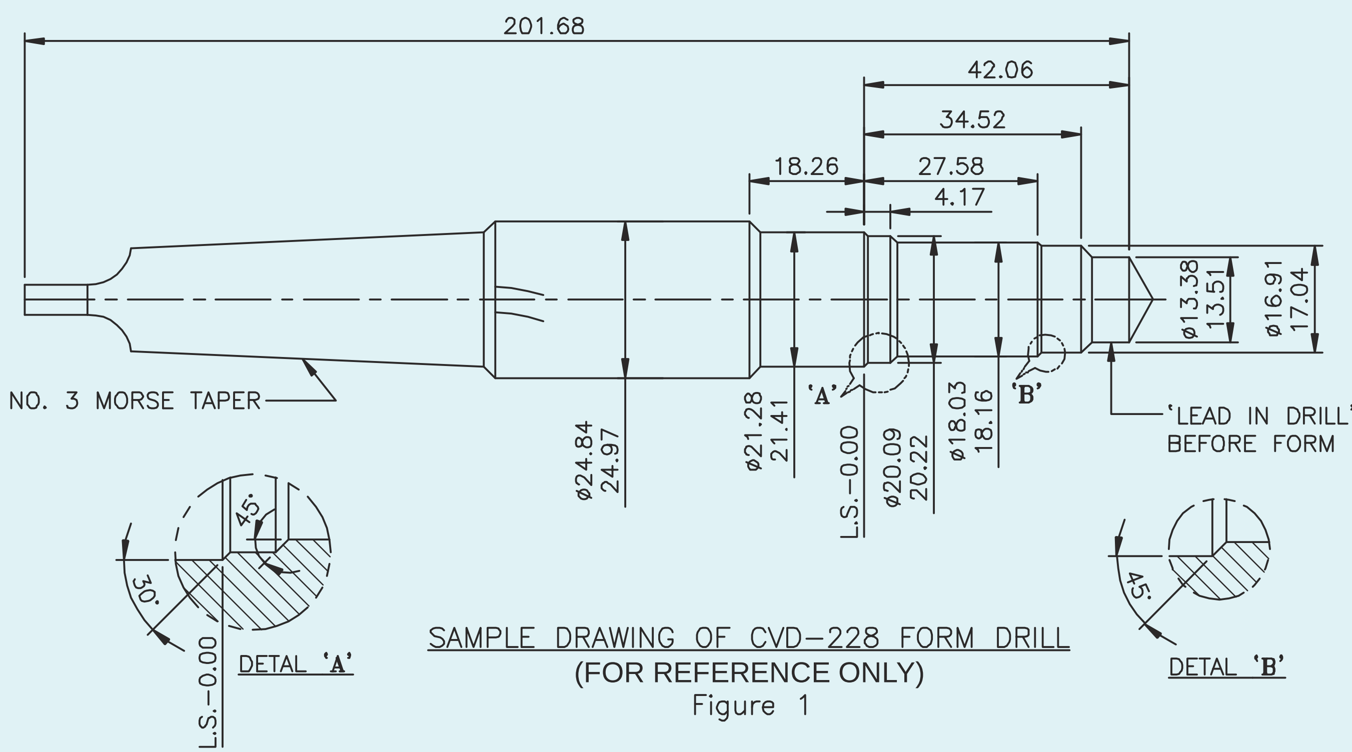
The following Technical Tip discusses a variety of points that should be considered when manufacturing a Microtact cavity. Many of the items discussed could be classified as general machining rules, but this paper puts them into the context of machining cavities that accept Microtact Hydraulics' cartridges.

Because many of Microtact's cartridges are installed in cavities manufactured outside of Microtact's walls, which is roughly two thirds of all the cartridges we manufacture, we offer this information to assist anyone making Microtact cavities. The Microtact cavity is integral to the proper operation of Microtact cartridges, and, if machined properly, ensures that the cartridge will work when installed (all Microtact cartridges are functionally tested at the factory). If the circuit itself is sound, a properly machined cavity translates to a fully functional manifold assembly that does not require testing!

