Hydraulic Engine Controls

Installation and Service

-04 SERIES

CAUTION!

THIS SYSTEM DOES NOT USE OIL.

Use 50/50 (by volume) ethylene-glycol/distilled water

DO NOT USE STOP-LEAK TYPE ANTI-FREEZE

THIS MANUAL SHOULD BE KEPT ON BOARD YOUR VESSEL

182042 Rev.5 1/05

LIMITED WARRANTY POLICY
TELEFLEX MORSE TRADEMARK PRODUCTS

Teleflex Morse warrants that its manufactured products shall be free from defects in materials and workmanship for a period of twenty-four (24) months from the date of original manufacture. Teleflex Morse will rebuild or replace, at its option, all products of its manufacture proven to its satisfaction to be defective within such warranty period and returned to Teleflex Morse, Sarasota Florida, transportation charges prepaid. Teleflex Morse's sole obligation, and buyer's exclusive remedy hereunder, is limited to such rebuilding or replacement.

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Purchaser shall be solely responsible for determining suitability for use of Teleflex Morse Products. Teleflex Morse shall not, in any event whatsoever, have any liability with respect to such determination.

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Teleflex Morse Engine Control System—Why it Works

The movement of a sender's control arm transmits mechanical energy to an internal piston which in turn pushes hydraulic fluid through the other corresponding control senders and single control slave. This movement of hydraulic fluid drives a piston in each of the senders and slave. The movement of the individual pistons causes shaft rotation in each unit.

The piston in each of the individual control senders and slaves has two small valves which are opened when the piston reaches the end of its stroke, allowing additional fluid to pass through the system. By allowing this flow of hydraulic fluid, the controls may be synchronized with each other by moving the control arm at one control station from stop to stop.

The control slave is very similar to the control sender, except the body is a rectangular block. An over-travel bungee is used in the linkage between the slave arm and engine control arm to assure that the slave can reach the end of its stroke in each direction. The slave for the transmission has a built-in detent mechanism to indicate neutral position.

On most engines the throttle exerts considerable force to return to the idle position. Each throttle slave is equipped with a pilot check valve which locks the throttle slave in the position it has taken in response to the sender. The throttle slave can be driven only by the sender, it cannot drive the sender.

Extra hydraulic fluid and a pressure head for the system is maintained by the system's reservoir. The reservoir is charged with 80 psi of air over the hydraulic fluid within it. This keeps the entire system under pressure at all times and prevents a vacuum from existing on the back side of any piston when the system is operated.

Fluid-flow to and from the reservoir is regulated by a charging valve located on the bottom of the reservoir. This valve is necessary to keep the system under pressure, and to prevent excessive pressures caused by the expansion of fluid when the fluid becomes warm.

Nylon tubing is used to pipe the system for two reasons: (1) ease of installation, (2) nylon tubing expands and contracts in very much the same manner as the hydraulic fluid (a most important factor). The expansion and contraction of the tubing reduces drift of the controls as temperature changes, thereby helping to keep all the components of the system synchronized. The tubing is virgin nylon, which has been heat and light stabilized and contains no plasticizers. The burst pressure of the tubing is in excess of 1200 psi.

Preparation for Installation

CAUTION

Dirt and foreign matter in the hydraulic system cause damage and malfunction. It is extremely important to keep tubing and fittings clean when installing and connecting components. Cut tube cleanly and tape the open end while running tubing.

Before installation is started, the parts list should be checked to verify that a complete system has been received. Parts lists are located on pages 16 and 17.

It is advised that all system components be installed, (senders, shift, throttle slaves, and reservoir) prior to running the system tubing. This allows the tubing to be run between two definite points with less chance of an error.

Should it become necessary for the tubing to be strung first, a system of marking the different tubing runs should be used.

Component Installation

Components have red plastic plugs installed in their ports to keep out foreign matter. As you remove these red plastic plugs, replace them immediately with the proper adapter; then install the red plugs into the adapters until you are ready to connect tubing.

Use Loctite ® hydraulic sealant on all NPT fittings prior to installation. **DO NOT** use teflon tape or pipe dope.

Sender Installation

1. Locate sender on panel so that the control arm's arc will not interfere with the ship's wheel or panel. Be certain that access is available to the small bleeder screw at the top of each sender head.

The design of the new Engine Control "T" handle requires a **minimum** distance between control heads to provide adequate handle clearance when **two sets** of controls are mounted side by side. See **Figure 1**.

NOTE: This minimum distance **does not apply** to installations using the optional "knob" style control handles.

2. Using the template provided in the appendix, mark and cut a hole for the sender. **Figure 29** is the proper template for the single head and **Figure 30** for the side by side sender mounting. Refer to **Figure 1** for minimum distance required when mounting two sets of controls side by side.

3. Drill 7/16" holes in the panel for the mounting bolts.

4. Set sender in place and check to see if all mounting holes match up.

5. The sender's ports are tapped 1/4" NPTF. Suitable adapters must be installed to accept the tubing used. It is more convenient to install these adapters prior to mounting the senders. (Instructions for copper tubing installations are on page 12.)

NOTE

If the area under the control panel is too confined to allow the tubing to be connected with moderate ease, do not secure the sender at this time. Proceed with the installation of the remaining senders per Steps 1 thru 5 above. The sender may be secured after the tubing has been connected to it.

6. Secure senders per **Figure 2** for single head, or **Figure 3** for side by side mounting.

7. The sender's handle position may be set within limits by loosening the tightening screw (using a 1/4" allen wrench) in the lower end of the arm and then rotating the arm as desired and resetting the screw. After the arm is set, it will have a 115° maximum arc.

8. Secure the remaining senders per Steps 1 thru 7.

NOTE

The minimum distance **does not** apply to installations using the "knob style" control handles.

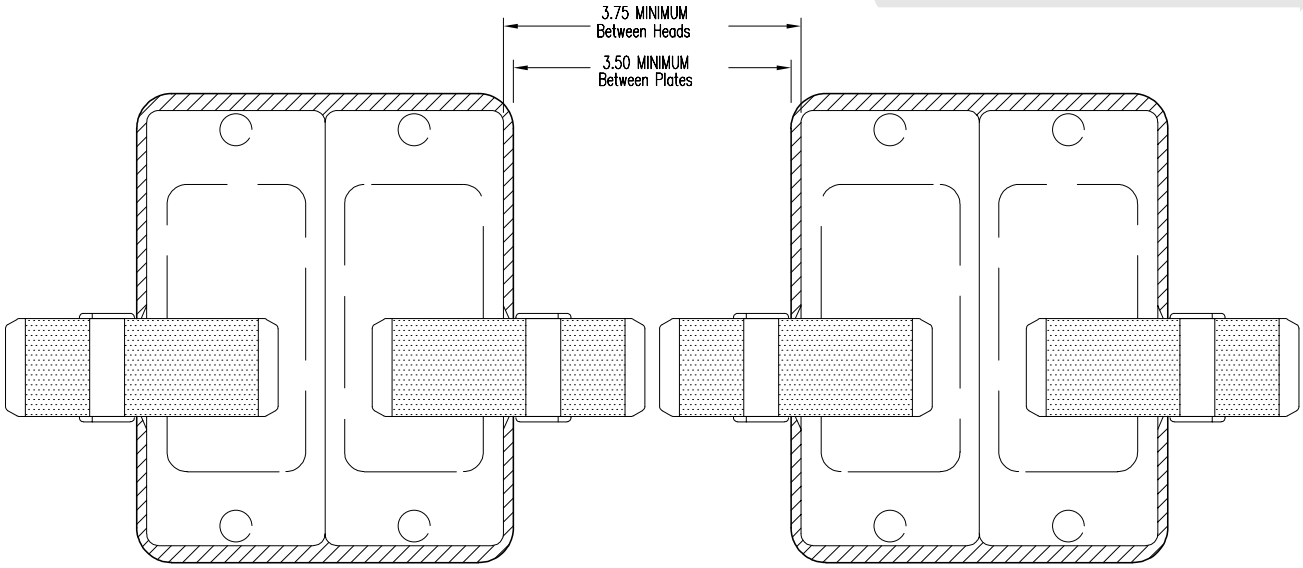


Figure 1. Mounting "T" Handle Controls Side by Side

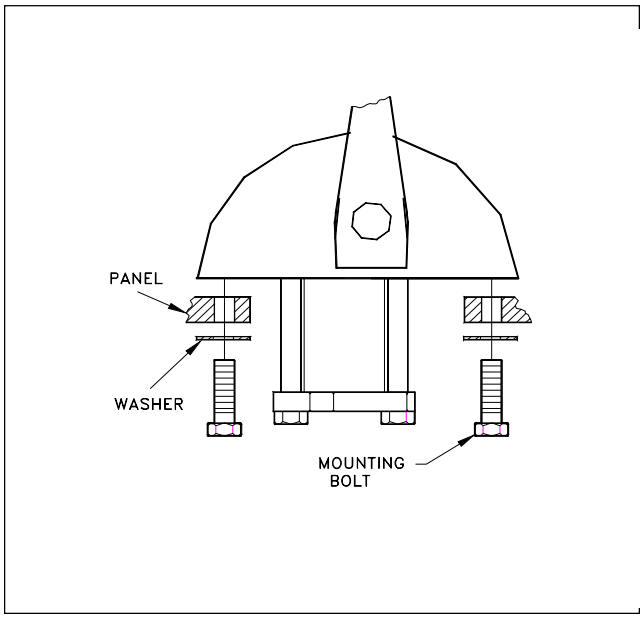


Figure 2. Single Head Sender

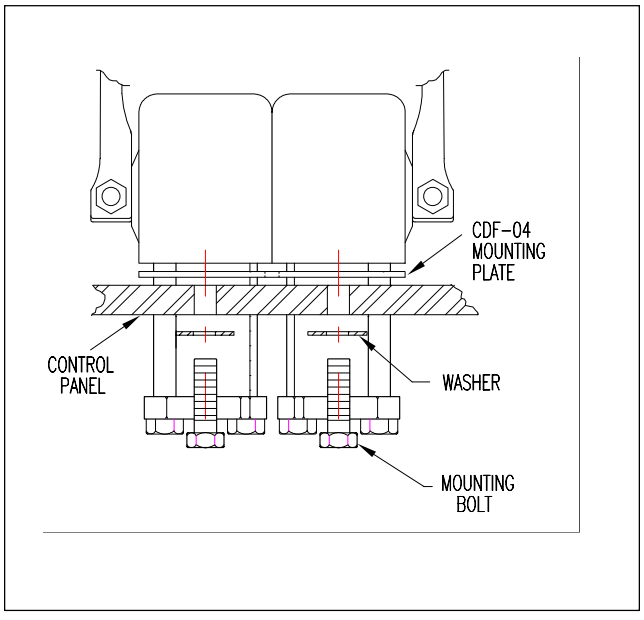


Figure 3. Side-By-Side Senders

Throttle Slave Installation

NOTE

The standard Teleflex Morse System, MC-04, uses the ST-06 Integrated Throttle Slave. You may have chosen to order a non-standard system which includes the ST-04 Throttle Slave and STV-10 Lock-out Valve. Depending on which system you have, follow the corresponding installation instructions in this section.

Teleflex Morse throttle slaves must be mounted so that at the mid-stroke of both the engine's throttle arm and the slave's control arm, they are: 1) In the same plane; 2) parallel to each other; and 3) right angles will be formed between the connecting linkage and each arm. See **Figure 4**.

If these criteria are met, an ideal installation will result.

A spring bungee-ball joint assembly is furnished with each throttle slave. It is installed in the slave arm-to- throttle linkage according to **Figure 4**. It allows up to 3/16" slave arm over-travel in each direction. This over-travel lets the slave cylinder travel its full stroke and still provide full travel to the throttle arm. You must use almost all of the slave travel, or about 75°, to operate the throttle. The slave must go full stroke in each direction in order to synchronize the system.

The throttle slave's arm may be set to any desired position by loosening the tightening screw (using a 3/16" allen wrench) in the lower end of the arm and then rotating the arm as desired and resetting the screw. After the arm is set, it will have a 78° maximum arc.

CAUTION

The Throttle Slave **must not** be mounted to any surface exceeding 220° F (103° C). If mounting in a "hot spot" is unavoidable, the slave must be insulated from the heat.

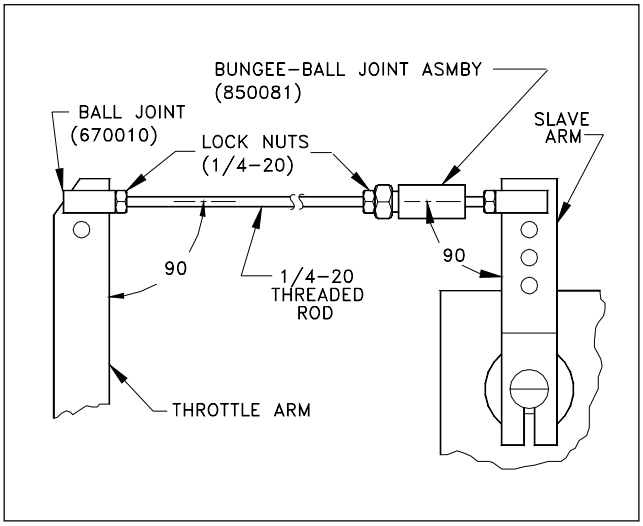


Figure 4. Throttle Slave to Throttle Arm Installation

Steps 1 thru 8 apply to both ST-04 and ST-06 Systems

1. Secure the mounting bracket to the engine. A suitable bracket must be fabricated.

2. Secure the throttle slave to the mounting bracket using 3/8-16 mounting bolts.

3. Install a lock nut and bungee-ball joint on the end of a 1/4-20 stainless or brass threaded rod.

4. Position the throttle slave to its mid-stroke and connect the bungee end of the 1/4-20 threaded rod to it (not provided).

5. Position the engine's throttle arm to its mid-stroke. Determine the length of threaded rod required and cut off the excess.

6. Connect a lock nut and a ball-joint to the engine's throttle arm and the free end of the threaded rod.

7. Find the proper hole in the slave arm to provide a linkage length combination that will allow idle to full throttle on the engine, using all but a few degrees of slave arm travel in each direction. By adjusting the ball-joint and bungee, a fine adjustment in both directions can be achieved. Be sure the slave arm can over-travel through the bungee to the end of its stroke in each direction.

8. After determining the correct rod length, securely lock the ball-joint and bungee assembly to the threaded rod with lock nuts provided. Disconnect the linkage from the throttle slave's arm.

ST-06 Installation Only

9. To prevent engine retard due to governor spring or vibration, a pilot check valve is built into the ST-06 Throttle Slave.

NOTE

This built-in valve will lock the slave arm in place allowing it to be moved only by the sender

10. Locate a tee and bleeder valve on the throttle slave and install suitable adapters to accept tubing, per **Figure 5**.

NOTE

Tube connectors are installed on the tubing per instructions under "Tubing Installation" and "Connection" on page 8.

11. Verify all fittings installed have been tightened. Repeat these throttle slave installation procedures for the second engine.

ST-04 Installation Only

9. To prevent engine retard due to governor spring or vibration, a separate STV-10 lock-out valve is used with the ST-04 Throttle Slave.

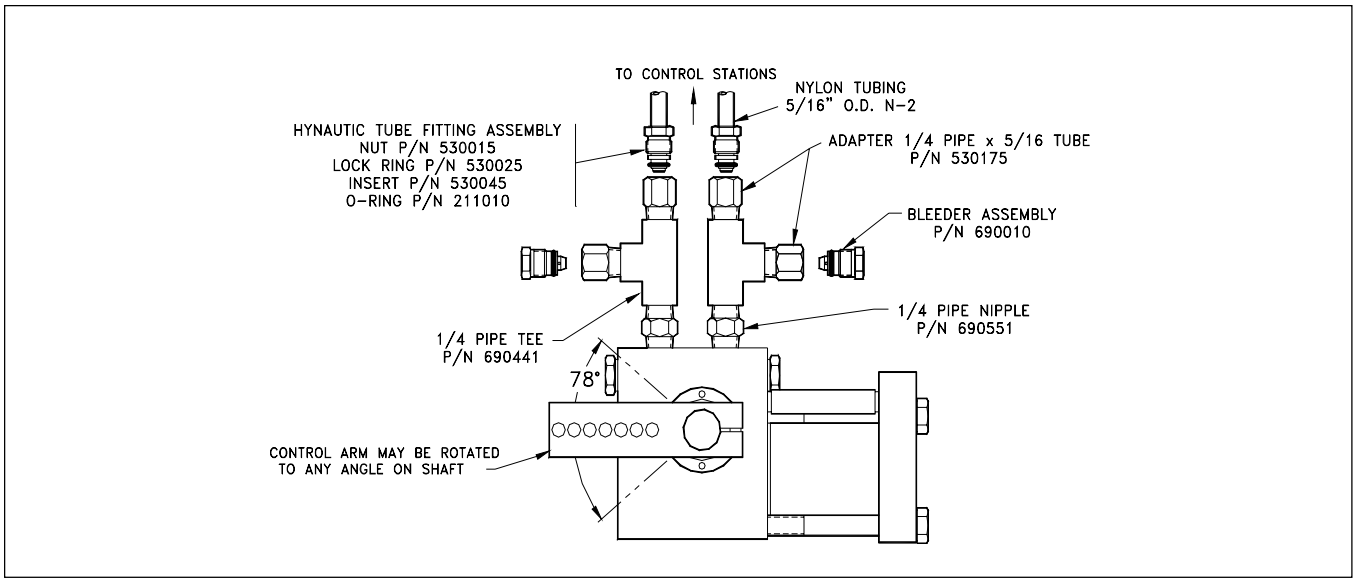


Figure 5. ST-06 Integrated Throttle Slave with Tee and Bleeder Valve Installation

NOTE

If the throttle slave is in a limited space, it may be removed from the bracket during the lock-out valve installation. The STV-10 Lock Out Valve must be plumbed as shown in Figure 6. The lock-out valve will lock the slaves arm and allow it to be moved by only the sender.

