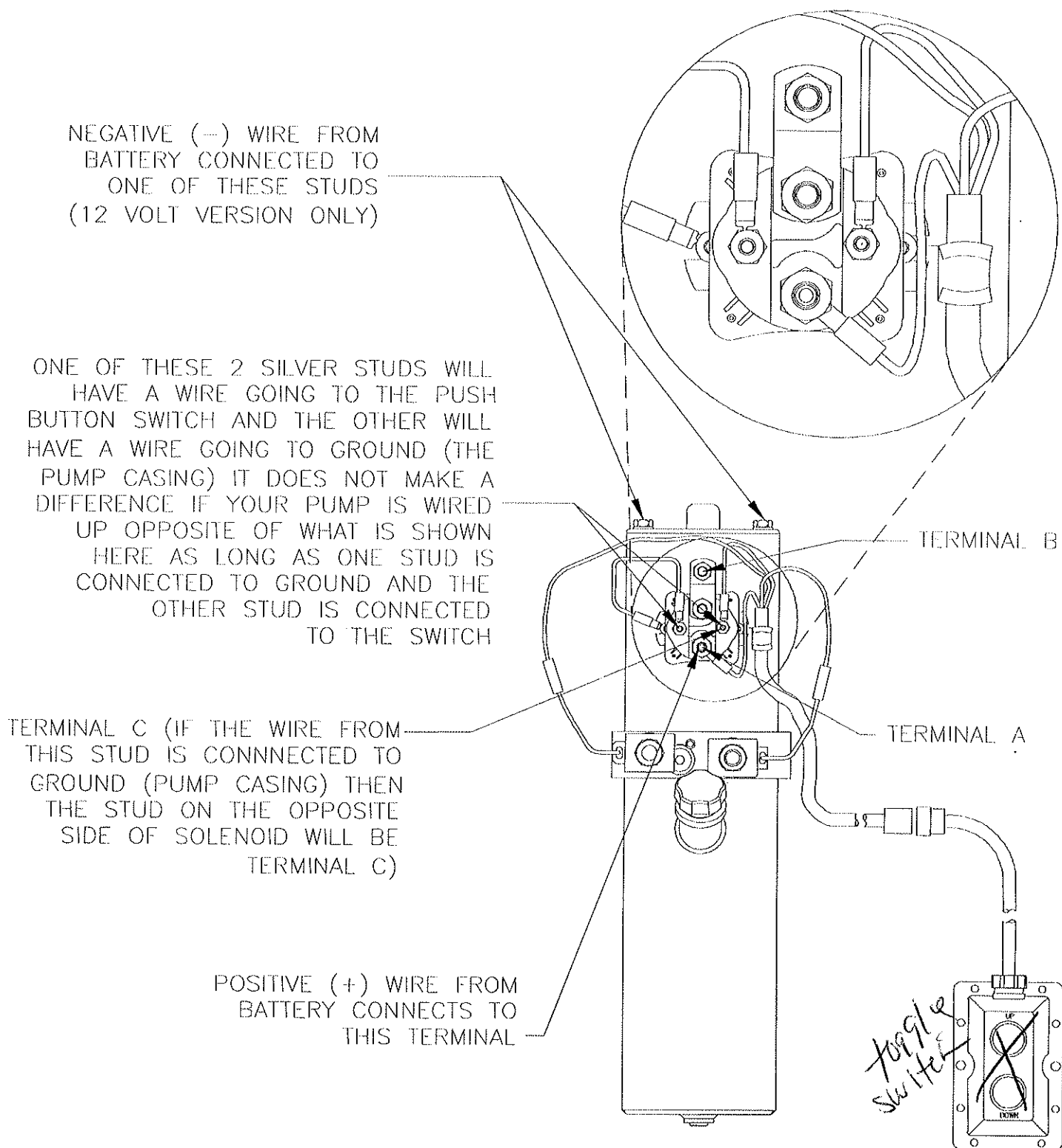


CAUTION: ALWAYS REMOVE POSITIVE WIRE (BLACK WITH RED STRIPE) FROM BATTERY PRIOR TO MOVING WIRES ON SOLENOID.

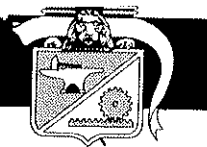
1. Make sure that your truck's battery kill switch is not engaged.
2. Make sure your Hy-Tower cutout switch is in the "on" position.
3. Make sure the electrical wires to the hydraulic pump are properly connected to the truck's battery, and the terminals are not corroded.
4. After doing these initial checks try to start the unit. If the unit still does not run continue with the following troubleshooting procedure.
5. Using a voltage meter, test the power going to the pump to verify that you have 12 volts being supplied to the pump (measure from terminal A to terminal B). Do this test while pushing one of the two buttons to start the pump, then while pushing the other button, and finally check voltage when no buttons are being pushed. If you do not have twelve volts being supplied to the pump for all three tests, then you have a problem with your wiring or your battery. If the voltage drops when pushing the buttons, then you have a bad battery or a loose wire. Continue on only if you have twelve volts and your pump still does not start.
6. Disconnect positive lead (black wire with red stripe) for the HY-TOWER pump from the battery.
7. Disconnect positive lead (black wire with red stripe) from terminal A and attach it to terminal B (see drawing above).
8. Connect positive lead back up to battery. If pump starts running then you know that the pump is working properly. You now have isolated the problem to the solenoid or the electrical wiring. (If the pump does not run, then you have a bad pump that needs to be replaced. Contact Donovan Enterprises at **1-800-327-8287** to make arrangements for another hydraulic pump.)
9. If your pump started running in step 8, then the next step is to disconnect the positive lead from the battery.
10. Remove the positive lead from terminal B (you connected it to this terminal in step 7) and connect it to terminal C.
11. Connect positive lead back up to battery. If pump starts running then you know that the pump and solenoid are both working properly. This means that you have a problem with the wiring. Check all the connections at the battery and the pump. Also verify that wire between the battery and the pump is in good condition.
12. Reconnect the pump to the battery as indicated on page one.

DONOVAN 12 VOLT HY-TOWER/SIDEWINDER PUMP TROUBLE SHOOTING GUIDE



Verify that the pump is wired up as shown above. If your pump is not wired up correctly it will not work properly, and it will be difficult to continue with the troubleshooting procedure.

Maintenance and Troubleshooting Guide for Monarch D.C. Hydraulic Power Units



WARNING

- Always wear eye protection and protective clothing when working around hydraulic systems.
- Remove jewelry and objects that might conduct electricity while working on power units.
- Fluid under pressure can pierce the skin and enter the bloodstream causing death or serious injury.
- Devices being operated by the hydraulic system should be securely propped or immobilized so they cannot move and cause injury while being inspected or repaired.
- Fluids should be contained and disposed of properly.

NOTE: Do not use Teflon tape on hydraulic fittings as it can easily jam valves and plug the filters in the system.

TEST EQUIPMENT

The following is a list of the test equipment required to troubleshoot D.C. powered hydraulic systems.

1. PRESSURE GAUGE

A small 0-5000 Pressure gauge, preferable glycerin filled, is a very valuable and relatively inexpensive tool for checking pressure in the various sections of the circuit.

2. D.C. TEST LIGHT

A test light is simply a light bulb which has one end connected by a wire to an alligator clip and the other end connected to a metal probe. It is used to check the electrical circuit when the battery is connected to the system. The alligator clip is grounded and the light glows when the probe comes in contact with a "HOT" electrical component. They are easily obtained from automotive jobbers or discount stores.

3. CONTINUITY LIGHT

A continuity light is like a test light but contains its own battery power source. It is used for testing electrical circuits when the components are not connected to a battery. They are easily obtained from discount stores or electrical jobbers at modest cost.

4. VOLT METER

A D.C. volt meter, as used in the automotive repair business, is a good investment for troubleshooting problems that are related to low voltage. They are used

in two ways: first, one probe is grounded while the other is used to probe the "HOT" leads, the meter shows the voltage available at the point where the second probe is connected; second, they can be used to measure a voltage drop in a wire, one probe is connected to one end and the remaining to the other end, the reading is the voltage drop.

5. OHM METER

An ohm meter is used to measure resistance and is a very useful tool when working on wire circuits and solenoid coils. On some coils the wire resistance is up to a level where a D.C. test light might show an open circuit and it really is not so. An infinite meter reading on any test shows that the circuit is open. A coil test, however, will always show some value of resistance but it must not be infinite. All tests conducted with an ohm meter must be done with the battery disconnected from the system.

