INTRODUCTION -- PRINCIPLES OF OPERATION

The R-601, R-602 and R-603 are pilot-operated station regulators. A pilot-operated regulator differs from the conventional type in that the pressure-adjusting spring force normally applied against the outer face of the diaphragm is applied instead by gas pressure supplied from a pilot regulator. The pilot regulator is adjusted in the same manner as a conventional regulator. When adjusted to the desired working pressure, the main regulator will deliver gas at this same pressure. A small passageway or bleed orifice in the main regulator diaphragm permits a continuous flow of gas through the pilot system. This flow of gas is discharged from the regulator along with the main flow.

The R-602 and R-603 are single-stage regulators in which the line pressure is reduced in a single step to the desired working pressure.

The R-601 is a two-stage, bronze constructed regulator. In the first stage, the line pressure is reduced to an intermediate pressure (usually 85 to 90 psi) by adjusting the first-stage pilot regulator. The intermediate pressure is then reduced to the desired working pressure which is obtained by adjusting the second-stage pilot regulator.

Two-stage regulators are recommended for operation requiring more critical delivery-pressure control than normally supplied by single-stage regulators or where a very large fluctuation in inlet pressure occurs.

TYPES OF PILOT REGULATORS

Two kinds of pilot regulators are available from Linde for control of the R-601, R-602, and R-603 Regulators. The standard types, R-6101, R-6102, R-6103 and R-6104, function just like any other conventional one-stage regulator. All installation specifications and tables in this booklet are based on the use of this kind of pilot regulator.

For special conditions, another kind of pilot regulator is available — the pressure-compensated variety. These pilot regulators (R-6109 through R-6113) have provision for varying the original pilot regulator delivery pressure inversely as the pressure at the point of rise rises or falls. They are recommended only for use where demand rate changes abruptly and substantially, and where there is considerable piping volume between the regulator and the actual point of use.

INSTALLATION

Because of the variety of conditions under which these regulators are used, the main regulator assemblies, pilot
regulator assemblies, and gauges are supplied separately. This arrangement permits selection of the main regulator and pilot regulator best suited for individual requirements. Listed below in Table 1 are the components grouped together to form complete regulating units.

Selection of complete regulating unit should be based on the desired maximum delivery pressure. If 17 psig maximum delivery pressure is desired with the R-601, use the pilots and gauges listed in the 20 psig maximum delivery pressure line. The 50, 65, and 90 psig delivery pressure grouping can be used but controlling delivery pressure at 17 psig or less will become more difficult for each higher delivery pressure grouping.

A. MAIN REGULATOR

1. Install the main regulator in the line between the station oxygen filter (or acetylene hydraulic back-pressure valve) and the apparatus. (An oxygen filter or an acetylene hydraulic back-pressure should always be installed in the line upstream of the regulator. The size of the filter or hydraulic will depend on the flow requirements.)

(Continued on page 4)

<table>
<thead>
<tr>
<th>Max. Inlet Pressure, psig (kPa)*</th>
<th>Max. Delivery Pressure, psig (kPa)*</th>
<th>Max. Flow Capacity, ft³/hr (m³/min)</th>
<th>Pilot Regulators</th>
<th>Pressure Gauges</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>First Stage</td>
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<tr>
<td>R-601 Oxygen Two-Stage Regulator - P/N 689247</td>
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<tr>
<td>350 (2410)</td>
<td>15 (103)</td>
<td>85,000 (38)</td>
<td>R-6109 P/N 638471</td>
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<td>R-6101 ** P/N 05X61</td>
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<td>150,000 (67)</td>
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<td>65 (448)</td>
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<td>40C (2760) P/N 978153</td>
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<td>90 (620)</td>
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<td>R-6113 P/N 689475</td>
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<td>150,000 (67)</td>
<td>R-6101 P/N 05X61</td>
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<td>R-603 Fuel Gas Single-Stage Regulator - P/N 05X25</td>
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<td>Acetylene 15</td>
<td>13 (90)</td>
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<td>Nat. Gas 150</td>
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<td>32,000 (14)</td>
<td>R-6110 P/N 689372</td>
<td>30 (206) P/N 5028Y67</td>
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<tr>
<td>Nat. Gas 150</td>
<td>75 (517)</td>
<td>190,000 (85)</td>
<td>R-6112 P/N 689474</td>
<td>100 (690) P/N 978152</td>
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*Kilopascal (kPa) is the unit of pressure accepted by the International System of Units (SI) in the new metric system. However, there are countries still using the kilogram per square centimeter (kg/cm²) of the old metric system for measuring pressure. The metric conversions are: 1 psi = 6.895 kPa = 0.0703 kg/cm². Two gauges (P/N 978152 and 978153) are equipped with dual pressure scales, up to 100 psi: 7 kg/cm² and 400 psi: 28 kg/cm².

