESSURE CONTROL ADJUSTMENTS



PRESSURE CONTROL KNOB

TURNING CLOCKWISE INCREASES PRESSURE
TURNING COUNTER-CLOCKWISE DECREASES PRESSURE

3

MINIMUM 40 P.S.I.
MAXIMUM 100 P.S.I.

NOTE: FLOW RATE IS DEPENDENT ON THE AMOUNT OF AIR PRESSURE THAT IS RECEIVED BY THE PUMP. FLOW RATES CAN BE INCREASED BY INCREASING AIR PRESSURE TO THE PUMP AND FLOW RATES CAN BE DECREASED BY DECREASING AIR PRESSURE TO THE PUMP.

ADJUST AIR PRESSURE TO DESIRED PRESSURE

AIR SOURCE

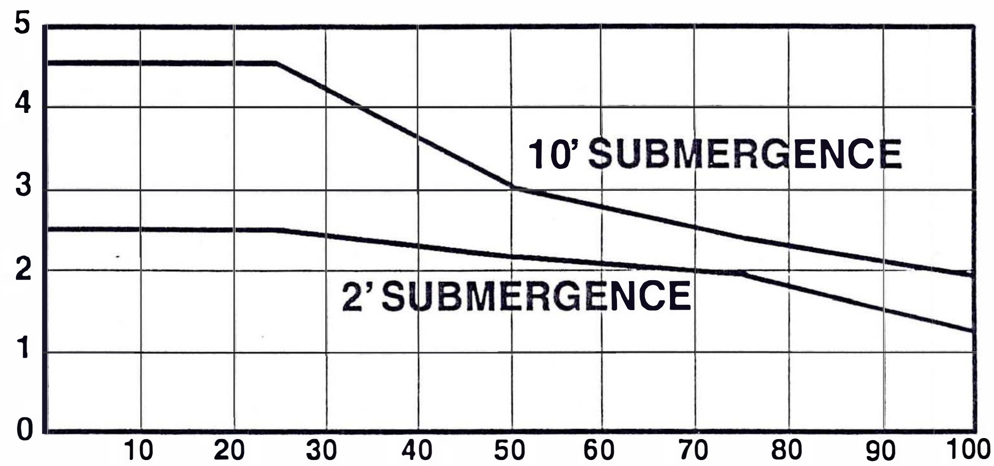
SP4000 SPECIFICATIONS

DIAMETER: 3.0" LENGTH: 48" WEIGHT: 11.5 LBS FITTINGS: TYPE-BARB SIZES-DISCHARGE 5/8" ID (3/4" OD) AIR 1/4" ID (3/8" OD) EXHAUST 3/8" ID (1/2" OD) VENT, (BRAIN) 3/16" ID (1/4" OD)	PRESSURE REGULATOR/FILTER DIMENSIONS: WIDTH-3" (OUT FROM CAP) WIDTH-5" (PARALLEL TO CAP) HEIGTH-2-1/2" (ABOVE CAP) OVERALL LENGTH-6-1/2"	PUMP TYPE: POSITIVE GAS DISPLACEMENT PUMP VOLUME: 1.9 LITERS (.5 GALLONS) Nominal MAXIMUM FLOW RATE-4.5 G.P.M. MATERIALS OF CONSTRUCTION: BODY-STAINLESS STEEL HOUSINGS-Q-TAL CHECKBALLS-TEFLON FITTINGS-BRASS AIR REQUIREMENTS: MINIMUM-40 P.S.I. MAXIMUM-100P.S.I.

SP4000 FLOW RATES

FLOW (GPM)

AT 100 P.S.I.



DEPTH (FEET)

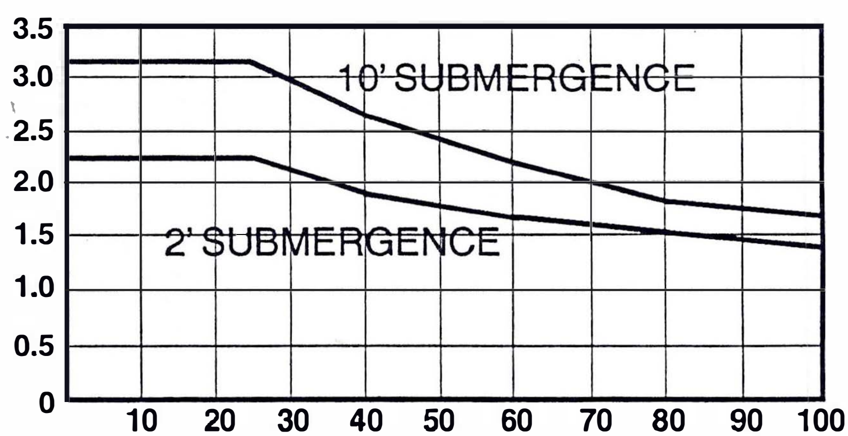
SP2000 SPECIFICATIONS

DIAMETER: 3.0" LENGTH: 24" WEIGHT: 8.5 LBS FITTINGS: TYPE-BARB VENT, (BRAIN) 3/16" ID (1/4" OD) SIZES-DISCHARGE 5/8" ID (3/4" OD) AIR 1/4" ID (3/8" OD) EXHAUST 3/8" ID (1/2" OD)	PRESSURE REGULATOR/FILTER DIMENSIONS: WIDTH-3" (OUT FROM CAP) WIDTH-5" (PARALLEL TO CAP) HEIGTH-2-1/2" (ABOVE CAP) OVERALL LENGTH-6-1/2"	PUMP TYPE: POSITIVE GAS DISPLACEMENT PUMP VOLUME: .36 LITERS (0.095 GALLONS) Nominal MATERIALS OF CONSTRUCTION: BODY-STAINLESS STEEL HOUSINGS-Q-TAL CHECKBALLS-TEFLON FITTINGS-BRASS AIR REQUIREMENTS: MINIMUM-40 P.S.I. MAXIMUM-100P.S.I.

SP2000 FLOW RATES

FLOW (GPM)

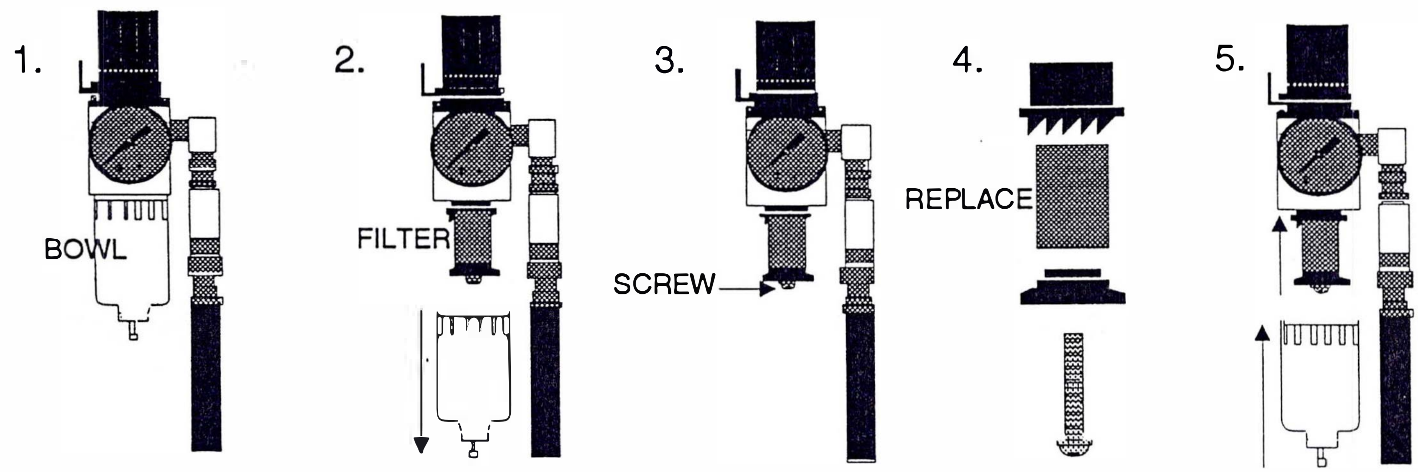
AT 100 P.S.I.



DEPTH (FEET)

SOLO MAINTENANCE: REPLACING FILTER ELEMENT

1. TO ACCESS FILTER ELEMENT SIMPLY UNSCREW FILTER BOWL COUNTERCLOCKWISE.
2. COMPLETELY REMOVE FILTER BOWL.
3. TO REMOVE FILTER UNSCREW HOLDING SCREW LOCATED AT BOTTOM OF FILTER ASSEMBLY.
4. ONCE SCREW IS REMOVED THE FILTER ASSEMBLY SHOULD COME APART AS SHOWN (4.) DISCARD OLD FILTER AND REPLACE WITH NEW ONE. REASSEMBLE FILTER ASSEMBLY AS IT WAS ORIGINALLY.
5. REATTACH FILTER AND THEN FILTER BOWL IN THE SAME MANNER AS THEY WERE REMOVED.



NOTE: REPLACEMENT FILTER ELEMENTS MAY BE PURCHASED THROUGH Q.E.D. PART NUMBER 36861

SP4000 PACKAGES

SOLO PUMP, WELL CAP AND REGULATOR FILTER
SOLO PUMP PACKAGES INCLUDE:

SOLO PUMP PACKAGES:

WELL DIAMETER	HOSE OR TUBE	PART NUMBER
4 INCH	HOSE	SP4000A
	TUBE	SP4000B
6 INCH	HOSE	SP4000C
	TUBE	SP4000D
8 INCH	HOSE	SP4000E
	TUBE	SP4000F

SP2000 PACKAGES

SOLO PUMP, WELL CAP AND REGULATOR FILTER
SOLO PUMP PACKAGES INCLUDE:

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WELL DIAMETER	HOSE OR TUBE	PART NUMBER
4 INCH	HOSE	SP2000A
	TUBE	SP2000B
6 INCH	HOSE	SP2000C
	TUBE	SP2000D
8 INCH	HOSE	SP2000E
	TUBE	SP2000F

PULSE PUMP® WARRANTY

QED Environmental Systems Inc. (QED) warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

This warranty shall be limited to the duration and the conditions set forth below. All warranty duration's are calculated from the original date of purchase.

1. Liquid contacting equipment including pumps (QED bladder style pumps are excluded from this warranty), and tubing are warranted for 1 year.

2. Control devices, control device mounting, and surface air supply hose are warranted for 1 year.

3. Separately sold parts and spare parts kits re warranted for ninety (90) days.

4. Repairs performed by QED are warranted for ninety (90) days from date of repair or for the full term of the original warranty, whichever is longer.

Buyer's exclusive remedy for breach of said warranty shall be as follows: if, and only if, QED is notified in writing within the applicable warranty period of the existence of any such defects in the said products, and QED upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from QED to Buyer, QED will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Buyer. If QED for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's/Buyer's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Buyer, or to refund the full purchase price. In no event shall such allegedly defective products be returned to QED without its consent, and QED's obligations of repair, replacement or refund are conditioned upon the Buyer's return of the defective product to QED.

IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY.

The foregoing warranty does not apply to major subassemblies and other equipment, accessories, and other parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties, if any, supplied by their respective manufacturers. QED makes no warranty concerning products or accessories not manufactured by QED, In the event of failure of any such product or accessory, QED will give reasonable assistance to Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANT ABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES

ARE EXPRESSLY EXCLUDED HEREBY, and of any other obligations or liabilities on the part of QED, and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with said products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty.

Chemical attack to liquid contacting equipment and supplies shall not be covered by this warranty. A range of materials is available from QED and it is the Buyer's responsibility to select materials to fit the Buyer's application. QED will only warrant that the supplied liquid contacting materials will conform to published QED specifications and generally accepted standards for that particular material.

QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the written consent of QED. If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component, at owner's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the Purchaser.

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of QED and:

1. Identify the product involved (by model or serial number or other sufficient description that will allow QED to determine which product is defective).

2. Specifying where, when, and from whom the product was purchased.

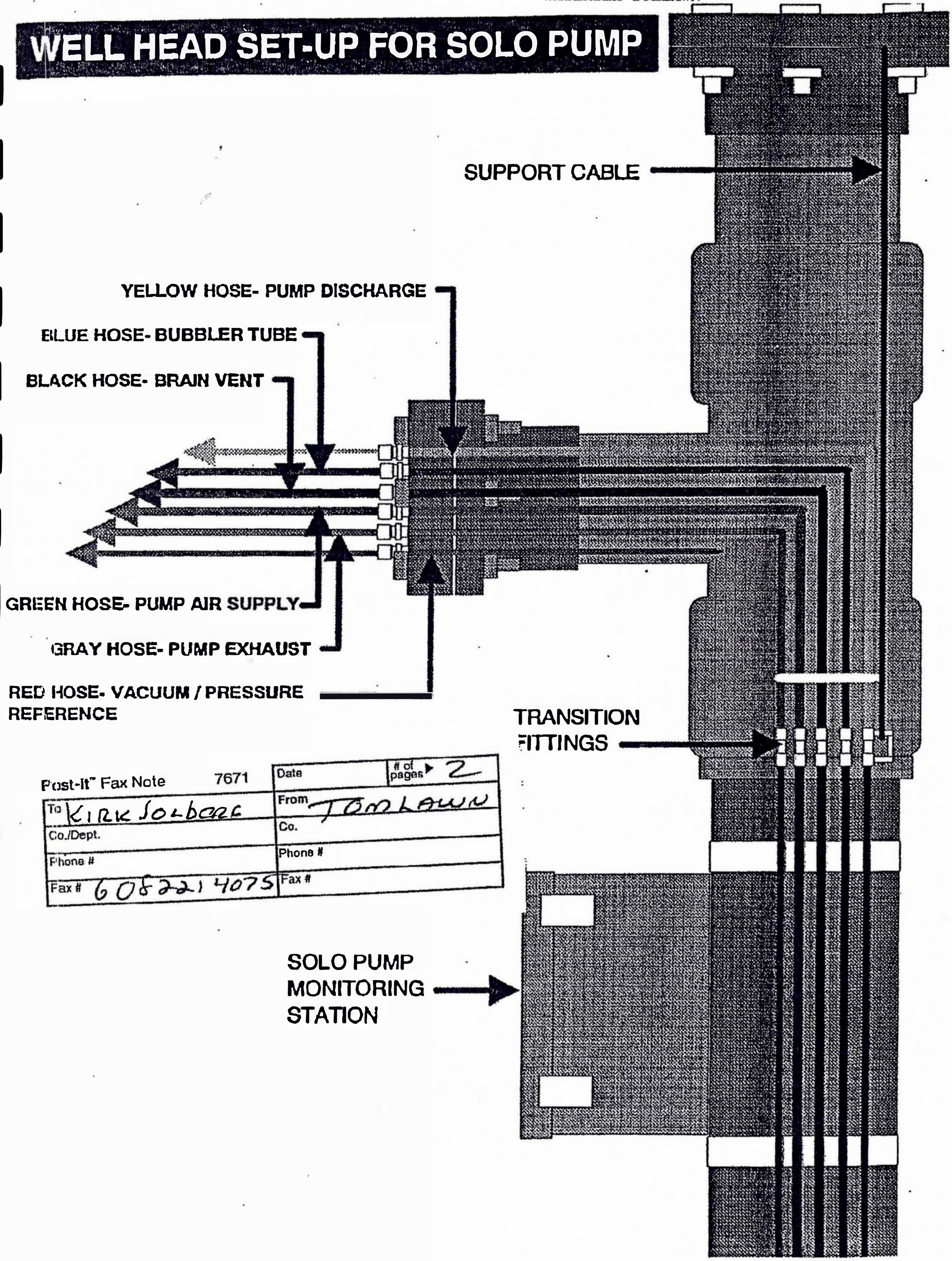
3. Describing the nature of the defect or malfunction covered by this warranty.