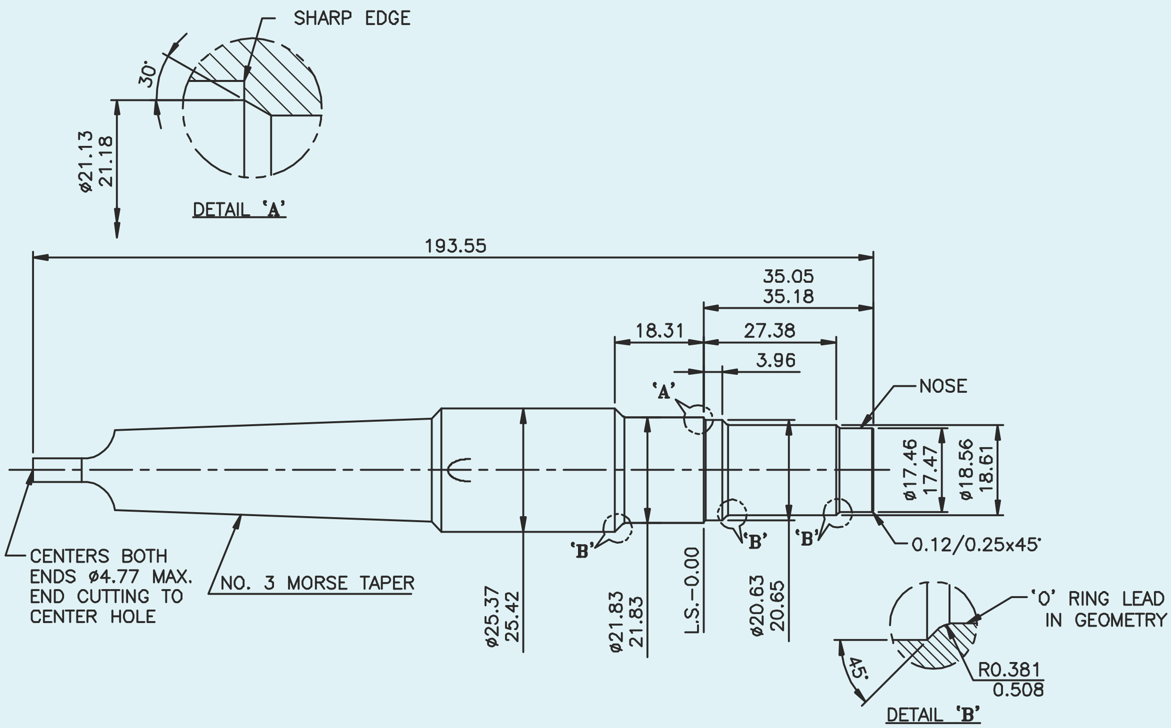
## Tooling Check

Periodic Tool inspection is a good way to prevent any problems that may arise from worn or damaged tooling. Following are a few tips on the inspection of tools:

- Look for any nicks or chips along the leading edge of the tool. These may affect the finish on the ID of the hole/cavity.
- Carefully use your thumb or finger to feel the sharpness of the flute edges. A sharp edge will tend to grip the grooves on the skin of your finger. This procedure may take a bit of trial and error in order to develop a feel for what is or is not sharp.
- Any material build up should be carefully removed. The use of a fine diamond file usually works well to remove this build up. (Be careful not to damage the edge.)
- The locating shoulder (L.S.) on the reamer should be checked to make sure that the sharp edge is maintained. See Figure 2, Detail A.
- If using a reground tool, check dimensions with reference to the locating shoulder in order to make sure that the depths and diameters are in agreement with the cavity drawing.
- Depth of "lead in drill" on the form drill is critical for valves that have components that extend beyond the nose during operation (see note on Figure 1).




