

3. SETUP AND OPERATION

A. GENERAL

This section describes a step-by-step operating procedure for the HTC TUBE HONING MACHINES. Prior to starting the Machine, Operator shall ensure:

All prerequisites described in Sections 1 and 2 are complete:

B. SAFETY PRECAUTIONS

The following precautions should be followed to ensure maximum safety of personnel while working on or around the HTC-TUBE HONING MACHINE.

1. Ensure all guards are in place before operating.
2. Ensure area is clear of other personnel before operating machine.
3. Keep loose tools and other foreign objects clear of machine.
4. Wear proper Safety items such as, safety glasses, gloves, non-slip safety shoes and other personal safety equipment as necessary or required.
5. DO NOT wear loose fitting clothes or jewelry while working on or around machine.
6. When lifting Work piece or tooling use proper lifting procedures.
7. Push E-STOP Button and turn OFF Main ON/OFF Switch when performing service not required power.
8. Turn OFF electrical power at Main Power Source when performing maintenance on or cleaning of Electrical Enclosure.
9. Clean up lubricant spills immediately.

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10. DO NOT adjust stroke length while Spindle Retractor Carriage is not locked position.
11. Stay clear of all moving parts.
12. Remove keys and wrenches from machine before honing.

C. START-UP

1. Disconnect Honing Tool.
2. Turn ON Main Power Switch.
3. Release all Emergency STOP Buttons. Also insure Carriage is in locked position and Universal Joint Cover is closed.
4. Press RESET Button on Control Panel.
5. To initialize: Press Automatic-Key on Control Panel. Menu Screen will than display a question: Do you want to initialize? - Press yes if you wish to continue. The Carriage will than travel slowly to the left hand side of the machine.
NOTE: Machine automatically comes up in Manual Mode when Machine is initialized.
6. Install and position Work piece (refer to Section 2).
7. Use CARRIAGE RIGHT Key (simultaneously pressed with safety Key) until Carriage moves close enough to Drive Shaft to be connected.
8. Reconnect Honing Tool and Drive Shaft as in Section 2 G.
9. Expand stones in Work piece bore by switching RAPID FEED EXPAND Switch, until all the stones contact the component bore wall. Moving the tool side to side while caring out this operation will remove the possibility of chatter ones Honing commences.
10. Retract stones slightly by turning the RAPID FEED RETRACT Switch. (Starting honing with the stones expanded tightly against the bore wall will encounter unnecessary stone wear).
11. Use CARRIAGE LEFT Button (with safety interlock switch) until Honing Tool is approximately a ¼ of the stone length out of to left hand end of the Work piece.

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12. On setup menu *Page 1*; set Stroke Start Position (Left Stroke Stop) by pressing START POSITION Keys (Display will than read „Pos: = 0 mm „).

13. **Set Left SAFETY SWITCH ACTIVATOR.**

14. Use CARRIAGE RIGHT Button to move Honing Tool to right end of Work piece; then run Tool approximately ¼ of Stone length out of Work piece to allow for overstrike.

15. Set Stroke End Position by pressing END POSITION Keys (DISPLAY will read „Pos: =....mm same Value in Length: =....mm“)

16. **Set Right SAFETY SWITCH ACTIVATOR.**

17. Set ID Diameter of workpiece and set Lever and Speed Handwheel on Spindle Motor according to the SPINDLE SPEED CHART on the Display.

NOTE:

The Lever on the Spindle Gear Box must be properly locket in the Positions 1, 2 or 3.

18. Select the proper tool for the ID Diameter.

19. On setup menu *Page 2*; set Dwell Time and Oscillation Length:

20. Set Stroke Speed and Oscillation Distance.

21. On setup menu *Page 3*; set Power Nominal (Feed Rate): Adjust the Feed *to the lowest setting that gives good cutting action with respect to bore diameter, condition of bore, material and stones used* (see Table 3-1)

NOTE: The Feed Settings shown in Table are offered as a suggested starting point. Experiences with your particular operation will dictate the most economic feed setting for your shop.

TABLE 3-1; Feed Adjustment

DIAMETER		SPINDLE	FEED SETTING		FOR FASTER STOCK REMOVAL INCREASE FEED IF STONES WEAR RAPIDLY: 1. REDUCE FEED 2. USE HARDER STONES
INCHES	mm	RPM	ROUGH BORE*	NORMAL BORE**	
2	50	350	10 %	30 %	* Always use this Setting during the first strokes ** For Finishing use Feed Setting 15-20%
3	75	230	10 %	40 %	
4	100	175	20 %	50 %	
5	125	140	20 %	60 %	
8	200	88	20 %	70 %	
12	305	58	20 %	75 %	
15	380	46	20 %	75 %	

22. Set the Power Limit and the Emergency Power

23. On setup menu *Page 4*; set Break Conditions: Processing Time and Spark-Out if necessary.

24. On setup menu *Page 5*; select the desired Hone-Mode (Normal / Correction.)

25. On setup menu *Page 6*; store the last used conditions under a Work piece Name or Number.

26. Position Coolant Nozzle to direct oil into the bore. Ensure there is enough clearance for overstroke by the Honing Tool. *Use ONLY one Coolant Nozzle, so metal chips may be properly flushed from the bore during honing*

27. Switch ON Coolant then open the Flow Control Valve on the Coolant Nozzle.

28. Install and position Splash Guards.

29. Recheck all values entered in the Control Panel.

30. Select Automatic Operation by pressing AUTOMATIC MODE.

CAUTION: By pressing AUTOMATIC MODE Carriage moves to Start-Position.

WARNING: DO NOT start the cycle until covers are securely in place.

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31. Press START Key. **The Machine Starts.**

NOTE: By pressing the Red E-STOP Button will Shut OFF power to all machine functions. After E-STOP Button has been pressed, the RAPID FEED RETRACT Switch must be used so that the stones will not be under pressure before the machine can be restarted. When the honing cycle is interrupted the Timer resets itself.

32. After the Timer reaches „0“, or the STOP Key is pressed the Machine Stops honing at the end of the next completed stroke. Automatically the Stone Retract to the last position you have set by the RAPID FEED SWITCH.