4. Sending the malfunctioning component, after authorization by QED to:

QED Environmental Systems Inc.
6155 Jackson Road
Ann Arbor, MI 48103

Telephone: 1-313-995-2547
1-800-624-2026
1-313-995-1170 FAX

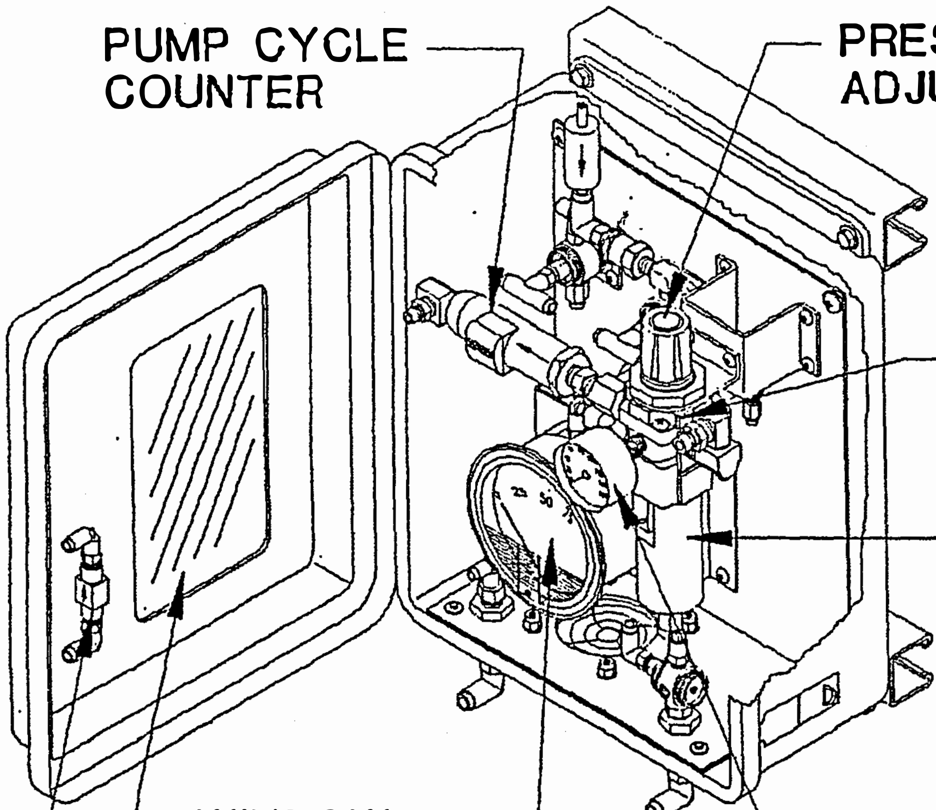
WELL HEAD SET-UP FOR SOLO PUMP



Post-it™ Fax Note 7671

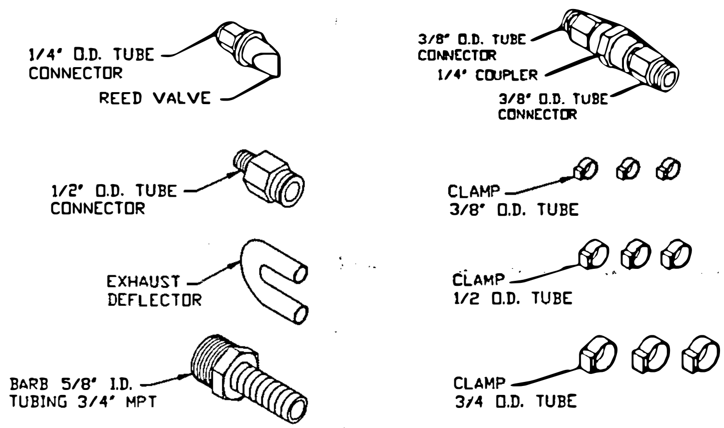
Date	# of pages ▸ 2
To KIRK SOLBERG	From TOM LAWN
Co./Dept.	Co.
Phone #	Phone #
Fax # 6082214075	Fax #

SOLO MONITORING STATION



SOLO II

PARTS SHIPPED LOOSE W/PUMP



INSTALLATION INSTRUCTIONS

1. TO CONNECT AIR SUPPLY, INSTALL COUPLER WITH TUBING CONNECTORS TO AIR SUPPLY FROM COMPRESSOR TO PUMP AIR SUPPLY.
   IF AIR SUPPLY LINE FROM COMPRESSOR IS 1/2" O.D. TUBING REMOVE 3/8" TUBE CONNECTOR AND REPLACE WITH 1/2" CONNECTOR.
2. TO INSTALL VENT DEFLECTOR TO THE VENT TUBE UNDER THE CAP. PUSH INTO 3/8" O.D. TUBE.
   CRIMP CLAMP FOR 3/8" O.D. TUBING AROUND TUBE.
3. 3/4" BARB IS TO BE USED TO CONNECT THE PUMP DISCHARGE LINE TO THE CUSTOMERS DISCHARGE LINE.
4. EXTRA TUBING CLAMPS ARE SUPPLIED FOR TUBING.
   ATTACH TO PUMP OR OTHER TUBING/BARB CONNECTIONS.
5. 1/4" O.D. TUBE CONNECTOR & REED VALVE ARE USED ON SOLO II WHEN YOU WANT TO KEEP OUTSIDE CONTAMINATES FROM ENTERING THROUGH THE BRAIN VENT LINE.

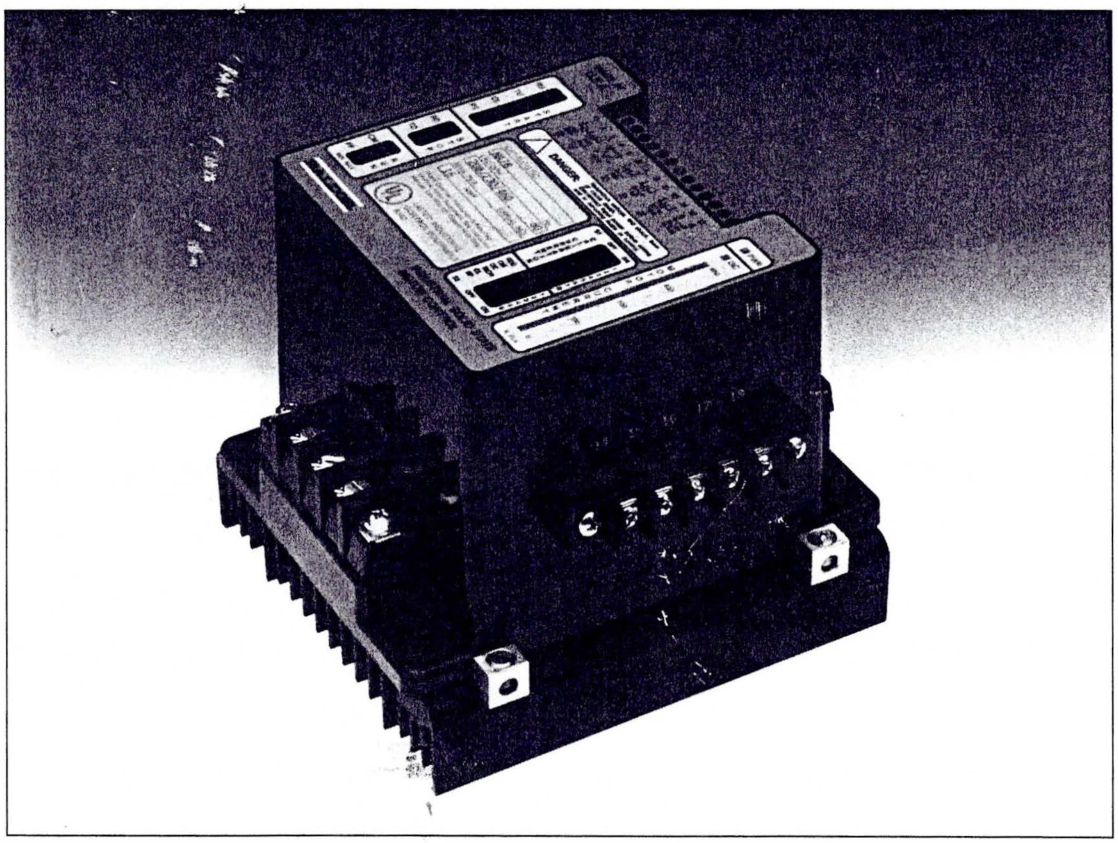
95099
REV. -

$25.00

BALDOR®
MOTORS AND DRIVES

Multipurpose Soft Starter

Sizes 8, 16 and 30 Amps



INSTALLATION AND OPERATING MANUAL

Baldor Electric Co.
5711 R.S. Boreham Jr. St.
Fort Smith, AR 72901

11/95
CMc 3000

MN804

TABLE OF CONTENTS

GENERAL INFORMATION

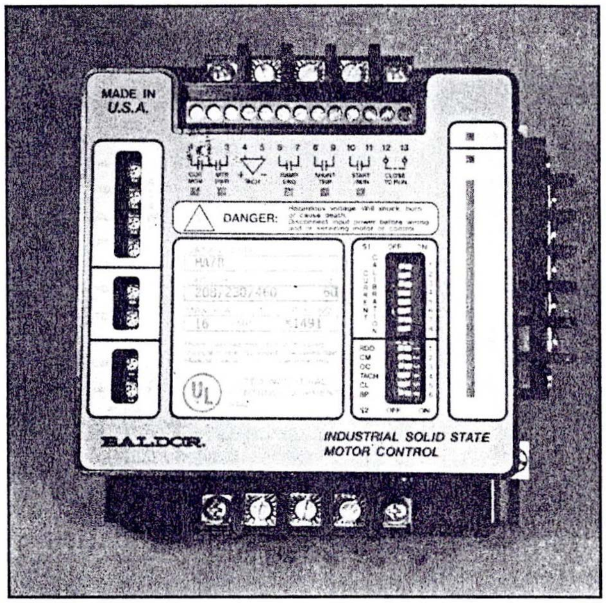
General Description

The Multipurpose Control is a versatile, reduced voltage, three phase motor starter. Ramp up and extended ramp down features provide an effective means of starting and stopping material handling and pumping equipment to minimize product spillage and water hammer problems. Adjustable current limit allows constant current starting of high inertia loads such as chippers, centrifuges and compressors. It also provides a current ceiling which reduces peak demand of power provided by utilities and generating equipment. The tachometer feedback feature may be used to provide consistent starting and stopping times with linear acceleration and deceleration, even with varying load conditions, on textile, material handling and pumping equipment.

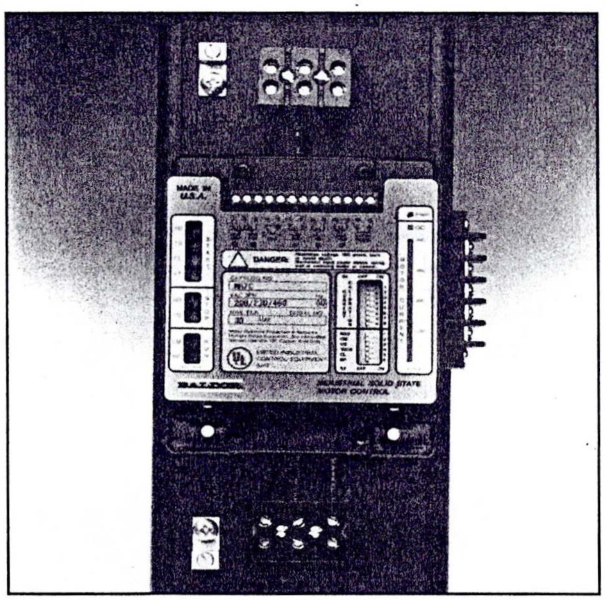
The Multipurpose Control uses six silicon control rectifiers (SCR) connected in inverse parallel to provide three phase full wave control of voltage and current delivered to a three phase AC motor. The control uses metal oxide varistors (MOV) to provide surge voltage protection.

Several methods of starting are selectable and adjustable. Setup is flexible yet compact with dip switch selection and potentiometer adjustment. LED indicators and status contacts monitor starting, running and stopping conditions. In addition, a ten-segment display provides a bar-graph representation of the motor current from 0 to 400% FLA to assist with setup and troubleshooting.

Refer to Figure 1, Multipurpose Logic Control Module.



8 and 16 Amp



30 Amp

Multipurpose Logic Control Module (LCM) Block Diagram

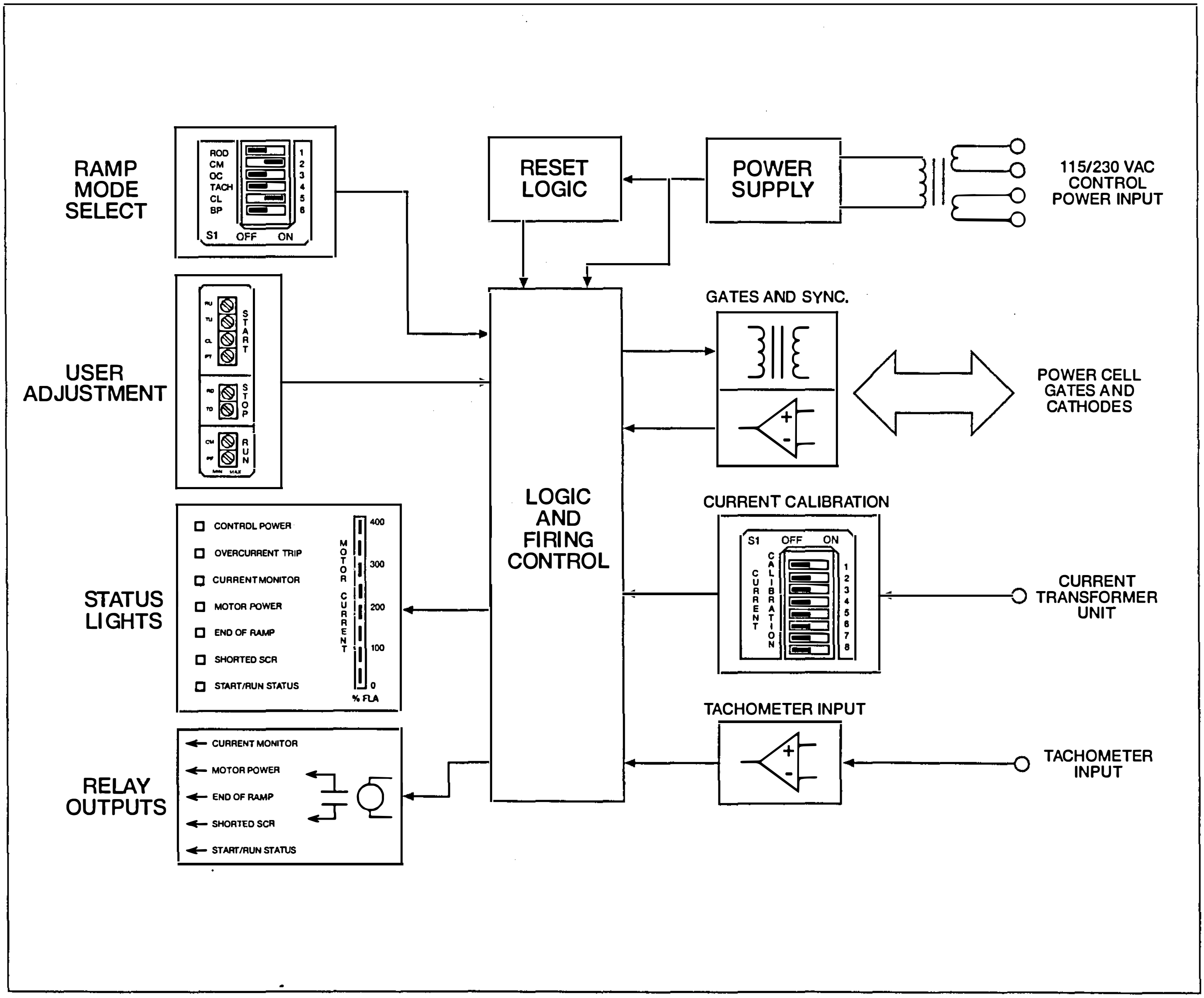


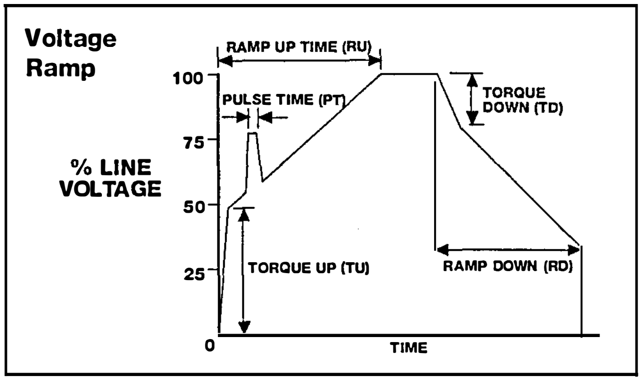
Figure 1

MULTIPURPOSE GENERAL OPERATION

TYPES OF STARTING

Voltage Starting

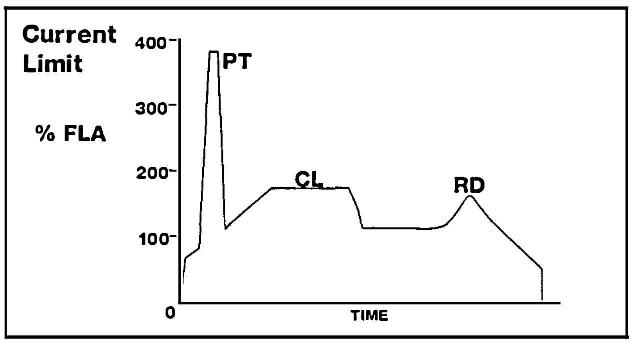
During start the initial voltage (TU) is set to a level where the motor will begin to turn when power is applied. The ramp time (RU) is adjustable to provide a smooth start. The pulse time (PT) is used for high friction loads to break loose "frozen" loads with up to 400% FLA.



If a ramp down function is needed, the initial voltage TD setting is used to lower voltage to a level where the motor will begin to slow down when the stop button is pushed. The ramp down function can only extend motor stopping time preventing sudden stopping problems such as water hammer.

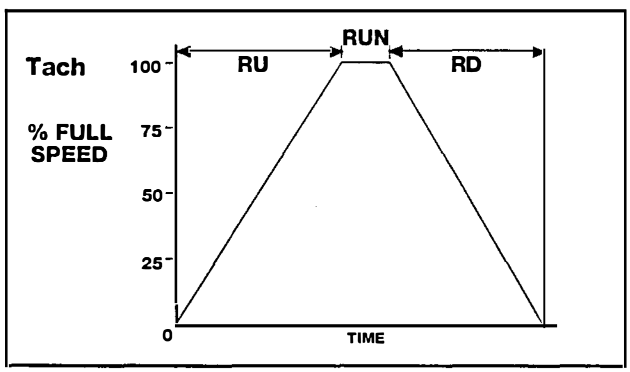
Current Limit Starting

If current limit starting is selected the starter will operate simular to voltage starting. On high inertia loads such as chippers and grinders the Current Limit (CL) setting is what determines the starting time. The starter will provide that current regardless of the ramp time setting. The CL setting must be high enough to provide enough starting current in all starting conditions.



Tach Feedback Starting

Tach feedback starting/stopping uses a 0-10 VDC Tach signal. The control will provide voltage to the motor to generate a smooth linear starting even under cycling load conditions.



START ADJUSTMENT

Ramp Up Time (RU):

Adjustable from 3 to 50 seconds. RU will adjust the voltage ramp or the tachometer starting ramp time.

Operating in the tachometer ramp mode, RU will adjust the motor starting time independent of the load when used in conjunction with a 0 to 10 VDC tachometer feedback signal.

In the voltage ramp mode, RU will adjust the time it takes the motor to reach full voltage. Actual starting time depends upon the motor load and the setting of the additional start adjustments.

Ramp Up Initial Starting Torque (TU):

TU is enabled only when in voltage ramp mode. Usually set high enough to start the motor slowly turning the instant the start button is pressed.