**OXWELD R-55138 Oxygen Regulator, P/N 998438, may be used in place of the R-6101 as a first stage pilot for the R-601 in applications where some variations in delivery pressure can be tolerated. Special fittings will be required for connections.

WARNING: Oil and grease are easily ignited and burn violently in the presence of oxygen under pressure. Handle oxygen apparatus only with clean hands or gloves. Never use oxygen as a substitute for compressed air.
Some typical installations

Fig. 1 - Pilot Installed on Single-Stage Regulator

Fig. 2 - Pilot Installed on Two-Stage Regulator

Fig. 3 - Pilot Installed Remotely from Single-Stage Regulator

Fig. 4 - Pilot Installed Remotely from Two-Stage Regulator

NOTE: Gauges and pilot regulators can be installed in either side of regulator.
(Continued from page 2)

2. Where flow requirements are greater than can be supplied by a single regulator, two or more regulators can be installed in parallel (Fig. 5).

B. PILOT REGULATOR

The pilot regulator can be installed on the main regulator (Figs. 1 and 2), or at some convenient location remote from the main regulator (Figs. 3 and 4).

Teflon tape or paste or an approved pipe compound must be used on all pipe threads.

1. To install the pilot on the main single-stage regulator (Fig. 1):
   a. Fit the pilot body with the two standard connections supplied with the pilot regulator. (P/N 3389 is supplied with oxygen regulators, P/N 3390 with fuel gas regulators.)
   b. Attach the pilot to the bracket (supplied with the pilot regulator) by means of the two 3/8-in. - 16 x 3/4-in. (19 mm) long hex head steel cap screws supplied.
   c. Remove one cap screw from the main regulator cap. Replace the cap screw with the stud supplied with the pilot regulator. (The long end of the stud is screwed into the main regulator.)
   d. Place the bracket (with pilot attached) in position on the main regulator so that the free end of the stud protrudes through the hole in the bracket. Place the lock washer and nut (both supplied) on the stud and tighten the nut with a wrench.
   e. Screw the low-pressure gauge directly into the top hole in the side of the main regulator body. (An elbow or other connection can be used between the regulator and the gauge, if desired.)
   f. Screw the 1/4-in. close nipple (supplied) into the bottom hole in the side of the main regulator body. Screw the 1/4-in. pipe tee (supplied) on to the end of the nipple.
   g. Screw a 3389 (for oxygen) or 3390 (for fuel gas) connection into the top opening of the tee and screw the high-pressure gauge into the open end of the tee.
   h. Screw a 1/4-in. pipe nipple (supplied) into the opening in the top of the main regulator.
   i. Make up two suitable lengths of 5/16-in. O.D. (8 mm) x No. 20 STUBS GA. (.035-in.) wall (0.9 mm), brass tubing with 03Z28 nipples and 3380 (for oxygen) or 3381 (for fuel gas) nuts at each end. (Slide the nuts onto the tubing before silver soldering the nipples to the tubing.)

Copper tubing may be used for oxygen, inert gases, and fuel gases but NEVER acetylene. Tubing especial-
ly washed and cleaned for oxygen service, is available from Linde in 25-, 50-, and 100-ft. coils (See WARNING on page 2.) Brass, aluminum, or stainless steel tubing may be used for acetylene.

j. Connect the tubing between the inlet of the pilot and the tee at the main regulator; and between the pilot outlet and the connection in the top of the main regulator.

k. Tighten all connections securely.