6. ASSORTED HOSES, HIGH PRESSURE FITTINGS

These can be used to connect and/or isolate certain parts of a hydraulic circuit to a pressure gauge or a shutoff valve for diagnosing hydraulic problems. 1/4" NPT and 3/8" NPT are the most commonly used sizes.

7. HIGH PRESSURE SHUTOFF VALVE

The shutoff valve can be used to choke off oil flow so that a "false" load can be put on the pump and other components. With the valve installed it can be slowly shut off while the equipment listed above records the data for making a proper diagnosis.

HYDRAULIC FLUID

1. THE PURPOSE OF OIL

The main purpose of hydraulic fluid is to transfer power from the pump to the actuators but it must also perform many other tasks which are critical to a well designed system. First, the oil must have good lubricity or be "slippery" so that the friction will be as low as possible to keep metal to metal wearing at a minimum. Second, the viscosity or "thickness" must be in the proper range at the operating temperature so that unwanted leakage will be at a minimum, but will still allow the oil to lubricate the close fitting parts in the system. (Oil that is too thin will leak past seals, valve spools, and the gears; Oil that is too thick will not flow properly and cause the pump to cavitate or starve.) Third, the oil must be compatible with the seals used in the system. Fourth, there should also be additives in the oil to slow down the effects of rust, oxidation (oxygen in the air combining with the oil to form sludge) foaming, and water

settling to the bottom of the reservoir. Fifth, the oil must be able to pour or flow at the lowest expected temperature so that the oil can reach or get into the pump. Sixth, the oil should contain EP (extreme pressure) additives to prevent breaking down the fluid.

For all the reasons just listed, automatic transmission fluid (ATF) was found, in most cases, to be the best fluid readily available in most climate conditions.

2. SELECTING FLUIDS FOR APPLICATIONS OUTSIDE OF ATF'S TEMPERATURE RANGE

When looking for fluids that can be used in the place of automatic transmission fluid, or for applications where the operating temperature is outside of the range of automatic transmission fluid, the following specifications should be discussed with your local oil distributor:

- A. Fluid must be compatible with Buna-N sealing compounds.
- B. The pour point must be below the lowest anticipated temperature that will be encountered.
- C. It should contain Rust and Oxidation as well as other detergent type inhibitors.
- D. The Viscosity (SUS) should lie between 80 as a minimum and 375 as a maximum in the operating range, with ideal viscosity near 200 SUS.
- E. The viscosity index should be as high as possible. As an example, automatic transmission fluid (ATF) has the following specifications as listed by most oil manufacturers:

A. Viscosity (SUS)	
100°F.	185 to 205
210°F.	45 to 55
B. Pour Point	-45°F. to -35°F.
C. Viscosity Index	145 to 165

NOTE: In an emergency for cold weather applications SAE 10W oil mixed by volume with no more than 30% #1 fuel oil or kerosene can be used. (It must be removed when the weather warms).

PUMP PRIMING

1. NEW INSTALLATIONS

New system installations, as well as those that are disassembled for repair, require proper priming to avoid possible pump failure. A pump is said to be "primed" when the internal cavity is full of oil and the air has been expelled. Prime a pump as follows:

- A. "Crack" or remove the high pressure line at or near the cylinder.

B. "Jog" the unit until oil flow is clear (Air is absent).

C. Retighten or replace hose.

2. ON SYSTEMS THAT FAIL TO PRIME OR LOSE THEIR PRIME, CHECK FOR THE FOLLOWING:

- A. Correct unit mounting position. Failure to mount the pump in the proper manner could mean that the pump cannot prime (pickup oil) because the suction tube is not submerged in the oil at all times.
- B. Partially clogged suction filter. (See Filter Section.)
- C. A loose or improperly installed suction hose or pickup tube.
- D. A bad front pump seal. (On systems with the seal cavity connected to suction.)
- E. A solid fill plug in reservoir with no vent. (See Reservoir Section.)
- F. Oil that is too thick - reference Hydraulic Fluid Section.
- G. Occasionally, a pump will not prime itself because a check valve spring in the high pressure port is too "Stiff" or the spring retainer is turned down too far. If this condition is expected, loosen the spring retainer (it is found in the high pressure outlet port), energize the pump to prime it, and then turn the retainer back to the correct depth. (See section on check valves.)

RESERVOIRS

1. USE RECOMMENDED FLUID

Fill reservoir with the approved fluid and refer to the Hydraulic Fluid Section.

2. CORRECT FILLING AND OPERATING PROCEDURE

- A. Operate unit several times starting with short cylinder strokes and increasing length with each successive stroke.
- B. Recheck oil level often and add as necessary to keep pump from picking up air.
- C. After system is completely "bled" check oil level in reservoir as described in owner's manual and install the filler/breather plug provided.



NOTE: Do not use a solid plug or a fill cap without a filler/breather element or damage will be caused to pump and/or reservoir.

3. PROBLEMS ASSOCIATED WITH THE RESERVOIR

- A. Clear oil flowing out of the fill hole might indicate that the cylinder(s) rod was not in it's retracted position when the reservoir was filled.
- B. Foamy oil flowing out of the fill hole points to the following:
 - 1. Air is present in the system; that is, cylinders and fluid lines. The response usually is "spongy" and the cylinder moves with "jerking" motion.
 - 2. There is no drop tube or "down spout" on the return line so that the oil is not returning to the bottom of the reservoir.
 - 3. Check for a loose suction tube.
 - 4. The return oil velocity is excessive; to correct; add a flow control valve to slow velocity, increase size of "down spout," add a diffuser, or use a larger reservoir to increase depth of oil above the end of the return tube.
 - 5. Damage to pump seal. (On systems with the seal cavity connected to suction.)
- C. Water in the oil.

Water can enter the reservoir through the fill hole if the unit is left outdoors or washed with high pressure washers. Protect the unit, whenever possible, and change oil regularly to minimize problems. In cold weather the water will freeze and the pump will not work until the ice melts.

4. TIPS AND COMMENTS

- A. In most cases the power unit is made to be mounted either vertically or horizontally and improper mounting will not allow the reservoir to be filled to capacity. (See Pump Priming Section)
- B. On units with a remote reservoir try to mount it above the pump whenever possible to "flood" the inlet.
- C. One of the functions of the reservoir is to keep the oil in the proper temperature range. If the reservoir cannot dissipate enough heat increase the size in order to bring the oil temperature down to the proper level. (See Hy-

draulic Fluid Section).

- D. Whenever reinstalling plastic reservoirs make sure that the hose clamp is torqued to 57 inch pounds.

FILTERS

1. SUCTION FILTERS

Most Monarch hydraulic controls have suction filters which must be cleaned periodically or whenever flow is slow or sluggish. Some filters can be washed in cleaning solvent and blown dry with compressed air; those which cannot be cleaned properly should be replaced. External high pressure filters may be added to the system for added protection and ease of cleaning.

2. ADDITIONAL SYSTEM FILTERS

- A. MODELS M-303, M-503, M-603, M-723, M-3593

These specific models have filters in addition to the pump suction filter for protecting the valve. One is located inside the two piece hex fitting just ahead of the DR (2-way, 2-position) cartridge lowering valve inside the reservoir. It can be taken apart for cleaning or replacing the filter element.

- B. Models in M-640 Series

These models also are equipped with additional filters for protecting the solenoid valves. First; each port, C¹, and C², on the flat surface have a cone shaped filter in the valve body. They can be reached as follows:

- 1. If the ports, C¹ and C², on the flat surface are not being used, remove the flush 1/4" pipe plugs.
- 2. If the ports, C¹ and C² on the flat surface are being used; remove the hoses.
- 3. Reach down into these ports with a 1/4" allen key and remove the filter retainer screws.
- 4. Remove the filters and clean or replace as necessary.
- 5. Reassemble in reverse order.

NOTE: Each cartridge has a "body" filter to provide additional protection from dirt. To clean or replace these filters the valve body must be removed from the reservoir and the cartridge removed from the body. Clean with solvent and compressed air or replace as required.

C. Models in M-670, M-680, and M-690 Series

Like the M-640 series these models also have port and cartridge filters. The port filters are located just below the surface in each outlet (C1, C2, C3). To clean or replace proceed as follows:

1. Remove the hoses from the valve body.
2. Remove the filter retainer screws with a 1/4" allen key.
3. Remove and clean or replace filters as required.
4. Reassemble in reverse order.

The cartridge "body" filters are removed and repaired in the same manner as described in the M-640 Models above.

- D. Most cartridge solenoid valves also have "body" filters located on the cartridge of the valve. Some can be replaced, others can only be cleaned.

NOTE: Do not use Teflon tape on hydraulic fittings as it can easily jam valves and plug the filters in the system.

the minimum required voltage could cause system failure. Refer to Battery Cable Guide.