Starting Pulse Time (PT):

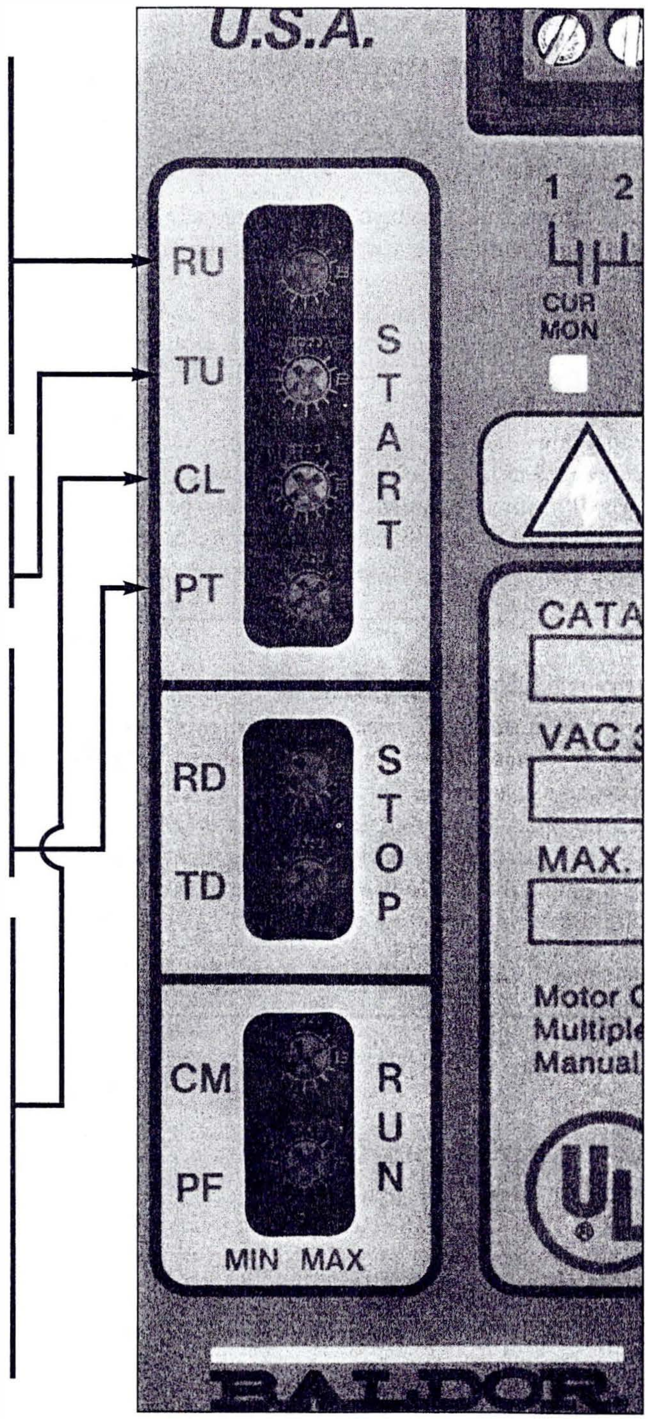
In the voltage ramp mode, PT is adjustable from 0 to 1.5 seconds. When the start button is pressed, the initial motor voltage will depend on the setting of TU. One second after the start button is pressed, a pulse of approximately 400% FLA will occur; the duration will depend upon the adjustment of PT.

Current Limit (CL):

CL is adjustable from 75 to 400% of FLA. It can be used in both the voltage and tachometer ramp modes of operation. When CL is enabled, motor starting and stopping current will not exceed the set point of CL, except during the pulse start.

NOTE

CL must be set high enough to allow the motor to start under maximum load conditions. In the tachometer ramp mode, CL will affect linearity and start and stop times. The current will be held at the CL limit until the motor current draw drops, regardless of the RU setting.



STOP ADJUSTMENTS

Ramp Downtime (RD):

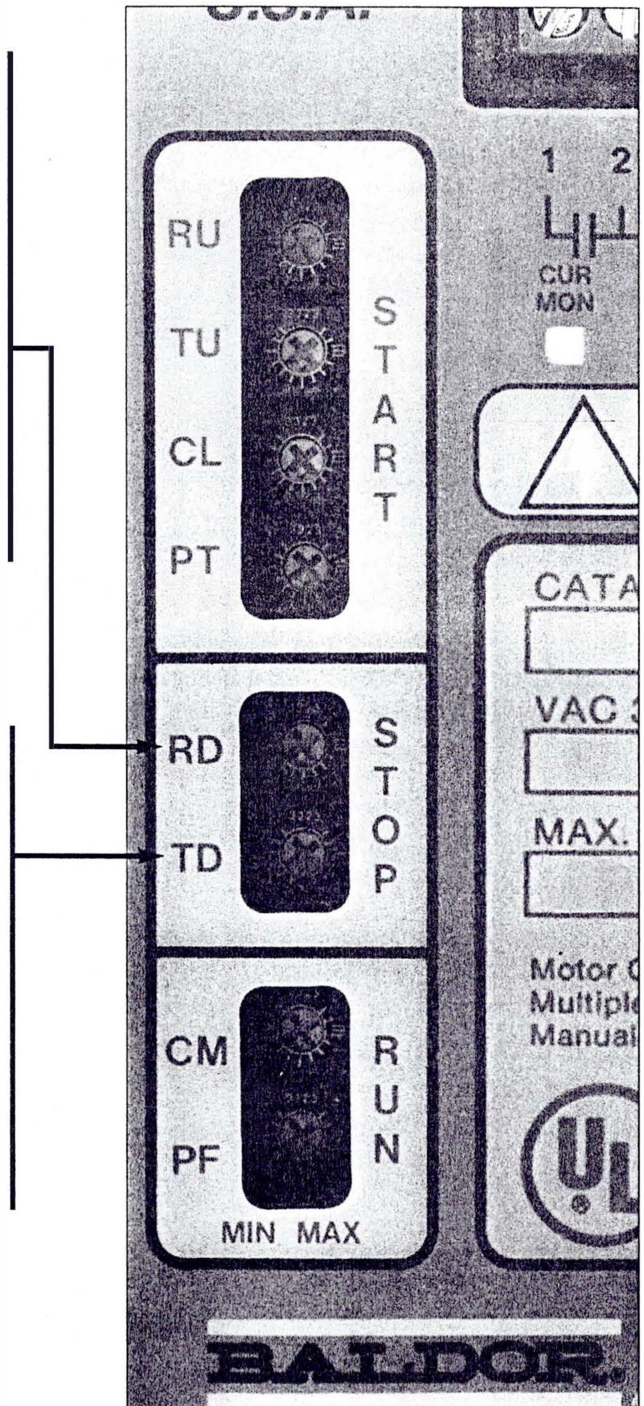
Adjustable from 5 to 50 seconds. RD can be used in both the voltage and tachometer modes.

In the tachometer ramp down mode, when used with a 0 to 10 VDC tachometer feedback signal, RD will adjust the actual stopping time independent of motor load condition.

In the voltage ramp mode, RD will adjust the time it takes to reach minimum motor voltage and turn off. The actual stopping time will depend on the motor load condition.

NOTE

Ramp down mode is not suitable for coasting or inertial loads that require braking. Ramp down will only extend the stopping time of loads that tend to stop too abruptly.



Torque Down Advance (TD):

Adjustable from 0 to 100% advance. TD sets the initial torque or speed from which ramp down starts and can be used in both voltage and tachometer modes.

In ramp down mode, when the stop button is pressed, motor speed or voltage will immediately drop to the set point of TD. Control will continue to ramp down to zero speed or voltage, depending upon RD adjustment. Control will turn off.

RUN ADJUSTMENTS

Current Monitor Set Point (CM):

Adjustable from 50 to 400% FLA to monitor the running current after the motor reaches the full run condition.

With CM enabled, if the running current exceeds the CM set point, the control will shut down, the CUR MON contact will close, and the LED will illuminate.

With CM disabled, if motor current exceeds CM set point, the control will not shut down, the CUR MON contact will close and the LED will illuminate.

Maximum Power Factor Effect: (PF):

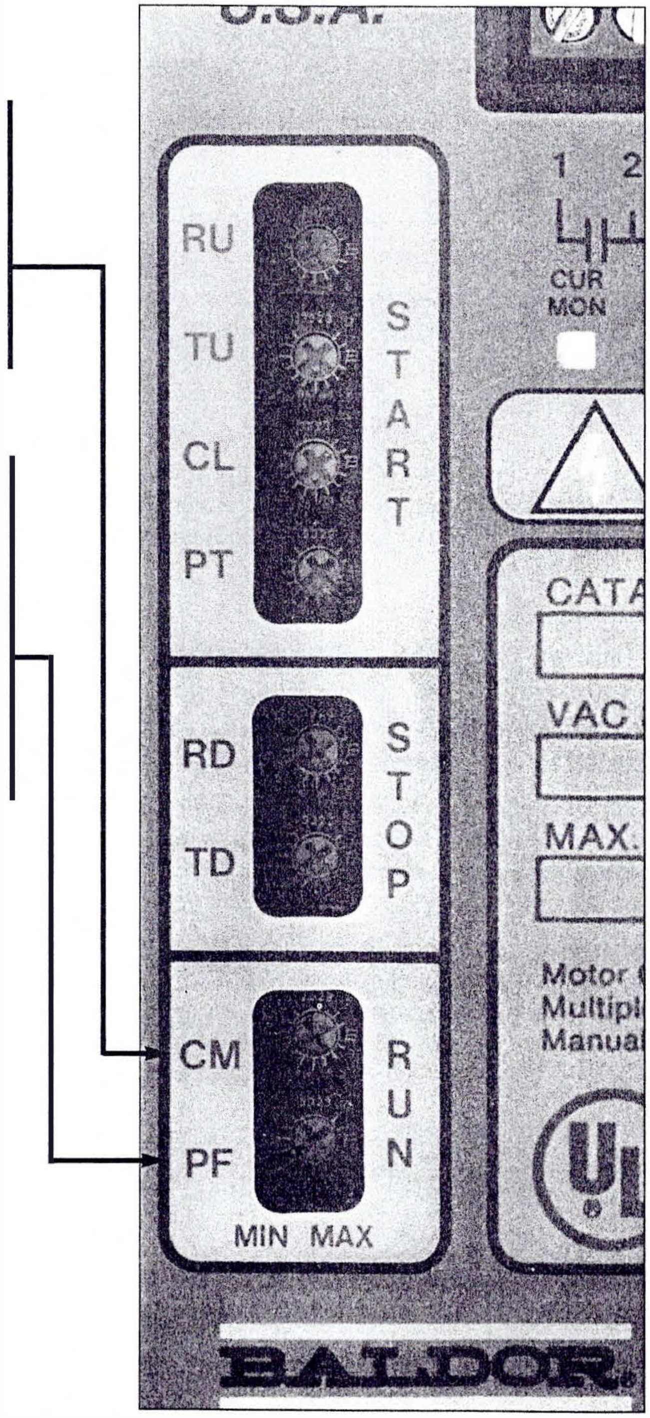
Adjustable from 0 to 100%. PF is used to adjust the maximum voltage applied to the motor under lightly loaded conditions to minimize motor current with minimum motor load.

PF is enabled after the motor reaches full on condition.

PF should be turned off (CCW) if more than one motor is used with one control or if a by-pass contactor is used.

NOTE

PF adjustment has no effect in bypass mode.

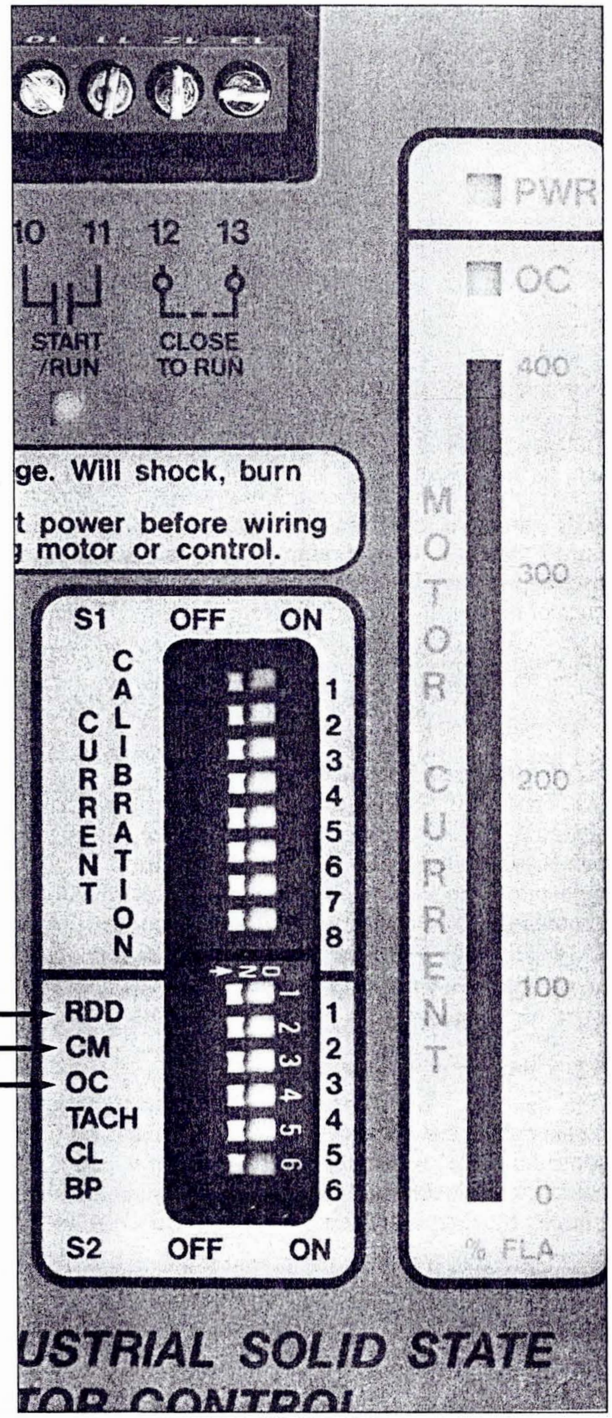


DIP SWITCH FUNCTIONS

Dip switches are conveniently located on the front panel of the Multipurpose Control module. S1-1 thru S1-8 select the current calibration needed to meet the motor requirements. The S2-1 thru S2-6 select the operating modes that best fit the application.

NOTE:

Refer to the Multipurpose Control Current Calibration Chart to match the dip switch setting to the motor FLA rating. Calibration is based on the motor nameplate full load amperes (FLA), not necessarily actual running current. Motors with higher than 6 times locked rotor current may require a higher setting to start properly.



S2-1 Ramp Down Disable (RDD):

"On" position: When the stop button is pressed, the control will immediately turn off. User stop adjustments RD (ramp down time) and TD (ramp down initial starting torque) are disabled.

"Off" position: When the stop button is pressed, the control will ramp down. In the voltage mode of operation, ramp down time depends on RD and TD adjustments and the load condition.

S2-2 Current Monitor (CM):

"On" position: If the motor running current exceeds the Current Monitor (CM) adjustment, the control will shut down. The shut down condition will be indicated by the current monitor LED and the closure of the current monitor contact. The current monitor is typically used to shut the control down when a jam occurs. To restart the control, press stop, then start; or open the close to run circuit, then close it.

"Off" position: If motor running current exceeds the current monitor adjustment, the current monitor LED and contact will indicate this condition but the control will not shut down. The current monitor can be used as an over and under current monitor.

S2-3 Over Current Indicator (OC):

"On" position: If an over current trip occurs (current exceeds 450% FLA), the control will shut down and the condition will be indicated by the OC LED and CM LED and the closure of the current monitor contact. To restart the control, press stop then start; or open the close to run circuit, then close it.

"Off" position: An over current trip will be indicated by the over current LED and will not affect the current monitor. The control will shut down.

S2-4 Tachometer and Voltage Ramp Select (TACH):

"On" position: The control is in the tachometer ramp mode during start and stop. Starting and stopping times will be independent of the load conditions. Ramp up (RU) will be dependent on the ramp up and current limit (CL) adjustments. RD will be dependent on the RD and CL adjustments. **NOTE:** The current limit adjustment is disabled if S2-5 is "Off". Operation in the tachometer mode requires an isolated input tach signal of 0 to 10 volts DC with a 10 msec response time or better. Tachometers with other voltage ranges may be used with this control. Consult the factory for instructions.

If the tachometer full speed voltage is less than 10 volts DC, the starting and stopping times will be proportionally shorter. For example, if the starting and stopping times are adjusted to 20 seconds with a 0 to 10 volt DC tachometer signal; for a 0 to 5 Volt DC tachometer signal with the same adjustment setting, the time will be 10 seconds.

"Off" position: The control is operating in the voltage ramp mode during start and stop (if ramp down is selected using S2-1). All user adjustments for start, stop and run can be used to set up the control to meet the application requirements. Starting and stopping times will be dependent on the actual load condition and control adjustments.

S2-5 Current Limit Enable (CL):

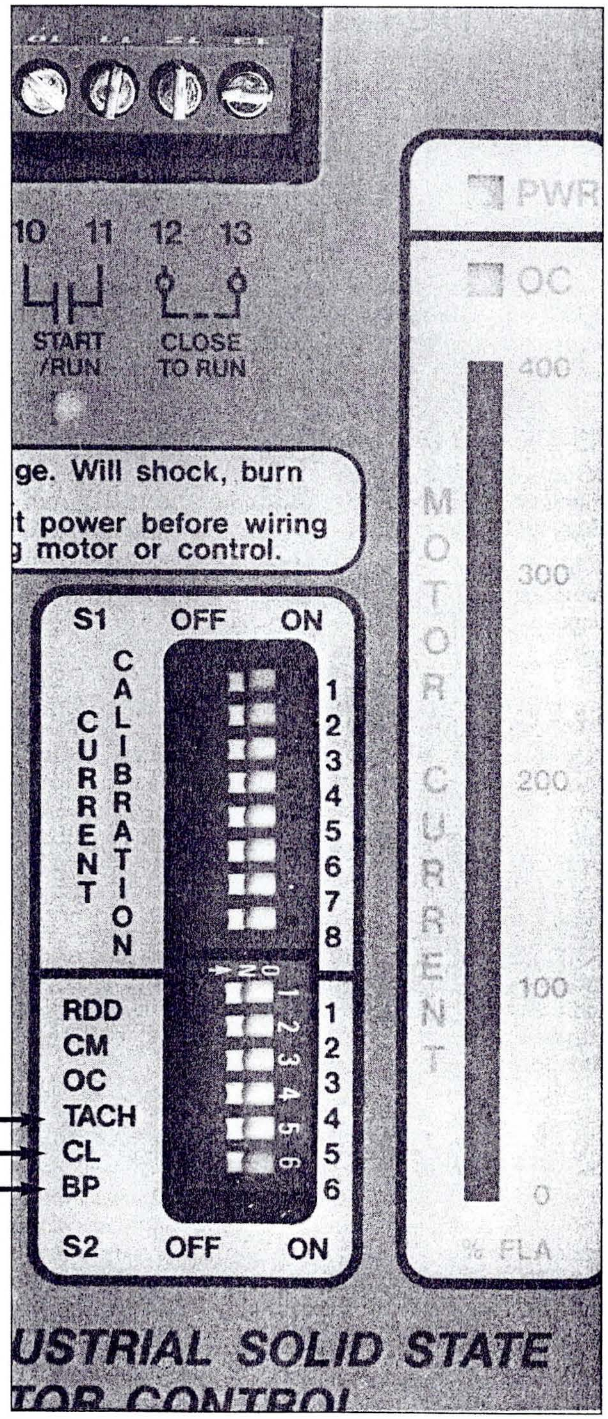
"On" position: Starting and stopping current will not exceed the setting of the current limit adjustment, except during the period of pulse start, if pulse start is being used. Current limit must be set high enough to allow the motor to start under maximum load conditions.

