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HP6A
AUTOMATIC CYLINDER HONING MACHINE

MACHINE SERIAL NUMBER

OPERATIONS AND MAINTENANCE
MANUAL



MANUFACTURED BY:

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Chapter 1 Introduction / Safety Installation:

This manual is divided into chapters as listed in the table of contents.

It is required that the new user of the HP6A honing machine read this manual. Pay close attention to the chapter concerning safety.

Description:

The model HP6A Honing Machine is a wet, complete cylinder block and general purpose-honing machine. A totally enclosed AC motor driving a belt and gear reduction drive mounted within a rocker arm arrangement supplies Hone rotating power. The honing head is driven through a universal joint.

An air cylinder with a hydraulic check system provides stroking power. Stroking may also be manually operated.

The support carriage is air floated and clamped to provide simple and easy hole-to-hole setup.

Convenient devices are provided to properly control honing operations and provide easy handling.

A 'V' fixture is provided, which efficiently holds V-6/V-8, and in-line blocks for honing. Optional clamps are available to clamp most any kind of in-line block or similar work piece.

A splash tank is located within the main frame and a coolant pump tank is located under the machine. A switch is provided on the control panel to operate the coolant system.

Limited Warranty:

Rottler Manufacturing company model HP6A parts and equipment is warranted as to materials and workmanship. This limited warranty remains in effect for one year from the date of delivery, provided the machine is owned and operated by the original purchaser and is operated and maintained as per instruction in this manual.

Tools proven defective within the warranty period will be repaired or replaced, at the factory's option.

We accept no responsibility for defects caused by external damage, wear, abuse, or misuse, nor do we accept any obligation to provide compensation for other direct or indirect costs in connection with cases covered by the warranty.

Freight charges on warranty items (non air shipment only) will be paid by Rottler Manufacturing for a period of 60 days only from date of installation or set up by a qualified service technician or sales rep.

Freight charges after the 60 days period are the customer responsibility.

Safety Information:**For Your Own Safety Read This Instruction Manual Before Operating This Machine.**

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.




This machine is capable of causing severe bodily injury.


**Safety Instructions for Machine Use**

1. **KEEP GUARDS IN PLACE** and in proper working order.
2. **KEEP WORK AREA CLEAN.** Cluttered areas and benches invite accidents.
3. **KEEP CHILDREN AND VISITORS AWAY.** All children and visitors should be kept a safe distance from work area.
4. **WEAR THE PROPER APPAREL. DO NOT** wear loose clothing, gloves, rings, bracelets, or other jewelry which may get caught in moving parts. Non-Slip foot wear is recommended. Wear protective hair covering to contain long hair.
5. **ALWAYS USE SAFETY GLASSES.** Also use face or dust mask if cutting operation is dusty. Everyday eye glasses only have impact resistant lenses, they are NOT safety glasses.
6. **DO NOT OVER-REACH.** Keep proper footing and balance at all times.

7. **USE THE RECOMMENDED ACCESSORIES.** Consult the manual for recommended accessories. The use of improper accessories may cause risk of injury.
8. **CHECK DAMAGED PARTS.** Before further use of the machine, a guard or other part that is damaged should be checked to determine that it will operate properly and perform its intended function. Check for alignment of moving parts, breakage of parts, mounting, and other conditions that may affect its operation. A guard or other part that is damaged should be properly repaired or replaced.
9. **NEVER OPERATE A MACHINE WHEN TIRED, OR UNDER THE INFLUENCE OF DRUGS OR ALCOHOL.** Full mental alertness is required at all times when running a machine.
10. **NEVER ALLOW UNSUPERVISED OR UNTRAINED PERSONNEL TO OPERATE THE MACHINE.** Make sure any instructions you give in regards to machine operation are approved, correct, safe, and clearly understood.
11. **IF AT ANY TIME YOU ARE EXPERIENCING DIFFICULTIES** performing the intended operation, stop using the machine! Then contact our service department or ask a qualified expert how the operation should be performed.


 **CAUTION** No list of safety guidelines can be complete. Every shop environment is different. Always consider safety first, as it applies to your individual working conditions. Use this and other machinery with caution and respect. Failure to follow guidelines could result in serious personal injury, damage to equipment or poor work results.


Electrical Power:

 **WARNING** All electrical power should be removed from the machine before opening the rear electrical enclosure. It is recommended that the machine have a electrical LOCK-OUT device installed.


Make sure all electrical equipment has the proper electrical overload protection.

In the event of an electrical short, grounding reduces the risk of electric shock by providing a path of least resistance to disperse electric current.

 **WARNING** Electrocutation or a fire can result if the machine is not grounded correctly. Make sure the ground is connected in accordance with this manual. DO NOT operate the machine if it is not grounded.

 **CAUTION** No single list of electrical guidelines can be comprehensive for all shop environments. Operating this machinery may require additional electrical upgrades specific to your shop environment. It is your responsibility to make sure your electrical system comply with all local codes and ordinances.

Machine Operator:

 **WARNING** Operator of this HP6A Honing machine should be a skilled machinist craftsman: that is well versed in the caution, care, and knowledge required to safely operating a metal cutting tool.

If the operator is not a skilled machinist, the operator must pay strict attention to the operating procedure outlined in this manual, and must get instruction from a qualified machinist in both the productive and safe operation of this HP6A Honing Machine.

Rottler HP6A Honing equipment has the following areas of exposed moving parts that you must train yourself to respect and stay away from when they are in motion:

WARNING

Work Clamping - Be sure work is clamped securely in accordance with the instructions.

Hone Head Area - Keep hands completely away from the rotating honing head at *ALL* times.

Honing - Do not engage rotation power when hone is out of a cylinder.

Power Stroking - Do not operate power stroking without upper travel limit lever locked.

CAUTION

Operator Controls - Familiarize yourself with the exact location of the stop button so you can immediately react to an emergency.

Lower Stop - Set lower limit carefully so that webs or other obstructions, in the bore, do not interfere with the guides or stones.

WARNING

Remember

Metal cutting tools have the speed and torque to severely injure any part of the human body exposed to them.

Machine Installation:

Location

The productivity of this machine will depend to a great extent on its proper initial installation, particularly the means by which cylinder blocks are lifted into the machine as well as the material handling to and from other operations in your shop.

The proper loading arrangement and location for your HP6A machine is extremely important.

A slow travel (6' to 10' per min.) power hoist, operated from either a bridge crane or a jib crane arrangement works very well. A 1000-lb. hoist is generally adequate for lifting the engine block. An air hoist with speed control makes an ideal method for fast, convenient loading.

If some production honing with this machine is anticipated, and the cylinder blocks are not directly loaded and unloaded from a conveyor, we would recommend considerable attention be given to the crane so that it covers an adequate area to allow the operator to back up and remove cylinder blocks without cluttering up his own area. If two machines are to be operated by one operator, we recommend that the open faces be placed at right angles to each other, with the machines approximately three feet apart.

Unpacking

Carefully uncrate the HP6A Machine. Remove all equipment in splash tank except the 'V' fixture frame.

Completely clean these articles as well as the machine's upper table with solvent also cleans the lower travel limit stop rods, Rust inhibitor is applied to the machine at the time of shipment and must be removed before operating the machine.

Shipping Hold Down Bolt

(Refer to illustration supplied with manual)

The hone carriage is shipped with the hold-down system locked. This system must be unlocked. Remove the cover (514-3-3J). Remove the cotter pin in the castle nut. Loosen the nut all the way. Tighten the nut back down with just your fingers. Loosen the nut 1/4 turn. Insert cotter pin.

Leveling

Eight cap screws and jam nuts are provided with the machine for leveling. Insert the screws from the bottom of the base. Place the jam nuts on top of the threaded hole in the base.

Using a precision level, level the upper table within .002" per foot in both directions (Except favor the high setting to the front for best coolant return).

Air Supply:

The HP6A machine requires 5.7 cubic feet/minute at 100 P.S.I. compressed air (a minimum 1 HP air compressor output).

Attach air supply to the filter regulator on the right side of the splash tank. Push and hold the float clamp button located on the front of the carriage. While holding the push button adjust the air regulator to 100 P.S.I. (located on the right side of the splash tank). (Push regulator knob down to set, pull up to lock).

Note: To assure a long service life for your HP6A machine the air supply must be moisture free. If there is any doubts about the air supply install a water trap.

Coolant :

Refer to the Coolant section in Chapter 3 of this manual for proper coolant types and mixes.

Power Supply:

⚠ CAUTION . Disconnect all power before servicing this machine. Failure to do so could result in electrical shock.

This machine has the following power requirements:

208 to 240 VAC

Single Phase

50 or 60 Hertz

20 amps

(See 514-2-97K wiring diagram for the HP6A Hone).

See illustration below for correct connection of "measured" incoming power. Connect single phase wiring to the main rear enclosure, located on the right rear of machine base. The connection point for power is located inside the enclosure. The connection termination point is located on the left hand side of the electrical panel about half way up. Connect L1 to the top terminal on the terminal block, L2 (neutral) to the second terminal on the terminal block. Attach wire from the grounding rod to the third terminal on the terminal block.

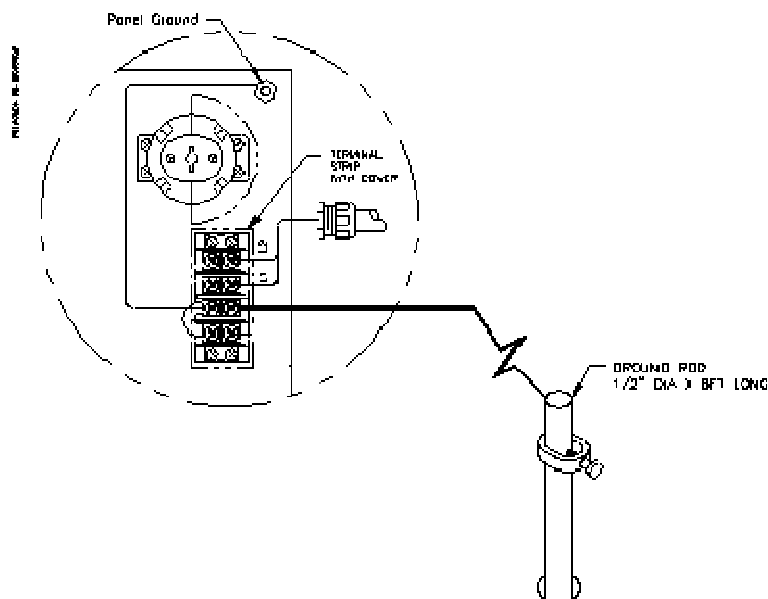
Important: *Electrically connect in accordance with national and local electrical codes.*

Grounding:

⚠ This machine must be connected to a good earth ground rod. A 6 foot, 1/2" diameter, 15 OHM, Copper grounding rod driven into the earth next to the machines is preferred. Not providing a grounding rod could void factory warranty.

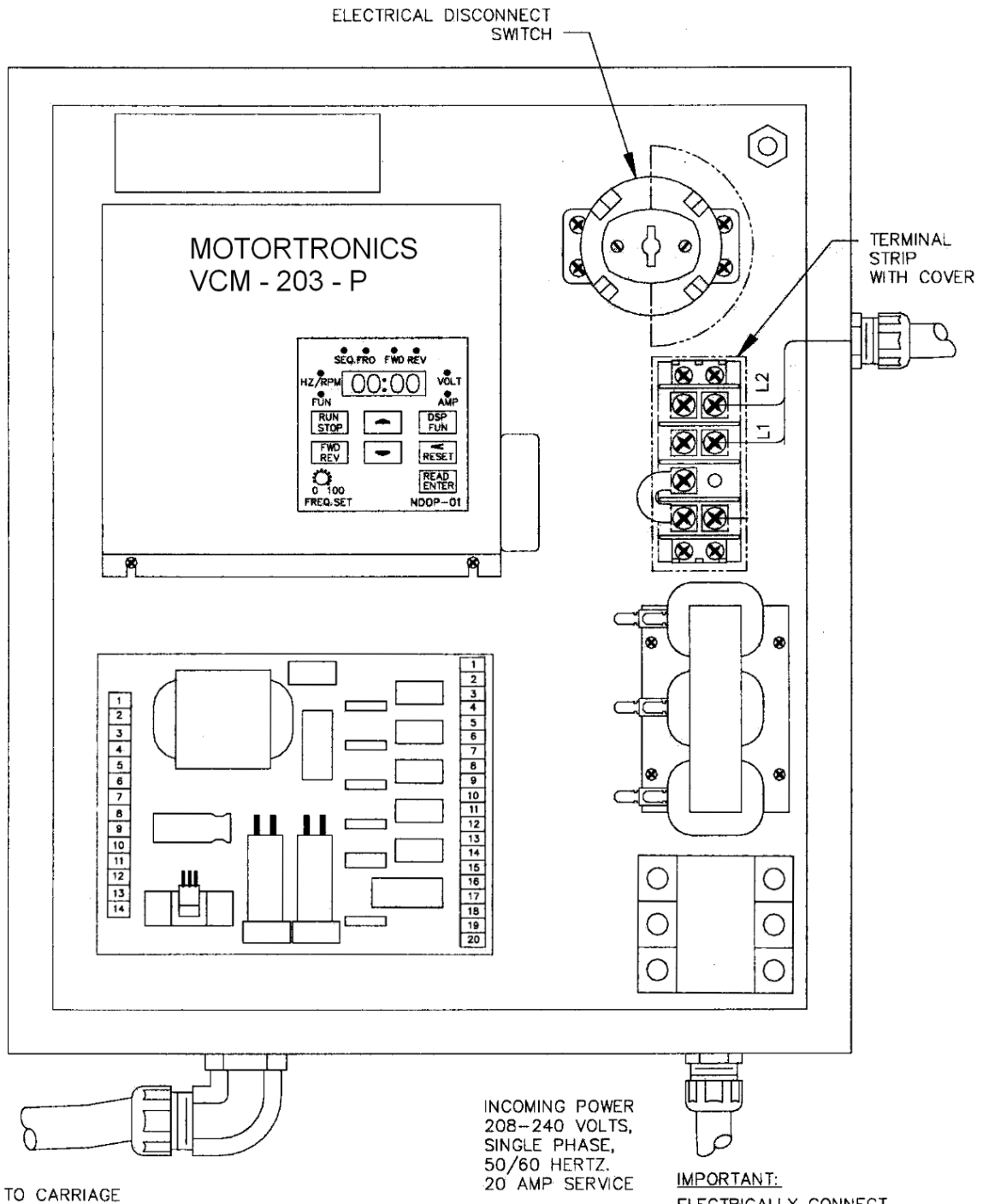
⚠ Note: *This machine requires the use of an electrical disconnect switch.*

⚠ CAUTION . This machine cannot be run on 440 volts. A transformer must be installed if 440 volts must be used.



Single Phase Electrical Hook-up:

REF:HP6A-11-11032001



IMPORTANT:
ELECTRICALLY CONNECT
IN ACCORDANCE WITH
NATIONAL ELECTRICAL
CODE AND YOUR LOCAL CODES.

Chapter 2 Control Definition:

The following information describes the sequence of control actions.

Description of Operation:

The HP6A hone has several modes of operation, all modes of operation are listed below.

- Target Load
- Target Load with auto short stroke and auto dwell options.
- Plateau Mode

Target Load (Standard):

In this mode of operation the operator will set a Roughing load and a Finish load on the control panel for the HP6A to operate at. For this example we will set the Roughing load at 70 and the Finish load at 30. These are percentages of full motor load. Once the automatic cycle is started the machine will automatically feed the stones out one increment at the bottom of each stroke until the Roughing load is reached. Once the Roughing load is reached the machine will maintain that load by feeding out when the load drops below 70 percent. This process will continue until the feed ring activates the Finish load sensor.

Once the Finish sensor (located on the rear of the Gearbox) has been activated the machine will automatically switch to Finish mode and display the set Finish load value. The machine will no longer feed out. It will continue stroking until the displayed load value matches the set Finish value. Once these values match machine will automatically stop at the top of the cylinder.

Note: *To set the Finish load the Finish sensor must be activated, otherwise the machine will display the Roughing load.*

Target Load (Auto Short Stroke and/or Auto Dwell):

This mode operates the same as the Target Load (standard) with some options. You are able to turn the Auto Short Stroke and Auto Dwell on and off in the Roughing as well as Finish modes of operation. Refer to the Machine Parameter table on page 2.5 for these address codes and their settings.

Short Stroke:

When the controller notices that the load in the lower $\frac{1}{4}$ of the bore is 10% higher than the average of the rest of the cylinder it will automatically short stroke to remove the taper. The short stroke cycle consists of ten (10) short strokes at the bottom of the cylinder and then four (4) normal length strokes. After this cycle the controller will again compare the loads and short stroke again if necessary.

Dwell:

When the controller notices that the load in the lower $\frac{1}{4}$ of the bore is 10% higher than the average of the rest of the cylinder it will automatically dwell to remove the taper. The amount of dwell time can be set in the Machine Parameter table on page 2.5. After this cycle the controller will again compare the loads and short stroke again if necessary.

Note: *This feature should only be used on blocks that have a interference problem in the lower portion of the bore that does not allow enough over stroke to be set. If this mode of operation is used continuously without setting the proper amount of over stroke, the stones can get uneven wear on them, increasing the amount of taper and problems in honing.*

Plateau Mode:

Plateau mode was designed to be operated with brushes and ridged abrasives after the main honing process is complete. To place the machine in Plateau mode, put the Rocker Arm in the park position and then press the "Inc" and "Dec" buttons at the same time. When you release these buttons they should start flashing. When the buttons are flashing, that indicates the hone is in the Plateau mode of operation.

Pressing the auto cycle in this mode will automatically start feeding the stones out one increment for every stroke until a 20% load is reached on the display. Once the 20% load is reached the machine will start counting down each stroke until the displayed number in the Rough/Finish display reaches zero. When in the Plateau mode the number of strokes that the machine is going to count down is set by pressing the "Inc" or "Dec" buttons and is displayed in the Rough/Finish display area.

Emergency Stop Button:

Pressing the E-Stop button cuts the power to the display circuit board, and cuts power to the various relays throughout the machine. All machine functions are stopped. If the machine is stroking when the E-Stop button is pressed, it may continue stroking until it reaches the top of the travel, depending on the load on the hone stones.

To restart, turn the E-Stop button counter clockwise, and it will 'pop' out. The machine will take approx. 5 seconds to reset, before it will be ready to run again.

Park Position Limit Switch:


An electrical limit switch is located on the carriage under the rocker arm pivot. Both the normally open and normally closed terminals hook up this switch. A cam on the rocker arm activates the switch. When the rocker arm is lowered into its working range, the switch is activated and it allows the air control solenoid valve and the motor drive to be energized. When the rocker arm is raised back up to the park position the switch is deactivated and the electrical control circuit loses power and the motor load display blanks out. The two display areas will then read PARK.

Push Buttons:

When push buttons on this display are activated they will light up. When they are deactivated they will go dark. When the machine is running an automatic cycle the associated push buttons will light as the machine operates the functions automatically.

Start/Stop Button:

Pressing the Start/Stop button will start the spindle rotating at the speed set by the potentiometer on the side of the control panel.


 **WARNING** NEVER start the spindle with the hone head out of a cylinder block. The Hone head could come into contact with the operator.

The spindle motor drives the hone head, through a V-belt and then a gear reduction box. The spindle motor will not operate unless the Park switch is activated (rocker arm down and locked into place).

Pressing the Start/Stop button again will stop the spindle rotation. If any other functions of the machine are running, such as stroke or auto cycle, all functions will be shut off.

Stroke Button:

Pressing the stroke button will energize the down stroke solenoid.

 **CAUTION** NEVER activate the stroke button without the stroke adjustment lever locked into place. This can cause damage to the machine and injury to operator.

The solenoid provides air pressure to the stroking cylinder on the topside forcing the rocker arm down. The solenoid is electrically controlled from the computer in the control panel, and is kept energized until the lower limit switch is activated.

Once the lower limit switch is activated the computer will shut off the down air solenoid and energize the up air solenoid. The up air solenoid provides air pressure to the bottom of the stroking cylinder forcing the rocker arm to move up, and will remain energized until the upper limit switch is activated. Once activated it will again force the rocker arm down. These actions will continue seamlessly until the Start/Stop, Stroke, or E-Stop is pressed. If the machine is running an automatic cycle the stroking will continue until the cycle is finished or any of the fore mentioned buttons are pressed.

Stroking Speed Control:

The rear cylinder on the carriage provides smooth control of the stroking motion, and stroking speed control. This hydraulic cylinder pumps liquid back and forth through a ball valve, which is located on the right side of the carriage.

Opening and closing this valve changes stroking speed. The current strokes per minute are displayed on the control panel. The strokes per minute can be changed at any time during the honing process.

A reservoir is located on the carriage behind the rocker arm pivot. This reservoir compensates for volume change due to temperature variations. The reservoir liquid is fed through a check valve, located on the side of the reservoir.

Hone Head RPM Control:

A potentiometer is located on the left-hand side of the control panel, and is used to vary the speed at which the hone head rotates. This potentiometer connects to a AC, 3 HP Inverter drive. The hone head has a variable speed between 85 and 285 RPM's. Turn the potentiometer clockwise to increase speed and counter clockwise to decrease speed. Use the formula on page 3.5 to determine Cross Hatch angle, RPM and Stroke Rate.

Short Stroke / Bottom Dwell Button:

The Short Stroke / Bottom Dwell button is located on the lower left hand side of the main control panel on the front of the machine. The button is electronically connected to the main computer in the control panel. This button has two (2) functions. It can be a short stroke at the bottom of the cylinder or it can be a dwell button at the bottom of the cylinder. Which function is used is determined by a address code setting. The Address Code that controls this function is number 75. Refer to the Machine Parameter table on page 2.5 of this manual for usage. If programmed for short stroke the control will energize the Up and Down solenoid in quick succession at the bottom of the cylinder for as long as the button is held in. If it is programmed for Dwell the head will stay down at the bottom of the cylinder and rotate until the button is released.

Note: *The Short Stroke / Dwell button is generally not needed when using the automatic cycle. As the Auto Cycle finishes it will straighten out the cylinder. Short stroke is usually only used when there is a clearance issue at the bottom of the bore that will not allow enough over stroke to be set.*

Finish RPM Bypass Switch:

This switch is for bypassing the preset finish mode RPM setting. In certain circumstances the desired cross hatch angle can not be obtained using the preset RPM in finish mode. In the off position the operator can control the spindle RPM using the control knob to obtain the desired cross hatch angle.

Strokes Per Minute Display:

This is the upper left display that counts and displays the number of strokes per minute the Rocker Arm is transitioning up and down.

Note: *The display needs a minimum of two strokes to display an accurate count. This display has the same operation in all modes of operation.*

Rough/Finish Load Display:

This display shows the set Rough and Finish loads the machine will operate at when running an automatic cycle. These values are changeable by pressing the “Inc” and “Dec” buttons on the front control panel. The Rough Load can be changed at any time by pressing these buttons. The Finish Load can only be changed when the feed ring activates the Finish sensor. The Finish sensor is located in the back of the gearbox.

When in Plateau Mode operation this display will show number of strokes to count down from, after the target load is reached.

Coolant Push Button:

This button turns on and off the coolant pump motor. If coolant is flowing and the Rocker Arm goes into the park position the coolant flow will stop and the light on the button will go off.

The lever on the left-hand side of the main carriage regulates the amount of coolant flow.

Manual Feed Button:

This button has two modes of operation, one in Standard mode and one in program mode.

Standard Operation:

Pressing this button will feed the hone stones out manually. One press of this button will feed the stones out .001” on the Standard, Junior and Minor hone heads. It will feed out .0003” on any of the Precision hone heads.

Programming Mode:

Refer to the Control Program section in this manual for this buttons function in the programming mode.

Auto Feed Button:

This button has two modes of operation. One in Standard mode and one in program mode.

Standard Operation:

Pressing this button will start the Auto Cycle of the machine. When an Auto Cycle is started, the control will start the Spindle, Stroke, Coolant and Feed controls. The cycle will continue until the finish parameters are reached. For description of Auto Cycle operating parameter refer to the Description of Operation earlier in this section. Pressing the Auto Cycle button once the cycle has begun will cause all functions of the machine to be shut off. Spindle Stop button will also shut off all operations of the machine if pressed while an Auto Cycle is running.

Programming Mode:

Refer to the programming section in this manual for this buttons function in the programming mode.

Control Program:


Almost all of the programming for the HP6A hone is hard written (cannot be changed by operator) into the CPU. However, there are a few variables that can be changed on the machine to set the control to the exact machine it is operating. These variables are called Address Codes throughout this manual. A list of these variables follows later in this section.

NOTE: *Changing any of the variables in the control without factory permission and direction may result in a non- operational machine and void factory warranty.*

Programming Mode:

When the machine is powered up it automatically goes into the standard operating mode. To put the machine into programming mode use the following steps.

- ✓ Machine must be out of the Park position.
- ✓ Machine must be powered up and ready for operation.
- ✓ Press the E-stop in and leave it in.
- ✓ Press and hold the Auto Feed key.
- ✓ While holding the Auto Feed key release the E-stop.
- ✓ When the machine is in programming mode a zero (0) will appear on the display. It is now OK to release the Auto Feed Key.
- ✓ When the Auto Feed key is released the zero that was display will change to a different value.

 **CAUTION** Controls are still active in programming mode. Observe all safety precautions that pertain to operating the hone.

You are now in the Programming Mode. Pressing and holding the Auto Feed key will display an Address Code designation (0-78). When you release the Auto Feed key the display will then show what value is stored in the last displayed Address Code. For example if you were holding the Auto Feed key in and the display said 0 that means you are looking at Address Code 0. When you release the Auto Feed key the data will change and display .012, this is the stored value for Address Code zero. Therefore, Address Code 0 = .012 and so on for all of the remaining address codes.

To change to a different Address Code designation simply press the “Inc” or “Dec” buttons while you are holding in the Auto Feed key.

To change the data stored in an Address Code use the “Inc” and “Dec” buttons when not holding in the Auto Feed key.

All changed data will be used to operate the machine until power is turned off. To save the changes you have made even after a power off condition, you need to press the Manual Feed key after you have made the changes and before you power down. If the Manual Feed key has been pressed the next time the machine is powered on the changes you have made will be present and operating the machine.

The following is a list of factory settings:

Address Code	Description	Factory Setting	Actual Setting
0	0 – 5% of Motor Load	.012	
1	5 - 10% of Motor Load	.012	
2	10 – 15% of Motor Load	.012	
3	15 – 20% of Motor Load	.012	
4	20 – 25% of Motor Load	.012	
5	25 – 30% of Motor Load	.012	
6	30 – 35% of Motor Load	.061	
7	35 – 40% of Motor Load	.086	
8	40 – 45% of Motor Load	.098	
9	45 – 50% of Motor Load	.110	
10	50 – 55% of Motor Load	.122	
11	55 – 60% of Motor Load	.135	
12	60 – 65% of Motor Load	.135	
13	65 – 70% of Motor Load	.147	
14	70 – 75% of Motor Load	.172	
15	75 – 80% of Motor Load	.172	
16	80 – 85% of Motor Load	.184	
17	85 – 90% of Motor Load	.208	
18	90 – 95% of Motor Load	.221	
19	95 – 100% of Motor Load	.221	
20-29	Not Used		
30	0 – 5 Strokes Per Minute	1.56	
31	5 – 10 Strokes Per Minute	1.56	
32	10 – 15 Strokes Per Minute	1.56	
33	15 – 20 Strokes Per Minute	1.19	
34	20 – 25 Strokes Per Minute	.77	
35	25 – 30 Strokes Per Minute	.67	
36	30 – 35 Strokes Per Minute	.57	
37	35 – 40 Strokes Per Minute	.47	
38	40 – 45 Strokes Per Minute	.37	
39	45 – 50 Strokes Per Minute	.37	
40	50 – 55 Strokes Per Minute	.25	
41	55 – 60 Strokes Per Minute	.19	
42	60 – 65 Strokes Per Minute	.18	
43	65 – 70 Strokes Per Minute	.13	
44	70 – 75 Strokes Per Minute	.11	
45	75 – 80 Strokes Per Minute	.11	
46	80 – 85 Strokes Per Minute	.07	
47	85 – 90 Strokes Per Minute	.01	
48	90 – 95 Strokes Per Minute	.01	
49	95 – 100 Strokes Per Minute	.01	
50-61	Not used		
62	Plateau Load Setting	5	
63	Deadband	10	
64	Minimum Motor Load Setting	1.2	
65	Maximum Motor Load Setting	6.3	
66	Short stroke Time Adjustment	.380	
67	Counter	N/A	N/A
68	Starting Target Load	50	
69	Factory Table Selection	1	
70	Plateau Stroke Setting	4	

71	Finish Mode Auto Dwell Selection 0 = Off 1 = Short Stroke 2 = Dwell	0	
72	Roughing Mode Auto Dwell Selection 0 = Off 1 = Short Stroke 2 = Dwell	0	
73	Roughing Mode percent of error	20	
74	Roughing / Finish Dwell time in seconds	10	
75	Short Stroke / Dwell button Selection 0 = Short Stroke 1 = Dwell	0	
76	Oiler Timer in 100 second increments	1XX	
77	Oiler Timer in 1 second increments	XX20	
78	Upper sensor lock out 0 = Disable 1 = Enable	1	

Shut Off Delay Knob:

This knob will add or subtract to the machines automatic calculated stop times. If the rotation of the head continues to long or stops early minor adjustment to the automatic stop time can be made by adjusting this knob. When the knob is at mid range the machine will use the automatically calculated stop times. Above and below the mid range will add or subtract respectively from the calculated time.

Motor Load Display:

The motor load display is divided into two parts. The single bar of lights across the bottom edge is the load bar. This light bar flashes out and back representing the average load along its scale, as the machine is honing. Motor load is measured and displayed as indication of tight and loose areas within a cylinder bore. Tight areas, areas where the bore is small, will cause the load bar to increase.

The rest of the display shows graphically the shape of the cylinder represented by the percent of motor load on the stones. As the machine is stroking, the series of lights in this section of the display, will show higher in the tight areas, and lower in the loose areas, creating a curve of the actual shape of the bore.

Clamp / Float Button:

This button is located on the right side of the carriage. The carriage is by default always in clamp. Press and hold the clamp / float button to float the carriage. This allows air to flow through a valve to a regulator, then out two ports of the regulator. Air from one port flow through the right orifice on the bottom of the float plate. Air from the other port flows through a flow control valve then to the left side of the float plate and out the orifice on the bottom of the float plate.

Auto Stop:

The auto stop feature, automatically switches to Finish Load when a predetermined amount of material has been removed.

The auto stop is located on the feed ring, above the handwheel, at the end of the rocker arm. This is a numbered band around the handwheel. With the number '0' lined up on the pointer, the sensor actuator will line up directly across from the sensor on the backside. This is the position in which the machine will switch to Finish Load.

To program for a certain amount of stock removal, rotate the feed ring to the desired amount and every time the hone head feeds out a click the sensor trip button will move closer to the sensor. After the desired stock removal the sensor will trip, switching the machine to Finish Load.

Note: *In order to start the Auto Cycle the feed ring MUST be rotated off the stop position.*

Lower Adjust Knob:

The lower limit is attached to a threaded shaft. This threaded shaft supports the switch that signals the stroke to go back up. Pull the rocker arm down to a point where the hone stones have the proper extension through the bottom of the cylinder bore. Loosen the lock knob, allowing the adjustment knob to be turned. Turn the adjustment knob to its correct position and lock down firmly with lock knob to avoid slippage.

When the machine is running the arm will go down until it hits the lower limit, reverse and go back up.

Upper Limit Lever:

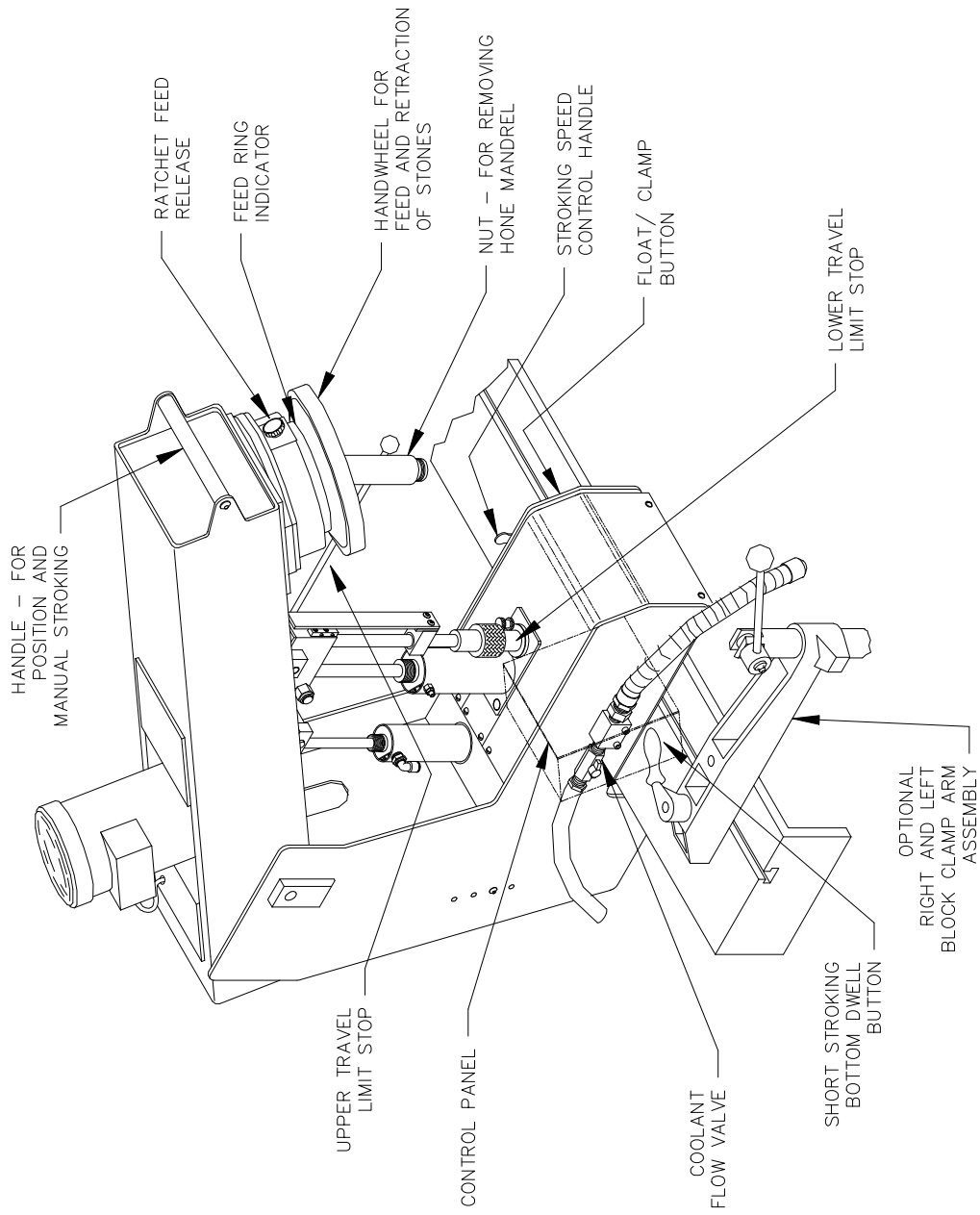
The upper limit lever is on the right side of the rocker arm. Tightening this lever clamps the rocker arm linkage to the stroke cylinder. The rocker arm is brought to the position where the hone stones are at the proper upper travel limit. The upper limit lever is then tightened and the rocker arm stays in position.

Note: *The lower Adjustment Knob must be set first.*

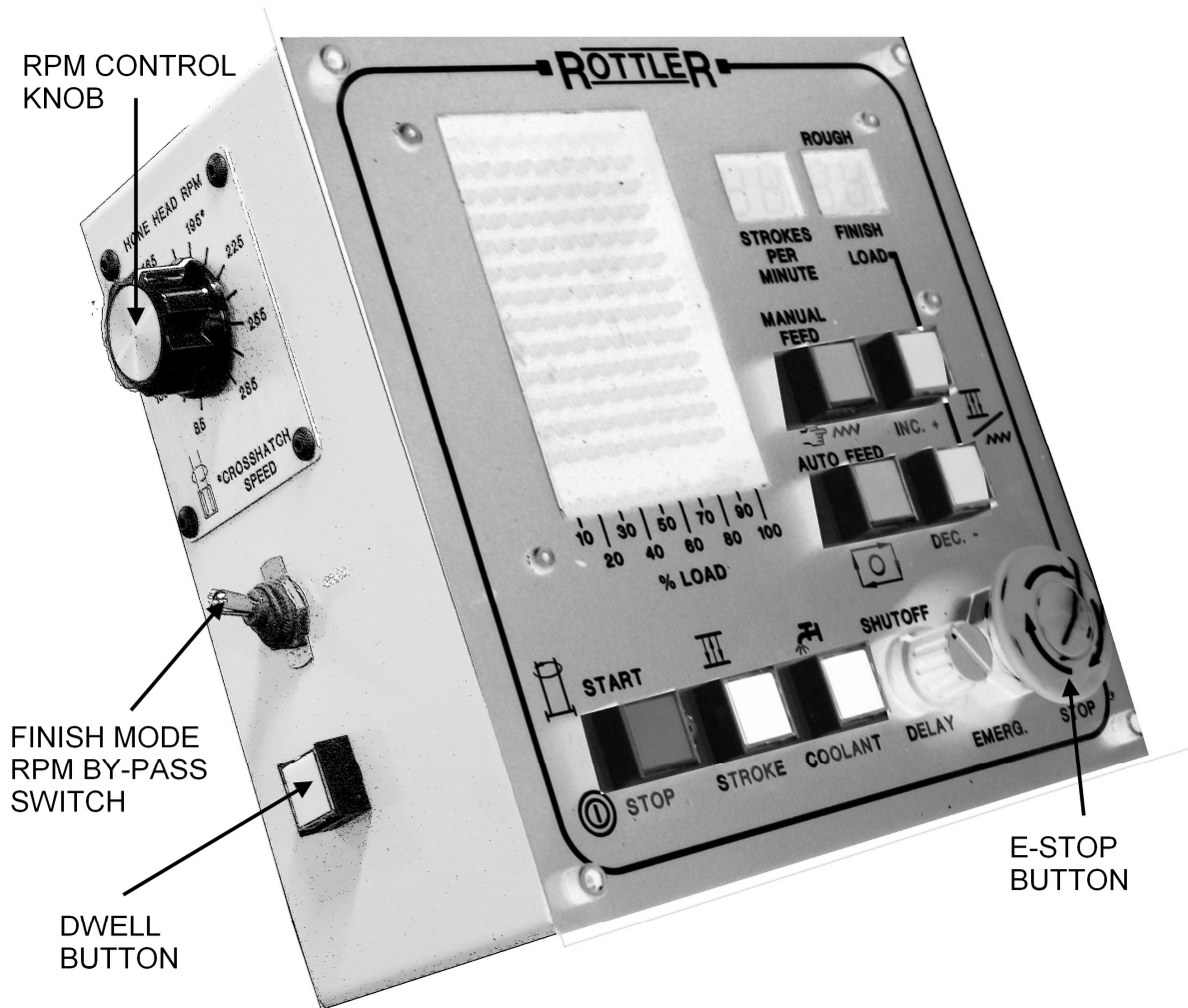
When stroke is started, the stroke cylinder pulls the rocker arm up and down.

Control Illustration:

HNE6-1-10092000



Control Panel Illustration:



Chapter 3 Operating Instructions:

Block Loading:

The block hold down fixture can be used for inline, 'V', and 'Y' blocks.

Move the hone carriage to the far right of the main base.

Place block supports onto cradle with key engaged into slot (see page 6.25). Place supports on edge for blocks with exposed main bearing caps (V-block). Place supports flat for blocks with main bearing caps recessed above the pan rail (Y-block).



CAUTION *Main bearing caps must be "ON".*

Place clamp bar through main bearings of block.

Rotate clamp screw out of the way.

Lower the block into the fixture. Align the clamp bar with the front clamp bar guides on the cradle ends. Pull the block toward you after the bar engages the front guides. The clamp bar will rotate into its clamping position. Allow the clamp bar to slide down these guides as the block is lowered.

Rotate clamp screws forward and clamp the bar evenly.

Squeeze the index handle on the right side of the fixture to allow the fixture to rotate. Release the handle allowing the stop block to fall into the appropriate slot in the index plate. After honing the first bank of a V-block, simply squeeze the handle and rotate the fixture so the other bank is in position for honing.

Setting the Bottom and Upper Stops:

Check for possible interference points in the lower part of all cylinders. Push the Clamp/Float button on the side of the hone carriage and move the machine to the cylinder that has the highest interference point. The bottom stop should be set in this cylinder.

Measure the distance from the top of the cylinder to the bottom of the cylinder to obtain the cylinder length. The over stroke distance should be approximately 1/2". Less if there is interference. Add the cylinder length and over stroke length to obtain the bottom stop length.

Expand or contract the stone assembly to the approximate bore size. To expand: turn handwheel counter clockwise (looking from the top). To contract: pull and turn ratchet feed release, turn handwheel clockwise (looking from the top).

Use the handle to pull the stroking arm down and to touch the bottom of the stone to the top of the engine block. Lock the stroking arm in this position using the upper stop lever.

Rotate the lower Adjustment Knob to the correct bottom stop length (cylinder length plus over stroke) using the bottom stop scale and the bottom of the pivot block.

Note: *The stroke length gauge is not to scale and should be used for reference only.*

Unlock the stroking arm and pull the stroking arm down against the bottom stop. **Make sure you pull hard enough to collapse the lower stop bumper.** At this position rotate the hone head one turn to make sure there are no obstructions. Adjust the bottom stop and re-check for obstructions if required. Bottom stop setting will not have to be changed in this block unless there is an obstruction in one of the other cylinders.

CAUTION

If the hone head crashes into a web or obstruction the pinion will twist or break. This condition *is not* covered by warranty.

Raise hone head until stones extend about 1/2" out of the top of the block. Lock the upper stop in this position. Do not over tighten.

Automatic Cycle Operation

Automatic Load:

When operating in Automatic Cycle, the machine will maintain a set motor load percentage until the desired amount of material has been removed from the bore. The Rough and Finish Load is set using the "Inc +" and "Dec -" buttons on the control panel and can be changed at anytime.

Rough Load:

When the feed ring is on any number other than zero and the machine is in Automatic operation the control will automatically maintain the Rough Load value set in the control display.

Finish Load:

When zero is reached on the feed ring in Automatic Cycle operation, the machine will automatically switch to a preset Finish Load, and continue stroking until this value is reached. Refer to page 2.3 to set the Finish Load. Once the Finish Load is activated by the feed ring, the value can be change while operating. The Finish Load value has a large effect on the finish cylinder accuracy. Thin wall cylinders generally require a lower finish load for accuracy than thick walled cylinders. The finish load is commonly set between 15% and 40% depending on the accuracy required.

Start Honing:

Press Start / Stop button once. This will start the hone head turning. Press the Coolant button, be sure the coolant is flowing directly into the cylinder being honed. Press the Stroke button to start the Rocker Arm stroking. Using the hand wheel feed out the stones until the load meter reads the same as the value set for the Finish Load. When this value is obtained engage the "ratchet feed release" to prevent the hand wheel from turning. Now turn the feed ring for the desired stock removal and lock in place using the setting thumbscrew pictured on page 6.7.

The machine is now ready to begin an automatic cycle. Press the Auto Cycle button and the machine will automatically feed out until the set Rough Load is reached. Once the rough load is reached, the machine will automatically maintain that load until "0" is reached on the feed out wheel. When "0" is reached the machine will display the Finish Load and continue to hone until the Finish Load is reached. When the Finish Load is reached the machine will stop at the top of the stroke.

Manual Stroking:

For some jobs you may wish to manually stroke the hone. This is done the same as any other honing sequence except, don't lock the upper travel limit lever, and don't press the stroke button. Use the Start / Stop button to start and stop the hone head rotation. Pump the Rocker Arm up and down by the handle on the end.



WARNING DO NOT operate the power stroking without upper travel limit lever locked. Damage to the machine and injury to operator may occur.

Limited Over Travel and Blind Holes:

A problem with stock removal with hone heads exists on many of today's blocks and cylinders. It may be necessary to relieve bores with a die grinder, portable grinder or boring bar.