A. Signals which point to low voltages are:

1. The minimum voltage between the motor stud and ground is 9.0 volts at maximum load conditions.
2. The minimum voltage between the valve solenoid power wire ("hot wire") and ground is 9-1/2 volts at maximum load conditions.

C. Causes for low voltage are:

1. Battery capacity too small.
2. Cable ends not electrically secure to battery cable.
3. Battery cable size too small for load and length of run. See Battery Cable Guide below. Larger copper battery cable, #1, #0, or #00, may be required for cable lengths over 25 feet to keep performance from deteriorating.
4. Ground cable size not equivalent or larger than the battery "hotside" cable.
5. Bad joints where cable ends are bolted to battery, motor solenoid, start switch, ground and etc.
6. Burnt contacts on motor solenoid or start switch.

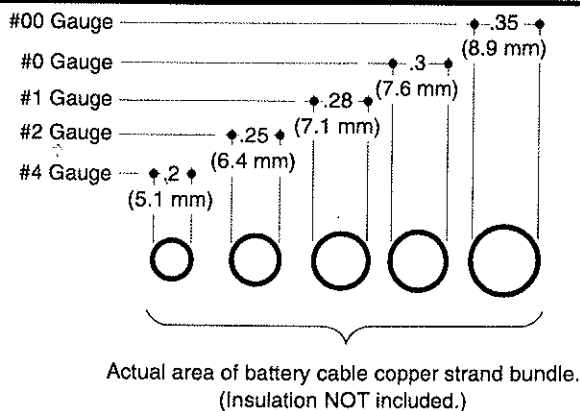
ELECTRICAL PROBLEMS

1. LOW VOLTAGE

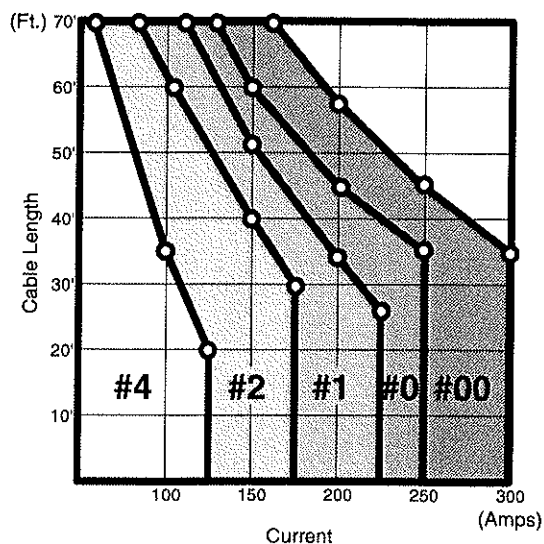
Operating direct current (D.C.) power units efficiently requires proper voltage. Any attempt to operate below



PLEASE REMOVE ALL RINGS, WATCHES AND JEWELRY PRIOR TO DOING ANY ELECTRICAL



Battery Cable Guide





- D. Check for low voltage as follows: (A volt meter will be required).
1. On vehicles equipped with an alternator the voltage should be approximately 13.5 volts with no electrical accessories operating and the engine running - Check it.
 2. Operate pump unit under maximum conditions; this would be either under full load or when pump is running over relief (cylinder dead headed). Use the volt meter to probe each connection, cable end, and cable from the battery all the way back to the motor stud and note the voltage losses. Make the necessary repairs. Increase the voltage above the minimum required.

NOTE: Check the ground side as well. Paint, rust, and dirt are insulators - remove them.

2. D.C. MOTORS (Wound Field)

Motors should be serviced periodically to insure proper performance.

Service as follows:

- A. Remove head assembly from motor.
- B. Check sleeve bearing in head assembly for wear.
- C. Place a few drops of oil on felt liner in head assembly.
- D. Check brush set for wear and replace if necessary.
- E. Blow dirt and dust out of motor housing and check for shorts, burnt wires, or open circuits in the field coil assembly.
- F. Check armature and commutator for shorts or open circuits.
- G. Check ball bearing on motor shaft, a growling motor can be caused by bad bearings.
- H. Check for excessive "end play" of armature and add thrust washers as required. (On motors designed with a ball bearing on commutator end make sure the wavy washer is behind the bearing to thrust it toward the pump.)

NOTE: A motor that does not turn in freezing weather could be caused by water that has frozen inside the housing.

- I. All D.C. motors turn counterclockwise when

viewed from the drive end - check it when replacing a motor with a new one.

- J. If motor fails to turn the pump, check the pump, by turning the drive shaft by hand - it may be "setup" and the pump needs replacing. Shaft rotates clockwise.

3. D.C. MOTORS (Permanent Magnet)

Permanent magnet motors are similar to wound field motors except the field coils are replaced with permanent magnets. If the brush holder is mounted to the head assembly, it must be aligned with timing marks to the motor shell. If you cannot find the marks, make your own before you loosen the bolts. Repair similar to wound field motor above with exception of the field coils.

Note: Permanent magnet motors must be handled with care. Timing marks must be properly aligned for maximum performance and efficiency. PM motors have powerful magnets which will attract ferrous materials. Magnets must be kept clean before inserting the armature. Keep fingers away from the area between the armature and the motor case when re-installing the armature in order to avoid injury.



THE MAGNETS WILL PULL THE ARMATURE INTO THE MOTOR UPON REINSERTION.

A wiring diagram guide for D.C. power units is also available. Request form #2347-99.

4. ELECTRICAL SWITCHES

- A. Push Button, Toggle and Rocker Types.

Defective switches are a common cause of electrical malfunction. What seems to be a serious system defect can often be caused simply by a faulty switch, especially where the switch controls two functions, that is: start the motor, and shift a valve. In those cases one half of the switch might be defective while the other half operates correctly and the fault appears to be with some other component.

Troubleshooting can be done by any one of three methods:

1. Use a "continuity light" to test switch. (See Test Equipment).
2. Use a circuit "test light" to test switch. (See Test Equipment).
3. Remove the wires from the switch and "touch" them together in the proper order to operate system.

Note: All switch control stations subjected to the weather should be mounted so that the cord exits the bottom to prevent water from entering the box.

B. "Contact finger" switches (Manual Valves).

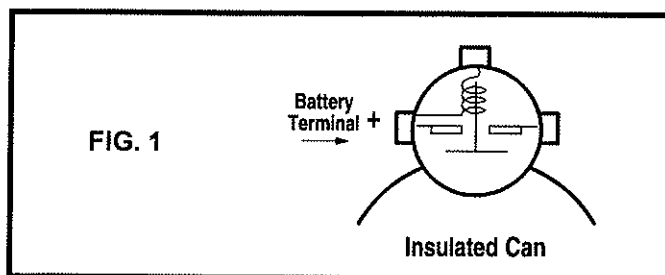
All models that use a contact finger(s) attached to the handle or shaft of a manual valve to start the D.C. motor do so by grounding the small post of a solenoid start switch. When repairing systems with contact fingers check for the following:

1. Improperly aligned or broken contact finger.
2. Nub nut assembly that is not insulated from ground.
3. Wires that are bare or shorted to ground.

C. Motor Start Solenoid Switches.

Although there are exceptions most solenoid switches found on Monarch systems are one of the following three types:

1. 3 Post Solenoid Switch (Fig 1.) (Insulated Can)



- a. The three post solenoid switch is wired and constructed as follows:
 - (1.) The large post marked "Bat" must be attached to the cable leading from the battery.
 - (2.) The small post connects to the control circuit. (Contact finger, push button, toggle switch, etc.)
 - (3.) The remaining large post attaches to the cable leading from the motor.

Note: Do not attach motor cable to post marked "Bat" as solenoid will not operate properly.

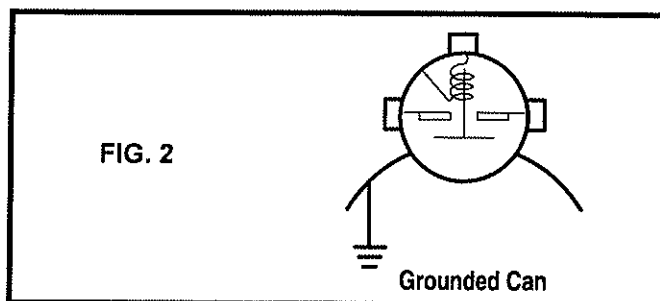
- (4.) Internally, the coil is constructed with one end connected to the post marked "Bat" and the other end to the small center-post. With the battery cable connected to the post marked "Bat", the solenoid switch is energized by grounding the small post; which in turn closes the main contacts and starts the motor.

b. Testing for a faulty solenoid switch:

When testing use an OHM meter, continuity light, or test light, and check all functions as described above. (See Test Equipment Section).