Timer automatically resets each time Honing Cycle START Key is pushed until you readjust the Timer.

33. Retract stones, by switching RAPID FEED RETRACT.

34. Unlock carriage by pressing the UNLOCK-CARRIAGE Key.

35. Slide Honing Tool out of Bore.

WARNING: IT IS DANGEROUS to touch rotating parts such as Drive Shafts and Honing Heads during Operation !

- **IMPORTANT:**
- **When turning OFF the machine, press E-STOP before switch OFF Main Power Switch.**
By doing this, the E-Stop deactivates first hardware and then the software. Otherwise a software crash can occur.
- **The Lever on the Spindle Gear Box have to be properly locked in the Positions 1, 2 or 3.**

D. STROKING OPERATION

There are several features on the HTC for correcting problems in the bore. These features are as follows:

1. During the automatic cycle, the REVERSE Key can be initiated at any time to reduce „Tight Spots“.
2. During the automatic cycle, both REVERSE Key can be initiated at any time, to activate Oscillation reduce „Tight Spots“.
3. Additionally, the DWELL Key can be used to stop or oscillate the stroke at either end of the bore, for correcting Barrel shape conditions.

E. SPINDLE RETRACTOR CARRIAGE

The Spindle Retractor Carriage allows the Honing Tool to be withdrawn from the Work piece for gaging, stone set replacement or installing a new Work piece, without removing tool or changing any of the settings.

NOTE: The Spindle Retractor Carriage provides 380 mm of tool withdrawal motion.

1. After honing cycle is completed, retract stones by switching RAPID FEED RETRACT Switch
2. Press UNLOCK-CARRIAGE Key, also the Tool Support Bar activates automatically, and slide carriage to the left.
3. Perform required operation.
4. Guide Hone Tool into the bore by sliding Spindle Retractor Carriage to the right until Carriage Release Locks in place.

WARNING: Do not hone with Tool Support Bar in load position; Honing Tool may catch on Bar and cause personal injury and/or Machine damage.

F. START WITH PREVIOUSLY SELECTED VALUES

NOTE: The machine is set up, the Main Power Switch is turned OFF, and the machine is supposed to start the next cycle with the previously selected values.

IMPORTANT: Work piece MUST maintain the old position !

1. Disconnect Tool.
2. Turn Main Power Switch ON.
3. Release all EMERGENCY STOP Buttons.
4. Press RESET Button.
5. Initialize machine. Press AUTOMATIC MODE or CARRIAGE RIGHT or LEFT Button, and press Initialize Yes. Carriage moves left to Initial Point.
6. Use CARRIAGE RIGHT Button (simultaneously pressed with safety Button) until Carriage moves close enough to Drive Shaft to be connected.
7. Insert Honing Tool in Work piece bore; then reconnect Tool.
8. Press AUTOMATIC MODE. Carriage moves to Start Position.
9. Lightly expand Tool in Work piece bore by switching RAPID FEED EXPAND Switch.
10. Press START. Honing cycle begins.

IMPORTANT:

When turning OFF the machine, press E-STOP before switch OFF Main Power Switch. By doing this, the E-Stop deactivates first hardware and then the software. Otherwise a software crash can occur.

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G. SPINDLE SPEED CHART

SPINDLE-SPEED IN RPM					
ø in mm	RPM	ø in mm	RPM	ø in mm	RPM
under 40	430	155	113	360	48
45	388	160	110	380	46
50	350	165	106	400	44
55	318	170	103	425	41
60	292	175	100	450	39
65	270	180	97	475	37
70	250	185	95	500	35
75	233	190	92	525	33
80	219	195	90	550	31
85	206	200	88	575	30
90	195	210	84	600	29
100	175	220	80	625	28
105	167	230	76	650	27
110	160	240	73	675	26
115	152	250	70	700	25
120	146	260	67	725	24
125	140	270	65	750	23
130	135	280	63	800	22
135	130	290	60	850	21
140	125	300	58	900	20
145	121	320	55	950	18,5
150	117	340	51	1000	17,5

Calculate Optimum Spindle Speed:
$$= \frac{17500}{\text{BORE DIAMETER (in Millimeters)}} = \text{RPM}$$

NOTE:

The Lever on the Spindle Gear Box have to be properly locket in the Positions 1, 2 or 3.

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H. MACHINE SETTINGS

The Machine Settings in this section are offered as a suggested starting point. Experience with your particular operation will dictate the most economic settings for your shop.

1. STROKE SPEED (m/min)

Set the Stroke Speed by pressing STROKE SPEED. For starting a new bore without a previous honing operation start with approximately 15m/min. after a few strokes increase to 25-32m/min.

2. SPINDLE SPEED (RPM)

Set the Spindle Speed by rotating Speed Adjustment Handwheel. (see Spindle Speed Chart)
The optimum cutting Speed is about 55m/min.

$$\text{SPINDLE SPEED:} = \frac{17500}{\text{BORE DIAMETER (in Millimeters)}} = \text{RPM}$$

3. FEED SETTING'S

TABLE 3-1; Feed Adjustment

DIAMETER		SPINDLE	FEED SETTING		
INCHES	mm	RPM	ROUGH BORE*	NORMAL BORE**	
2	50	350	10 %	30 %	FOR FASTER STOCK REMOVAL INCREASE FEED IF STONES WEAR RAPIDLY: 1. REDUCE FEED 2. USE HARDER STONES * Always use this Setting during the first strokes ** For Finishing use Feed Setting 15-20%
3	75	230	10 %	40 %	
4	100	175	20 %	50 %	
5	125	140	20 %	60 %	
8	200	88	20 %	70 %	
12	305	58	20 %	75 %	
15	380	46	20 %	75 %	

NOTE: For other calculation formulas such as: Stock removal, Honing Time, Surface Finish, Stone Consumption and Crosshatch Angle refer to CALCULATIONS FORMULAS.

4. ROUTINE SERVICE

A. PURPOSE

This section gives suggested routine service and maintenance instructions.

B. GENERAL

The following procedures and suggested maintenance periods are given as guides only and are not to be construed as absolute or invariable. Local conditions must always be considered. Each machine must be maintained individually, according to its particular requirements.