Cross Hatch Angle:

Below is a formula used to determine what Strokes Per Minute and RPM to use to get a given cross hatch angle. This formula is also available in Microsoft Excel format from Rottler Manufacturing via e-mail or floppy disk. Several factors affect the crosshatch angle, below is a definition of these factors as they are used in the formula.

RPM = Revolutions Per Minute the hone head is turning

L = Stroke Length. Actual length the hone head is moving up and down.

DIA = Bore Diameter

SPM = Strokes Per Minute of the Rocker Arm

A = Cross Hatch Angle

Mathematical Equation for SPM with given angle: $(\text{TAN}(A/2))(*\text{DIA}*\text{RPM})/(0.6366*L)$

You will need a Scientific calculator to figure the TAN (tangent) or use the following table to get the Tangent for a given angle.

Example:

A = 27 Degrees

DIA = 4.00

RPM = 195

L = 4.00

$(\text{TAN}(27/2))(*4.00*195)/(0.6366*4.00)$ – Instead of doing the calculation in the shaded area use the table to get the Tangent for that Angle as such: $(.2400)(*4.00*195)/(0.6366*4.00)$

ANGLE	TANGENT	ANGLE	TANGENT
20	.1763	30	.2679
21	.1853	31	.2773
22	.1943	32	.2867
23	.2034	33	.2962
24	.2125	34	.3057
25	.2216	35	.3152
26	.2308	36	.3249
27	.2400	37	.3346
28	.2493	38	.3443
29	.2586	39	.3541

The remaining equation would be as follows:

Step 1, multiply first set: $.2400 \times 4.00 \times 195 = 187.2$
 Step 2, multiply second set: $0.6366 \times 4.00 = 2.5464$
 Step 3, divide Step 1 by Step 2 $187.2 / 2.5464 = 73.5$ or 74 Strokes Per Minute

Honing In General

The HP6A is capable of honing a cylinder very accurately with very little or no work from the operator. The goal of the operator should be to set the Upper and Lower Stops correctly, select the proper stone length, and honing pressure that will allow the machine to hone the cylinder to size.

While the HP6A is running, pay attention to the load display (upper left on the control panel). The load display measures the actual motor load and displays it in percentage of rated motor current. As the HP6A is honing, the control takes current measurements from the motor throughout the length of the cylinder and displays them with the lights. The farther the lights move to the right the smaller the bore is

in that area. For example, if the lights near the bottom of the display move farther to the right than the rest of the lights, it means the bottom of the bore is a slightly smaller diameter near the bottom. The same would be true for the top and middle of the bore.

Large Amount of Material Removal:

When you have large amounts of material to remove from a cylinder (.005 and up) the following steps should be used to maintain size control.

For stock removal of .010 or more it is best to use a two step process. Start with 80 grit stones (.004" removal per minute) and bring all cylinder to within .005" of the final size. Switch to stones that will leave you the desired RA value and remove the final amount of material.

When there is less that .010" to remove start with 270 grit stones and bring cylinders to within .002" of final size. Switch to stones that will leave you the desired RA value and remove the final amount of material. You can also use the 270 grit stones and bring the cylinder to final size. Then install finishing stones and use the Plateau Mode of operation to bring the cylinder to your desired RA value.

Common Surface Finishes:

Today's modern engines are demanding smoother and more precise surface finishes. There are two commonly used plateau surface finishes in automotive engine cylinder bore finishing today. They are both described below. The single step, non-plateau finish is no longer recommended for engine cylinder bores. The processes described below are commonly used in the engine building industry. If the engine or ring manufacturer recommends a particular finish the engine manufacturers specifications or ring manufactures recommendation should be followed.

Non-Plateau:

The typical Ra finishes used for a Non-Plateau finish should be in the 16-24 range. A 16-24 Ra finish leaves adequate peaks to be knocked off during the engine break in period yet is not so rough as to cause oil burning problems before the cylinder walls have been plateaued by the rings. During initial start up of the engine the rings will create the plateau by knocking off the peaks of a non-plateau finish. Most modern ring manufacturers do not recommend using this type of finish.

Plateau

Plateau surface finishes are required to meet the demands of the modern engine designs whether the engine is a standard automotive engine or a performance engine. There are sophisticated measuring devices able to measure the details of a plateau finish. Although the cost of these devices have lowered significantly in the last few years, they are still cost prohibitive to the average shop. Rottler has established honing procedures, if closely followed, will produce a finish meeting the specifications of the engine or ring manufacturers.

Below are the current finish recommendations for most automotive engines.

Ra	10 to 20
Rpk	10 to 20
Rvk	30 to 60
Rk	25 to 50

The Plateau finish has become very popular. One of its purposes is to minimize the break-in or ring seating period. A plateau finish involves the use of a roughing stone followed by a finer grit finishing stone. When the finishing stone is used, only a few strokes are required to create the plateau. If you were to continue honing with the finer grit stone you would eventually eliminate the plateau effect and create a simple non-plateau finish equal in roughness to the finish stone.

Plateau Caution

When using plateau brushes do not exceed 7 strokes. Doing so may cause burnishing of the bore surface, which lead to improper ring seating and excess oil consumption.

Following are two slightly different methods for achieving the above finish. They differ slightly depending on the end use of the engine.

Method 1

Cast Iron Rings or Tougher Duty Cycle Applications

This finish is used for cast iron rings or with moly rings where the end use of the engine is for tough or long duty cycle application – dirt track racing or standard automotive use.

Step One:

Use part number 514-9-14K (170/200grit) diamond stones. Use a roughing load of 50% and a finishing load of 20%. Hone the cylinder to size.

Step Two:

Use part number 514-9-14L for 5 strokes in each cylinder. You can use the brushing mode or make sure you have 20% load on these stones. Caution do not hone longer than 5 strokes or shorter than 5 strokes. This will affect your overall finish.

Step Three:

After using the 514-9-14L stones now install the 514-9-14H brushes for plateau finishing. Use brush setting on machine and brush each cylinder 3 strokes.

Method 2

Moly Rings or Shorter Duty Cycle Engine Applications

This finish is used with moly rings where the end use of the engine is for short duty cycles such as drag racing.

Step One:

Use part number 514-9-14J (270/325grit) diamond stones. Use a roughing load of 50% and a finishing load of 20%. Hone the cylinder to size.

Step Two:

Use part number 514-9-14L for 5 strokes in each cylinder. You can use the brushing mode or make sure you have 20% load on these stones. Caution do not hone longer than 5 strokes or shorter than 5 strokes. This will affect your overall finish.

Step Three:

Now install the 514-9-14H brushes for plateau finishing. Use brush setting on machine and brush each cylinder 3 strokes.

Productivity:

Whether using vitrified or diamond abrasives, the honing process should be studied to maximize the productivity of the work center while providing the desired end result. Following is an example of two different ways to accomplish the same end result of an 18-22 Ra non-plateau finish. The customer requires .003 in./0.07mm stock removal for honing after boring.

Single Step Honing:

Process:

Abrasive: Diamond 500 Grit.

Set machine stop to hone to size. 60 strokes per minute. Set the roughing load at 85%. Set the finishing load between 25 and 35%. At .0003 in./0.007mm per feed out a stock removal rate of .0015 in./0.038mm per minute is achieved. The result is 2 minutes of honing time per cylinder.

During this time the machine is running unattended allowing the operator to accomplish other tasks. Rottler does no longer recommends a single step honing process to finish engine cylinder bores.

Total honing time for a V8 block = 16 minutes.

Two Step honing:

Step One:

Abrasive: Diamond 270 Grit

Set Feed Ring to leave .0005" / .01mm maximum for second honing process. 60 Strokes per Minute. 70% Roughing Load and 30% Finish Load. When using the precision hone head you will achieve .003" / .076mm per minute stock removal. The result is 55 seconds of honing time per cylinder. During this time the HP6A is running unattended allowing the operator to accomplish other tasks.

Honing time for a V8 block = 7.3 minutes

Step two:

Abrasive: Diamond 500 Grit

Set Feed Ring to hone to size. 60 Strokes per Minute. 70% Roughing Load and 30% Finish Load. . When using the precision hone head you will achieve .0015" / .038mm per minute stock removal. The result is 24 seconds of honing time per cylinder.

Honing time for a V8 block = 3.2 minutes

Total honing time for a V8 Block with a Two Step Process = 10.5 minutes

Note:

When looking at actual honing time only, the two step process is 5.5 minutes faster than the single step process. Because the operator must change abrasives in the two-step process 1-2 minutes should be added for two abrasive changes. Considering the operator must position the machine in each cylinder two times for the two-step process, the time difference between the two methods is slight. The single step process allows for more operator uninterrupted free time.

The single step process would allow the operator to easily run two machines at one time or perform work other than honing.

The two step process becomes more effective as the ending surface finish requirement becomes smoother. If a 12 - 16 Ra finish was required, the honing time for a single step process would become approximately 24 minutes and the honing time for the two-step process would remain near 10.5 minutes. The two step process becomes more productive when more than .003 of material must be removed. The above calculations should be made to determine the best method for the customer's particular requirements. Actual times will vary depending on the engine block material, stock removal required, and the desired accuracy. The purpose of the above comparison help the user understand different methods may be used to obtain the same result and that there is a significant difference in potential productivity when comparing the different methods.

Using Vitrified Abrasives

Abrasive grades are available for most any finish you want to achieve. Two or three bond hardnesses are available with most grits. The right bond hardness will break down gradually depending on the grit used. Too soft a bond will lose abrasive excessively. Too hard a bond will chatter and start glazing the bore, with rapid heating and poor stock removal.

Finer grit stones generally break down much faster than coarse grit does. They must break down quickly to prevent the stone from loading or glazing.

Bond hardness will act differently with different cutting oils. Rottler abrasives were designed to be used with Rottler honing oils or equivalent. In general, Rottler honing oil is of low Sulfur content. Using other honing oils may have an adverse effect on the abrasive performance. Faster spindle rotation and light pressures will make abrasive act harder. Faster stroke speed and heavy pressures will make abrasive act softer.

Abrasive should wear relatively evenly and parallel to the shim support. If you encounter uneven abrasive wear, the cause may be damaged universal drive joint, unmatched stones, or misalignment of hone drive with cylinder bore.

Standard Vitrified abrasives **can not** be used in synthetic or water base coolants.

Generally, lighter honing pressures are required when using vitrified stones compared with diamond stones. The finer the grit the lighter the load should be as follows.

80 Grit40 – 60%
180 Grit40 – 60%
220 Grit30 – 50%
320 Grit20 – 40%
400 Grit10 – 30%
600 Grit05 – 25%

See H-Series Accessories for list of available abrasives.

Using Diamond Abrasives.

General

In the proper application, diamond abrasives are very effective for cylinder honing. The Rottler Precision Hone Head brings the cost of diamond honing down to a range that is much more affordable. Competitive hone heads require the purchase of multiple hone heads to cover the same size range as the Precision Head. The Rottler system is approximately 1/5 the cost.

Because of the long life of diamond abrasives the cost per hole of diamond abrasives is approximately 1/5 of the vitrified abrasives.

Diamond abrasives in combination with the Rottler Precision Honing Head make a very rigid honing head. The system will do an excellent job of truing tapered or out of round holes with little or no operator attention. An operator can set the roughing and finishing loads and expect the machine to hone the cylinder to size unattended with little or no attention. It is important to use proper stone pressure when using diamond abrasives. The roughing motor load setting should be in the 50 - 90% range. The finishing load should be set in the 20 – 40% area. Generally, the higher the roughing motor load reading the faster the stock removal. The lower the finishing load is set, the more accurate the bore will be.

The HP6A is capable of removing an unlimited amount of material from a cylinder with a high degree of accuracy. Generally, it is desirable for overall engine block geometry to use a boring machine to bore all material out except for .003 of hone stock.

It is important to use Rottler Synthetic Coolant, part number 514-4-71C, when using diamond stones. It must be mixed with water and maintained properly to give optimum honing results.

Note: When mounting new stones in holders it is recommended that you flat stone the back of the stones to remove any possibility of burrs causing misalignment of stones mounted in holders.

Scratching

Scratching in the cylinder looks as though a single grit of a larger abrasive particle has lodged between the cylinder wall and the hone head. Often the scratch will be less than one revolution of the hone head and it will follow the cross hatch angle of the honing machine. Several things can cause this problem.

Improper coolant mix.

The ratio of water to synthetic additive to water will change after the initial mix is put in the coolant tank. A Refractometer can be purchased to accurately check the ratio. When the ratio is measured as a percentage it should be 5 – 8%. This corresponds to a reading of 3-5 on the Refractometer. It is important not to confuse the percentage with the true Refractometer reading.

Unacceptable synthetic coolant brand.

Lack of abrasive dressing.

Dirty Coolant.

Breaking In A New Set of Diamond Abrasives

Rottler diamond abrasives are pre-radiuses to minimize the breaking in period. When a new set of diamonds is installed the surface finish obtained on the first few blocks will be 5-10 Ra rougher than after the break in period. You must hone 2 - 5 blocks before the surface finish stabilizes.

Dressing Diamond Abrasives

Diamond Abrasives use a metal bond to hold the individual diamond particles. Failing to dress the stones after honing 30 - 50 blocks will increase the pressure required to remove stock or the stock removal rate slows down significantly. This will result in finishes with excessive folded and torn metal. Undressed stones will also cause excess bore distortion and inaccuracies in the boring process. This is caused by the diamond abrasive dulling or the bond not breaking down. The edge of the stone will also become very sharp. This is a normal occurrence and is easily corrected by removing the holder/abrasive assembly, use a wire brush to dress the abrasive. A common method is to remove the stone holder from the hone head. Leave the stone in the stone holder and move the stone through a bench grinder wire wheel. The brush rotation should be across the narrow width of the stone. Turn the holder over and pass the stone through the wheel again. This process will return the abrasive to a like new cutting condition, and put a slight radius on the edge of the abrasive stick (approx. .005 inch.)

Torn Metal

This is often caused by improper coolant mix, lack of dressing, or the use of high honing pressure during the finishing process. The Rottler hone head is capable of very high loads. If problems with torn metal are encountered verify the coolant mix, proper dressing of the abrasives, and reduce the finishing load during the final hone stage. If required make several strokes by hand with minimum stone pressure (10-20%).

Stock Removal Rate

The hardness of the cylinder you are honing will affect the stock removal rate. If you find the stock removal rate for a given cylinder is slower than normal check to make sure you have properly dressed the stones. Improperly dressed stones can increase honing time by as 50% or more. Improperly dressed stones will also produce an unacceptable finish.

Diameter Range

Because the diamond abrasives break down very slowly, a single set of stones is limited in its diameter range. One set of diamonds should be used for each stone holder range. A set of diamonds can not be constantly changed from one stone holder size to another. The stones would constantly be in the break-in process and very poor performance or finishes will result.

Cross Hatch Angle and Washout

The ideal situation would be for a hone to change the direction it is traveling instantaneously. If this was possible the angle of the cross hatch would stay consistent through the entire cylinder. The Rottler HP6A uses high speed electronics in cooperation with an air driven ram to change the direction of travel. This reduces the amount of Cross Hatch wipeout considerably from a crank driven rocker arm. As a rocker arm changes direction, the rate of travel slows but the rotation speed of the hone head stays consistent. This is the cause of washout at the top and bottom of cylinders. Below are examples of ideal cross hatch, Rottler HP6A cross hatch and a crank driven cross hatch.



REFHNE6-40-02042003

It is possible to mistake the slight washout of the cross hatch at the top of the cylinder as the hone head rotating after it has come to a stop at the top of the cylinder. It is important to understand the difference in washout and over rotation.

Stroking Speed

The HP6A is set at the factory to operate up to XXX inches per minute of stroking speed without banging at the top of the cylinder. The strokes per minute indicator on the HP6A cannot be used to judge the Inches Per Minute the hone head is traveling at. Stroking at 60 SPM in a 6 inch cylinder is allot different than stroking at 60 SPM in a 10 inch bore. The following will show how to correctly calculate Inches Per Minute with the HP6A.

Stroke Length = Length of Bore + Top and Bottom Overhang of stones – Length of stones.

Inches Per Minute = Stroke Length X Strokes per minute

Example:

60 SPM in 6 inch bore.

Stroke Length = Length of Bore (6) + Top and Bottom Overhang (.5 Top and .5 Bottom) – Length of Stones (4) = 3. The actual stroke of the rocker arm is 3 inches.

Inches Per Minute = Length of Stroke (3) X Strokes Per Minute (60) = 180 IPM

Vs.

60 SPM in 10 inch bore.

Stroke Length = Length of Bore (10) + Top and Bottom Overhang (.5 Top and .5 Bottom) – Length of Stones (4) = 7. The actual stroke of the rocker arm is 7 inches.

Inches Per Minute = Length of Stroke (7) X Strokes Per Minute (60) = 420 IPM

As shown above, there is quite a difference in the speed the hone head is traveling. The excessive speed will cause the machine to “bang” at the top of the cylinder. The correct way to solve this is to lower the stroking rate and increase the RPM of the Hone head. Use the cross hatch angel calculation chart in this manual to determine correct stroke rate and RPM for your desired cross hatch angle.

Coolant:**Coolant types and Selection:**

When using Vitrified honing stones you must use a petroleum based coolant. Such as Mobil Met 33 or Upsilon or any equivalent light honing oil. This is required since vitrified honing stones are not compatible with water based synthetic coolants.

Diamond stones will work with oil or water based synthetic coolants, but work most efficiently with the water based synthetic coolants. Rottler Manufacturing recommends the use of Rottler 514-4-71C water based, synthetic coolant for diamond only applications. This coolant works best when mixed to a 5% – 8% solution.

Refractometer:

A Refractometer is used to measure the amount of coolant to water ratio. A 5% to 8% ratio will read a 3 – 5 on the Refractometer. It is important not confuse the ratio with the actual Refractometer reading.

Coolant to Water Ratio is 1:20 thus 1 gallon of coolant to 20 gallons of water.

Coolant Pump System:

The coolant tank on the HP6A will hold a maximum of 50 gallons of the selected coolant. Unless a Auxiliary tank is purchased, which will increase the capacity to 100 gallons.

Honing of Alusil, Silitec, and Lokasil Materials

These instructions are for honing Alusil and Lokasil materials with Rottler HP6A honing machine and water base coolant.

Equipment and parts needed

Machine: Rottler HP6A

Coolant: Rottler part# 514-4-71C

Hone Head: Rottler part# 514-9B

Stone Holders: Rottler parts determined by size of bore

Abrasives: Rottler 400 grit diamonds part# 514-9-14V (do not substitute different grit size)

KS finishing diamonds Rottler part# 514-9-18P

KS silicon exposing stones Rottler part# 514-8-18N.

Alternative to exposing stones is felt wipers and silicon compound. Rottler part# for felt wipers 514-9-21E. Rottler part# for silicon compound 514-9-21F

Instructions for Honing Alusil and Lokasil Cylinders

Cylinders should be bored to within .002 with a PCD insert. This is very important to prevent fracturing of silicon particles below the finish surface of bore. If PCD isn't used the exposure of the silicon will result in a defective sliding surface for piston and rings.

**NOTE: When using the diamond stones they should be trued in to diameter of cylinder by using them in cast iron cylinder the same diameter of aluminum cylinder being honed. This includes the KS finish diamonds also.*

Cylinders should then be honed on HP6A using Rottler 400 grit diamond stones (no substitutes only use 400 grit) to size with tolerance of +.0002 -.0000. Machine parameters should be set as follows: RPM 200 to 225, Honing loads should be set at 20% to 25% for roughing and 15% finish load.

Next install the KS finishing diamonds and run one cycle in the plateau mode. The plateau mode parameters for the HP6A hone are normally 20% load and 7 strokes per cycle. You will need to change these parameters (see operating instructions) to 10 strokes per cycle and a honing load of 15%. Cylinders should already be to size from previous step. You are not trying to remove much material with this operation. The need for this operation is to lower the surface finish for the next step.

**NOTE: Chamfer or break the edge of the exposing stones prior to using them in bore. This will help prevent chipping on stone edges.*

The last step in the process is to expose the silicon particles by eroding the surrounding metal away from the silicon particles. This can be accomplished with different methods. The first method (easiest and cleanest) is to use the exposing stones part# 514-918N. These stones will need to be installed in machine and run for two plateau cycles. The plateau cycles should be same as prior step (10 strokes and 15% honing load). The bores should be flushed with coolant after the first plateau cycle and then second cycle run. It is extremely important that during this last stage that operator not force exposing stones into cylinders. Operator should start stones slightly away from cylinder wall and let machine feed stones into cylinder wall at the 15% honing load specified. These stones are extremely soft and any forcing of stones into cylinder wall will shorten stone life.

The second method to exposing the silicon particles is to use Rottler part# 514-9-21E. These are a felt wiper that is used with Rottler part# 514-9-21F which is a silicon compound paste. When using this method the coolant will need to be shutoff. Take a small paint brush and apply paste to felt wipers and the entire cylinder. Install hone head in bore, hone for approximately 45 to 60 seconds per cylinder. Machine settings for this operation should be RPM 160 to 170, strokes per minute of 60, shut-off automatic stone feed up. Start machine and feed stones up manually until load reaches 15%. Let machine run for 45 to 60 seconds per cylinder. Reapply silicon compound to each cylinder. There is no need to over stroke cylinder during this process so shorten stroke length accordingly.

For honing the Lokasil and Alusil cylinders the preferred method is the use of exposing stones; however the other method will work.

When Honing Silitec Cylinders

When honing Silitec cylinders use the above method of boring and honing cylinders. When removing metal away from silicon particles the second method of silicon paste and felt wipers must be used for Silitec cylinders only.

Chapter 4 Maintenance:

Lubrication:



Refer to the Material Safety Data Sheets in Section 8 for information on proper use and handling of lubricants mentioned in this maintenance section.

Refer to illustrations on page 4.3 and a list of manufacturers and oil types on page 4.4.

Grease Fittings

There are two grease fittings located on the rocker arm pivot bearings. On the block hold down fixture there are two grease fittings. Each optional clamp arm assembly has one grease fitting.

Every 175 hours, these grease fittings should be greased, using Unoba EP 2 Multi-purpose grease, or equivalent NLGI-2 grease.

Gear Housing

The gear housing is located at the front end of the rocker arm. The gear housing is what drives and adjusts the hone head.

Every 1,000 hours, check the oil level in the gear housing. The arm must be in the horizontal position. Remove the plug on the upper left side of the gear housing. The oil level should be up to this hole. If oil is needed, add to this hole. ***Use any 20-weight (ISO VG-) non-detergent motor oil.***

NOTE: *DO NOT OVER FILL! If over-filled, oil will spill out of breather cap. To drain oil remove a screw from the stop sensor bracket.*

Universal Joint

The universal joint connects the hone head adjusting shaft assembly to the gear housing.

Every 8 hours, Lubricate the hinge points of the universal joint with 30 weight (ISO VG-) machine oil.

Automatic Lubricator

The oil injection lubricator is located on the back of the main base. The oil injector lubricates the stroking cylinder. The automatic injection lubricator is controlled by the program. The controller will activate the injection lubricator at a predetermined time interval. The time interval can be changed in the controller. See Machine Parameters.

When needed, add hydraulic oil to the reservoir. ***Use Mobil DTE 24 hydraulic oil, or any equivalent, highly refined, turbine, or hydraulic S.A.E #10 (ISO VG-46) or lighter petroleum oil (non -detergent) with medium aniline point (ASTM oil #2). Rottler sells lubricator oil by the quart, part # 514-3-93A***

NOTE: Only use oil that is compatible with Nitril seals, and will not cause them to swell.

DO NOT use compounded oils containing graphite, silicones, soaps or fillers. Hydraulic fluids containing phosphate esters (skydrol, fyrouel, pydraul, etc.) or fire resistant oils containing phosphate esters.

Air Filter / Regulator

To maintain maximum filtering and efficiency, and to avoid excessive pressure drop, the filter regulator must be kept clean. Erratic regulator operation or loss of regulation is most always due to dirt in the disc area. If the air supply is kept clean the regulator should provide long periods of uninterrupted service.

As needed, Depressurize and disassemble the filter / regulator (remove the *bowl, filter and disc assembly). Clean parts with denatured alcohol and blow out body with compressed air. When reassembling, make sure disc stem fits into its center hole of diaphragm assembly. If diaphragm assembly is replaced, make sure disc stem fits into its center. Tighten bonnet slightly more than finger tight (50 inch pounds).

Wash porous filter elements with denatured alcohol.

*Clean plastic bowl only with household soap.

Coolant Pump Honing Oil

The coolant pump is located in the back of the splash tank. The coolant drains under the block fixture into a sump under the machine.

Every 8 hours, change the filter paper. Change the honing oil when it gets dirty. When changing oil, completely clean tank and filter screen. ***Use 50 gallons max. of Mobilmet Upsilon or any equivalent light honing oil (ISO).***

Hydraulic System

This system is used to regulate the stroking speed.

Every 175 hours, check the hydraulic liquid level in the back of the carriage under the Rocker Arm. ***If hydraulic oil is needed add specified oil to the top of the reservoir. Remove breather to fill.*** Fill to mark on reservoir.

Use Mobil DTE EXCEL 46, or equivalent ISO VG 46 hydraulic oil.

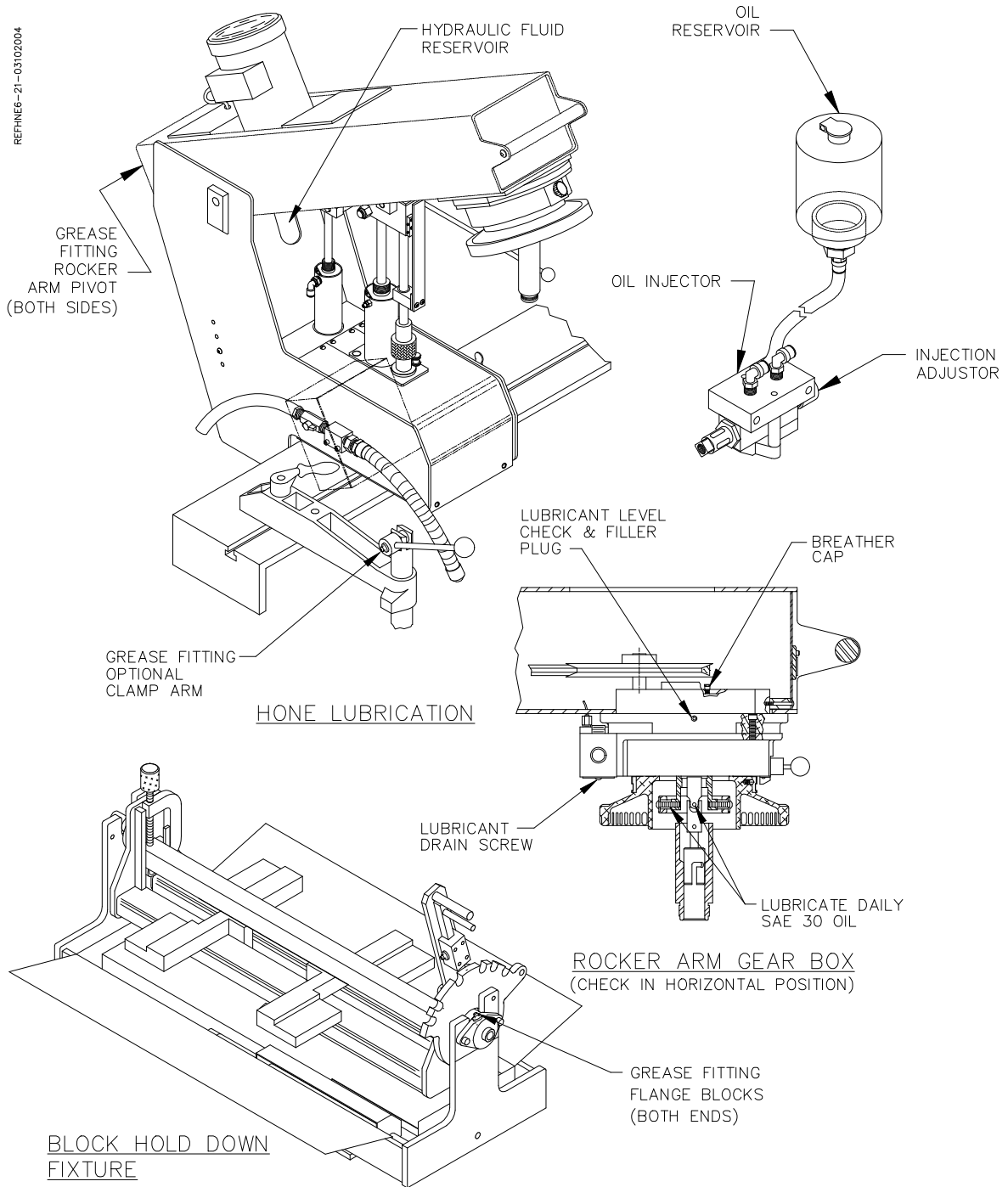
Muffler Exhaust

(See page 6.23)

The exhaust muffler on the main stroking system must be replaced periodically. If hone loses power in the stroking operation, a plugged exhaust muffler could cause it.

The exhaust muffler is located at the rear of the machine. Remove the mount screws from enclosure. Remove cover. Unscrew the muffler and replace with a new filter.

Lubrication Illustration:



Air Valve Lubricants:

Rottler Manufacturing has compiled a partial list of suitable oils for customer applications. If given a choice, this list should help avoid potential problems down the road. The information is provided as a result of recent lab testing and a great deal of field experience. The suitable oil should have an aniline point in the 180-210 range and a viscosity of 150-200 seconds at 100 PSI (S.A.E. #10).

The following oils, without additives, are satisfactory:

<u>Manufacturer:</u>	<u>Oil Number</u>
NFO	NFO 10 H/NR
NFO	NFO 10 W/NR
CHEVRON	AW 10 MACHINE OIL
CHEVRON	HANDY OIL 15
EXXON	TERESSTIC 32
MOBIL	MOBIL DTE LIGHT
MOBIL	DEXRON II ATF
MOBIL	AFT 210 TYPE F
MOBIL	DTE 13M
MOBIL	ALMO 525
MOBIL	MIST LUBE 24
MOBIL	DTE 24
MOBIL	HYDRAULIC OIL 13
MOBIL	HYDRAULIC OIL AW 32
WOLVERINE	A-INDUSTRIAL 150 R&O
TITAN	TYPE F ATF
TITAL	DEXRON II ATF
AMERICAN	INDUSTRIAL OIL 32

The use of Kerosene, animal or vegetable fats should be avoided for use as additives and or cleaning agents



Any penetrants such as WD40 or Marvel Wonder Oil should **NEVER** be used in the HP6A. Damage to the solenoid seals will result and are not covered by warranty.

Hydraulic System:

System Description:

The stroking action of the Rocker Arm is accomplished by applying air pressure to the top and bottom of the air cylinder, located in the middle of the Rocker arm. To control the speed of the air cylinder there is a closed hydraulic loop system. The Hydraulic fluid flow is restricted by the stroking speed control valve. As more or less fluid is allowed to pass through the speed control valve the faster or slower the Rocker Arm will stroke.

System Check:

With the machine running, watch the Rocker Arm and see if there is any jerking, or bouncing when the Rocker Arm is changing directions, slow down the stroking speed to 40 SPM. Jerking and bouncing indicate air in the hydraulic system.

Note: *At very slow stroking speeds, there may be some bouncing of the Rocker Arm at the bottom of the stroke. This is normal. Increase the stroking speed slightly.*

System Refilling and Bleeding:

Locate the Hydraulic Bleeder kit (514-3-30C) that came with the HP6A. It should include the following:

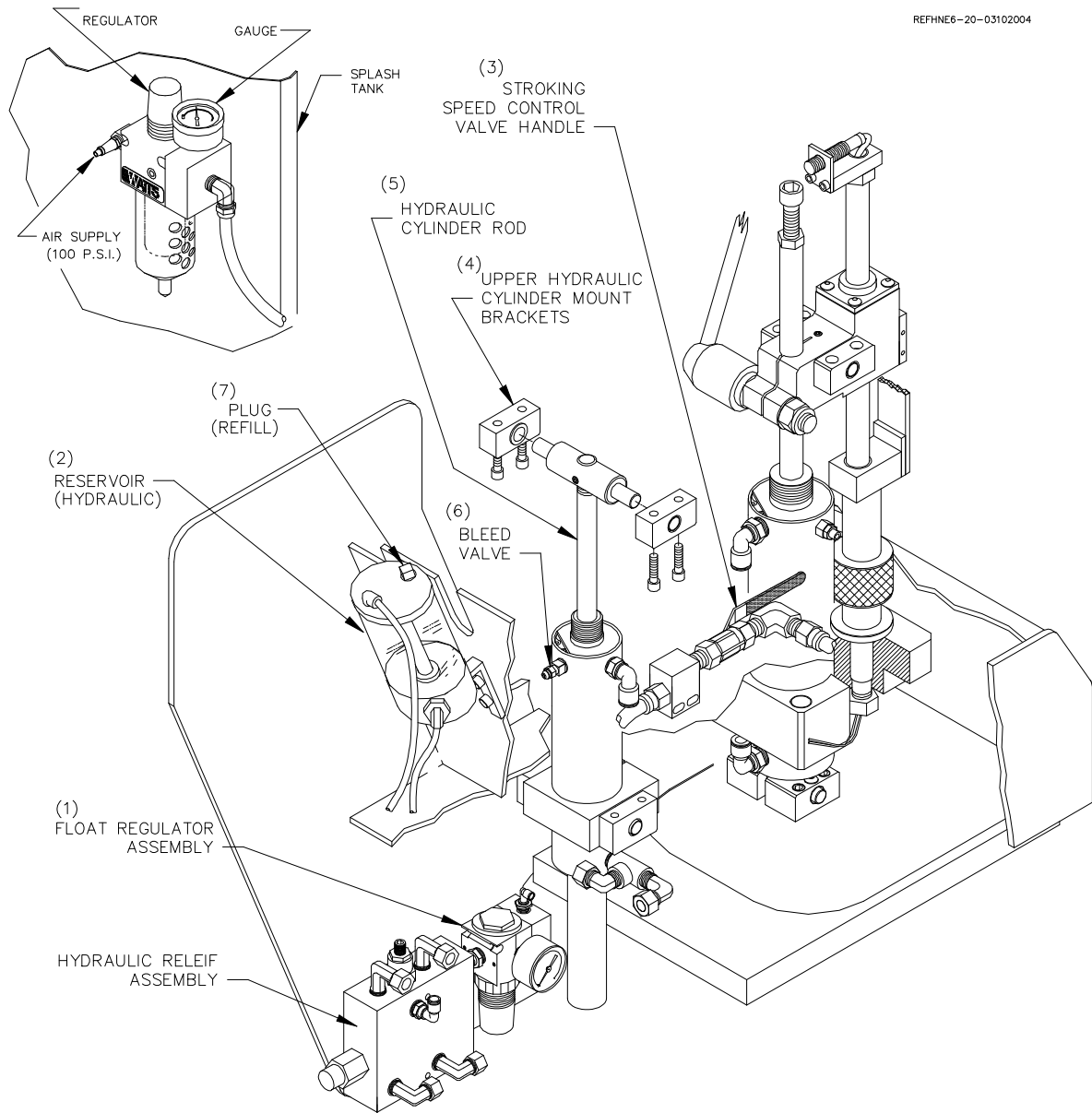
- (1) 502-11-17H – 3/8" to 1/4" adapter
- (2) 514-4-17W – 1/4" fitting
- (2 ft) 514-4-26 – 1/4" air line
- (1.5 ft) RX-514-3-30B – Clear Bleeder Tubing

- 1) Turn the main air off.
- 2) Remove power from machine.
- 3) Remove the Plug (7) from the top of the Reservoir (2). Fill the Reservoir (if it is not full) with specified hydraulic oil. Fill to the mark on the reservoir, do not over fill.
- 4) Insert one of the 1/4" fittings into the 3/8" to 1/4" adapter. Insert the 1/4" air line into the fitting. Screw the adapter into the Hydraulic Reservoir where the plug was removed.
- 5) Screw the other 1/4" fitting into an air nozzle.
- 6) Open the Stroking Speed control valve all the way. (This is the lever on the right hand side of the carriage. Turn it Horizontal.)
- 7) Disconnect the Upper Hydraulic Mounting brackets (4) from the Rocker Arm.
- 8) Push the Hydraulic Cylinder Rod (5) all the way down.
- 9) Slip the length of Bleeder Hose over the Bleed Valve (6). Run the other end of the hose into a small container.
- 10) Open the bleed valve. Apply no more than 15 PSI to the 1/4" air line that runs to the top of the Hydraulic Reservoir. As the air is applied to the reservoir, fluid will come out of the Bleed Valve.

NOTE: *Do not let all of the fluid run out of the Hydraulic Reservoir. This will induce more air into the Hydraulic System.*

- 11) Close the Bleed Valve and re-fill the reservoir.
- 12) Repeat the above procedure until there are no air bubbles coming through the bleed Hose.
- 13) Raise the Hydraulic Cylinder Rod (5) fully.
- 14) Repeat the filling and draining procedure again until there are no air bubbles coming through the bleed hose.
- 15) Reattach the Hydraulic Cylinder Rod to the Rocker arm via the Mounting Brackets.
- 16) Reapply air and electrical to the machine.
- 17) Start the machine stroking at 40 SPM, if there is still bouncing or jerking of the Rocker Arm repeat the bleeding procedure. Not all of the air has been removed from the Hydraulic System.

Bleeding Illustration:



V-Belt Adjustment and Removal



WARNING

Disconnect all electrical and air power before making any repairs.

V-Belt Adjustment

Remove the wedge shaped cover on top of the rocker arm. Loosen the 4 motor bracket mounting screws from the top of the rocker arm. Push the motor back until there is approximately 1/2 inch deflection of the v-belt. Measure deflection midway between the motor and the gear housing.

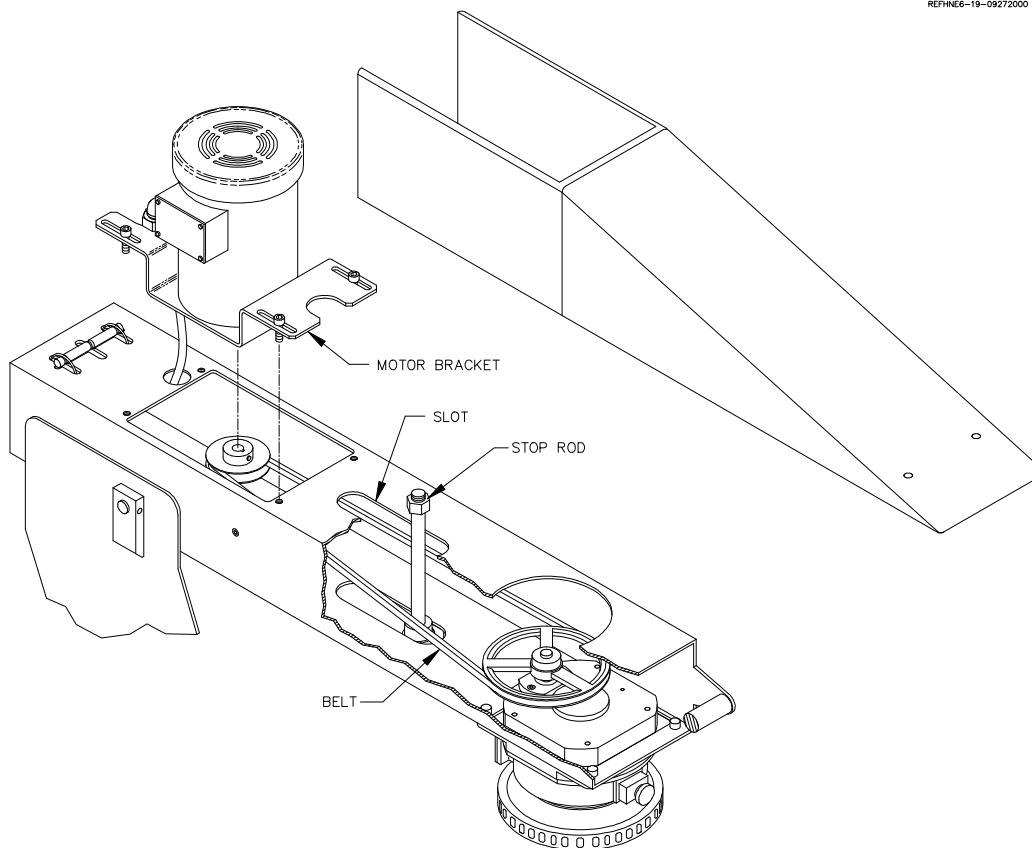
NOTE: *Do not over tighten belt.*

Tighten the motor mounting plate. Replace the front cover and tighten its screws.

V-Belt Removal

Remove the wedge shaped cover on top of the rocker arm. Loosen the 4 motor bracket mounting screws from the top of the rocker arm. Slide the motor forward. Remove V-belt through the stop rod slot in the top of the rocker arm.

Installation of the new belt is the reverse. See above for V-belt adjustment.



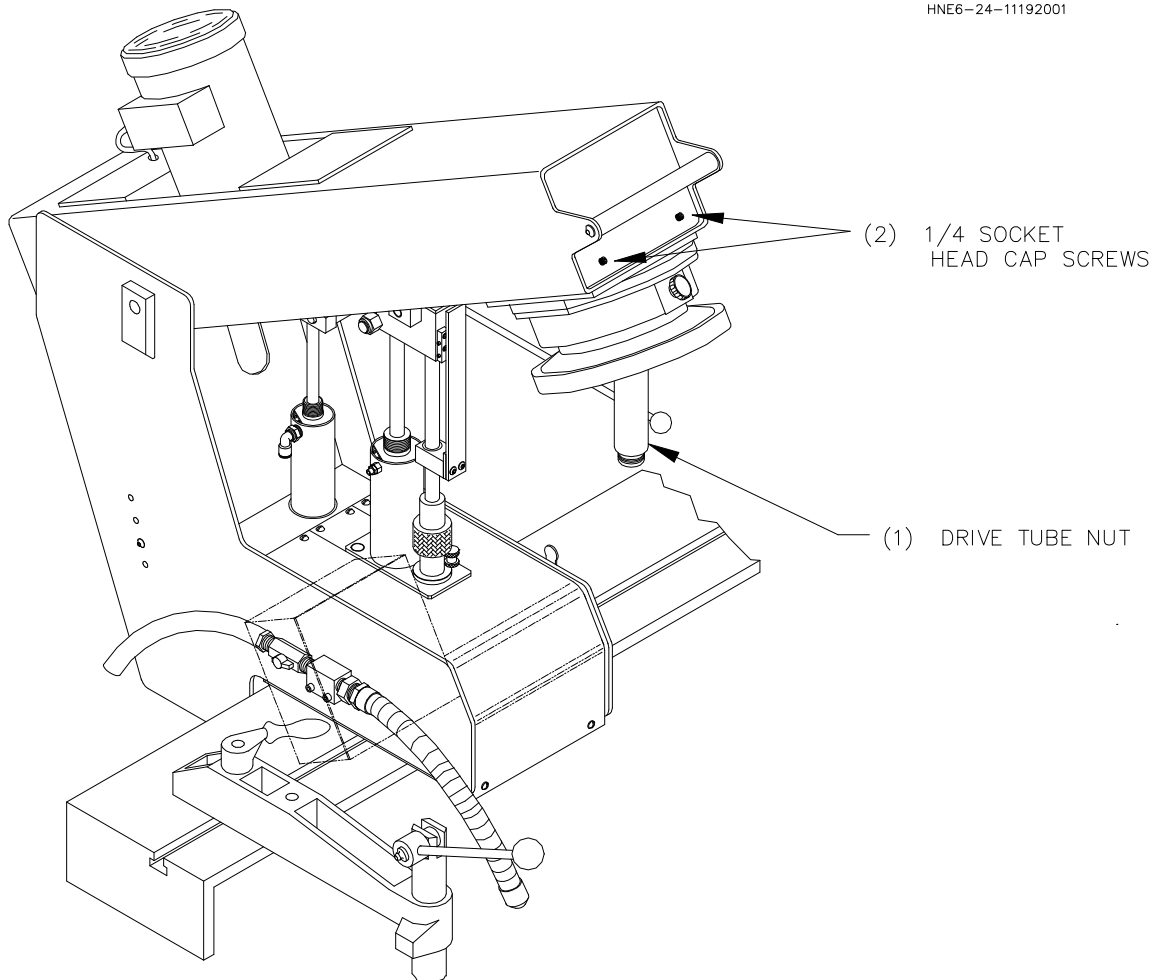
Gear Housing Removal:**WARNING**

Disconnect all electrical and air power to hone before making any repairs.