The check valve and slave must be mounted in close proximity to one another. If they're not, abnormal locking action and poor performance will result.

10. Install the lock-out valve on the throttle slave and secure it using clean lubricant or Loctite hydraulic sealant on the threads. Install appropriate adapters to accept tubing. Refer to **Figure 6**.

NOTE

Tube connectors are installed on the tubing per instructions under “Tubing Installation” and “Connection.”

11. Using a short piece of tubing provided, connect the open port on the tee to the **S2** port on the lock-out valve. See **Figure 6**. (See Figure 16 for Copper Tubing connection.) Plug open fittings at the V1 and V2 ports.

12. Verify all fittings installed have been tightened. Repeat these throttle slave installation procedures for the second engine.

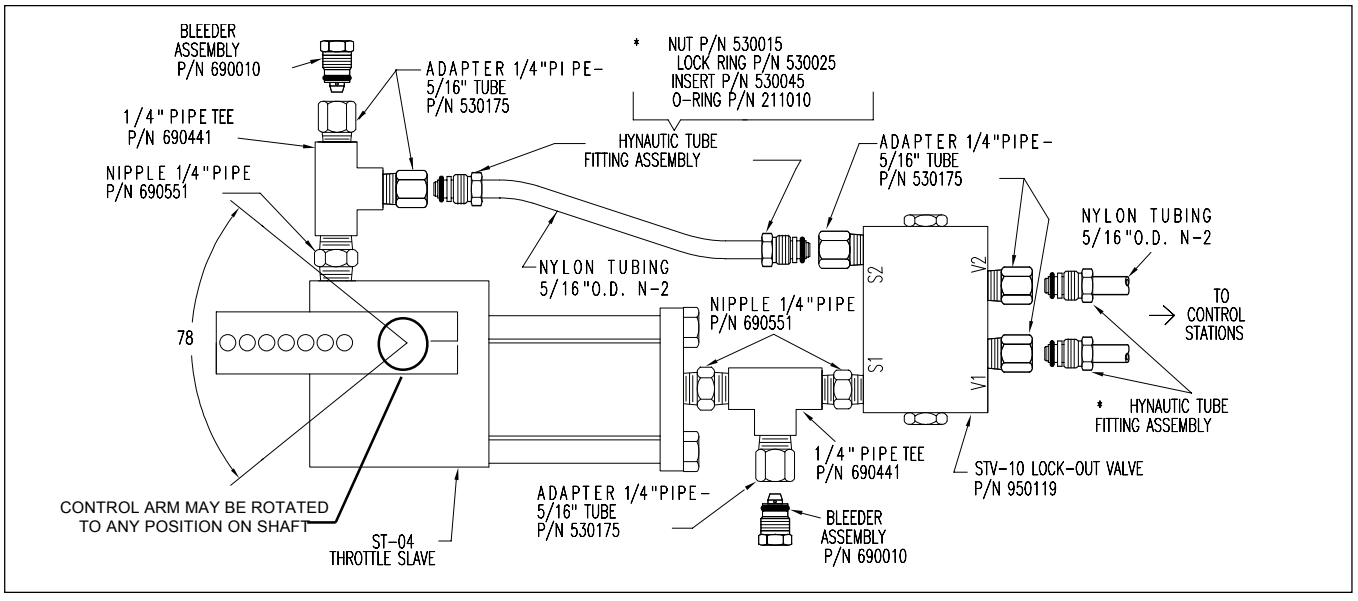


Figure 6. ST-04 Throttle Slave with STV-10 Lock-Out Valve

Clutch Slave Installation

The Morse clutch slave must be mounted so that when the engine's transmission is in neutral and the Morse clutch slave's arm is at its mid-stroke, both arms will be: 1) in the same plane; 2) parallel to each other; and 3) right angles will be formed between connecting linkage and each arm, see **Figure 7**.

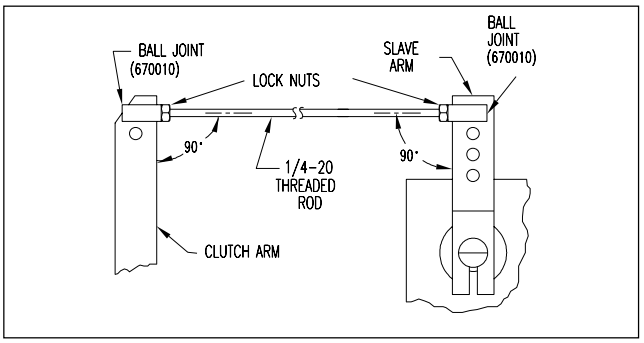


Figure 7. Proper Clutch Slave to Throttle Arm Installation

NOTE

The clutch slave's arm may be set to any desired position by loosening the tightening screw (using a 3/16" allen wrench) in the lower end of the arm. Rotate arm as desired and reset the screw. After the arm is set it will have a 78° maximum arc.

1. Secure mounting bracket to the engine. A suitable bracket must be fabricated.

2. Secure the transmission slave to the mounting bracket using the 3/8-16 mounting bolts.

3. Set the transmission in the neutral position, and the clutch slave's arm at its mid-stroke.

4. Loosen the set screw in the detent ring on the clutch slave and rotate the detent ring to the full detent position. To locate the detent ring, see **Figure 8**.

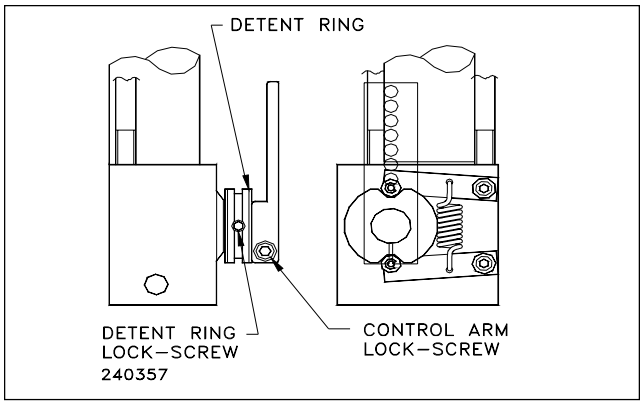


Figure 8. Detent Ring Location

5. Secure detent ring in this position by tightening the set screw.

6. Install a lock nut and ball joint on the end of the 1/4-20 stainless steel or brass threaded rod (not provided).

7. Position the clutch slave to its mid-stroke and connect the ball joint end of the 1/4-20 threaded rod to it.

8. Position the engine's clutch arm to neutral, determine the proper length of the threaded rod required and cut off the excess.

9. Install a lock nut and ball joint on the other end of the threaded rod.

10. By locating the slave arm ball-joint in its proper hole and adjusting both ball joint on the threaded rod, find the correct length of linkage that will allow both "full- forward" and "full-reverse" on the transmission for full throw on the clutch slave arm.

11. After determining the correct linkage length, securely lock the ball-joints to the threaded rod with lock-nuts provided. Disconnect the linkage from the clutch slave's arm.

12. Locate and secure in place two tees, two bleeder valves, and two tubing adapters, per **Figure 9**.

13. Repeat this clutch slave installation procedure for the second engine.

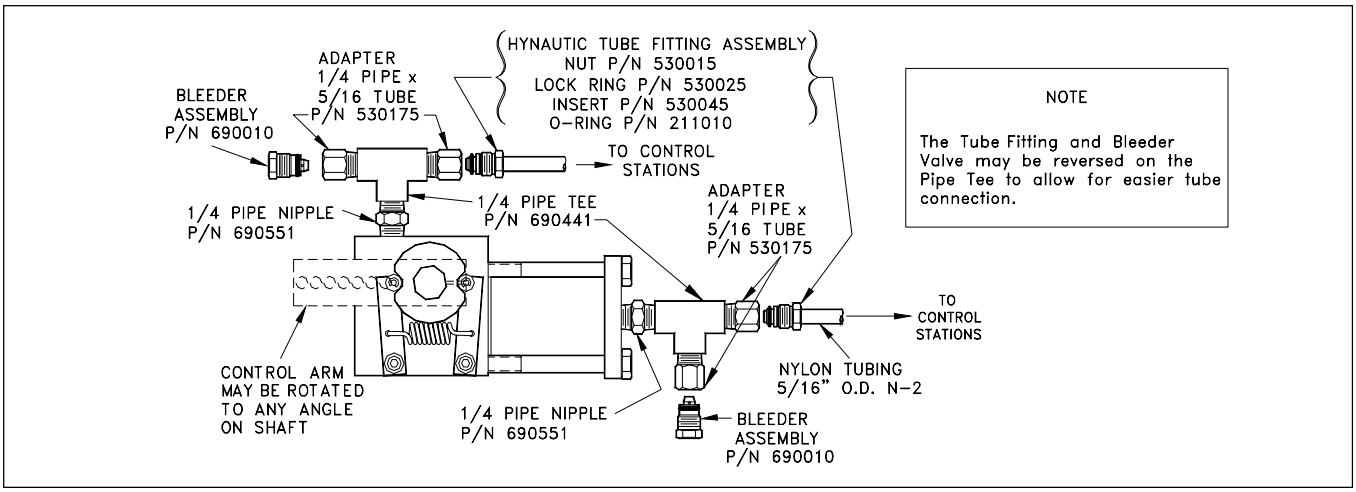


Figure 9. SS-04 Shifter Slave - Bleeder Valve and Tubing Adapters Installation

Reservoir Installation

NOTE

The standard Morse System, MC-04, uses the R-13 Integrated Reservoir. You may have a different system which includes the R-04 Reservoir and an MCV-04 Charging Valve. Depending on which system you have, follow the corresponding installation instructions in this section.

NOTE

If your installation includes two reservoirs (one for each engine), or is a single-engine installation, special plumbing will required which is not covered in this manual. Contact Teleflex Morse for this information.

R-13 Reservoir Installation

The reservoir should be located in the ship's engine room in an accessible location. In locating the reservoir the following conditions should be met:

1. Reservoir must be in a vertical position with pressure gauge on top.

2. Sight glass must be visible and easy to read.

3. Pressure gauge must be visible and easily read.

4. The operator must have easy access to the air filler valve on the top of the tank.

5. The operator must have easy access to the fill port on top of the tank.

6. The operator must have easy access to charging valve on bottom of reservoir.

7. Reservoir must be mounted to the bulkhead, wall, or post, using either bolts or screws.

NOTE

The charging valve is located on the bottom of the reservoir. The plug located on the charging valve holds the fluid filter in place. This plug and filter can be removed to drain the reservoir's fluid. See **Figure 10.**

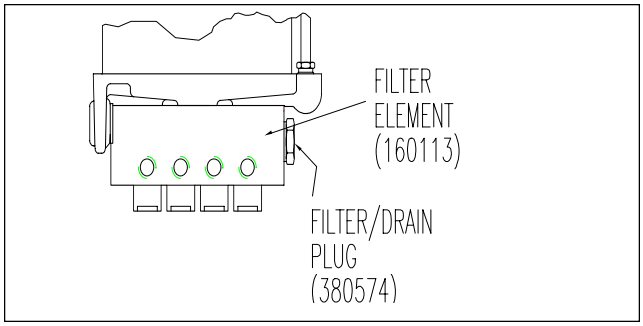


Figure 10. Charging Valve on R-13 Reservoir

R-04 Reservoir Installation

The reservoir should be located in the ship's engine room in an accessible location. In locating the reservoir the following conditions should be met:

1. Reservoir must be in a vertical position with pressure gauge on top.

2. Sight glass must be visible and easy to read.

3. Pressure gauge be visible and easily read.

4. The operator must have easy access to the air filler valve on the top of the tank.

5. The operator must have easy access to the fill port on top of the tank.

6. Reservoir must be mounted to the bulkhead, wall or post using either bolts or screws.

NOTE

There are two ports located on the bottom of the reservoir. One is plugged and can be used as a drain port. The other has a filter assembly and is used for connecting to the system. See Figure 11.

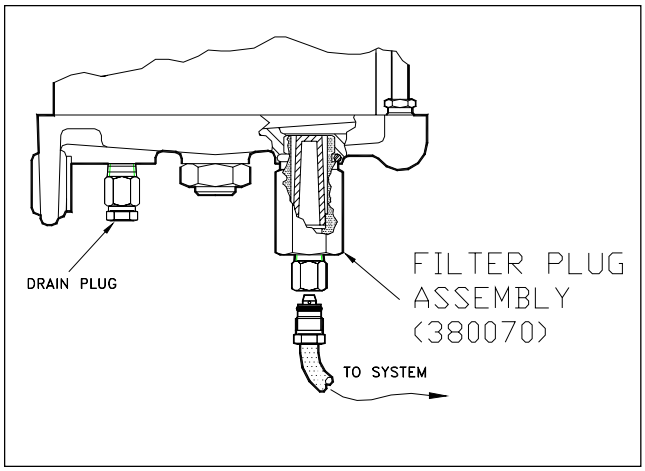


Figure 11. Ports on Bottom of R-04 Reservoir

MCV-04 Charging Valve Installation

The charging valve should be located in the general vicinity of the reservoir.

1. Install appropriate adapters for the tubing used. For port locations see **Figure 12.**

2. Mount the charging valve using two screws or bolts.

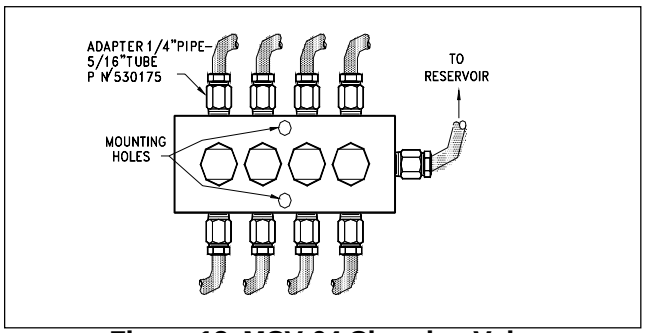


Figure 12. MCV-04 Charging Valve

Tubing Installation and Connection

CAUTION

Dirt and foreign matter in the hydraulic system cause damage and malfunction. It is extremely important to keep tubing and fittings clean when installing and connecting components. Cut tube cleanly and tape the open end while running tubing.

Four tubing installation plans are provided in the Tubing Diagrams Section later in this manual:

1. Twin Engine, One Station, (Plan I)

2. Twin Engine, Two Station, (Plan II)

3. Twin Engine, Three Station, (Plan III)

4. Twin Engine, Four Station, (Plan IV)

Before beginning to run the tubing, it is recommended that each tube be assigned a number which is marked on both ends, and correspondingly, marked at the origin and destination of that tube. These designations should also be recorded on the chosen plan diagram for future reference.

Rules for Routing Tubing

NOTE

The instructions and illustrations in this section apply to **nylon** tubing ONLY. Information on use of **Copper Tubing** may be found on page 12.

1. Keep tubing free of dirt and foreign matter.

2. Keep tubing away from batteries, since battery acid is corrosive to the tubing.

3. Tie the tubing down at regular intervals using non-metallic ties and clamps.

4. Do not allow tubing to become kinked. If it does, replace that particular run of tubing.

5. String tubing so that it will not interfere with hatchways or machinery removal.

6. Use only nylon tubing supplied with system from Morse.

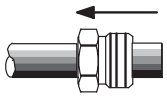
Assemble tubing connectors on every tube end as described and illustrated in **Figure 13.**

NOTE

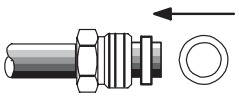
The roll of tubing should be laid in a horizontal position and moved as little as possible to avoid kinking and tangling.

1. Cut the tubing with a razor or very sharp knife, leaving the cutoff end as square as possible.

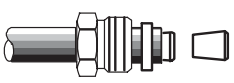
2. Slip the nut (530015) over the tubing end. The nut should slide freely.



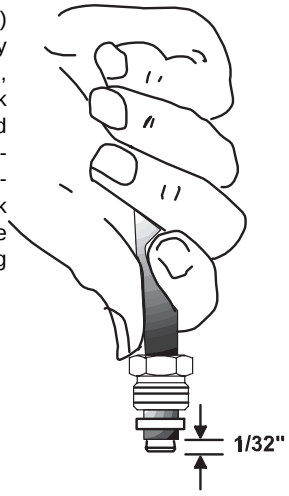
3. Push the lock ring (530025) over the end of the tubing and move it back at least one sleeve length from the end. The lock ring may slide on freely or require slight pressure and "screw-on" action. (The lock ring has a left hand thread.)



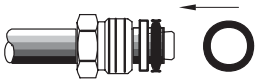
4. Insert the sleeve (530045) in the tube until it just makes contact all around.