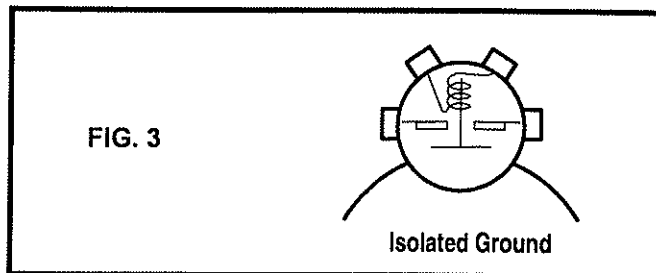
2. 3 Post Solenoid Switch (Fig 2.) (Ground to Can)

a. The three post solenoid switch is wired and constructed as follows:



- (1.) One large post must be attached to the cable leading from the battery.
- (2.) The small post connects to the control circuit. (Push button, rocker switch or toggle, etc.)
- (3.) The shared "hot" lead from the control circuit must also be attached to the large post from the battery.
- (4.) The remaining large post attaches to the cable leading from the motor.

3. 4 Post Solenoid Switch (Fig 3.) (Isolated Ground)





- a. The four post solenoid switch is wired and constructed as follows:
 - (1.) One large switch post is connected to the battery cable (either one).
 - (2.) The remaining large post is connected to the motor cable.
 - (3.) The 2 small posts are connected to the coil, one post to each end.
 - (4.) With access to both ends of the coil, the specific wiring arrangements can be varied, but to energize the coil one lead has to be positive and the other end negative.
- b. Testing for a faulty solenoid switch:

When testing use an OHM meter, continuity light, or test light, and check all functions as described above. (See Test Equipment Section).

5. SHORTS, "GROUNDING FAULTS" AND "OPEN" CIRCUITS

In control wiring, shorts can only occur when "hot" lines (lines connected directly to the battery) come in contact with ground. A short will either cause a fuse to blow, if there is one, or burn the wire off at its weakest point. Likely spots for shorts are switches, electrical strain relief, electrical junction boxes, and control cord(s) that have been pinched or cut.

6. SOLENOID COILS

Coils are used in solenoid operated valves and solenoid start switches. Failures can be caused by vibration, water, improper voltage, or corrosion. The best way to test a coil is with an OHM meter. The meter should read some value of OHMS and an infinite reading means that the coil has an open circuit. The reading between any lead on the coil and the "can" should be infinite unless there is

only one lead wire and the coil is grounded to the can.

7. ELECTRICAL POLARITY

Motors and valves supplied by Monarch can be used on either positive or negative ground systems with the exception of the model M-310 or any system using the round (cylindrical shaped) manual valve with a covered switch on the back plate. In these units there is a capacitor connected on the switch which must be "polarized." They are normally wired for negative ground systems and if used on a positive ground system the capacitor must be turned end for end as the + sign must face the most positive side of the circuit. Failure to align properly will cause the lead wire to "blow" off the capacitor, which in turn could make a "ground fault" and cause the motor to run with no control.

NOTE: Do not use teflon tape on hydraulic fittings as it can easily jam valves and plug the filters in the system.

RELIEF VALVES

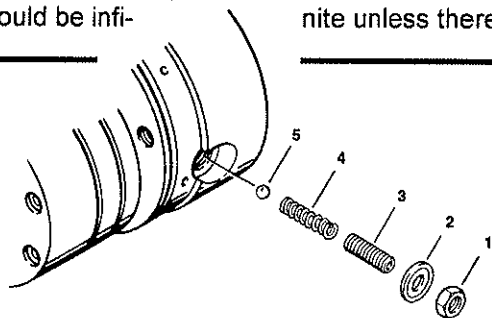
1. THE PURPOSE OF A RELIEF VALVE IS TO:

- A. Keep the maximum system pressure at a safe level.
- B. Keep the amp draw and battery drain at a minimum when the cylinder "dead heads" (reaches full stroke).

2. THE TWO STYLES OF RELIEF VALVES USED BY MONARCH ARE:

A. Loose Component Style

1. Internal Cavity with Loose Components. (See Fig. 4 & 5).

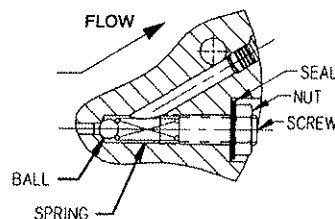


1. LOOSEN JAM NUT. (1)
2. TURN SCREW CLOCKWISE TO INCREASE PRESSURE. (3)
3. TURN SCREW COUNTER-CLOCKWISE TO DECREASE PRESSURE. (3)

NOTE:

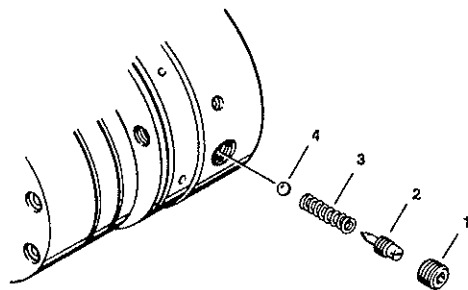
OUTLET PORT FLOW MUST BE BLOCKED TO MAKE RELIEF VALVE OPERATE WHILE ADJUSTING.

4. TIGHTEN JAM NUT. (1)



RELIEF (STD.)

FIG. 4

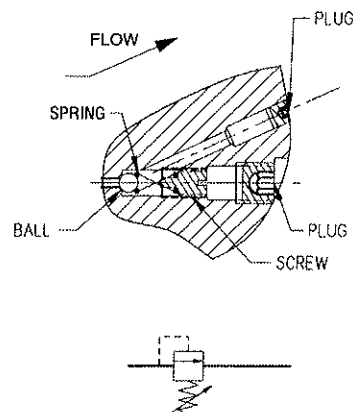


1. REMOVE FLUSH PLUG. (1)
2. TURN SCREW CLOCKWISE TO INCREASE PRESSURE. (2)
3. TURN SCREW COUNTER-CLOCKWISE TO DECREASE PRESSURE. (2)

NOTE:

OUTLET PORT FLOW MUST BE BLOCKED TO MAKE RELIEF VALVE OPERATE WHILE ADJUSTING.

4. REINSTALL FLUSH PLUG. (1)



OLD STYLE RELIEF

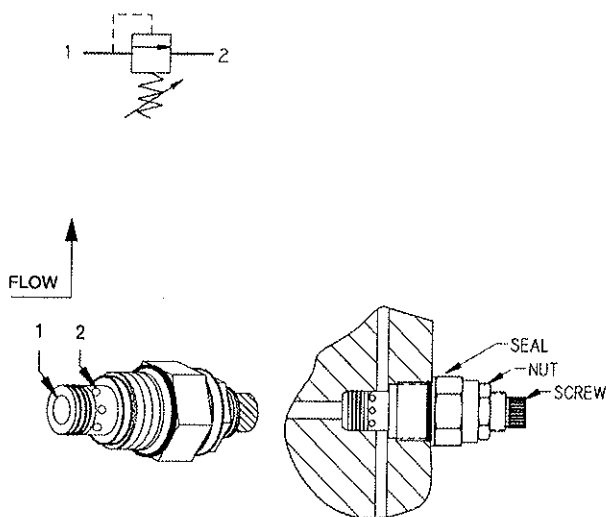
FIG. 5

An "internal" cavity is drilled into the pump base into which the following parts are inserted to make up the relief valve assembly.

- a. Ball or cone, heavy spring, and in some cases a jam nut and seal washer.

B. Cartridge Style. (See Fig.6)

A complete cartridge is assembled into an integral cavity.



CARTRIDGE RELIEF VALVE

FIG. 6

3. DIAGNOSING AND REPAIRING RELIEF VALVES

NOTE: When testing or making adjustments on the relief valve the system must be "dead headed" (cylinder at full stroke or in a position where cylinder movement is zero).

A. Relief Valve Pressure Too High

1. Symptoms:
 - a. Amp draw and battery drain excessive when system is "dead headed".
 - b. Motor RPM is slow in comparison to full load system operation.
2. Repair Procedure:
 - a. Turn relief valve adjusting screw counterclockwise using a gauge, tee'd into the high pressure line, to record the proper pressure setting. (See Fig. 4 & 5). In style shown in Fig 4 loosen jam nut. In style shown in Fig 5 remove flush plug.

B. Relief Valve Pressure Too Low

1. Symptoms:
 - a. Motor RPM is faster than normal.
 - b. Cylinder will not extend.
 - c. Excessive turbulence in the reservoir.