(1) Remove the hone head, at drive tube nut. The drive tube nut is located below the adjusting handwheel.

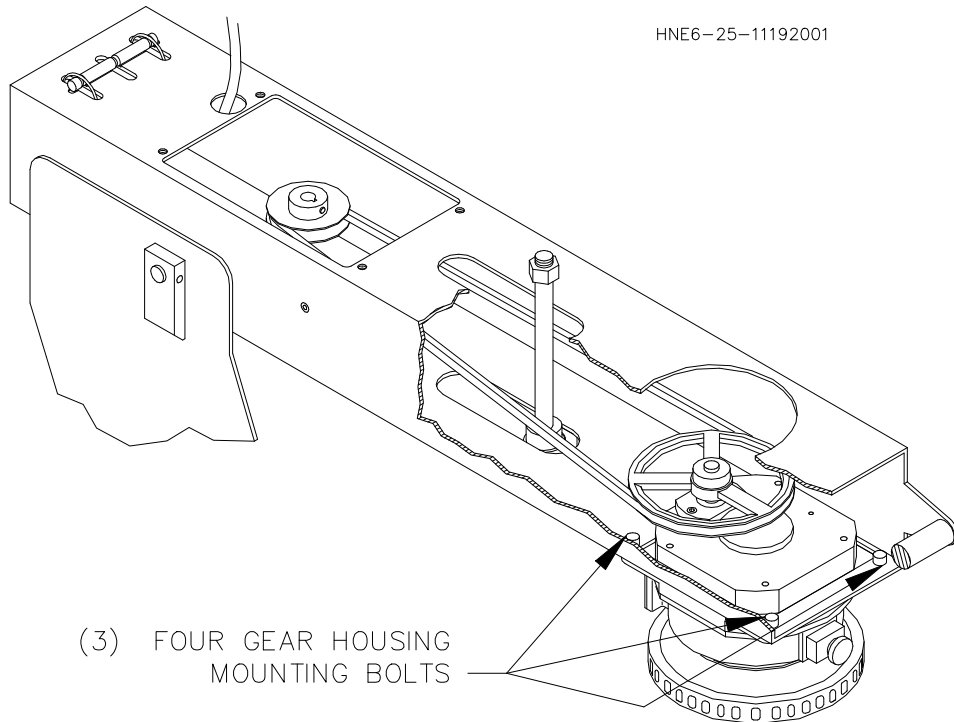
Remove the drive belt as described on page 4.6.

(2) Remove two 1/4" socket head cap screws in the front cover of the rocker arm.




- (3) Remove the four gear housing mounting screws, from inside the rocker arm.

Note: *The Pulley, air and sensor must be removed from the gear housing before it is removed from the machine.*



Note: *Use care, as the gear housing will be free to drop when all of the screws are removed.*

Adjusting Drag Pin Tension:

 **WARNING** *Disconnect all electrical and air power before making any repairs*

- 1 Remove top rocker arm cover to gain access to drag pin adjustment.



- 2 Loosen set screw holding drag pin housing in place.




- 3 Use large screwdriver to adjust drag pin tension. It may be necessary to use a wrench on the screwdriver to overcome hardened thread sealer.



- 4 When adjustment is completed tighten set screw on drag pin housing.
- 5 Replace top rocker arm cover.

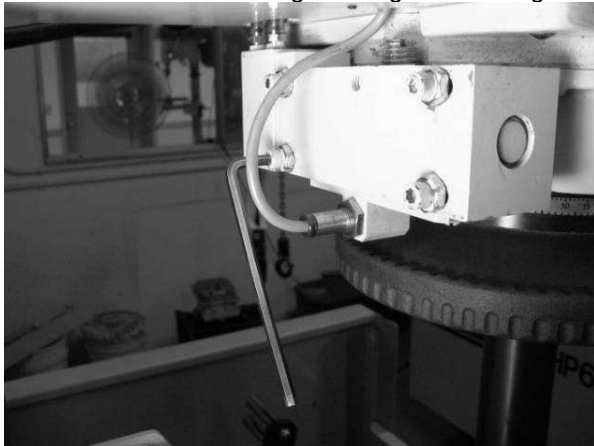
Adjusting Feed Out Actuator Housing:

 **WARNING** *Disconnect all electrical and air power before making any repairs.*

- 1 Place scribe mark on feed out actuator housing to mark original location.



- 2 Loosen 4 bolts holding housing to back of gearbox.



- 3 Use rubber mallet to move housing to the left or right as needed. Take caution not to strike shifting spool pin.
- 4 Tighten bolts then test feed out performance.
- 5 Make further adjustments as needed.

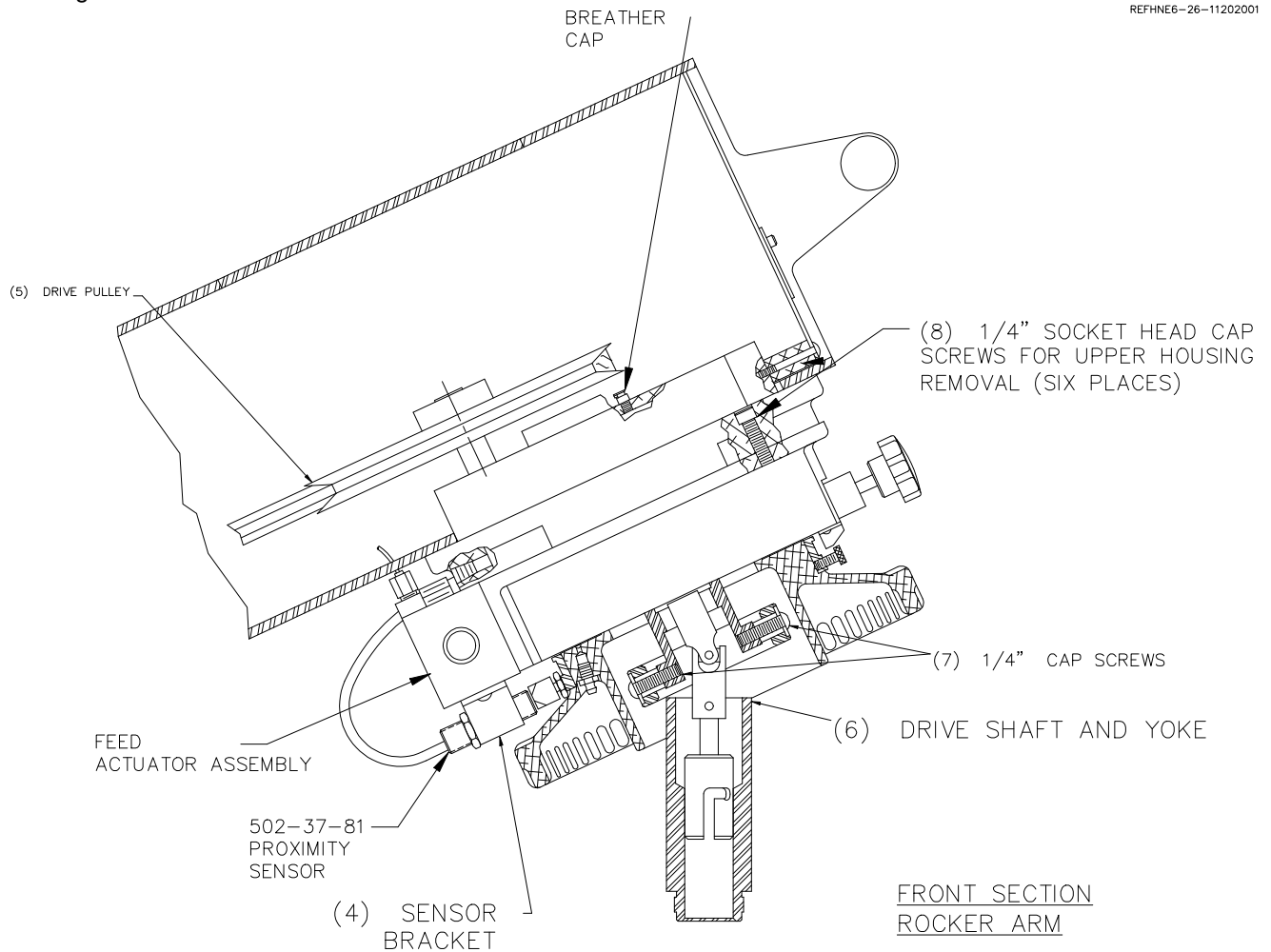
Gear Housing Disassembly:

(4) Drain the oil out of the Gear Housing by removing the sensor bracket located on the bottom of the Feed Actuator assembly.

Hold the Drive Pulley (5) securely and unscrew the drive Tube. Replace drive pin in pulley (5) with a dowel pin or bolt. Place bar through pulley to prevent it turning. Unscrew drive tube assembly using a pipe wrench or special tool available from Rottler MFG.

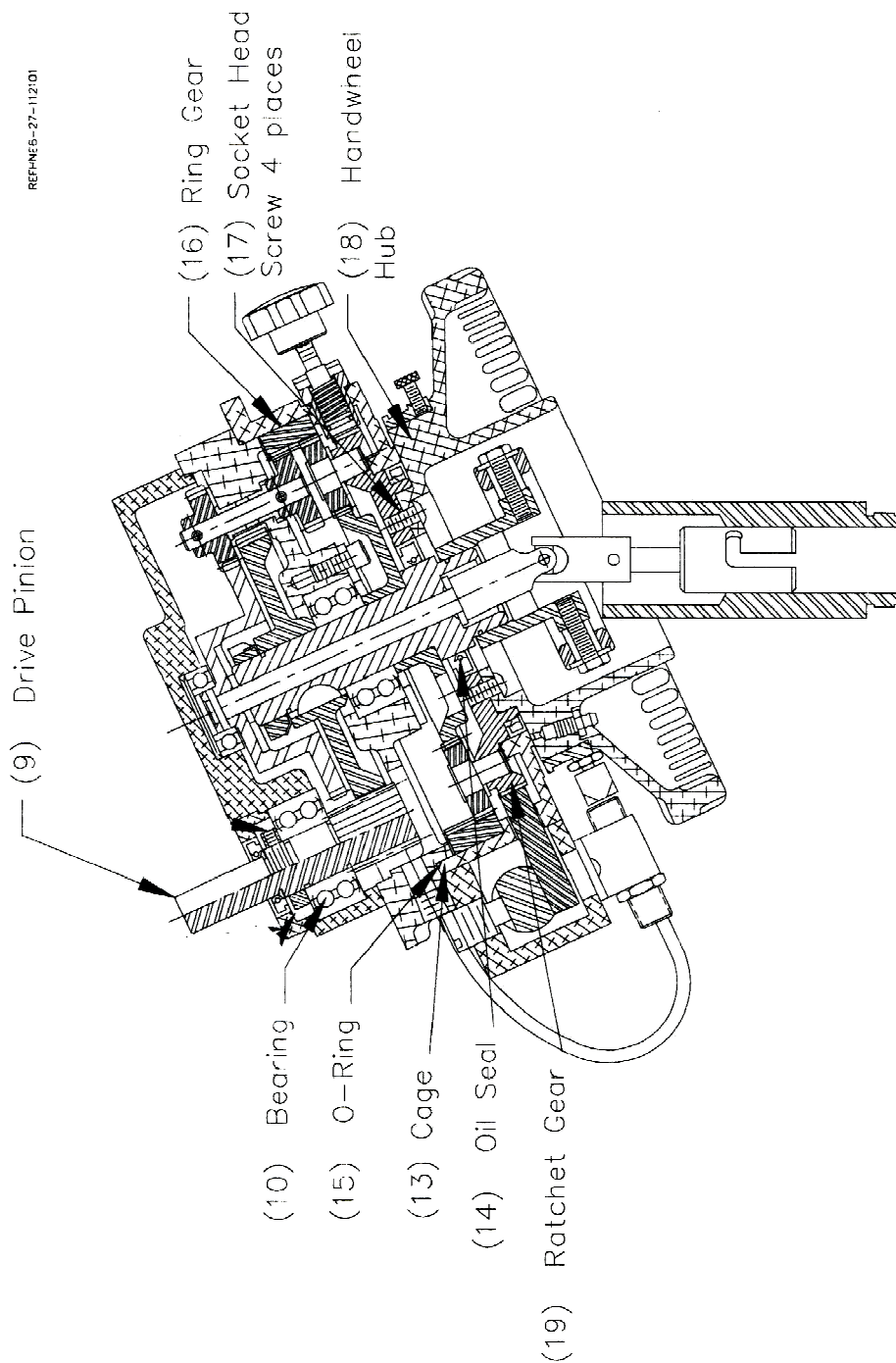
(7) To disassemble universal joint, remove its four 1/4" cap screws. On re-assembly of the universal joint make sure all screws are tight.

(8) Remove the six socket head cap screws on top of upper gear housing. Remove upper half of gear housing.



Remove bearing retainer from the upper gear housing. Press pinion out of the housing. Remove bearings from bearing retainer.

Remove the four screws (located on the top of the Upper Housing) securing the lower gear housing to the cage (13). Remove the cage and hand wheel carefully. When reassembling be careful not to damage the oil seal (14). Note the o-ring on the outer lip of cage (15). Ring gear (16) can be lifted out of cage. Remove the four-socket head screws (17) in the handwheel hub (18). Remove hand wheel and ratchet gear (19).



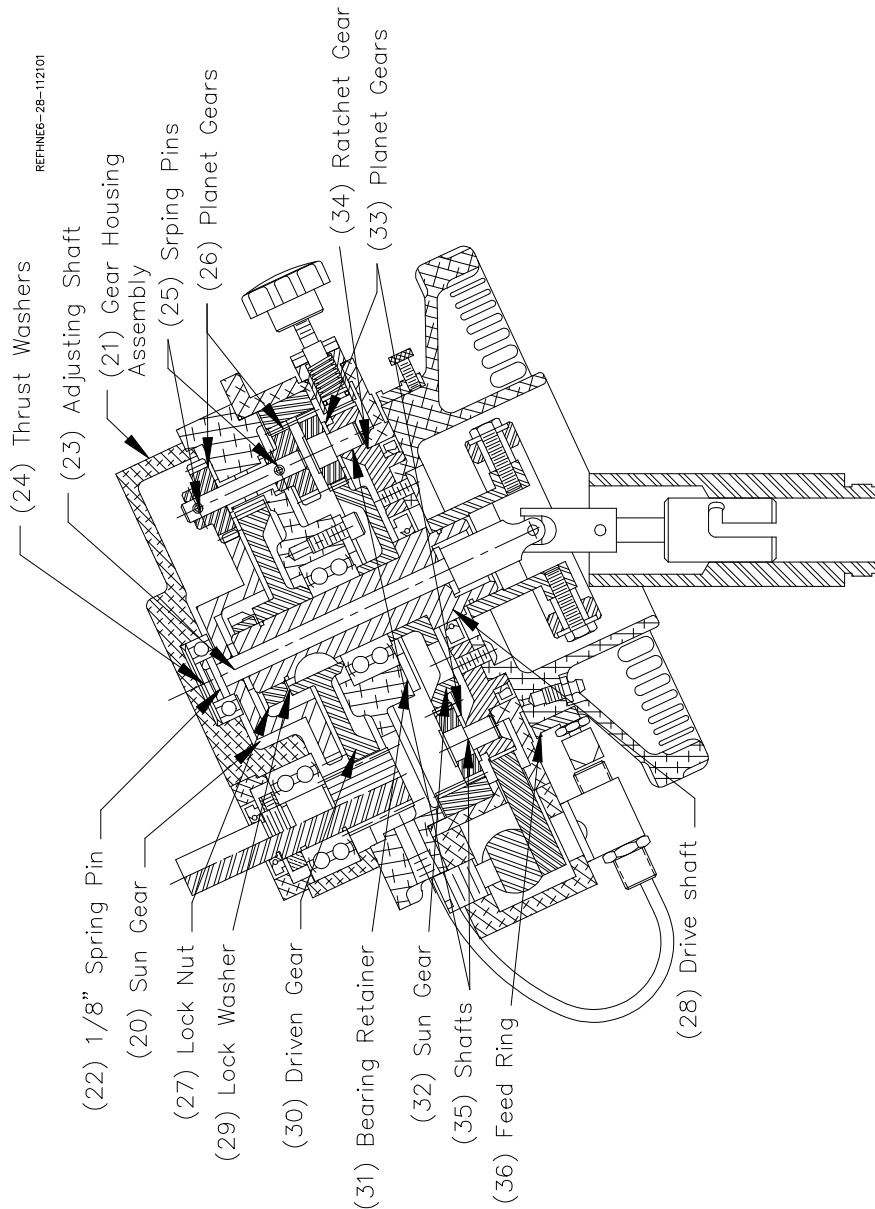
Remove sun gear (20) (514-6-35), from the gear housing assembly (21). Press out the 1/8" spring pin (22). The adjusting shaft (23) (514-6-43) and the thrust washers (24) can be removed by sliding down. Press out the spring pins (25) securing, the driven planet gears (26) (514-6-32A), remove the gears.

Locate the lock nut (27) on top of the driven shaft (28) (514-6-36). Bend the tabs of the lock washer (29) out of the way. Remove the lock washer. Pull the driven gear (30) (514-6-28) off of the driven shaft. Remove the three screws in the bearing retainer (31) (514-2-3C). You must align the access holes in the sun gear (32) (514-6-29) in order to get an Allen wrench on the screws. Press the shaft and bearing out of the upper housing. Press the bearing and the sun gear off of the driven shaft.

To remove the planet gears (33) from the ratchet gear (34), press the shafts (35) (700-6-5) out of the ratchet gear.

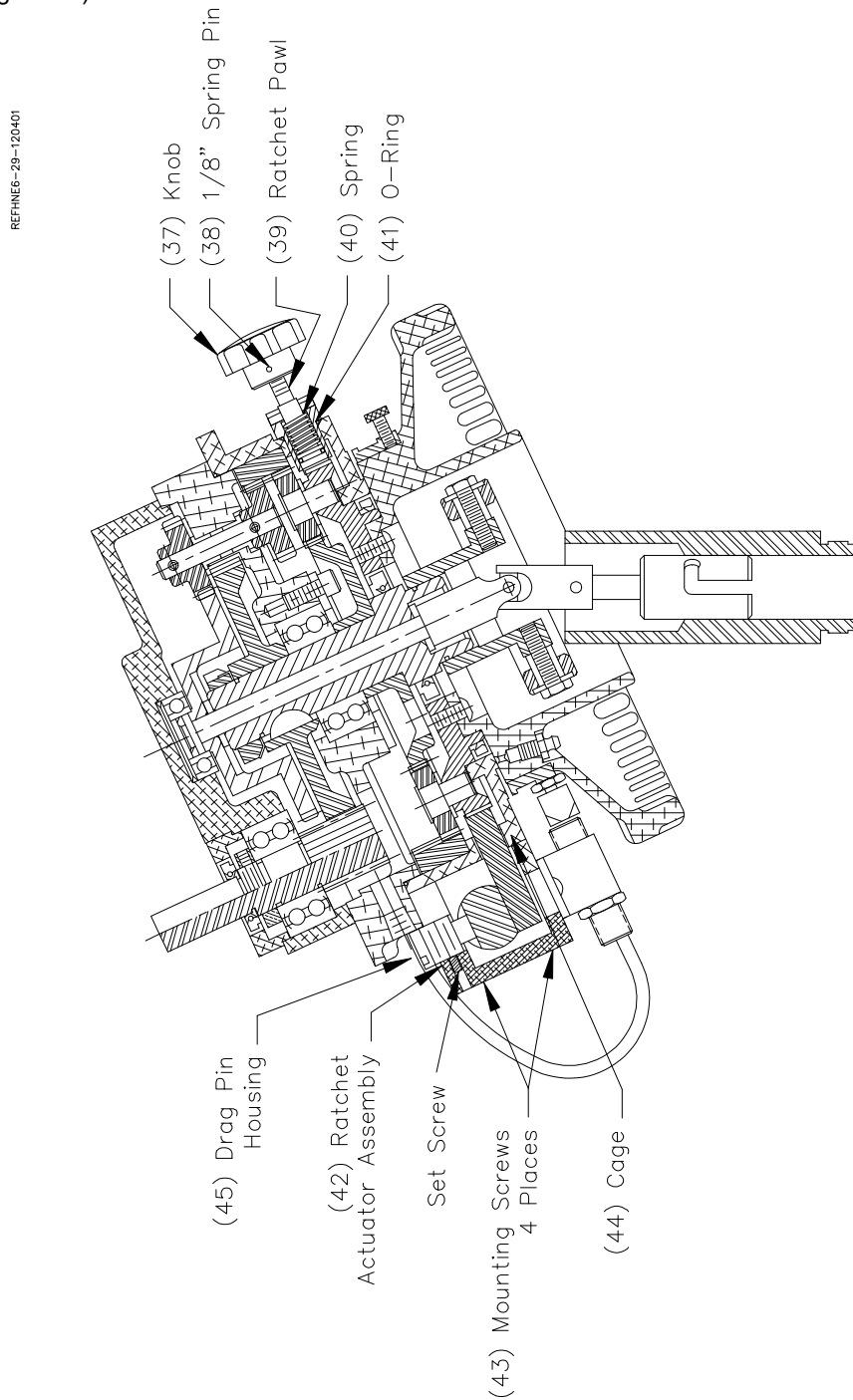
Remove the feed ring (36) (514-6-80C) by pulling it off of handwheel.

Remove ratchet feed assembly from cage by removing one 1/4" socket head mounting cap screw. Note O-Ring seal around Hub.



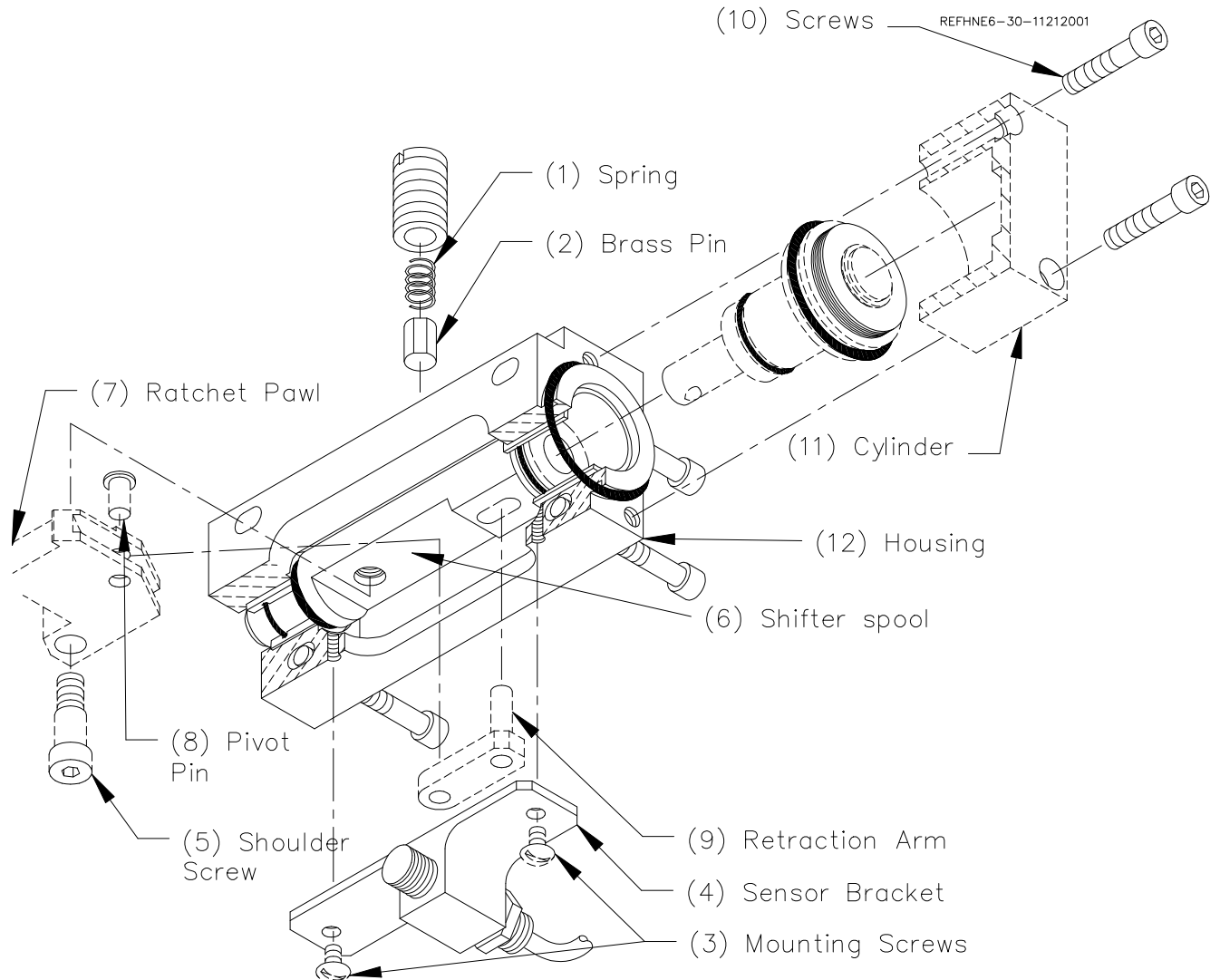
Disassemble ratchet feed assembly by removing knob (37) and pressing out 1/8" spring pin (38). Ratchet pawl (39), spring (40) and o-ring (41) can then be removed from carrier.

Remove Ratchet Actuator Assembly (42). Remove the four screws (43) holding the Ratchet Actuator Assembly to the ratchet gear cage (44). Disassemble Ratchet Actuator Assembly. Loosen drag pin housing Set Screw and unscrew the drag pin housing (45) (514-7-33), remove the spring (1) and the pin (2) (refer to page 4.13).



Remove the two screws (3) and the Sensor Mounting Bracket (4) (514-6-80A). Remove the shoulder screw (5) (514-7-32) from the shifter spool (6) (514-7-26). Pivot the ratchet pawl (7) (514-7-29) out and remove the pivot pin (8) (514-7-31). Remove the ratchet pawl. Pivot the retraction arm (9) (514-7-30) back inline with the spool. Lift the retraction arm straight out through the slot in the housing. Remove the three screws (10) securing the cylinder (11) (514-7-28) to the housing (12).


Once the cylinder is removed the piston (514-7-27A), and the shifting spool (514-7-26) can be pulled out from the end.



Reassemble is the reverse. The drag pin assembly should be tightened until spring is fully compressed, then loosen approximately 1/8 turn. Reassemble the auto feed housing onto the ratchet gear cage, the upper gear housing must be removed so the ratchet pawl can be seen while being assembled, and the spring loaded ratchet pawl can be attached.

Adjust the engagement of the pawl to the ratchet wheel by loosening the auto feed housing mounting screws, and moving the housing sideways. Ratchet pawl must just miss one ratchet tooth then fully engage the next.

Replacing Shear Pin:

 **WARNING** *Disconnect all electrical and air power before making any repairs.*

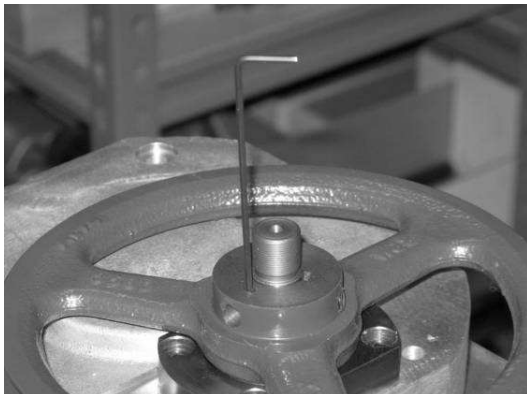
- 1 Remove motor cover, front cover plate, and handle.
- 2 Loosen bolts on motor bracket and remove v-belt from gearbox pulley.



- 3 Remove pulley lock down nut and 2 bellville washers.



- 4 Remove set screw holding shear pin.



- 5 If shear pin is not broken it can be driven out with a small punch.
- 6 If shear pin is broken, loosen nylon bolt and remove pulley.
- 7 Remove broken pieces from pulley and pinion shaft.
- 8 Install new shear pin and reverse above procedure to reassemble.

Removing Drive Tube Assembly:

! WARNING *Disconnect all electrical and air power before making any repairs.*

- 1 Follow procedure: Replacing Shear Pin
- 2 Place small pry bar or screwdriver in shear pin bore to prevent pulley from turning.



- 3 Drive tube assembly is screwed onto the gearbox with a normal right hand thread.




- 4 Use a pipe wrench to break the drive tube assembly loose. (If you wish to avoid scaring the drive tube with a pipe wrench, Rottler Mfg. has a special removal tool available for loaner use. Contact parts order desk for full details.)



- 5 Unscrew drive tube assembly.
- 6 Replace drive tube assembly by screwing back on hand tight. There is no need to tighten further. Normal operation will lock drive tube assembly in place.
- 7 Replace shear pin.

Removing Adjusting Shat Assembly:

 **WARNING** *Disconnect all electrical and air power before making any repairs.*

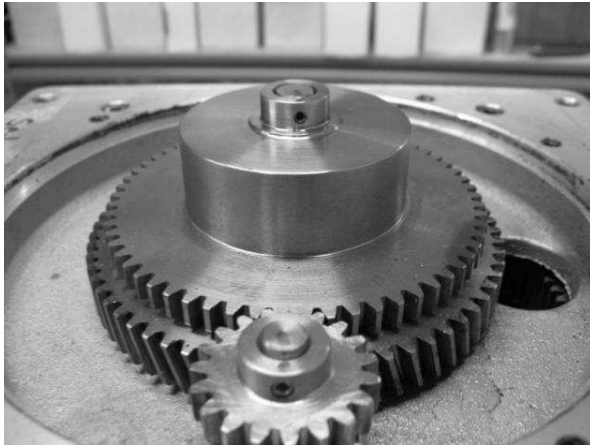
- 1 Follow procedure for replacing shear pin.
- 2 Place rocker arm in a level position.
- 3 Remove 6 bolts from top gearbox housing.



- 4 Remove top gearbox housing.



- 5 Remove bearing from top of sun gear.



- 6 Mark gear location on shaft then remove roll pin.
- 7 Remove gear and thrust washer.



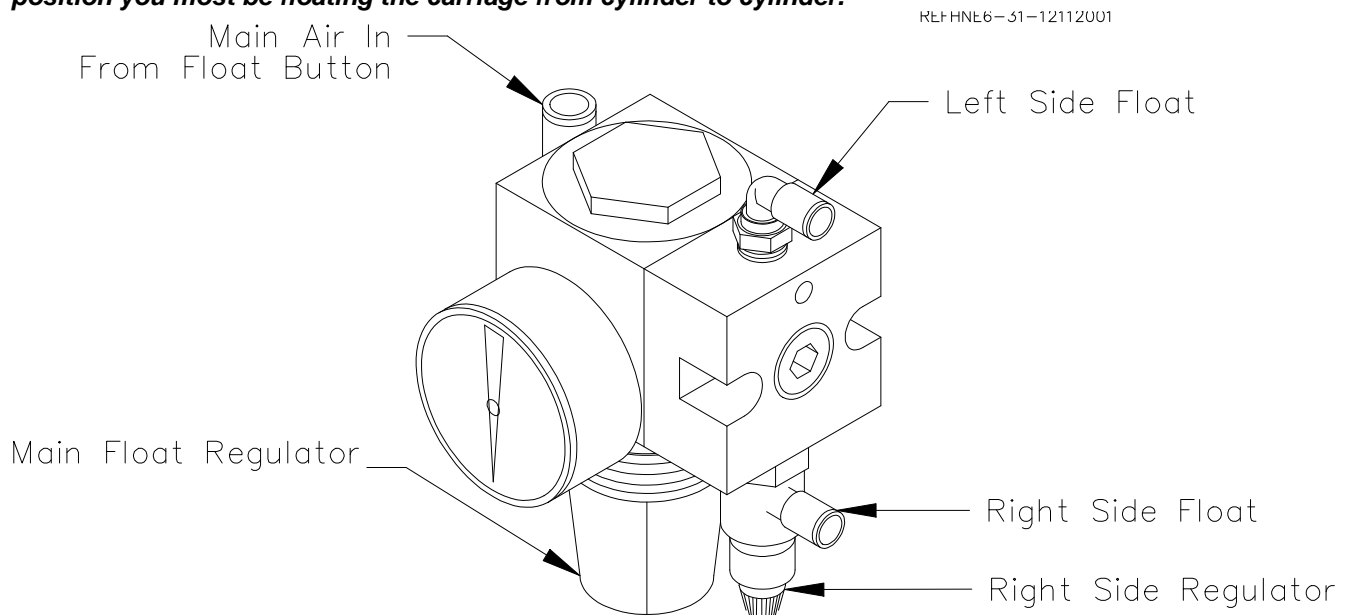
- 8 Slide shaft assembly out through bottom of drive tube.
- 9 Reassemble by reversing above procedure.

Float and Clamp:

Float

Press the air float button, located on the right hand side of the carriage. This allows air to flow to the main float regulator. This regulator sets the pressure that goes to the left side float plate. It also sets the pressure that goes to the right side regulator. From the right side regulator the air goes to the right side float plate. Set the Main Float regulator to 20 – 25 PSI. When pressing the float button you should be able to hear air coming from the bottom of the carriage base. If the air flow is uneven or comes out in bursts lower the air pressure slightly until the flow evens out. Then adjust the Right Side Regulator until you get a nice even float of the carriage. It may take a few times to get used to the adjustment.

Note: *The float characteristic will change as the Rocker arm is raised and lowered as it changes the center of gravity of the carriage. Make the float adjustment with the Rocker Arm in the position you must be floating the carriage from cylinder to cylinder.*




NOTE: *Hone will not float correctly unless Carriage clamp is adjusted properly.*

Clamp

With the carriage clamped (float button not depressed). The air flows from the float button to the air clamp cylinder. This cylinder lifts the clamp lever, which pulls up on key in t-slot. It may be necessary to adjust the air clamp system after the machine is installed.

Remove the four screws securing the carriage cover plate. Remove the cover. Disconnect the air supply. Remove the Cotter Key from the Castle Nut located in the center of the carriage. Back the nut off and then hand tighten. Loosen nut approximately 1/4 turn. Insert cotter pin. Reconnect air supply. If the rod of either clamp cylinder sticks in the up position, turn nut one notch tighter until rod no longer stick. This means the clamp cylinder rod was over extended.

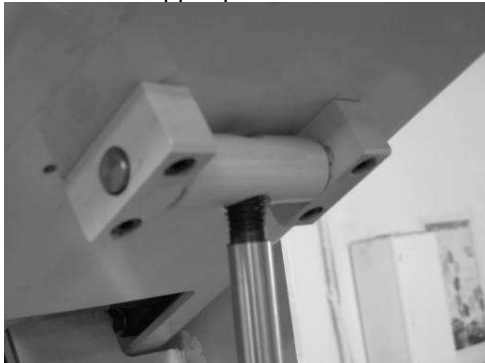
Replacing Hydraulic Cylinder:

 **WARNING** *Disconnect all electrical and air power before making any repairs.*

- 1 Remove rear carriage cover.
- 2 Using bleed kit, drain fluid from system.



- 3 Unscrew hydraulic lines 22 and 25 at both ends.
- 4 Unscrew hydraulic line 26 at cylinder fitting.
- 5 Remove upper pivot blocks. Note if there are any shims located under pivot blocks.



- 6 Loosen set screw on upper pivot pin then remove pivot pin from cylinder shaft.



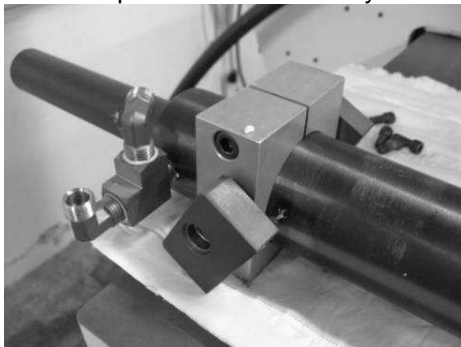
7 Remove fittings from top of cylinder.

8 Remove bolts holding lower pivot blocks to carriage.



9 Pull out cylinder and remove pivot blocks from housing bracket.

10 Place pivot blocks on new cylinder.



11 Hold new cylinder in place and attach lower pivot blocks to carriage.

12 Install fittings and pivot pin.

13 Install hydraulic lines that were removed.

14 Bleed hydraulic system following bleed procedure located in maintenance section of this manual.


15 Replace upper pivot blocks including any shims that may have been present when old cylinder was removed.

16 Test machine operation.

17 Remove upper and lower pivot block bolts individually, place blue Loctite on threads, then replace and tighten.

18 Replace rear carriage cover.

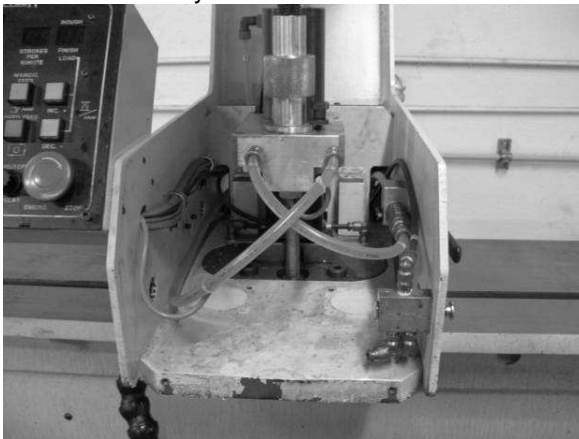
Replacing Air Cylinder:

 **WARNING** *Disconnect all electrical and air power before making any repairs*

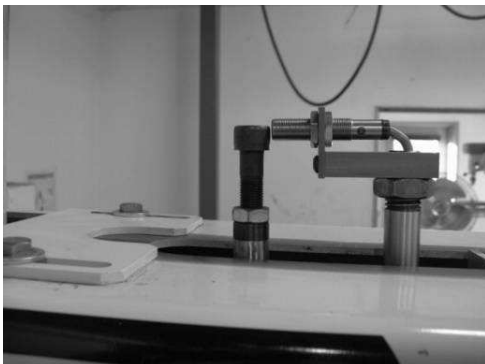
- 1 Remove upper cover from rocker arm.



- 2 Remove carriage cover plates.
- 3 Remove clamp bar and lever arms.
- 4 Remove air cylinders.



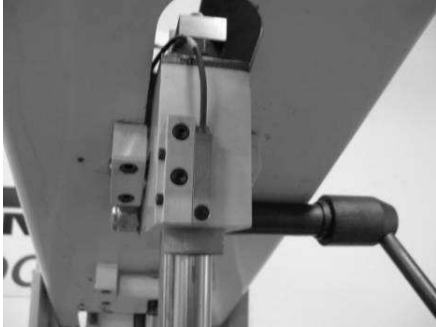
- 5 Remove actuation bolt and lock nut.





6 Remove bore length gauge and lower sensor target.

7 Remove lower sensor from pivot clamp assembly.



8 Remove upper air line, oil line, and fittings from cylinder.



9 Remove lower air line and fitting.



10 Remove pivot blocks for upper pivot clamp assembly.



11 Bottom out air cylinder shaft. Lift up and rotate pivot clamp assembly.



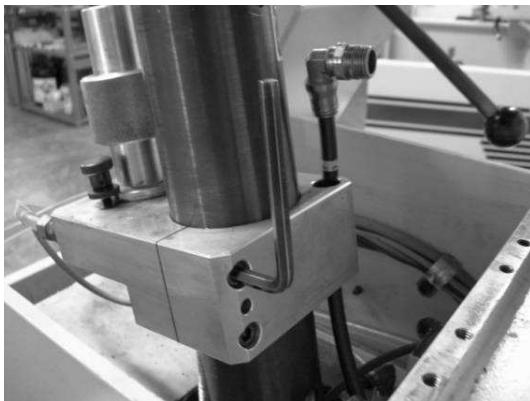
12 Measure and make note of cylinder trunion location.



13 Loosen lower pivot blocks.



14 Loosen bolts holding trunion to cylinder.

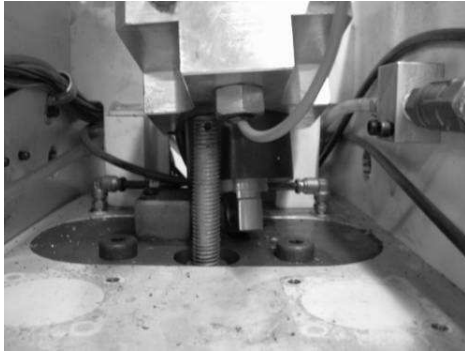


15 Tighten recessed set screw to open trunion bore.



16 Remove bolts from one pivot block.

17 Remove pivot block and pivot pin.



18 Remove old cylinder.



19 Install new cylinder.

20 Install pivot pin and pivot block. Leave bolts loose.

21 Place upper pivot clamp assembly back on cylinder shaft.

22 Raise cylinder shaft to full up position.

23 Attach pivot clamp assembly to rocker arm by installing upper pivot blocks. Leave bolts loose.

24 Adjust height of cylinder trunion, loosen set screw, and tighten clamping bolts.

25 Tighten bolts for upper and lower pivot blocks.

26 Move rocker arm up and down, checking for freedom of movement. If movement is free and smooth remove pivot block bolts individually, apply Loctite and tighten.

27 Install cylinder fittings, upper and lower air lines, and oil line.

28 Install lower sensor, target, and bore length gauge.

29 Install clamp cylinders, lever arms, and cross bar.

30 Install actuation bolt and lock nut. Adjust by following procedure located in the maintenance section of this manual.

31 Install carriage cover plates.

32 Install top rocker arm cover.

Replacing Pivot Block Assembly:



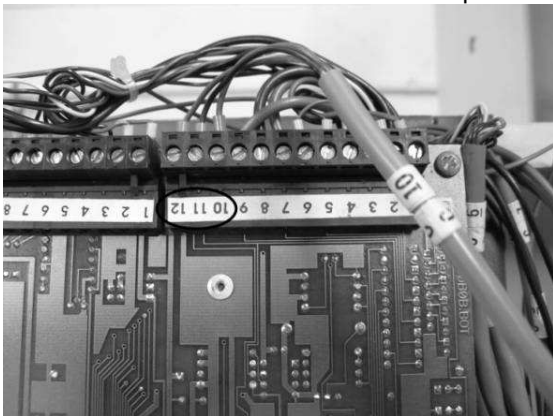
WARNING

Disconnect all electrical and air power before making any repairs

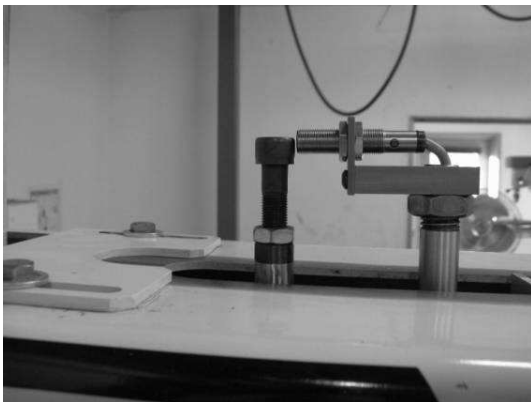
- 1 Remove upper cover from rocker arm.



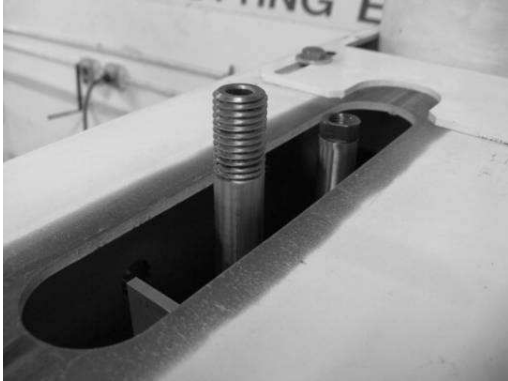
- 2 Remove carriage cover plate.
- 3 Remove cable C-10 from terminal strip on back side of control panel. Note wire locations.



- 4 Remove actuation bolt and lock nut.