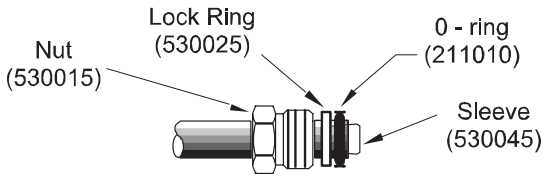


5. Force the sleeve (530045) into the end of the tubing by pushing it against a clean, flat surface. Thread the lock ring (530025) toward the end of the tube as far as possible by hand. Leave sufficient room between the lock ring and the end of the tube to install the O-ring (211010).



6. Install the 0-ring (211010) over the end of the tubing and against the lock ring (530025).





Completed Tube Assembly

Figure 13. Assembling Tubing Connectors

Install Tubing Between Senders and Slaves

(See Pages 22-27 for Plumbing Circuits)

1. Locate the tubing roll in a convenient location.

2. Starting at the highest control station, begin running tubing from the upper tubing port of the right most sender to its connecting point as shown on the diagram.

> **NOTE**
>
> Tubing may be run from the sender to connecting point or from connecting point to sender, whichever is easier.

3. Secure each end of the newly run tube by Inserting the tube end assembly into the proper adapter (#530175), previously installed in components. Tighten down only until there is firm resistance felt on the wrench.

4. Run the tubing from the lower port of the same sender, repeating the previous steps.

5. Progress leftward across the control panel until all lines have been run and secured. Then go to the next lower station and run tubing from it in the same manner as it was from the upper station.

6. If the boat has more than two stations, continue running tubing from them in the same manner, still following the tubing diagram.

7. At this point all tubing should be run and connected. Now, secure tubing using ties and clamps. This should be done prior to filling the system.

> **NOTE**
>
> When securing tubing with clamps, do not over- tighten clamps or ties, as overtightening will crimp the tubing causing poor system operation.

Filling and Bleeding System

Filling the System

1. Verify that all sender arms are free to traverse their complete arc.

2. Verify that all bleeder valves on the throttle and clutch slaves are closed, and linkages disconnected.

> **IMPORTANT NOTE**
>
> See section on **"System Fluid"** for fluid specifications on Page 10.

3. Remove fill port plug from the reservoir and fill the reservoir within one inch of the top of the sight tube with MCO-03 water glycol fluid. Replace fill port plug.

4. Pressurize reservoir to 100 +/-10 psi through the air filler valve in the top of the reservoir.

5. The system will now begin to fill with fluid. As the system fills the fluid level in the reservoir will become lower. When the fluid level is between 1 to 2 inches from the bottom of the sight glass release the pressure and refill the tank, as in Step 4.

6. Repressurize the system and repeat this procedure of filling the reservoir as required until no fluid drop is noted. At this point, the system is filled and must now be bled.

7. Check entire system for leaks and correct as required.

Bleeding the System at Slave

> **NOTE**
>
> The bleeding procedure is much easier for two people to perform than one. (One to keep the reservoir filled and under pressure, while the other one bleeds the system.)

1. Fill the reservoir as required.

> **NOTE**
>
> Verify that linkage is disconnected, and sender's handles are free to move.
>
> While bleeding, move the slave arm and verify that the piston has bottomed.

2. Using the bleeder tube provided and a clean, empty container, insert the bleeder tube in the bleeder valve at one side of a slave. Open the bleeder valve about one turn and bleed system until no air bubbles are evident in the flowing fluid. When the fluid is clear, close the bleeder valve. During the bleed operation maintain the system pressure above 60 psi, and the fluid level in the sight gauge above the two-inch mark. Should the fluid level drop below two inches close the bleeder valve and release the pressure from the system. Refill the reservoir with the fluid that has been bled off, repressurize the system and continue bleeding. Bleed long enough that no air or foam remains in this branch of the system. Draw at least a full reservoir of fluid thru each side of each circuit.

> **NOTE**
>
> Since there are two positions at each slave to be bled and four slaves, the reservoir must be filled at least 8 times during the bleed operation. The fluid which has been bled off should be used to refill the reservoir.

3. Tighten bleeder valve after the bleed operation.

4. Bleed the second port of the slave as described in Steps 1, 2, and 3.

5. Repeat steps 1 thru 4 with a second person at the sender moving the handles back and forth slowly five to ten times

6. Continue performing the preceding five steps for each remaining slave.

Bleeding the System at Senders

After bleeding system at each slave bleeder valve, each sender must now be bled. A small amount of air will be trapped at the high point in each sender head.

1. Refill reservoir if required (fill tank at this time to between 1/2 and 2/3 full), and leave about 100 psi on the pressure gauge.

> **NOTE**
>
> Place a rag over the bleeder hole on the sender, to prevent fluid from spilling on the console.

2. Very slowly open the bleeder plug using a 3/16" allen wrench. See **Figure 10** for location of bleeder screw.

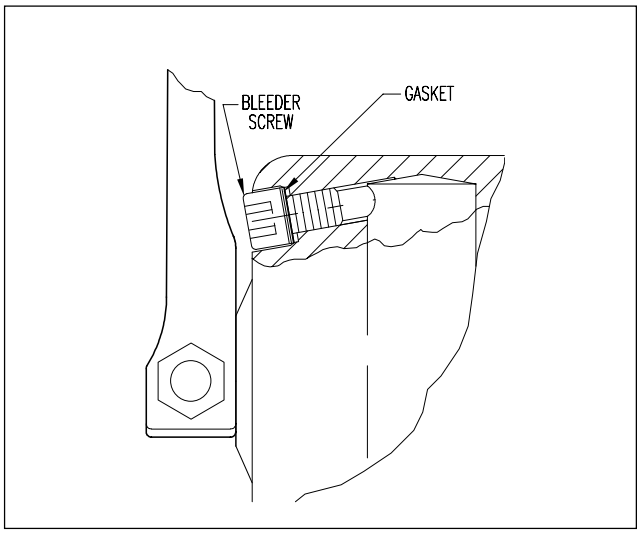


Figure 14. Bleeder Screw

3. Allow the fluid to bleed out until the fluid is clear without air bubbles.

4. Tighten the bleeder screw after bleeding.

5. Repeat Steps 1 to 4 above, for each sender.

6. The reservoir level should be between 1/2 and 2/3 full. If the level is below this, the reservoir should be filled to this level. Verify that pressurize in the reservoir is between 80 and 85 psi.

System Fluid

The fluid recommended for use in the system is a 50/50 mixture by volume of distilled water and ethylene glycol. The type of ethylene glycol used is very important for proper operation of your system and especially the synchronization (charging) valve. Some additives, especially silicone additives, are very thick in consistency and will clog the elements in the synchronization valve. If this occurs your system will be unable to maintain synchronization between sender and slave.

The ethylene glycol chosen for use should be as pure (no additives) as possible, proportionately mixed with distilled water then filtered to assure its purity. **NEVER USE STOP-LEAK TYPE ANTI-FREEZE.**

Filtration is accomplished by passing the fluid through a 5 micron filter before using in the system.

Field service pre-filtering can be accomplished by using a “Mr. Coffee”or equivalent paper filter placed in a funnel and then pouring the ethylene glycol solution through it.

One paper filter will filter approximately 1/2 gallon ` of ethylene glycol solution.

The MCO-03 fluid provided by Morse is proportionately mixed and filtered to assure its purity and is ready for use.

Making the System Operational

Synchronizing the Controls

The system is now operational except for synchronizing the controls.

1. Go to one control station and move each sender’s arm from stop to stop, 3 to 5 complete cycles. Each sender should be synchronized at this time.

> **NOTE**
>
> This synchronization can be performed at any of the control stations.

2. If the position of the sender’s handle requires an awkward motion by the user, adjust the handle by loosening the set screw (using a 1/4" allen wrench) and rotating the handle so that the user has more of a direct push-pull motion. Do not position handle so that it binds against the sender body at either end of its stroke.

3. Should one of the controls not come into synchronization, go to that station which is out of synchronization and perform Step 1.

Connecting Engine Controls

1. Connect throttle linkages to the throttle slave. Repeat for both engines.

2. Connect clutch linkages to the clutch slave. Repeat for both engines.

> **NOTE**
>
> For any operational problems at this point, consult the trouble shooting section.

Operation

Throttle Senders

Forward Motion — Increases Throttle.

Aft Motion — Decreases Throttle.

WARNING

When working on engine and operating the engine throttle arm by hand, disconnect throttle linkage from the control slave. If linkage is not disconnected the pilot check valve will not allow a throttle retardation unless a sender arm is actuated to decrease the throttle.

NOTE

Prior to starting engines, both throttles and clutches should be synchronized. This is done by moving the sender's control arm in a complete cycle fore and aft, stop to stop. This needs to be done at only one station.

Clutch Senders

Forward Position — Forward Direction
Center Position — Neutral
Aft Position—Reverse Direction

Maintenance

The clutch and throttle sender bodies are made of 6061-T6 aluminum, which has been anodized. To clean them, a warm soapy solution should be used. Do not attempt to use an abrasive compound as is done when shining brass.

Maintenance Schedule

Every 30 Days:

1. Check hydraulic fluid level (should be between 1/2 and 2/3 full on the sight glass).
2. Check system pressure (pressure should be between 70-90 psi), see note below concerning reservoir pressure.

NOTE

The reservoir pressure will vary between 70-90 psi due to temperature changes. There is no reason to become alarmed unless the pressure drops below 70 psi, then the system should be repressurized to 80+ psi. If the pressure loss is over a relatively short period check for air leakage. Should the pressure loss from full pressure to minimal operation pressure be over an extended time period just repressurize the system. This extended pressure loss is normal and may be compared to the same type pressure loss one experiences with a good set of automotive tires after an extended time.

Every 6 Months:

1. Check fluid level in the reservoir (level should be approximately 1/2 to 2/3 of sight glass).
2. Check system pressure, it should be between 70-90 psi. Consult the note above about system pressure change.
3. The system is self-lubricating, but the ball-joints on control linkages should be oiled.
4. Check mounting bolts on the control slaves (clutch and throttle) to verify that vibration has not loosened them.
5. Check lock nuts on control linkages; verify that they are tight.
6. Check fitting connections for any leakage.
7. Where tubing runs are exposed and are bordering heavy traffic areas, check for damage and repair as required.

Copper Tubing Installation and Connection

Use these instructions in conjunction with this Manual's Section on Tubing Installation, Page 8.

1. Use 5/16" OD soft copper refrigeration type tubing.
2. Use standard 45° flares for fittings. Be careful to make good flares and do not allow dirt or chips into the system. **DO NOT** use pipe dope on fitings. Refer to cautions in this manual.
3. All tubing runs outside the engine room should be run together. (Single-bundled)
4. Inside the engine room, lengths of tubing on each side of the same circuit should be essentially the same length.
5. If desired, short lengths (maximum 24") of Aeroquip 2651-5 Hose with 401-5B Fittings may be used for the transition from hull-mounted to engine-mounted tubing. This will prevent work-hardening of the copper from flexing and vibration. Again, make sure no dirt or chips are introduced into the hose ends or damage and malfuntion of the system may occur.

The following figures illustrate the proper connections for copper tubing installation between components of the Engine Contol System.