SAMPLE DRAWING OF CVD–228 FORM DRILL
(FOR REFERENCE ONLY)
Figure 1




SAMPLE DRAWING OF CVR–228 FORM REAMER

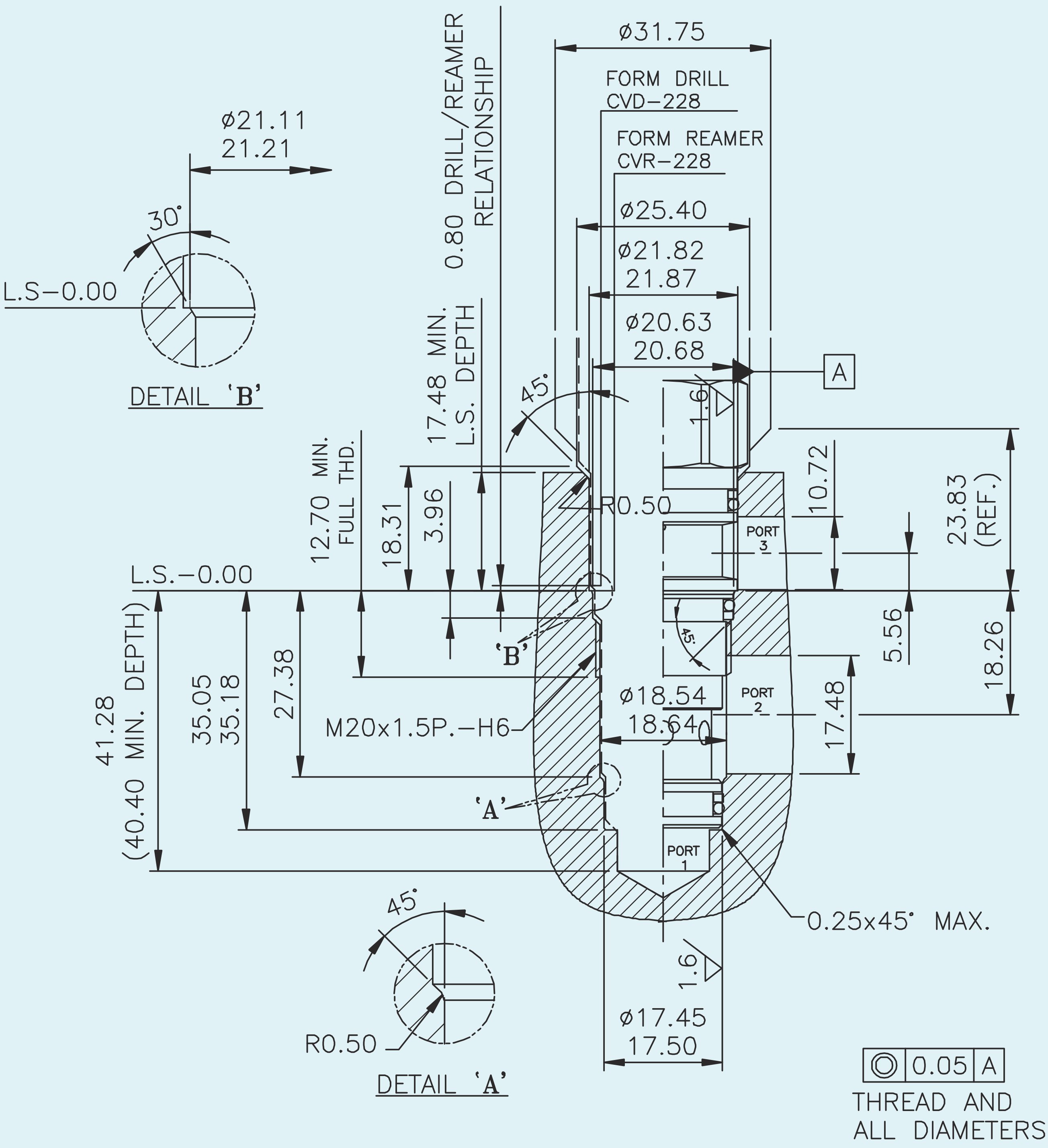
**(FOR REFERENCE ONLY)**

Figure 2

## Cavity Check

The finished cavity should be checked for dimensional accuracy against a Microtact detailed cavity drawing. Microtact recommends the use of Go / NoGo cylindrical plug and thread gages for final inspection of cavity dimensions. One of the more critical points on the cartridge cavity that needs to be checked is the nose of the cavity. This section is critical because this area is where the reamer performs the most work. If a worn form reamer is used, there is the potential for inaccurate finished geometry . The following points describe what may happen when a worn tool is used and what to look out for during inspection (see Figure 3):