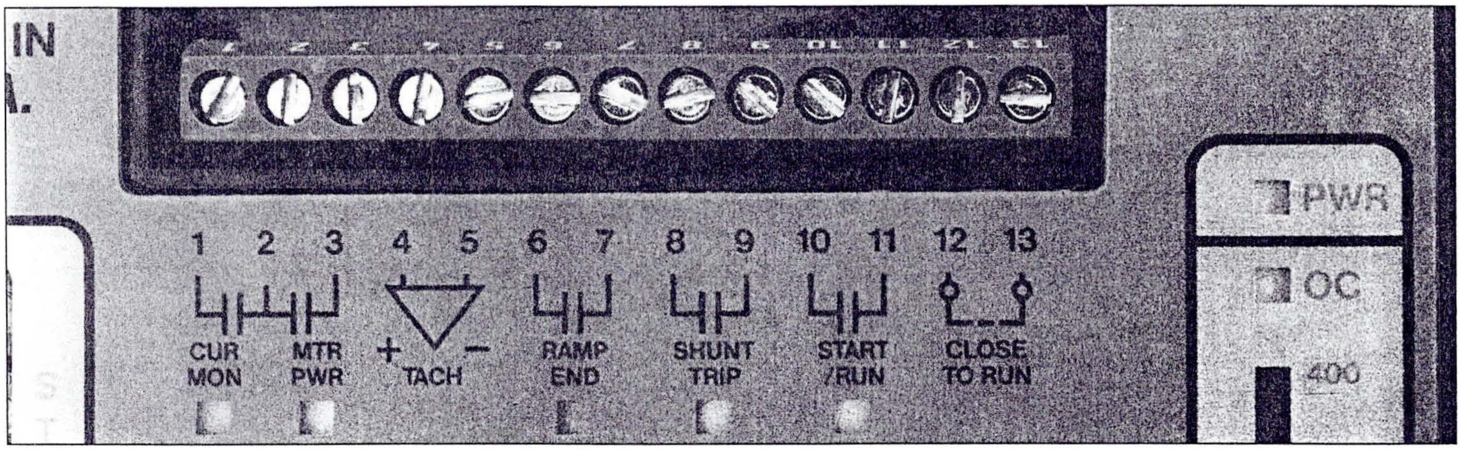
"Off" position: The current limit adjustment is disabled. Maximum motor current will be limited by the over current shutdown circuit to 450% FLA, preset at the factory.

S2-6 By-Pass Select (BP):

"On" position: When the end of ramp contact closes, the circuit breaker shunt trip circuit (the shunt trip contact on the Multipurpose control module) is disabled after the starter is in the full run condition. This allows the use of a by-pass contactor without tripping the circuit breaker when the power cells are bypassed.

"Off" position: the shunt trip circuit is enabled at all times.





INPUTS, INDICATORS AND STATUS CONTACTS

Available for the following signals and conditions:

CLOSE TO RUN start input	PWR control power on
CUR MON current monitor	RAMP END end of ramp up
MOTOR CURRENT motor current display	SHUNT TRIP shorted SCR detection
MTR PWR motor power	START/RUN maintain start
OC over current shutdown	TACH tachometer input

CLOSE TO RUN Close to Run Input, Terminals 12 and 13:
Close to run contacts must be closed to initiate ramp up and run.

Close to Run contacts must be opened to initiate ramp down to stop. Close to run contacts must be dry and electrically isolated contacts.

CUR MON Current Monitor LED and Contacts, Terminals 1 and 2:

A user adjusted monitor. Maximum running current is adjustable from 50% to 400% FLA. Dip Switch S2-2 controls the CM monitor.

S2-2 "On" position: If motor current exceeds the CUR MON setting, the LED will light and the contact will close. In addition, the motor power and ramp end LEDs will go out and their contacts will open. The control will shut down. The START/RUN LED will stay on and the contact will remain closed. Typically used to shut down the control in case of a mechanical jam. To restart a CUR MON shutdown, press stop then start; or open the Close to Run circuit, then close it.

S2-2 "Off" position: If current exceeds the CUR MON setting, the LED will light and the contact will close for the duration of the over current. The control will not shut down. In this mode, the CUR MON monitor can be used as an over and under current monitor.

MOTOR CURRENT Motor Current Display:
The Motor Current display is a 10 segment bar-graph representation of motor current from 0 to 400% FLA. Used to check ramp up, run and ramp down current conditions while the control is in operation.

MTR PWR Motor Power LED and Contacts, Terminals 2 and 3:

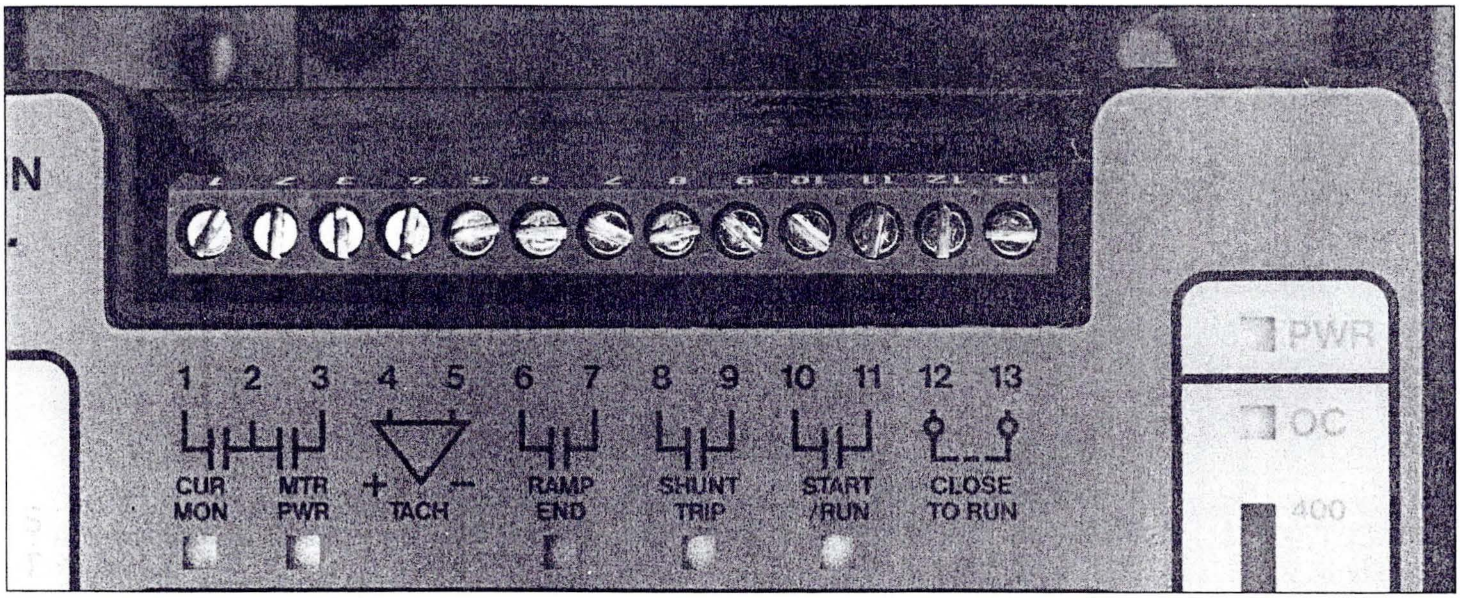
The MTR PWR LED and contact indicates that voltage and current are supplied to the motor. If a current monitor or an over current shut down condition occurs, the MTR PWR LED and contact will be deactivated.

OC Over Current Shutdown LED:
If the control shuts down due to an over current condition above 450% FLA, the OC LED will light. To restart the control, press stop, then start; or open the close to run circuit, then close it.

PWR Control Power LED:
The PWR LED indicates that power is supplied to the internal power supply of the control.

Caution:

If the power LED is not illuminated, it does not necessarily mean that the line voltage is off.



RAMP END Ramp End LED and Contact, Terminals 6 and 7: In the voltage or the tachometer modes of operation, when the starting ramp is completed and the control is in the full run mode, the RAMP END LED will light and the contact will close. The starting current limit will be disabled and CUR MON (running current monitor) will be enabled.

NOTE

> Since most loads do not require full voltage and torque to reach full speed, when control is in the voltage ramp mode, the motor will reach full speed before the RAMP END contact and LED are activated. RAMP END will only be activated after the motor and control reach full voltage.

The RAMP END contact can be used to sequence the start of other motors or equipment and close the contactor on a bypassed system.

SHUNT TRIP Shunt Trip LED and Contact, Terminals 8 and 9:

If the control detects a shorted SCR condition, the SHUNT TRIP LED will light and the contact will close. The SHUNT TRIP contact is used to operate a shunt trip circuit breaker or similar disconnection means to remove the motor and controller from the line should a shorted SCR condition occur.

The shunt trip circuit will also detect loss of phase or low voltage on a phase. The circuit may not work properly on grounded delta systems or open delta systems.

START/RUN Start/Run LED and Contact, Terminals 10 and 11: When the Close to Run circuit is closed, the START/RUN LED will light and the contact will close. Typically used to seal in the start button circuit.
As long as the Closed to Run circuit remains closed, the START/RUN LED and contact will remain activated. This condition also applies to an over current or a current monitor shutdown.

TACH Tachometer Input, Terminals 4 and 5:
The TACH inputs are used in the tachometer ramp mode S2-4 "On". The input required for TACH feedback is a 0 to 10 volt DC signal with a maximum 10 ms response time.

■

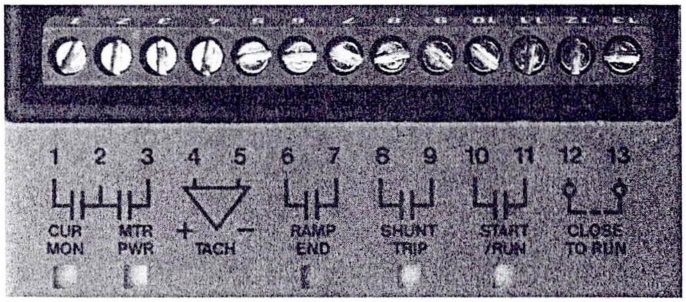
SUMMARY OF CONTROL FUNCTIONS

Input and output terminals

Inputs

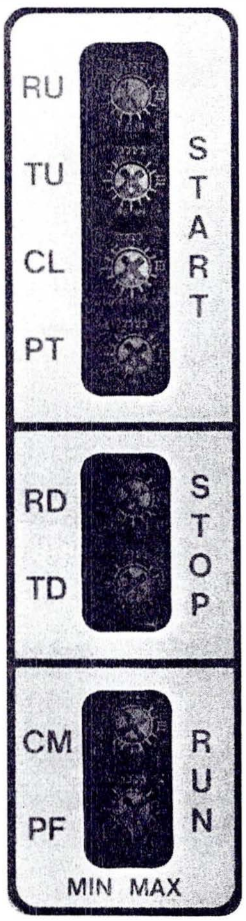
Tach 0-10VDC Tach Input

Close to run - closing 12 to 13 starts the control



Outputs

Each output contact is rated for 0.5 Amps at 125 VAC. At 230 VAC each contact is rated for 60VA.
For each contact there is a LED indicator which illuminates with contact closure.



Contact sequence during starting and stopping

TO START MOTOR – CLOSE 12-13

10-11	closes confirming start input
2-3	closes as power goes to motor and the ramp up begins
6-7	closes at the end of the ramp up

TO STOP MOTOR – OPEN 12-13

10-11	opens to confirm stop input
6-7	opens immediately

WITHOUT RAMP DOWN		WITH RAMP DOWN	
2-3	opens immediately	2-3	opens when ramp down is complete

SHUNT TRIP

8-9	if a shorted or miss firing SCR is detected, or loss of a phase the contact closes

Adjustments

Adjustments are labeled START - STOP - RUN.
This designates when the functions are active.

Start

RU - Ramp Up adjustable 3-50 seconds
TU - Torque Up adjustable 40-75% of VAC
CL - Current Limit adjustable 75-400% of FLA.
PT - Pulse Time adjustable 0-1.5 seconds

Stop

RD - Ramp Down adjustable 5-50 seconds
TD - Torque Down adjustable 0-100% of VAC

Run

CM - Current Monitor adjustable 50-400% of FLA
PF - Power Factor adjustable 0-100%

S2 Switch Setting

S2-1 RDD Ramp Down Disable in the "on" position Turns the Ramp Down function off.

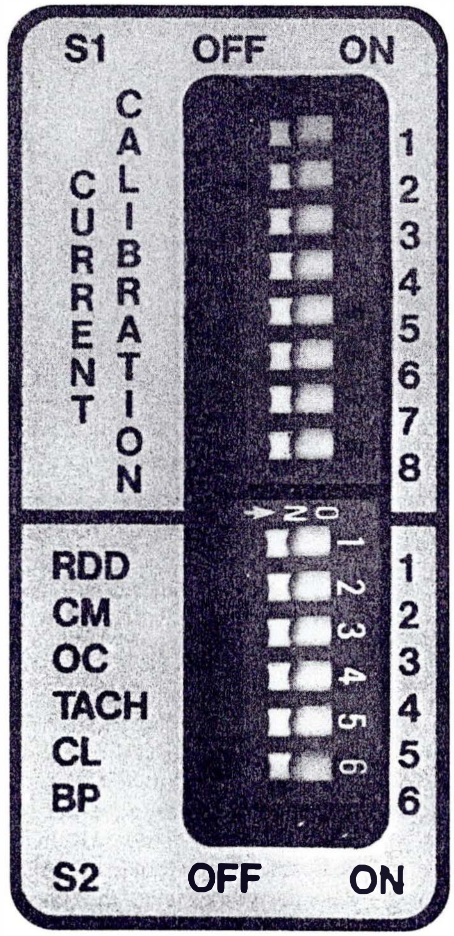
S2-2 CM Current Monitor adjusts 50-400% of motor FLA. The circuit is active after the start ramp ends. In the "on" position it will act as an electronic shear pin when the set point is reached. This is used with loads that are subject to jamming. In the "off" position, the contact closes to warn of an overload.

S2-3 OC Overcurrent set at 450% of the motor FLA as calibrated on S1. Any time the control sees 450% it will act as an electronic shear pin turning the control off. In the "on" position at overcurrent, it will also close the current monitor (CM) contact. In the "off" position only the OC LED will turn on.

S2-4 Tach - input in the "on" position the control will adjust the output to the motor to give smooth start regardless of load.

S2-5 Setting S2-5 in the "on" position activates current limit starting in combination with the "CL" adjustment sets the maximum amount current the motor will have for starting. If the switch is in the "off" position the starting will not be current limited.

S2-6 BP Bypass Contactor - when a bypass contactor is used, set S2-6 in the "on" position to disable the shunt trip circuit until 12-13 is opened. The proper SCR operation is verified before power is turned off to the motor.



STARTER SPECIFICATIONS

Multipurpose Starter Specifications

Model # Control only	208/230/460 VAC 60 Hz ①		MA7-008-CA	MA7-016-CA	MA7-030-CA
	208/230/460/575 VAC 60 Hz ①		MA8-008-CA	MA8-016-CA	MA8-030-CA
Output Ratings	HP Rating	230 VAC	2	5	10
		460 VAC	2	10	20
		575 VAC	5	10	25
	Current Rating		8 Amp	16 Amp	30 Amp
	Overload Rating		Continuous 115% of FLA 400% for 30 Seconds		
	Derate		Above 1000m (3300 Ft.) Decrease Amp Rating 1% For Each Additional 100m (330 Ft.)		
			Above 45° (115°F) Decrease Amp Rating 1.5% For Each Additional °C (.84%/°F)		
Input Rating	Frequency		± 5% of 60 Hz, or ± 5% of 50 Hz		
	Voltage		+ 10% - 15% (Except for 575 VAC units Max. VAC is 620)		
	Phase		Three Phase		
Control Spec.	Control Method		6 SCRs connected in inverse parallel for full-wave control		
	Start Time		Adjustable 3-50 Seconds (Current limit starting is not timed)		
	Stop Time		Adjustable 5-50 Seconds (can only extend stopping time)		
	Initial Torque		Adjustable Starting 40-75% Stopping 0-100%		
	Current Limit (Selectable)		Adjustable 75-400% of Full Load Amps		
	Pulse Time (Selectable)		Adjustable 0-1.5 Seconds		
	Current Monitor (Selectable)		Adjustable 50-400% of Full Load Amps (Causes a contact closure or control shut down when Current level is reached after Starting)		
	Power Factor		Adjustable for Max. Reduced Motor Voltage Dependent on Motor Load		
	Tach. Input (Selectable)		0-10 VDC (maximum 10 msec. response time from the tach)		
	Status Contacts		125 VAC at .5 Amp Normally Open (230 VAC at 60 VA but not UL/CSA)		
SCR Spec.	Peak Inverse Voltage		460 VAC Starters 1200 VAC PIV		
			575 VAC Starters 1600 VAC PIV		
	Heat Loss		3.3 Watts per running Amp		
	Voltage		+ 10% - 15% (Except for 575 VAC units Max. VAC is 620)		
Protective Functions	Over Current		Over Current Shut Down at 450% of Motor FLA		
	Shorted SCR Detection		Shunt Trip Contact		
	Phase Loss		Shunt Trip Contact		
	Overload		Electronic Overload Relay		
	Voltage Transient		Metal Oxide Varistor (MOV)		
Ambient Conditions	Temperature		Enclosed 0-45°C (32 to 113°F)	Open/Panel 0 to 55°C (32 to 122°F)	Storage - 40 to 60°C
	Relative Humidity		0 to 95% Non-Condensing		
Agency Approvals	UL Listed and UL Canada				

① 50 Hz versions have a 220V, 380 or 415 VAC input. The current rating and other specifications remain the same.

