SUNNEN®

ABOVE AND BEYOND **HONING**

# SUNNEN® HONING TECHNIQUES

## DATA FILE: #112

## EXTERNAL HONING

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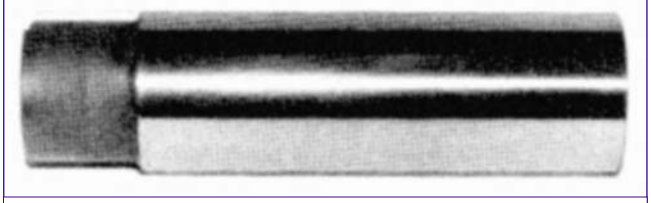
# EXTERNAL HONING

## EXTERNAL HONING

In almost all external-honing operations, the requirements as to stock removal are light compared to that of internal honing.

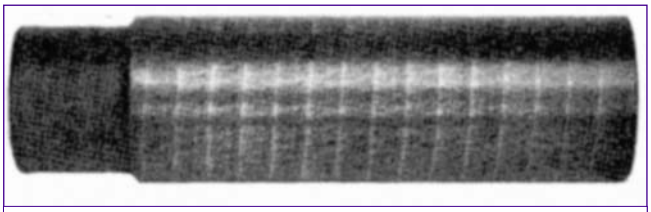
The reason is that it's generally easier to finish outside diameters than inside diameters. Say we have a rough bore in hardened steel, 1.000 in. ID by 12 inches long, to be fitted with a hard steel plunger of equal length. The mating parts must be round, straight, have a fine finish, and be a very close tolerance, hydraulic "fluid control" sliding fit.

For the internal diameter pre-machining in this hardened steel, neither boring nor grinding would be easy because of the length and diameter of boring bar or grinding quill, and it would be best to just hone from the rough . . . even though it might call for two honing operations . . . deburr and finish hone.



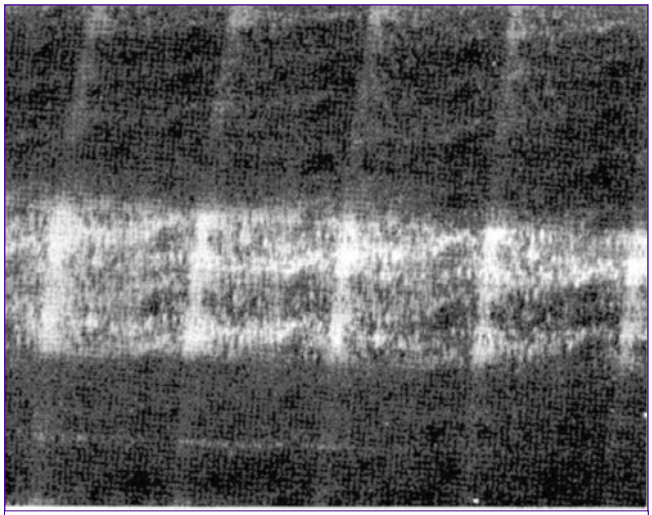
Fine grind on hardened steel plunger . . . traverse spirals are barely visible.

**Figure 1, Steel Plunger**



After the surface has been blackened and a light pass taken with a fine grit hone, the surface imperfections become clearly visible.

**Figure 2, Steel Plunger**



Small area of surface shown in Figure 2 magnified.

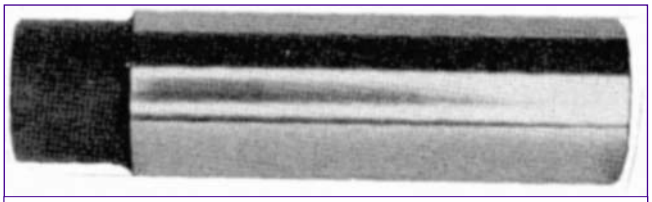
**Figure 3, Steel Plunger**

Now when, it pomes to the plungers, it is a different story. The rough turned and hardened parts, can be easily externally ground between centers or even centerless ground, and just a final finish external honing operation with a medium or fine grit stone would complete the job quickly with very little stock removal.

One might say, "Why hone the plungers at all-why not do a precision grinding job and let it go at that?" There are several reasons why you might want to use external honing . . . maybe a good OD grinder is not available, or, maybe the lot is too small to justify the long setup on an OD grinder. Or, if you're after a top-notch quality job, you might be wanting to correct the hidden faults that are sometimes found in ground finishes, especially in hardened alloy steel surfaces.

Let's take an example. Note in *Figure 1* that a hardened and ground steel plunger justs off the grinder looks fine and measures good. But now note, in *Figure 2*, after the part's surfaces has been blackened and a light pass taken over its surfaces with an external hone fitted with medium or fine grit stones, that grinding spirals are clearly visible.