Note: On applications where the cylinder is being replaced or the mechanical mechanism is being modified, make sure the pressure capability of the pump is not being exceeded.



2. Repair Procedure.

- a. There are 2 possible causes for lack of pressure.
 - (1) The adjusting screw has backed up.
 - (2) Foreign matter or "dirt" is trapped between the seat and the ball or cone.
- b. Repair as follows:
 - (1) Using a gauge, tee'd into the pressure line, loosen the jam nut and turn the adjusting screw clockwise a turn or two and watch the gauge; if it goes up, continue to turn the screw until the required setting is reached. Retighten the jam nut. In the "Old Style" relief, if the screw does not remain in the correct position use one with a patch. (In an emergency the screw threads can be deformed slightly with a small prick punch and hammer).

- (2) If the pressure does not increase when the adjusting screw is tightened; turn the adjusting screw counterclockwise all the way out; energize the pump to "flush" the dirt past the seat.



WARNING

- Always wear eye protection and protective clothing when working around hydraulic systems.
- Remove jewelry and objects that might conduct electricity while working on power units.
- Fluid under pressure can pierce the skin and enter the bloodstream causing death or serious injury.
- Devices being operated by the hydraulic system should be securely propped or immobilized so they cannot move and cause injury while being inspected or repaired.
- Fluids should be contained and disposed of properly.

Inspect the cone or ball for nicks and replace it if necessary; reseal the ball or cone using a small drift punch and hammer with a light tap; reinstall the spring and adjusting screw and reset the pressure.

- (3) If you are replacing a cartridge relief valve it cannot be readily disassembled. Push a blunt object into the nose area to push the poppet after you have the screw backed off as far out as possible. Blow compressed air thru side port to try and get dirt to "exit" the way it "entered". Pick it out if possible. If you cannot dislodge the contamination you will need to replace the cartridge.

Note: In an emergency if, a pressure gauge is not available, turn the relief valve screw in until the cylinder moves under worst conditions and then tighten 1/2 to 3/4 additional turns.

- (4) If the above mentioned procedure fails to increase the relief valve setting, check for a worn pump or leaking cylinder.

Note: Do not use teflon tape on hydraulic fittings as it can easily jam valves and plug the filters in the system.

CHECK VALVES

1. PURPOSE OF A CHECK VALVE

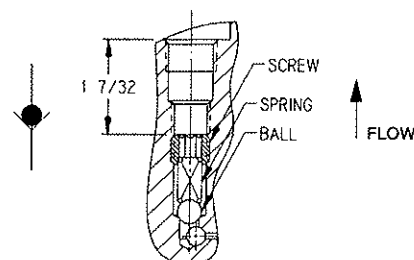
To allow free flow in one direction but block reverse flow.

2. THREE TYPES OF CHECK VALVES ARE USED

A. Ball Type

A Ball Type Check Valve is made up of the following: (See Fig. 7)

- Ball
- Light Spring
- Spring Retainer



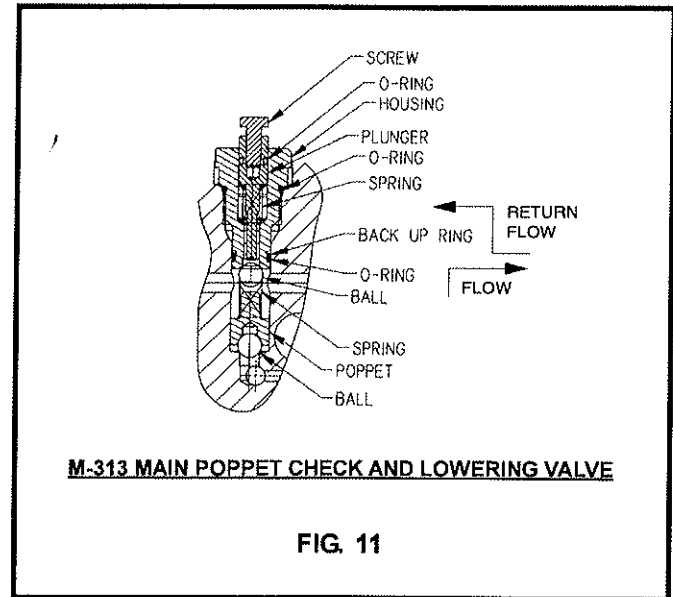
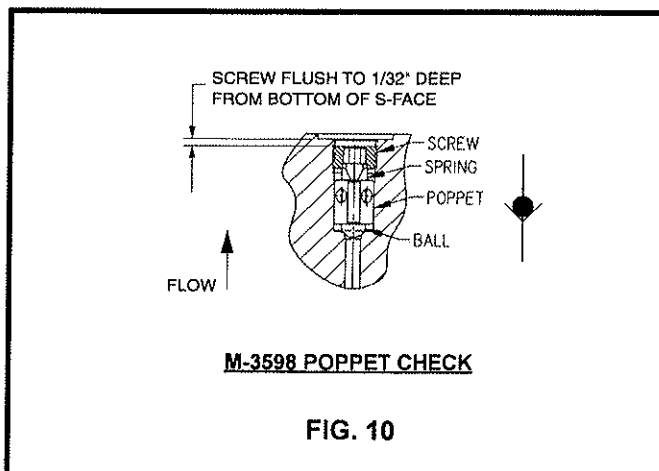
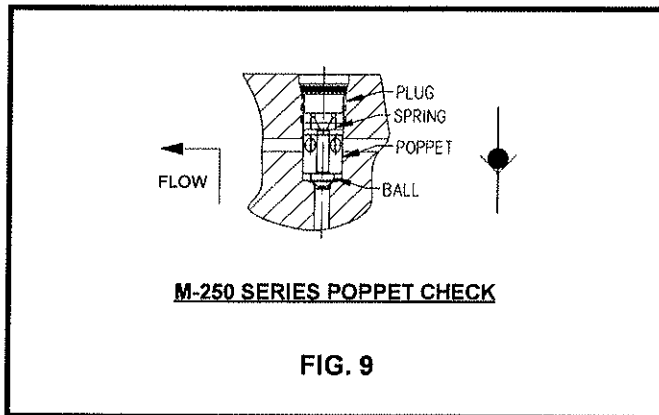
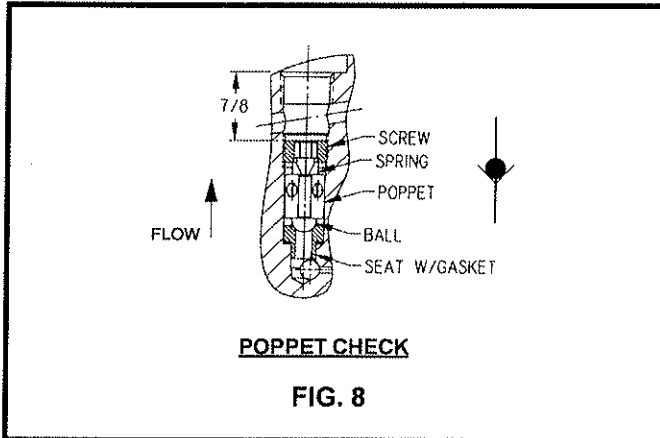
BALL CHECK

FIG. 7

B. Poppet Type

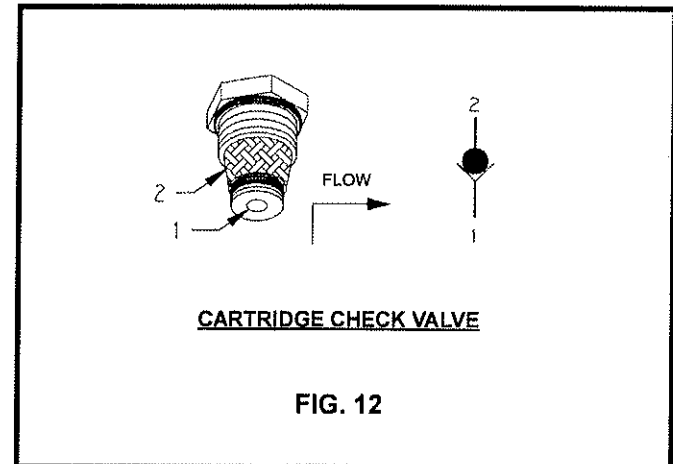
A Poppet Type check valve is made up of the following: (See Fig. 8, 9, 10 & 11)

- Ball
- Ball Follower
- Light Spring
- Spring Retainer



C. Cartridge Type

A Cartridge Type Check Valve is made up of a ball or poppet in a completely contained cartridge. (See Fig 12).