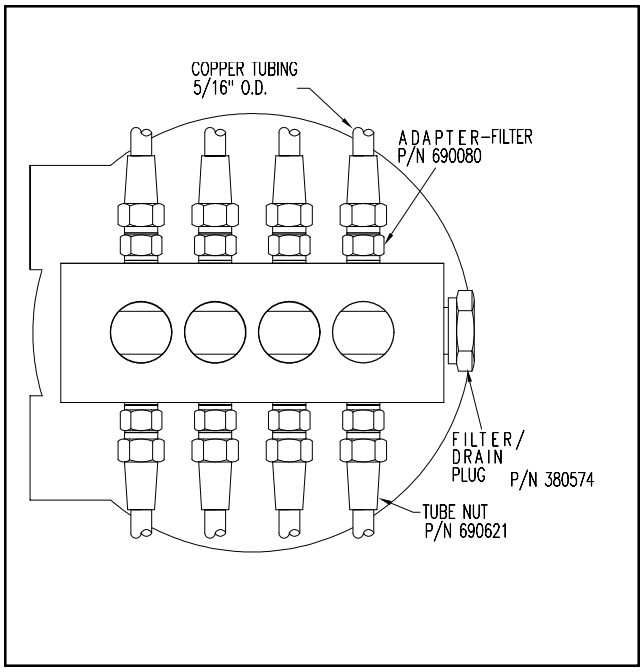


Figure 15. Charging Valve on Bottom of R-13 Integrated Reservoir

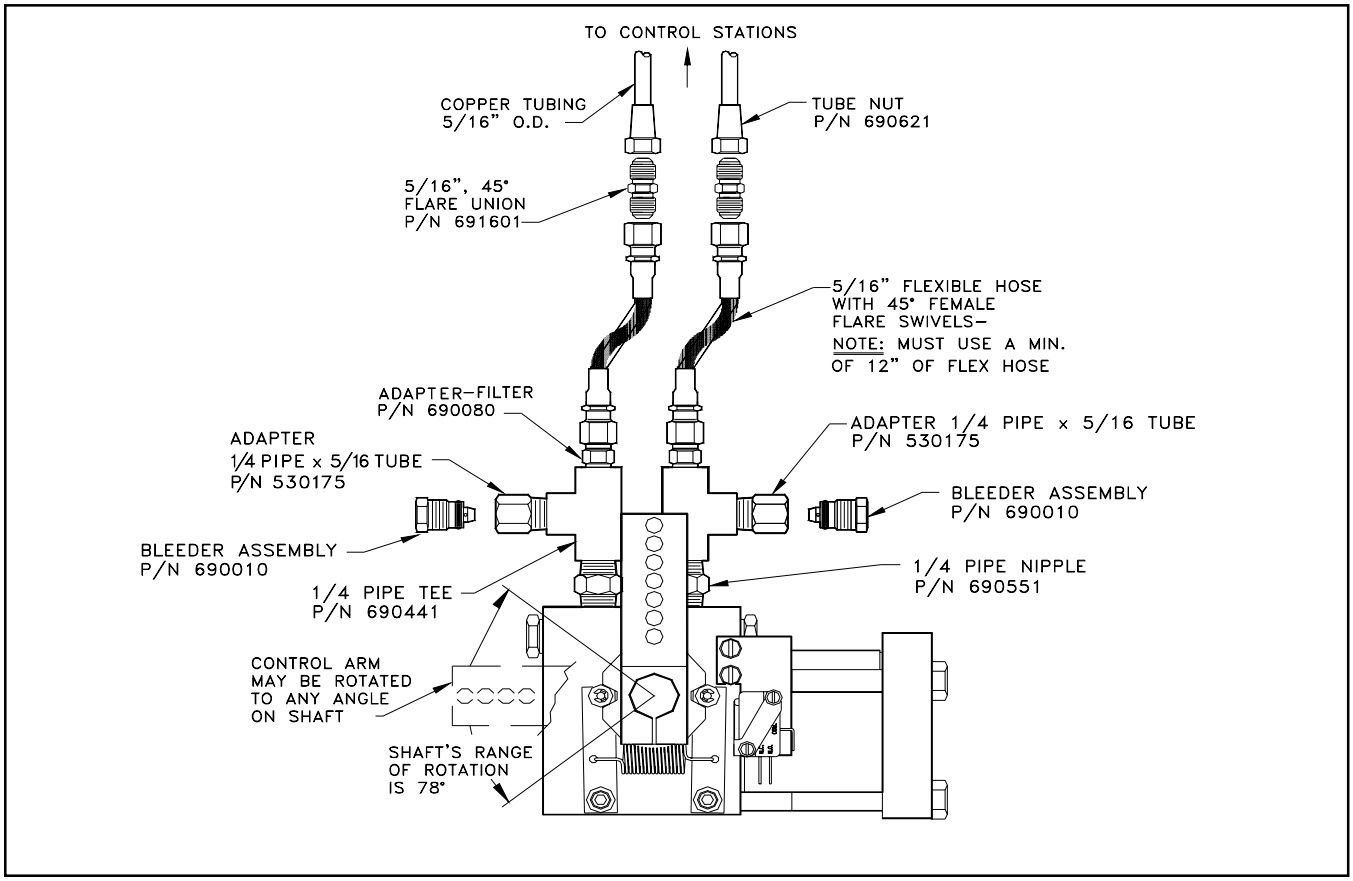


Figure 16. ST-06 Integrated Throttle Slave

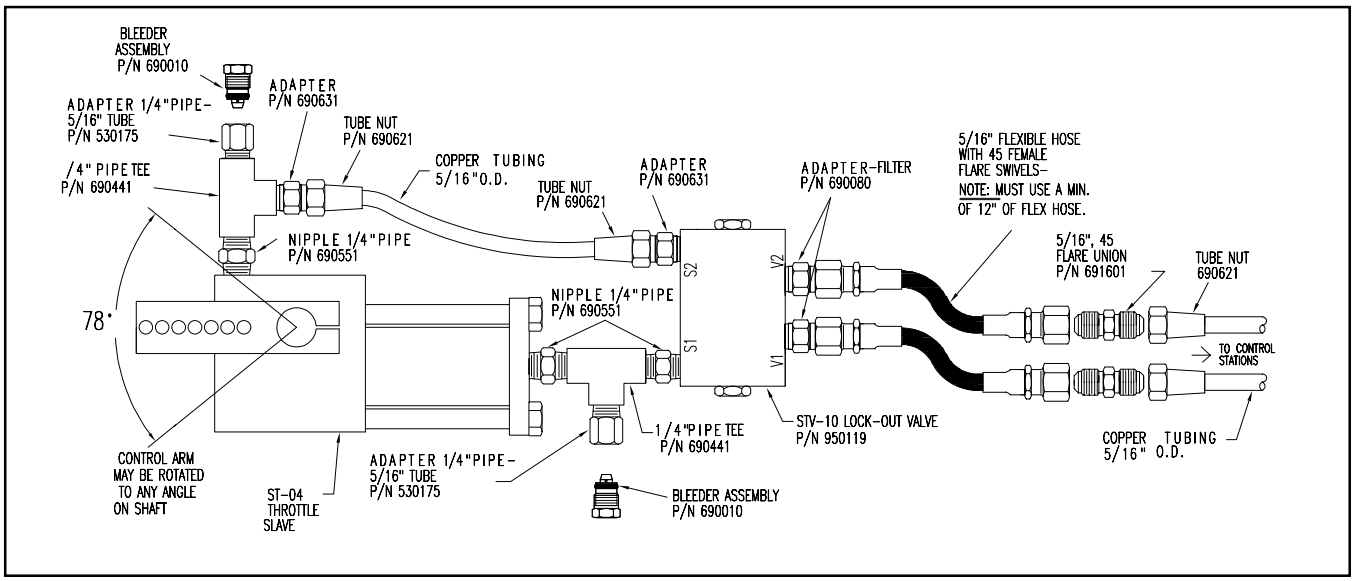


Figure 17. ST-04 Throttle Slave with STV-10 Lock-Out Valve

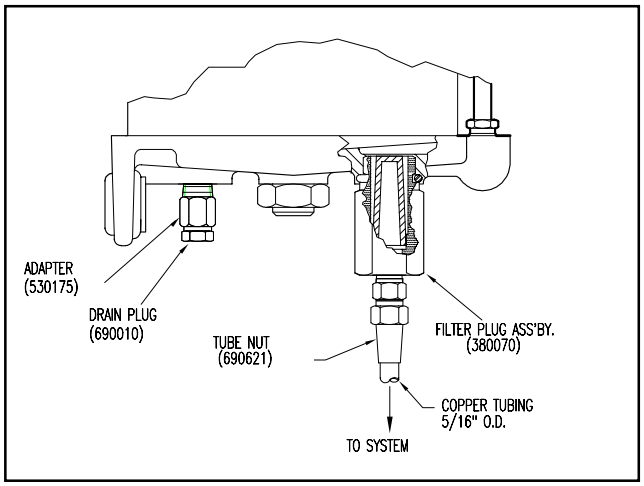


Figure 18. Ports on Bottom of R-04 Reservoir

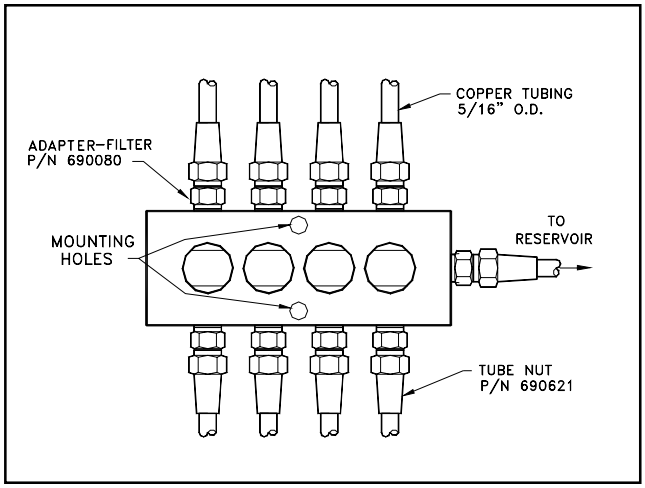
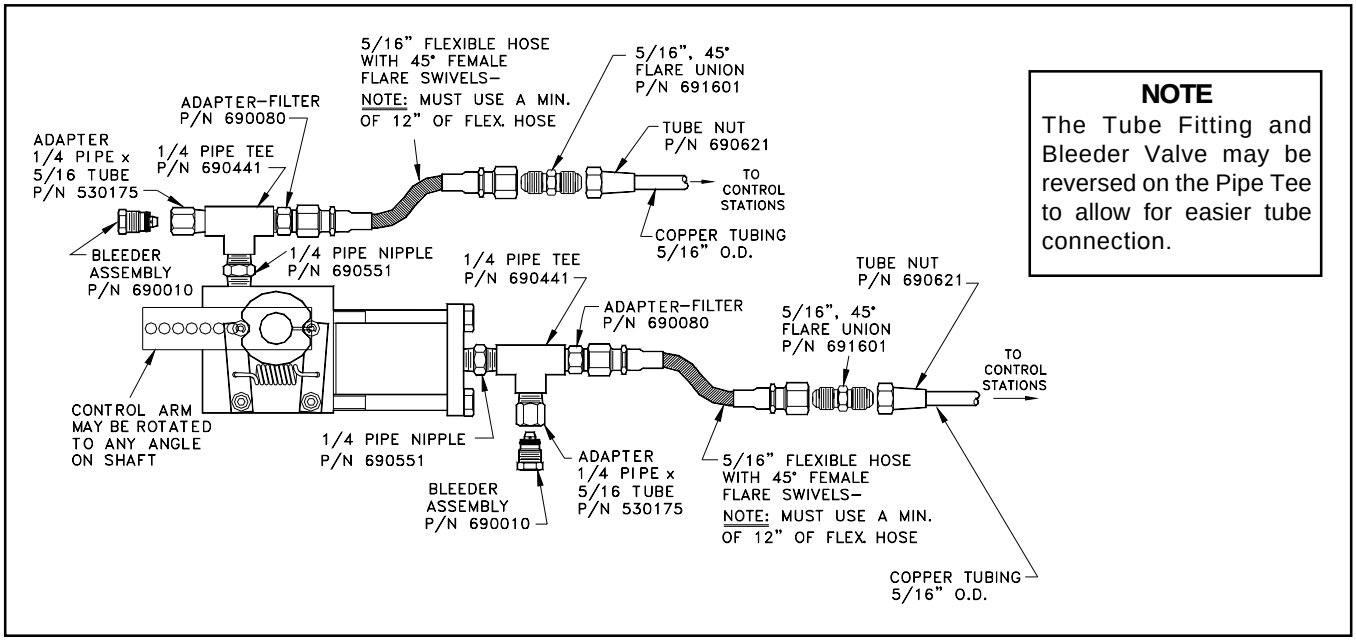


Figure 19. MCV-04 Charging Valve



NOTE

The Tube Fitting and Bleeder Valve may be reversed on the Pipe Tee to allow for easier tube connection.

Figure 20. SS-04 Shifter Slave

System Parts List
Nylon Tubing

COMPONENT	DESCRIPTION	SINGLE ENGINE						TWIN ENGINE					
		MC-B4-S1 (Ball Handle) or MC-T4-S1 ("T" Handle)	MC-B4-S1D (Ball Handle) or MC-T4-S1D ("T" Handle)	MC-B4-S2 (Ball Handle) or MC-T4-S2 ("T" Handle)	MC-B4-S2D (Ball Handle) or MC-T4-S2D ("T" Handle)	MC-B4-S3 (Ball Handle) or MC-T4-S3 ("T" Handle)	MC-B4-S3D (Ball Handle) or MC-T4-S3D ("T" Handle)	MC-B4-T1 (Ball Handle) or MC-T4-S1 ("T" Handle)	MC-B4-T1D (Ball Handle) or MC-T4-T1D ("T" Handle)	MC-B4-T2 (Ball Handle) or MC-T4-T2 ("T" Handle)	MC-B4-T2D (Ball Handle) or MC-T4-T2D ("T" Handle)	MC-B4-T3 (Ball Handle) or MC-T4-T3 ("T" Handle)	MC-B4-T3D (Ball Handle) or MC-T4-T3D ("T" Handle)
R-13	Reservoir & Charging Valve	1	1	1	1	1	1	1	1	1	1	1	1
MCVF-04	Charging Valve Fittings	-	-	-	-	-	-	1	1	1	1	1	1
MCVF-05	Charging Valve Fittings	1	1	1	1	1	1	-	-	-	-	-	-
CL-B4 or CL-T4	Control-Left (Ball Handle) or Control-Left ("T" Handle)	1	1	2	2	3	3	2	2	4	4	6	6
CR-B4 or CR-T4	Control-Right (Ball Handle) or Control-Right ("T" Handle)	1	1	2	2	3	3	2	2	4	4	6	6
CDF-04	Dual Mounting Plate	-	1	-	2	-	3	-	2	-	4	-	6
CF-04	Control Fittings	2	2	4	4	6	6	4	4	8	8	12	12
SS-04	Shift Slave	1	1	1	1	1	1	2	2	2	2	2	2
SSF-04	Slave Fittings	1	1	1	1	1	1	2	2	2	2	2	2
ST-06	Throttle Slave & Double Pilot Check Valve	1	1	1	1	1	1	2	2	2	2	2	2
STF-12	Slave Fittings	1	1	1	1	1	1	2	2	2	2	2	2

ADDITIONAL REQUIREMENTS - NOT INCLUDED IN SYSTEMS

MCEF-04	Extra Fittings Package	1	1	1	1	1	1	1	1	1	1	1	1
MCT-02	100' Nylon Tube	2*	2*	2*	2*	3*	3*	3*	3*	4*	4*	-	-
MCT-05	500' Nylon Tube	-	-	-	-	-	-	-	-	-	-	1*	1*
MCO-03	Hydarulic Fluid	2*	2*	2*	2*	3*	3*	2*	2*	3*	3*	4*	4*

*As Required

System Parts List
Copper Tubing

COMPONENT	DESCRIPTION	SINGLE ENGINE: MC-B5-S1 (Ball Handle) or MC-T5-S1 ("T" Handle)	MC-B5-S1D (Ball Handle) or MC-T5-S1D ("T" Handle)	MC-B5-S2 (Ball Handle) or MC-T5-S2 ("T" Handle)	MC-B5-S2D (Ball Handle) or MC-T5-S2D ("T" Handle)	MC-B5-S3 (Ball Handle) or MC-T5-S3 ("T" Handle)	MC-B5-S3D (Ball Handle) or MC-T5-S3D ("T" Handle)	TWIN ENGINE: MC-B5-T1 (Ball Handle) or MC-T5-S1 ("T" Handle)	MC-B5-T1D (Ball Handle) or MC-T5-S1D ("T" Handle)	MC-B5-T2 (Ball Handle) or MC-T5-T2 ("T" Handle)	MC-B5-T2D (Ball Handle) or MC-T5-T2D ("T" Handle)	MC-B5-T3 (Ball Handle) or MC-T5-T3 ("T" Handle)	MC-B5-T3D (Ball Handle) or MC-T5-T3D ("T" Handle)
R-13	Reservoir & Charging Valve	1	1	1	1	1	1	1	1	1	1	1	1
MCVF-10	Charging Valve Fittings	-	-	-	-	-	-	1	1	1	1	1	1
MCVF-11	Charging Valve Fittings	1	1	1	1	1	1	-	-	-	-	-	-
CL-B4 or CL-T4	Control-Left (Ball Handle) or Control-Left ("T" Handle)	1	1	2	2	3	3	2	2	4	4	6	6
CR-B4 or CR-T4	Control-Right (Ball Handle) or Control-Right ("T" Handle)	1	1	2	2	3	3	2	2	4	4	6	6
CDF-04	Dual Mounting Plate	-	1	-	2	-	3	-	2	-	4	-	6
CF-05	Control Fittings	2	2	4	4	6	6	4	4	8	8	12	12
SS-04	Shift Slave	1	1	1	1	1	1	2	2	2	2	2	2
SSF-06	Slave Fittings	1	1	1	1	1	1	2	2	2	2	2	2
ST-06	Throttle Slave & Double Pilot Check Valve	1	1	1	1	1	1	2	2	2	2	2	2
STF-13	Slave Fittings	1	1	1	1	1	1	2	2	2	2	2	2

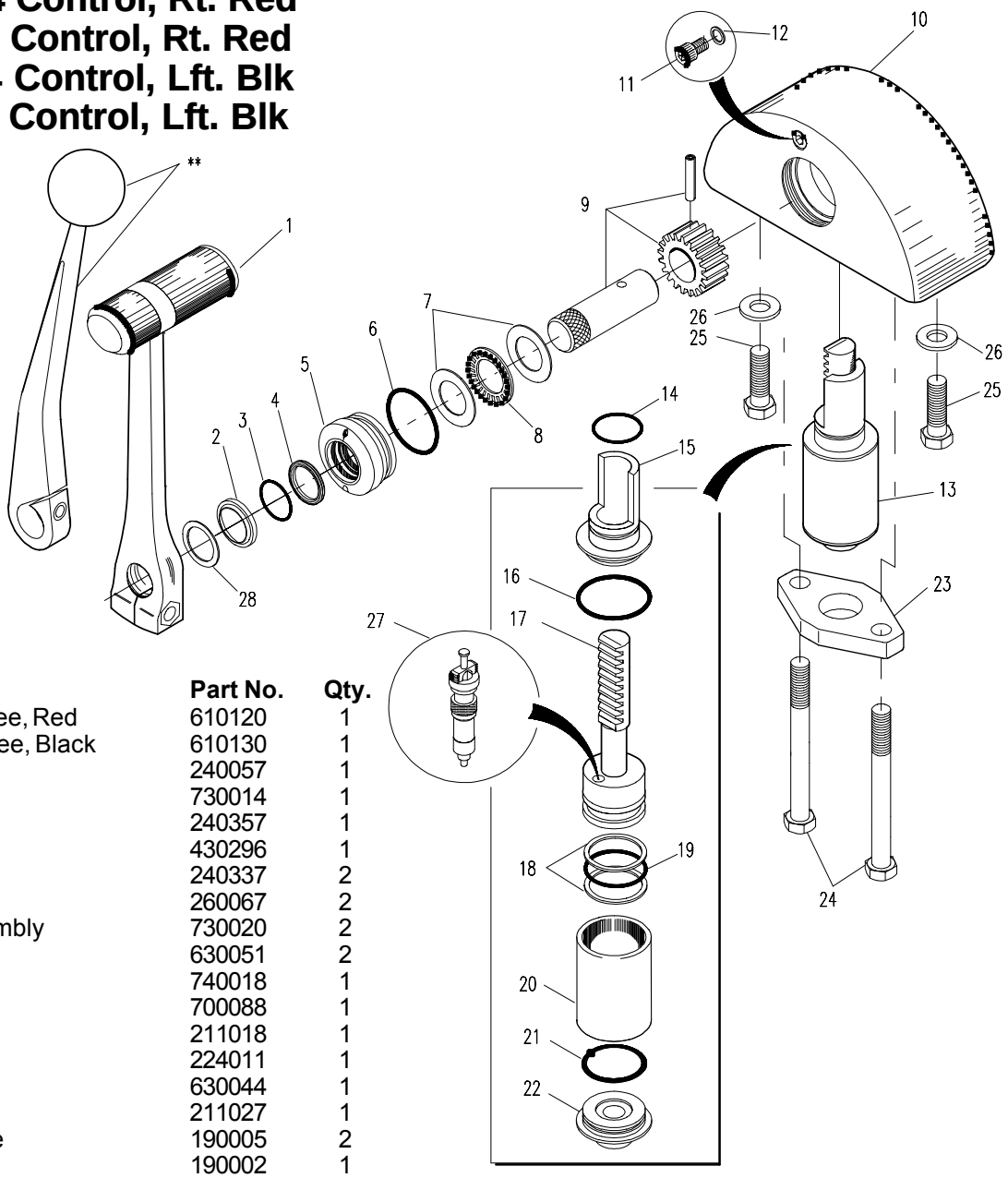
ADDITIONAL REQUIREMENTS - NOT INCLUDED IN SYSTEMS

MCO-03	Hydraulic Fluid*	2	2	2	2	3	3	2	2	3	3	4	4
	Copper Tubing, 5/16" O.D.*	*As Required											

Parts List (Continued)

Sender Assembly

Model CR-B4 Control, Rt. Red
Model CR-T4 Control, Rt. Red
Model CL-B4 Control, Lft. Blk
Model CL-T4 Control, Lft. Blk



Item		Description	Part No.	Qty.
1.		Lever Arm, Tee, Red	610120	1
		Lever Arm, Tee, Black	610130	1
2.		Screw	240057	1
3..		Cam	730014	1
4..		Setscrew	240357	1
5..		Spring	430296	1
6..		Screw	240337	2
7..		Washer	260067	2
8..		Detent Assembly	730020	2
9.		Bushing	630051	2
10.		Washer	740018	1
11.	*	Wiper	700088	1
12.	*	0-Rlng	211018	1
13.	*	Quad Seal	224011	1
14.		Bushing	630044	1
15.	*	0-Ring	211027	1
16.		Bearing Race	190005	2
17.		Bearing	190002	1
18.		Pinion Assembly	720150	1
19.		Body	900254	1
20.		Cylinder Assembly	500120	1
21..	*	0-Ring	211020	1
22.		Cylinder End (Eccentric)	560034	1
23..	*	0-Ring	211028	2
24.		Piston Assembly	600070	1
25.	*	Teflon Back-up Ring	252125	2
26. .	*	0-Ring	211125	1
27.		Cylinder Tube	500131	1
28.		Cylinder End	560064	1
29.		Plate	520014	1
30.		Bolt	240717	2
31.	*	Dill Valve (w/red seal)	160061	2

** Optional Handle (Red) CK-01
Red Knob 610058
Optional Handle (Black) CK-02
Black Knob 610048

* - Part of Seal Kit ECS-05
Consists of:

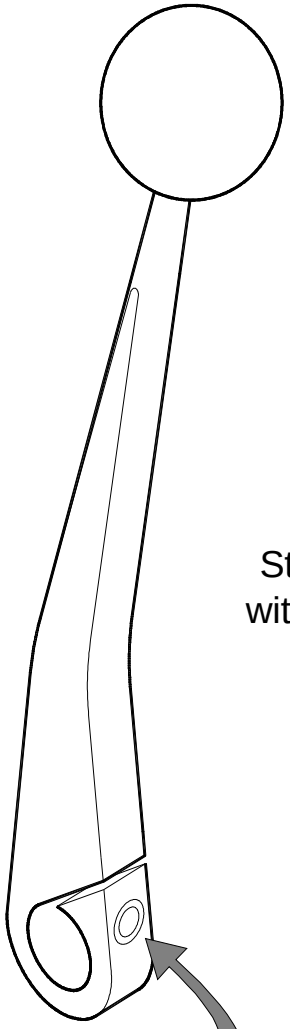
2	Valves	160011
1	O-Ring	211018
1	O-Ring	211020
2	O-Rings	211024
1	O-Rings	211027
1	O-Ring	211121
1	Seal	224011
2	Rings	252121
1	Gasket	390028
1	Wiper	700088

Figure 21. Sender Assembly

Ball and Tee Handle Installation

CAUTION
When Installing ball handle do not torque screw to more than 10 ft. lbs.