- A worn form reamer can create a taper at the nose that may not be easily detectable if it is not measured with care. The problem with a taper at the cavity nose is that it can create a situation where the nose of the cartridge gets wedged into the cavity upon installation. Consequently, when the cartridge is unscrewed for servicing the body can come out while the cartridge nose remains wedged in the cavity. Therefore, when checking the nose dimensions, the diameter needs to be checked from the beginning of the nose all the way down to the nose support, to ensure that the nose is not tapered.
- A visual inspection should be performed to determine if the machined cavity has a smooth surface, free from voids. Voids (incomplete seal diameter clean up) may result from excessive drill "walk" yielding a local oversized diameter.
- A worn tool can leave a rough finish on the sealing areas, possibly creating a leak path and a reduction in seal life. Surface roughness in excess of 63 Ra can result in reduced seal life.
- Using an improperly reground form reamer, where the distance from the locating shoulder to the nose has not been maintained (e.g. it was ground shorter than specified), will yield a situation where the cartridge nose will get compressed into the cartridge body at installation. (When the valve is torqued in place, movement of the working parts in the floating nose can be inhibited.)
- Another critical area is the locating shoulder. This small area is where the valve is seated when it is torqued at installation. If a worn tool has been used, and the geometry is not created accurately, the locating shoulder on the cartridge valve will not rest on the locating shoulder of the cavity. Referring to Figure 2, the locating shoulder should be created with a sharp edge on the reamer. If that edge is worn to the degree that it becomes a radius, an equivalent radius will be created in the cavity. This condition will allow the valve to rest on this radius, rather than a flat edge.




CV–228 CAVITY

(FOR REFERENCE ONLY)

Figure 3

The following illustration (Figure 4) details some of the characteristics of the Microtact cavity and how they interact with the unique Microtact floating design cartridge.

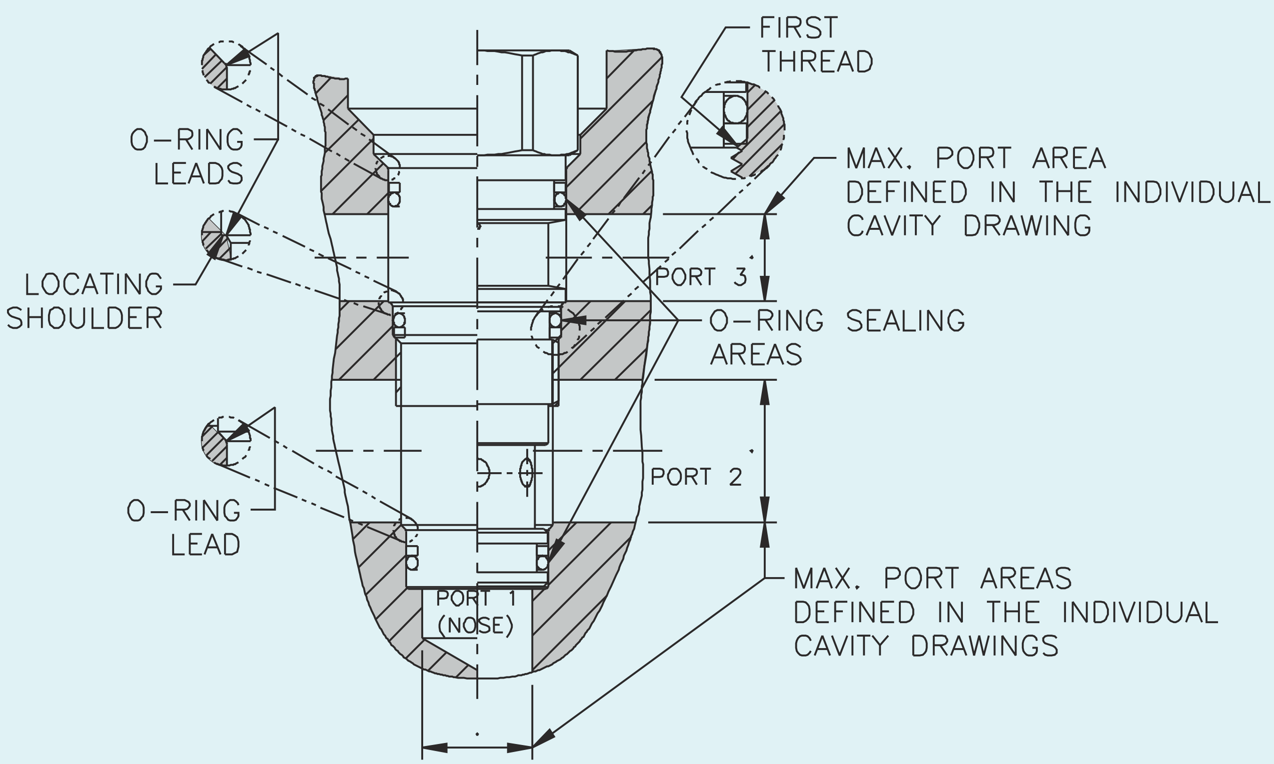
- **O-RING LEAD:** The inclined step of a cavity located at the top of a seal area that gradually compresses or squeezes the oring as the cartridge is screwed into the cavity. It must be smooth and free of scratches and nicks.