3. TROUBLESHOOTING AND REPAIRING CHECK VALVE FAILURES

A. Load Drift Failure

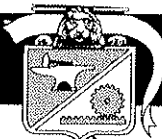
1. Symptom

In most cases a check valve will fail such that the load will drift down when the unit is in the "hold" position.

2. Repair Procedures (Loose Parts Design)

- Remove the spring retainer.

NOTE: Measure the depth of the retainer so it can be reassembled to the same depth after repair.



- b. Remove spring.
 - c. Remove ball or follower and ball.
 - d. Start pump to "flush" dirt from the seat area. (Caution: divert oil into a container. Do not look into the port).
 - e. Inspect the ball for damage and replace if necessary.
 - f. Reinstall ball or ball and follower.
 - g. "Seat" the ball using a small drift punch and hammer with a light tap.
 - h. Reinstall the spring.
 - i. Replace the spring retainer to the correct depth.
3. Repair Procedure (Cartridge)
 - a. Remove cartridge and clean or replace (See Specialty Valve Section A)
- B. Blocked Flow Failure
1. Symptom

Once in a while a ball type check valve will restrict flow to the point where the spring will collapse and the flow will be greatly reduced (even blocked) causing flow over relief.
 2. Repair Procedure (Loose Parts Design)
 - a. Remove the check valve components and replace the spring.
 - b. If the problem persists replace the ball type with a poppet type as they cannot completely block flow.
 - c. Adjust screw to proper depth.
 3. Repair Procedure (Cartridge)
 - a. Replace cartridge (See Specialty Valve Section A)

DIRECTIONAL CONTROL AND SPECIALTY VALVES

1. 2-WAY/2-POSITION NORMALLY CLOSED VALVES

These valves allow for free flow in one direction (from the bottom port to the side ports) at all times and checked flow in the opposite direction until the solenoid coil is energized. (See Fig. 13) Troubleshoot and repair as follows:

- A. If the valve does not shift, check for and repair the following:
1. The valve "hot" wire. (See section on open circuits).
 2. The valve ground wire. (See section on open circuits).

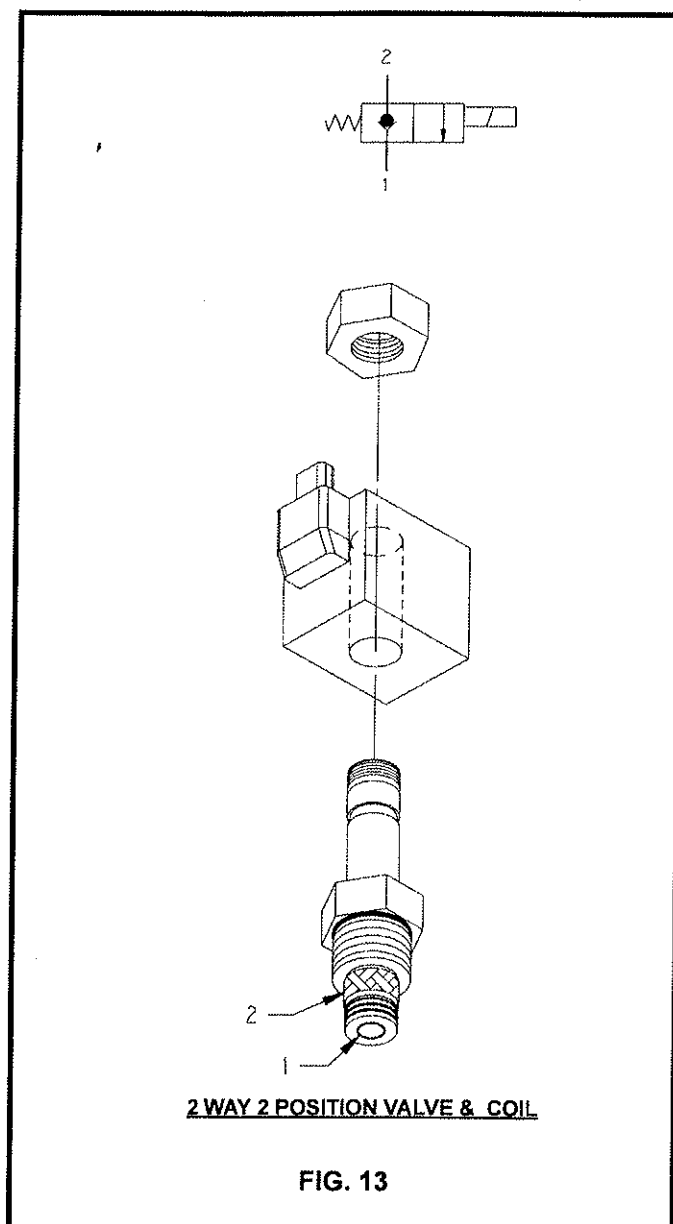


FIG. 13

3. The switch controlling the valve. (See section on Electrical Switches).
4. Low Voltage. (See section on low voltage).
5. The solenoid coil. (See section on solenoid coil).
6. Dirt in the valve cartridge. This can be done by energizing the valve without starting the motor and listening for the valve to shift (a definite "Click" is heard when the valve is energized. If the valve does not shift, remove the cartridge from the valve body. Blow compressed air through the cartridge in both directions while holding the plunger off its seat (use a

blunt object inserted through bottom of cartridge). It will help to have the "body" filter removed.

7. A bent valve stem. Replace valve.

NOTE: The cartridge itself cannot be disassembled in the field as the proper tolerances cannot be duplicated. If the dirt cannot be removed the cartridge will have to be replaced.

- B. If the valve does not return to the neutral or unshifted position, check for dirt in the valve cartridge or a bent stem.

2. 3-WAY/2-POSITION AND 4-WAY/2-POSITION VALVES

Troubleshoot and Repair As Follows: (See Fig. 14 and Fig. 15)

- A. If the valve does not shift, check for and repair the following:

1. The valve "hot" wire. (See section on Open Circuits).
2. The valve ground wire. (See section on Open Circuits).
3. The switch controlling the valves. (See section on Electrical Switches).
4. Low Voltage. (See section on Low Voltage).
5. The Solenoid Coil. (See section on Solenoid Coils).
6. Dirt in the valve cartridge. This can be done by energizing the valve without starting the motor and listening for the "valve shift". If it cannot be heard, remove the cartridge from the valve body and blow compressed air through all parts to dislodge dirt. Clean all parts in solvent, blow dry, and lubricate.

- B. If the valve does not return to the neutral or unshifted position, check for dirt in the valve cartridge and repair in the same manner as above.

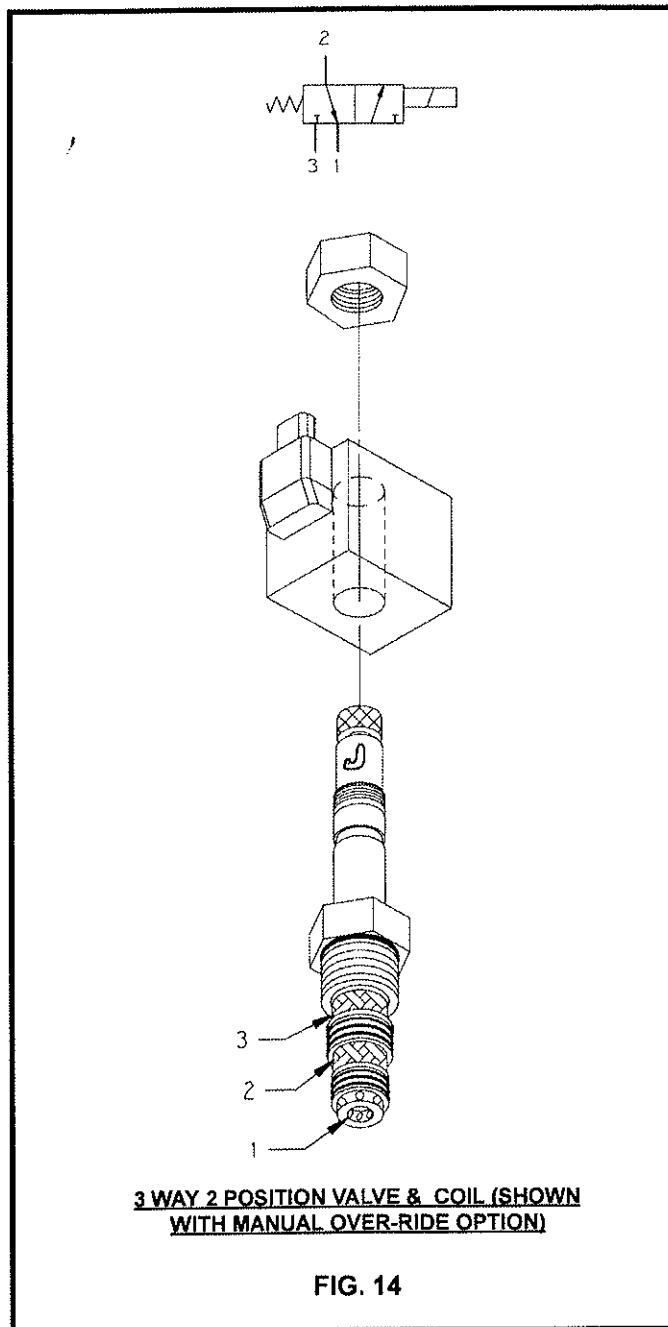
3. SPECIALTY VALVES:

- A. Cartridge Style Check Valves.