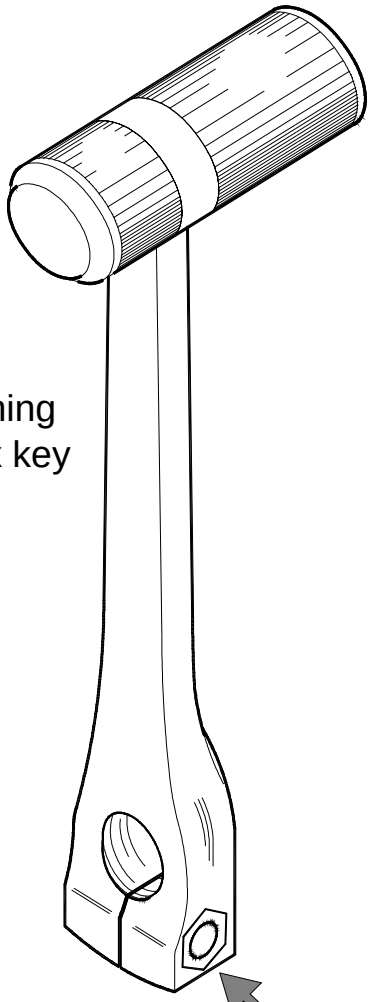
CAUTION
When installing tee handle do not torque screw to more than 14 ft. lbs.



TORQUE TO 90-110 IN-LBS (10-12.5 Nm)

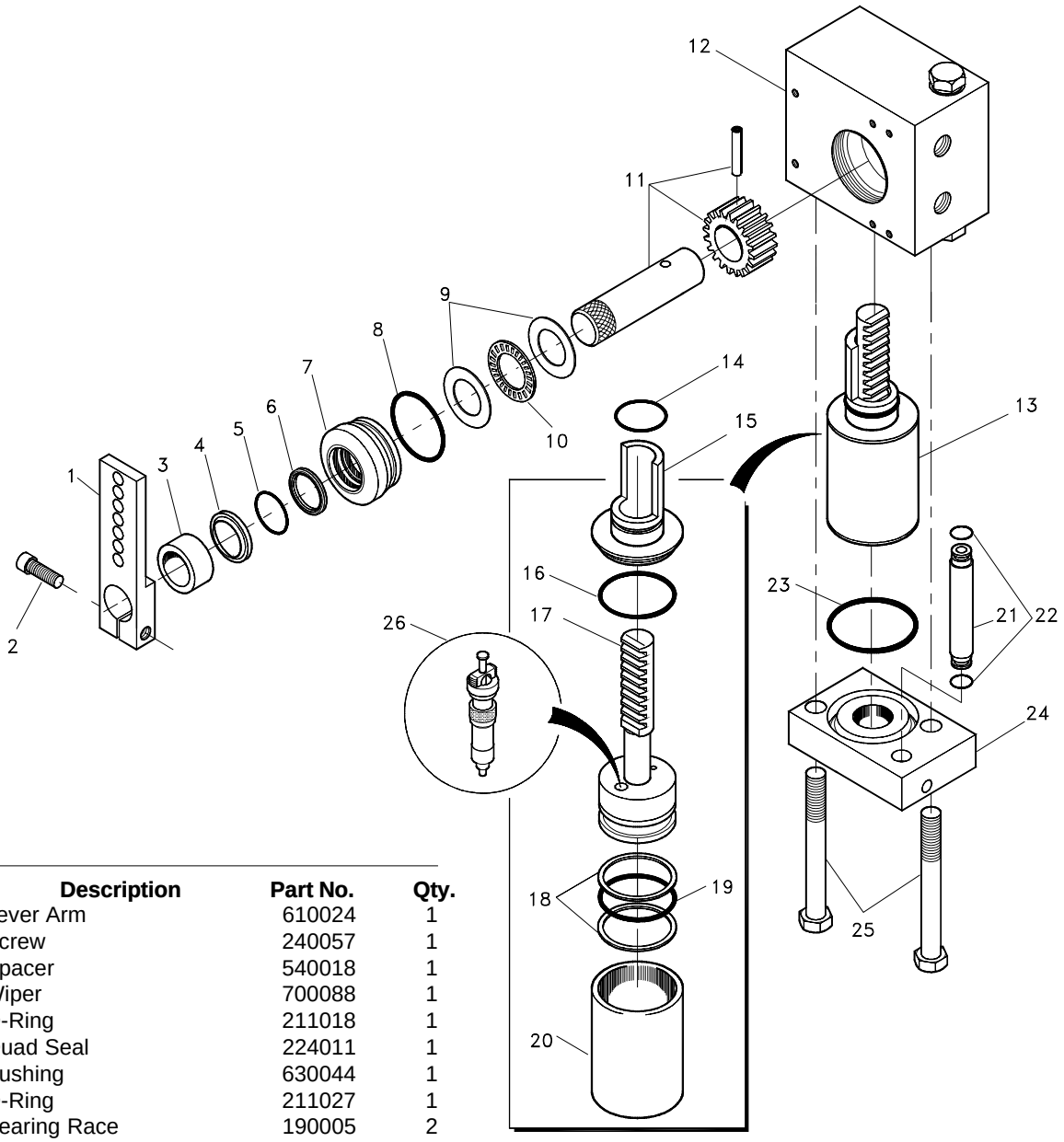
NOTE

Standard hand-tightening with 1/4" short arm hex key wrench will not over-torque screw.



TORQUE TO 90-110 IN-LBS (10-12.5 Nm)

Parts List (Continued)



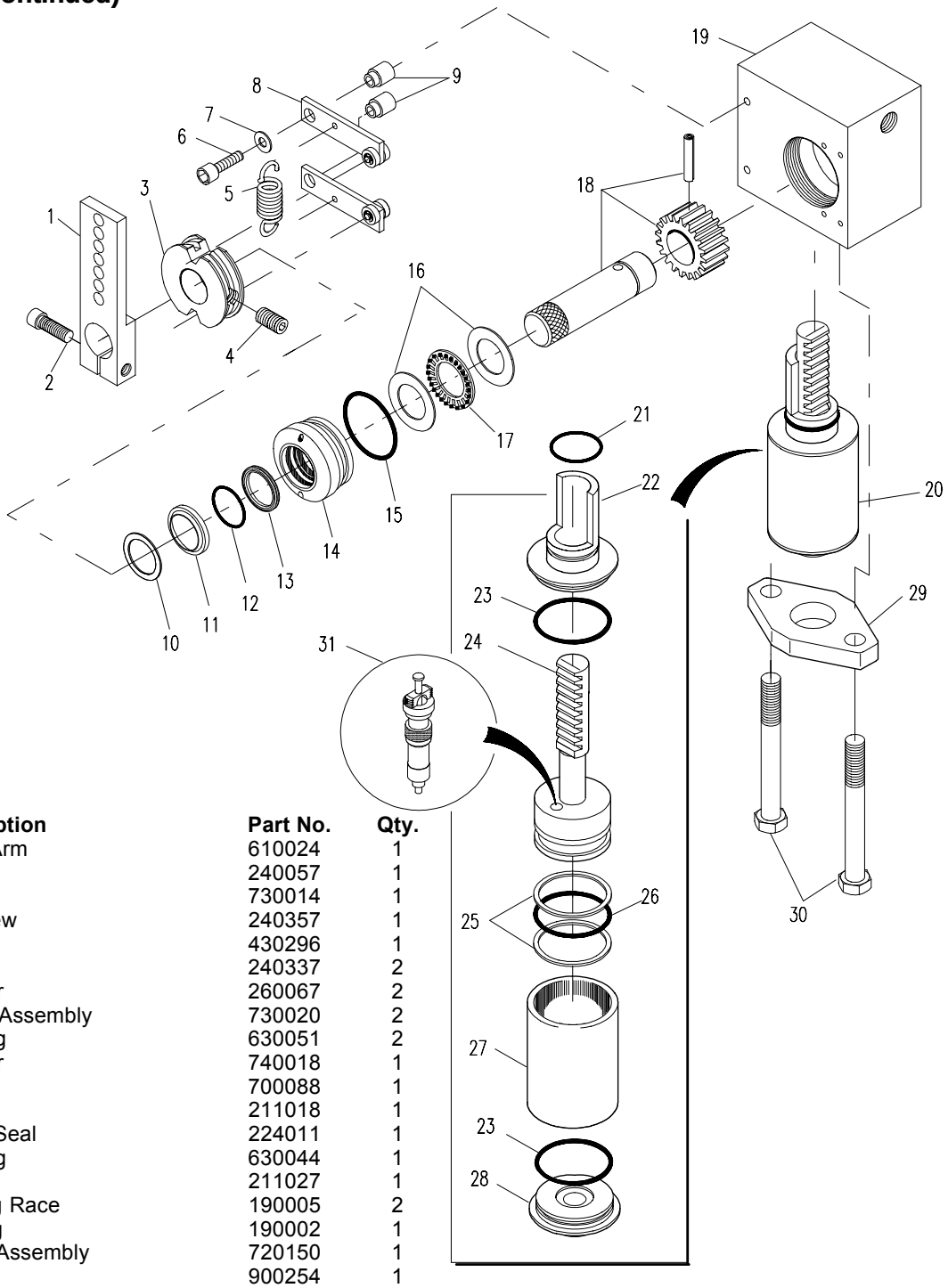
Item		Description	Part No.	Qty.
1.		Lever Arm	610024	1
2.		Screw	240057	1
3.		Spacer	540018	1
4.	*	Wiper	700088	1
5.	*	O-Ring	211018	1
6.	*	Quad Seal	224011	1
7.		Bushing	630044	1
8.	*	O-Ring	211027	1
9.		Bearing Race	190005	2
10.		Bearing	190002	1
11.		Pinion Assembly	720150	1
12.		Body	901054	1
13.		Cylinder Assembly	501120	1
14.	*	O-Ring	211020	1
15.		Cylinder End (Eccentric)	560034	1
16.	*	O-Ring	211028	1
17.		Piston Assembly	600070	1
18.	*	Teflon Back-Up Ring	252125	2
19.	*	O-Ring	211125	1
20.		Cylinder Tube	500131	1
21.		Tube	500164	1
22.	*	O-Ring	211010	2
23.	*	O-Ring	211030	1
24.		Plate	520634	1
25.		Bolt	240717	2
26.	*	Dill Valves (w/red seal)	160061	2

*** - Part of Seal Kit, ECS-06**
Consists of:

2	Dill Valves	160061
2	O-Rings	211010
1	O-Ring	211018
1	O-Ring	211020
1	O-Ring	211027
2	O-Rings	211028 (1 extra)
1	O-Ring	211030
1	O-Ring	211125
1	Seal	224011
2	Rings	252125
1	Wiper	700088

Figure 22. ST-06 Throttle Slave Assembly

Parts List (Continued)



Item		Description	Part No.	Qty.
1.		Lever Arm	610024	1
2.		Screw	240057	1
3.		Cam	730014	1
4.		Setscrew	240357	1
5.		Spring	430296	1
6.		Screw	240337	2
7.		Washer	260067	2
8.		Detent Assembly	730020	2
9.		Bushing	630051	2
10.		Washer	740018	1
11.	*	Wiper	700088	1
12.	*	0-RIng	211018	1
13.	*	Quad Seal	224011	1
14.		Bushing	630044	1
15.	*	0-Ring	211027	1
16.		Bearing Race	190005	2
17.		Bearing	190002	1
18.		Pinion Assembly	720150	1
19.		Body	900254	1
20.		Cylinder Assembly	500120	1
21.	*	0-Ring	211020	1
22.		Cylinder End (Eccentric)	560034	1
23.	*	0-Ring	211028	2
24.		Piston Assembly	600070	1
25.	*	Teflon Back-up Ring	252125	2
26.	*	0-Ring	211125	1
27.		Cylinder Tube	500131	1
28.		Cylinder End	560064	1
29.		Plate	520014	1
30.		Bolt	240717	2
31.	*	Dill Valve (w/red seal)	160061	2

*** - Part of Seal Kit, ECS-06**

Consists of:

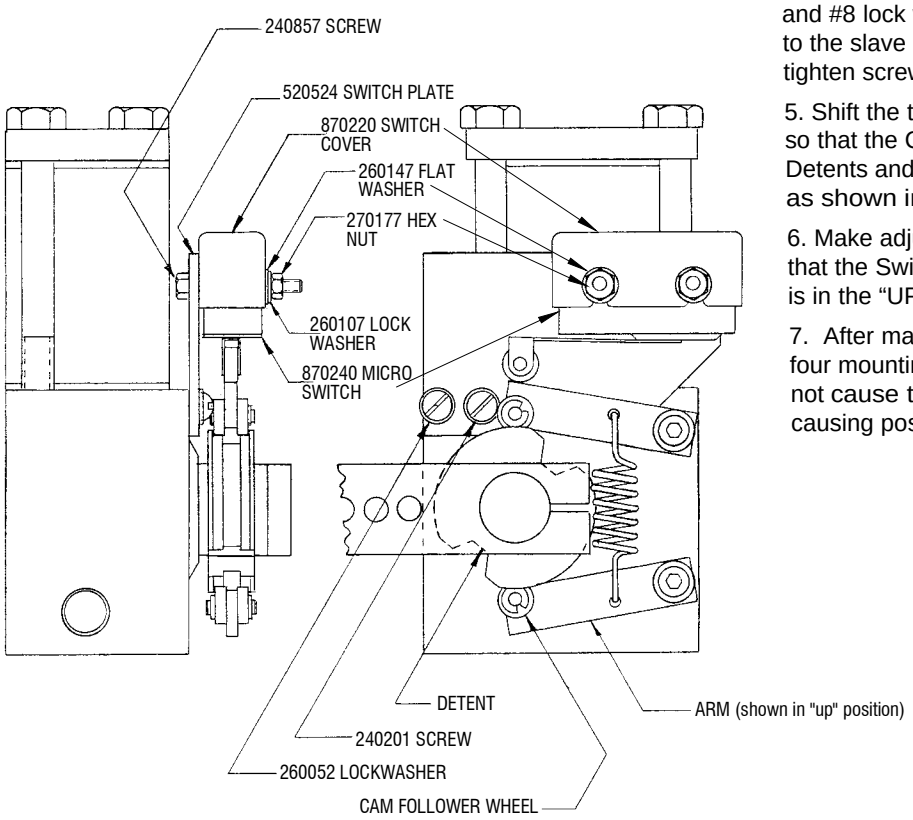
2	Dill Valves	160061
2	O-Rings	211010 (not used)
1	O-Ring	211018
1	O-Ring	211020
1	O-Ring	211027
2	O-Rings	211028
1	O-Ring	211030 (not used)
1	O-Ring	211125
1	Seal	224011
2	Rings	252125
1	Wiper	700088

Figure 23. SS-04 Transmission Slave Assembly

Optional Neutral Safety Switch Kit SSH-01
Installation Instructions

1. Before wiring the Switch, determine the best routing for the wires as they lead away from the switch.
2. Break out an appropriate knock-out in the Switch Cover and feed the wires through before placing cover on Switch. When positioning the wiring be sure that it will not interfere with the mechanical function of the switch or slave.
2. Using the “common” and “normally closed” Switch Terminal Screws, wire the switch into the circuit between the Starter Solenoid and the Starter Key Switch in accordance with the engine manufacturers recommendations.
3. Using #6-32 screws (p/n 240857), #6 flatwashers (p/n 260147), #6 lock washers (p/n 260107), and #6-32 hex nuts (p/n 270177), mount Switch to Plate as shown in drawing. (Do not tighten screws at this time.)
4. Using #8-32 round head screws (p/n 240201) and #8 lock washers (p/n 260052), mount the Plate to the slave body as shown in drawing. (Do not tighten screws at this time.)
5. Shift the transmission to “Forward” or “Reverse” so that the Cam Follower Wheels are out of the Detents and the Arms are in the “UP” position as shown in the drawing.
6. Make adjustments to the Switch and Plate so that the Switch makes contact when the slave arm is in the “UP” position.
7. After making necessary adjustments, tighten all four mounting screws. Be sure the slave arm does not cause too much overtravel on the Switch causing possible damage to the switch arm.