WARNING: TURN THE DISCONNECT SWITCH AND THE ELECTRICAL AT THE MAIN POWER SOURCE OFF BEFORE SERVICING!

C. CLEANING AND LUBRICATING

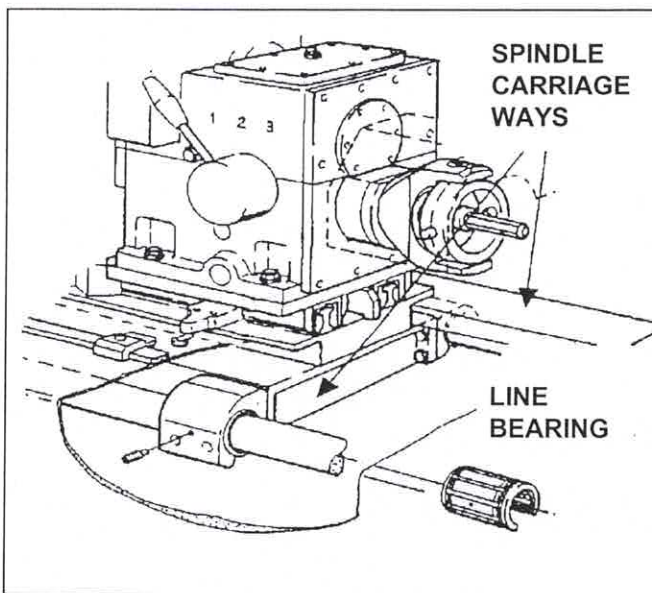


FIGURE 4-1; Spindle Carriage Ways

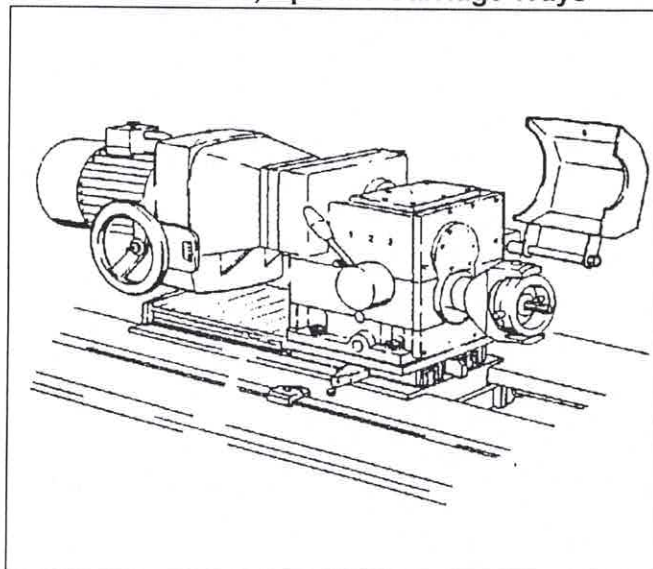


FIGURE 4-2; Spindle Drive Gear Box

1. **MACHINE EXTERIOR:** Clean exterior of the Machine with warm water and a mild detergent or mild industrial solvent. Rinse thoroughly with clean hot water and wipe it dry.
2. **SPINDLE CARRIAGE WAYS:** Wipe Spindle Carriage Ways (see Figure 4-1) with a clean soft cloth, and lubricate with MOBIL WAY OIL 300 or its equivalent. (EVERY THREE MONTHS)
3. **SPINDLE DRIVE GEAR BOX** (see Figure 4-2)
When Spindle Drive is not running, checks lubricant level in Sight Glass on the Spindle Drive Gear Box and fill as required. (WEEKLY)

NOTE: Oil level should be above the middle of Sight Glass. Add oil as required, according to label on Gear Box (Mobilgear ... CLP ISO VG 220, or its equivalent).

Change lubricant in the Spindle Drive Gear Box every 5000 hour of operation, and fill with fresh lubricant above the middle of Sight Glass on Gear Box (Mobilgear ... CLP ISO VG 220, or its equivalent).

NOTE: Capacity of the Spindle Drive Gear Box is 7,5 Liters

D. CHAIN LUBRICATION

Lubricate the Chain of Spindle Carriage with a Chain Spray (same as Motor-Cycle) EVERY THREE MONTHS.

E. CHAIN ADJUSTING

Check the Chain tension of Spindle Carriage as follows.

Bring the Spindle Carriage in the middle of stroke, then move by hand forward and backward.

If you feel any clearance go to the next.

Adjust the Chain tension of Spindle Carriage (see Figure 4-3) by the following operations.)

1. Spindle Carriage should be approximately in the middle of stroke length of machine.
2. Press E-STOP.
3. Loosening Screw in Top of Chain Adjuster approx. $\frac{1}{2}$ Turn.
4. Loosening both Nuts of Chain Adjuster.
5. Pull back the Chain Adjuster by hand and tighten first nut by hand.
6. Then tight first Nut with a 46 mm Open End Wrench ... Turn and tighten second Nut.
HTC 2000 = $\frac{3}{4}$ Turn
HTC 3000 = 1 Turn
HTC 4000 = 1 $\frac{1}{4}$ Turns
HTC 5000 = 1 $\frac{1}{2}$ Turns
HTC 6000 = 1 $\frac{3}{4}$ Turns
7. Tighten the Screw in Top of Chain Adjuster.