Metal Oxide Varistor (MOV)
Four varistors connected in a delta configuration with one to ground.

MOV505EL
Maximum line voltage = 510 VAC
Wattage = 1.0
Maximum surge @ 8 x 20 usec 1 time = 6500 A

MOV620E
Maximum line voltage = 625 VAC
Wattage = 1.0
Maximum surge @ 8 x 20 usec 1 time = 6500 A

MULTIPURPOSE PARTS – 8 THRU 30 AMP

Size	Control Transformer	Circuit Breaker	Rating Plug	Fuses	Overload Relay ①	SCR	MOV
MA7-008	TXF0125	MCP080A	15 AMP PLUG MCP0150	FUS0140(3)	OVL1050 OVL0005	SCR0005	MOV505L
MA7-016	TXF0125	MCP080A	20 AMP PLUG MCP0155	FUS0140(3)	OVL1060 OVL0005	SCR0005	MOV505L
MA7-030	TXF0125	MCP085A	50 AMP PLUG MCP0160	FUS0140(3)	OVL1005 OVL0005	SCR0015	MOV505L
MA8-008	TXF0125	MCP080A	15 AMP PLUG MCP0150	FUS0140(3)	OVL1050 OVL0005	SCR0010	MOV620L
MA8-016	TXF0125	MCP080A	20 AMP PLUG MCP0155	FUS0140(3)	OVL1060 OVL0005	SCR0010	MOV620L
MA8-030	TXF0125	MCP085A	50 AMP PLUG MCP0160	FUS0140(3)	OVL1005 OVL0005	SCR0020	MOV620L
MA9-008	TXF0255	MCP080A	15 AMP PLUG MCP0150	FUS0140(3)	OVL1050 OVL0005	SCR0005	MOV505L
MA9-016	TXF0255	MCP080A	20 AMP PLUG MCP0155	FUS0140(3)	OVL1060 OVL0005	SCR0005	MOV505L
MA9-030	TXF0255	MCP085A	50 AMP PLUG MCP0160	FUS0140(3)	OVL1005 OVL0005	SCR0015	MOV505L

① The top number is for electronic overload. The lower number is for a bi-metal overload.

MULTIPURPOSE PART NUMBERING BREAKDOWN

MA7-008-BB-**

Control Type
- M - Multipurpose

Voltage Code
- 7 - 208/230/460 60 Hz.
- 8 - 208/230/460/575 60 Hz.
- 9 - 220/380/415 Hz.

Disconnect Size
- 0 - Normally not shown unless smaller size disconnect is used with control.
- 1 - Reduced size disconnect is used, i.e., 800 AMP circuit breaker on am 840 AMP control instead of a 1000 AMP.

Enclosure
- A - Open
- B - NEMA 1
- C - NEMA 12/3R
- P - Panel Mount

Bypass Contactor
- 0 - Bypass contactor normally not shown unless a reduced size bypass is used with the control.

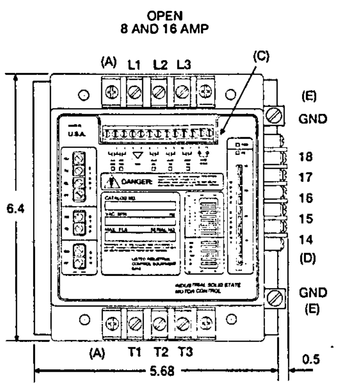
Control Group
- A - Self powered control module

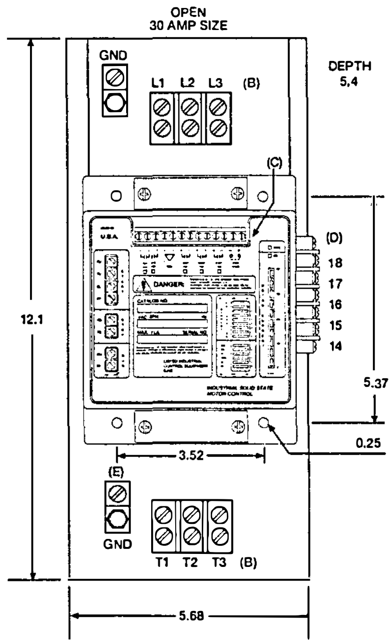
Configuration
- A - Combination (with Overload & Circuit Breaker)
- B - Non-combination (with Overload)
- C - Starter Only
- D - Combination with fuse disconnect

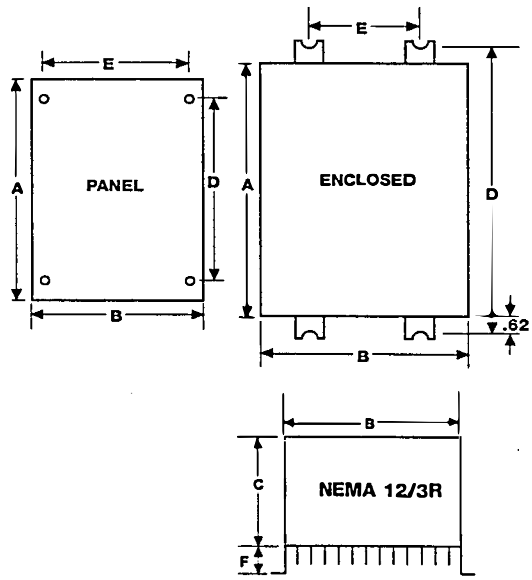
Size
- 008 - 8 Amp
- 016 - 16 Amp
- 030 - 30 Amp

* - If left blank, option 0 will be used.

MOUNTING DIMENSIONS







OPEN AND NEMA1

STARTER ONLY AND NON-COMBINATION							COMBINATION				
RATING	ENCLOSURE	A	B	C	D	E	A	B	C	D	E
8, 16 30 AMP	PANEL NEMA 1	12.25 21	10.25 14.5	5.5 6.0	10.49 19.50	8.49 13.0	17 24	13 16	5.5 6.62	15.5	11.5

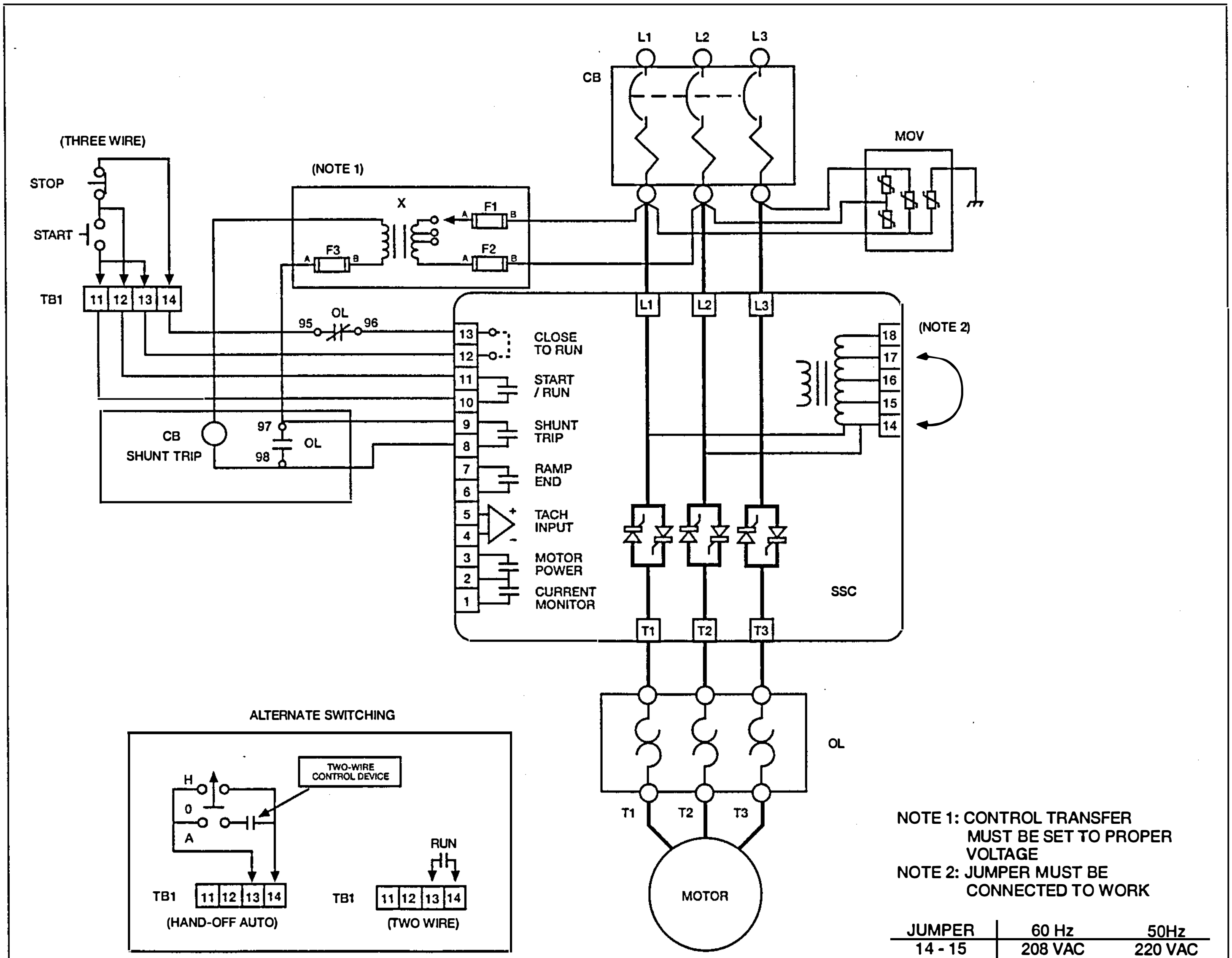
NEMA 12/3R

STARTER ONLY AND NON-COMBINATION						COMBINATION				
RATING	A	B	C	D	E	A	B	C	D	E
8, 16, 30 AMP	14	11	6	12	10.25	23	11	8	21	11.75

TORQUE SPECIFICATIONS

TERMINAL	WIRE SIZE AWG	TORQUE lb-in
A	10 - 16	20
B	8 - 18	35
C	12 - 22	12
D	14 - 22	12
E	6 - 14	45

WIRING DIAGRAM FOR NON-REVERSING STARTER

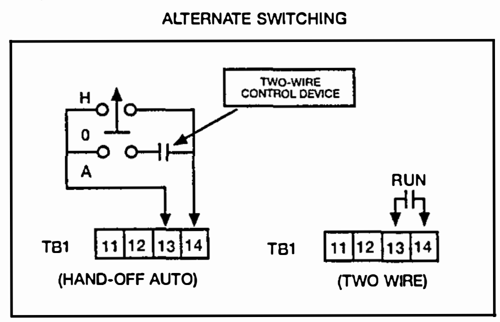


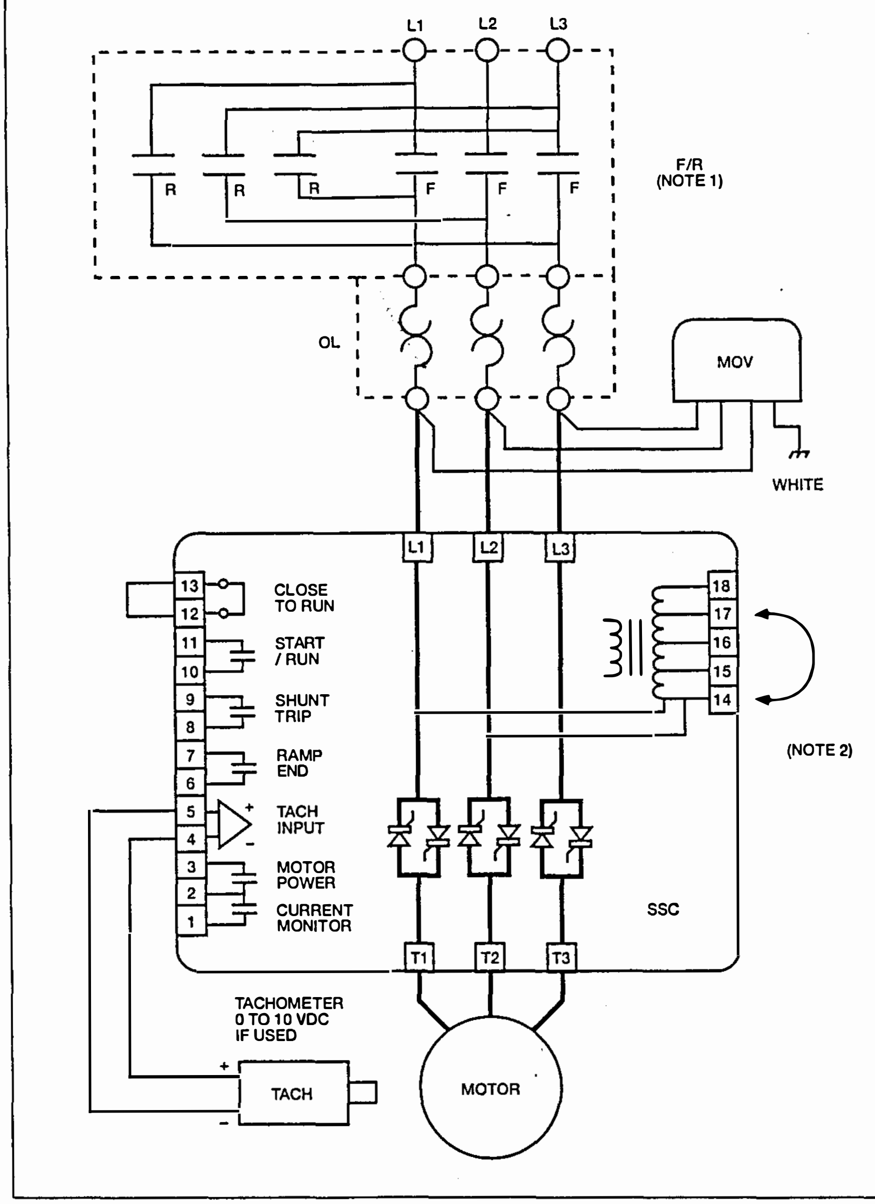
NOTE 1: CONTROL TRANSFER MUST BE SET TO PROPER VOLTAGE

NOTE 2: JUMPER MUST BE CONNECTED TO WORK

JUMPER	60 Hz	50Hz
14 - 15	208 VAC	220 VAC
14 - 16	230 VAC	380 VAC
14 - 17	460 VAC	415 VAC
14 - 18	575 VAC	—

WIRING DIAGRAM FOR REVERSING STARTER





NOTE 1: MAY BE SINGLE DIRECTION CONTACTOR. IF CONTACTOR IS REVERSING, IT MUST BE MECHANICALLY INTERLOCKED

NOTE2: JUMPER MUST BE CONNCETED TO WORK.

JUMPER	60 Hz	50Hz
14 - 15	208 VAC	220 VAC
14 - 16	230 VAC	380 VAC
14 - 17	460 VAC	415 VAC
14 - 18	575 VAC	—

MULTIPURPOSE START-UP INSTRUCTIONS

DANGER: Hazard of Electrical Shock or Burn

Disconnect input power before wiring or servicing any equipment.

Up to 600 volts to ground may exist at load terminals even when device is in the "OFF" state.

Recommended Equipment

- Volt - ohmmeter (VOM), 20,000 ohms per volt true RMS meter.
- Clamp on ammeter, able to measure 5 times motor full load current (FLA).
- Adjustment wand provided with Multipurpose Kit.

INSTALLATION

NOTE: The installation, troubleshooting or repair of this equipment should only be performed by qualified technicians, electricians or electrical maintenance personnel familiar with its operation and the hazards involved.

Receiving, Inspection and Storage

Remove the Multipurpose Starter from the carton. Inspect for shipping damage to case.

Check the packing list to ensure that all items were received.

Check the catalog number to verify that you have the correct starter for your application requirements (size, voltage, current, etc.).

Store parts in a clean, dry environment, free from contaminates. Temperature should not exceed the maximum ambient temperature 60° C (140° F).

Starting Adjustments

The following adjustment procedures are intended to be used as a guideline for matching motor starting characteristics to various loads. Actual loads may be characterized by more than one of the following types. The user may deviate from these procedures to obtain the best results. Keep in mind that reducing the starting current by one half will reduce the starting torque to approximately one quarter and take four times as long to reach full speed. In situations where overloads tend to trip because of long starting times, increasing the starting current and decreasing the ramp up time may prevent nuisance trips.

CAUTION!

DO NOT CHANGE ANY DIP SWITCH POSITION WITH POWER APPLIED.

Set the dip switches and potentiometer adjustments located on the Multipurpose Control to match the application and the starting characteristic of the motor load. **These are not preset by the factory.** The potentiometer adjustments have a maximum span of 270 degrees. Use the adjustment wand provided and do not force adjustments beyond stops.

START-UP CHECKLIST

CAUTION:

- **Follow the requirements as specified in the National Electrical Code and any applicable state and local codes and provide proper branch circuit protection.**
- **Do not megger (high-voltage insulation test) this equipment. High voltage could damage the electronics.**
- **Do not use power factor correction capacitors on the output of this control. When power factor correction capacitors are used, they must be connected on the line side of the control.**
- **If a brake motor is used, the initial starting voltage may not be sufficient to release the brake. It may be necessary to wire the brake separately from the starter.**
- **Proper ventilation must be provided or the starter will not operate properly (see page 3-1).**

WIRING

When wiring the Multipurpose Starter, consult the standard wiring diagrams in SECTION 3 for the proper configuration.

- Mount enclosure or panel in a vertical position. Allow space for ventilation and dissipation of heat generated by the heat sinks.
- Ground enclosure and control per NEC Article 250 and applicable state and local codes.
- Check the jumper on the module for the correct voltage setting.
- Motor overload protection is required.
- Use minimum 75°C Copper wire only.
- Mounting dimensions are on page 3-3.
- All wiring must be tightened as specified on page 3-3.
- Keep high voltage and low voltage wiring separate.
- Verify proper branch circuit protection. See the appendix for more information.