These valves screw into a cartridge cavity and allow for free flow from the end to the side and block reverse flow. (See Fig. 12)

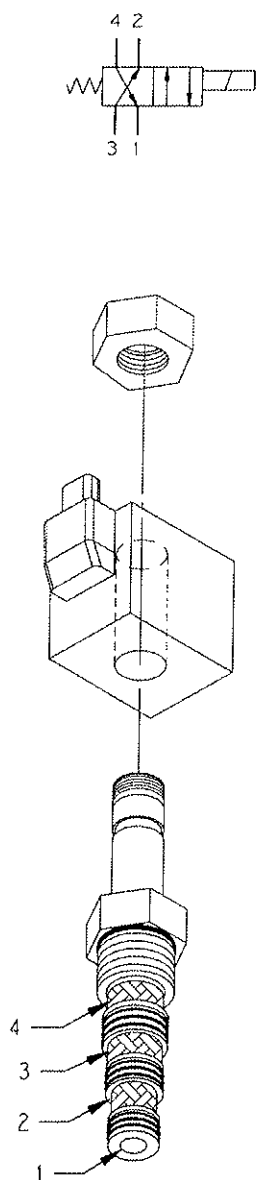
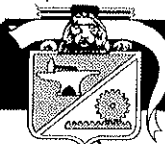
Troubleshoot and Repair as Follows:

If the valve does not hold, remove the cartridge



from the housing. Blow compressed air through the cartridge from the side to the bottom while holding the ball or poppet off the seat (use a blunt object inserted through the bottom of the cartridge to hold the poppet off the seat).

NOTE: The valve itself cannot be disassembled in the field; replace it if cleaning does not the problem.



4 WAY 2 POSITION VALVE & COIL

FIG. 15

B. Pressure Compensated Orifice.

The valves are "normally" installed in the return portion of a hydraulic circuit. They maintain a "more constant" flow even if the pressure is changing. They are made by "matching" an orifice to a special spring so they can meter flow.

Troubleshoot and Repair as Follows: (See Fig. 16)

If flow is blocked it could be because a particle of dirt has covered the orifice hole in the piston. It could also be caused by a piston that has "over travelled" the return ports in the side of the housing and has become "jammed" in contamination at the bottom of the cavity. The inner housing and piston can be removed as an assembly. Inspect orifice hole for dirt and blow compressed air through side holes to dislodge contamination. Push on inner piston with a blunt object and observe the piston moving past side holes in the housing. If it is smooth, it is working properly. If it is sticky, remove push clip and disassemble. Clean with solvent and compressed air, oil the parts, and reassemble. Do not use emery paper or steel wool to polish parts or touch orifice with a pick or drill bit (compressed air only). Replace as an assembly if it does not work properly.

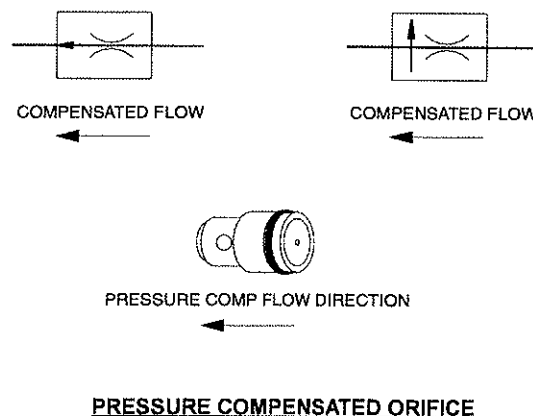


FIG. 16

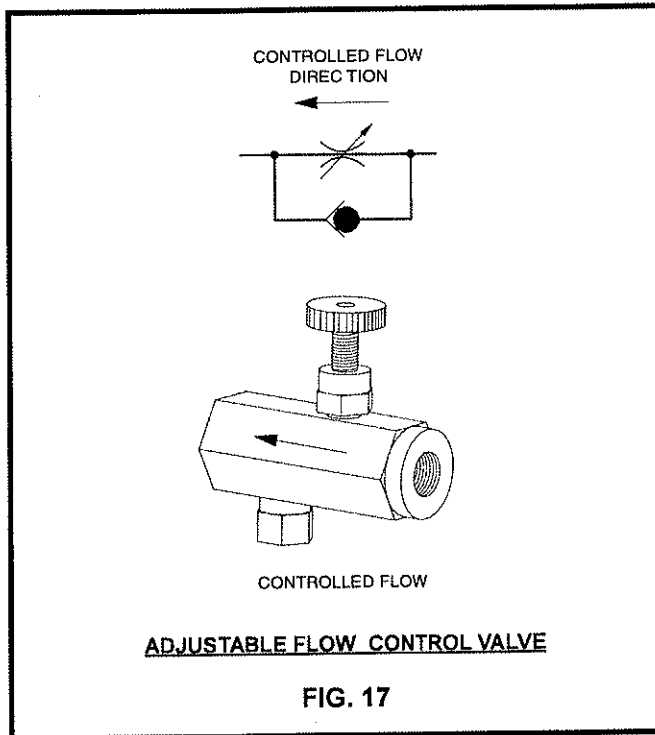
C. Adjustable Flow Control.

This valve has a needle to adjust oil flow in the direction of the arrow. It has an internal check valve so reverse flow (opposite the arrow) is unaffected by the needle.

Troubleshoot and Repair as Follows: (See Fig. 17).

Open needle by loosening the jam nut on the stem and turn the stem out. Inspect for dirt in ports and remove if possible. Blow com-

pressed air through valve first against the arrow and then with the arrow. Turn needle to full closed position (do not jam on seat or permanent damage could result). If compressed air is blown against the direction of the arrow it will pass through the valve freely; if compressed air is blown in the direction of the arrow it will be blocked or almost blocked. If this is not true, replace the valve; make sure the arrow points in the proper direction.



D. Adjustable Needle Valve.

This valve has a needle to adjust oil flow. It affects flow in either direction.

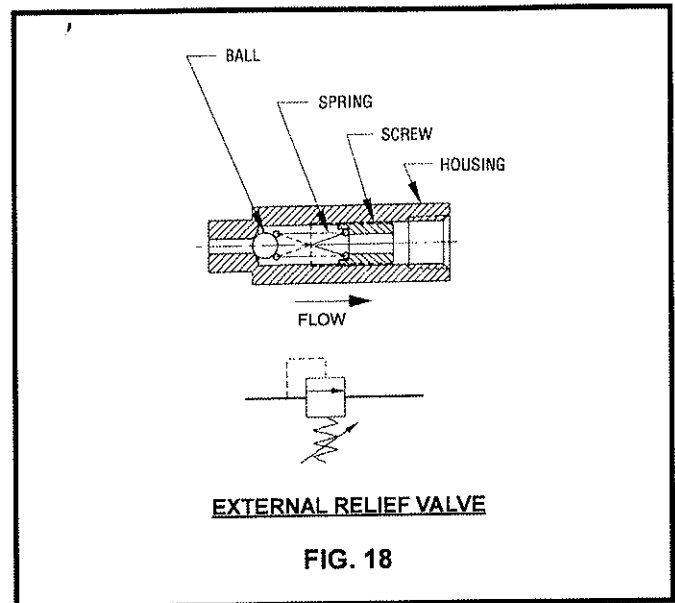
Troubleshoot and Repair as Follows:

Open needle by loosening the jam nut on the stem and turn the stem out. Inspect for dirt in ports and remove if possible. Blow compressed air through valve. Turn needle to full closed position (do not jam on seat or permanent damage could result). Blow compressed air into one port and check to see if it is blocked from exiting the other. Replace if dirt cannot be removed.