2. To install the pilot regulators on the two-stage regulator (Fig. 2):
   a. Instructions for installing the pilot on the first stage of the two-stage regulator are the same as given in B-1 for the single-stage regulator except that the tubing between the main regulator and the pilot inlet goes to the center hole (not the bottom hole) in the side of the main regulator body.
   b. Instructions for installing the second-stage pilot are the same as for the first-stage pilot, except the pilot inlet is connected to the top hole in the side of the main regulator body, and the pilot outlet is connected to the hole in the bottom (cap) of the main regulator.

3. To install the pilot remotely from the main regulator (Figs. 3 and 4):
   a. Except for the location of the Pilot(s) and gauges, instructions for installing the pilot regulators remotely are practically the same as those given in B-1 and 2 for installing the pilot(s) on the main regulator.

OPERATING INSTRUCTIONS

A. TO PUT THE REGULATING UNIT IN OPERATION

1. MAKE SURE the pilot regulator pressure-adjusting screw (the R-601 has two) is fully released by turning it counterclockwise as far as it will go.

2. SLOWLY open the station valve. NEVER stand in front of or behind regulator gauges when opening the station valve; always stand to one side.

3. Turn in the pilot regulator pressure-adjusting screw until the desired working-pressure is obtained. (On the R-601 adjust the first-stage pilot regulator adjusting-screw until a reading of 100-120 psi (670-827 kPa) is obtained on the intermediate pressure gauge. Then adjust the second-stage pilot regulator adjusting-screw until the desired working-pressure is obtained.)

4. Close the valves on the gas consuming apparatus.

5. Test all connections and joints with Leak Test Solution suitable for oxygen service, such as P/N 998771 (8 oz. container).

B. TO TAKE THE REGULATING UNIT OUT OF SERVICE

If work is to be stopped for a day or more, release pressure from the regulating unit as follows:

1. Close the main station valve.

2. Open the valves on the apparatus in use and release all pressure.

3. When delivery pressure gauge reading drops down to zero, close the apparatus valves.

Follow the same procedure in removing the regulating unit from the installation.

When storing the regulators, keep the openings suitably covered to prevent dirt from entering. Turn in the pilot regulator pressure-adjusting screw just enough to lift the valve seat off the nozzle.

MAINTENANCE INSTRUCTIONS

After each three months of continuous service, an examination and replacement of parts shown with a single asterisk (*) in the parts list on pages 9 and 11 is recommended. A yearly examination and replacement of parts shown with a double asterisk (**) is also recommended for best possible service.

In the second-stage of the two-stage (R-601) regulator certain parts are recommended for replacement at the end of each six months of continuous service. These parts are shown with a triple asterisk(***) in the parts list on page 11.

To follow these recommendations a stock of parts sufficient for one year's maintenance should be kept on hand. Where more than one part is used, the total number used in each assembly is indicated in parentheses at the end of the description in the parts list. The yearly maintenance will be one, two, or four times the total number of parts used in each case.

A. TO EXAMINE AND REPLACE PARTS IN THE R-602 AND R-603

1. Disconnect the tubing from the pilot regulator at the main regulator.

2. Remove the main regulator cap.

3. Remove (lift off) the complete diaphragm assembly. (At the yearly overhaul, the diaphragm (30Z92) is removed from between the two diaphragm plates (689252 and 689253, or 30Z94 and 30Z95), and replaced with a new one.)

4. Remove (unscrew) the hold down nut (37295).

5. Remove the eight screws (6164-4087) which hold the baffle plate (689277 or 68Z90) in place. Remove (lift out) the baffle plate.

6. Unscrew the four screws which hold the two nozzle clamps (152Z39). Lift off the clamps and pull out the nozzle (32Z79).

7. Remove (pull out) the valve seat and stem (33Y77). (At the yearly overhaul, this whole assembly is replaced; see 9 and 10 which follow.)