BEFORE APPLYING POWER

❑ Check page 4-3 for special considerations.
❑ Verify the control transformer is jumpered to proper line voltage.
❑ Verify the jumper on the control module has been set to the proper line voltage.
❑ Set S1 to the motor FLA see page A-2. (High slip motors and high efficient motor may need a higher setting).
❑ Set S2 for the type of operation for the application. See page 4-4.
❑ Adjust pots. See page 4-4.
❑ Set potentiometers as suggested on page 4-2.
❑ Verify wiring to the motor.

AFTER POWER IS APPLIED

❑ Verify LED is on.
❑ Verify shunt trip light is "off". If it is "on", verify load is connected and all three phase are present
❑ Verify the input voltage to the starter.

NON-MOTOR AND SPECIAL MOTOR APPLICATIONS

Non-motor load: The Multipurpose Control is designed to provide reduced voltage starting for standard three phase induction motors. The control may also be used to start non-motor loads. In situations where solid state switching or controlled inrush of resistive or inductive loads is necessary, this control may be applicable. Consult the factory if a non-motor load is to be used.

Wye-delta or part winding starter: If the Multipurpose Control is replacing a wye-delta or part winding starter, remove the existing contactors. Wire the motor in its "run" (delta) configuration and connect it to the terminal side of the controller. The motor can be used as if it were a standard design B motor.

Wound rotor motors: Consult the factory if a wound rotor or slip ring type motor is used with the Multipurpose Control. This type of motor produces high starting torque with reduced starting current and speed. The Multipurpose Control provides low starting current and low starting torque. In applications where high starting torque and a continuous speed reduction is not required, the Multipurpose Control may be applicable. Some resistance may be left in the rotor circuit to increase the starting torque.

High slip motors: High slip motors, such as design D, can be used with the Multipurpose Control. These motors are usually applied to large inertial loads requiring extended starting times. Reduced voltage starting will reduce the starting current and extend the starting time. Long starting times may require the use of slow trip overloads. The motor and control thermal capabilities must be evaluated before extending overload trip times.

Multi-speed motors: Consult the factory if a multi-speed motor is used with the Multipurpose Control. The control can be used to start multi-speed motors if a multi-speed starter is used between the control and the motor. In this case, an additional MOV must be wired to the terminal side of the control. Switching is usually accomplished by wiring auxiliary contacts on the multi-speed starter to the control circuit on the Multipurpose Control.

Motors on grounded delta systems and open delta systems: These systems may cause the shunt trip circuit to turn "on" during starting. If a shunt trip breaker is being used, remove the plug-in relay to prevent it from tripping the breaker. A time delay relay can then be used to allow for starting time when the shunt trip circuit might turn "on."

QUICK SET-UP

Step 1: Initial Setup

- Check continuity of the motor wiring.
- Connect "start-stop" wiring (see page 3-6 and 3-7).
- Wire jumper to terminals 11-14 (see page 3-6 and 3-7).
- If a control transformer is supplied, verify it is set to the proper voltage tap.
- Calibrate S1 (see page A-2).
- See page 4-2 for check list.

Step 2: Switch and Pot Setting

Voltage Ramp Starting (fans or lightly loaded motors)
Ramp up with no ramp down.

S2-1	ON	Ramp Down Disable
S2-2	OFF	Current Monitor
S2-3	OFF	Over Current Shut Down
S2-4	OFF	Tachometer Enable
S2-5	OFF	Current Limit Enable
S2-6	OFF	Bypass Contactor

(Turn RU, TU, PT and PF Fully CCW)

For ramp down, switch S2-1 "OFF," set RD and RT at midpoint

If a bypass contactor is used, switch S2-6 "ON"

If the control OC trips, use the current ramp starting settings.

Current Ramp Starting (high inertial loads)
Ramp up with no ramp down.

S2-1	ON	Ramp Down Disable
S2-2	OFF	Current Monitor
S2-3	OFF	Over Current Shut Down
S2-4	OFF	Tachometer Enable
S2-5	ON	Current Limit Enable
S2-6	OFF	Bypass Contactor

(Turn TU, PT, RD, TD, PF fully counter clockwise; turn RU, fully clockwise, turn CL to midpoint.)

For ramp down, switch S2-1 "OFF," set RD and RT at midpoint

For use with a bypass contactor, switch S2-6 "ON"

For high friction loads see page 4-3

Tach Feedback Starting
Use the voltage ramp setting, except switch S2-4 "ON"

Step 3: After Initial Starting

The motor should just begin to rotate when power is applied and reach "ramp end" in a minimum starting time.

If the motor:

- Starts with jerk – decrease TU by turning it counterclockwise.
- Starts too slowly – increase the CL adjustment (turn clockwise) and decrease ramp time (turn counterclockwise).
- Starts too quickly – decrease the CL adjustment (turn counterclockwise) and increase ramp time (turn clockwise).
- Is on a high inertial load or a high slip motor – it may be necessary to increase the S1 setting to allow more current for faster starting.
- Is still not starting properly – see page 4-3 for more information on starting adjustments.
- The current monitor and overcurrent shutdown should be reviewed for their proper application with the motor and load.

- The motor is properly adjusted if the motor starts smoothly when power is applied and comes up to speed as quickly as possible. Be sure to set CL high enough that the motor can start when the machine is fully loaded.
- The starter is finished starting when the Ramp End Light turns on.

Choose the following load description that best matches your application and set the control accordingly.

VARIABLE LOAD WITH VOLTAGE RAMP (DIP SWITCHES S2-4 AND S2-2 "OFF"):

Typically used for non-inertial loads, loads that increase with speed and changing loads.

1. Set RU, TU, PT, RD, TD and PF fully counterclockwise CCW).
   Set CL and CM fully clockwise (CW).
2. Adjust TU clockwise sufficiently to start load slowly moving at moment of switching.
3. Adjust RU clockwise to achieve desired starting time with normal load conditions.
   Note: Proceed to "Running Adjustment Procedure" if ramp down is not used.
4. Adjust TD clockwise sufficiently to cause the load to slow down soon after stop button is pressed, with normal load conditions
5. Adjust RD clockwise to achieve desired stopping time with normal load conditions.

Running Adjustment Procedure:

After adjusting the starting and stopping characteristics, the current monitor/trip (CM) and power factor (PF) adjustments can be made. If the power factor circuit is not used, turn the PF adjustment fully counterclockwise.

Power Factor Correction Adjustment (PF):

1. Use an ammeter to monitor motor running current.
2. With the motor at full speed, minimum load and LCM "RAMP END" LED on, adjust PF clockwise to minimize running current without oscillation. If there is no noticeable drop in current, repeat this step while monitoring motor voltage.

Current Monitor/Trip (CM):

1. Set LCM S2-2 "Off".
2. Allow the motor to reach full speed and the LCM "RAMP END" LED to turn on.
3. Adjust CM to the desired threshold by observing the "CUR MON" LED.
4. The "CUR MON" contact can be used to signal this threshold, or by setting the LCM S2-2 "On", the starter will shut down. Press stop to reset the shutdown and trip condition.

Post Adjustment Check List

1. Check fans for proper operation.
2. If bypass contactor is used, check to ensure that contactor is closing at ramp end.
3. Using a current probe, monitor current on all three motor phases. Be sure the current is balanced during ramp on, run and ramp down.
4. With the motor in run mode (RAMP END LED "On"), check phase current of all three phases. Currents should be balanced and within nameplate FLA.
5. Monitor the line voltage at the control during ramp up to ensure voltage does not drop below minimum operating voltage.

HIGH FRICTION LOAD WITH VOLTAGE RAMP (DIP SWITCHES S2-4 AND S2-2 "OFF"):

Typically used for loads that require high breakaway torque and low acceleration torque; i.e., conveyors in icy environment, equipment that resists starting due to lack of use, etc.

1. Set RU, TU, PT, RD, TD and PF fully counterclockwise (CCW).
2. Adjust PT clockwise sufficiently to start load slowly moving at moment of switching.
3. Adjust TU clockwise sufficiently to keep load moving after starting pulse.
4. Adjust RU clockwise to achieve desired starting time with normal load conditions.

NOTE

Proceed to "Running Adjustment Procedure" if ramp down is not used.

5. Adjust TD clockwise sufficiently to cause the load to slow down soon after stop button is pressed, with normal load conditions.
6. Adjust RD clockwise to achieve desired stopping time with normal load conditions.

Running Adjustment Procedure:

After adjusting the starting and stopping characteristics, the current monitor/trip (CM) and power factor (PF) adjustments can be made. If the power factor circuit is not used, turn the PF adjustment fully counterclockwise.

Power Factor Correction (PF):

1. Use an ammeter to monitor motor running current.
2. With the motor at full speed, minimum load and "RAMP END" LED on, adjust PF clockwise to minimize running current without oscillation. If there is no noticeable drop in current, repeat this step while monitoring motor voltage.

Current Monitor/Trip (CM):

1. Set LCM S2-2 "Off".
2. Allow the motor to reach full speed and the LCM "RAMP END" LED to turn on.
3. Adjust CM to the desired threshold by observing the "CUR MON" light.
4. The "CUR MON" contact can be used to signal this threshold, or by setting the LCM S2-2 "On", the starter will shut down. Press stop to reset the shutdown and trip condition.

Post Adjustment Check List

1. Check fans for proper operation.
2. If bypass contactor is used, check to ensure that the contactor is closing at ramp end.
3. Using a current probe, monitor current on all three motor phases. Be sure the current is balanced during ramp up, run and ramp down.
4. With the motor in run mode (RAMP END LED "On"), check phase current of all three phases. Currents should be balanced and within nameplate FLA.
5. Monitor the line voltage at the control during ramp up to ensure voltage does not drop below minimum operating voltage.

INERTIAL LOAD (DIP SWITCHES S2-1 AND S2-5 "ON", S2-4 OFF"):

Typically used on coasting and/or flywheel loads; i.e., chippers, compressors, chillers, band saws, etc.

NOTE

Ramp down and pulse start would not normally be used with inertial loads.

1. Set TU, PT, RD, TD and PF fully counterclockwise (CCW).
   Set RU approximately 90% clockwise.
   Set CL to midpoint.
   Set CM fully clockwise (CW).
2. Adjust CL sufficiently to allow motor to reach full speed in desired time with maximum normal load.

Running Adjustment Procedure:

After adjusting the starting and stopping characteristics, current monitor/trip (CM) and power factor (PF) adjustments can be made. If the power factor circuit is not used, turn the PF adjustment fully counterclockwise.

Power Factor Correction Adjustment (PF):

1. Use an ammeter to monitor motor running current.
2. With the motor at full speed, minimum load and LCM "RAMP END" LED on, adjust PF clockwise to minimize running current without oscillation. If there is no noticeable drop in current, repeat this step while monitoring motor voltage.

Current Monitor/Trip (CM):

1. Set LCM S2-2 "Off".
2. Allow the motor to reach full speed and the LCM "RAMP END" LED to turn on.
3. Adjust CM to the desired threshold by observing the "CUR MON" light.
4. The "CUR MON" contact can be used to signal this threshold, or by setting the LCM S2-2 "On", the starter will shut down. Press stop to reset the shutdown and trip condition.

Post Adjustment Check List

1. Check fans for proper operation.
2. If a bypass contactor is used, check to ensure that the contactor closes at ramp end.
3. Using a current probe, monitor current on all three motor phases. Be sure the current is balanced during ramp up, run and ramp down.
4. With the motor in run mode (RAMP END LED "On"), check phase current of all three phases. Currents should be balanced and within nameplate FLA.
5. Monitor the line voltage at the control during ramp up to ensure voltage does not drop below minimum operating voltage.

TACHOMETER MODE (DIP SWITCHES S2-4 "ON", S2-5 "OFF"):

Typically used for changing loads that require consistent starting and stopping times, independent of load condition, and pumping applications with severe head pressure to reduce water hammer; i.e., pumps, conveyors, stackers and other material handling equipment.

1. Set RU, TU, PT, RD, TD and PF fully counterclockwise (CCW).
   Set CL and CM fully clockwise (CW).
2. Adjust RU and RD for desired ramp up and ramp down time.
   RD is only effective with S2-1 "Off".

Running Adjustment Procedure:

After adjusting the starting and stopping characteristics, current monitor/trip (CM) and power factor (PF) adjustments can be made. If the power factor circuit is not used, turn the PF adjustment fully counterclockwise.

Power Factor Correction Adjustment (PF):

1. Use an ammeter to monitor motor running current.
2. With the motor at full speed, minimum load and SSC "RAMP END" LED on, adjust PF clockwise to minimize running current without oscillation. If there is no noticeable drop in current, repeat this step while monitoring motor voltage.

Current Monitor/Trip (CM):

1. Set LCM S2-2 "Off".
2. Allow the motor to reach full speed and the LCM "RAMP END" LED to turn on.
3. Adjust CM to the desired threshold by observing the "CUR MON" light.
4. The "CUR MON" contact can be used to signal this threshold, or by setting the LCM S2-2 "On", the starter will shut down. Press stop to reset the shutdown and trip condition.

Post Adjustment Check List

1. Check fans for proper operation
2. If a bypass contactor is used, check to ensure that the contactor closes at ramp end.
3. Using a current probe, monitor current on all three motor phases. Be sure the current is balanced during ramp up, run and ramp down.
4. With the motor in run mode (RAMP END LED "On"), check phase current of all three phases. Currents should be balanced and within nameplate FLA.
5. Monitor the line voltage at the control during ramp up to ensure voltage does not drop below minimum operating voltage.

■

MAINTENANCE AND TROUBLESHOOTING

MAINTENANCE

Up to 600 volts to ground may exist at load terminals even when device is in the "Off" state.

Caution:

- **Follow the requirements as specified in the National Electrical Code and any applicable state and local codes and provide branch circuit protection. Size, wire and ground control per these codes.**
- **Do not megger (high-voltage insulation test) this equipment. High voltage could damage the electronics.**
- **Do not use power factor correction capacitors on the output of this control. When power factor correction capacitors are used, they must be connected on the line side of the control.**
- **If a brake motor is used, the initial starting voltage may not be sufficient to release the brake. It may be necessary to wire the brake separately from the starter.**

NOTE

It is recommended that maintenance, troubleshooting or repair of this equipment be performed only by qualified technicians.

Periodic Maintenance

The control should be checked at regular intervals. Disconnect power when any checking or maintenance is performed.

- Check fans for proper operation.
- Check to ensure relays are tight in sockets.
- Check all connections for tightness and signs of overheating.
- Check for cracked or damaged insulators and terminal blocks.
- Inspect heat sink for cleanliness. Make sure it has proper ventilation.
- Check MOVs for physical damage and signs of overheating.
- Test overload trip function.
- Remove excessive dust and dirt by vacuuming. Power must be "Off". Do not use water or solvents.

TROUBLESHOOTING

In the event of trouble, disconnect all power to the control and proceed with preliminary checks.

Preliminary Checks

Preliminary checks are intended to identify problems that can be corrected with a minimum of effort. If the preliminary checks do not identify the problem, proceed to the Troubleshooting Chart.

Power Off - Quick Check

- Check all connections for tightness and signs of overheating.
- Check for cracked or damaged insulators and terminal blocks.
- Check that wiring is correct.
- Is control transformer fuse blown?
- Is the motor connected to the control?
- Do a resistance check for a shorted SCR and module. (See figure 4).
- Check the Motor.

CHECKING FOR SHORTED SCR

Resistance Check:

Disconnect leads from the line and load terminals. Using an ohmmeter (20,000 ohms per volt or greater), measure the resistance between the line and load terminals of each phase on the control module. Do not megger (high voltage insulation test) the control.

Measure (On The Module) From:

L1 to T1	L2 to T2	L3 to T3

Resistance should be greater than 10,000 ohms

Blocking Voltage Check:

This check need only be performed if the resistance check for shorted SCRs is inconclusive. Always perform the resistance check first. If the resistance is greater than 10,000 ohms, but an SCR still appears to be shorted, it may be breaking down when voltage is applied. Before power is reapplied to the control. be sure that there will be no danger if the motor should rotate due to shorted SCRs.

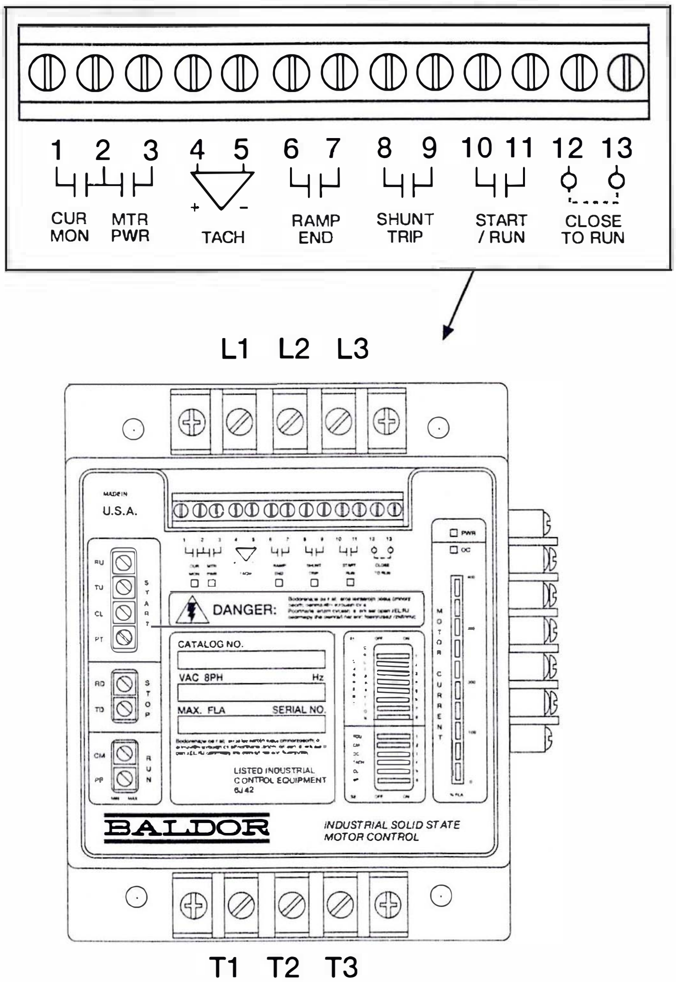
The T1, T2 and T3 terminals on the control should be connected to the motor when making this test. Disconnect one of the wires to the shunt trip contact on the control. This prevents the shorted SCR detection circuit from operating the disconnect device while you are performing this test.