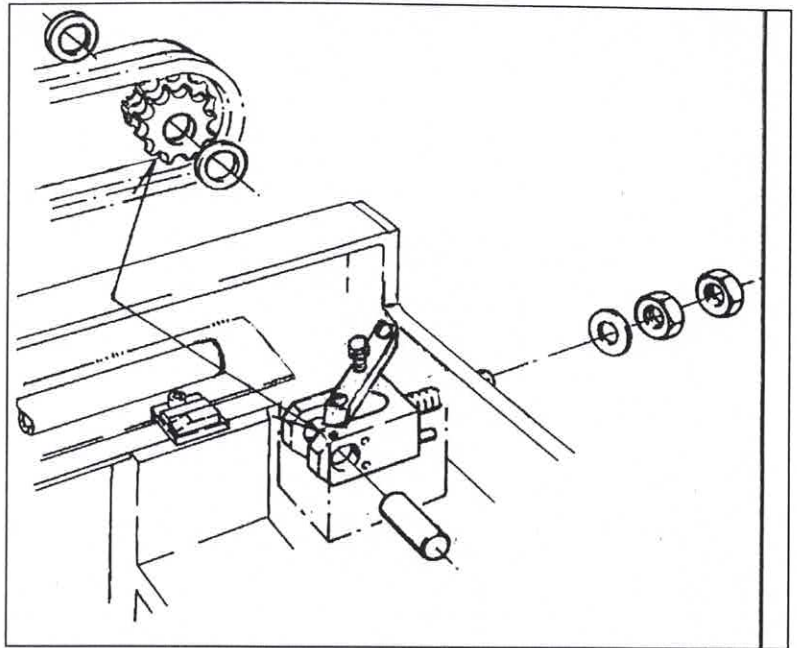


FIGURE 4-3; Chain Adjusting

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F. COOLANT RESERVOIR

(If TURBO SEPARATOR OPTION please refer to the turbo separator manual)

Clean Coolant Reservoir and Replace Coolant as follows: (see Figure 4-4)

1. Direct one or more Coolant Nozzles into an approved waste container.
2. Open Coolant Control Valves.
3. Press Coolant Key on and pump waste Coolant into waste container.
4. As Coolant flow drops off, press E-Stop Button.
5. Close Coolant Control Valves.
6. Disconnect Plug X5 and X6 from Connecting Panel.
7. Remove Dump Tube and disconnect the oil fitting, then slide Reservoir out from Machine.
8. Take out Magnetic Filter from the Reservoir.
9. To remove the Coolant that was not pumped out by the Pump, loosen Draincock on the front of Reservoir
10. Drain and clean Canister.
11. Slide Reservoir under the Machine
12. Connect the oil fitting, then install the Dump Tube and connect Plugs X5 and X6.

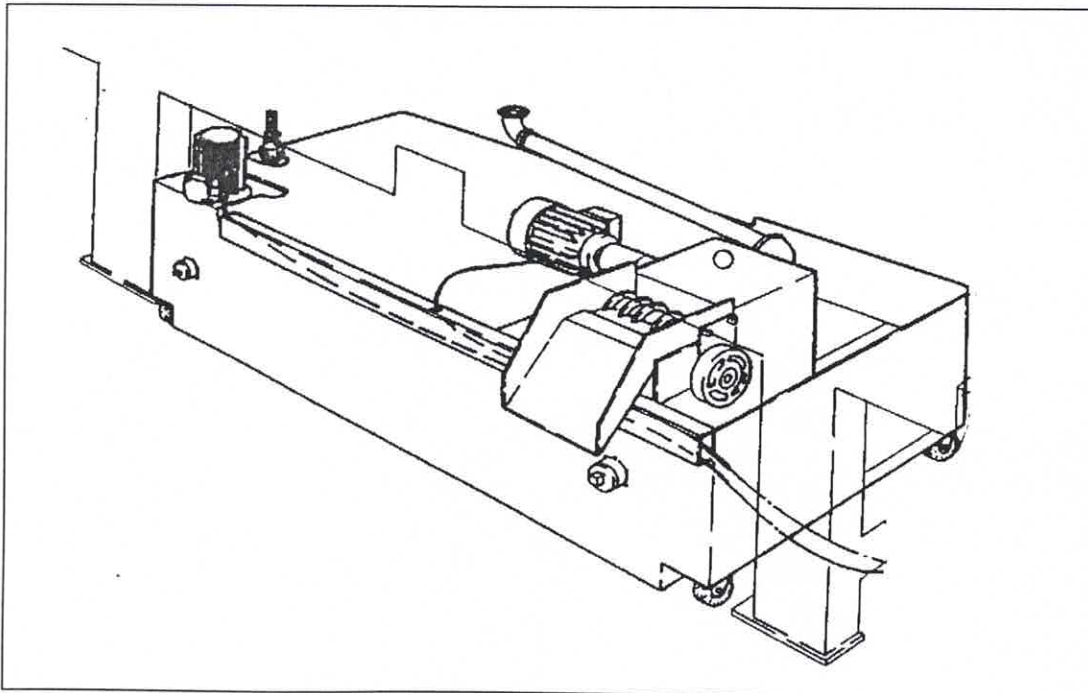


Figure 4-4; Coolant Reservoir

H. REPLACE COOLANT FILTER

To replace Filter Element, (Optional) proceed as follows (refer to Figure 1-?? on Page ?)

1. Turn off the Coolant flow by the Operator Panel
2. Place a suitable waste container under Draincock.
3. Open Air Vent in Canister Cover.
4. Open Draincock on bottom of Canister and drain about 4 Liters of Coolant from the Canister.
5. Close Draincock and Air Vent.
6. Loosen Cover Clamp Ring and remove Cover Clamp Ring.
7. Slowly pull dirty Filter Element out of Canister and place in the waste container to drain.
8. Insert new Filter Element into Canister; rotate element slightly so it will slide down the center post easily.
9. Replace Canister Cover and Cover Clamp Ring. Then tighten Ring.
10. Open Air Vent in Filter Canister Cover ½ turn counterclockwise.
11. Switch the Coolant ON/OFF Key ON.

As coolant fills the Filter Canister, air will escape through the air Vent. When coolant appears in the partially opened Vent, close the Vent. Then wipe any coolant from around Vent.

5. TROUBLESHOOTING

A. GENERAL

This section contains Troubleshooting information in table form which should be used when problems occur with the machine. The table lists problems encountered, possible causes, and solutions for problems along with reference to the section of the manual where instructions may be found to correct the problems.

B. OPERATIONAL TROUBLESHOOTING INDEX

For suggestions on correcting problems with bore conditions or with honing operations, consult Table 5-1.