5 Remove upper sensor, bracket, and lock nut.

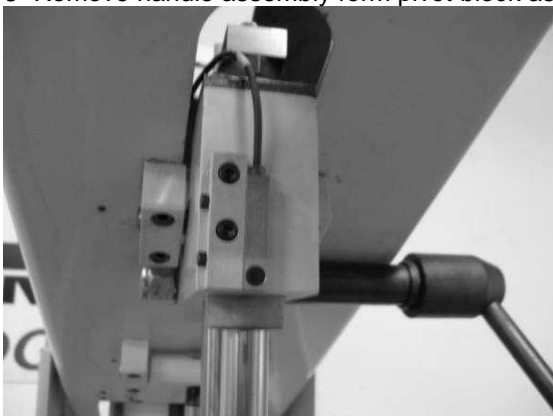


6 Remove bore length gauge and lower sensor target.



7 Remove lower sensor from pivot block assembly.

8 Remove handle assembly from pivot block assembly.



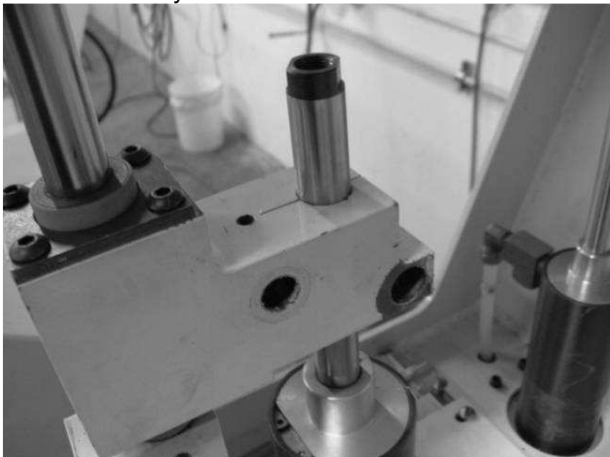
9 Remove pivot blocks from upper pivot block assembly.



10 Remove set screw and pivot pin from pivot block assembly.



11 Lower air cylinder shaft.



12 Lift pivot block assembly and remove from inside of pivot arm.



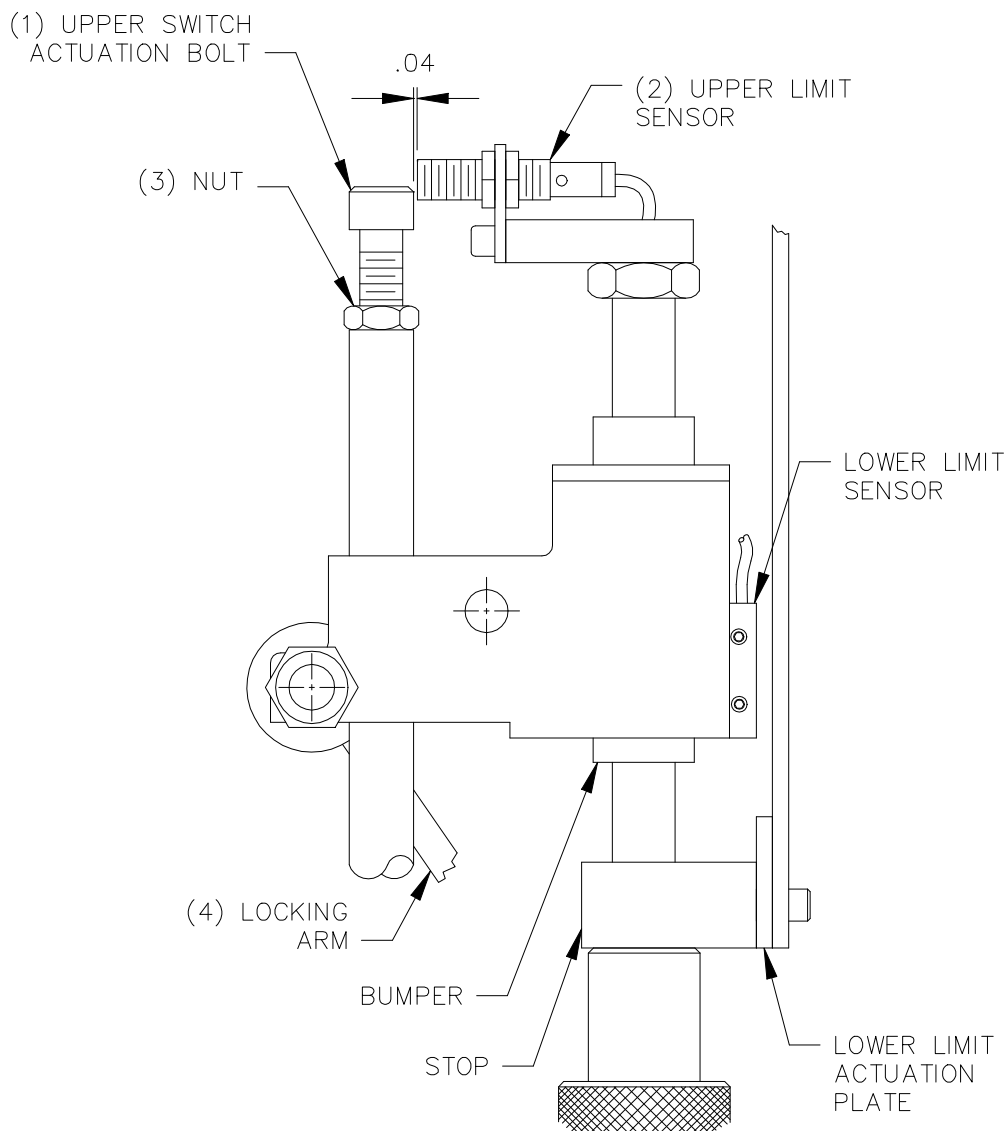
13 Replace pivot block assembly and reverse above procedure to reassemble. Make certain that flat on pivot pin aligns with set screw. Apply Loctite to set screw and pivot block bolts.

14 After hone is reassembled adjust upper sensor actuator bolt per instructions in maintenance section of this manual.

Upper Limit Switch Adjustment:

- 1) Engage e-stop button so that control panel is not active.
- 2) Leave main air on the machine. This will keep the Stroking Cylinder Rod in the full up position. The Stroking Cylinder Rod must be in the full up position for accurate adjustment.
- 3) Remove the cover from the Rocker Arm (refer to page 6.5 part number 514-6-24F). There are two screws at the front and rear of this cover.
- 4) Move the lower stop down so the bolt (1) and sensor (2) can be seen above the Rocker Arm when it is brought down to the lower stop.
- 5) Adjust the sensor gap to the bolt, to .04 inches by loosening the two Allen bolts at the rear of the sensor.
- 6) Loosen the Locking Nut (3) and start turning the Adjustment Bolt (1) CW until the light on the sensor goes off. If the light is already off, go to step 7.
- 7) Start turning the Adjustment Bolt in a CCW direction until the light on the sensor comes on. Once the light is on turn the Adjustment Bolt another 3 turns and lock the Nut (3)

HNE6-18-03212003



RT201A1B HP6A
Error codes

- ER01 Watchdog, cpu fault
- ER02 LENZ motor drive fault
- ER03 Input volts too low
- ER04 Input volts too high
- ER05 Park limit switch NO/NC transition fault

Chapter 5 Troubleshooting:

The Following is a basic guide in trouble shooting the HP6A Honing machine.

Symptom: Hone head will not feed out.

Possible Cause: *Air not getting to the Ratchet Actuator Assembly.*

The Ratchet Actuator Assembly is located on the rear of the main gearbox (514-6-22A). See (page 6.18) of this manual for location of this assembly.

If the hand wheel on the gearbox does not try to feed out, then the Actuator assembly may not be getting air from the Feed Out solenoid. Locate the feed out solenoid in the rear of the spindle carriage (514-2-70H page 6.17). There is a small button on this solenoid so it can be manually activated. Using a small Allen wrench or similar device to depress this button and see if the head feeds out.

If the head feeds out when manually activated, then the solenoid may have gone bad, a wiring connection has broken loose, or the machine is not seeing the strokes. The machine will not feed out if it is not seeing the strokes. Verify that the machine is seeing the stroke by changing the speed of the strokes, and the stroke speed display should change as you are changing the speed. Turn the machine power off, and check the wiring on the solenoid by removing the wire cap. Check all wire connections in the rear enclosure. If the head still does not feed, contact the factory for solenoid or possible board replacement.

If the head does not feed out when you activate the solenoid manually, then you may not be getting air to the solenoid. Check the incoming air supply and verify there is air to the solenoid pack.

Possible Cause: *Precision Hone head assembly dirty.*

If the precision hone head assembly is not kept clean and free of rust, the head may not feed out properly.

See (page 7.15) of this manual for disassembly of the precision hone head. Pay particular attention to the threads on the cone (524-9-7A). If they are not clean and free of rust, the feed of the head will not operate properly.

When the head has been thoroughly cleaned, re-assemble and test.

Possible Cause: *Drag Pin tension on Ratchet Actuator Assembly not set correctly.*

The Ratchet Actuator Assembly is located on the rear of the main gearbox (514-6-22A). See (page 6.13) of this manual for location of this assembly.

When the head is not feeding out correctly, put pressure with your thumb on the shifting spool (514-7-26 Page 6.18) where it exits the housing on the left hand side. If the machine starts feeding correctly with pressure applied, then the drag pin tension is too light.

Refer to (page 6.18) of this manual for the location of the drag pin. Loosen the locking set screw on the rear of the housing to allow the drag pin to be adjusted. Turn the drag pin counter-clockwise only a 16th of a turn at a time, and test the feed. Do not over tighten the drag pin tensioner. (Also see Adjusting Drag Pin Tension in maintenance section of this manual.)

Possible Cause: *Ratchet Actuator Assembly not adjusted properly.*

The Ratchet Actuator Assembly is located on the rear of the main gearbox (514-6-22A). See (page 6.6) of this manual for location of this assembly.

Air from the feed solenoid is sent to this assembly when a feed is required. The air moves the piston inside this assembly, which in turn activates a pawl (514-7-29 see page 6.18). The pawl is the mechanism, which feeds out the gearbox.

If the Actuator Assembly is not adjusted correctly (left to right), then the head will not feed out under load. The actuator housing has four (4) slotted mounting holes in it. Loosen the four bolts in the mounting holes and move the Actuator housing to the left (as you are facing the front of the machine) by 1/32" at a time. After making an adjustment tighten the housing down again and try the feed system. Continue adjusting the box and testing until the head will feed out under load.

(Also see Adjusting Feed Out Actuator Housing in the maintenance section of this manual)

Symptom: Hone Head continues to feed out without reaching preset load setting.**Possible Cause: *Sheared roll pin in hone head assembly or in gearbox.***

Determine location of sheared pin by removing hone head assembly from drive tube. Place hone head in cylinder and feed out stones by hand by turning drive coupling until stones make contact with cylinder wall. Use a wrench to tighten stones further. If stones can't be tightened to lock up, then sheared pin is located in hone head assembly. If stones lock up, the sheared pin is located in the gearbox.

Symptom: Taper or bore not straight.

There are several items in the honing procedure, that if not followed properly will cause the cylinder not to be straight. This could be taper, bowed out in the middle, or too big at the top. Any one, or combination of the causes listed below could cause the problem. It is very important to follow all steps of the honing process correctly. If you are in doubt of the correct process, contact your area representative or the factory for assistance.

Possible Cause: *Incorrect Over stroke settings.*

If the over stroke (length the stones extend out of the hole at the top and bottom) is set too long, the bore will end up being bigger in the area where the over stroke is not set correctly.

If the over stroke is set too short, that part of the cylinder will end up being small (taper). On some blocks it is not possible to get the correct amount of over stroke set on the bottom of the cylinder due to interference with the main webs. When this is the case, the dwell button can be used to straighten out the cylinder.

NOTE: Upper and Lower stops settings are very important when honing. Incorrect stop settings can cause the operator to think he needs to dwell the cylinder when that is not the case. Excessive dwelling can cause the stones to become tapered. If this happens it compounds the problem of taper in the cylinder.

Possible Cause: *Tapered Stones.*

If your over stroke is set correctly use a micrometer to measure the stones. When measuring the stones, measure the top of one stone to the top of the stone across from it. Record this reading

and then measure the bottom of the same stones. If the bottom of the stones measure out smaller than the top, this will also create taper in the cylinder.

Possible Cause: *Incorrect Pressure settings.*

It is possible to set the Rough and Finish load setting improper for a certain type of cylinder. If there is very little support around a cylinder, using a high rough setting can cause the walls of the cylinder to push out while honing, and then to come in when there is no longer pressure on the cylinder wall. This would create a hour glass shaped cylinder. You can account for this by lowering the rough and finish settings. A lower rough setting will not push the walls out as much. A lower finish setting gives the hone head additional time to remove material from the block to straighten it.

Possible Cause: *Diamonds need dressing.*

For diamond dressing instructions refer to page 3.8 of this manual.

Symptom: Erratic Finish Sizes

If the hone is not maintaining size from one bore to the next.

Possible Cause: *Hone Head not connected properly.*

The most common cause of erratic cylinder size is a wrong connection between the Driven Coupling (514-6-44 page 7.2) and Coupler Sleeve (514-6-41 page 6.15). When changing the hone head and yoke be sure not to put any upward pressure on the cone (514-9-7A page 7.2), this will cause the driven coupling not to engage correctly with the coupler sleeve. When not engaged correctly the driven coupling can move around and cause the stones not to feed out correctly.

Possible Cause: *Fluctuating Power.*

If the incoming power to the machine is fluctuating more than 10 volts AC, it will cause the load display to fluctuate. Since the machines stopping times are set on the load value this can cause size variance. The power company can usually monitor the power and make recommendations for fixing the problem.

Possible Cause: *Spindle Speed Changes.*

Changing the spindle speed between cylinders will increase the load on the motor and thus the machine will shut off at a different size. Do not change the spindle speed between bores.

Symptom: Chatter in bore.

Vertical lines extending from the top to the bottom of the bore.

Possible Cause: *Bad Bearings.*

If a bearing goes bad in the upper gearbox, it will tend to leave a vertical pattern in the cylinder. When honing especially hard blocks, the chatter becomes a lot more noticeable. A bearing can go bad from normal or hard usage and from a machine crash in the bottom of the bore. Contact the factory for a loaner gearbox while yours is being repaired.

Symptom: Slow Stock Removal.

Possible Cause: *Diamonds need dressing.*

For diamond dressing instructions refer to page 3.8 of this manual.

Symptom: Machine not stroking.**Possible Cause: *Feed Ring not set correctly***

If you are making a small adjustment to the Feed Ring it is important to back off the hand wheel several notches (5 to 10) before pressing the Auto Cycle button again. The HP6A takes at least two strokes to calculate the Strokes Per Minute and the load on the stones. If there is not enough stoking time before the "0" on the feed ring is reached, the control does not have enough data to calculate the correct stopping time for the hone head.

Possible Cause: *Upper Stop Sensor Adjustment*

If the upper stop sensor is not reading the machine can stroke and then stop at the top of the cylinder and not return towards the bottom. This can be intermittent. The hone head will continue to rotate even after travel has stopped. Refer to the Upper Sensor adjustment in the Maintenance section of this manual.

Possible Cause: *Stroke Lever*

Sometimes the stroking speed lever on the front right hand side of the spindle carriage has been moved into the full upright position. This will not allow any hydraulic fluid to pass. Therefore, the machine will not be able to stroke.

Possible Cause: *Solenoid or Board Failure.*

As with all electronic devices, solenoids will eventually fail. To determine if the solenoid is bad, turn the spindle on and press the stroke button. Does the stroke button light up?

If not then the control panel should be replaced (514-7-54G page 6.11).

If the light does come on, but the rocker arm still does not stroke, leave the light on and locate the stroking solenoids in the back of the carriage (514-2-70P & 514-2-70N page 6.17). There is a small button on these solenoids so they can be manually activated. Use a small Allen wrench or similar device to depress these buttons. The rocker arm should go down. If you release the buttons the rocker arm should go back up. If the rocker arm does not go down when the buttons are depressed check all air lines for kinks.

If the rocker arm goes down as stated, turn the machine power off, check all wiring at solenoids, and in the rear enclosure. If the machine still does not stroke after checking the wiring, contact the factory for possible solenoid or board replacement.

Possible Cause: *Oiler tank empty*

If the Oiler tank (located on the right hand side of the hone tank) goes dry the O-Rings in the shifting spooler may go dry. Add oil to the oiler, turn the drops per minute way up and start the machine stroking to re-lubricate the O-Rings. The Stroking may have to be activated by hand.

Symptom: Uncontrollable Stroking Speed.**Possible Cause: Air in the Hydraulic System**

If there is allot of air in the hydraulic system, it will become compressed as the machine changes directions. If the air is becoming compressed the hydraulic fluid is not forced to go through the speed control ball valve, thus the rocker arm speed is uncontrollable. Take the precision head off of the machine, set the stroke length to its maximum travel, set the stroke speed to slow. This will allow the air to compress and then start forcing the hydraulic fluid through the speed control valve. The Rocker arm will be erratic at the top and the bottom of the stroke but this will confirm that there is air in the Hydraulic system.

Possible Cause: Check Valve Failed

The Check Valve (514-7-58) coming off of the bottom of the Reservoir may have failed.

Possible Cause: Hot Oil Shuttle may have failed.

To determine if this is the cause, watch the Reservoir while the machine is stroking. If there is excess fluid flowing into the reservoir from the top, the Hot Oil Shuttle relief valve has failed or is not adjusted correctly. If the relief valve has not been adjusted by your personnel, this is not the cause.

Symptom: Banging at Top of Stroke.**Possible Cause: Upper Sensor has moved.**

It is possible the upper sensor has moved from its factory position. Refer to Upper Limit Switch Adjustment in the Maintenance section of this manual for the proper factory setting.

Possible Cause: Improper Stroking Speed for length of cylinder being honed.

Correct stroking speed can be calculated. Refer to Stroking Speed in the Operating Instructions chapter in this manual.

Symptom: ER04 Error Code on Control Panel.**Possible Cause: High input voltage.**

Power cycle the hone. If the display returns to normal the error code may have occurred from a voltage spike. If the error code remains on the display check the incoming voltage to the hone. If it exceeds 240 volts, it will need to have it corrected.

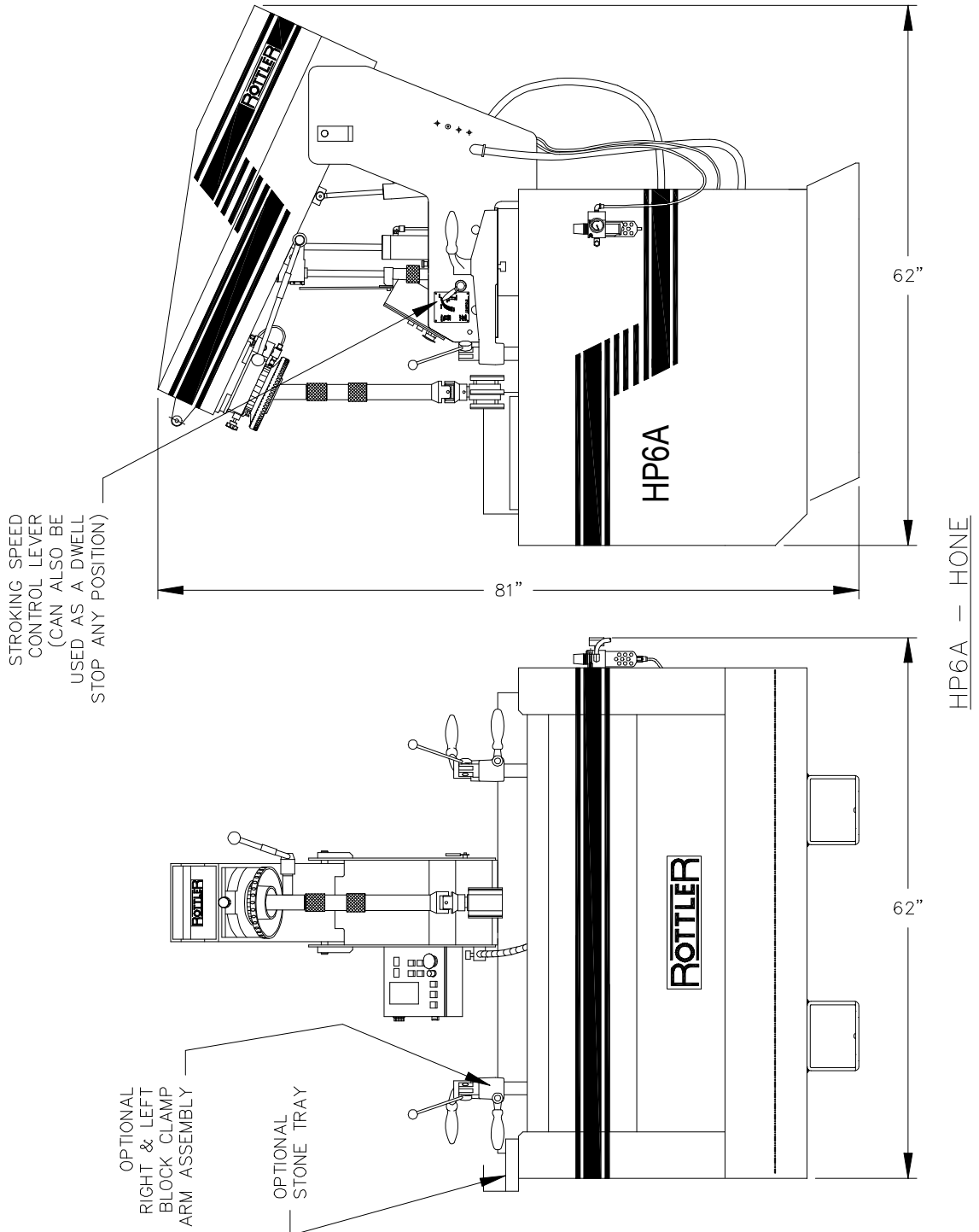
Possible Cause: Defective voltage sensor.

The voltage sensor on the control panel may be defective and not reading the voltage properly. This can be checked by disabling the voltage sensor. This is done by flipping the number 1 dip switch to the open position. (See electrical diagram for location of dip switch.) If the display now shows a normal reading and the hone works correctly that indicates that the voltage sensor is faulty. You can leave the dip switch in the open position and use the hone normally. You should have this repaired as soon as possible. Without a properly functioning voltage sensor you risk burning out the CPU due to high voltage.

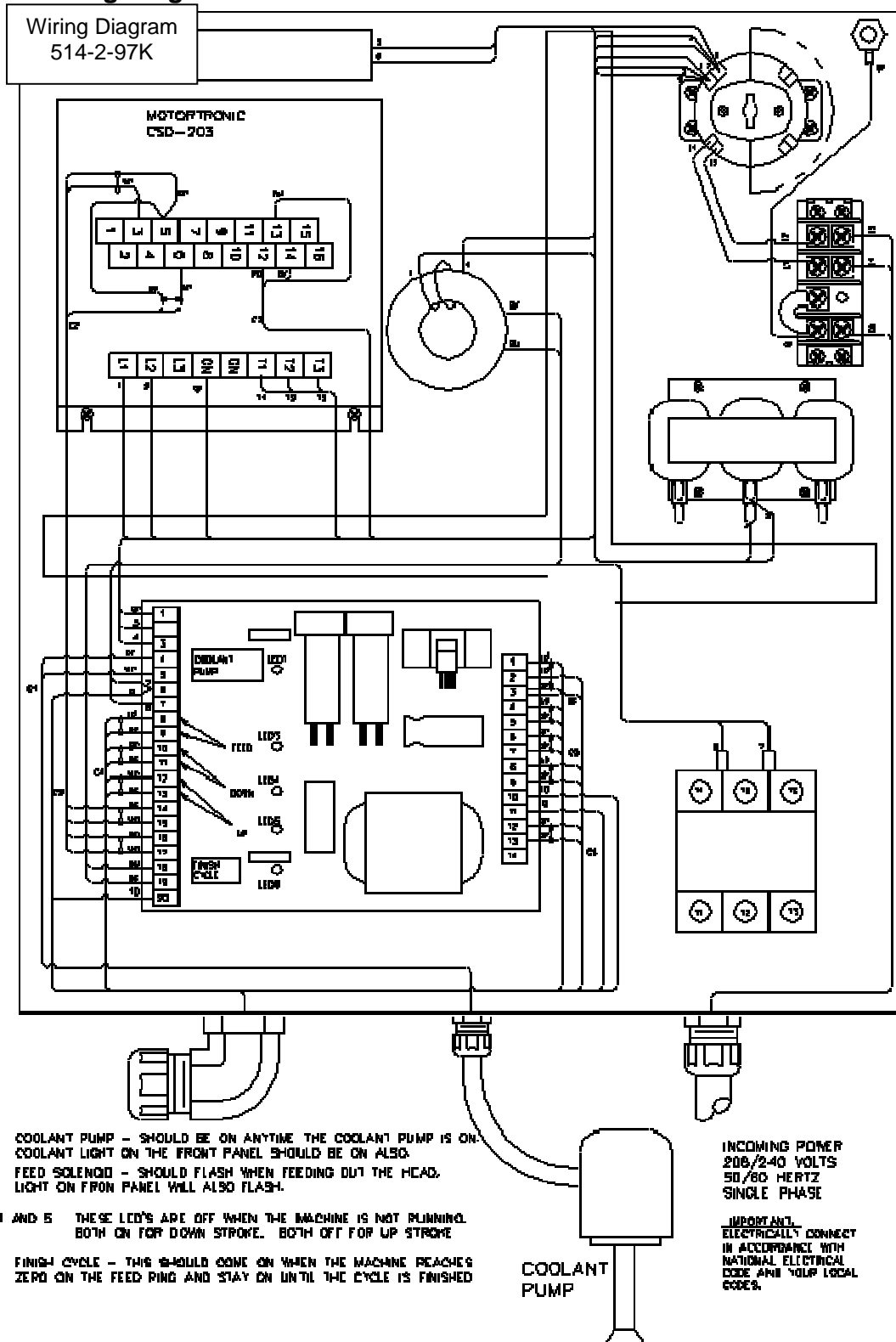
Chapter 6 Machine Parts

Front / Right Side View:

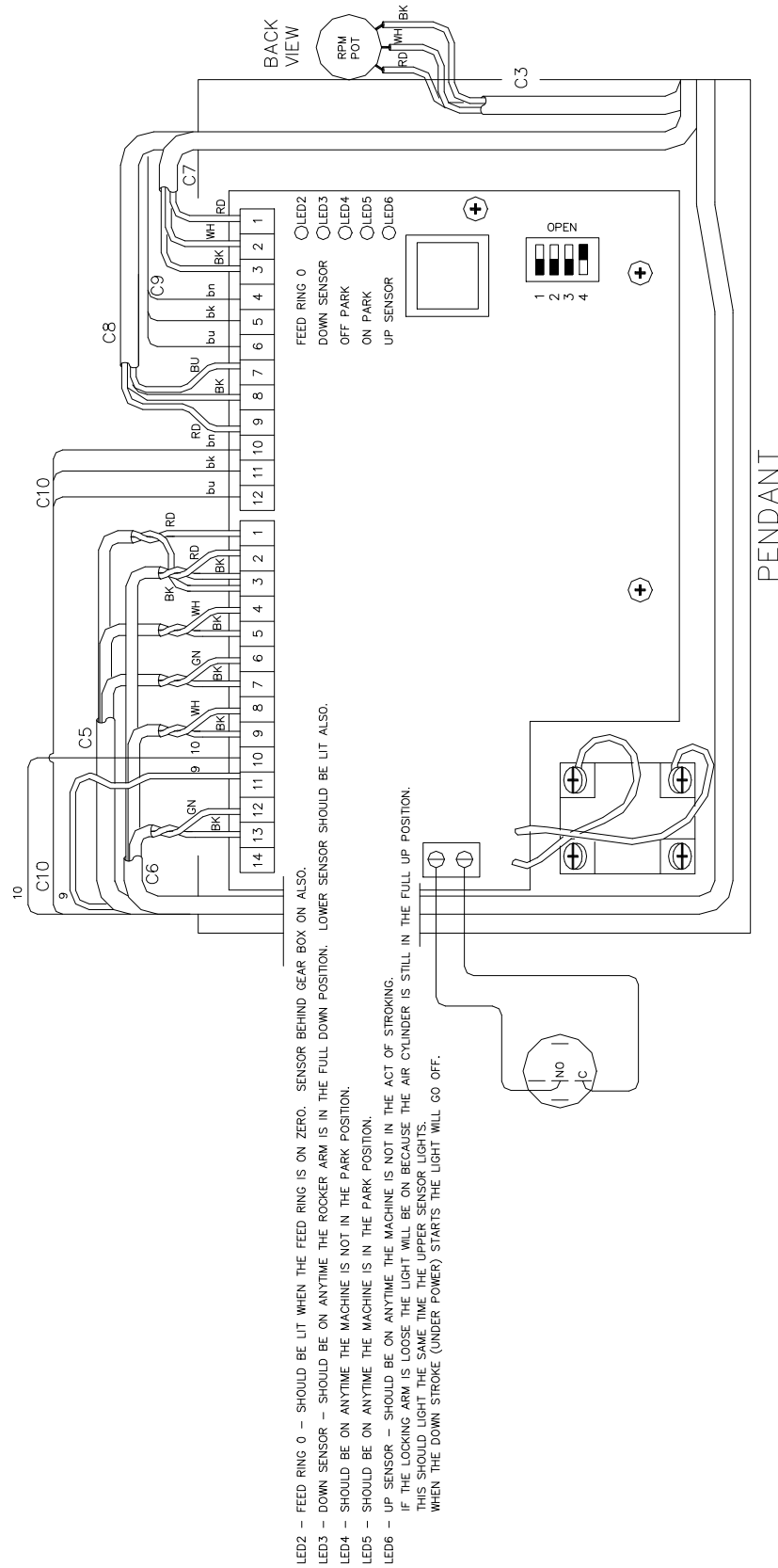
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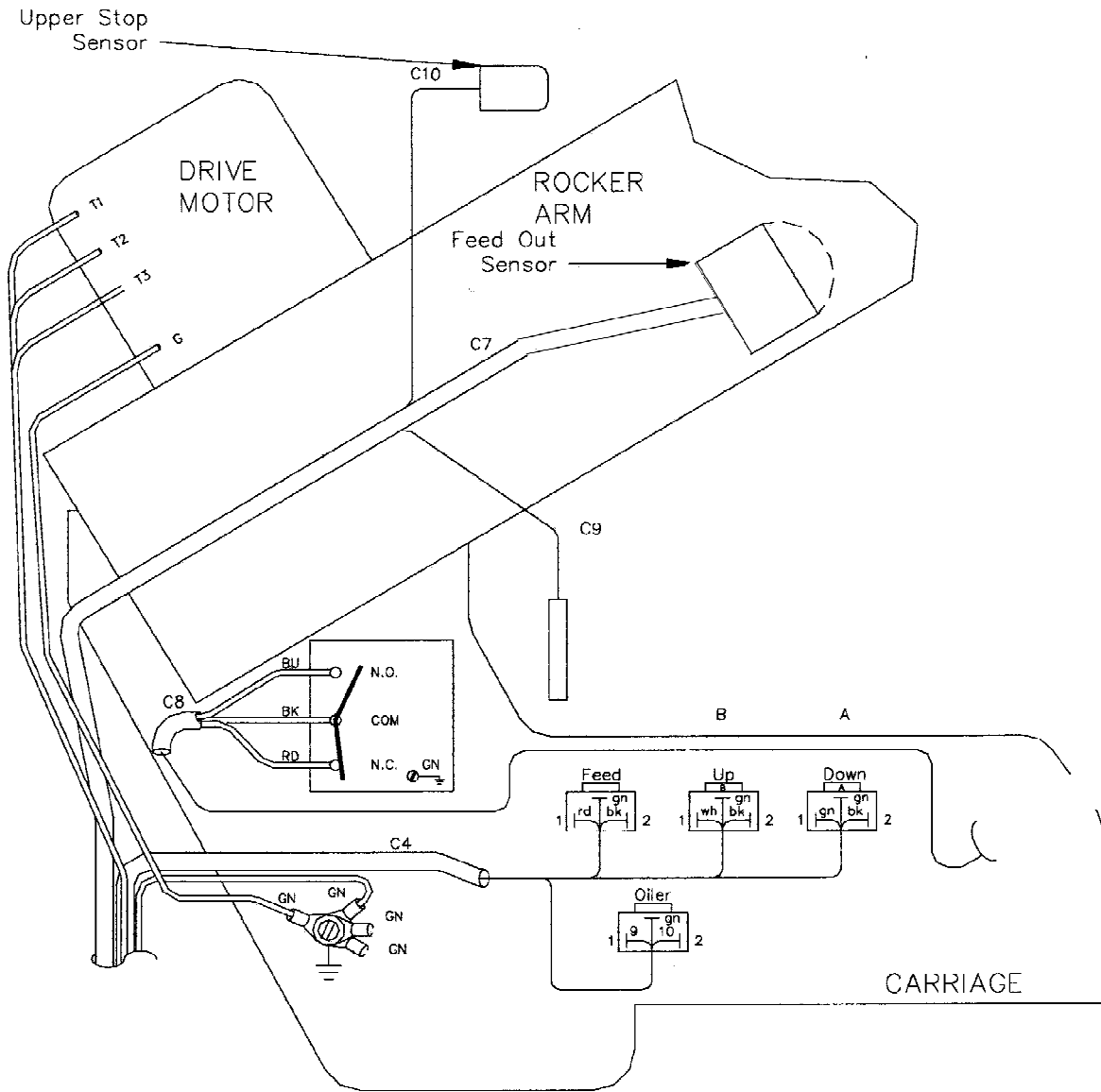
Electrical Wiring Diagram Part 1:



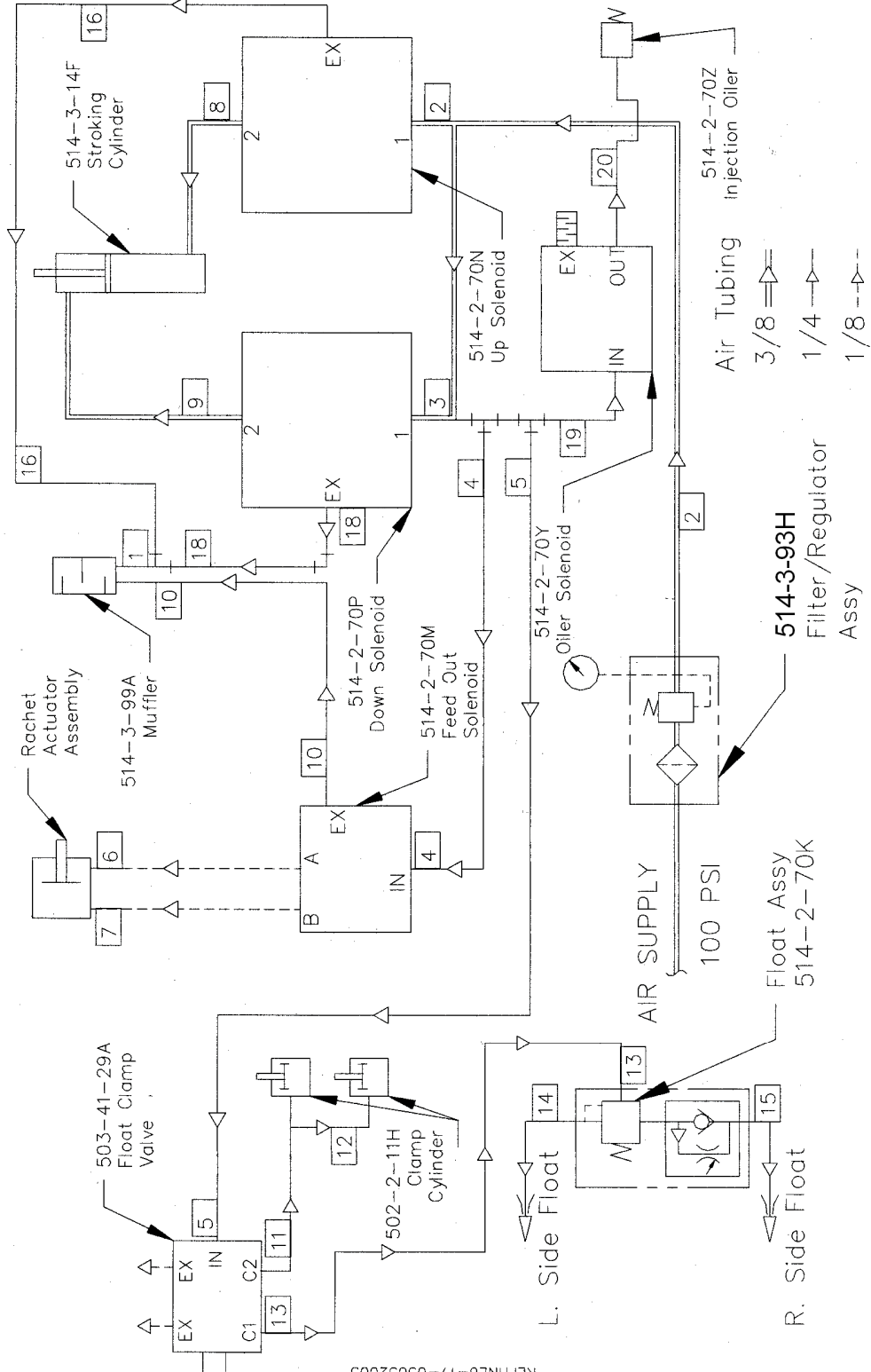
Electrical Wiring Diagram Part 2:



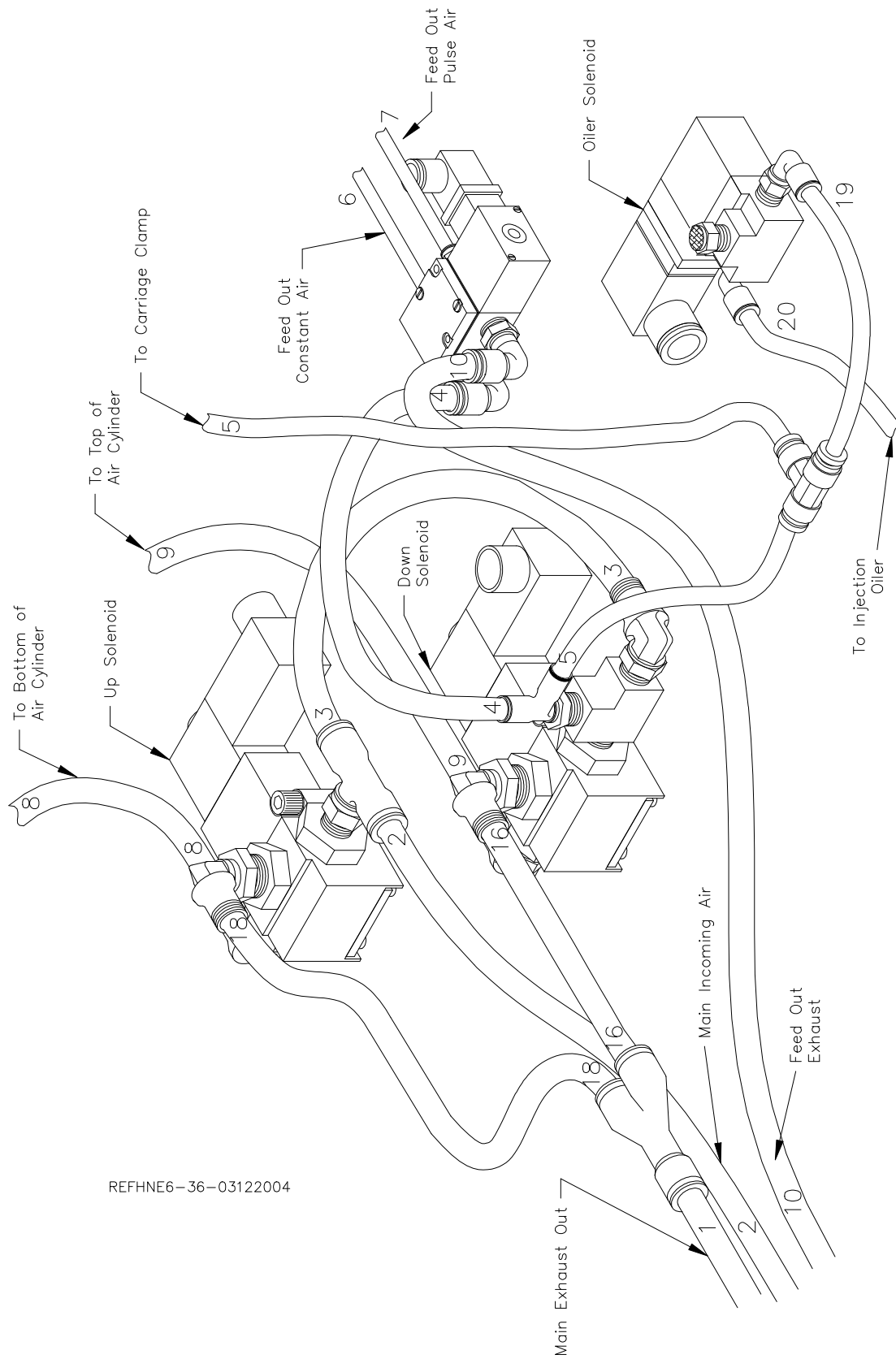
Electrical Wiring Diagram Part 3:



Air Logic Diagram:

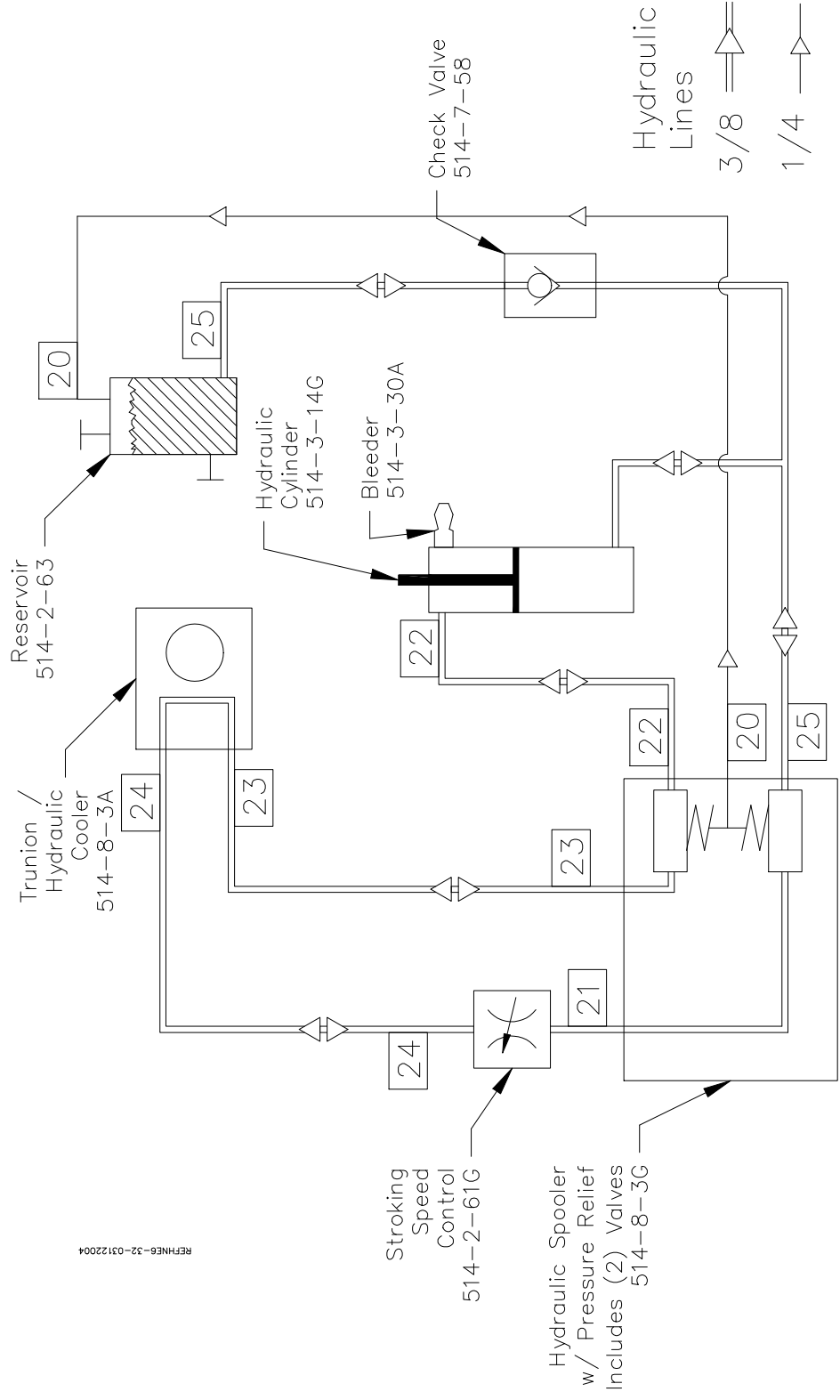


Air System Connections:



REFHNE6-36-03122004

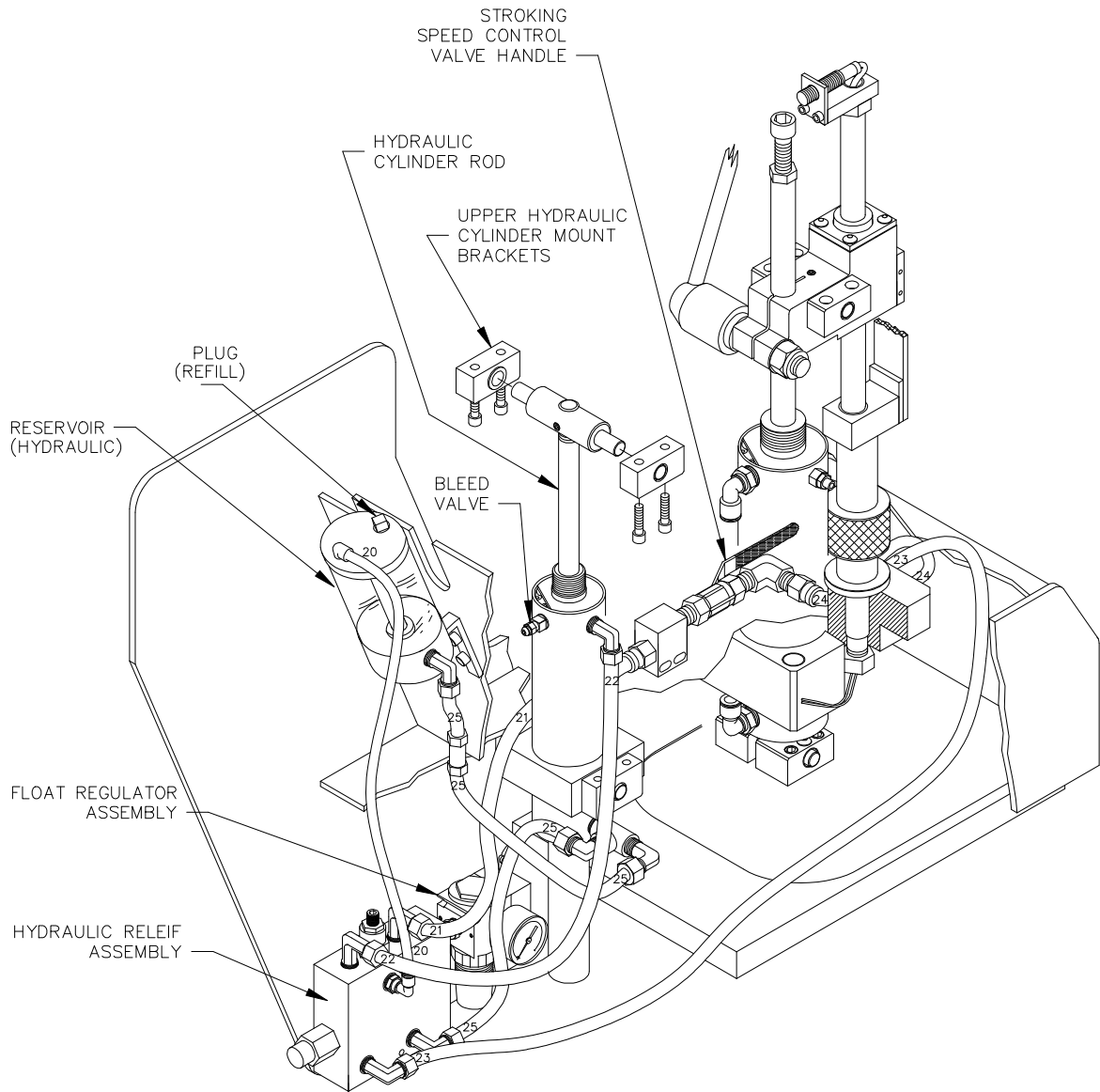
Hydraulic Logic Diagram



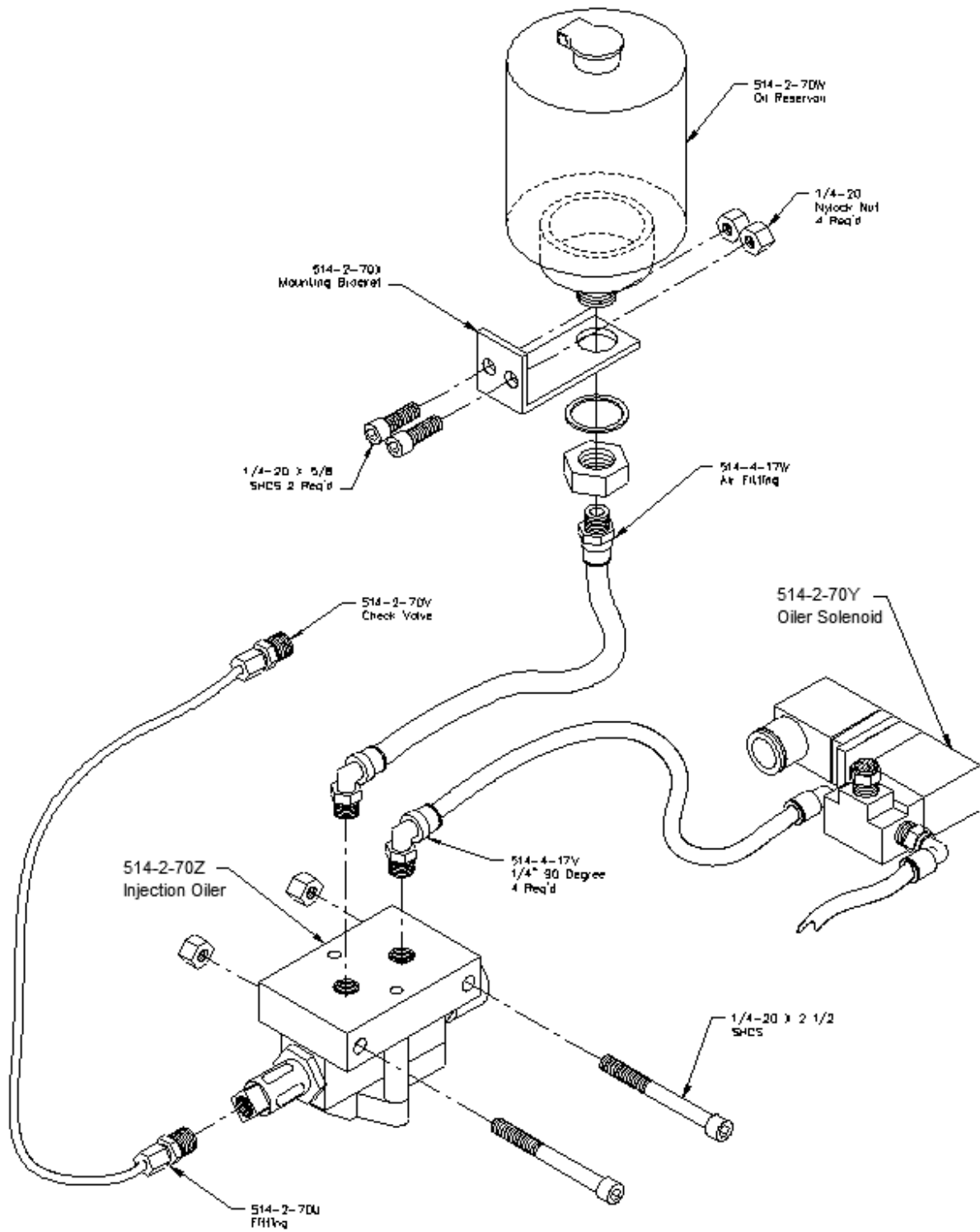
REFHNE6-32-03122004

Hydraulic System Connections:

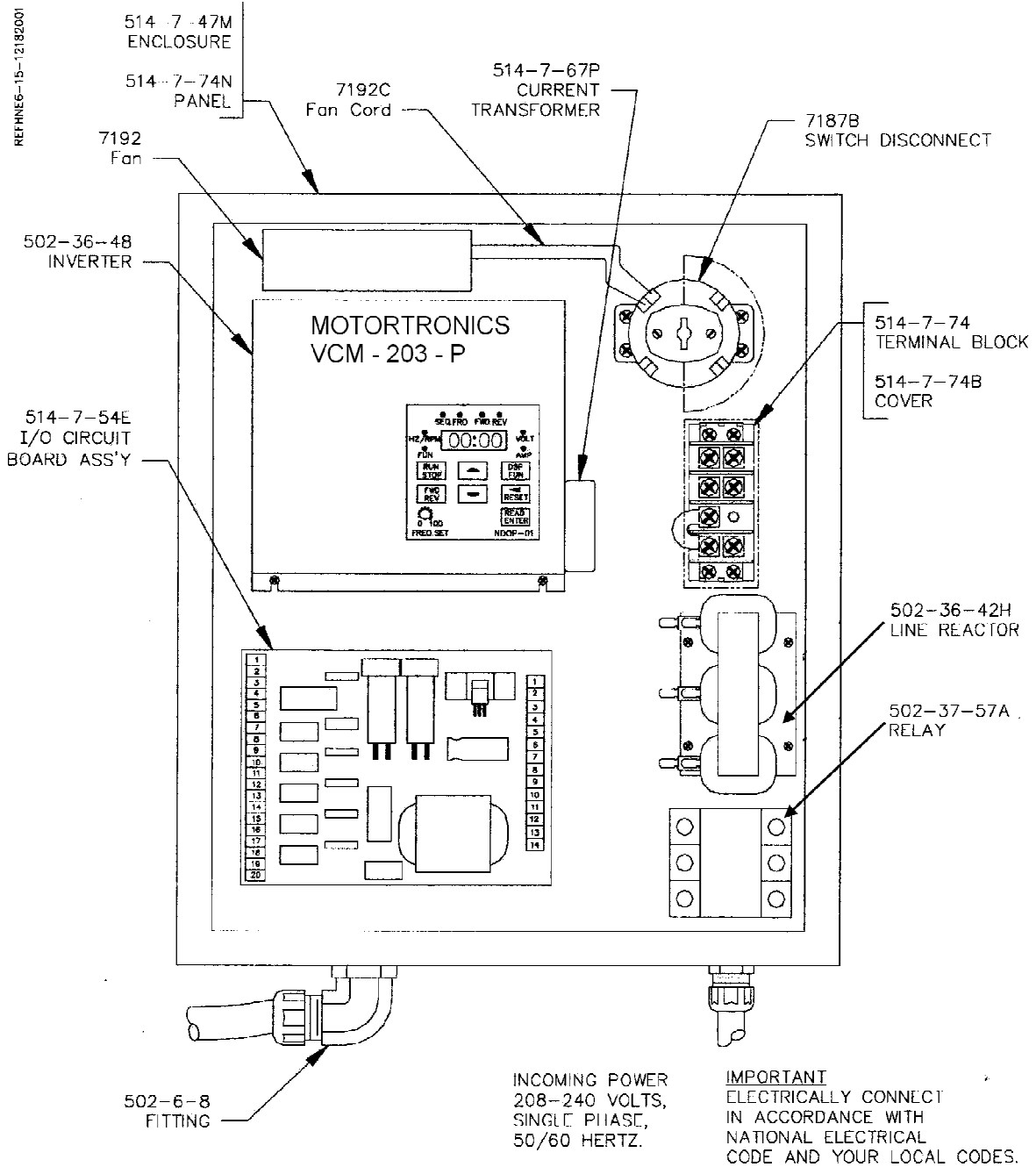
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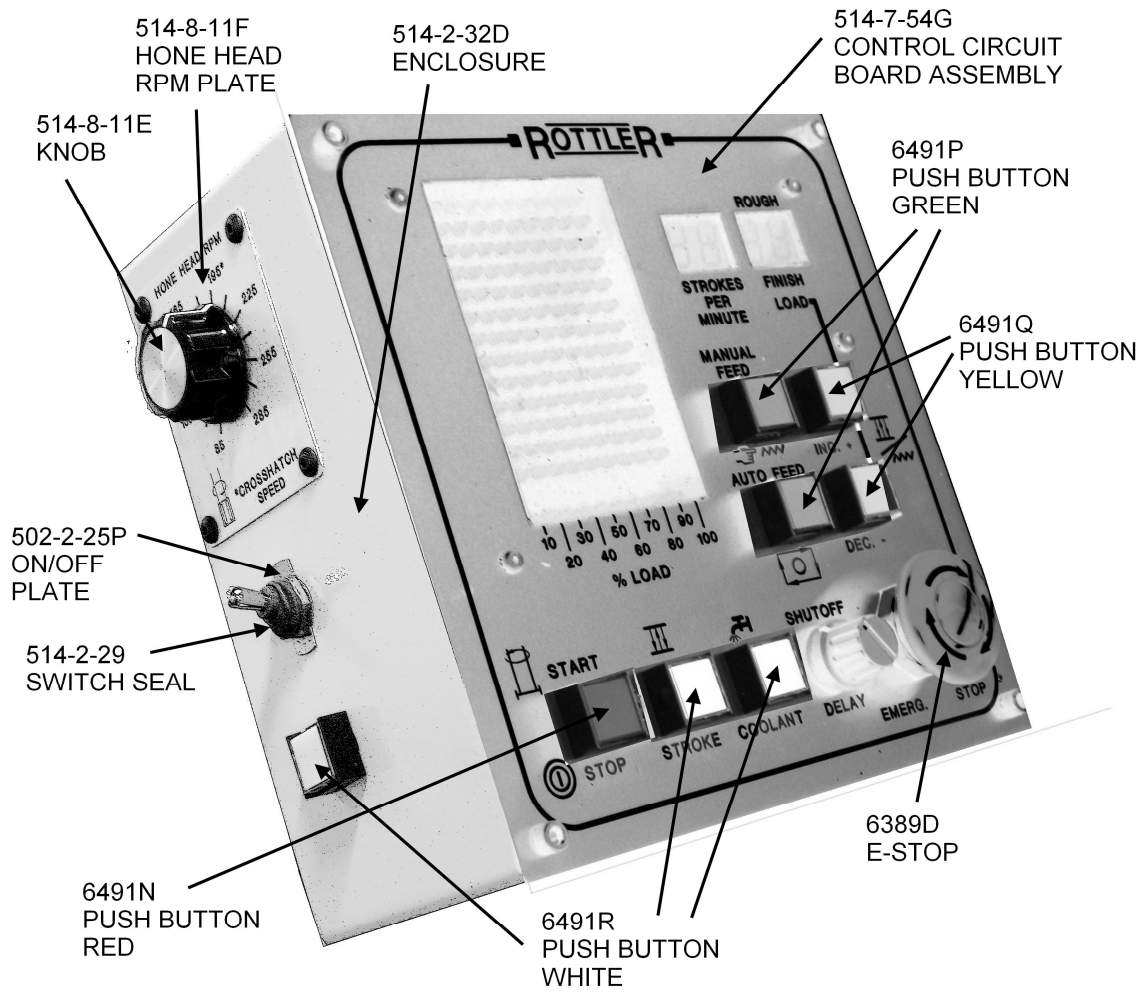
Injection Oiler:



Electrical Power Supply Enclosure:

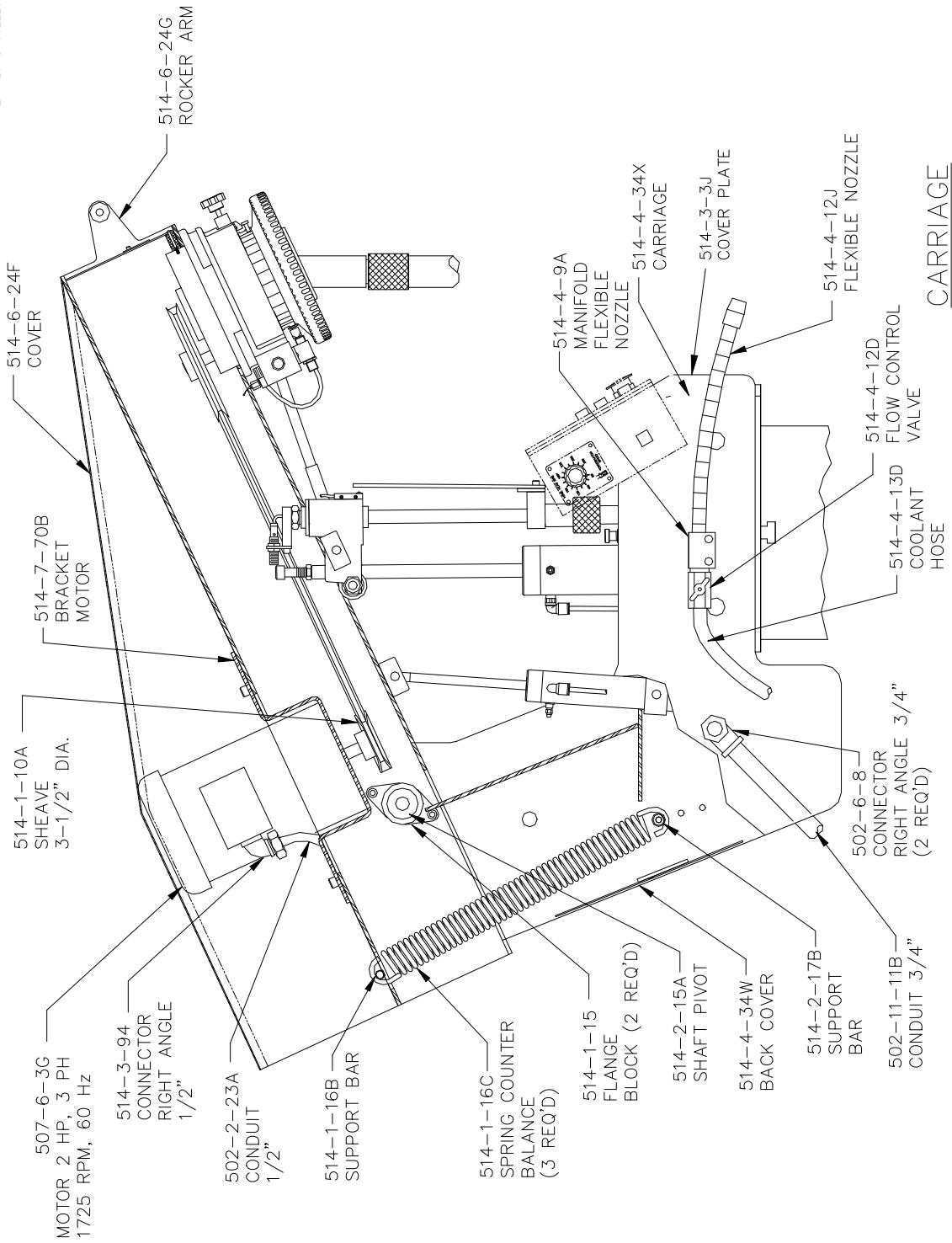


Control Panel:

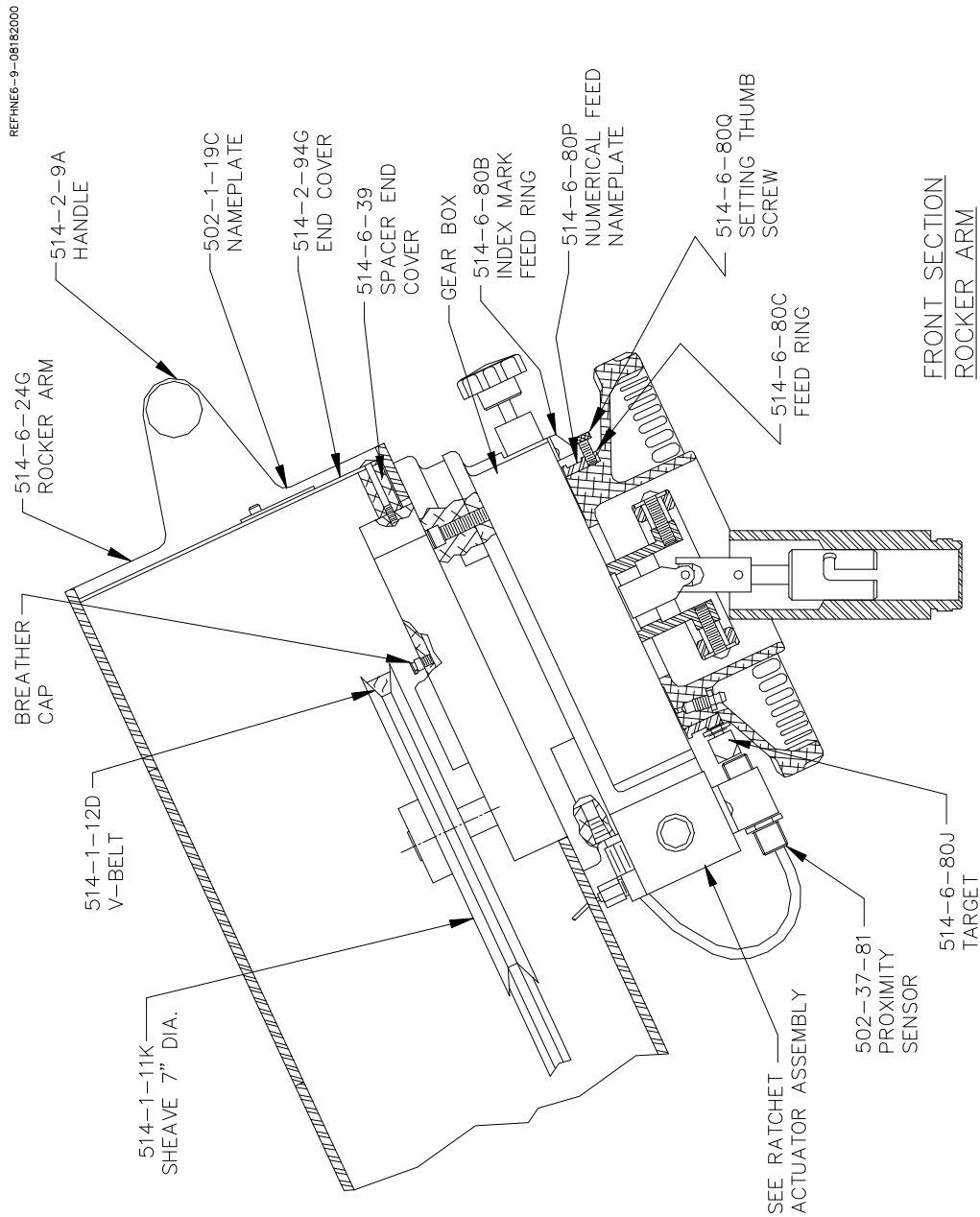


Carriage:

REFHNE6-8-0322002

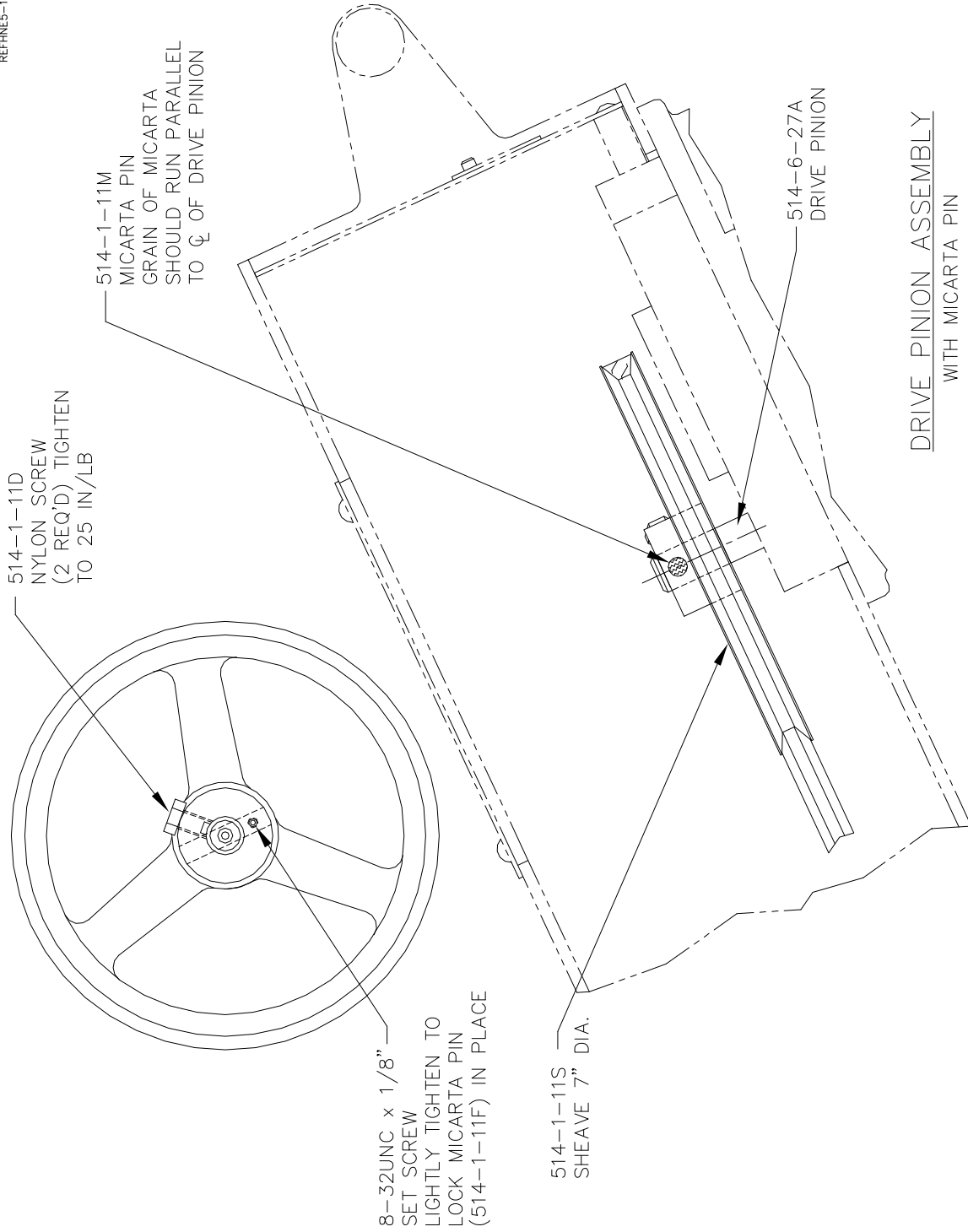


Front Section Rocker Arm:

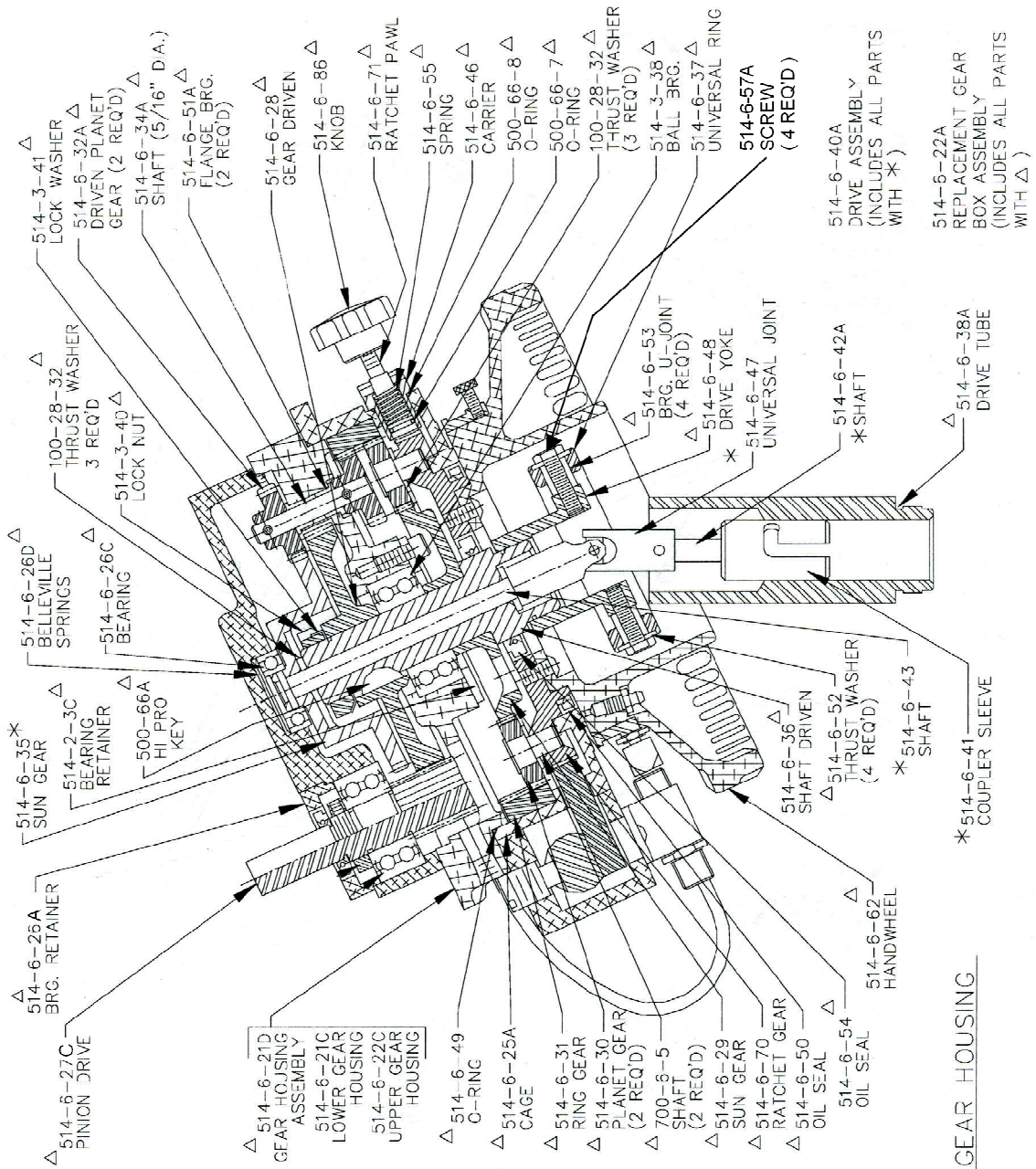


Drive Pinion Assembly:

REFHNE5-12-05052005



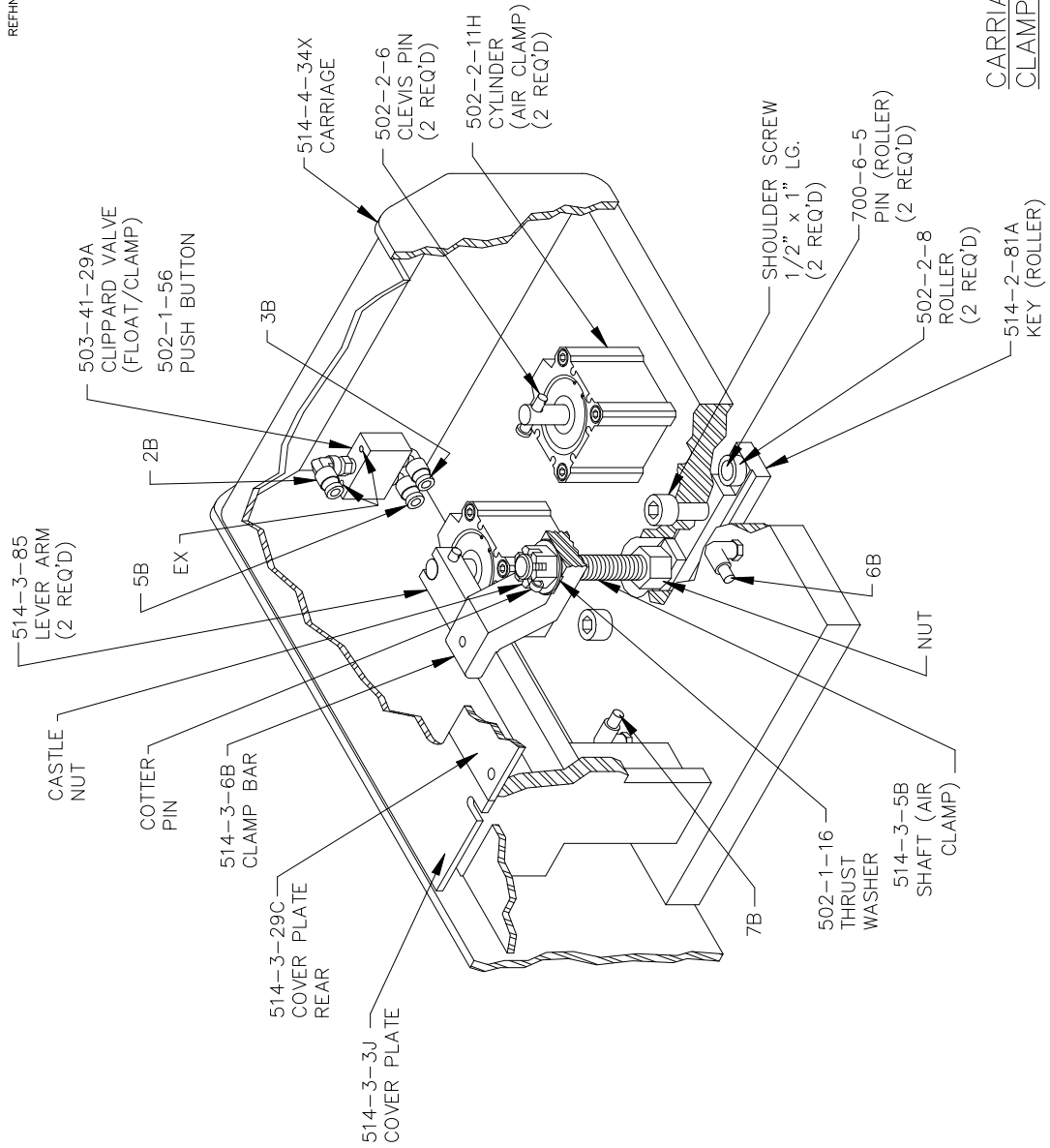
Gear Housing Section:



GEAR HOUSING

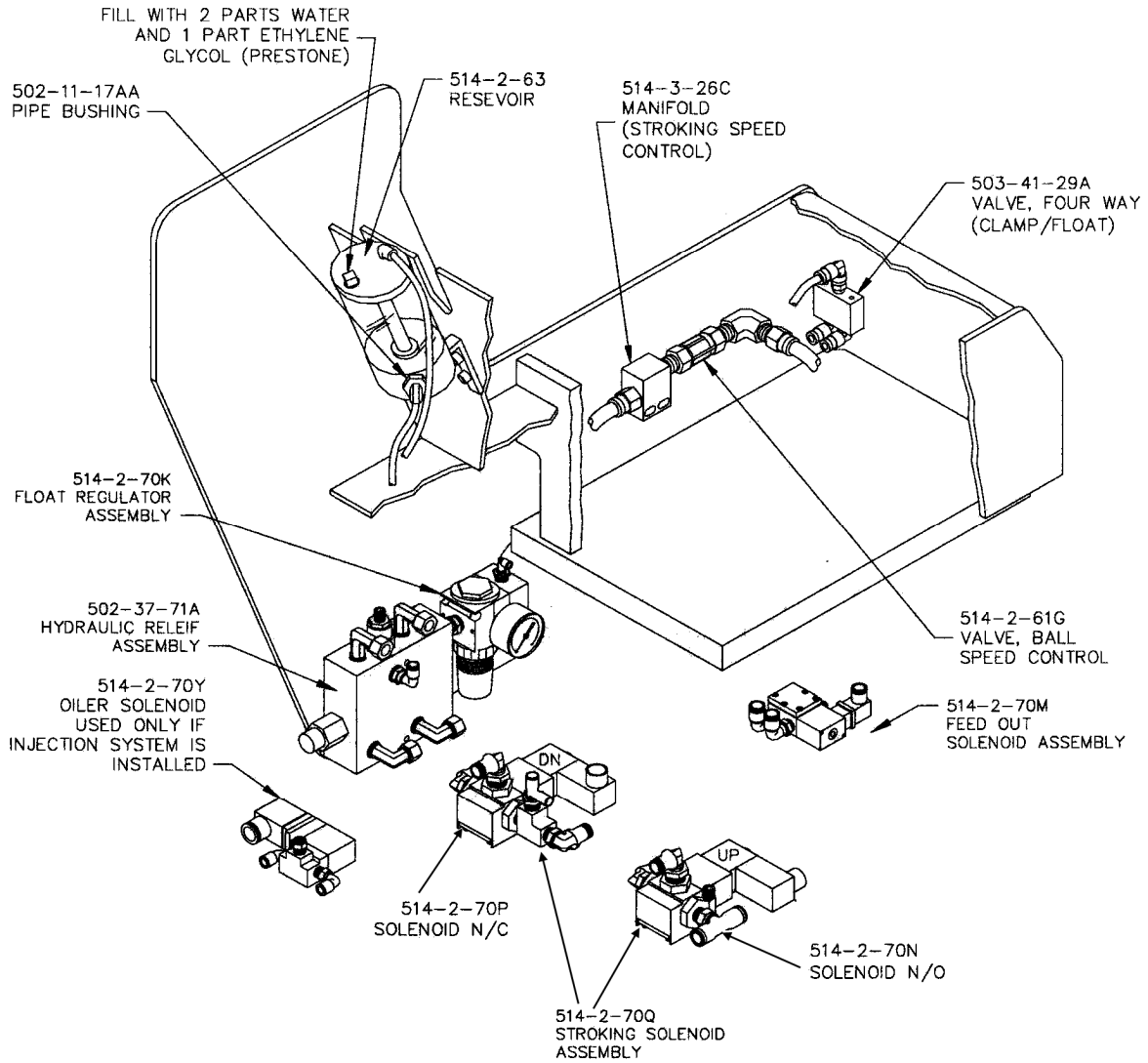
Carriage Float / Clamp:

REFHNE6-3-08092000

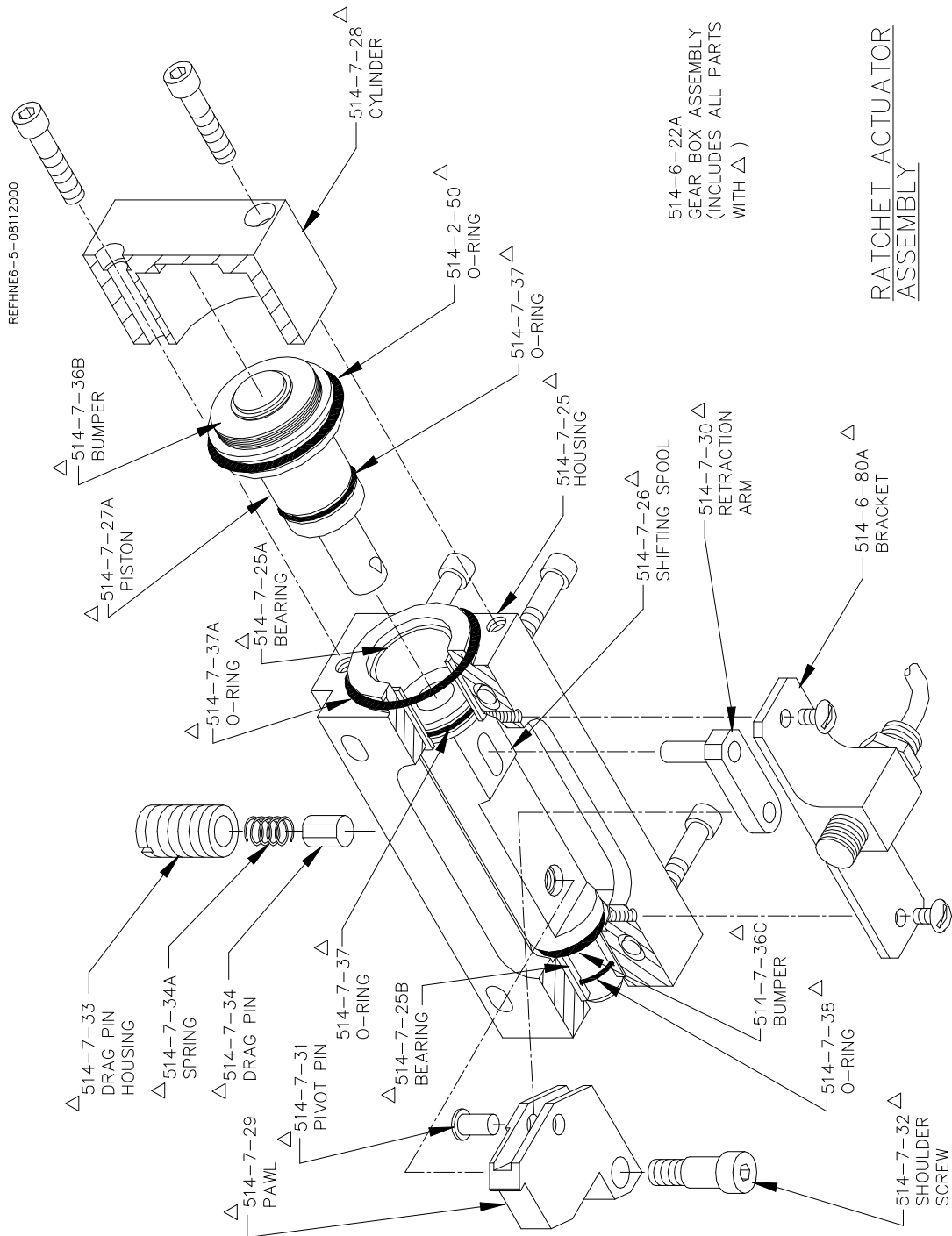


CARRIAGE FLOAT / CLAMP

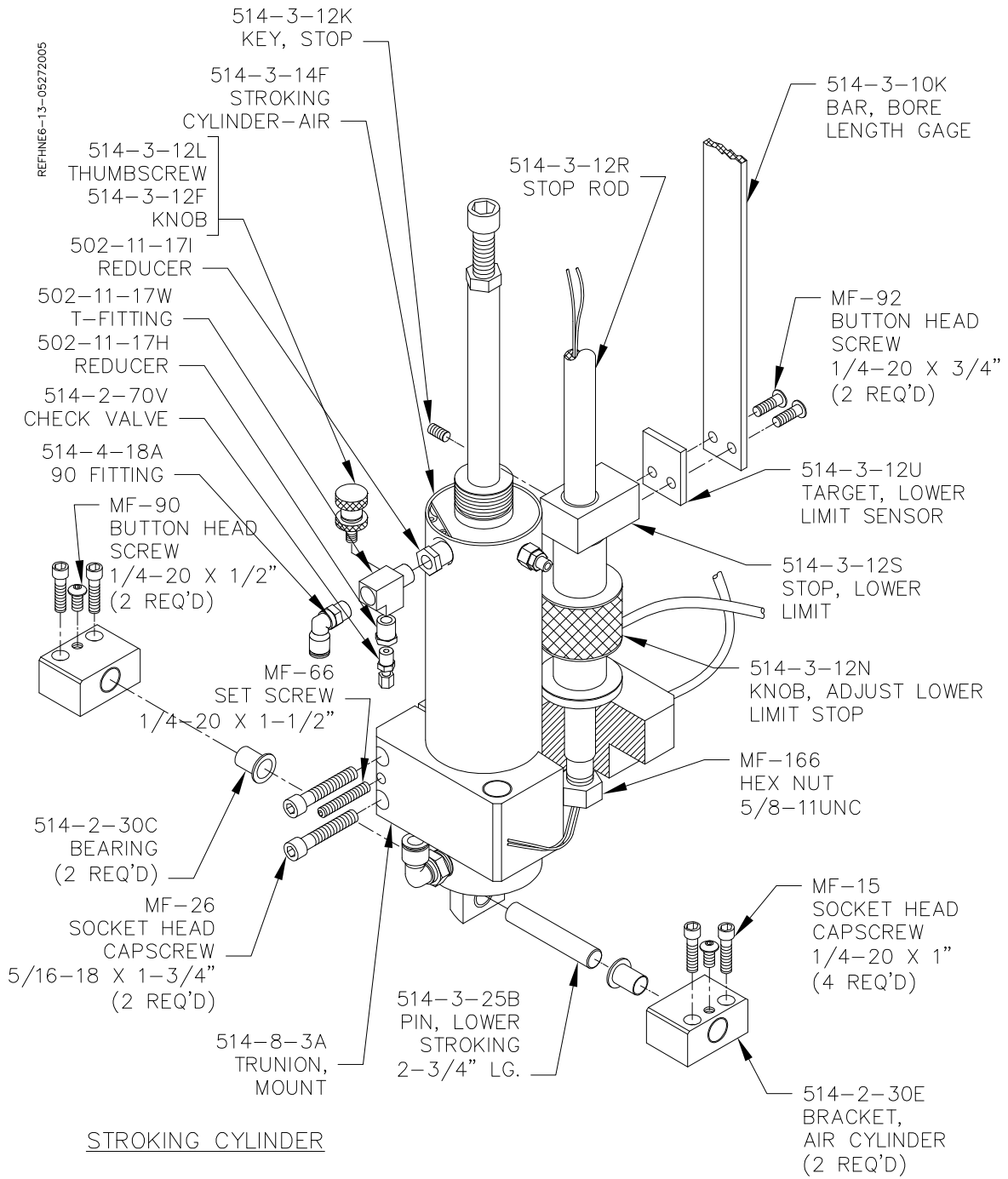
Stroking Control - Air:



Ratchet Actuator Assembly:

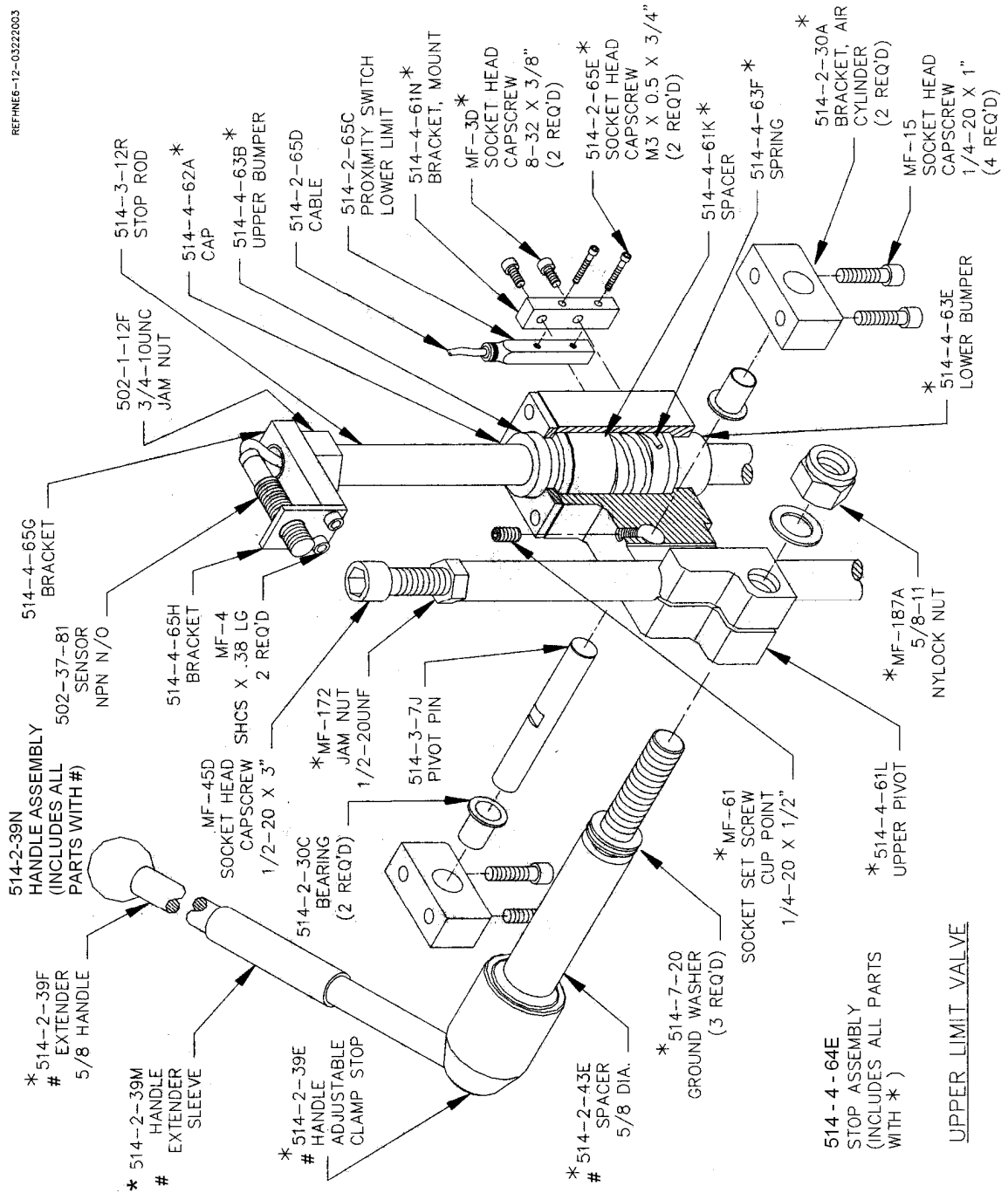


Stroking Cylinder:



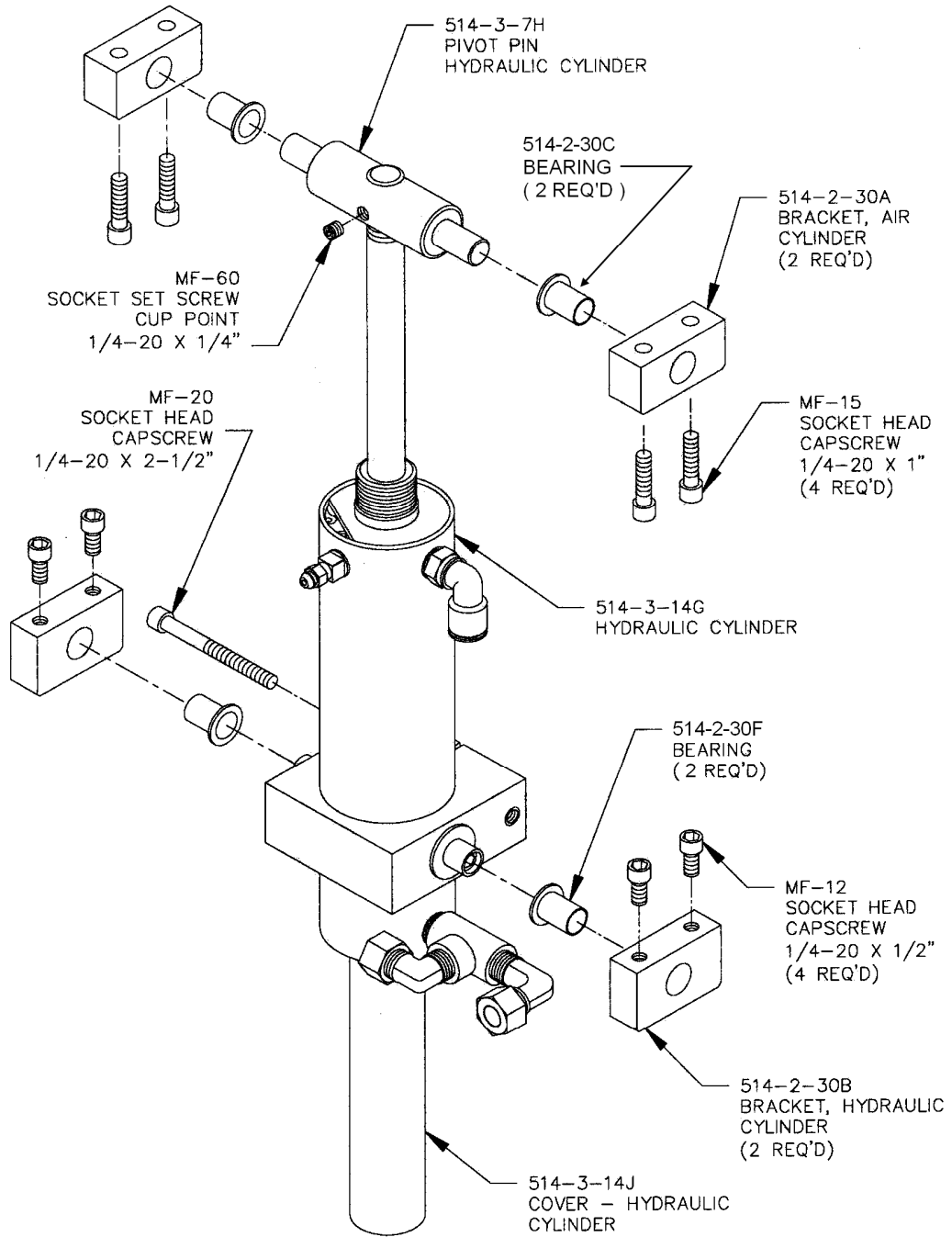
Upper Limit Assembly:

REFPHE6-12-03222003



Hydraulic Cylinder:

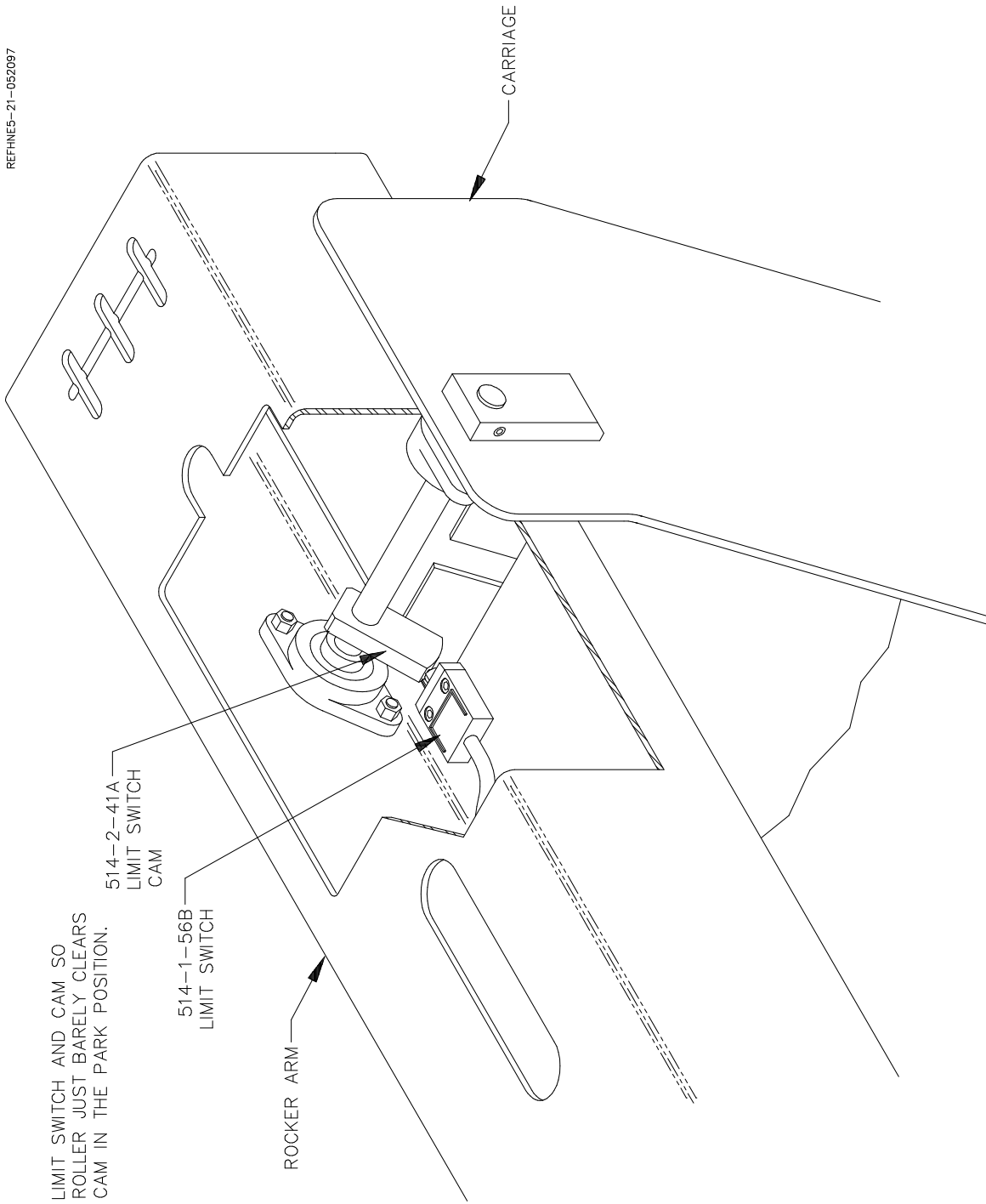
REFHNE6-14-08312000



HYDRAULIC CYLINDER

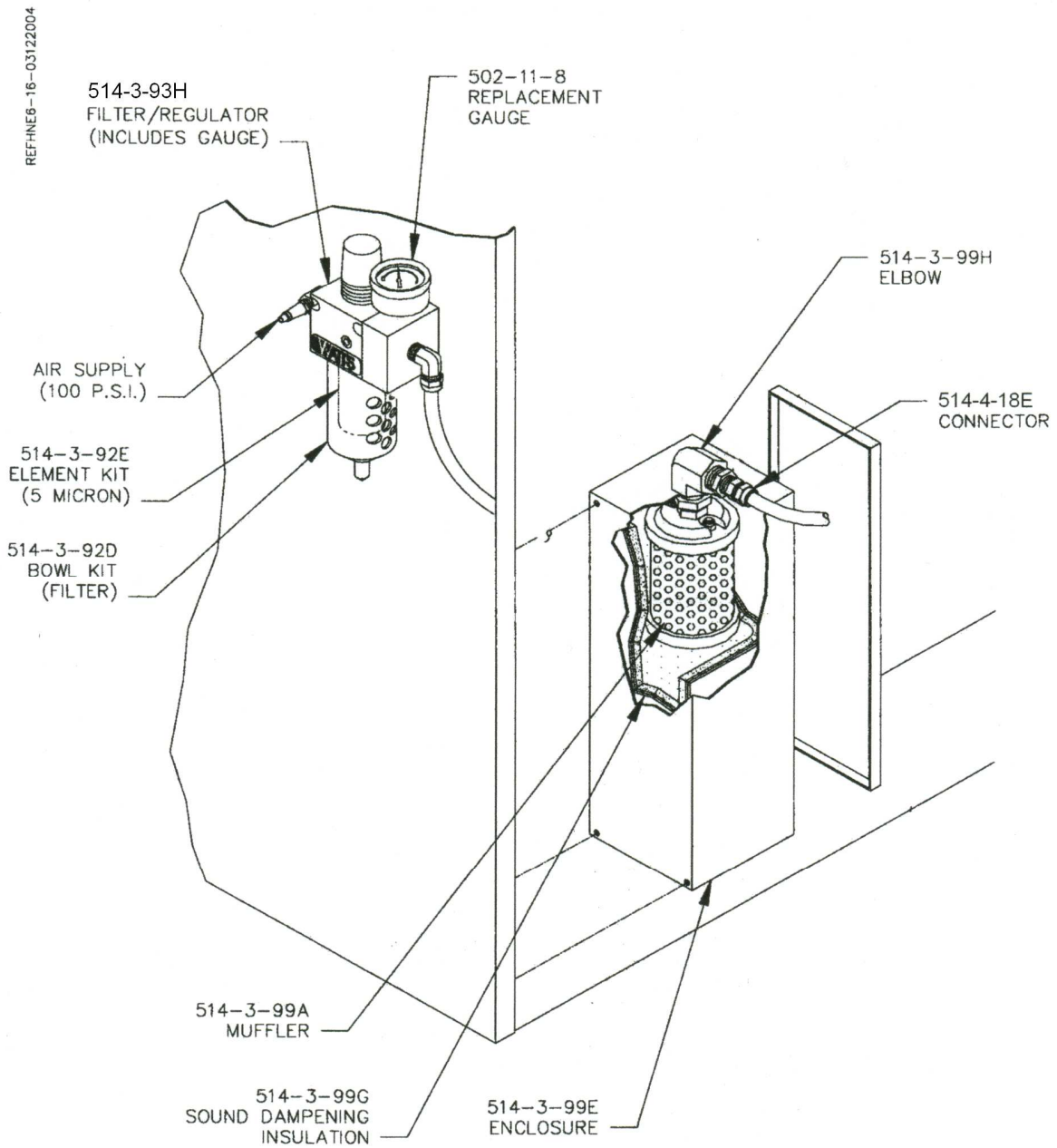
Motor - Safety Switch:

REFHNE5-21-052097



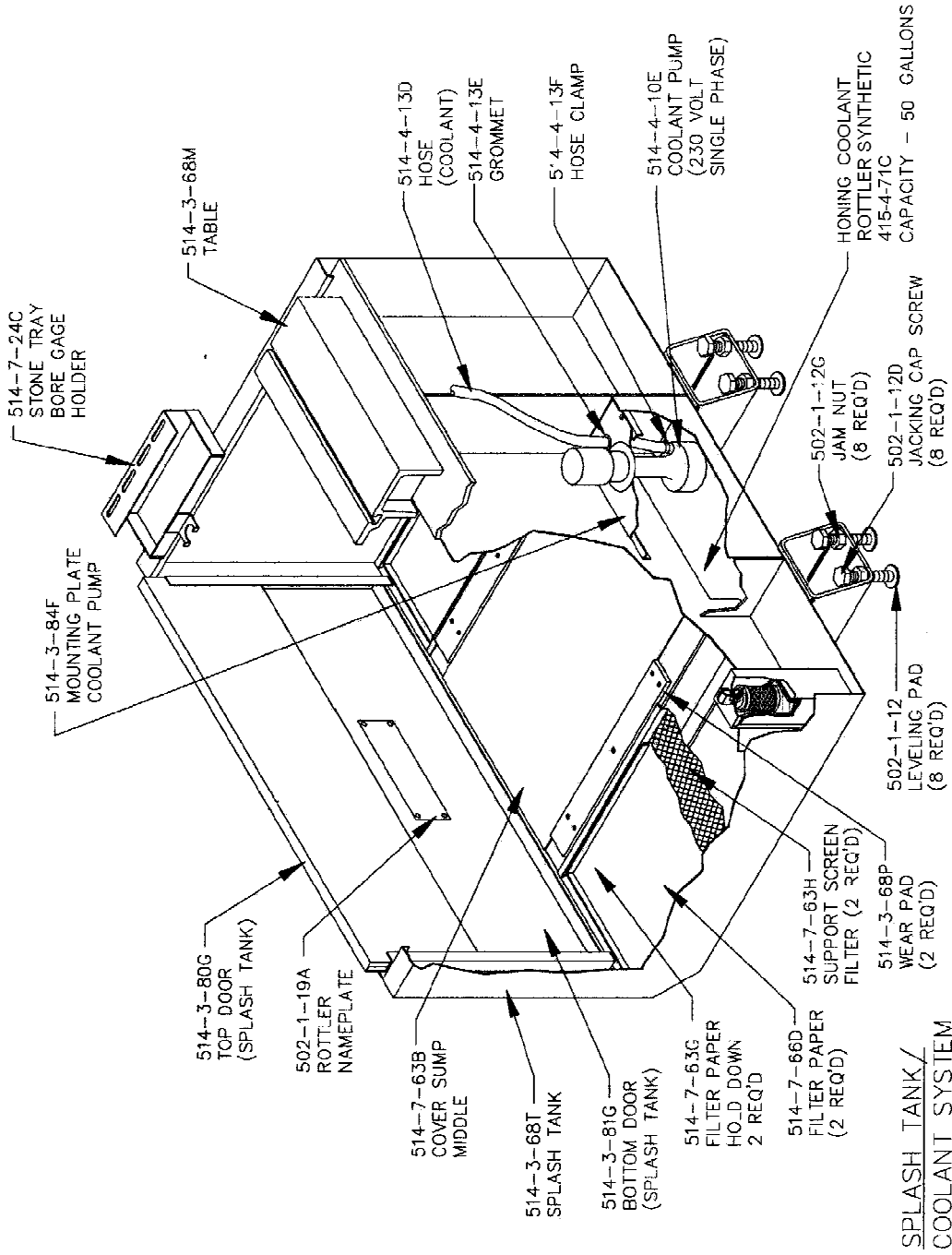
SET LIMIT SWITCH AND CAM SO THE ROLLER JUST BARELY CLEARS THE CAM IN THE PARK POSITION.

Pneumatic Power Supply:

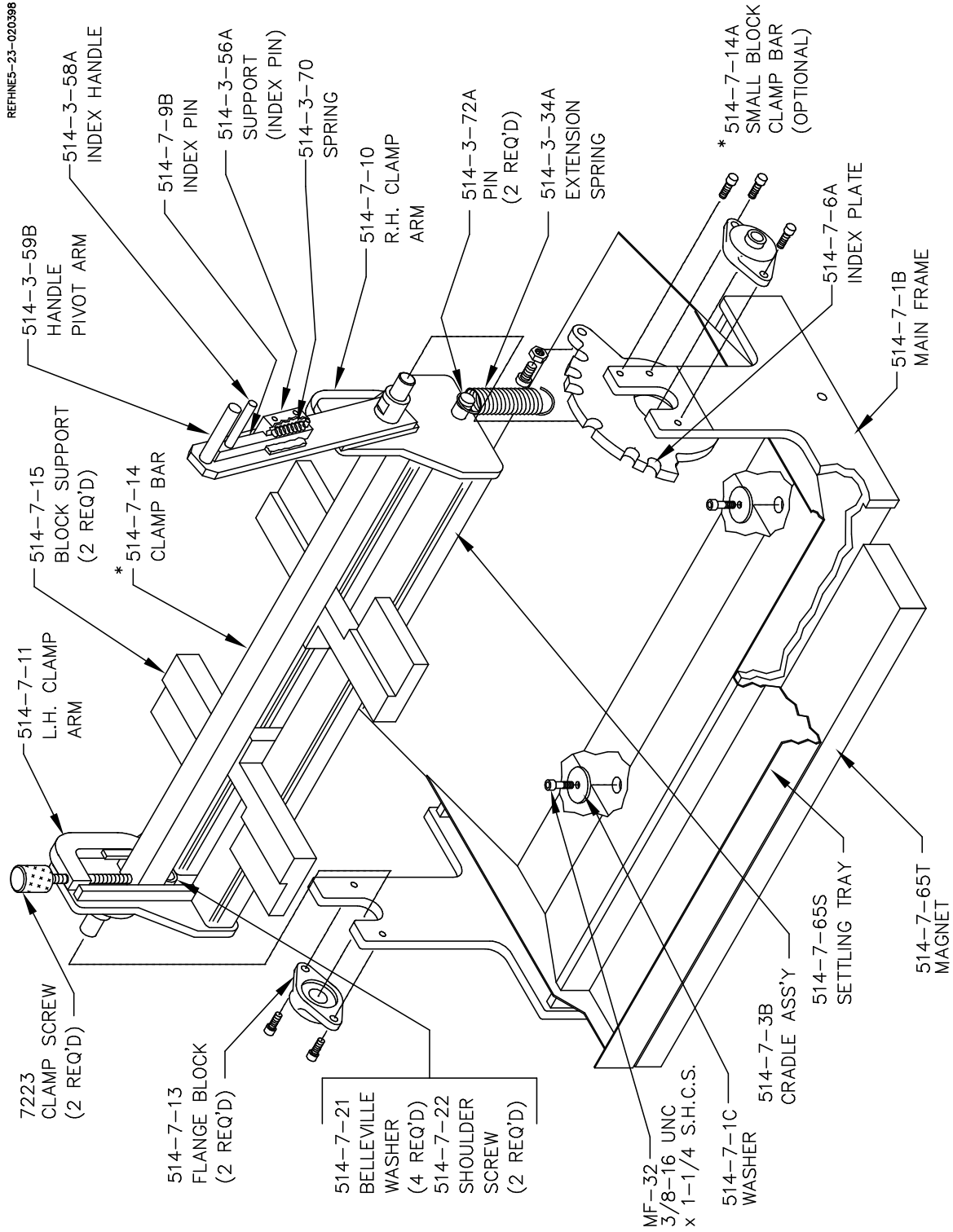


Splash Tank / Coolant System:

REFINES-7-08 52000



Block, Hold Down - Fixture Assembly:



Chapter 7

Precision Hone Head:

General Operation:

Important - Read this and study carefully **before** operating the precision head to implement the full capability of the precision head.

The precision head provides a very stiff back-up of the abrasives. This in turn provides rapid bore correction with very little material removal. The four cutting stones provide more abrasive area and cutting capability than two-stone heads and should perform 10 to 25% faster with less abrasive cost. You must, however, have the proper combination of cutting fluid, abrasive bond hardness, stone grit, hone pressure and feed rate. As with all machines, patience is necessary initially so that you organize and become familiar with the mesh of these variables. Blending them and proper adaptation to switching holders for the size changing will increase your productivity.

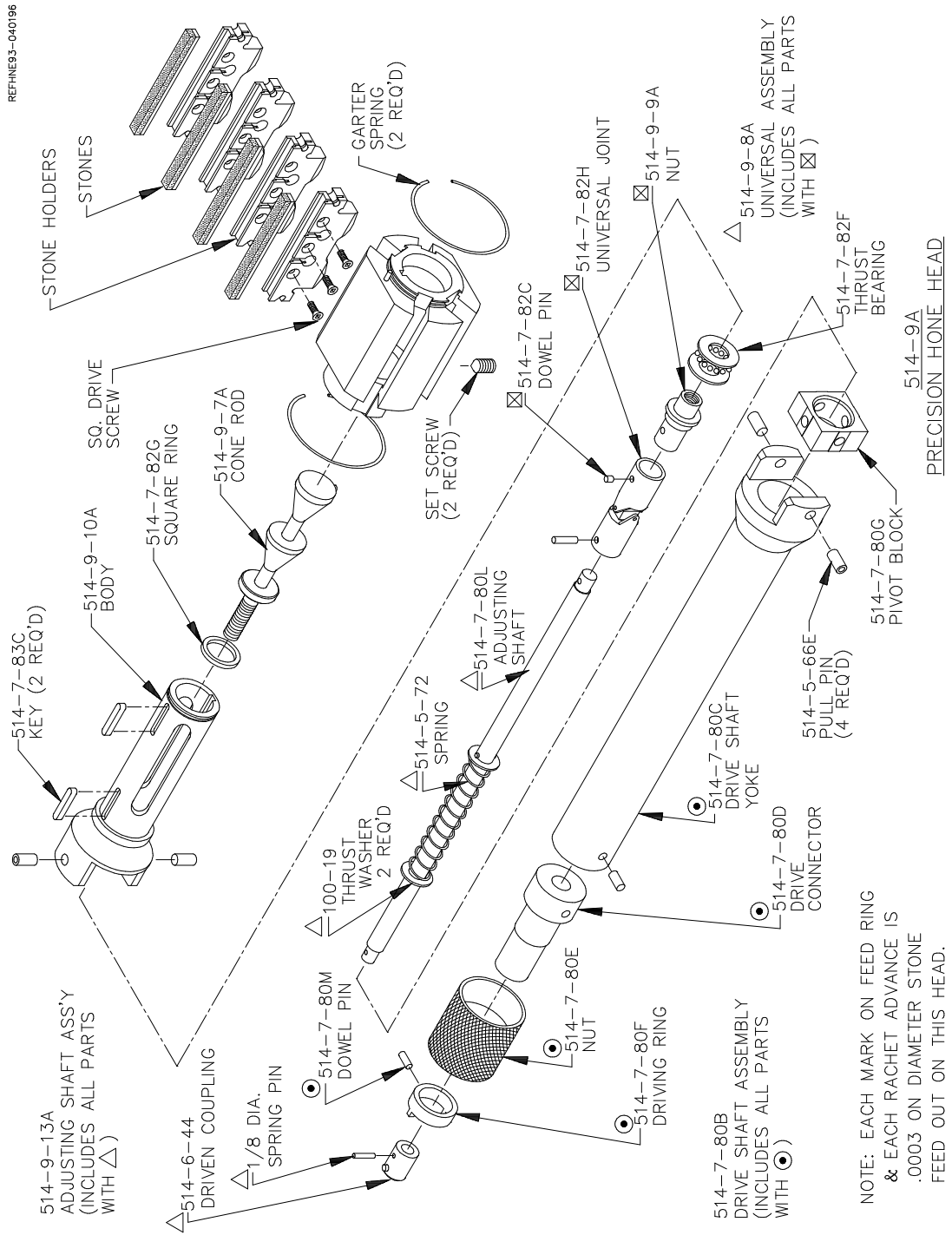
Care must be exercised in starting honing operations in a tapered hole since the stiffness of the abrasives can easily lock the hone head in tight bore. If the hone is started in the large end of a tapered hole the hone head could bind by the time it reaches the small end of the tapered hole.

Carefully study how to switch holders for size ranges. Once you have adequate abrasives loaded in the holders and you keep them stored properly in the file, size changes can be made in a minute. If it is necessary to change sleeves to a new range, that will take a minute more.

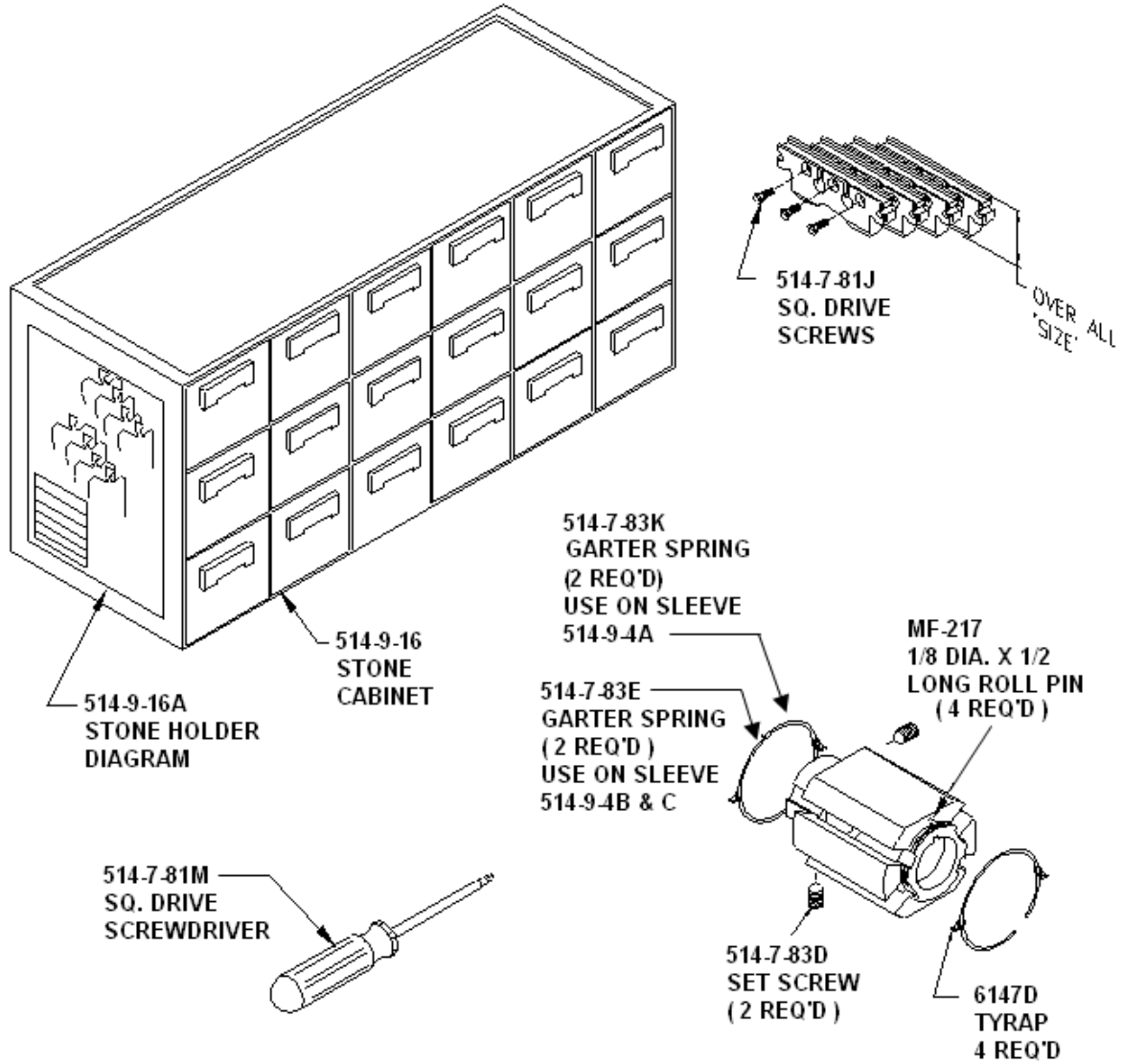
The precision hone head expands .0003" (.008 mm) with every wheel graduation or up-feed. Ten feed-ups will remove .003" (.08 mm) of stock, less abrasive wear, if the load meter remains constant.

Automotive bores often require a good deal of attention at the bottom of cylinders which allow limited lower over-stroke. Use the part 514-8-27, stone depth scale assembly, to maximize over-strokes. Use 3" abrasives and make sure the lower stop is set as low as possible without interfering with lower bore obstructions. The finish load percentage has a large affect on lower bore and thin wall cylinder geometry. Generally lowering the finish load percentage will increase the accuracy of the lower bore area.

Precision Hone Head



Stone Holder - Sleeve Sets:



STONE HOLDER SIZE RANGE:

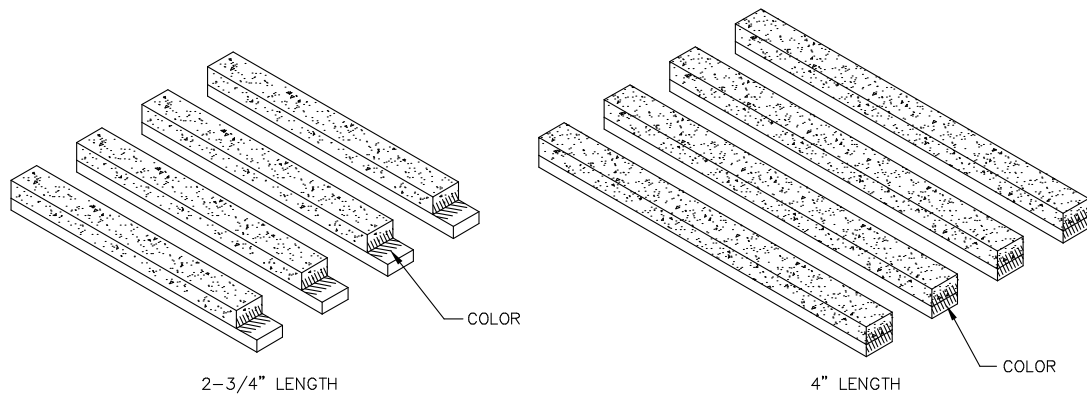
STONE HOLDER SET WITH DIAMONDS			SLEEVE		
SIZE	PART NUMBER	RANGE (DIA)	SIZE	PART NUMBER	RANGE (DIA)
1.04	514-9-6J	*2.840/3.440 72.14/87.38	A,B,J	514-9-4A	*2.840/3.880 72.14/98.55
1-1/8	514-9-6A	3.190/3.620 81.03/91.95			
1-1/4	514-9-6B	3.440/3.880 87.38/98.55			
1-3/8	514-9-6C	3.690/4.120 93.73/104.65	C,D,E	514-9-4B	3.690/4.670 93.73/118.62
1-1/2	514-9-6D	3.940/4.380 100.01/111.25			
1-5/8	514-9-6E	4.300/4.670 109.22/118.62			
1-3/4	514-9-6F	4.440/4.900 112.78/124.46	F - S	514-9-4C	4.440/7.360 112.78/136.40
1-7/8	514-9-6G	4.690/5.120 119.13/130.05			
2	514-9-6H	4.940/5.370 125.48/136.40			
2-1/8	514-9-6K	5.190/5.620 131.83/142.75			
2-1/4	514-9-6L	5.440/5.880 138.18/149.35			
2-3/8	514-9-6M	5.680/6.100 144.27/154.94			
2-1/2	514-9-6N	5.900/6.330 149.86/160.78			
2-5/8	514-9-6P	6.140/6.600 155.96/167.64			
2-3/4	514-9-6Q	6.420/6.680 163.07/169.67			
2-7/8	514-9-6R	6.680/7.080 169.67/179.83			
3	514-9-6S	6.880/7.360 175.75/186.94			

* MINIMUM 2.840 (72.14mm)WITH SPECIAL 1/4" HEIGHT STONE

STONE HOLDER SET WITH 514-9-14Y BRUSHES			SLEEVE		
SIZE	PART NUMBER	RANGE (DIA)	SIZE	PART NUMBER	RANGE (DIA)
1.04	514-9-6J	3.335/3.785 84.65/96.08	A,B,J	514-9-4A	3.335/4.225 84.65/107.25
1-1/8	514-9-6A	3.535/3.965 89.73/100.65			
1-1/4	514-9-6B	3.785/4.225 96.08/107.25			
1-3/8	514-9-6C	4.065/4.465 102.43/113.35	C,D,E	514-9-4B	4.065/5.015 102.43/127.32
1-1/2	514-9-6D	4.285/4.725 108.71/119.95			
1-5/8	514-9-6E	4.645/5.015 117.92/127.32			
1-3/4	514-9-6F	4.785/5.245 121.48/133.16	F - S	514-9-4C	4.785/7.705 121.48/195.64
1-7/8	514-9-6G	5.035/5.465 127.83/138.75			
2	514-9-6H	5.285/5.715 134.18/145.10			
2-1/8	514-9-6K	5.380/5.810 140.53/151.45			
2-1/4	514-9-6L	5.785/6.225 146.88/158.05			
2-3/8	514-9-6M	6.025/6.445 153.42/163.64			
2-1/2	514-9-6N	6.245/6.675 158.56/169.48			
2-5/8	514-9-6P	6.485/6.945 164.66/176.34			
2-3/4	514-9-6Q	6.765/7.025 175.73/178.37			
2-7/8	514-9-6R	7.025/7.425 178.37/188.53			
3	514-9-6S	7.225/7.705 184.45/195.64			

STONE HOLDER SET WITH 514-9-14H BRUSHES			SLEEVE		
SIZE	PART NUMBER	RANGE (DIA)	SIZE	PART NUMBER	RANGE (DIA)
1.04	514-9-6J	3.490/3.940 88.65/100.08	A,B,J	514-9-4A	3.490/4.380 88.65/111.25
1-1/8	514-9-6A	3.690/4.120 93.73/104.65			
1-1/4	514-9-6B	3.940/4.380 100.08/111.25			
1-3/8	514-9-6C	4.190/4.620 106.43/117.35	C,D,E	514-9-4B	4.190/5.170 106.43/131.32
1-1/2	514-9-6D	4.44/4.880 112.71/123.95			
1-5/8	514-9-6E	4.800/5.170 121.92/131.32			
1-3/4	514-9-6F	4.940/5.400 125.48/137.16	F - S	514-9-4C	4.940/7.860 125.48/199.64
1-7/8	514-9-6G	45.190/5.620 131.83/142.75			
2	514-9-6H	5.440/5.870 138.18/149.10			
2-1/8	514-9-6K	5.690/6.120 144.53/155.45			
2-1/4	514-9-6L	5.940/6.380 150.88/162.05			
2-3/8	514-9-6M	6.180/6.600 157.42/167.64			
2-1/2	514-9-6N	6.400/6.830 162.56/173.48			
2-5/8	514-9-6P	6.640/7.100 168.66/180.34			
2-3/4	514-9-6Q	6.920/7.180 179.73/182.37			
2-7/8	514-9-6R	7.180/7.580 182.37/192.53			
3	514-9-6S	7.380/7.860 188.45/199.64			

Stone Sets:



Vitrified Stones: Use with mineral based coolant only

Rottler Part No.	Abrasive	Grit	Length	Color	Finish Ra.	Notes
514-9-18	Vitrified	80L	2-3/4"	Red	80-95 Ra	Roughing
514-9-18A	Vitrified	180L	2-3/4"	Green	30-35 Ra	
514-9-18B	Vitrified	180M	2-3/4"	Blue	30-35 Ra	
514-9-18C	Vitrified	220L	2-3/4"	Yellow	20-26 Ra	
514-9-18D	Vitrified	320M	2-3/4"	White	18-22 Ra	
514-9-18F	Vitrified	400L	2-3/4"	Black	10-15 Ra	
514-9-18G	Vitrified	600L	2-3/4"	Orange	5-10 Ra	
514-9-18H	Vitrified	320K	2-3/4"			
514-9-20	Vitrified	80L	4"	Red	80-95 Ra	
514-9-20A	Vitrified	180L	4"	Green	30-35 Ra	
514-9-20B	Vitrified	180M	4"	Blue	30-35 Ra	
514-9-20C	Vitrified	220L	4"	Yellow	20-26 Ra	
514-9-20D	Vitrified	320M	4"	White	18-22 Ra	
514-9-20E	Vitrified	400L	4"	Black	10-15 Ra	
514-9-20F	Vitrified	600L	4"	Orange	5-10 Ra	

NOTE:

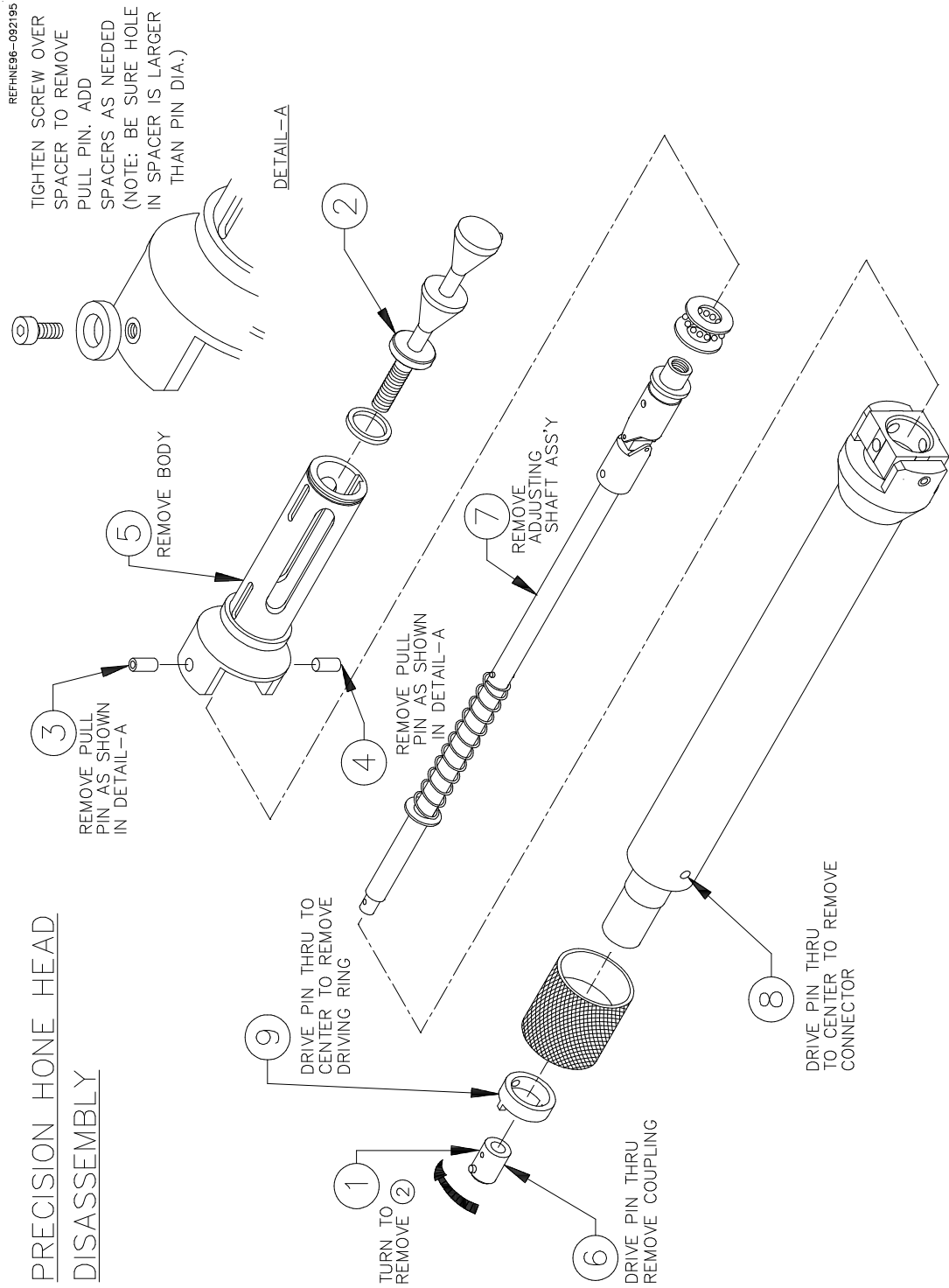
Hardness designation: The lower the alphabetical designation the softer the bond. For example, 'L' is softer than 'M'.