E. Inline "External" Relief Valve (Port Relief).

This valve is made up of a housing (usually hex), ball, spring, and an adjustable screw. Its

usual function is to control a port at a lower pressure than the "main" relief in the pump base. (See Fig. 18)



Troubleshoot and Repair as Follows:

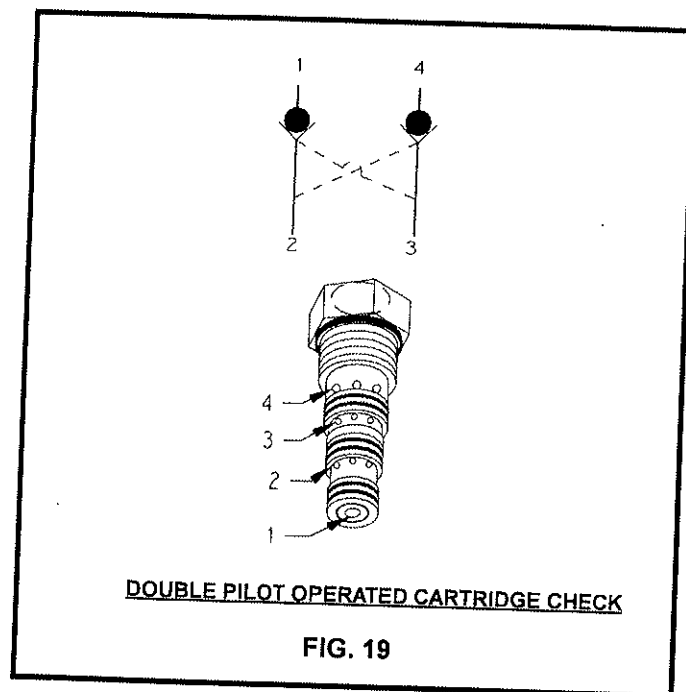
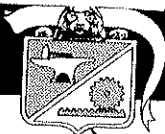
"Dead Head" the port in question. Tee a gauge into the port, start pump and note pressure. If it is too high the adjusting screw will need to be turned counterclockwise (use 1/4" allen key). If it is too low, turn the adjusting screw clockwise a turn and note the pressure gauge reading. If it does not move turn screw counterclockwise, start pump, and flush dirt past the ball. Then, turn the screw to the proper pressure setting. Note that the screw threads can be deformed slightly with a small prick punch and hammer to hold the pressure setting. Also see: Relief Valve section for more general information.

F. Cartridge Type Port Relief (See section above and Fig. 6 on Cartridge Relief Valves for repair).

G. Double Pilot Operated Checks.

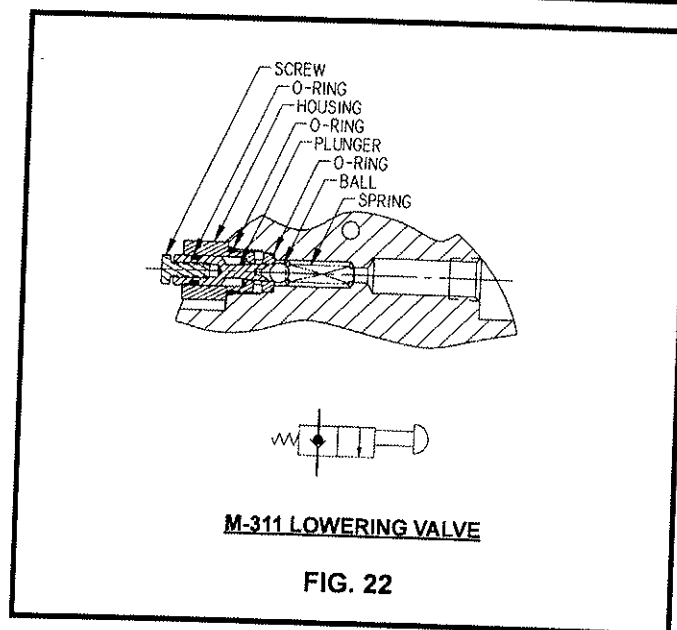
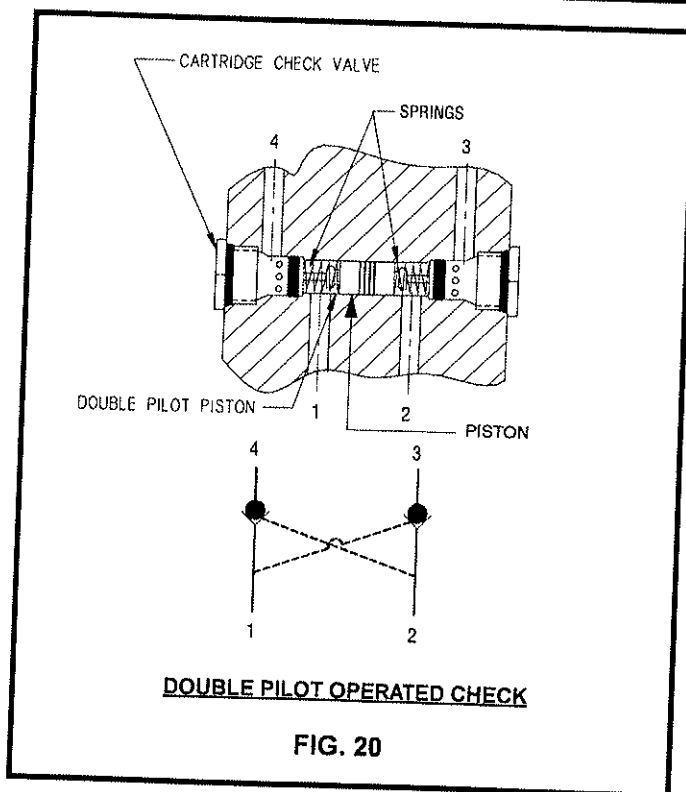
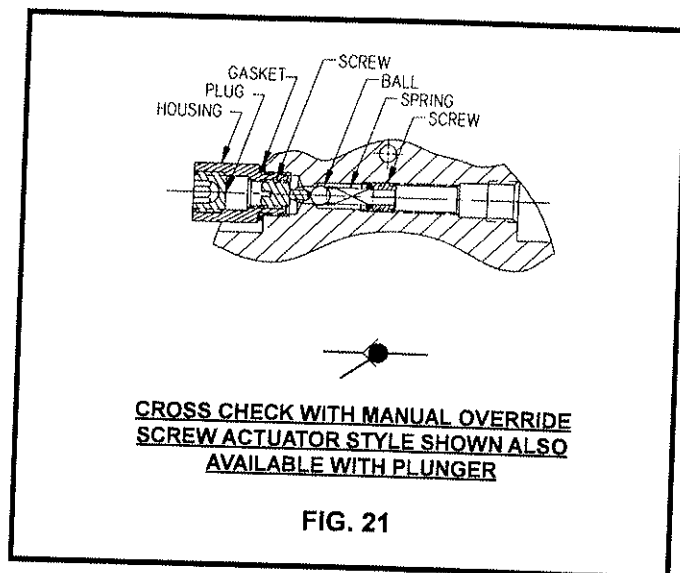
Two styles of Double Pilot Operated checks are used. One is a cartridge type (See Fig. 19). The other is made up of two check valves and a pilot piston complete with springs (See Fig. 20).

Both styles can be cleaned by blowing compressed air through them. But the cartridges cannot be disassembled. Replace the valves if air does not dislodge the contamination.



I. Lowering Valves

Manual lowering valves are used in power up/ gravity down circuits, as either a primary lowering device using a plunger, or as a back-up device using a screw. They are made using a ball and spring with an actuator to dis-lodge the ball. They can be repaired like internal check valves. See Check Valve Section on ball valves. (See Fig. 11 above and Fig. 21 & 22 below).



H. Double Cross Over Relief Valves

There are two styles used. One style is made up of a loose ball, spring, screw seal and a jam nut. Clean as described in Relief Valve section "2 A" above. The other is a cartridge relief. See Relief Valve section "2 B" above for cleaning instructions.

TIPS ON REPAIRS

1. Do not screw cartridge valves into cavity too fast; use a back and forth motion and have O-rings well lubricated.
2. Clean all parts thoroughly before assembly and lubricate with clean oil.
3. Do not use Teflon tape on hydraulic connections as it can easily jam the valves and plug the filters in the system.
4. Use care when working on electrical components to prevent shorts, "ground faults", and "open" circuits.
5. Remove all rings, watches and jewelry that might come into contact with electrical connections prior to working on the electrical system.



WARNING

- Always wear eye protection and protective clothing when working around hydraulic systems.
- Remove jewelry and objects that might conduct electricity while working on power units.
- Fluid under pressure can pierce the skin and enter the bloodstream causing death or serious injury.
- Devices being operated by the hydraulic system should be securely propped or immobilized so they cannot move and cause injury while being inspected or repaired.
- Fluids should be contained and disposed of properly.