- **O-RING SEAL AREAS:** The area on a cavity that o-rings seat or squeeze against to create a seal. This seal prevents oil in one port area from leaking into another port area. Must be smooth and free of scratches and nicks. A surface finish of 63 Ra or lower is acceptable.

- **L.S. LOCATING SHOULDER:** This is the shoulder that the cartridge is torqued or tightened against. This ledge helps the cartridge align itself with the centerline and diameters of the cavity. It must be completely formed and free of scratches and nicks.

- **PORT AREAS:** Port areas are the openings on a cavity that expose fluid flow and pressure to the cartridge that the cavity holds. Each cavity has defined port areas. Drillings into these areas cannot exceed the maximum defined port area on the cavity drawing. Otherwise, they could run into o-ring leads, seal areas, locating shoulders, or remove threads. Openings into cavities must be free of all burrs and sharp edges.

- **FIRST THREAD:** The first thread on all Microtact cavities is important as it is needed to help support the backup ring above it (square o-ring that protects and supports the round o-ring). Although the starting thread is in this area, which usually is sharp, a complete thread should be maintained. Threads should not be crossing or missing.




Typical Microtact 3–port Cavity
Figure 4

# APPLICATION GUIDELINES

### PRESSURE DROP

Select the valve that has minimum pressure drop at the required flow condition. Performance curves on preceding pages show approximate pressure drops (? P) through valves using 100 SUS fluids having 0.865 specific gravity. Pressure drop for fluids of other viscosities is approximately:

| VISCOSITY (SUS) | 75 | 150 | 200 | 250 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|
| %OF ?P FROM CURVE (APPROX.) | 93 | 111 | 119 | 126 | 132 | 137 | 141 |

For any other specific gravity ($G_1$), pressure drop (?$P_1$) will be ?$P_1$= ?P($G_1$)/G. For pressure drop data beyond the published curves in this booklet, a close proximation can be made by reading the pressure drop at 1/2 the required flow and multiplying it by 4.

When installing a valve connecting lines should have as few bends and fittings as possible. High pressure lines and fittings restrict flow and may result in excessive pressure drop through the system. They should be used only where necessary in a pressure line.

Select quality tubing with as large an ID as economically possible. Avoid long lines and sharp bends. A good bend radius is 2-1/*2* to 3 times the tube ID. The increased pressure drop in sharper bends is caused by abrupt changes in flow direction, particularly in the inner edge of flow. Even in large radius bends, pressure drop increases due to an increase in turbulence.