8. Remove the parts (washer, bearing segments and spring) located within the nozzle recess. (At the yearly overhaul,
replace the spring and eight bearings segments.) Remove and discard “O” Ring (85W89).

9. Remove and discard the screw (34Z81) which holds the dampener in place. Discard the dampener (52Z17), but retain the two springs (28Z94) for further use. (At the yearly overhaul, replace the two springs.)

10. Wipe clean and examine the seating surface of the valve seat and stem (33Y77). If in good condition, continue to use it until the yearly overhaul, then replace it with a new one.

11. Assemble the springs, new dampener, and new screw to the valve seat and stem.

12. Place the new “O” ring (85W89) over the 3-3/4-in. diameter (95 mm) of the nozzle so that it fits snugly against the underside of the largest diameter of the nozzle.

13. Place one washer (94Z57) in the bottom of the nozzle recess. Arrange the four bearing segments in the washer and around the stem. Slide a second washer (94Z57) down over the four bearing segments. Slide the spring (29Z43) down over the stem.

14. Slide the valve seat and stem assembly into position in the nozzle. Place a brass washer (94Z57) on top of the spring. Arrange the four remaining segments in the washer and around the stem. Place the remaining washer (94Z57) on top of the segments.

15. Screw the hold-down nut (37Z95) into position in the nozzle. Hand tighten. Check the fit of the seat and stem in the nozzle. It must fit snugly yet move in and out freely.

16. Insert the nozzle in the regulator. Attach the two clamps (152Z39) to the body with the four screws provided. Torque the screws to 190 in.-lbs. (215 N·m).

17. At this point it is advisable to test the nozzle for porosity and leakage past the seating surfaces. To do this: fill the nozzle with water, then admit 100 psi (690 kPa) pressure into the regulator.

18. Wait about 10 minutes, then examine the nozzle for leakage (indicated by bubbles). Paint around the upper edge of the nozzle with a light film of Leak Test Solution. For porosity, release pressure and replace the nozzle with a new one. For other leaks, release pressure, disassemble, clean seating surfaces, replace “O” ring, reassemble, and retest.

19. Empty out all water and blow dry.

20. Install the baffle plate (689277 or 68Z90) and fasten it in position by means of the eight screws (6164-4087).

21. Install the hold down nut in the nozzle. Tighten it securely.

22. Install the diaphragm assembly and regulator cap. Torque hold-down cap screws to 300 in.-lbs. (339 N·m).

23. Reconnect the tubing from the pilot regulator to the main regulator cap.

24. Adjust the pilot regulator to the usual operating pressure and test around the main regulator cap and connections with Leak Test Solution. Check to make sure that the pointer on the delivery-pressure gauge does not climb excessively when the apparatus in use is shut off.

**B. TO EXAMINE AND REPLACE PARTS IN THE R-601**

Refer to Fig. 7 and Parts List on Page 11.

1. To replace first-stage parts:

   The first stage of the R-601 is the same as the R-602. After disconnecting the two pilots, follow the instructions given in Section A.

2. To replace second-stage valve parts:

   a. Remove (unscrew) the seat clamping flange (52Z87). (A special wrench, Tool No. 5250136, is available for this.)

   b. Remove (lift out) the complete valve assembly.

   c. Remove the slip ring (93Z21), four bearing segments (52Z83), and spring guide (52Z82) from the top of the valve stem (33Y85). Discard the segments.

   d. Remove the spring (29Z68). Retain it for use until the yearly overhaul, then replace it with a new one.

   e. Remove (pull) the stem from the nozzle.

   f. Remove (unscrew) the locknut (136Z11). Remove and discard the seat (32Y41).

   g. Remove (unscrew) the nozzle cap (31Z99) from the bottom end of the nozzle (32286).

   h. Remove the slip ring (93Z21), four bearing segments (52Z84), and spring guide (52Z82) from the bottom of the valve stem. Discard the segments.

   i. Remove the spring (29Z04). Retain it for use until the yearly overhaul, then replace it with a new one.