1. Before wiring the Switch, determine the best routing for the wires as they lead away from the switch.
2. Break out an appropriate knock-out in the Switch Cover and feed the wires through before placing cover on Switch. When positioning the wiring be sure that it will not interfere with the mechanical function of the switch or slave.
2. Using the “common” and “normally closed” Switch Terminal Screws, wire the switch into the circuit between the Starter Solenoid and the Starter Key Switch in accordance with the engine manufacturers recommendations.
3. Using #6-32 screws (p/n 240857), #6 flatwashers (p/n 260147), #6 lock washers (p/n 260107), and #6-32 hex nuts (p/n 270177), mount Switch to Plate as shown in illustration. (Do not tighten screws at this time.)



4. Using #8-32 round head screws (p/n 240201) and #8 lock washers (p/n 260052), mount the Plate to the slave body as shown in drawing. (Do not tighten screws at this time.)

5. Shift the transmission to “Forward” or “Reverse” so that the Cam Follower Wheels are out of the Detents and the Arms are in the “UP” position as shown in illustration.

6. Make adjustments to the Switch and Plate so that the Switch makes contact when the slave arm is in the “UP” position.

7. After making necessary adjustments, tighten all four mounting screws. Be sure the slave arm does not cause too much overtravel on the Switch causing possible damage to the switch arm.

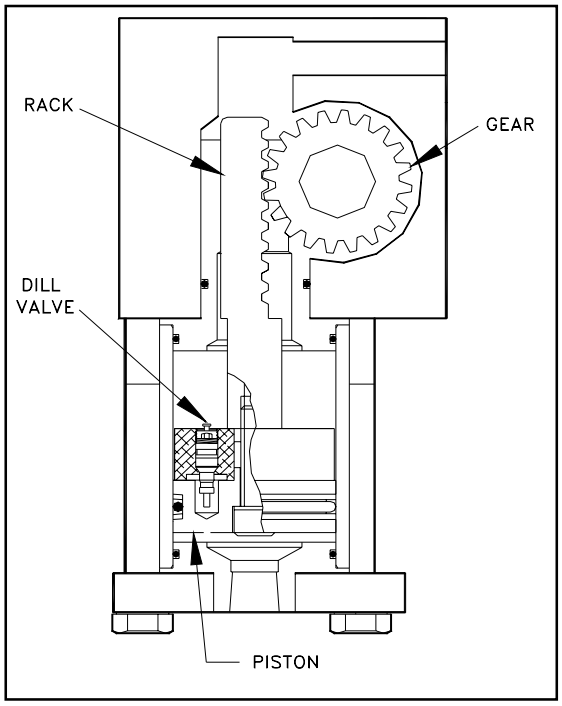


Figure 24. Clutch Slave

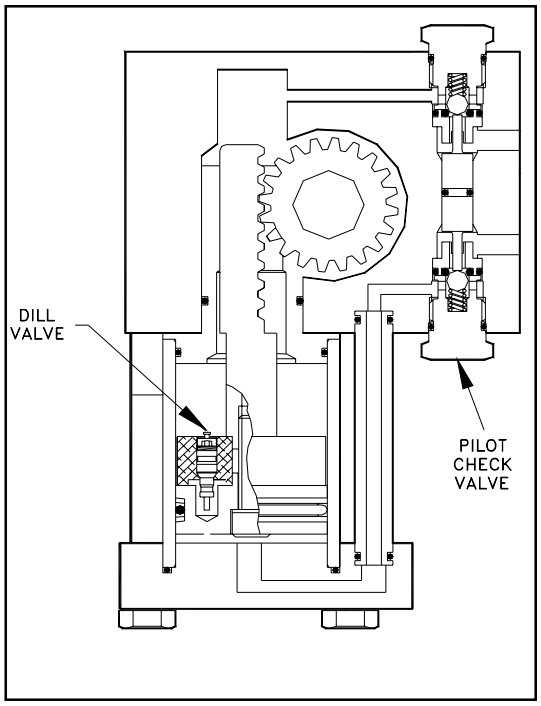
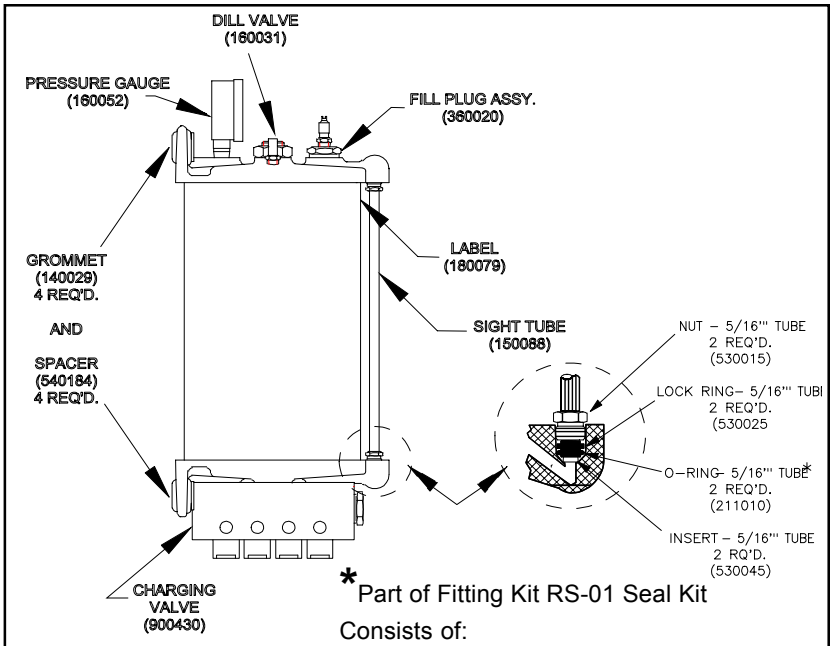


Figure 25. Throttle Slave

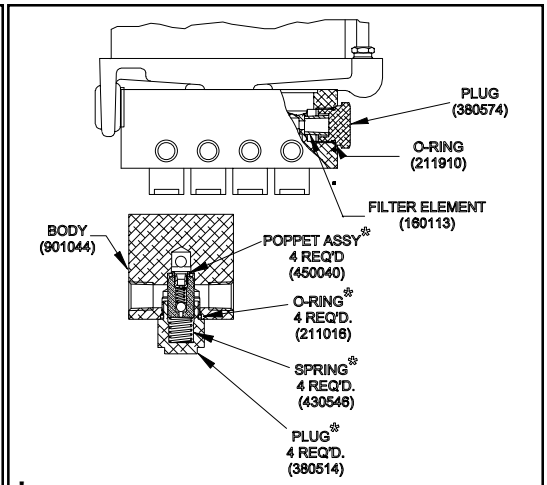


*Part of Fitting Kit RS-01 Seal Kit

Consists of:

2	O-ring	211010
1	O-ring	211011
1	O-ring	211117
2	O-ring	211206
2	O-ring	211910
2	Seal	224014
1	Inst. Sheet	181033

Figure 26. R-13 Integrated Reservoir



*Part of Fitting Kit MCVF-08

Consists of:

4	O-ring	211016
4	Plug	380514
4	Spring	430546
4	Poppet Assy	450040
1	Reservoir Plug	380030
1	Inst. Sheet	180054

Figure 27. Charging Valve on R-13 Integrated Reservoir

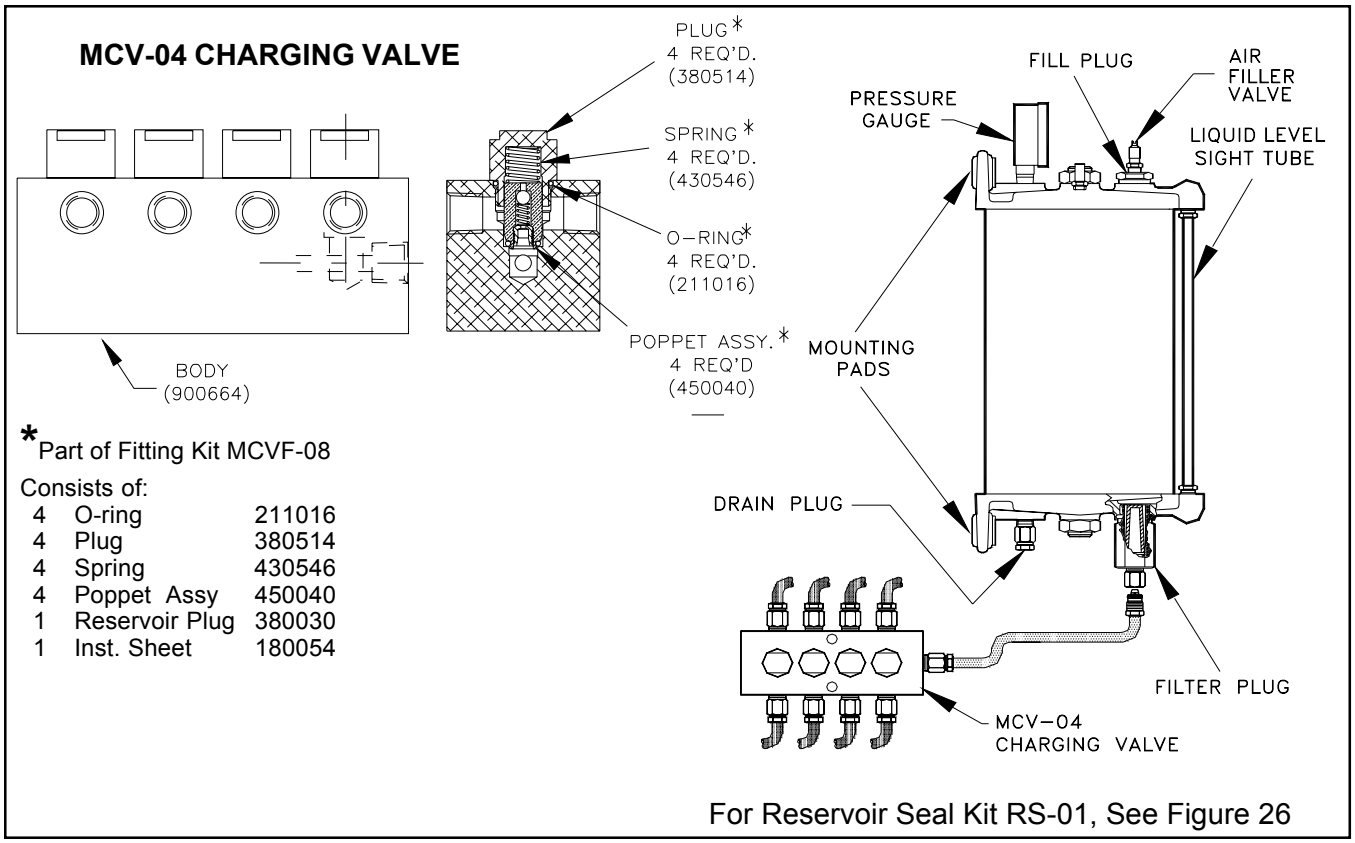


Figure 28. R-04 Reservoir with MCV-04 Charging Valve

Templates

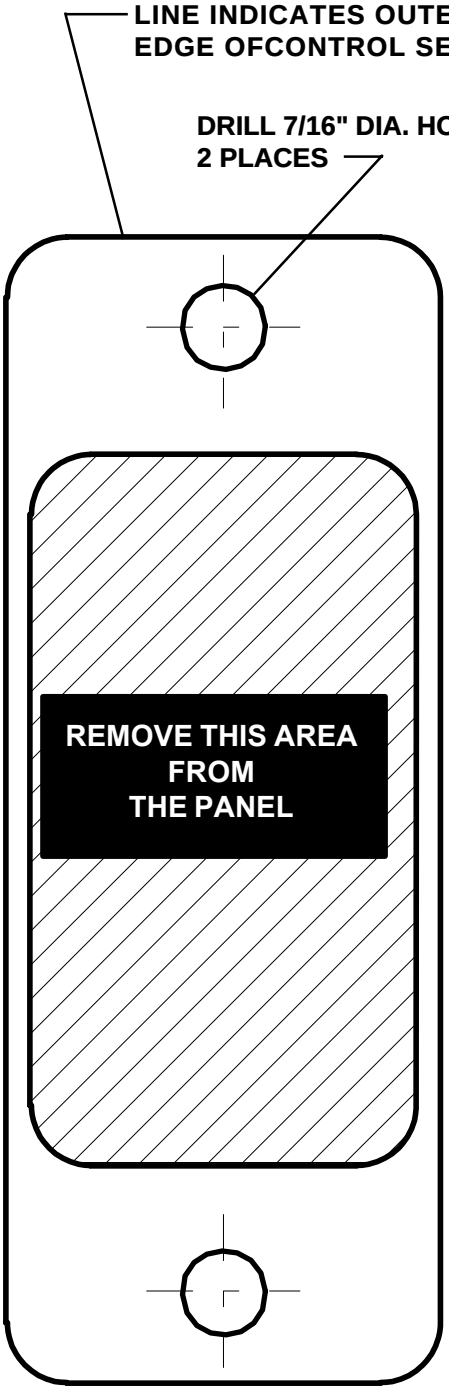


Figure 29. Single Head

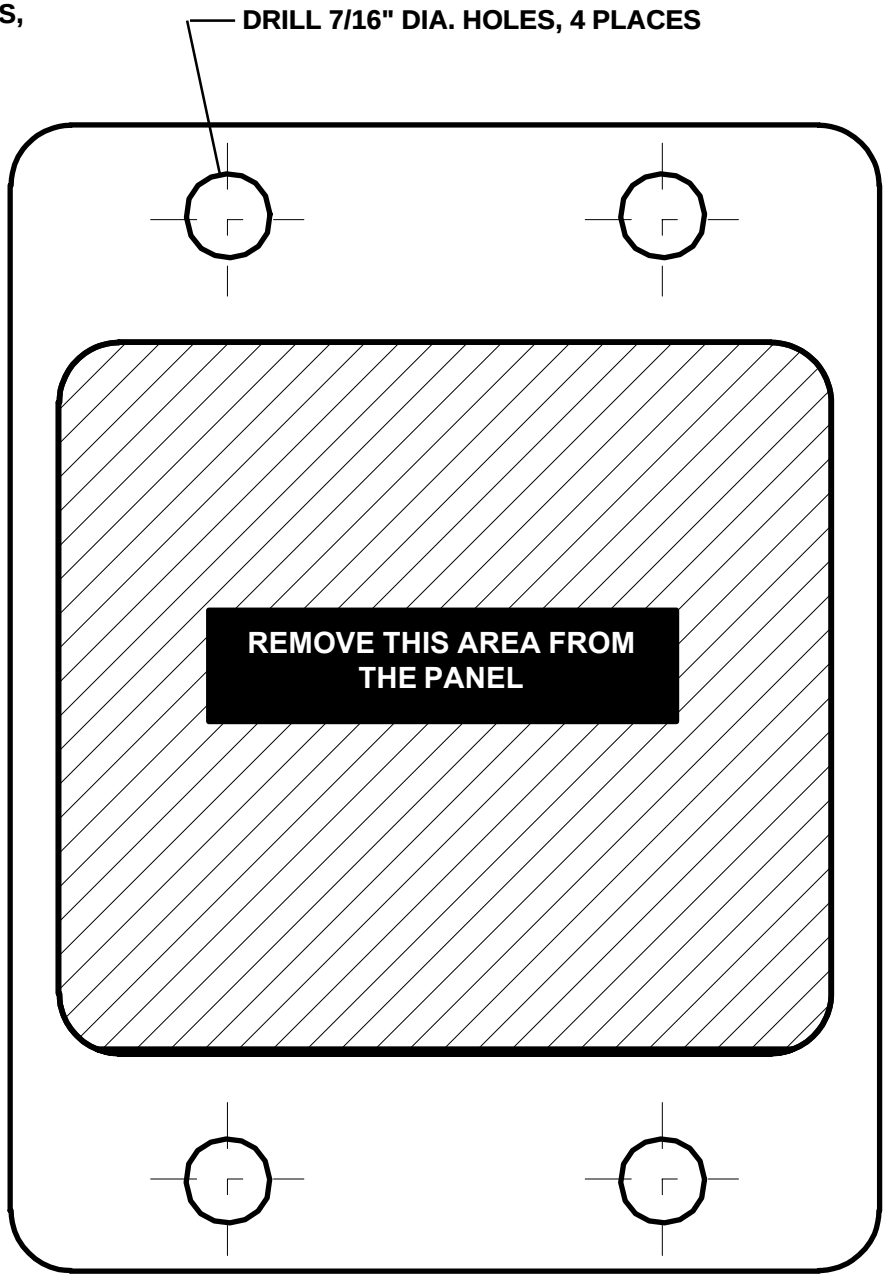


Figure 30. Side-by-Side Mounting

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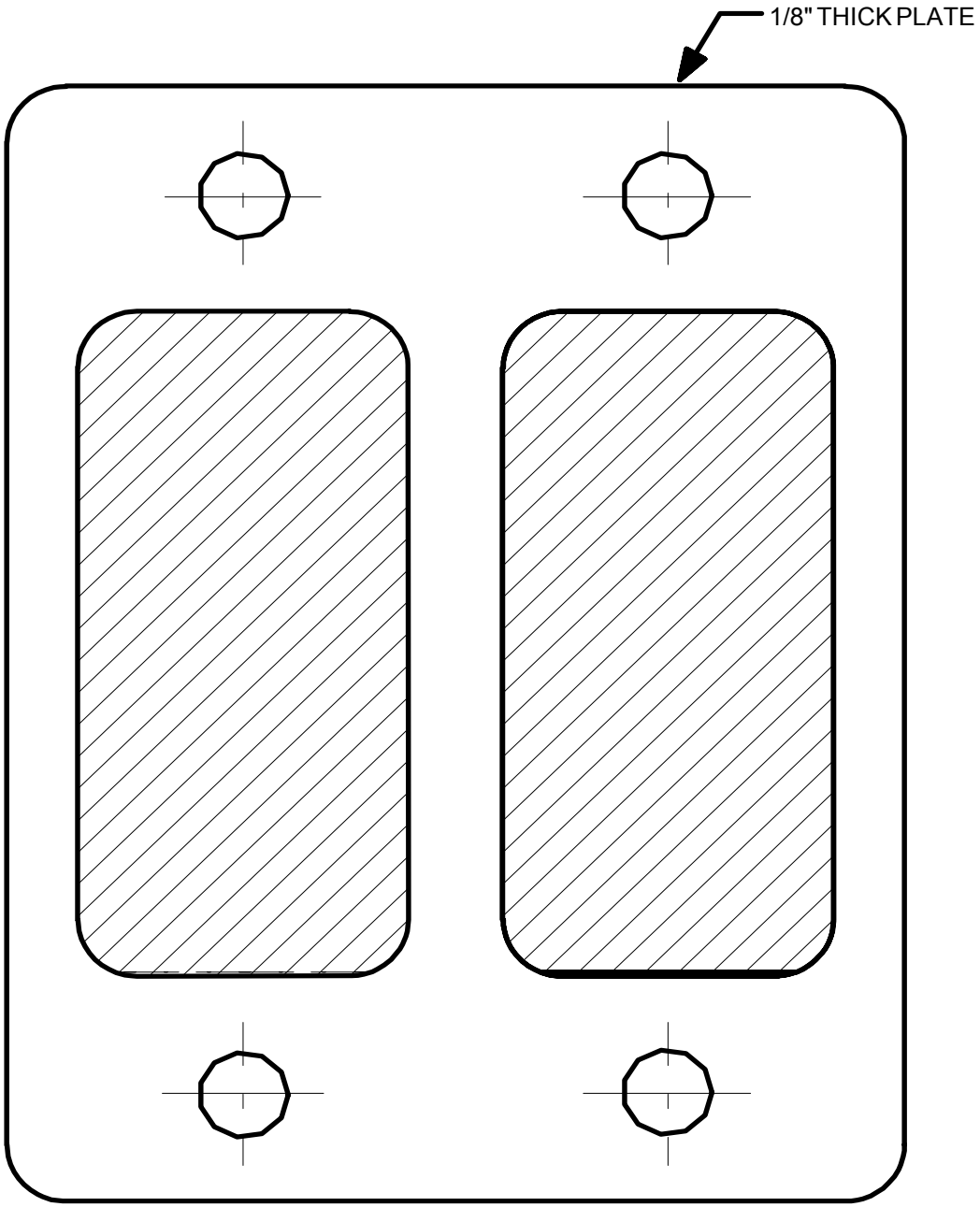
CDF-04 Mounting Plate

This plate simplifies mounting of 1-CL and 1-CR control as a dual unit.

1. Select mounting location, checking for adequate handle clearance throughout full arc. Also check for access to the allen screw bleeders in the control heads and clearance below the mounting surface.
2. When location is determined, use the plate as a templete and mark position of the 4 mounting bolt holes and outline of material to be removed.

3. Remove plate from dash. Drill 4-7/16" diameter holes. Remove material from shaded area as shown.

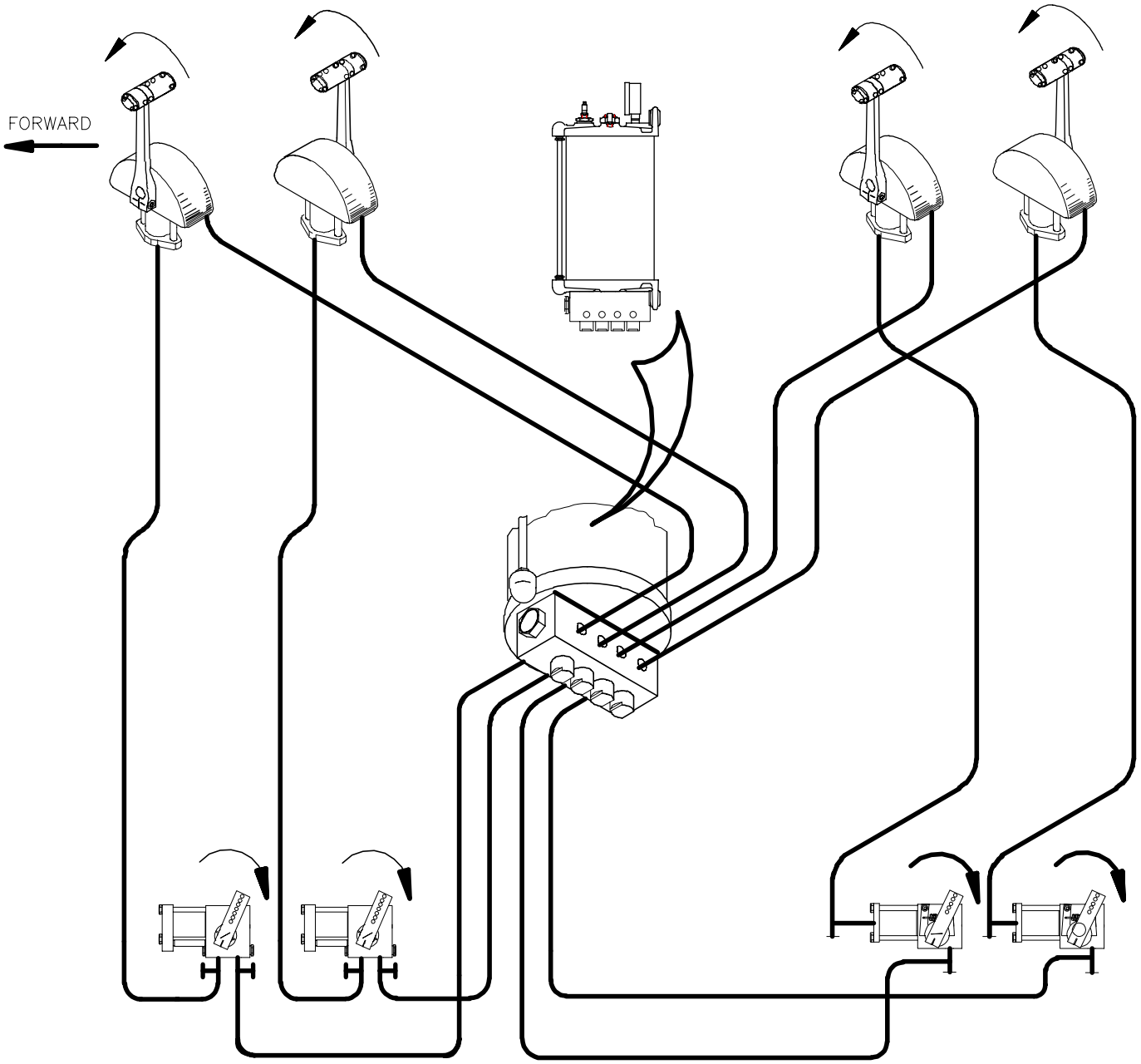
4. Proceed with sender mounting per installation manual.



Tubing Circuits

Plan I - Twin Engine, One Station

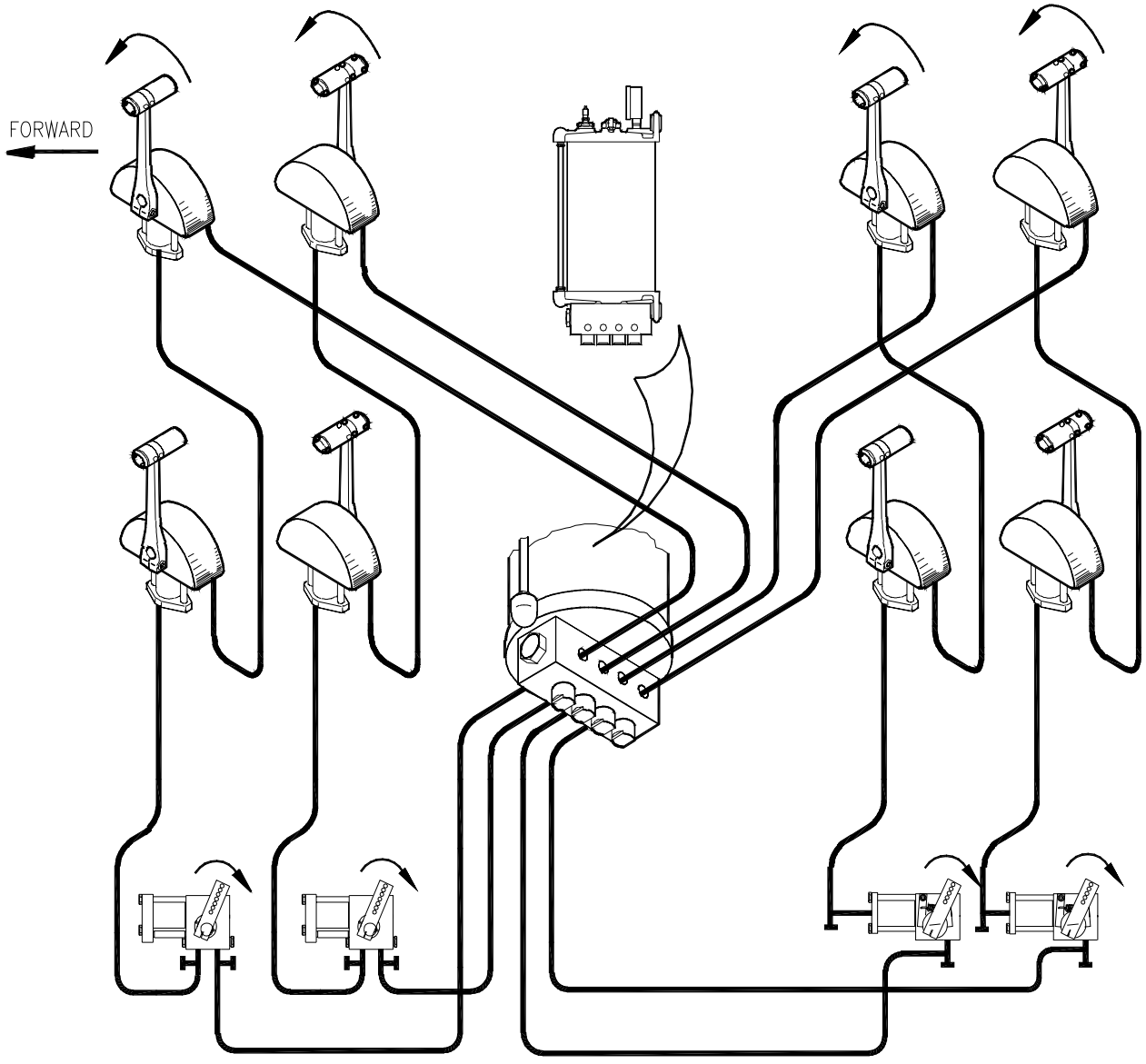
Throttle plumbing shown in diagram advances throttle in a clockwise direction. For a counter-clockwise throttle advance see supplemental diagram Plan I-S and replumb throttle citcuits accordingly.



Tubing Circuits

Plan II - Twin Engine, Two Station

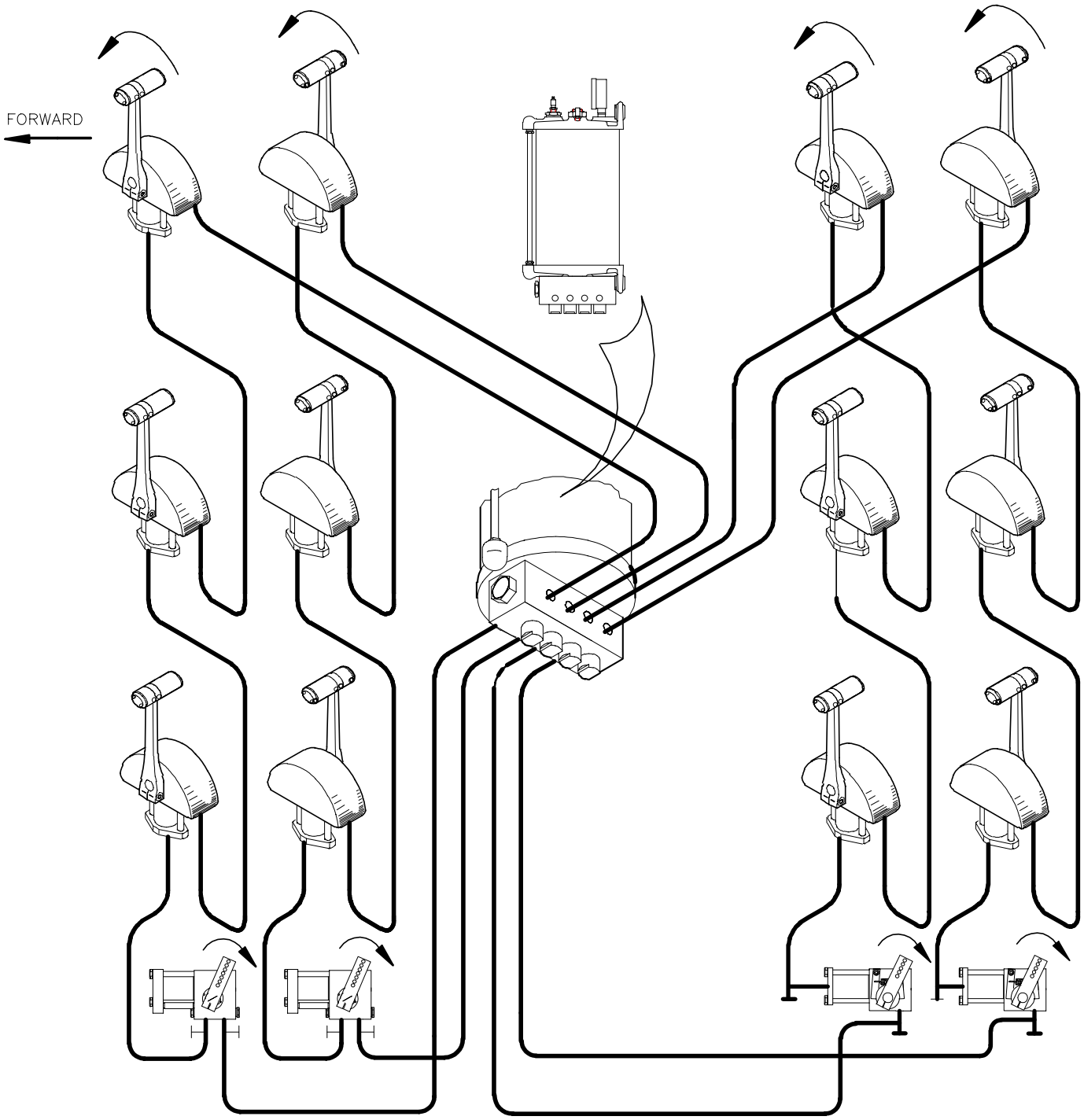
Throttle plumbing shown in diagram advances throttle in a clockwise direction. For a counter-clockwise throttle advance see supplemental diagram Plan II-S, and replumb throttle citcuits accordingly.