TABLE 5-1; Operational Troubleshooting Index

PROBLEM	PROBABLE CAUSE	SOLUTIONS
Stone not cutting	1. Stone Glazing (Stone locks clean) 2. Stone Loading (Metal particles on stone surface)	A. Dress stone B. Increase feed C. Increase stroking speed D. Use softer stone A. Dress stone B. Increase stroking speed C. Use softer stone D. Use coarser stone E. Check coolant *
Slow stock removal	1. Improper spindle speed 2. Inadequate stone feed up 3. Improper stone	A. Increase spindle speed A. Increase feed A. Use softer stone B. Use coarser stone
Poor stone life	1. Excessive stone feed up 2. Inadequate spindle speed 3. Improper stone	A. Decrease feed A. Increase spindle speed A. Use harder stone B. Use coarser stone
Bellmouth	1. Improper overstroke 2. Improper stone	A. Shorten overstroke A. Use softer stone
Barrel	1. Improper overstroke 2. Improper stone	A. Increase overstroke A. Use finer stone
Taper in Open End	1. Part	A. Short stroke tight end
Taper in Blind End	1. Inadequate coolant flow 2. Part 3. Material 4. Inadequate relief in blind end	A. Adjust coolant nozzle A. Short stroke tight end A. Use hardtip stone A. Provide sufficient relief
Out-Off-Round	1. Work piece flexing (thinwall)	A. Decrease feed B. Change method of fixturing
Rough Finish	1. Improper feed 2. Improper stone 3. Improper or Diluted coolant	A. Decrease feed A. Use finer stone A. Use softer stone B. Check coolant *
Scratches in Bore (Random)	1. Improper feed 2. Improper stone 3. Improper or diluted coolant	A. Decrease feed A. Use finer stone B. Use softer stone A. Check coolant *

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C. CALCULATIONS FORMULAS (HTC)

STOCK REMOVAL in cm ³	
STOCK REMOVAL:	$= \frac{\varnothing \times Length \times Stock\ Removal}{636} = \text{cm}^3$
EXAMPLE:	$\frac{100\text{ mm} \times 1200\text{ mm} \times 0,28\text{ mm}}{636} = 52,8\text{ cm}^3$

HONING TIME in minutes (700 cm ³ /h)	
HONING TIME:	$= \frac{\varnothing \times Length \times Stock\ Removal}{7200} = \text{min.}$
EXAMPLE:	$\frac{100\text{ mm} \times 1200\text{ mm} \times 0,28\text{ mm}}{7200} = 4,7\text{ min.}$

Stock Removal for SURFACE FINISH	
Required Stock Removal on \varnothing :	$= \frac{Existing\ Finish \times Desired\ Finish}{100} = \text{mm}$
EXAMPLE:	$\frac{0,8\text{ Ra (N6)} \times 0,1\text{ Ra (N3)}}{100} = 0,007\text{ mm}$

STONE CONSUMPTION	
One Set of Stones consists of 4 Sticks 0,85 cm x 0,85 cm x10.2 cm long = 29.48 cm ³ in one set of H70-A45N Stones. On the assumption of stone wear being at a ratio of 1:25 to Material Removed = 29.48 x 25 = 737 cm ³ material removed with one set of H70 Stones	
Parts per Set of Stone:	$= \frac{737\text{ cm}^3}{Stock\ Removal} = \text{Parts}$
EXAMPLE:	$\frac{737\text{ cm}^3}{52.8\text{ cm}^3} = 14\text{ Parts per Set of Stone}$

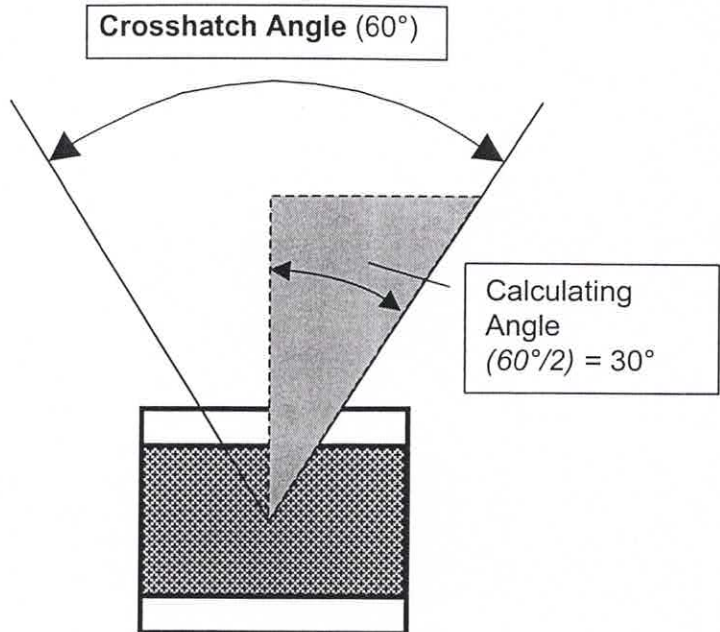
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CROSSHATCH ANGLE

$30^\circ = \text{tg } 15^\circ \quad (0,2679)$
 $45^\circ = \text{tg } 22,5^\circ \quad (0,4142)$
 $60^\circ = \text{tg } 30^\circ \quad (0,5774)$
 $90^\circ = \text{tg } 45^\circ \quad (1,0)$

Example to calculate:

Bore Diameter: = 100 mm
RPM: = 175
Crosshatch Angle: = 60°
V m/min.: = ??



To calculate the Crosshatch Angle consult following Formulas:

$$\text{Stroke Speed } V \text{ (m/min.):} = \frac{\varnothing \times 3,14 \times \text{RPM} \times \text{tg}(30^\circ)}{1000} = \text{m/min}$$

(by 175 RPM)

$$\text{EXAMPLE:} \quad \frac{100 \times 3,14 \times 175 \times 0,5774}{1000} = 31,73 \text{ m/min}$$

$$\text{Spindle Speed RPM:} = \frac{1000 \times V \text{ (m/min)}}{\varnothing \times 3,14 \times \text{tg}(30^\circ)} = \text{RPM}$$

(by V = 30 m/min)

$$\text{EXAMPLE:} \quad \frac{1000 \times 30}{100 \text{ mm} \times 3,14 \times \text{tg } 0,5774} = 165,5 \text{ RPM}$$