Circuit design to eliminate undesirable pressure drop can never be 100 percent effective. Some energy losses through heat generation must be accepted. Therefore wherever possible, valves should be placed in the open where heat can be dissipated readily. If heat is added to the system faster than it can be rejected, some method of forced fluid cooling such as air or water-cooled heat exchangers may be required.

### PIPING

Lines should be installed in such a way that high vehicle flexure does not cause stresses in the tubing which can be transmitted to valve port fittings.

When applications incorporate long hydraulic lines, or lines providing high velocity, the use of larger capacity lines is recommended to reduce line losses. Lines should not be smaller than the nominal port sizes shown on installation drawings. Flow capacities of piping are shown on pipe sizing chart on **Page 73.**

Connections should always be tight, but not to the point of distortion, to prevent air from entering the system,' Particular care must be used to employ joints, seals and gaskets that will not leak or deteriorate. See preceding "pressure drop" section for additional information on piping.

### HOSE

When installing a hose, allow enough slack to avoid kinking. A taut hose will not allow movement with pressure surges. Slack in the line compensates for surges, relieving strain. The hose should not be twisted during installation or while in operation. Twisting will weaken the hose and loosen connections.

A neater installation is usually obtainable by using extra fittings to minimize unusually long loops in a hose. Hoses should be secured and protected against rubbing, chafing, and entanglement with moving parts.

### RELIEF VALVES

Relief valve settings specified in model codes are nominal "cracking pressures." Any-increase in relief valve pressure due to flow is called the "full flow pressure," System tank pressures are also additive to the Relief Valve settings.

It is preferable to keep a 250 psi differential between the System Relief Valve setting and the port Relief Valve setting to prevent interaction between the two valves. Port Relief Valves with pressure settings lower than the System Relief Valve setting can be used to protect functions incorporating components with low pressure ratings.

It is desirable to have the system designed so that relief valves are inoperative during the normal work cycle. Such a system eliminates one of the causes of heat generation and oil aeration.

On functions incorporating a hydraulic motor and a blocked cylinder port spool, it is preferable to provide a cross port relief valve as close as possible to the motor to prevent motor failure.

### SHIFTING FORCES

Standard centering springs provide spool centering at maximum rated flow and maximum rated pressure. Each valve is tested to ensure centering prior to shipping. On applications where valves are being used below rated conditions, or where maximum rated flow and maximum rated pressure are not achieved simultaneously, lower spring loads which provide lower shifting forces can be provided.

### INTERNAL LEAKAGE

The spool and body of each Directional Valve are select fitted to provide low leakage. It is not practical to replace spools on units in the field. On applications where no cylinder drift is allowable when supporting a load, pilot check valves or similar means should be provided.

When using Directional Valves in closed-center constant pressure type systems, consideration should be given to cylinder creep due to leakage from the pressure area of the valve into the cylinder ports.

## APPLICATION GUIDELINES

### FLOW

On functions encountering overrunning loads, protection should be provided to prevent cavitation. Cavitation can draw air and contaminants into the circuit, reducing component life. On functions incorporating cylinders with differential areas, consideration should be given to the high return flows experienced when retracting cylinders.

### MOUNTING

Valves can be mounted in any position. They should be securely bolted to a flat surface or resilient mounting pad to prevent distortion of the valve body.

Valves should be mounted in a protected area, free from falling debris, to protect linkage and spool extensions. Enough clearance must be left to provide access to port connections, and to permit actuation of the control mechanism.

### OPERATING LINKAGE

Linkage for actuation of the valve spool must be properly aligned. Binding linkage will restrict the spool from returning to the neutral position when the control mechanism is released.

Operating linkage should rely on maximum travel stops provided in the valve to assure full spool travel and avoid adjustment problems.

### FILTRATION

To insure reliable system performance, adequate fluid filtration and protection from environmental contaminant ingression should be provided. The system should not have a contamination level greater than 18/13 as measured in accordance with the ISO cleanliness code (Proposed ISO Solid Contaminant Code).