Tubing Circuits

Plan III - Twin Engine, Three Station

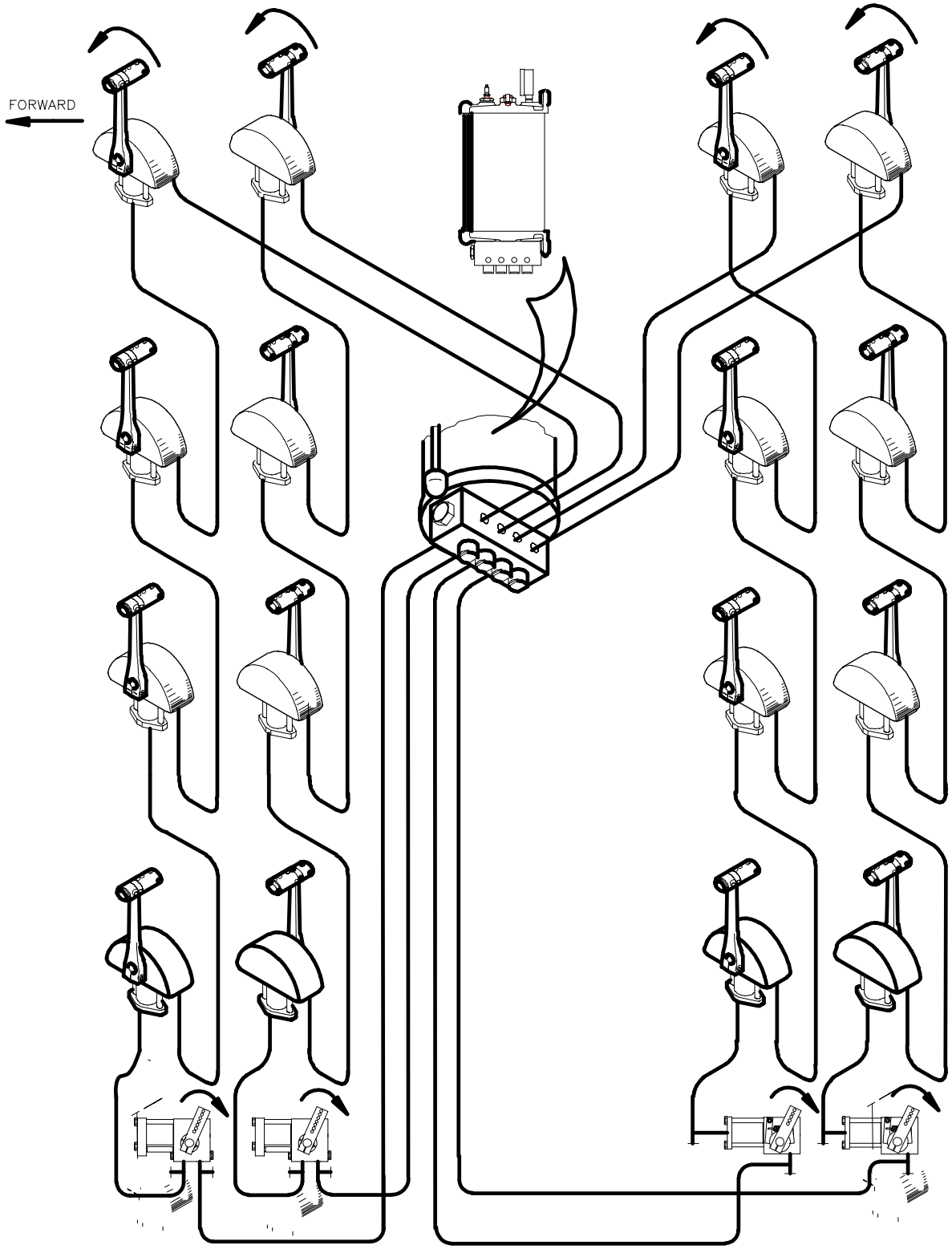
Throttle plumbing shown in diagram advances throttle in a clockwise direction. For a counter-clockwise throttle advance see supplemental diagram Plan II-S, and replumb throttle citcuits accordingly.



Tubing Circuits

Plan IV - Twin Engine, Four Station

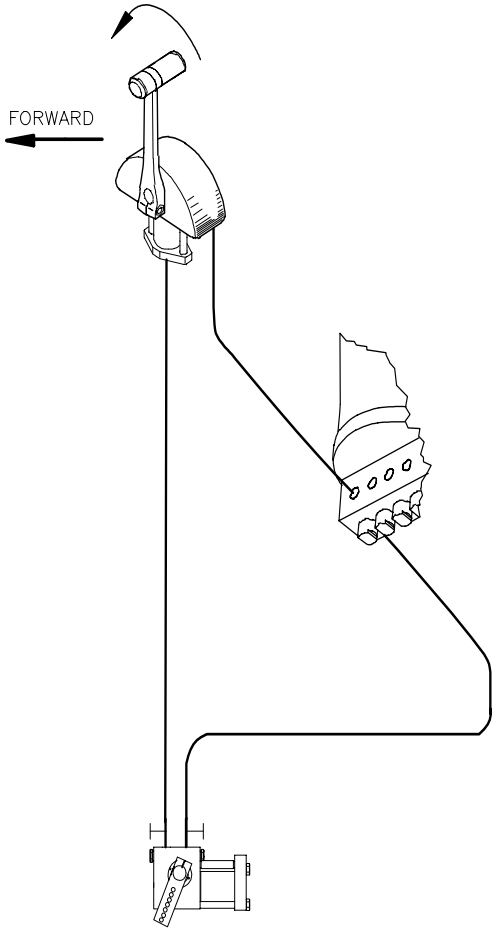
Throttle plumbing shown in diagram advances throttle in a clockwise direction. For a counter-clockwise throttle advance see supplemental diagram Plan IV-S, and replumb throttle citcuits accordingly.



Supplemental Throttle Control Circuits

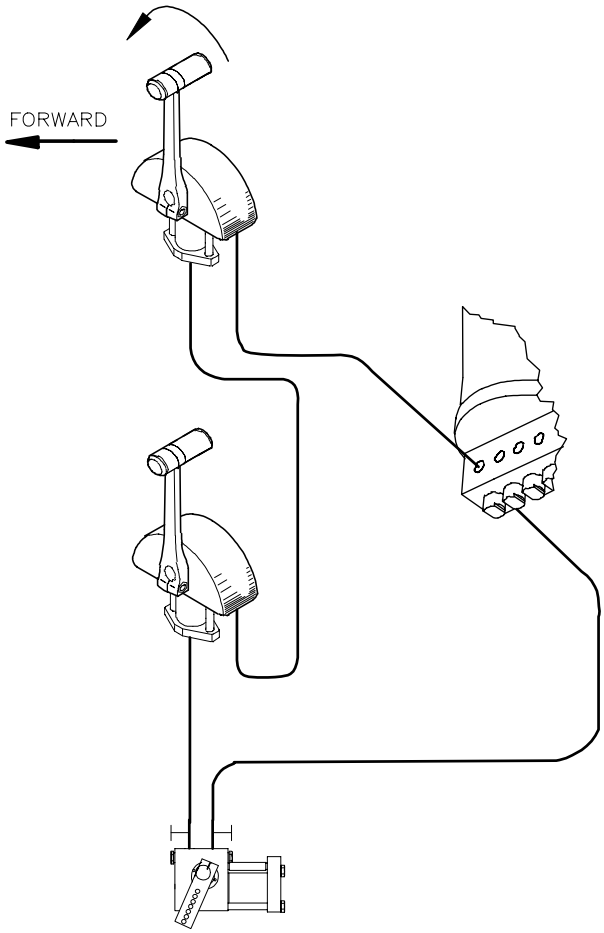
Plan I-S

Single Station Counterclockwise Throttle Advance



Plan II-S

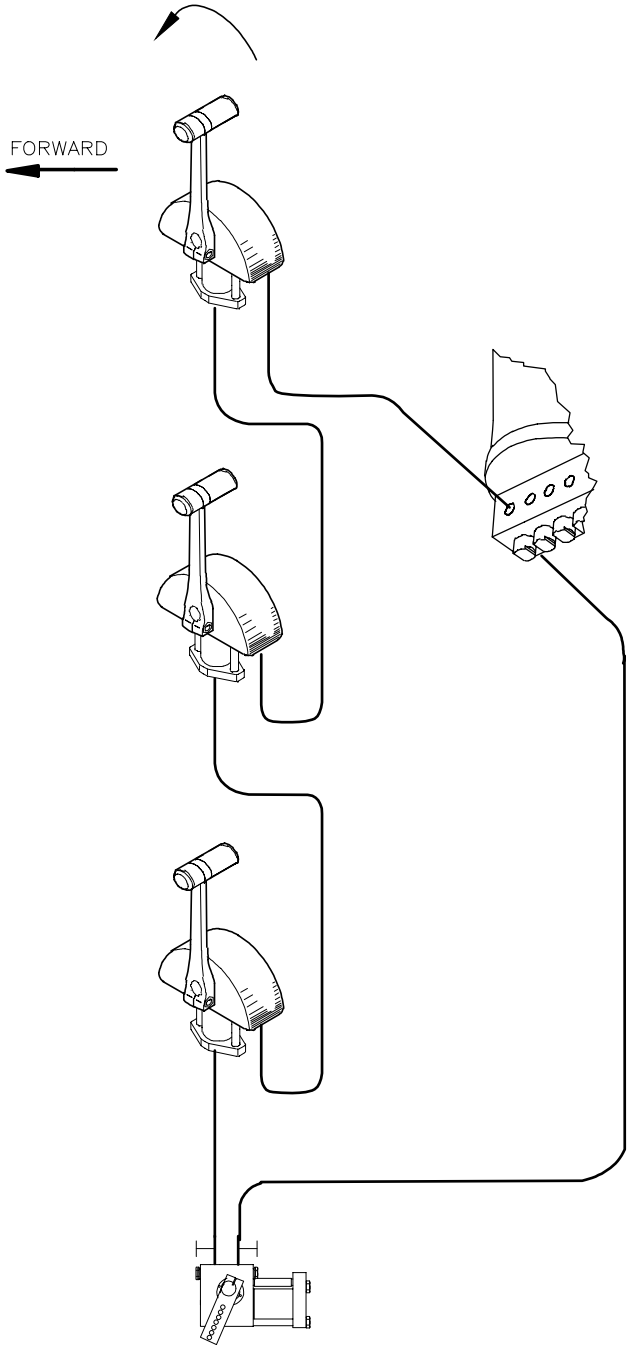
Two Station Counterclockwise Throttle Advance



Supplemental Throttle Control Circuits (Continued)

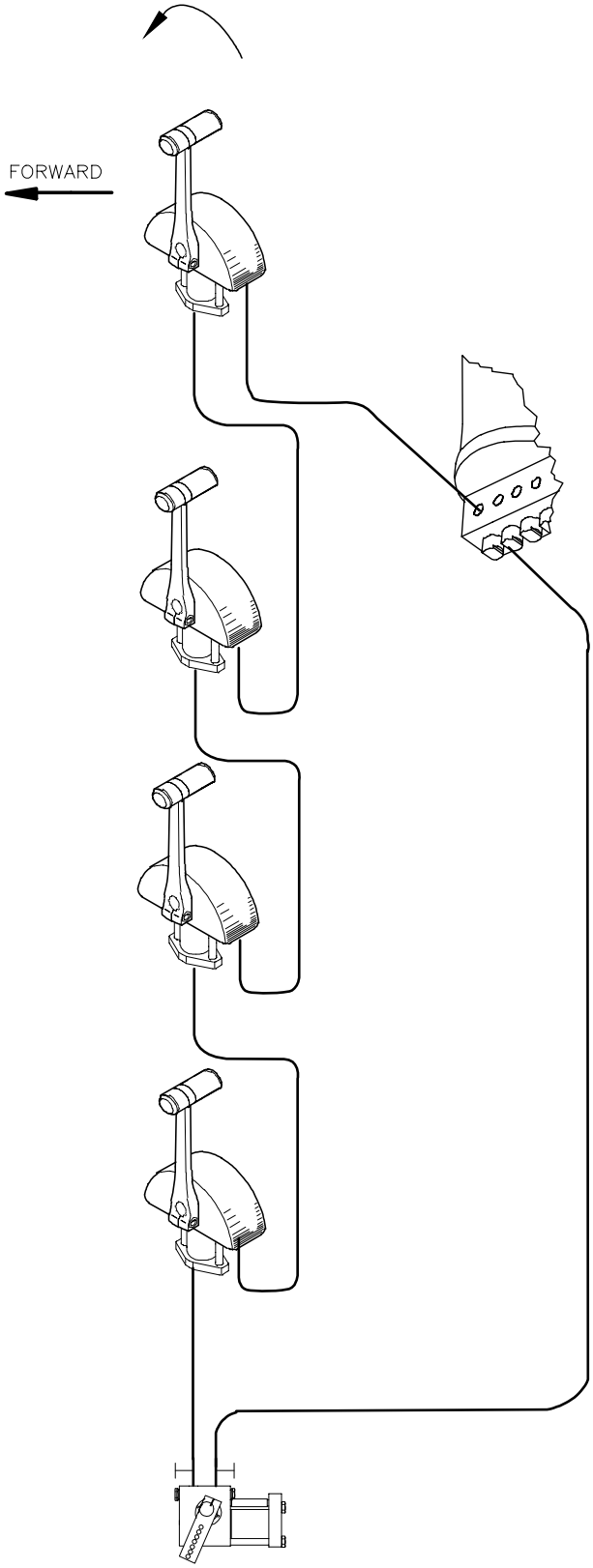
Plan III-S

Three Station, Counterclockwise Throttle Advance



Plan IV-S

Four Station, Counterclockwise Throttle Advance



Troubleshooting

Problem	Cause	Solution
Spongy Controls (Entire System)	Air in System	1. Check reservoir and verify that there is fluid and pressure is 80 psi. 2. Inspect for fluid leaks at all connections. 3. Check for air leaks in the reservoir (use soapy water solution) 4. Bleed entire system. 5. Synchronize controls on one clutch or throttle system.
Spongy Controls on one clutch or throttle system.	Air in that singular system.	1. Check reservoir, verify that there is fluid and pressure is 80 psi. 2. Inspect for fluid leaks at all connections of the s ystem in question. 3. Bleed system in question. 4. Synchronize controls.
Sender arm wants to stop at its mid-stroke.	Controls out of synchronization.	Synchronize controls.
FuII throttle on the sender will not achieve maximum throttle RPM on Engine	1. Throttle linkage length out of adjustment. 2. Engine out of tune.	1. Re-adjust length of the throttle linkage. 2. Service Engine
Full idIe on sender will not achieve idle RPM on engine	1. Throttle linkage length out of adjustment. 2. Engine governor out of adjustment 3. Engine out of tune.	1. Re-adjust length of the throttle linkage. 2. Service Engine
Engine Throttle tends to creep toward idle	Pilot check valve malfunctioning.	1. Remove pressure from system. 2. Re-pressurize the system. 3. Re-purge the system of air.
	Slave's internal piston seals or synchronizing valves leaking due to wear or debris.	1. Remove pressure from system. 2. Rebuild or replace throttle slave. 3. Re-pressurize the system. 4. Re-purge the system of air.
Full Throttle on sender gives idle on engine.	System tubing connected backward.	1. Remove pressure from the system. 2. Reverse tubing at the throttle slave. 3. Pressurize system. 4. Synchronize throttle control.
After a long running period the Throttle tends to go out of synchronization.	Slave is located at an engine hot spot which has caused excessive heating of the throttle slave, which in turn has caused the slave to develop a vapor lock.	Several Suggested Remedies: 1. The use of heat resistant gasket material (approximately 1/8' Thick) between the mounting bracket and engine. 2. Spaces between the bracket and engine, and slave and bracket. 3. Shielding around the throttle slave. 4. Re-mounting of the throttle slave in a less hot area.
	Contamination in pilot check valve keeping it from functioning properly.	1. Remove pressure from system. 2. Re-pressurize the system. 3. Re-purge system of air.
	If twin engines are equipped with synchronizer, governor or synchronizer's tension springs are out of adjustment.	1. Re-adjust springs proper tension. NOTE: excessive tension in either throttle extremes will cause synchronization problems.

Troubleshooting (Continued)

Problem	Cause	Solution
Loss of system pressure but not loss of fluid	Air leak in reservoir.	While pressure is on system, use a soapy water solution to find an air leak on the tank. When leak is found remove pressure and repair, re-pressurize system to 80 psi.
NOTE System pressure will vary as much as +10 psi due to temperature changes. When system pressure drops below 70 psi a leak should be checked for.		
Loss of pressure and fluid on system.	System leak.	1. With pressure on system check for fluid leaks at all connections. 2. When found repair leak. If a tubing connection is leaking remove and replace 0-ring (if leak persists see section of trouble shooting which concerns leaks at fittings for further repair procedures). 3. Pressurize system, bleed system, filling as required. 4. Synchronize controls.
Sender arm moved at one station results in the wrong arm movement at the other station (s).	Improper reversed tubing connections.	1. Recheck tubing connections made against tubing diagram used. 2. Remove pressure from the system. 3. Reconnect tubing as required. 4. Re-pressurize and bleed system. 5. Synchronize controls.
Sender arm moved at one station results in another arm moving at the same station.	Tubing runs improperly connected. Prime area for improper connection would be at the charging valve.	1. Compare tubing connections made with tubing diagram used (check area of charging valve). 2. Remove pressure from system. 3. Reconnect tubing as required. 4. Pressurize system, bleed system. 5. Synchronize controls.
Crimp or kink in tubing.	Numerous.	1. Cut out kinked or crimped portion of line. 2. Splice line together using tube connectors and union.
Leak at a fitting.	Bad 0-Ring	Remove fitting, replace 0-Ring, replace fitting, Pressurize system, and check for leakage. If Leakage continues replace entire tubing connector and adapter as required.
Throttle System seems locked up after initial installation	Slipped sender handle	1. Re-establish sender's handle position, if required, to allow full 115 degree travel.
Forward or reverse on clutch sender will not obtain a full forward or reverse on transmission	Clutch save to transmission linkage out of adjustment	Re-adjust linkage length.
Forward on clutch sender gives reverse on engine	Tubing incorrectly connected	1. Remove pressure from system. 2. Reverse tubing at the clutch slave. 3. Pressurize and bleed system. 4. Synchronize clutch controls.

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