D. SET-UP & OPERATION CHECK LIST

1. Disconnect Honing Tool.
2. Turn ON Main Power Switch
3. Release Red E-STOP Buttons and close Carriage Release and Universal Joint Cover.
4. Press RESET Button.
5. Initialize: Press AUTOMATIC MODE and Initialize. Carriage moves left to Initial Point
6. Install and position Work piece.
7. Use CARRIAGE RIGHT to move carriage far enough to the right so Honing Tool and Drive Shaft can be connected.
8. Reconnect Honing Tool and Drive Shaft.
9. Expand stones lightly in Work piece bore with RAPID FEED SWITCH. Turn to EXPAND.
10. Use CARRIAGE LEFT to move Honing Tool to left end of Work piece; then add $\frac{1}{4}$ of Stone length to allow for overstroke.
11. Set Stroke Start Position by pressing START POSITION .
12. Set Left SAFETY STOP ACTIVATOR.
13. Use CARRIAGE RIGHT to move Honing Tool to left end of Work piece; then add $\frac{1}{4}$ of Stone length to allow for overstroke.
14. Set Stroke End Position by pressing END POSITION.
15. Set Right SAFETY STOP ACTIVATOR
16. Set Spindle Speed on Lever and Speed Hand wheel by the Spindle Gear Box.
NOTE: The Lever on the Spindle Gear Box have to be properly locket in the Positions 1, 2 or 3.
17. Set Dwell Time.
18. Set Stroke Speed.
19. Select the proper Feed setting.
20. Set Processing Time and Spark-Out Strokes.
21. Select the Hone Modes.
22. Adjust Coolant Nozzle and open Flow Control Valve.
23. Position Splash Guards.

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24. Select Automatic Operation by Pressing AUTOMATIC MODE. Carriage moves to Start Position.
25. Press START. Machine starts honing cycle.
26. Machine stop honing when Timer reaches Zero „00:00“ or the STOP is pressed.
27. Retract stones, by turning Rapid Feed Switch to RETRACT.
28. Push UNLOCK CARRIAGE Button and slide honing tool out of the bore.

E. WORK CYCLE CHECK LIST

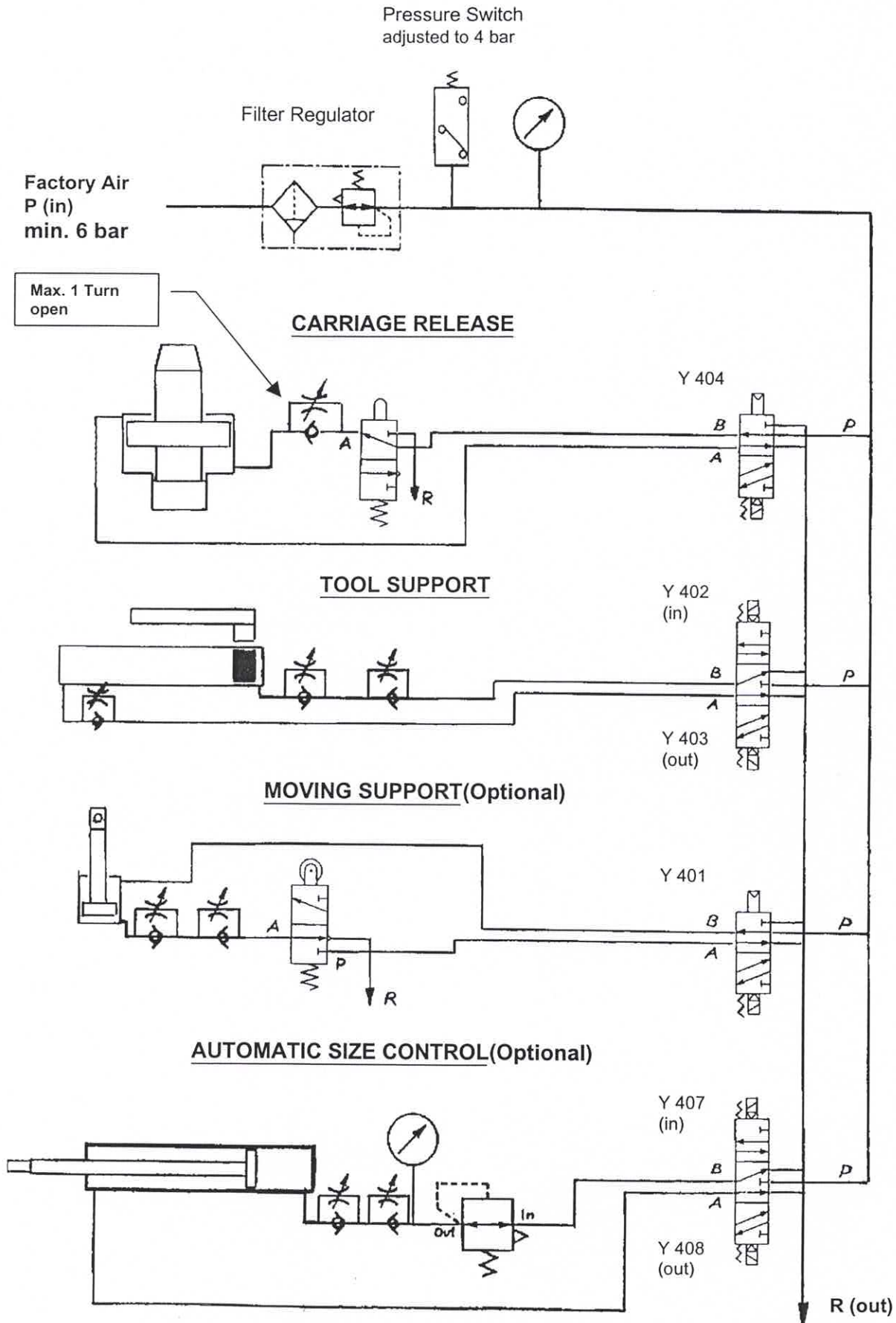
NOTE: The machine is set up, the Main Power Switch is turned OFF, and the machine is supposed to start the next cycle with the previously selected values.

IMPORTANT: Work piece MUST maintain the **old** position.