   j. Remove the spring washer (52284) from the stem.

   k. Clean and examine the seating surface of the nozzle. If the surface is marred, replace the nozzle with a new one.

   l. Using new parts for those discarded, reassemble as follows:

   m. Place the valve seat on the holder portion of the stem. Screw the locknut into position and tighten it, snugly. (Using the flats provided on the seat holder portion of the stem, clamp the stem in a vise so that the sliding surface of the stem does not mar while tightening the locknut.)

   n. Place the stem and seat assembly in the nozzle. Hold the stem by the short end (with nozzle on top) and assemble the washer, small (29Z04) spring, guide, four (4) bearing segments, and slip ring, in that order.

   o. Screw the cap (31Z99) onto the nozzle. Tighten it snugly.

   p. Invert the assembly then assemble the large (29Z68) spring, guide, four (4) bearing segments, and slip ring to the stem.

   q. Replace the “O” ring (85W87) in the recess of the regulator body with a new one.

   r. Place the assembly into the regulator recess.

   s. Screw the flange (52Z87) into position. Tighten it securely.

   t. Repeat for all four valves.

3. To replace the second-stage diaphragm (yearly):

   Directions for replacing the second-stage diaphragm are
the same as for the first-stage diaphragm except that access to it is obtained by removing the bottom cap of the regulator.

4. Replacement of gauges (yearly):
   Replacement of all pressure gauges at the end of each year's service is recommended. (See page 2, for the part numbers.)

*For Maintenance Instructions covering the pilot regulators, refer to F-9654 (R-6101 thru R-6104) or F-12-736 (R-6109 thru R-6113) which is packed with each regulator.*
Fig. 6 - R-602 Single Stage Oxygen Station Regulator - 2112142

Fig. 7 - R-603 Single Stage Fuel Gas Station Regulator - 05X25
NOTE: The R-602 is now a bronze body constructed regulator equipped with brass diaphragm and baffle plates. The plates can replace the aluminum plates in the old R-602 aluminum body regulator. The bronze body has 3/4" - 10 tapped holes at inlet and outlet for mounting standard ANSI 8-bolt flanges (not supplied, see below). The old R-602 aluminum body regulators were supplied with 4-bolt ammonia type flanges which are no longer available.

**Hardware**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Part No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>6020-1075</td>
<td>1/4&quot;-18 Hex Socket Steel Pipe Plug</td>
<td>6164-4107</td>
<td>1/4&quot;-10 x 7/8-in. Stainless Steel Flat Socket Cap Screw</td>
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<td>♦6134-1279</td>
<td>3/4-in.-10 x 1-3/4-in. Hex Head Cap Screw</td>
<td>6164-4133</td>
<td>3/8-in.-16 x 1-in. Lg. Flat Socket Head Stainless Steel Cap Screw</td>
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<td>6134-2189</td>
<td>1/2-in.-13 x 1-5/8-in. Lg. Steel Hex Socket Cap Screw</td>
<td>6360-0100</td>
<td>1/4-in.-20 Stainless Steel Hex Nut</td>
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<tr>
<td>6164-4087</td>
<td>1/4-in.-20 x 1/2-in. Lg. Stainless Steel Flat Socket Head Cap Screw</td>
<td>6460-7946</td>
<td>1/4-in. External Type Shakeproof Lockwasher, Stainless Steel</td>
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**Parts Supplied**

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<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
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<tr>
<td>3380</td>
<td>&quot;B&quot; Size Oxygen Nut (8) (supplied with R-602)</td>
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<td>3381</td>
<td>&quot;B&quot; Size Acetylene Nut (8) (supplied with 05X25)</td>
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<td>3389</td>
<td>&quot;B&quot; Size Male Oxygen Connection (8) (supplied with 05X20)</td>
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<td>3390</td>
<td>&quot;B&quot; Size Male Acetylene Connection (8) (supplied with 05X25)</td>
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<td>03Z28</td>
<td>&quot;B&quot; Size Nipple (8)</td>
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<td>6710-1075</td>
<td>1/4-in. N.P.T. Brass Close Nipple</td>
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<td>6812-0075</td>
<td>1/4-in. N.P.T. Female Brass Coupling (2)</td>
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<tr>
<td>6816-1103</td>
<td>1/4-in. Brass Tee</td>
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**Parts Not Supplied (R-602)**

Commercial Flange (2 req'd), standard 8-bolt, 3-in. NPT, 300-pound forged steel, raised or flat face; cap joint, weld-neck or slip-on type.