Diamond and special application stones

514-9-14F	Diamond	80	3-1/2"		90 Ra	Stock Removal .004/min.
514-9-14R	Diamond	80	3-1/2"		90 Ra	
514-9-14W	Diamond	140	3"		50-75Ra	
514-9-14K	Diamond	170 /170	3"		45-60 Ra	
519-9-14M	Diamond	170 /200	3-1/2"		45-60 Ra	
514-9-14J	Diamond	270 /375	3"		35-45Ra	
514-9-14T	Diamond	270 /375	3-1/2"		35-45 Ra	
514-9-14E	Diamond	325 /400	3"		24-30 Ra	
514-9-14Q	Diamond	325 /400	3-1/2"		24-30Ra	
514-9-14X	Diamond	325 /400	4"		24-30 Ra	
514-9-14V	Diamond	400	3"		15-19 Ra	Required for bores under 2.8"
514-9-14U	Diamond	500	2-1/2"		18-22 Ra	
514-9-14C	Diamond	500	3"		18-22 Ra	
514-9-14P	Diamond	500	3-1/2"		18-22 Ra	
514-9-14D	Diamond	500	3"		18-22 Ra	
514-9-14L	Diamond	550	3"		15-19 Ra	
514-9-14N	Diamond	550	3-1/2"		15-19Ra	
514-9-14G	Diamond	600	3"		8-12 Ra	
514-9-14S	Diamond	600	3-1/2"		8-12 Ra	
514-9-21	Cork		3"			
514-9-14H	Fiber	320	3-1/2"			
514-9-14Y	Fiber	320	3-1/2"			
514-9-18P	Composite-Diamond		3"			

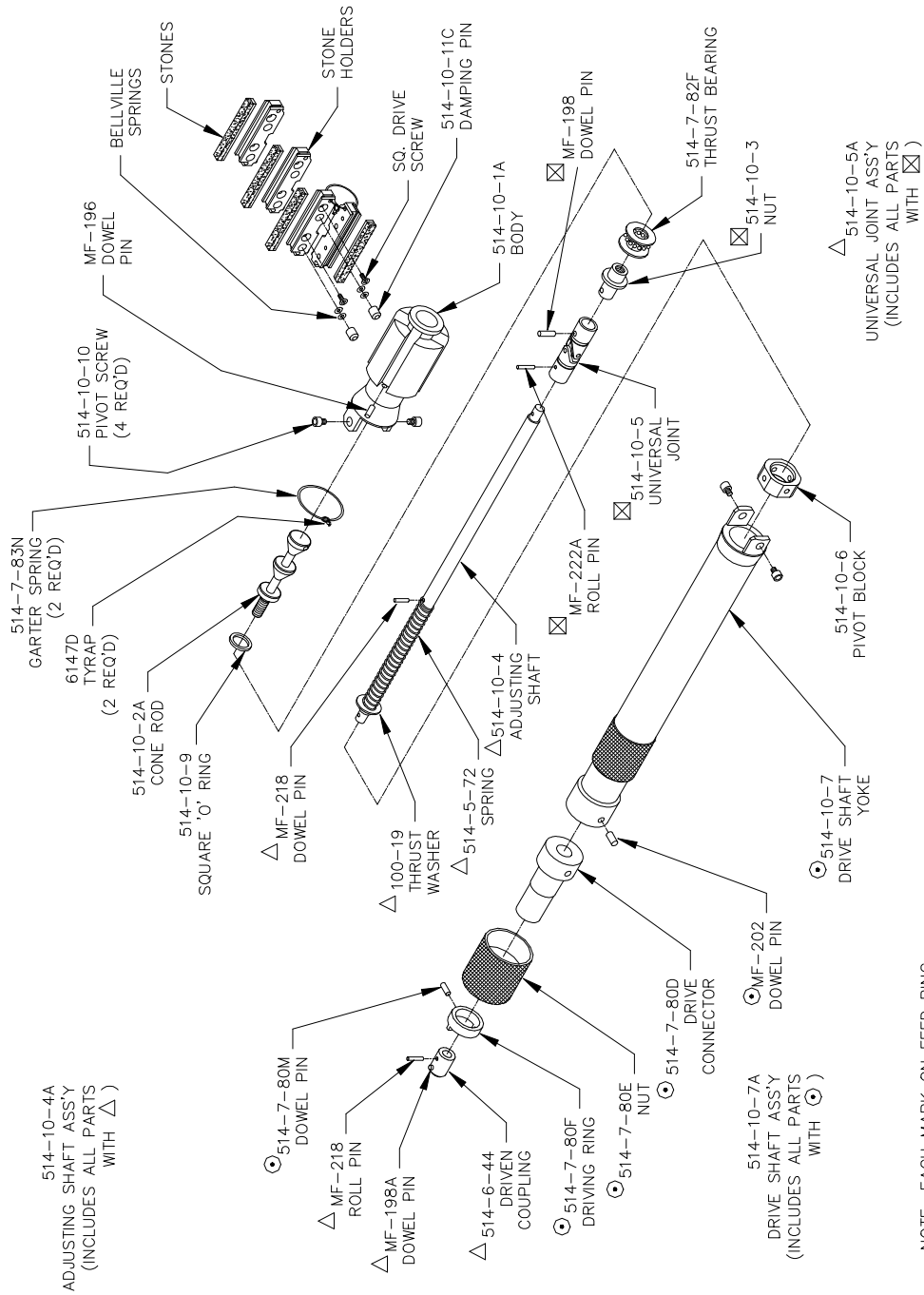
Cork bond for polishing
 Fiber brushes for plateau finishing
 Fiber brushes .312" height
 Special finishing diamonds for use on Aluminum Silicone cylinders

Disassembly Instructions:



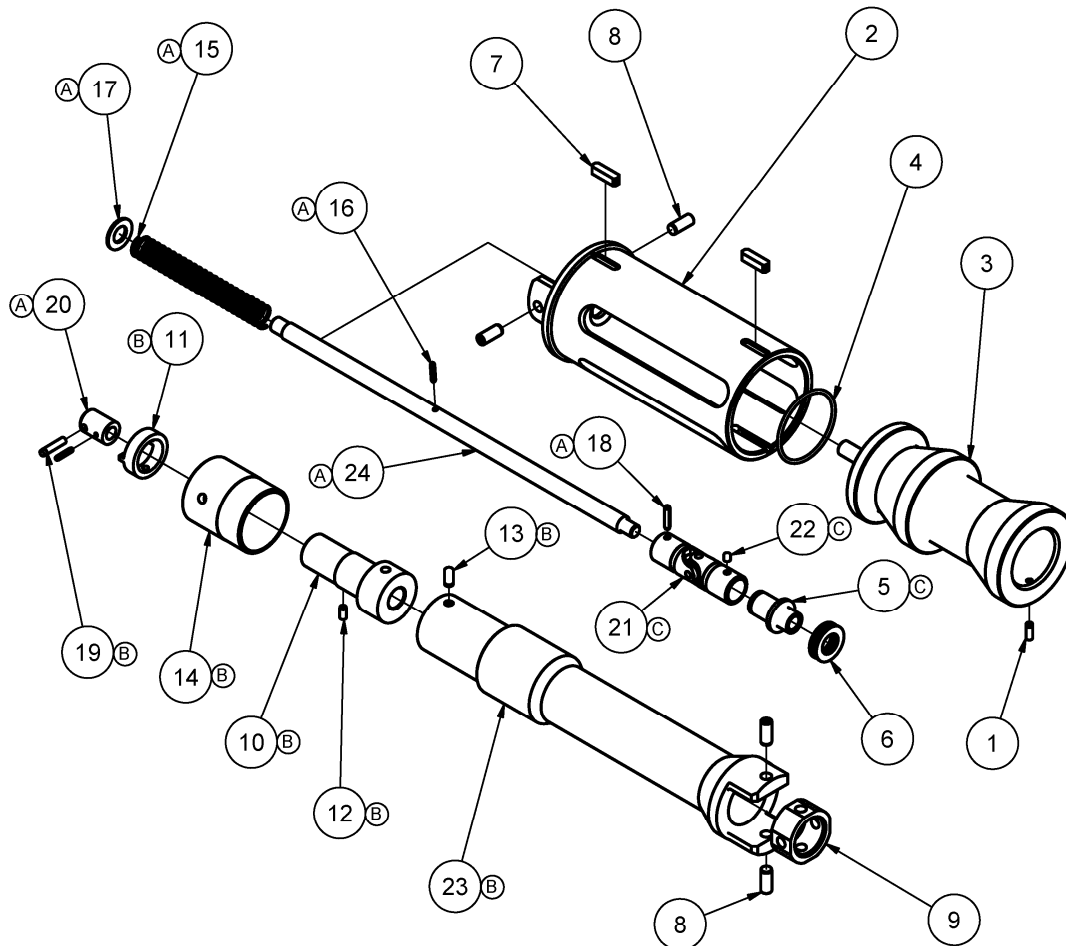
Junior Precision Hone Head

REF: 61-4-2000A



NOTE: EACH MARK ON FEED RING & EACH RATCHET ADVANCE IS .0003 ON DIAMETER STONE FEED OUT ON THIS HEAD.

514-9D Extra Large HD Hone Head Assembly



514-9D
EXTRA LARGE H.D. HONE HEAD ASSEMBLY
WITHOUT TOOLING
514-9E WITH TOOLING

514-9-13B
ADJUSTING SHAFT ASSEMBLY
(INCLUDES ALL PARTS
WITH (A))

514-7-80U
DRIVE SHAFT ASSEMBLY
(INCLUDES ALL PARTS
WITH (B))

(A) 514-9-8A
UNIVERSAL ASSEMBLY
(INCLUDES ALL PARTS
WITH (C))

514-9D Extra Large HD Hone Head Assembly Parts List

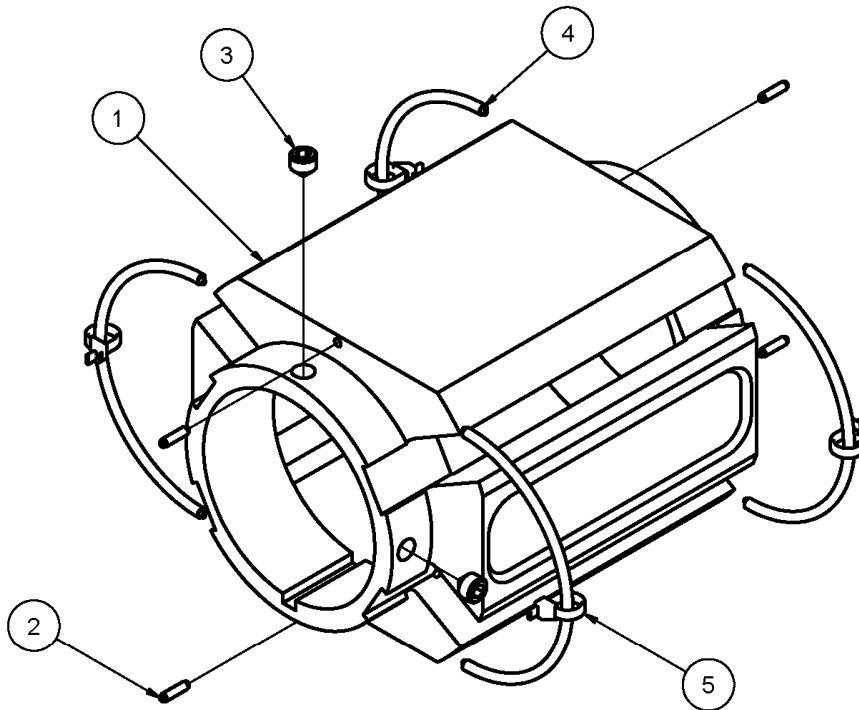
514-9D EXTRA LARGE H.D. HONE HEAD ASSEMBLY			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	MF-196	3/16 x 1/2 Dowel Pin
2	1	514-9-10B	BODY, EXTRA LARGE HONE HEAD
3	1	514-9-7C	CONE ROD, EXTRA LARGE HONE HEAD
4	1	514-7-82J	O-RING
5	1	514-9-9A (A)(C)	NUT, UNIVERSAL JOINT
6	1	514-7-82F	THRUST WASHER
7	2	6062	Spindle Key
8	4	514-5-66E	PIN, PIVOT - HEAVY DUTY HONE HEAD (PULL OUT STYLE)
9	1	514-7-80G	PIVOT BLOCK, UNIVERSAL - HEAVY DUTY HONE HEAD
10	1	514-7-80D (B)	DRIVE CONNECTOR - HEAVY DUTY HONE HEAD
11	1	514-7-80F (B)	DRIVING RING - HEAVY DUTY HONE HEAD
12	1	514-7-80M (B)	DOWEL PIN REWORK - HEAVY DUTY HONE HEAD
13	1	MF-202 (B)	1/4 x 1/2 Dowel Pin
14	1	514-7-80E (B)	NUT, DRIVE SHAFT - HEAVY DUTY HONE HEAD
15	1	514-5-72 (A)	SPRING COMPRESSION
16	2	MF-218 (A)	1/8 x 5/8 Roll Pin
17	1	100-19 (A)	Washer
18	1	MF-222A (A)	5/32 x 3/4 Roll Pin
19	1	MF-198A (A)	3/16 x 7/8 Dowel Pin
20	1	514-6-44 (A)	DRIVEN COUPLING - HONE #2
21	1	514-7-82H (A)(C)	UNIVERSAL JOINT REWORK - HEAVY DUTY HONE HEAD
22	1	514-7-82C (A)(C)	DOWEL PIN REWORK - HEAVY DUTY HONE HEAD
23	1	514-7-80W (B)	YOKE, DRIVE SHAFT - SPECIAL EXTRA LARGE H.D. HONE HEAD
24	1	514-7-80V (A)	ADJUSTING SHAFT - HEAVY DUTY HONE HEAD

514-9-13B ADJUSTING
SHAFT ASSEMBLY INCLUDES (A)

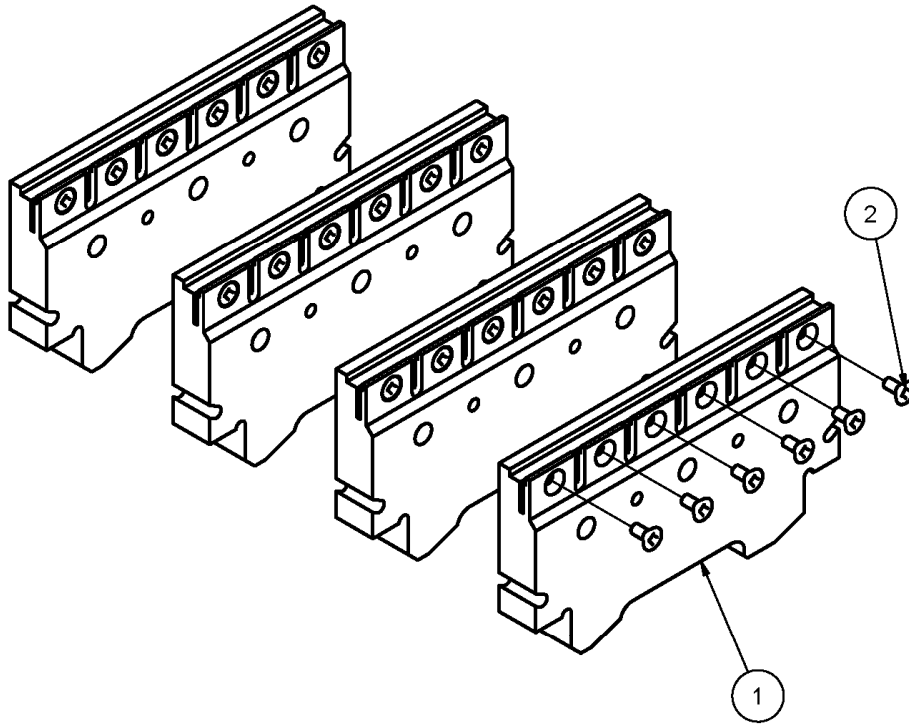
514-7-80U DRIVE
SHAFT ASSEMBLY INLCUDES (B)

514-9-8A UNIVERSAL
ASSEMBLY INCLUDES (C)

514-9-4D Sleeve Assembly



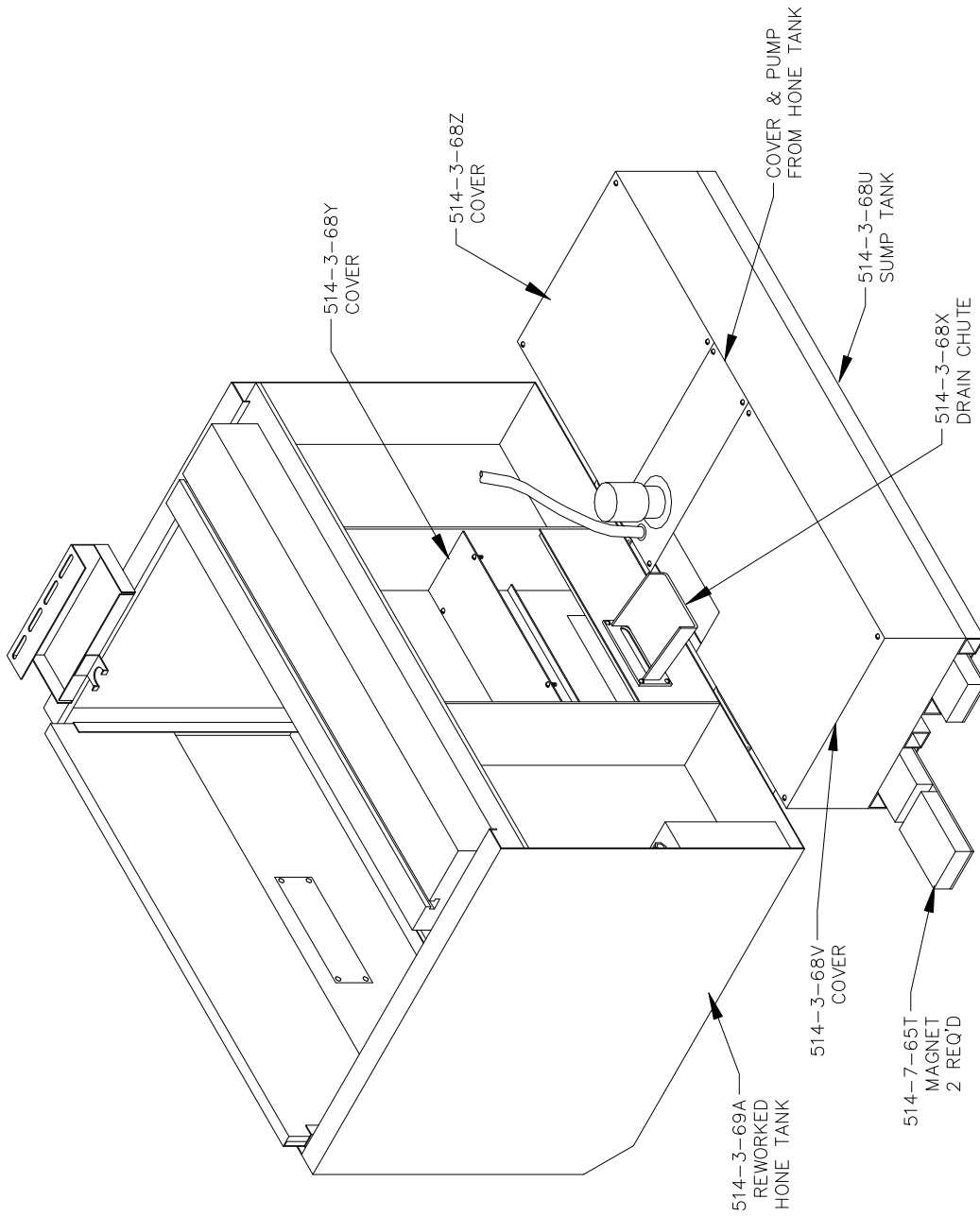
514-9-4D SLEEVE ASSEMBLY - EXTRA LARGE H.D. HONE HEAD			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	514-9-3D	EXTRA LARGE H.D. HONE SLEEVE
2	4	MF-217	1/8 x 1/2 Roll Pin
3	2	514-7-83D	3/8-24UNF x 3/8" LG. CONE POINT SET SCREW
4	4	514-7-83E	GARTER SPRING
5	4	6147D	TYRAP, ELECTRICAL

514-9-5T Stone Holder Set

STONE HOLDER SET (MATCHED SET OF 4) (9.30-9.56 RANGE)			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	514-9-5T	HOLDER, STONE (9.30-9.56 DIA.) SET OF 4
2	24	514-7-81J	SCREW, FLAT HEAD SQUARE DRIVE - ROTTLER HEAVY DUTY HONE HEAD

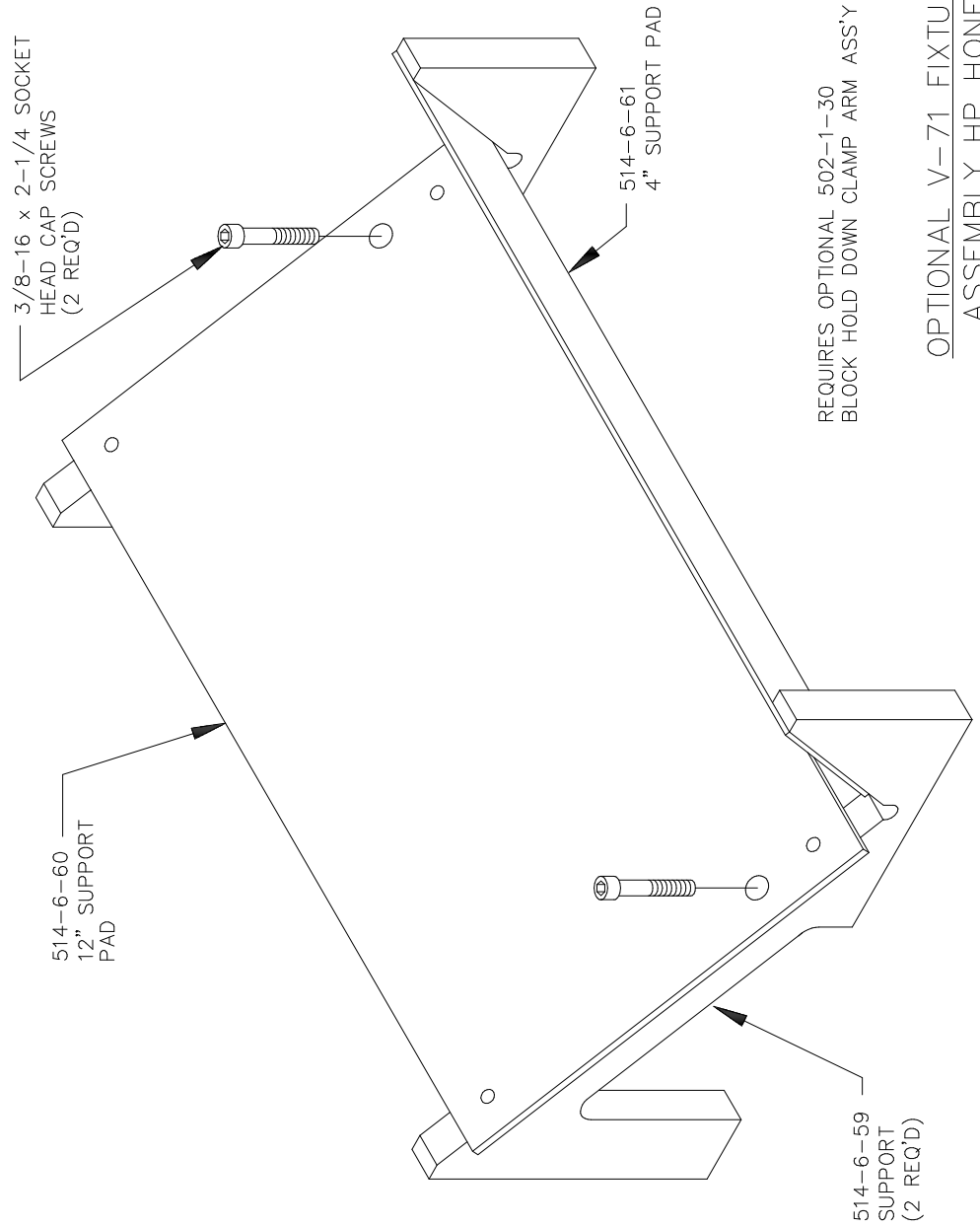
Auxiliary Sump Tank:

REFINES-25-081197



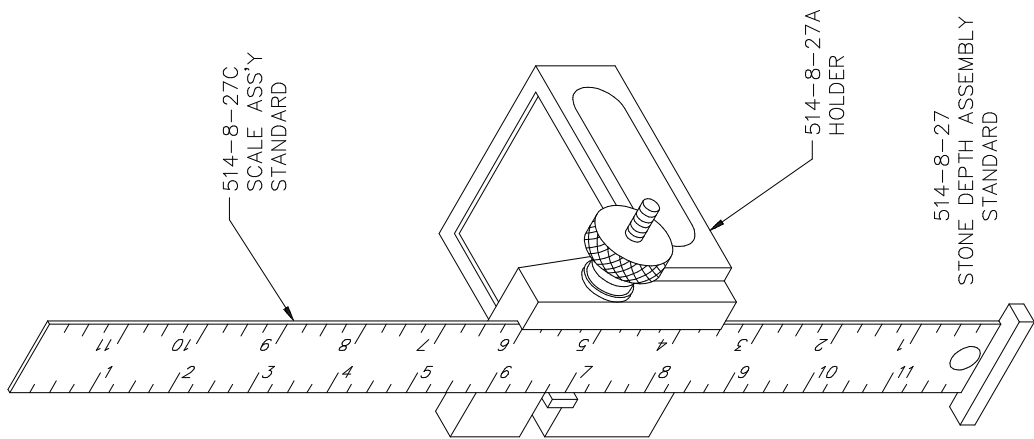
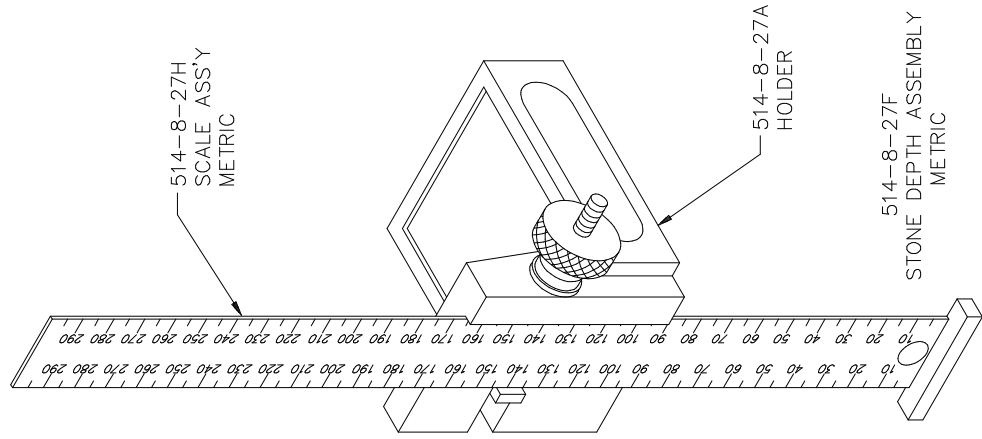
V-71 Fixture:

REFHNE52-092095



Stone Depth Assembly

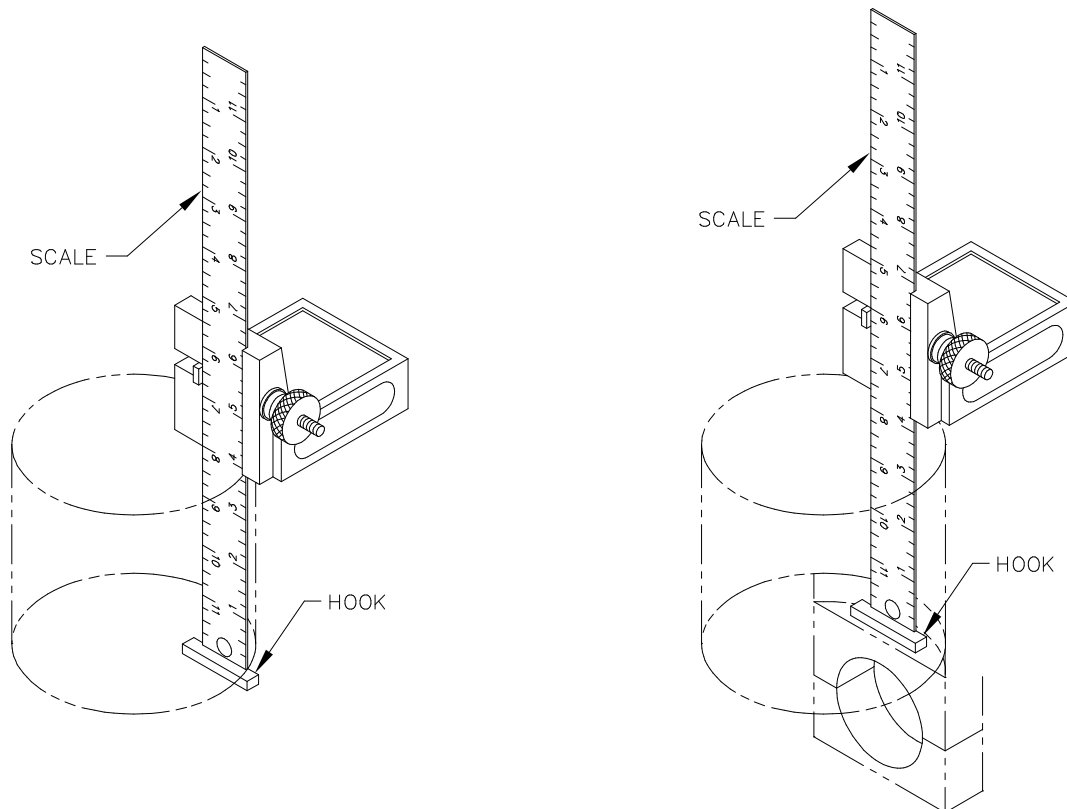
REFINE141-092095



OPTIONAL STONE DEPTH
ASSEMBLY

Stone Depth Assembly Set-up:

REFHNE142-020298



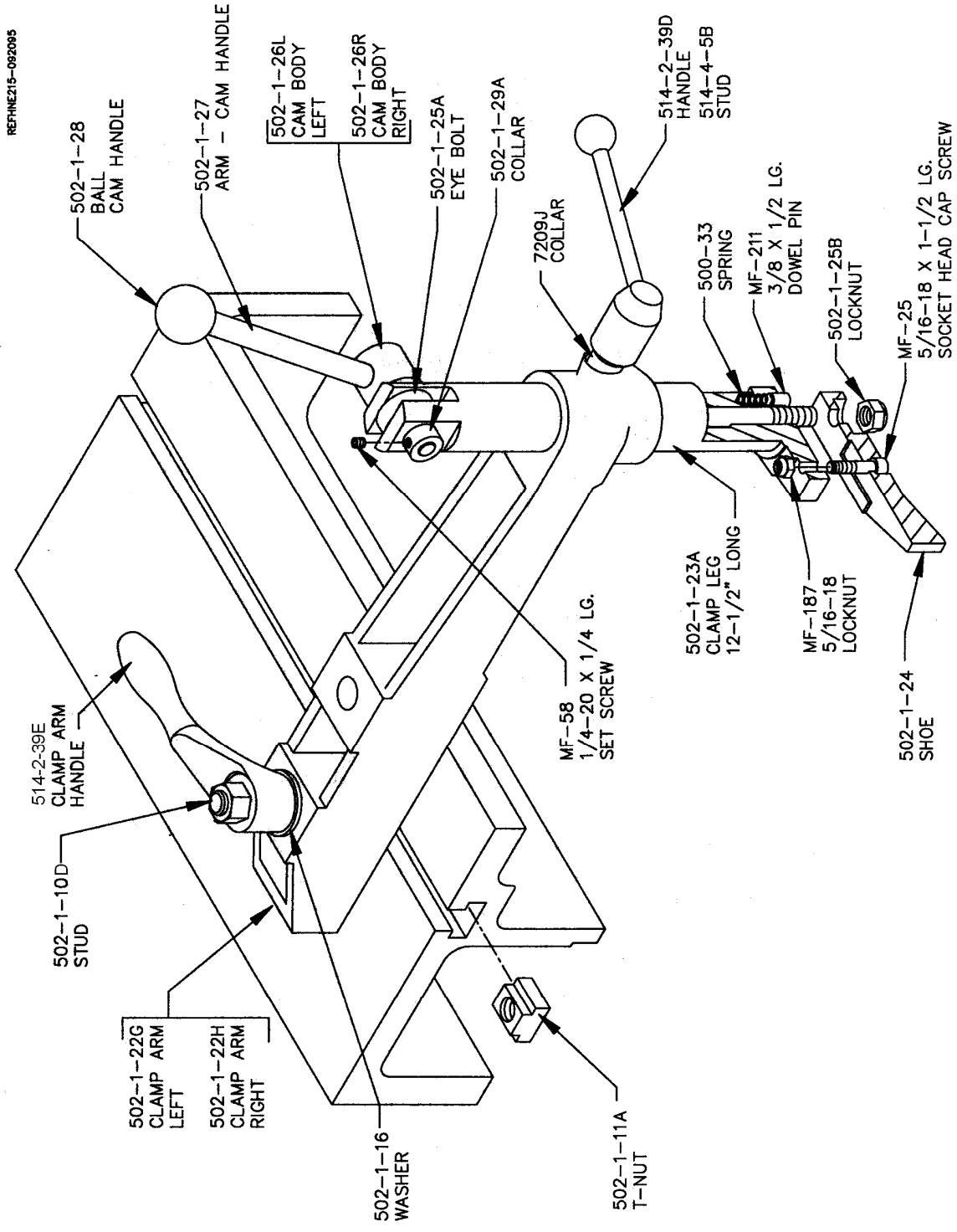
Setting lower travel limit:

1. Place stone depth setting assembly on deck surface of block with scale in cylinder.
2. Lower scale to touch upper surface of hook on deepest point of cylinder wall.
3. Read depth on scale, and then lower scale 3/4" to 1" (19mm to 25mm). Lock scale.
4. Lower hone head into cylinder and touch the bottom of the stones to the upper surface of the hook. Lock this lower limit setting in the stroking cylinder.

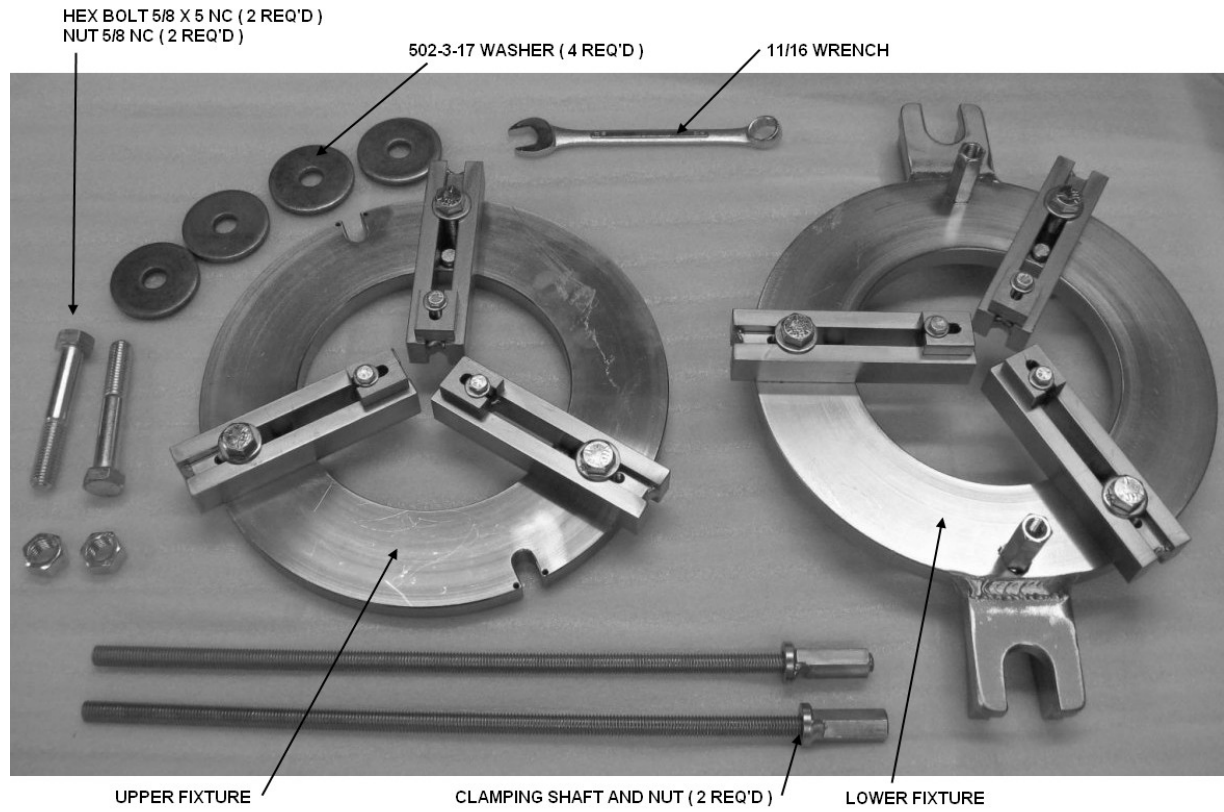
Setting lower travel limit with obstructions:

1. Place stone depth setting assembly on deck surface of the block with the scale in the cylinder.
2. Lower scale until bottom of the hook touches the highest point of the obstruction (main bearing web, etc....).
3. Lower hone head into cylinder and touch the bottom of the stones to the upper surface of the hook. Lock this lower limit setting on the stroking cylinder.

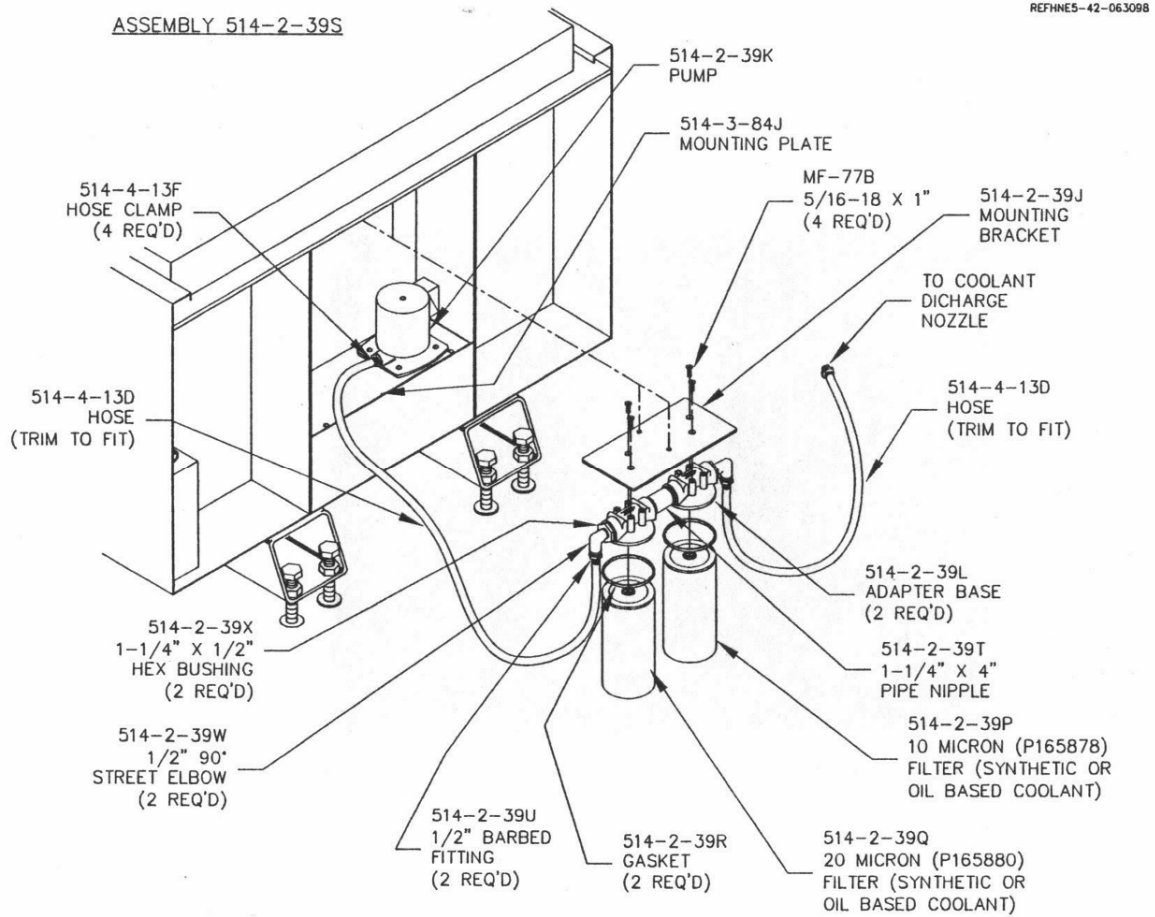
Block, Hold Down - Clamp Assembly:



514-7B CYLINDER SLEEVE FIXTURE



514-2-39S: Optional Filter System



Chapter 8 Material Data Safety Sheets

***** PRODUCT IDENTIFICATION *****

MOBILMET UPSILON

Supplier:	Mobil Oil Corp	Health emergency telephone:	(212) 883-4411
Chemical names and synonyms:	Pet. Hydrocarbons and additives	Transport emergency telephone:	(800) 424-9300 (CHEMTREC)
Use or description:	Cutting fluid		

***** II. TYPICAL CHEMICAL AND PHYSICAL PROPERTIES *****

Appearance: ASTM 5.0 liquid	Odor: Mild	PH: NA
Viscosity at 100 F, SUS: 62.0	at 40 C, CS: 10.2	
Viscosity at 210 F, SUS: 35.1	at 100 C, CS: 2.7	
Flash point F (C): >325 (163)	(ASTM D-92)	
Melting point F(C): NA	Pour point F(C): 30 (-1)	
Boiling point (F/C): > 600 (316)		
Relative density, 15/4 C: 0.849	Solubility in water: Negligible	
Vapor pressure-MM HG 20C: < .1		
NA = Not applicable	NE = Not established	D = decomposes

For further information contact your local marketing office.

***** III. INGREDIENTS *****

	WT PCT (Approx.)	EXPOSURE MG/M3	LIMITS PPM	SOURCES (and notes)
Hazardous ingredients:	None			
Other ingredients:	Refined mineral oils	>95		
	Additives and/or other ingredients	< 5		

Key to sources: A = ACGIH-TLV, A* = suggested – TLV, M = Mobil, O = OSHA
 Note: Limits shown for guidance only. Follow applicable regulations.

***** IV. HEALTH HAZARD DATA *****

Threshold limit value: 5.00 MG/M3 Suggested for oil mist
 Effects of overexposure: Prolonged repeated skin contact with low viscosity oils may lead to irritation caused by dissolving of the natural oils from the skin. Slight skin irritation.