1. Disconnect Honing Tool.
2. Turn ON Main Power Switch
3. Release Red E-STOP Buttons and close Carriage Release and Universal Joint Cover.
4. Press RESET Button.
5. Initialize: Press AUTOMATIC MODE and Initialize. Carriage moves left to Initial Point.
6. Use CARRIAGE RIGHT to move carriage far enough to the right so Honing Tool can be connected.
7. Reconnect Honing Tool and Drive Shaft.
8. Press AUTOMATIC MODE. Carriage moves to Start Position
9. Lightly expand tool by turning Rapid Feed Switch to EXPAND.
10. Press START. Honing cycle begins (DO NOT start the cycle until covers are securely in place.)
11. Machine stop honing when Timer reaches Zero „00:00“ or the STOP is pressed.
12. Retract stones, by turning Rapid Feed Switch to RETRACT.
13. Push UNLOCK CARRIAGE Button and slide honing tool out of the bore.

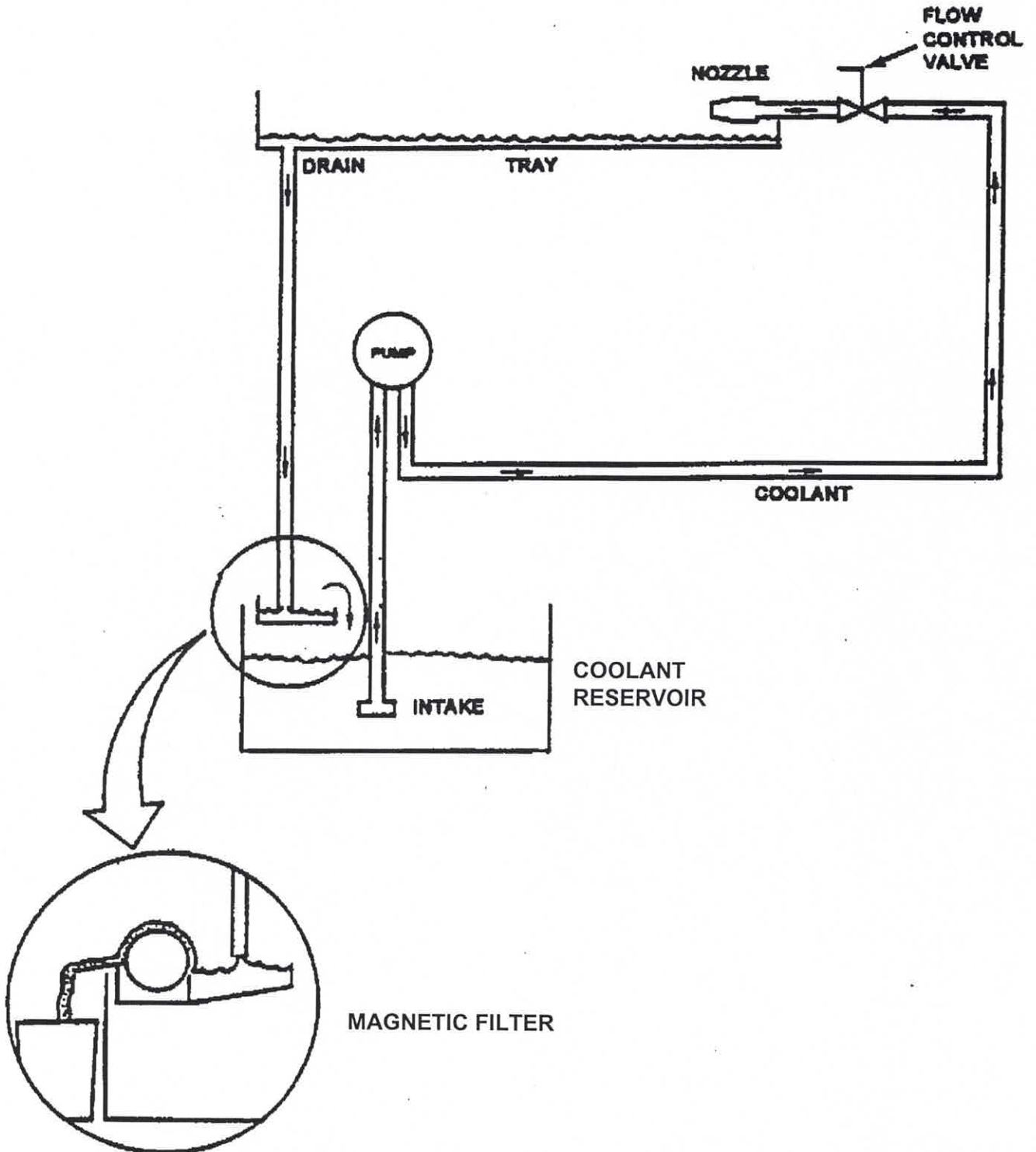
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F. PNEUMATIC FLOW DIAGRAM (HTC)



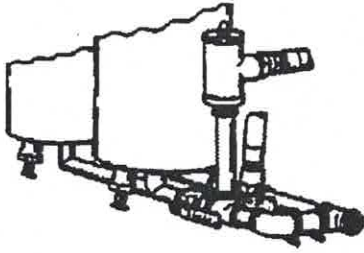
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G. OIL FLOW DIAGRAM (CENTRIFUGAL PUMP)