Close the disconnecting means and check the voltage from the control line terminal to load terminals on each phase. The measured voltage should be approximately 0.58 times the system line to line voltage. If the voltage on any pole is significantly less than this, one or both SCRs in the pole may be shorted.

If a shorted SCR is detected, check for possible shorted connections, system grounds or any other condition which might be causing the short. Replacement of SCRs or power poles without determination of the cause of failure may result in repeated failure of the SCRs.

LOGIC CONTROL MODULE RESISTANCE CHECK

- Disconnect the logic module from all external wiring before conducting resistance checks.
- Use an ohmmeter with 20,000 ohms per volt or greater.
- Check the measured values against the resistance chart, Figure 4.



LINE / LOAD

CIRCUIT	RESISTANCE
L1 - L2	GREATER THAN 500 KOHM
L1 - L3	
L2 - L3	
T1 - T2	
T2 - T3	
T2 - T3	
L1 - T1	
L2 - T2	
L3 - T3	

LINE / LOAD

CIRCUIT	RESISTANCE
14 - 15 16 - 17	130 OHMS TO 180 OHMS

FIGURE 4

TROUBLESHOOTING CHART

Symptoms	Likely Causes	Recommended Action
MCP Trips as it is Closed (See–Shunt Trip Comes On)	Motor is not connected.	Connect motor control.
	ST contact on control always closed.	Replace or repair control module.
	Improper voltage.	Correct line voltage.
	Shorted SCR.	Repair or replace SCR.
	Control wired for the wrong voltage.	Wire for correct voltage.
MCP Trips as Motor is Started (See–Shunt Trip Comes On)	MCP trip setting too low.	Adjust higher.
	Line voltage drops during start.	Correct incoming line voltage.
	Motor or terminal wiring faults.	Check terminal and motor wiring.
	Capacitors on output of control.	Remove capacitors or move to line side of starter
	Defective control module.	Replace control module.
	Improper current calibration.	Check S1 for correct dip switch setting.
MCP Trips After Motor is Running (See–Shunt Trip Comes On)	PF over adjusted	Adjust PF counterclockwise.
	Occasional line imbalance.	Turn S2-6 "On" to disable shunt trip while running.
	Ground or motor fault.	Check motor and wiring.
	S2-6 "On", no bypass contactor installed.	Check position of S2-1.
Starter Does Nothing When Start Button is Pressed	No line voltage.	Restore line voltage.
	Overload open.	Reset overload.
	No contact closure across terminals 12 and 13, Close to Run.	Check start circuit.
	Current trip occurs.	Check S1 dip switch settings for correct current calibration.
	Control module has no power.	Check Control transformer jumper for proper connection.
Control does not Accelerate Motor to Full Speed (Stalls)	CL set too low.	Adjust CL clockwise.
	Line voltage dropping below minimum operating voltage during start.	Correct line voltage regulation.

Symptoms	Likely Causes	Recommended Action
Insufficient Torque Available from Current Limit (CL)	Improper current feedback.	Check S1 for proper dip switch settings.
Motor Accelerates Too Slowly	CL set too low.	Adjust CL clockwise.
	Ramp up time (RU) set too long.	Adjust RU clockwise.
	Improper current feedback.	Check S1 for proper dip switch settings.
Motor Accelerates Too Quickly	Current limit set too high.	Adjust (CL) counterclockwise.
	Ramp up time set too short.	Adjust (RD) counterclockwise.
	Initial pulse time set too long.	Adjust (PT) counterclockwise.
	Improper current feedback.	Check S1 dip switches for proper settings.
	Light or no load on motor is dependent on	Motor acceleration time motor load. A lightly loaded motor will reach full speed with low starting current or voltage. Motor may require the use of tachometer.
Over Current Trip Occurs at the Beginning of Start	Improper current feedback.	Check S1 dip switches for proper settings.
	Initial pulse time set too long.	Adjust (PT) counterclockwise.
	Ramp up time set too fast.	Adjust (RU) counterclockwise.
Over Current Trip Occurs After Motor Reaches Full Speed	Current monitor set too low.	Adjust (CM) clockwise.
Current Trip Does Not Occur With Motor at Full Speed and (CM) Full Counterclockwise	Improper current feedback.	Check S1 dip switches for proper settings.
	Motor current below 50% FLA. FLA value. Calibration with a lower FLA value will lower the minimum current monitor trip.	Minimum current monitor trip setting is 50% of current calibrator

TROUBLESHOOTING CHART

Symptoms	Likely Causes	Recommended Action
Motor Current and Voltage Oscillates After Start	Power factor correction over adjusted.	Adjust (PF) counterclockwise until oscillation stops.
Motor Is Noisy or Vibrates When Starting	Line voltage dropping below minimum operating voltage during start.	Correct line voltage regulation.
	Single phasing due to open phase.	Check wiring and overload heaters.
	Single phasing or unbalanced current due to non-firing SCR.	Check for shorted SCR.
	Single phasing or unbalanced current due to defective control module.	Repair or replace control module.
	Defective motor.	Check motor for shorts, opens or grounds.
Overload Relay Trips When Starting	Incorrect heater size or setting.	Check heater calibrator chart.
	Loose or burned heater.	Tighten or replace heater.
	Long starting time. (High inertia applications may require slow trip overloads).	Motor thermal capabilities must be evaluated before extending overload trip times.
	Mechanical problems.	Check machinery for binding or excessive loading.
	Single phasing or unbalanced start current.	Refer to "motor is noisy" section of Trouble-shooting Chart.
	Excessive starting time (current limit may be set too low.)	Adjust (CL) clockwise.
Overload Relay Trips When Running	Incorrect heater size or setting.	Check Calibrator/heater Chart.
	Loose or burned heater.	Tighten or replace heater.
	Mechanical problems.	Check machinery for binding or excessive loading.
	Single phasing or unbalanced current.	See "motor is noisy" section in Troubleshooting Chart.
	Ambient temperature too high	Use ambient compensated overload relay.
Motor Decelerates Too Quickly (RDD OFF)	Ramp down time set too short.	Adjust RD counterclockwise.
Motor Decelerates Too Slowly (RDD OFF)	Ramp down time set too long.	Adjust RD counter clockwise.
Erratic Operation	Loose connections.	Check all connections.
Shunt Trip LED Comes On	The shunt trip circuit comes on if:	
	• No load attached	Connect a motor
	• Loss of phase or low voltage to the starter	Correct input power
	• Bad or misfiring SCR	Doing a resistance check
	• A grounded delta motor power supply	Shunt trip is not effective See Pages 3-4
NOTE:	If the MCP is tripping, remove the relay or disconnect the wires from terminals 10-11. This will allow you to determine if the breaker (MCP) is tripping or if it is the module opening the breaker (MCP).	

GLOSSARY

BP	BYPASS CONTACTOR
CC	CURRENT CALIBRATOR
CCW	COUNTERCLOCKWISE
CL	CURRENT LIMIT
CM	CURRENT MONITOR
CS & RS	CAPACITOR & RESISTOR SERIES CIRCUIT
CUR MON	CURRENT MONITOR
CT	CURRENT TRANSFORMER
CW	CLOCKWISE
FLA	FULL LOAD AMPERES
LCM	LOGIC CONTROL MODULE
LED	LIGHT EMITTING DIODE
MCP	MOTOR CIRCUIT PROTECTOR
MOV	METAL OXIDE VARISTOR
MTR PWR	MOTOR POWER
OC	OVER CURRENT SHUTDOWN
OL	OVERLOAD RELAY
PC	POWER CELLS
PF	POWER FACTOR CORRECTION
PIV	PEAK INVERSE VOLTAGE
PT	STARTING PULSE TIME
PWR	POWER
RAMP END	END OF RAMP
RD	RAMP DOWN TIME
RDD	RAMP DOWN DISABLE
RMS	ROOT MEAN SQUARED
RU	RAMP UP TIME
SCR	SILICON CONTROLLED RECTIFIER
SHUNT TRIP	SHORTED SCR DETECTION
SSC	SOFT START CONTROL
TACH	TACHOMETER
TD	RAMP DOWN INITIAL STARTING TORQUE
TU	RAMP UP TIME STARTING POINT
X	CONTROL TRANSFORMER

RU — RAMP UP TIME (3-50 sec.)
(dial: 50 – 3)
TACHOMETER: Time to reach full speed.
VOLTAGE: Time to reach full speed.

TU — TORQUE UP (40-75% voltage)
(dial: 40 – 75)
TACHOMETER: Disabled.
VOLTAGE: Initial starting voltage for ramp.

CL — CURRENT LIMIT (75-400% FLA)
(dial: 75 – 400)
TACHOMETER or VOLTAGE: Enabled with S2-5 ON.
Maximum current during ramp up and ramp down.

PT — PULSE TIME (0-1.5 sec.)
(dial: 0 – 1.5)
TACHOMETER: Disabled.
VOLTAGE: Duration of 400% FLA starting pulse.

RD — RAMP DOWN TIME (5-50 sec.)
(Disabled with S2-1 ON.)
(dial: 50 – 5)
TACHOMETER: Time to reach zero speed.
VOLTAGE: Time to reach zero speed.

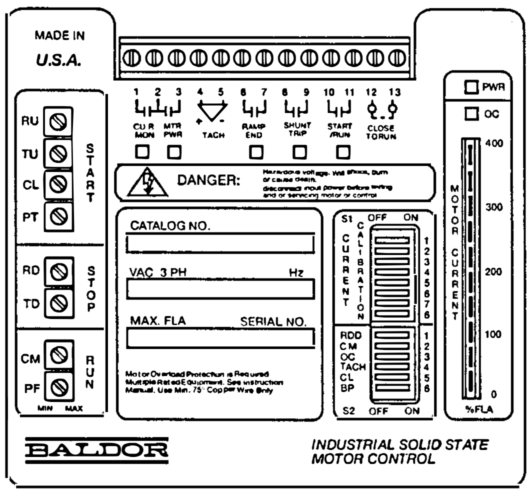
TD — TORQUE DOWN ADVANCE (0-100%)
(Disabled with S2-1 ON.)
(dial: 0 – 100)
TACHOMETER or VOLTAGE: Percent advance to ramp down initial starting point.

CM — CURRENT MONITOR (50-400% FLA)
(Enabled at end of ramp and full on condition)
(dial: 50 – 400)
S2-2 ON: Current that will shut down control and turn on CM contact and LED.
S2-2 OFF: Currnet that will cause CM contact and LED to turn on.

PF — POWER FACTOR EFFECT (0-100%)
(dial: 0 – 100)
Maximum motor voltage reduction to improve power factor

MULTIPURPOSE QUICK REFERENCE CHART

CUR MON:	Indicates Current Trip or Current Monitor condition.
MTR PWR:	Power to motor during start, run and ramp down.
TACH:	Tachometer input (0 to 10 VDC).
RAMP END:	Indicates end of ramp up and full on condition.
SHUNT TRIP:	Indicates Shunt Trip condition due to shorted SCR.
START/RUN:	Indicates Close to Run contact is close.
CLOSE TO RUN:	Close a contact across this input to start and run control. Opening contact initiates ramp down.



PWR: Internal control power on.

OC: Over current shut down (450% FLA).

MOTOR CURRENT:
Ten segment motor current monitor. accuracy is dependent on S1.

S1: S1-1 thru S1-8 select 255 current calibration points for motor FLA. See current calibration chart.

RDD: S2-1, Ramp Down Disable
ON: Control will immediately turn off when Close to Run circuit opens.
OFF: Control will ramp down when Close to Run circuit opens.

CM: S2-2, Current Monitor Trip
ON: Control will turn off if current exceeds CM adjustment. To reset, open Close to Run.
OFF: Current Monitor will indicate only.

OC: S2-3, Over Current Shut Down
ON: Over Current Shut Down will turn on Current Monitor contact and LED.
OFF: Will turn off control without affecting Current Monitor contact and LED.

TACH: S2-4, Tachometer Enable
ON: Control is in tachometer ramp mode.
OFF: Control is in voltage ramp mode.

CL: S2-5, Current Limit Enable
ON: Current will not exceed adjustment CL during ramp up and down except during pulse start.
OFF: Current Limit adjustment has no effect.

BP: S2-6, Bypass Contactor Enable
ON: Shunt Trip circuit is disabled during full on condition to allow a Bypass Contactor to be used.
OFF: Shunt Trip circuit is enable in all conditions.

MULTIPURPOSE CURRENT CALIBRATION CHART FOR S1 SWITCH

0 = OFF   1 = ON

NOTE: S1 switch settings are based on motors with 600% locked rotor Amps (LRA).
Motors with higher LRA should be set to a higher FLA setting.

MA7-008-★★
MA8-008-★★
MA9-008-★★

MOTOR	S1 SWITCH CONFIGURATION							
FLA	1	2	3	4	5	6	7	8
1.0 - 1.1	1	1	1	0	0	0	0.	1
1.1 - 1.2	0	0	0	0	1	0	0	1
1.2 - 1.3	0	0	0	1	1	0	0	1
1.3 - 1.4	0	0	0	0	0	1	0	1
1.4 - 1.5	0	1	1	0	0	1	0	1
1.5 - 1.6	0	0	1	1	0	1	0	1
1.6 - 1.7	1	0	0	0	1	1	0	1
1.7 - 1.8	0	1	1	0	1	1	0	1
1.8 - 1.9	0	0	1	1	1	1	0	1
1.9 - 2.1	0	0	0	0	0	0	1	1
2.1 - 2.3	1	0	1	0	0	0	1	1
2.3 - 2.5	0	1	0	1	0	0	1	1
2.5 - 2.7	0	1	1	1	0	0	1	1
2.7 - 3.0	0	1	0	0	1	0	1	1
3.0 - 3.3	0	1	1	0	1	0	1	1
3.3 - 3.6	1	0	0	1	1	0	1	1
3.6 - 3.9	0	0	1	1	1	0	1	1
3.9 - 4.4	0	0	0	0	0	1	1	1
4.4 - 4.8	1	1	0	0	0	1	1	1
4.8 - 5.2	1	0	1	0	0	1	1	1
5.2 - 5.6	1	1	1	0	0	1	1	1
5.6 - 6.0	1	0	0	1	0	1	1	1
6.0 - 6.4	0	1	0	1	0	1	1	1
6.4 - 6.8	0	0	1	1	0	1	1	1
6.8 - 7.4	0	1	1	1	0	1	1	1
7.4 - 8.0	1	1	1	1	0	1	1	1

MA7-016-★★
MA8-016-★★
MA9-016-★★

MOTOR	S1 SWITCH CONFIGURATION							
FLA	1	2	3	4	5	6	7	8
6.0 - 6.5	1	0	0	0	0	1	1	1
6.5 - 7.0	0	0	1	0	0	1	1	1
7 - 8	1	1	1	0	0	1	1	1
8 - 9	1	0	0	1	0	1	1	1
9 - 10	1	1	0	1	0	1	1	1
10 - 11	1	0	1	1	0	1	1	1
11 - 12	1	1	1	1	0	1	1	1
12 - 13	0	0	0	0	1	1	1	1
13 - 14	0	1	0	0	1	1	1	1
14 - 16	1	1	0	0	1	1	1	1

MA7-030-★
MA8-030-★
MA9-030-★

MOTOR	S1 SWITCH CONFIGURATION							
FLA	1	2	3	4	5	6	7	8
12 - 13	1	0	0	0	0	1	1	1
13 - 14	1	1	0	0	0	1	1	1
14 - 15	1	0	1	0	0	1	1	1
15 - 16	1	1	1	0	0	1	1	1
16 - 18	1	0	0	1	0	1	1	1
18 - 20	1	1	0	1	0	1	1	1
20 - 22	1	0	1	1	0	1	1	1
22 - 24	0	1	1	1	0	1	1	1
24 - 27	0	0	0	0	1	1	1	1
27 - 30	0	1	0	0	1	1	1	1

WARNING: Use only the chart for that control rating. Using a different chart can damage the control.

Branch Circuit Protection

• Motor Overload Protection is Required • Use a Minimum of 75°C Copper Wire Only

The Multipurpose starter is suitable for use on a circuit capable of delivering not more than 5KA RMS symmetrical amperes, 600V maximum when protected by J Class fuses or by type SKLA or SGLA motor circuit protector, manufactured by GE.

Starter Size	MCP Rating	Class J Fuses
8,16	20Amp	100Amp
30	50 Amp	200 Amp①

① 100 Amp class RKl may also be used.

Overload Relay - Electronic

The electronic overload relay is a class 30. It is fully adjustable without heaters. Set the dial for the motor running current. If a lower setting is required than what is available on the dial, loop the wire through the opening as shown in figure 1. This will lower the range as shown in the chart Figure 2.