***** V. EMERGENCY AND FIRST AID PROCEDURE *****

Eye contact: Flush with water.
 Skin contact: Wash contact areas with soap and water.
 Inhalation: Not expected to be a problem.
 Ingestion: Do not induce vomiting. Administer vegetable oil. Get medical assistance. (Note to physician: Material if aspirated into the lungs may cause chemical pneumonitis. Treat appropriately)

***** VI. FIRE AND EXPLOSION HAZARD DATA *****

Flash point F(C): > 325 (163) (ASTM D-92)

Flammable limits. LEL: .6 UEL: 7.0

Extinguishing media: Carbon dioxide, foam, dry chemical and water fog. Special fire fighting procedures: Firefighters must use self-contained breathing apparatus.

Unusual fire and explosion hazards: None

NFPA hazard ID: Health: 0, Flammability: 1, Reactivity: 0

***** VII. REACTIVITY DATA *****

Stability (thermal, light, etc.): Stable

Conditions to avoid: extreme heat

Incompatibility (materials to avoid): Strong oxidizers

Hazardous decomposition products: Carbon monoxide.

Hazardous polymerization: Will not occur

***** VIII. SPILL OR LEAK PROCEDURE *****

Environmental impact: Report spills as required to appropriate authorities. U.S. Coast Guard regulations require immediate reporting of spills that could reach any waterway including intermittent dry creeks. Report spill to Coast Guard toll free number 800-424-8802.

Procedures if material is released or spilled: Adsorb on fire retardant treated sawdust, diatomaceous earth, etc. Shovel up and dispose of at an appropriate waste disposal facility in accordance with current applicable laws and regulations, and product characteristics at time of disposal.

Waste management: Product is suitable for burning in an enclosed, controlled burner for fuel value or disposal by supervised incineration. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at any government approved waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

***** IX. SPECIAL PROTECTION INFORMATION *****

Eye protection: No special equipment required.

Skin protection: If prolonged or repeated skin contact is likely, oil impervious gloves should be worn.

Good personal hygiene practices should always be followed.

Respiratory protection: No special requirements under ordinary conditions of use and with adequate ventilation.

Ventilation: No special requirements under ordinary conditions of use and with adequate ventilation.

***** X. SPECIAL PRECAUTIONS *****

Storage: See Appendix for precautionary label. CL-402

***** XI. TOXICOLOGICAL DATA *****

--- ACUTE ---

Oral toxicity (rats): LD50: > 5 G/KG slightly toxic (estimated) --- based on testing of similar products and/or the components.

Dermal toxicity (rabbits) LD50: > 2 G/KG slightly toxic (estimated) – based on testing of similar products and/or the components.

Inhalation toxicity (rats): LC50: >5 MG/L for 4 hours. 0/10 rats died at this dosage level. Practically nontoxic.

Eye irritation (rabbits): Caused no significant irritation to rabbits. Eye irritation scores: 2.3 at 1 hour, 0.1 at 24 hours, 0 at 7 days.

Skin irritation (rabbits) Slightly irritating to rabbits. Primary irritation score: 1.6/8

--- OTHER DATA ---

****This mixture or a similar mixture did not result in any fatalities to rats at concentrations (see inhalation toxicity above) substantially higher than the 5 MB/M3 TLV suggested for oil mists.

***** XII. REGULATORY INFORMATION *****

TSCA inventory status: All components registered.

D.O.T. shipping name: Not applicable

D.O.T. hazard class: Not applicable

US OSHA Hazard Communication Standard: Product assessed in accordance with OSHA CFR 1910.1200 and determined to be hazardous.

RCRA information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, part 261D); does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity, and is not formulated with the metals cited in the EP toxicity test. However, used product may be regulated.

The following product ingredients are cited on the lists below:

CHEMICAL NAME (OIL MIST)	CASE NUMBER	LIST CITATIONS
		2,10,11

--- KEY TO LIST CITATIONS ---

1 = OSHA Z,	2 = ACGIH,	3 = IARC,	4 = NTP,	5 = NCI,
6 = EPA CARC,	7 = NFPA 49,	8 = NFPA 325M,	9 = DOT HMT,	10 = CA RTK,
11 = IL RTK,	12 = MA RTK	13 =MN RTK	14 = NJ RTK,	15 = MI 293,
16 = FL RTK,	17 = PA RTK.			

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Nothing is intended as a recommendation for uses, which infringe valid patents or as extending license under valid patents. Appropriate warnings and safe handling procedures should be provided to handlers and users.

MOBILMET UPSILON

665554

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Prepared by: Mobil Oil Corporation
Environmental Affairs and Toxicology Department, Princeton, NJ
For further information, contact:
Mobil Oil Corporation, Product Formulation and Quality Control, 3225 Gallows Road, Fairfax, VA 22037
(703) 849-3265

***** APPENDIX *****

For Mobil use only: (fill no: MTJ354*M201) MHC: 1* 1* 0 0 1 PPEC: A US86-089 approve revised 04/18/86

Precautionary label text for packaged products:

Contains low viscosity oil



May cause skin irritation on prolonged, repeated skin contact.

Avoid prolonged or repeated contact that could effect the skin.
Wash skin contact areas with soap and water.

Launder contaminated clothing before reuse. Avoid wearing of clothing soaked with fluid. Avoid prolonged inhalation of mists or vapors.

When use conditions are likely to result in excessive misting (greater than 5 MG/M3), provide adequate local ventilation or respiratory protection.

For industrial use only, not intended or suitable for use in or around a household or dwelling.

Attention:

Empty containers may contain product residue, including flammable or explosive vapors. Do not cut, puncture or weld on or near container. All label warnings and precautions must be observed until the container has been thoroughly cleaned or destroyed.

Refer to Product Material Safety Data Bulletin for further safety and handling information.

Mobil Oil Corporation, New York, NY 10017 CL-402 (1/86)

D.O.T. Shipping name: Not applicable

D.O.T. Hazard class: Not applicable

ROTTLER COOLANT PRODUCT DATA SHEET

GENERAL DESCRIPTION:

ROTTLER Coolant is truly a revolutionary new water miscible synthetic coolant formulated for use in honing, grinding and machining of aluminum, cast iron and steel. ROTTLER Coolant has the lubricating properties of micro-emulsion products but does not contain oil!! This technology break through allows ROTTLER Coolant the great characteristics of a synthetic but the cutting lubricity of micro-emulsions. ROTTLER Coolant is highly recommended where the demand for a dependable low maintenance coolant is a must. ROTTLER Coolant is a great choice for general machining operations because of its excellent detergency, anti-corrosion and stable performance characteristics. ROTTLER Coolant is completely safe for machining aluminum and is non-staining, while exhibiting excellent tramp oil resistance and anti-foaming ability.

BENEFITS OF USE:

1. Increased tool life.
2. Excellent detergency – low foaming formulation.
3. Excellent anti-corrosion properties.
4. Non-staining on aluminum.
5. More environmentally friendly – ease of disposal.
6. Low maintenance.
7. User friendly.

USING PROCEDURES:

1. Machining	Aluminum	4% - 6%
	Cast Iron	4% - 6%
2. Grinding	Aluminum	2% - 4%
	Cast Iron	2% - 4%
	Steel	2% - 4%

PROPERTIES:

Appearance (Concentrate).....Light Yellow Liquid.
 (Diluted solution).....Clear.
 Solubility in ater.....100%.

SECTION I

<u>Product name or number</u> (as it appears on label) ROTTLER Coolant		<u>Date</u> October, 1999
<u>Manufacturer's Name</u> Yuma Industries Incorporated	<u>Emergency Phone #</u> YUMA 317-398-9862 CHEMTREC 800-424-9300	
Address (Number, Street, City, State, & Zip Code) 783 W. Mausoleum Road, Shelbyville, IN 46176-9720		
Hazardous material description, proper shipping name, haz. class, haz. ID# None		
<u>Additional hazard classes (as applicable)</u> None		
<u>Chemical family</u> Water miscible cutting and grinding fluid concentrate	<u>Formula</u> See Section II	

SECTION II - INGREDIENTS

CAS Registry #	Wt%	Chemical Name(s)	Listed as a carcinogen in NTP, IARC, or OSHA1910(z) (specify)
102-71-6	1-9	Triethanolamine ACGIH(TLV): TWA=5mg/m3,	Not listed
Balance classified as non-hazardous Ingredients			

SECTION III – PHYSICAL DATA

<u>Boiling Point</u> Not available	<u>Specific Gravity</u> (H ₂ O=1) @ 20°C 1.02	<u>Odor Threshold (ppm)</u> Not available
<u>Vapor Pressure</u> Not available	<u>Percent Volatile (Vol. %)</u> Not available	<u>Percent Solid (Wt. %)</u> Not available
<u>Vapor Density</u> Not available	<u>Evaporation Rate</u> Not available	<u>Freezing Point (°C)</u> Not available
<u>Solubility in Water</u> 100%	<u>pH</u> (4%) 9.6	<u>Material is</u> Liquid
<u>Appearance & Odor</u> Yellow with mild odor	<u>Volatile Organic Compounds (VOC)</u> Not available	

SECTION IV – FIRE AND EXPLOSION HAZARD DATA

<u>Flash Point</u>	<u>Method Used</u>	<u>Flammable Limits</u>	<u>Auto-Ignition Temperature (°C)</u>
None		LEL/UEL Not available	Not available
<u>Extinguishing Media</u>			
As appropriate for surrounding fire			
<u>Special Fire Fighting Procedures</u>			
None			
<u>Unusual Fire and Explosion Hazards</u>			
None			

SECTION V – HEALTH HAZARD DATA

<u>Threshold Limit Value</u>			
See Section II			
<u>Effects of Overexposure – Conditions to avoid</u>			
Transient eye irritation. Possible skin defatting and subsequent irritation on repeated or prolonged contact.			
<u>Primary Routes of Entry</u>	Inhalation : :	Eye Contact: :	
	Skin Contact: X:	Ingestion : :	
<u>Emergency and First Aid Procedures</u>			
Eyes: Flush with cool, clean water for at least 15 minutes Skin: Wash with soap and warm water Inhalation: Remove to fresh air. Ingestion: If large quantities are ingested, pump stomach			
In every case get medical attention as required			

SECTION VI – REACTIVITY DATA

<u>Stability</u>	Unstable : :	Hazardous	May occur : :
	Stable : X :	Polymerization	Will not occur : X :
<u>Conditions to Avoid</u>			
None			
<u>Incompatibility (material to avoid)</u>			
Avoid strong oxidizing agents, strong acid and nitrites.			
Hazardous Decomposition Products			
Thermal decomposition may produce CO, CO ₂ , NO _x and SO _x .			

SECTION VII - SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled	
Mop up or use dry absorbent.	
<u>Waste Disposal Method</u>	
Dispose in accordance with local, state and federal regulations	

SECTION VIII – SPECIAL PROTECTION INFORMATION

<u>Respiratory Protection (specify type)</u>		
None		
VENTILATION:	<u>Local Exhaust (specify rate)</u>	Special _
	<u>Not normally required</u>	None _
	<u>Mechanical (general) (specify rate)</u>	Other _
	<u>General room ventilation should be sufficient.</u>	None
<u>Protective Gloves (specify type)</u>	<u>Eye Protection (specify type)</u>	
None	Safety glasses	
<u>Other Protective Equipment</u>		
None		

SECTION IX – SPECIAL PRECAUTIONS

<u>Precautions to be Taken in Handling and Storing</u>
Keep container closed.
Wash thoroughly after handling.
<u>Other Precautions</u>
None

MOBIL DTE OIL HEAVY MEDIUM**SECTION 1 PRODUCT AND COMPANY IDENTIFICATION****PRODUCT**

Product Name: MOBIL DTE OIL HEAVY MEDIUM
Product Description: Base Oil and Additives
Product Code: 201560501590, 600163-00, 970172
Intended Use: Turbine oil

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA

24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300
ExxonMobil Transportation No. 281-834-3296
MSDS Requests 713-613-3661
Product Technical Information 800-662-4525, 800-947-9147
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID: Health: 0 Flammability: 1 Reactivity: 0
HMIS Hazard ID: Health: 0 Flammability: 1 Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Aldehydes, Oxides of carbon, Sulfur oxides, Smoke, Fume, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: >223C (433F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. U.S. regulations require reporting releases of this material to the environment which exceed the reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants. Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL, 5 mg/m³ - OSHA PEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider: No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include: No special requirements under ordinary conditions of use and with adequate ventilation. For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly effect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include: No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include: No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid
Color: Amber
Odor: Characteristic
Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.87
Flash Point [Method]: >223C (433F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0
Autoignition Temperature: N/D
Boiling Point / Range: > 316C (600F)
Vapor Density (Air = 1): > 2 at 101 kPa
Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 C
Evaporation Rate (n-butyl acetate = 1): N/D
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): > 3.5
Solubility in Water: Negligible
Viscosity: 67.9 cSt (67.9 mm²/sec) at 40 C | 8.7 cSt (8.7 mm²/sec) at 100C
Oxidizing Properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: N/A
Pour Point: -27°C (-17°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION**ACUTE TOXICITY**

Route of Exposure	Conclusion / Remarks
Inhalation	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
Ingestion	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS**Contains:**

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

Additional information is available by request.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC

3 = IARC 1

5 = IARC 2B

2 = NTP SUS

4 = IARC 2A

6 = OSHA CARC

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY**Biodegradation:**

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

RCRA Information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Empty Container Warning PRECAUTIONARY LABEL TEXT: Empty containers may retain residue and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

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MOBIL DTE OIL LIGHT-----
1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: MOBIL DTE OIL LIGHT
SUPPLIER: MOBIL OIL CORP.
PRODUCTS AND TECHNOLOGY DEPT.
3225 GALLOWES RD.
FAIRFAX, VA 22037

APPROVAL DATE: 05/08/95

24 - HOUR EMERGENCY (CALL COLLECT): 609-737-4411
PRODUCT AND MSDS INFORMATION: 800-662-4525 703-849-3265
CHEMTREC: 800-424-9300 202-483-7616

2. COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENTS CONSIDERED HAZARDOUS TO HEALTH:

THIS PRODUCT IS NOT FORMULATED TO CONTAIN INGREDIENTS WHICH HAVE EXPOSURE LIMITS ESTABLISHED BY REGULATORY AGENCIES. IT IS NOT HAZARDOUS TO HEALTH AS DEFINED BY THE EUROPEAN UNION DANGEROUS SUBSTANCES/PREPARATIONS DIRECTIVES. SEE SECTION 15 FOR A REGULATORY ANALYSIS OF THE INGREDIENTS.

SEE SECTION 8 FOR EXPOSURE LIMITS (IF APPLICABLE).

3. HAZARDS IDENTIFICATION

US OSHA HAZARD COMMUNICATION STANDARD: PRODUCT ASSESSED IN ACCORDANCE WITH OSHA 29 CFR 1910.1200 AND DETERMINED NOT TO BE HAZARDOUS.
EFFECTS OF OVEREXPOSURE: NO SIGNIFICANT EFFECTS EXPECTED.
EMERGENCY RESPONSE DATA: LIGHT AMBER LIQUID. DOT ERG NO. - NA

4. FIRST AID MEASURES

EYE CONTACT: FLUSH THOROUGHLY WITH WATER. IF IRRITATION OCCURS, CALL A PHYSICIAN.
SKIN CONTACT: WASH CONTACT AREAS WITH SOAP AND WATER.
INHALATION: NOT EXPECTED TO BE A PROBLEM.
INGESTION: NOT EXPECTED TO BE A PROBLEM. HOWEVER, IF GREATER THAN 1/2 LITER (PINT) INGESTED, IMMEDIATELY GIVE 1 TO 2 GLASSES OF WATER AND CALL A PHYSICIAN, HOSPITAL EMERGENCY ROOM OR POISON CONTROL CENTER FOR ASSISTANCE. DO NOT INDUCE VOMITING OR GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: CARBON DIOXIDE, FOAM, DRY CHEMICAL AND WATER FOG.
SPECIAL FIRE FIGHTING PROCEDURES: WATER OR FOAM MAY CAUSE FROTHING.
USE WATER TO KEEP FIRE EXPOSED CONTAINERS COOL. WATER SPRAY MAY
BE USED TO FLUSH SPILLS AWAY FROM EXPOSURE. PREVENT RUNOFF FROM
FIRE CONTROL OR DILUTION FROM ENTERING STREAMS, SEWERS, OR
DRINKING WATER SUPPLY.
SPECIAL PROTECTIVE EQUIPMENT: FOR FIRES IN ENCLOSED AREAS, FIRE
FIGHTERS MUST USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS: NONE. FLASH POINT C(F): >
207(405) (ASTM D-92). FLAMMABLE LIMITS - LEL: NA, UEL: NA.
NFPA HAZARD ID: HEALTH: 0, FLAMMABILITY: 1, REACTIVITY: 0
HAZARDOUS DECOMPOSITION PRODUCTS: CARBON MONOXIDE. ELEMENTAL OXIDES.
METAL OXIDES.

6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: REPORT SPILLS AS REQUIRED TO APPROPRIATE
AUTHORITIES. U. S. COAST GUARD REGULATIONS REQUIRE IMMEDIATE
REPORTING OF SPILLS THAT COULD REACH ANY WATERWAY INCLUDING
INTERMITTENT DRY CREEKS. REPORT SPILL TO COAST GUARD TOLL FREE
NUMBER (800) 424-8802. IN CASE OF ACCIDENT OR ROAD SPILL NOTIFY
CHEMTREC (800) 424-9300.
PROCEDURES IF MATERIAL IS RELEASED OR SPILLED: ADSORB ON FIRE
RETARDANT TREATED SAWDUST, DIATOMACEOUS EARTH, ETC. SHOVEL UP
AND DISPOSE OF AT AN APPROPRIATE WASTE DISPOSAL FACILITY IN
ACCORDANCE WITH CURRENT APPLICABLE LAWS AND REGULATIONS, AND
PRODUCT CHARACTERISTICS AT TIME OF DISPOSAL.
ENVIRONMENTAL PRECAUTIONS: PREVENT SPILLS FROM ENTERING STORM SEWERS
OR DRAINS AND CONTACT WITH SOIL.
PERSONAL PRECAUTIONS: SEE SECTION 8

7. HANDLING AND STORAGE

HANDLING: NO SPECIAL PRECAUTIONS ARE NECESSARY BEYOND NORMAL GOOD
HYGIENE PRACTICES. SEE SECTION 8 FOR ADDITIONAL PERSONAL
PROTECTION ADVICE WHEN HANDLING THIS PRODUCT.
STORAGE: DO NOT STORE IN OPEN OR UNLABELLED CONTAINERS. STORE AWAY
FROM STRONG OXIDIZING AGENTS OR COMBUSTIBLE MATERIAL.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

VENTILATION: NO SPECIAL REQUIREMENTS UNDER ORDINARY CONDITIONS OF USE AND WITH ADEQUATE VENTILATION.

RESPIRATORY PROTECTION: NO SPECIAL REQUIREMENTS UNDER ORDINARY CONDITIONS OF USE AND WITH ADEQUATE VENTILATION.

EYE PROTECTION: NORMAL INDUSTRIAL EYE PROTECTION PRACTICES SHOULD BE EMPLOYED.

SKIN PROTECTION: NO SPECIAL EQUIPMENT REQUIRED. HOWEVER, GOOD PERSONAL HYGIENE PRACTICES SHOULD ALWAYS BE FOLLOWED.

EXPOSURE LIMITS: THIS PRODUCT DOES NOT CONTAIN ANY COMPONENTS WHICH HAVE RECOGNIZED EXPOSURE LIMITS. HOWEVER, A THRESHOLD LIMIT VALUE OF 5.00 MG/M3 IS SUGGESTED FOR OIL MIST.

9. PHYSICAL AND CHEMICAL PROPERTIES

TYPICAL PHYSICAL PROPERTIES ARE GIVEN BELOW. CONSULT PRODUCT DATA SHEET FOR SPECIFIC DETAILS.

APPEARANCE: LIQUID

COLOR: LIGHT AMBER

ODOR: MILD

ODOR THRESHOLD: NA

PH: NA

BOILING POINT C(F): > 316(600)

MELTING POINT C(F): NA

FLASH POINT C(F): > 207(405) (ASTM D-92)

FLAMMABILITY: NA

AUTO FLAMMABILITY: NE

EXPLOSIVE PROPERTIES: NA

OXIDIZING PROPERTIES: NA

VAPOR PRESSURE-MMHG 20 C: < 0.1

VAPOR DENSITY: > 2.0

EVAPORATION RATE: NA

RELATIVE DENSITY, 15/4 C: 0.87

SOLUBILITY IN WATER: NEGLIGIBLE

PARTITION COEFFICIENT: > 3.5

VISCOSITY AT 40 C, CST: > 28.8

VISCOSITY AT 100 C, CST: 5.1

POUR POINT C(F): -7(20)

FREEZING POINT C(F): NE

VOLATILE ORGANIC COMPOUND: EXEMPT IN U.S.

NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): STABLE.
CONDITIONS TO AVOID: EXTREME HEAT.
INCOMPATIBILITY (MATERIALS TO AVOID): STRONG OXIDIZERS.
HAZARDOUS DECOMPOSITION PRODUCTS: CARBON MONOXIDE. ELEMENTAL OXIDES.
METAL OXIDES.
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): PRACTICALLY NON-TOXIC (LD50: GREATER THAN 2000 MG/KG). ---BASED ON TESTING OF SIMILAR PRODUCTS AND/OR THE COMPONENTS.
DERMAL TOXICITY (RABBITS): PRACTICALLY NON-TOXIC (LD50: GREATER THAN 2000 MG/KG). ---BASED ON TESTING OF SIMILAR PRODUCTS AND/OR THE COMPONENTS.
INHALATION TOXICITY (RATS): NOT APPLICABLE ---HARMFUL CONCENTRATIONS OF MISTS AND/OR VAPORS ARE UNLIKELY TO BE ENCOUNTERED THROUGH ANY CUSTOMARY OR REASONABLY FORESEEABLE HANDLING, USE, OR MISUSE OF THIS PRODUCT.
EYE IRRITATION (RABBITS): PRACTICALLY NON-IRRITATING. (DRAIZE SCORE: 0 OR GREATER BUT 6 OR LESS). ---BASED ON TESTING OF SIMILAR PRODUCTS AND/OR THE COMPONENTS.
SKIN IRRITATION (RABBITS): PRACTICALLY NON-IRRITATING. (PRIMARY IRRITATION INDEX: 0.5 OR LESS). ---BASED ON TESTING OF SIMILAR PRODUCTS AND/OR THE COMPONENTS.
OTHER ACUTE TOXICITY DATA: THE ACUTE TOXICOLOGICAL RESULTS SUMMARIZED ABOVE ARE BASED ON TESTING OF REPRESENTATIVE MOBIL PRODUCTS. REPRESENTATIVE MOBIL FORMULATIONS HAVE SHOWN NO ACUTE EFFECTS, ADMINISTERED VIA THE INHALATION ROUTE, WHEN TESTED AT MAXIMUM ATTAINABLE OIL MIST OR VAPOR CONCENTRATIONS.

---SUBCHRONIC TOXICOLOGY (SUMMARY)---

REPRESENTATIVE MOBIL FORMULATIONS HAVE BEEN TESTED AT THE MOBIL ENVIRONMENTAL AND HEALTH SCIENCES LABORATORY BY DERMAL APPLICATIONS TO RATS 5 DAYS/WEEK FOR 90 DAYS AT DOSES SIGNIFICANTLY HIGHER THAN THOSE EXPECTED DURING NORMAL INDUSTRIAL EXPOSURE. EXTENSIVE EVALUATIONS, INCLUDING MICROSCOPIC EXAMINATION OF INTERNAL ORGANS AND CLINICAL CHEMISTRY OF BODY FLUIDS, SHOWED NO ADVERSE EFFECTS.

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---

DERMAL EXPOSURE OF PREGNANT RATS TO REPRESENTATIVE FORMULATIONS DID NOT CAUSE ADVERSE EFFECTS IN EITHER THE MOTHERS OR THEIR OFFSPRING.

---CHRONIC TOXICOLOGY (SUMMARY)---

THE BASE OILS IN THIS PRODUCT ARE SEVERELY SOLVENT REFINED AND/OR SEVERELY HYDROTREATED. CHRONIC MOUSE SKIN PAINTING STUDIES OF SEVERELY TREATED OILS SHOWED NO EVIDENCE OF CARCINOGENIC EFFECTS.

(SECTION CONTINUED NEXT PAGE)

THESE RESULTS ARE CONFIRMED ON A CONTINUING BASIS USING THE MOBIL MODIFIED AMES TEST.

---SENSITIZATION (SUMMARY)---

REPRESENTATIVE MOBIL FORMULATIONS HAVE NOT CAUSED SKIN SENSITIZATION IN GUINEA PIGS.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

ACUTE LC/EC50 FISH: JUVENILE RAINBOW TROUT: PRACTICALLY NON-TOXIC ---BASED ON TESTING OF SIMILAR PRODUCTS.

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: PRODUCT IS SUITABLE FOR BURNING IN AN ENCLOSED, CONTROLLED BURNER FOR FUEL VALUE OR DISPOSAL BY SUPERVISED INCINERATION. SUCH BURNING MAY BE LIMITED PURSUANT TO THE RESOURCE CONSERVATION AND RECOVERY ACT. IN ADDITION, THE PRODUCT IS SUITABLE FOR PROCESSING BY AN APPROVED RECYCLING FACILITY OR CAN BE DISPOSED OF AT ANY GOVERNMENT APPROVED WASTE DISPOSAL FACILITY. USE OF THESE METHODS IS SUBJECT TO USER COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS AND CONSIDERATION OF PRODUCT CHARACTERISTICS AT TIME OF DISPOSAL.

RCRA INFORMATION: THE UNUSED PRODUCT, IN OUR OPINION, IS NOT SPECIFICALLY LISTED BY THE EPA AS A HAZARDOUS WASTE (40 CFR, PART 261D), NOR IS IT FORMULATED TO CONTAIN MATERIALS WHICH ARE LISTED HAZARDOUS WASTES. IT DOES NOT EXHIBIT THE HAZARDOUS CHARACTERISTICS OF IGNITABILITY, CORROSIVITY, OR REACTIVITY AND IS NOT FORMULATED WITH CONTAMINANTS AS DETERMINED BY THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP). HOWEVER, USED PRODUCT MAY BE REGULATED.

MOBIL DTE EXCEL 46

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: MOBIL DTE EXCEL 46

SUPPLIER:

EXXONMOBIL OIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect):

609-737-4411

24 - Hour Transportation Emergency:

CHEMTREC: 800-424-9300 202-483-7616

LUBES AND FUELS: 281-834-3296

Product and Technical Information:

Lubricants and Specialties: 800-662-4525

800-443-9966

Fuels Products: 800-947-9147

MSDS Fax on Demand:

613-228-1467

MSDS Internet Website:

<http://emmsds.ihssolutions.com/>

SECTION 2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: PET. HYDROCARBONS AND ADDITIVES

GLOBALLY REPORTABLE MSDS INGREDIENTS:None.

See Section 8 for exposure limits (if applicable).

SECTION 3. HAZARDS IDENTIFICATION

Under normal conditions of use, this product is not considered hazardous according to regulatory guidelines (See section 15).

EMERGENCY OVERVIEW: Light Amber Liquid.

Note: Pressurized mists may form a flammable mixture.

DOT ERG No. : NA

POTENTIAL HEALTH EFFECTS: Under normal conditions of intended use, this product does not pose a risk to health. Excessive exposure may result in eye, skin or respiratory irritation.

For further health effects/toxicological data, see Section 11.

SECTION 4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.

SKIN CONTACT: Wash contact areas with soap and water. Remove and clean oil soaked clothing daily and wash affected area.

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

INHALATION: Not expected to be a problem. However, if respiratory irritation, dizziness, nausea, or unconsciousness occurs due to excessive vapor or mist exposure, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or mouth-to-mouth resuscitation.

INGESTION: Not expected to be a problem. Seek medical attention if discomfort occurs. Do not induce vomiting.

SECTION 5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.

SPECIAL FIRE FIGHTING PROCEDURES: Water or foam may cause frothing. Use water to keep fire exposed containers cool. Water spray may be used to flush spills away from exposure. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Note: Pressurized mists may form a flammable mixture.

COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.

Flash Point C(F): > 200(392) (ASTM D-92).

Flammable Limits (approx.% vol.in air) - LEL: 0.9%, UEL: 7.0%

NFPA HAZARD ID: Health: 0, Flammability: 1,

Reactivity: 0

SECTION 6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED: LAND SPILL: Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping or contain spilled material with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.

WATER SPILL: Confine the spill immediately with booms. Warn other ships in the vicinity. Notify port and other relevant authorities. Remove from the surface by skimming or with suitable absorbents. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

SECTION 7. HANDLING AND STORAGE

HANDLING: High pressure injection under the skin may occur due to the rupture of pressurized lines. Always seek medical attention. No special precautions are necessary beyond normal good hygiene practices. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Keep containers closed when not in use. Do not store in open or unlabelled containers. Store away from strong oxidizing agents and combustible materials. Do not store near heat, sparks, flame or strong oxidants.

SPECIAL PRECAUTIONS: Prevent small spills and leakages to avoid slip hazard.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS: When mists/aerosols can occur, the following are recommended: 5 mg/m³ (as oil mist)- ACGIH Threshold Limit Value (TLV), 10 mg/m³ (as oil mist) - ACGIH Short Term Exposure Limit (STEL), 5 mg/ m³ (as oil mist) – OSHA Permissible Exposure Limit (PEL)

VENTILATION: If mists are generated, use adequate ventilation, local exhaust or enclosures to control below exposure limits.

RESPIRATORY PROTECTION: If mists are generated, and/or when ventilation is not adequate, wear approved respirator.

EYE PROTECTION: If eye contact is likely, safety glasses with side shields or chemical type goggles should be worn.

SKIN PROTECTION: Not normally required. When splashing or liquid contact can occur frequently, wear oil resistant gloves and/or other protective clothing. Good personal hygiene practices should always be followed.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid

COLOR: Light Amber

ODOR: Mild

ODOR THRESHOLD-ppm: NE pH: NA

BOILING POINT C(F): > 316(600)

MELTING POINT C(F): NA

FLASH POINT C(F): > 200(392) (ASTM D-92)

FLAMMABILITY (solids): NE

AUTO FLAMMABILITY C(F): NA

EXPLOSIVE PROPERTIES: NA

OXIDIZING PROPERTIES: NA

VAPOR PRESSURE-mmHg 20 C: < 0.1

VAPOR DENSITY: > 2.0

EVAPORATION RATE: NE

RELATIVE DENSITY, 15/4 C: 0.875

SOLUBILITY IN WATER: Negligible

PARTITION COEFFICIENT: > 3.5

VISCOSITY AT 40 C, cSt: 46.0

VISCOSITY AT 100 C, cSt: 6.7

POUR POINT C(F): < -18(0)

FREEZING POINT C(F): NE

VOLATILE ORGANIC COMPOUND: NE

DMSO EXTRACT, IP-346 (WT.%): <3, for mineral oil only
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES
FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

SECTION 10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Extreme heat and high energy sources of ignition.
INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

DERMAL TOXICITY (RABBITS): Practically nontoxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.

EYE IRRITATION (RABBITS): Practically nonirritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.

SKIN IRRITATION (RABBITS): Practically nonirritating. (Primary Irritation Index: greater than 0.5 but less than 3). ---Based on testing of similar products and/or the components.

OTHER ACUTE TOXICITY DATA: Although an acute inhalation study was not performed with this product, a variety of mineral and synthetic oils, such as those in this product, have been tested. These samples had virtually no effect other than a nonspecific inflammatory response in the lung to the aerosolized mineral oil. The presence of additives in other tested formulations (in approximately the same amounts as in the present formulation) did not alter the observed effects.

---SUBCHRONIC TOXICOLOGY (SUMMARY)--- No significant adverse effects were found in studies using repeated dermal applications of similar formulations to the skin of laboratory animals for 13 weeks at doses significantly higher than those expected during normal industrial exposure. The animals were evaluated extensively for effects of exposure (hematology, serum chemistry, urinalysis, organ weights, microscopic examination of tissues etc.).

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---

No teratogenic effects would be expected from dermal exposure, based on laboratory developmental toxicity studies of major components in this formulation and/or materials of similar composition.

---CHRONIC TOXICOLOGY (SUMMARY)---

Repeated and/or prolonged exposure may cause irritation to the skin, eyes or respiratory tract. Overexposure to oil mist may result in oil droplet deposition and/or granuloma formation. For mineral base oils: Base oils in this product are severely solvent refined and/or severely hydrotreated. Chronic mouse skin painting studies of severely treated oils showed no evidence of carcinogenic effects. These results are confirmed on a continuing basis using various screening methods such as Modified Ames Test, IP-346, and/or other analytical methods. For synthetic base oils: The base oils in this product have been tested in the Ames assay and other tests of mutagenicity with negative results. These base oils are not expected to be carcinogenic with chronic dermal exposures.

---SENSITIZATION (SUMMARY)---

Not expected to be sensitizing based on tests of this product, components, or similar products.

SECTION 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS: In the absence of specific environmental data for this product, this assessment is based on information for representative products.

ECOTOXICITY: Available ecotoxicity data (LL50 >1000 mg/L) indicates that adverse effects to aquatic organisms are not expected from this product.

MOBILITY: When released into the environment, adsorption to sediment and soil will be the predominant behavior.

PERSISTENCE AND DEGRADABILITY: This product is expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Bioaccumulation is unlikely due to the very low water solubility of this product, therefore bioavailability to aquatic organisms is minimal.

SECTION 13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning in an enclosed, controlled burner for fuel value. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at an appropriate government waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.


RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Unoba EP Grease

1. Product and Company Identification

Product Name:	Unoba® EP Grease (All Grades)
MSDS Number:	722490
Synonyms:	76 Unoba® EP Grease 00 76 Unoba® EP Grease 0 76 Unoba® EP Grease 1 76 Unoba® EP Grease 2 76 Unoba® EP Grease 3
Intended Use:	Lubricating Grease
Manufacturer/Supplier:	ConocoPhillips Lubricants 600 N. Dairy Ashford, 2W900 Houston, Texas 77079-1175
Emergency Health and Safety Number:	Chemtrec: 800-424-9300 (24 Hours)
Customer Service:	U.S.: 888-766-7676 or International: +1-83-2486-3363
Technical Information:	800-435-7761
MSDS Information:	Internet: http://w3.conocophillips.com/NetMSDS/

2. Hazards Identification

<u>Emergency Overview</u>	<u>NFPA</u>
<p>CAUTION!</p> <p>Eye Irritant</p>	

Appearance: Green
Physical Form: Semi-Solid
Odor: Petroleum

Potential Health Effects

Eye: Eye irritant. Contact may cause stinging, watering, redness, and swelling.

Skin: Contact may cause mild skin irritation including redness and a burning sensation. Prolonged or repeated contact can defat the skin, causing drying and cracking of the skin, and possibly dermatitis (inflammation). No harmful effects from skin absorption are expected.

Inhalation (Breathing): No information available on acute toxicity.

Ingestion (Swallowing): No harmful effects expected from ingestion.

Signs and Symptoms: Effects of overexposure may include irritation of the digestive tract, nausea and diarrhea. Inhalation of oil mist or vapors at elevated temperatures may cause respiratory irritation.

Pre-Existing Medical Conditions: Conditions which may be aggravated by exposure include skin disorders and eye disorders.

See Section 11 for additional Toxicity Information.

3. Composition / Information on Ingredients

Component	CASRN	Concentration*
Lubricant Base Oil (Petroleum)	VARIOUS	<90
Additives	PROPRIETARY	>12
Zinc dialkyl dithiophosphate	68649-42-3	<2

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First Aid Measures

Eye Contact: If irritation or redness develops from exposure, flush eyes with clean water. Remove contact lenses if present and easy to do. For direct contact, hold eyelids apart and flush the affected eye(s) with clean water for at least 15 minutes. If irritation persists, seek medical attention.

Skin Contact: Remove contaminated shoes and clothing and cleanse affected area(s) thoroughly by washing with mild soap and water or a waterless hand cleaner. If irritation or redness develops and persists, seek medical attention.

Inhalation (Breathing): If respiratory symptoms develop, move victim away from source of exposure and into fresh air in a position comfortable for breathing. If symptoms persist, seek medical attention.

Ingestion (Swallowing): First aid is not normally required; however, if swallowed and symptoms develop, seek medical attention.

Notes to Physician: High-pressure hydrocarbon injection injuries may produce substantial necrosis of underlying tissue despite an innocuous appearing external wound. Often these injuries require extensive emergency surgical debridement and all injuries should be evaluated by a specialist in order to assess the extent of injury.

5. Fire-Fighting Measures

NFPA 704 Hazard Class

Health: 1 **Flammability:** 1 **Instability:** 0 (0-Minimal, 1-Slight, 2-Moderate, 3-Serious, 4-Severe)

Unusual Fire & Explosion Hazards: This material may burn, but will not ignite readily. If container is not properly cooled, it can rupture in the heat of a fire.

Extinguishing Media: Dry chemical, carbon dioxide, foam, or water spray is recommended. Water or foam may cause frothing of materials heated above 212°F. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces.

Fire Fighting Instructions: For fires beyond the incipient stage, emergency responders in the immediate hazard area should wear protective clothing. When the potential chemical hazard is unknown, in enclosed or confined spaces, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8).

Isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from immediate hazard area if it can be done safely. Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done safely. Avoid spreading burning liquid with water used for cooling purposes.

Hazardous Combustion Products: Combustion may yield smoke, carbon monoxide, and other products of incomplete combustion. Oxides of sulfur, nitrogen or phosphorus may also be formed.

See Section 9 for Flammable Properties including Flash Point and Flammable (Explosive) Limits

6. Accidental Release Measures

Personal Precautions: This material may burn, but will not ignite readily. Keep all sources of ignition away from spill/release. The use of explosion-proof electrical equipment is recommended. Stay upwind and away from spill/release. Notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate protective equipment, including respiratory protection, as conditions warrant (see Section 8). See Sections 2 and 7 for additional information on hazards and precautionary measures.

Environmental Precautions: Stop spill/release if it can be done safely. Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Use water sparingly to minimize environmental contamination and reduce disposal requirements. Spills into or upon navigable waters, the contiguous zone, or adjoining shorelines that cause a sheen or discoloration on the surface of the water, may require notification of the National Response Center (phone number 800-424-8802).

Methods for Containment and Clean-Up: Notify relevant authorities in accordance with all applicable regulations. Immediate cleanup of any spill is recommended. Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal.

7. Handling and Storage

Precautions for safe handling: Wear eye/face protection. Wash thoroughly after handling. Use good personal hygiene practices and wear appropriate personal protective equipment.

High pressure injection of hydrocarbon fuels, hydraulic oils or greases under the skin may have serious consequences even though no symptoms or injury may be apparent. This can happen accidentally when using high pressure equipment such as high pressure grease guns, fuel injection apparatus or from pinhole leaks in tubing of high pressure hydraulic oil equipment.

Do not enter confined spaces such as tanks or pits without following proper entry procedures such as ASTM D-4276 and 29CFR 1910.146. Do not wear contaminated clothing or shoes.

"Empty" containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. "Empty" drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSI Z49.1, and other references pertaining to cleaning, repairing, welding, or other contemplated operations.

Conditions for safe storage: Keep container(s) tightly closed. Use and store this material in cool, dry, well-ventilated area away from heat and all sources of ignition. Store only in approved containers. Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage.

8. Exposure Controls / Personal Protection

Component	US-ACGIH	OSHA	Other
Lubricant Base Oil (Petroleum)	TWA: 5mg/m ³ STEL: 10 mg/m ³ as Oil Mist, if generated	TWA: 5 mg/m ³ as Oil Mist, if generated	---

Note: State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

Engineering controls: If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits, additional engineering controls may be required.

Eye/Face Protection: The use of eye protection that meets or exceeds ANSI Z.87.1 is recommended to protect against potential eye contact, irritation, or injury. Depending on conditions of use, a face shield may be necessary.

Skin/Hand Protection: The use of gloves impervious to the specific material handled is advised to prevent skin contact. Users should check with manufacturers to confirm the breakthrough performance of their products. Suggested protective materials: Nitrile.

Respiratory Protection: Respiratory protection is not normally required under intended conditions of use. Emergencies or conditions that could result in significant airborne exposures may require the use of NIOSH approved respiratory protection. An industrial hygienist or other appropriate health and safety professional should be consulted for specific guidance under these situations.

Suggestions provided in this section for exposure control and specific types of protective equipment are based on readily available information. Users should consult with the specific manufacturer to confirm the performance of their protective equipment. Specific situations may require consultation with industrial hygiene, safety, or engineering professionals.

9. Physical and Chemical Properties

Note: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

Appearance:	Green
Physical Form:	Semi-Solid
Odor:	Petroleum
Odor Threshold:	No data
pH:	Not applicable
Vapor Pressure:	<0.1mm Hg
Vapor Density (air=1):	> 5
Boiling Point/Range:	No data
Melting/Freezing Point:	No data
Solubility in Water:	Negligible
Partition Coefficient (n-octanol/water) (Kow):	No data
Bulk Density:	7.5 lbs/gal
Percent Volatile:	Negligible
Evaporation Rate (nBuAc=1):	<1
Flash Point:	450°F / 232°C
Test Method:	Cleveland Open Cup (COC), ASTM D92
LEL (vol % in air):	No data
UEL (vol % in air):	No data
Autoignition Temperature:	No data

10. Stability and Reactivity

Stability: Stable under normal ambient and anticipated conditions of use.

Conditions to Avoid: Extended exposure to high temperatures can cause decomposition.

Materials to Avoid (Incompatible Materials): Avoid contact with strong oxidizing agents and strong reducing agents.

Hazardous Decomposition Products: Not anticipated under normal conditions of use.

Hazardous Polymerization: Not known to occur.

11. Toxicological Information

Chronic Data:

Lubricant Base Oil (Petroleum)

Carcinogenicity: The petroleum base oils contained in this product have been highly refined by a variety of processes including severe hydrocracking/hydroprocessing to reduce aromatics and improve performance characteristics. All of the oils meet the IP-346 criteria of less than 3 percent PAH's and are not considered carcinogens by NTP, IARC, or OSHA.

Acute Data:

Component	Oral LD50	Dermal LD50	Inhalation LC50
Lubricant Base Oil (Petroleum)	>5 g/kg	>2 g/kg	No data
Zinc dialkyl dithiophosphate	>2000 mg/kg (rat)	>2000 mg/kg (rat)	No data

12. Ecological Information

Ecotoxicity: Experimental studies show that acute aquatic toxicity values are in the range 1-100 mg/l. These values are consistent with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. Should be regarded as capable of causing long term adverse effects in the aquatic environment.

Mobility: Volatilization to air is not expected to be a significant fate process due to the low vapor pressure of this material. Components may behave differently in the aquatic environment with soaps dispersing and dissolving to some extent in water while the hydrocarbons will float on the surface due to their low water solubility. The hydrocarbon portion would be expected to show low mobility in soil and water. The major environmental fate would be expected to be biodegradation.

Persistence and degradability: The base oil constituents of greases are expected to be inherently, but not readily biodegradable. Some of the thickening agents may be readily biodegradable.

Bioaccumulation Potential: Log Kow values measured for the hydrocarbon components of this material range from 4 to over 6, and therefore regarded as having the potential to bioaccumulate. In practice, metabolic processes may reduce bioconcentration.

13. Disposal Considerations

The generator of a waste is always responsible for making proper hazardous waste determinations and needs to consider state and local requirements in addition to federal regulations.

This material, if discarded as produced, would not be a federally regulated RCRA "listed" hazardous waste and is not believed to exhibit characteristics of hazardous waste. See Sections 7 and 8 for information on handling, storage and personal protection and Section 9 for physical/chemical properties. It is possible that the material as produced contains constituents which are not required to be listed in the MSDS but could affect the hazardous waste determination. Additionally, use which results in chemical or physical change of this material could subject it to regulation as a hazardous waste.

This material under most intended uses would become "Used Oil" due to contamination by physical or chemical impurities. Whenever possible, Recycle Used Oil in accordance with applicable federal and state or local regulations. Container contents should be completely used and containers should be emptied prior to discard.