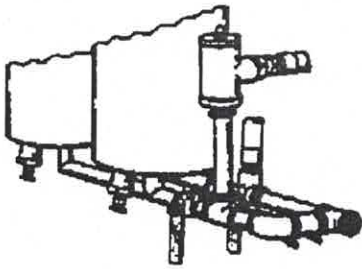
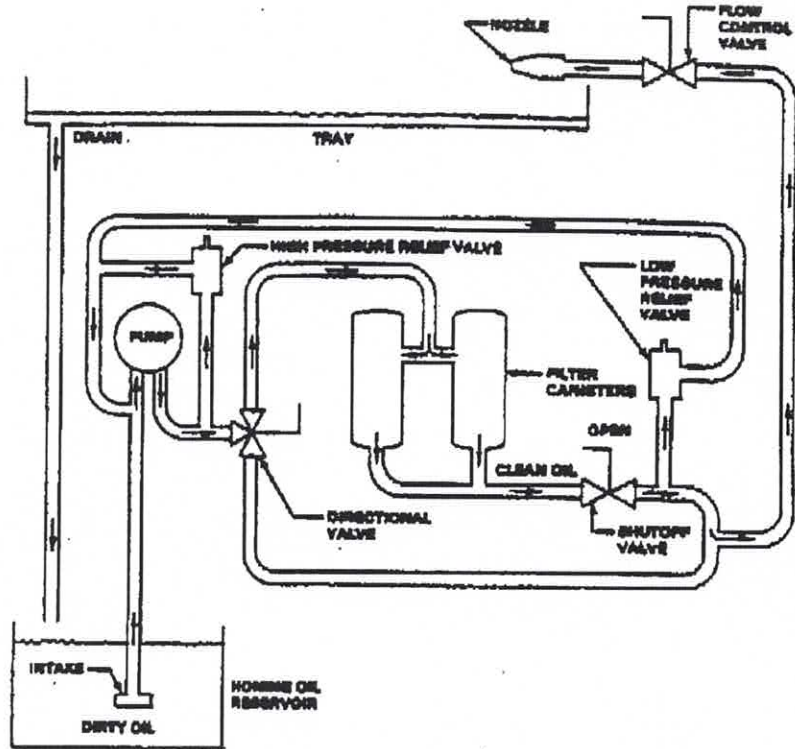
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H. OIL FLOW DIAGRAM (PF-400, FILTER UNIT)



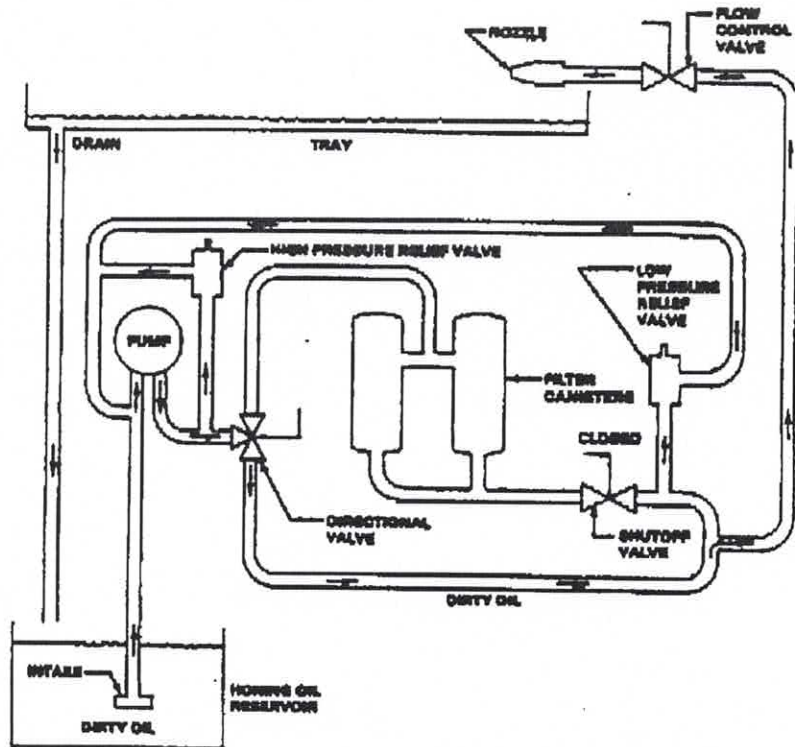
FILTERED

With valves handles in their horizontal position: The coolant system with filter engaged - coolant passes through filters, delivering filtered coolant to the machine.



UNFILTERED

With valves handles in their vertical position: The coolant filters are disengaged - coolant bypasses filters, delivering unfiltered coolant to the machine.



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I. SURFACE ROUGHNESS TABLE

Rt µm	Rz µm	N 1-N 10	Ra / CLA		RMS µin.	GUS Knocc
			µm	µin.		
0,1 - 0,3	0,17	N1	0,02	0,8	0,9 - 1,0	14
0,2 - 0,5	0,3	N2	0,04	1,6	1,8 - 1,9	13
0,3 - 0,7	0,43		0,06	2,4	2,6 - 2,9	12
0,4 - 0,8	0,52	N3	0,08	3,2	3,5 - 3,8	11
0,5 - 1,0	0,65		0,10	4,0	4,4 - 4,8	
0,6 - 1,2	0,77	N4	0,12	4,8	5,3 - 5,8	
0,65 - 1,4	0,86		0,14	5,6	6,2 - 6,8	
0,7 - 1,6	1,00		0,16	6,4	7,0 - 7,7	
0,8 - 1,7	1,07		0,18	7,2	7,9 - 8,6	10
0,9 - 1,9	1,20		0,20	8,0	8,8 - 9,6	
1,1 - 2,3	1,45	N5	0,25	10,0	11,0 - 12,0	
1,3 - 2,7	1,70		0,30	12,0	13,2 - 14,4	
1,5 - 3,0	1,95		0,35	14,0	15,4 - 16,8	
1,7 - 3,4	2,20		0,40	16,0	17,6 - 19,2	9
1,9 - 3,8	2,45	N6	0,45	18,0	19,8 - 21,6	
2,3 - 4,2	2,70		0,50	20,0	22,0 - 24,0	
2,7 - 5,2	3,45		0,65	26,0	28,6 - 31,2	8
3,7 - 7,0	4,60	N7	0,90	36,0	39,6 - 43,2	
4,5 - 8,2	5,45		1,10	44,0	48,4 - 52,8	
5,2 - 9,5	6,35		1,30	52,0	57 - 62	7
6,0 - 10,0	7,10		1,50	60,0	66 - 72	
7,1 - 12,5	8,45	N8	1,80	72,0	79 - 86	
9,6 - 16,5	11,20		2,50	100	110 - 120	6
13,0 - 22,0	15,10	N9	3,50	140	154 - 168	
17,0 - 28,0	19,40		4,50	180	198 - 216	
18,0 - 30,0	20,60		5,00	200	220 - 240	5
22,0 - 35,0	24,50		6,00	240	264 - 288	
25,0 - 40,0	27,90	N10	7,00	280	308 - 336	
28,0 - 45,0	31,40		8,00	320	352 - 384	