*Not supplied with the R-602.*
Fig. 8 - R-601 Two-Stage Oxygen Station Regulator - 689247
R-601 - 2-Stage Oxygen Station Regulator - 689247

NOTE: The standard R-601 regulator is now a bronze body constructed assembly equipped with brass diaphragm and baffle plates. Available on special order are R-601 regulator assemblies P/N 686931 (Bronze body Φ 4 bolt) and P/N 688444 (Bronze body Φ 8 bolt) with the following aluminum diaphragm and baffle plates so that performance can be matched with existing regulators in a multi-regulator installation predating the change to the bronze body construction:

- Diaphragm Plate, Top (2 used) .......... 30Z95
- Diaphragm Plate, Bottom (2 used) ...... 30Z94
- Baffle Plate, 1st Stage .................. 68Z90
- Baffle Plate, 2nd Stage .................. 68Z91

### Hardware

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<th>Part No.</th>
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<tr>
<td>6020-1075</td>
<td>1/4-18 Hex Socket Steel Pipe Plug</td>
<td>6164-4133</td>
<td>3/8-in.-16 x 1-in. Lg. Flat Socket Hd. Stainless Steel Cap Screw</td>
</tr>
<tr>
<td>6134-2189</td>
<td>1/2-in.-13 x 1-5/8 Lg. Steel Hex Socket Cap Screw</td>
<td>6360-0100</td>
<td>1/4-in.-20 Stainless Steel Hex Nut</td>
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<tr>
<td>6164-4087</td>
<td>1/4-20 x 1/2-in. Lg. Stainless Steel Flat Head Socket Cap Screw</td>
<td>6460-7946</td>
<td>1/4-in. External Type Shakeproof Lock Washer, Stainless Steel</td>
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<tr>
<td>6164-4107</td>
<td>1/4-in. 20 x 7/8-in. Stainless Steel Flat Head Socket Cap Screw</td>
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### Parts Not Supplied

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<td>Nut - 3/8-16 Hex Steel Nut</td>
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<td>3389</td>
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<td>6420-7275</td>
<td>3/4-in. Shakeproof External Tooth Lockwasher</td>
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<td>03228</td>
<td>“B” Size Nipple (14)</td>
<td>6430-2126</td>
<td>3/8-in. x 1/8-in. x 3/32-in. Steel Lockwasher (2)</td>
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<tr>
<td>05Z70</td>
<td>25-ft. 5/16-in. x No. 20 (.035 wall) seamless annealed brass tubing</td>
<td>6710-1075</td>
<td>1/4-in. N.P.T. Brass Close Nipple (2)</td>
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<tr>
<td>05Z71</td>
<td>50-ft. 5/16-in. x No. 20 (.035 wall) seamless annealed brass tubing</td>
<td>6812-0075</td>
<td>1/4-in. N.P.T. Female Brass Coupling (3)</td>
</tr>
<tr>
<td>6134-1279</td>
<td>3/4-in. 10 x 1-3/4-in. Hex Head Steel Cap Screw</td>
<td>6816-1103</td>
<td>1/4-in. N.P.T. Female Brass Tee (2)</td>
</tr>
<tr>
<td>6134-1287</td>
<td>3/4-in. 10 x 2-in. Hex Head Steel Cap Screw</td>
<td></td>
<td>Flange (2 req'd), standard 8-bolt 3-in. pipe, 300-pound forged steel, raised or flat face; lap-joint, weld-neck, or slip-on type.</td>
</tr>
</tbody>
</table>