Figure 1

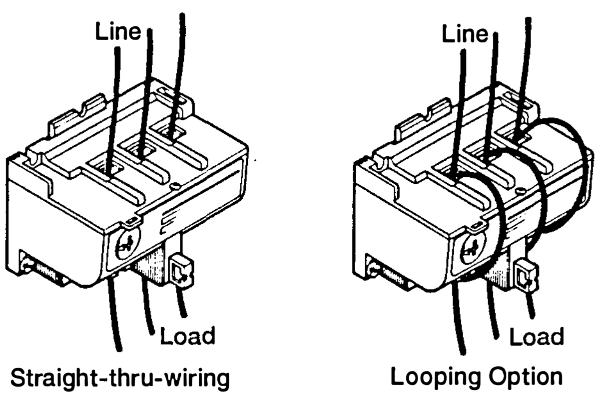


Figure 2

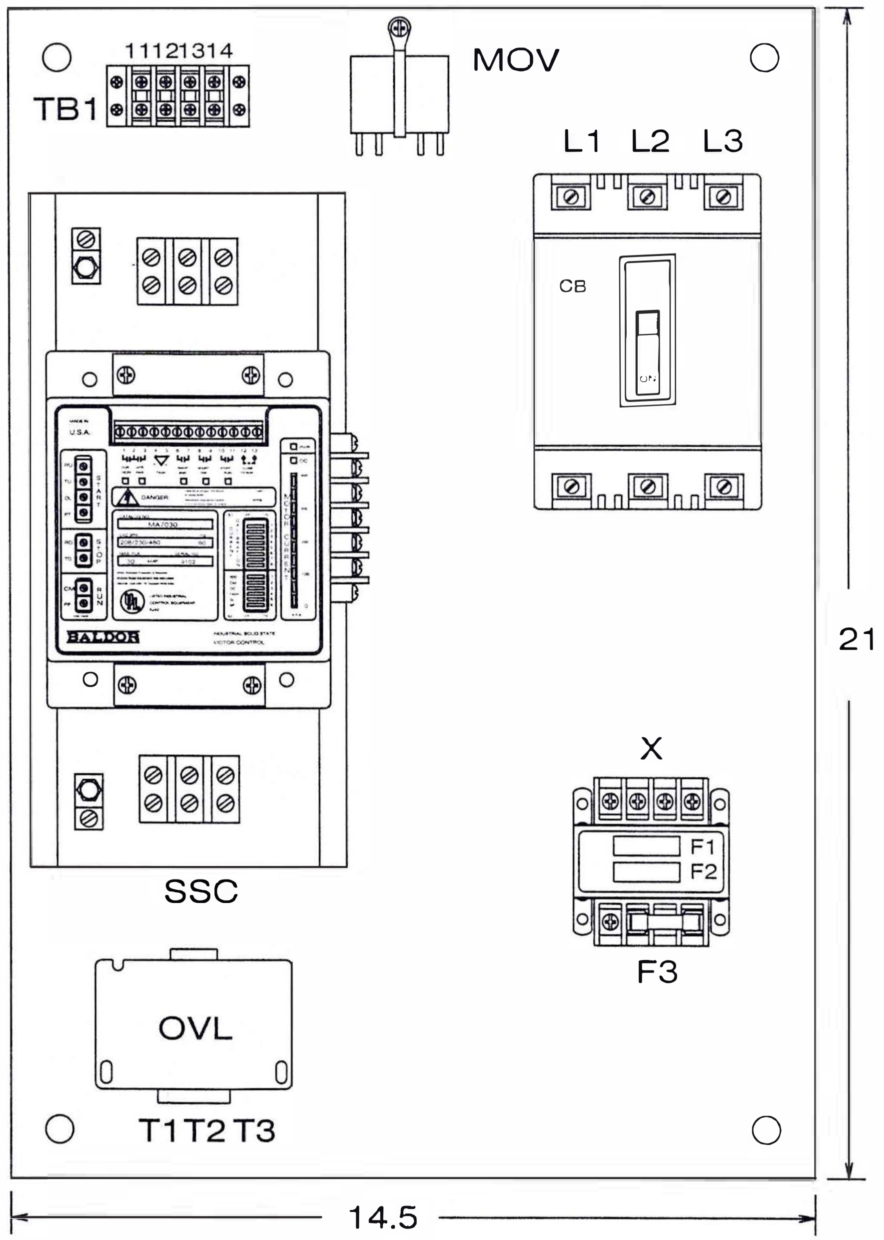
Overload Range	# of Loops	Dial Range
5-10	0	5-10 Amps
	1	2.5-5
	2	1.6-3.3
9-18	0	9-18 Amps
	1	4.5-9
	2	3-6
20-40	0	20-40
	1	10-20
	2	6.6-13.3

Overload Relay - Bimetal - Verify heater element is correct for the motor current and set dial.

Combination Starter Layout NEMA 1 and Panel Mounted

Size 8 to 30 Amp

See page 3-3 for outside dimensions

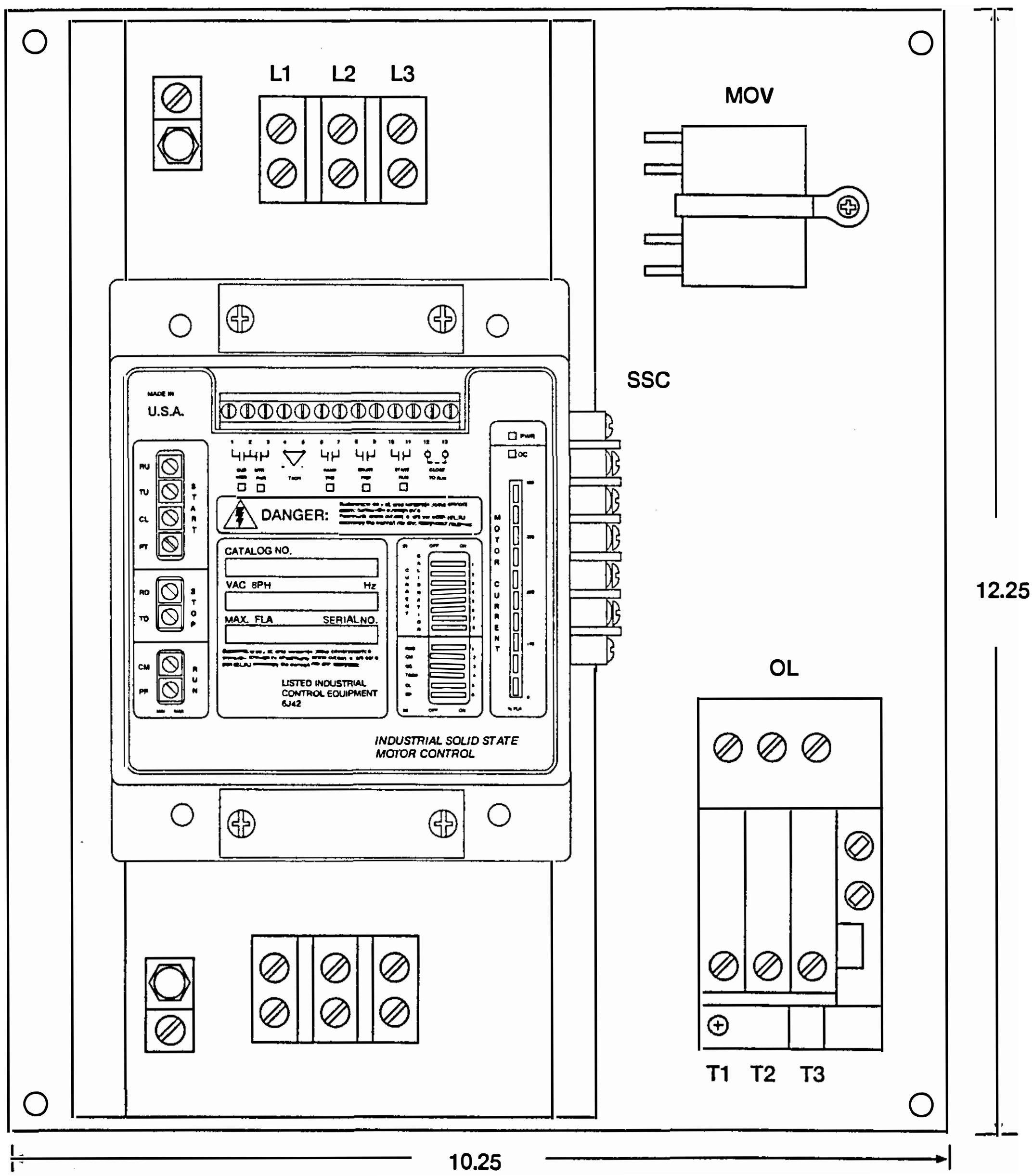


Non-combination NEMA 1 and Panel Mounted

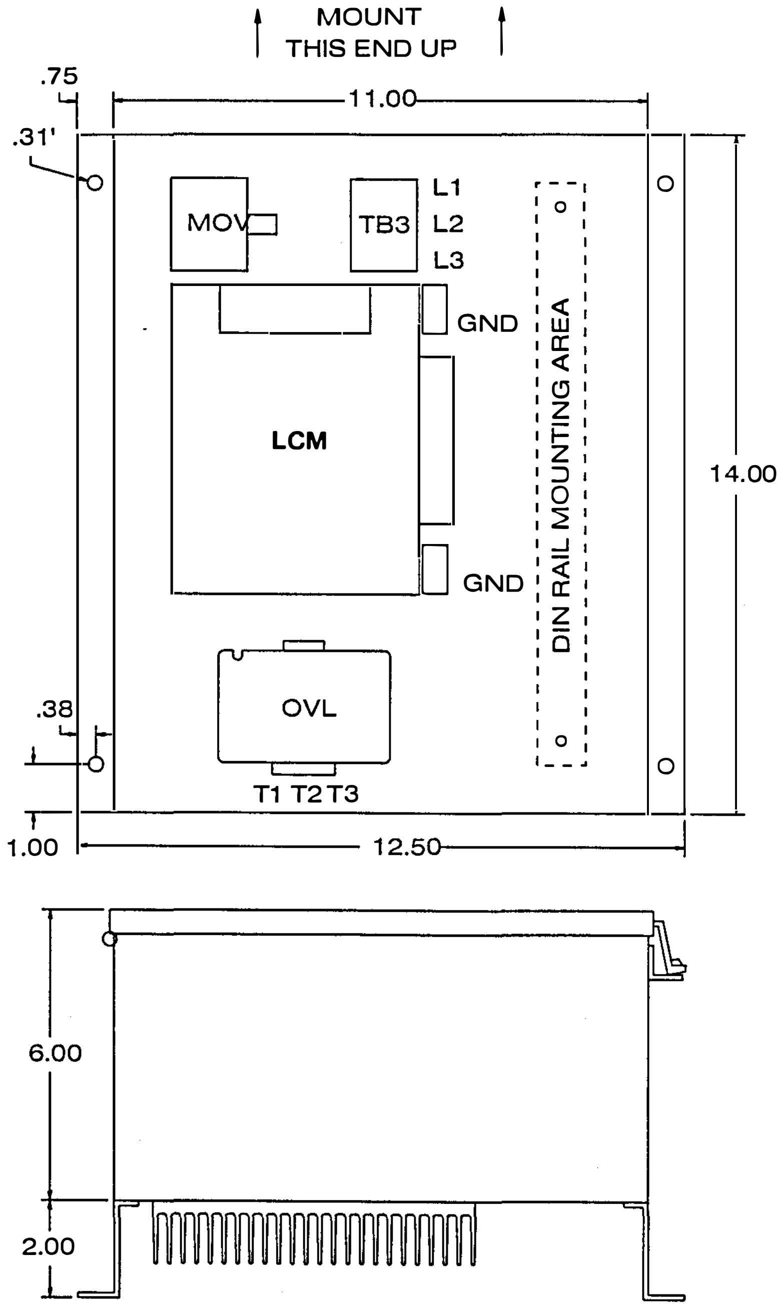
Bimetal Overload Relay is Shown. Electronic Overload Version Will Vary Slightly

See page 3-3 for outside dimensions

Size 8 to 30 Amp

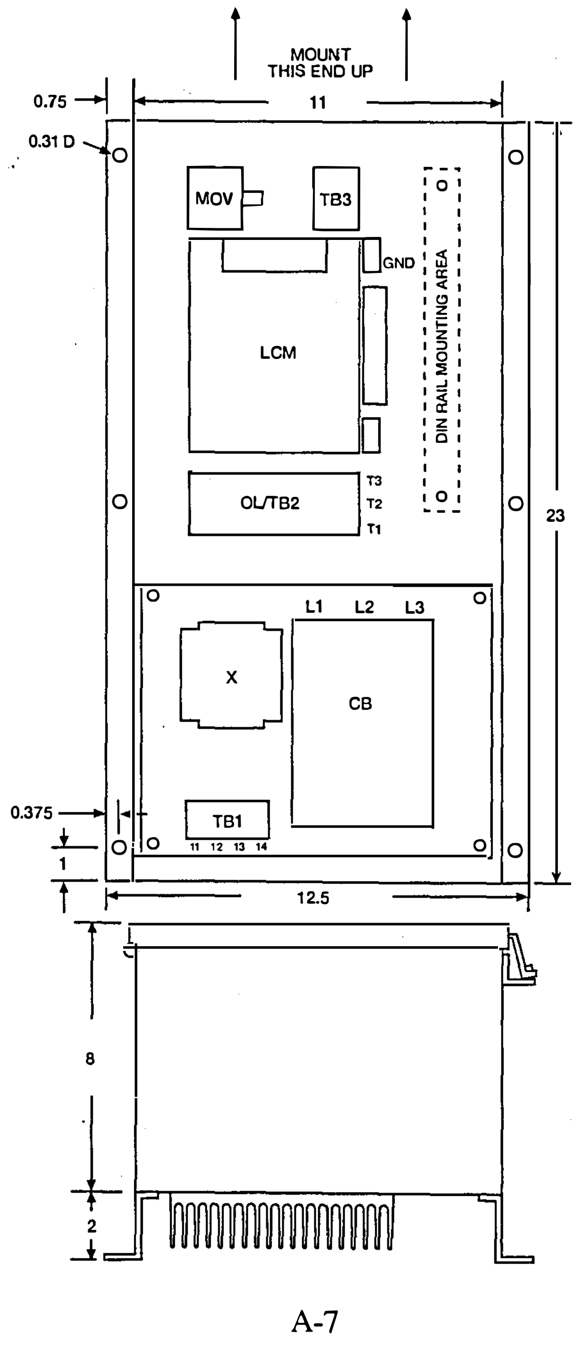


Non-combination Starter NEMA 12/3R, Size 8 to 30 Amp



Combination Starter NEMA 12/3R, Size 8 to 30 Amp

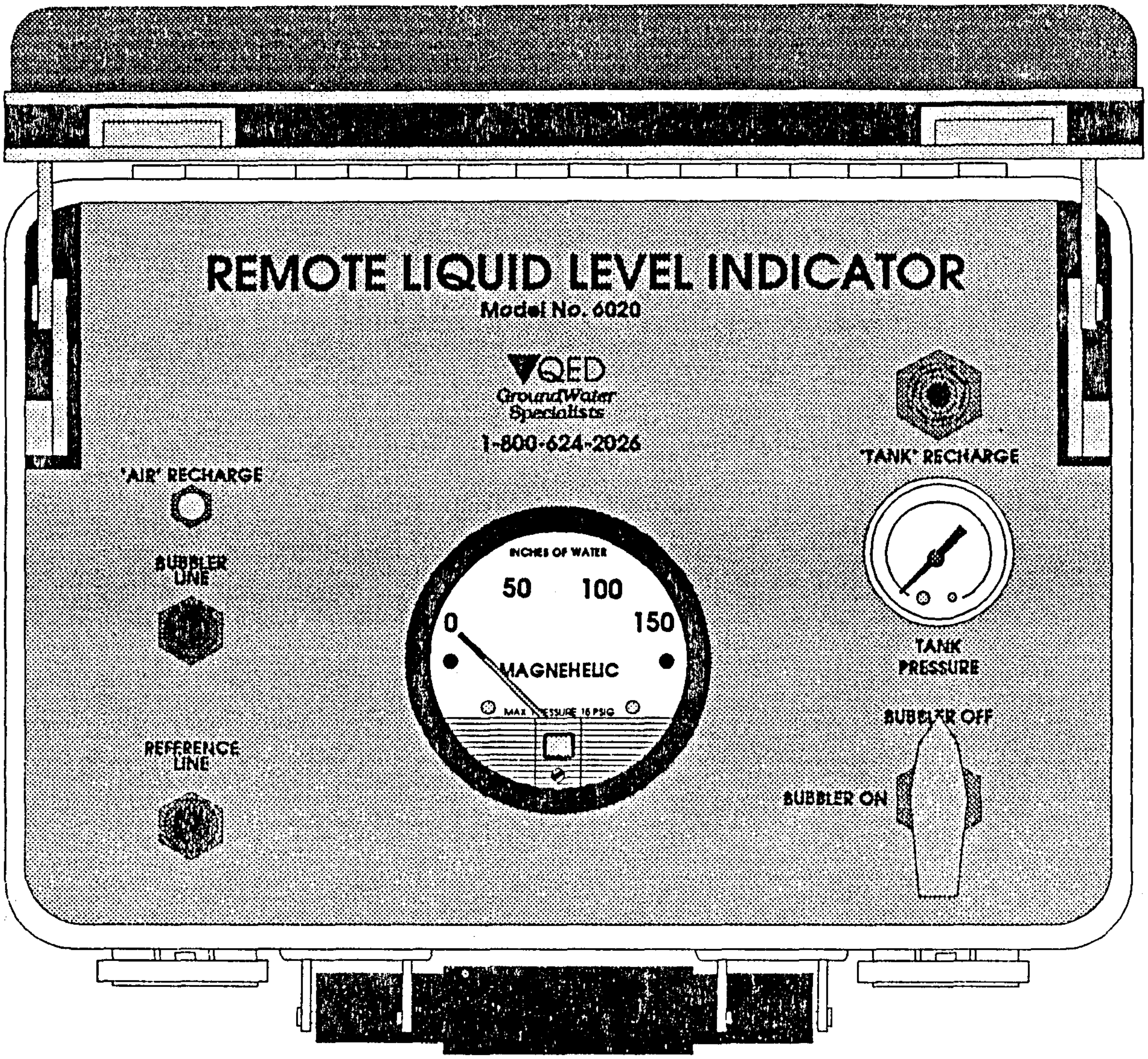
Bimetal Overload Relay is Shown. Electronic Overload Version Will Vary Slightly



WARRANTY

For a period of two (2) years from date of original purchase BALDOR will repair or replace without charge controls which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The warranty does not cover short-circuited output or shorted SCRs or other warranty or guarantee expressed or implied. BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.

Model 6020 Remote Liquid Level Indicator



Operating Instructions

1. Disconnect the airline from the filter/regulator, (located on the MS1050), and connect it to the 'TANK RECHARGE'. NOTE: Bubbler on/off valve should be in the 'off' position.
2. Charge tank to 100 P.S.I., (indicated by the 'TANK PRESSURE' gauge). Remove air line once gauge reaches 100 P.S.I. and re-attach the airline back into the filter/regulator of the MS1050.
3. Connect bubbler and reference lines to the 6020, (blue hose=bubbler line and red hose=reference line).
4. Turn bubbler valve to the 'BUBBLER ON' position.
5. Press and hold the 'AIR RECHARGE' button until you start to see a stabilized reading on the water level gauge.
6. Release the 'AIR RECHARGE' button and wait until the water level gauge indicator has stabilized.
7. Take reading.
8. Turn the bubbler valve to the 'BUBBLER OFF' position and disconnect all lines from the 6020.

NOTE: When the 6020's tank has been fully charged to 100 P.S.I. it should have the capacity to do approximately 4-6 wells, (depending on length of tubing runs and well conditions).

P/N 95066 12-6-93