A 10-micron filter in Microtact' OF series, sized to accommodate full return tine flow, is recommended for most operating environments. If the system operates in a severely contaminated atmosphere, it is recommended that the 3 micron element be used because of its higher contaminant removal rate. The air breather should also be of a similar high contaminant removal rate. The filter element contaminant holding capacity and change interval are important selection criteria.

Filters should have nominal pressure, bypass check valves (Figure 1) to protect the system during cold starts and whenever the filter element becomes clogged. Bypass filters should be able to filter the equivalent of all system fluid within eight hours.

When possible, filters should be located in the tank return line where they trap contaminants before the oil re-enters the reservoir (Figure 2). This location also permits using a low-pressure type filter. Since return line filter elements must be changed at regular intervals, the filter should be located in an accessible area. For this reason, it is best not to locate the filter inside the reservoir.

### RESERVOIR

Reservoir and circuit design must prevent aeration of the fluid. Any opaqueness or milky appearance of the fluid in the lines or reservoir indicates excessive aeration. Bubbles on the surface of reservoir fluid may also indicate excessive aeration. It is best to use windows and sight glasses in reservoirs and inlet lines during vehicle prototype evaluation to determine whether significant amounts of air are present in the fluid.

Return lines discharging into the reservoir should discharge below the low limit oil level, as far from the pump inlet as possible (Figure 3). This will prevent aeration and cavitation when oil is being drawn from the reservoir to fill voids in the valve. Tank return lines should be attached to the reservoir by flanges or welded heavy-duty coupling.

A baffle plate in the reservoir is desirable to separate the suction and return lines. The plate causes return oil to circulate around the outer wall for cooling before it re-enters the pump. It also helps provide time for entrained air to separate from the oil. Baffle plate openings should be designed to minimize cascading effects and resultant air entrainment.

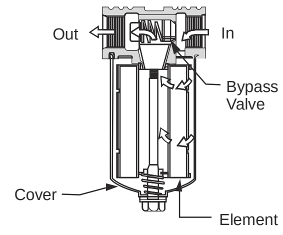
Magnets can be used in a reservoir to pick up ferrous particles not retained by filters or strainers. Magnets should be assembled to the support bars located between suction and return lines, and be accessible for cleaning.

### MISCELLANEOUS

For optimum seal life, tank pressure at the Directional Valve should be held to a minimum.

Systems should be designed to operate at a maximum temperature of 120° F.

Under certain conditions, the valves described in this booklet may be operated at flows and pressures higher than published. If standard valves do not meet your system requirements, customized units can be made available. Please contact your local Microtact representative regarding special application requirements.



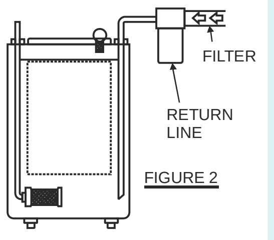
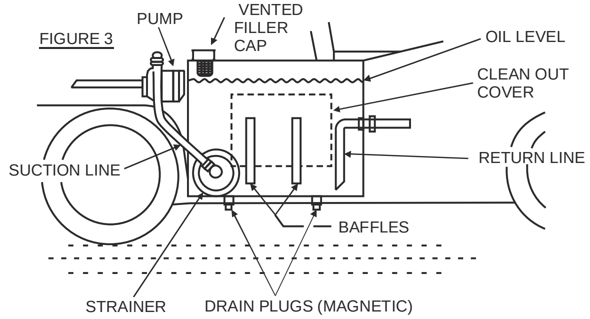




FIGURE 2

FIGURE 3



# OIL RECOMMENDATIONS

THE OIL IN A HYDRAULIC SYSTEM SERVES AS THE POWER TRANSMISSION MEDIUM. IT IS ALSO THE SYSTEM'S LUBRICANT AND COOLANT. SELECTION OF THE PROPER OIL IS A REQUIREMENT FOR SATISFACTORY SYSTEM PERFORMANCE AND LIFE.

The following recommendations will assist in the selection of suitable oils for use with Microtact products. Microtact does not publish a recommended oil list by brand name or supplier due to the extremely wide variety of oil types on the market.

In most cases, use of these recommendations will lead to selection of a suitable oil. However, due to the complex nature of oil formulation, the variety oils available and peculiarities of individual hydraulic applications, there will be rare instances where an oil selected on the basis of these recommendations will yield unsatisfactory results Microtact cannot be responsible for such exceptions. In this respect, the customer is encouraged to consult Microtact representative when selecting an oil.

IMPORTANT-FACTORS IN SELECTING AN OIL

ADDITIVES - Hydraulic fluids contain a number of additive agents which materially improve various characteristics of oil for hydraulic systems These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point.

Pump performance and reliability are directly affected by the antiwear additive formulation contained in the oil. Oils providing a high level of antiwear protection are recommended for optimum performance and long life.

VISCOSITY - Viscosity is the measure of fluidity. The oil selected must have proper viscosity to maintain an adequate lubricating film at system operating temperature.

In addition to dynamic lubricating properties, oil must have sufficient body to provide an adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause' pump cavitation or sluggish valve action. Optimum operating viscosity of the oil should be between 16cSt (80SUS) and 4O cSt (180 SUS).

"Viscosity index" reflects the way viscosity changes with temperature. The smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both a temporary and permanent decrease in viscosity due to oil shear encountered in the operating hydraulic system. The actual viscosity can, therefore be far less in the operating hydraulic system than what is shown in normal oil data. Accordingly, when such oils are selected, it is necessary to use those with high shear stability to insure that viscosity remains within recommended limits while in service.

CHEMICAL STABILITY - Oxidative and thermal stability are essential characteristics of oils for Mobile hydraulic systems. The combination of base stocks and additives should be stable during the expected lifetime of the oil when exposed to the environment of these systems.

SUITABLE TYPES OF OIL

CRANKCASE OIL having letter designation SC. SD, SE or SF per SAE J183 FEB80. Note that one oil may meet one or more of these designations.

**OIL VISCOSITY RECOMMENDATIONS**
**CRANKCASE OILS**

| Hydraulic System Operating Temperature Range* | SAE Viscosity Designation |
|---|---|
| -23°C to 54°C (-10°F to 130°F) | 5W, 5W-20, 5W-30 |
| -18°C to 83°C ( 0°F to 180°F) | 10W |
| -18°C to 99°C ( 0°F to 210°F) | 10W-30,10W-40 |
| 10°C to 99°C (50°F to 210°F) | 20-20W |

**ANTIWEAR HYDRAULIC OILS**

| Hydraulic System Operating Temperature Range* | ISO Viscosity Grade |
|---|---|
| -21°C to 60°C (-5°F to 140°F) | 22 |
| -15°C to 77°C ( 5°F to 170°F) | 32 |
| -9°C to 88°C ( 15°F to 190°F) | 46 |
| -1°C to 99°C ( 30°F to 210°F) | 68 |

* Temperatures shown are cold (ambient) start-up to maximum operating. During cold start-up, avoid high-speed operation of hydraulic components until the system is warmed up to provide adequate lubrication.

ARTIC CONDITIONS represent a specialized field where extensive use is made of heating equipment before starting. If necessary, this and judicious use of the following recommendations should be used:

1. SAE 5W or 5W-20 oil.
2. Oils specially developed for use in artic conditions, such as synthetic hydrocarbons, esters, or mixtures of the two.

Operating temperature should be closely monitored to avoid exceeding a temperature of 54°C (I30°F) with any lightweight oil.

SPECIAL REQUIREMENTS

When special considerations indicate a need to depart from recommended oils or operating conditions, consult your Microtact representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

1. Clean (flush) entire system to remove paint, metal chips welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminant into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of the system from entry of airborne contamination by sealing the system and/or by proper filtration of the air,
5. Maintain the proper oil level and regularly service filters, breathers and reservoirs. The importance of these precautions cannot be overemphasized.
6. Use good system and reservoir design and control fluid temperature to insure minimum oil aeration.
7. Take precautions to prevent moisture contamination. Change fluid whenever contamination occurs because even small amounts of water can have a substantial effect on system performance, as well as induce corrosion and oil breakdown.