The spirals, of course, indicate the ratio of travel rate of the grinding machine's table to the work's revolving speed. The narrow width bright spirals, brightened by the hone's light pass, indicate that they are "high" in relation to the wider dark area spirals, which contain many scattered bright "specks" indicating a more or less torn surface. *Figure 3* shows a small area of the work's surface magnified. *Figure 4* shows the part after externally honing the part's surface down to base metal.



Honing with either a medium or fine grit honing stone has removed the thin, stressed surface-layer and has reached undisturbed base metal. Now any degree of fine finish can be achieved with a finer grit honing stone and with only a very few "tenths" of stock removal. The plunger is now round and straight within .0001 in.

**Figure 4, Steel Plunger**

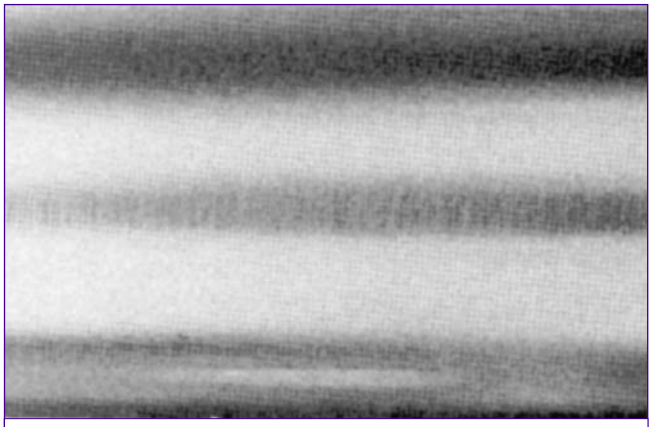
*Figure 5* shows the finish of a small section of the surface, magnified.

Another very common surface error found in ground finishes . . . caused by grinding machine vibration and showing up as faintly visible parallel lengthwise marks in the freshly ground surfaces *(see Figure 6)* . . . is easily eradicated by external honing. As you can see in *Figures 7 and 8*, this defect shows up distinctly when, blackened and then lightly honed. The finished honed part is shown in *Figure 9* and a magnified section of it in *Figure 10*.

External honing is used to a large extent to cure the ills of various types of previous machining operations, and to refine the work's surface for both accuracy and surface finish with minimum stock removal.

Honing produces no surface damage such as hard or soft spots or surface tensions, simply because it cannot burn spots into the work's surface that cause such hidden damage. With very light stock removal, it removes such "skin deep" damage while achieving high accuracy and a fuzz free, long lasting, almost frictionless work surface.

While a good percentage of external honing jobs are short enough to be chucked in the spindle of and honed on the honing machine, there are many parts of long lengths being done on lathes or simple shop made horizontal revolving rigs such as shown in

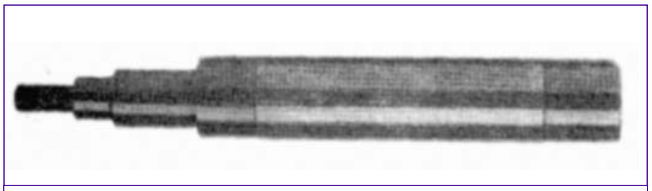


Small area of surface shown in Figure 4 magnified.

**Figure 5, Steel Plunger**

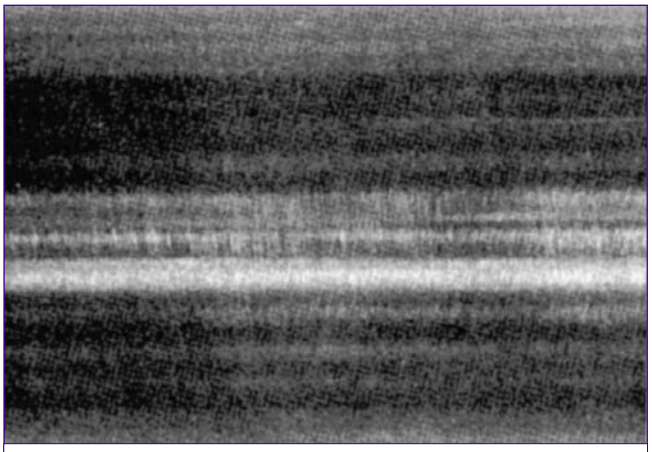
Fine ground finish on hardened steel shaft shows very faint reflection of lengthwise markings caused by chatter. Often these out-of-round deviations can-not be detected by eye but can be measured by roundness checks.

**Figure 6, Ground Finish**



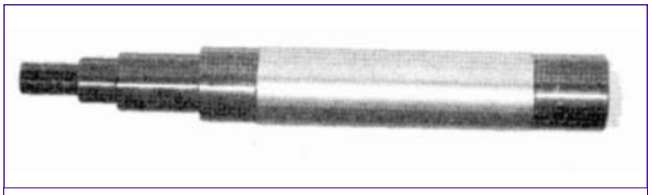
After having its surface brackened and externally honed lightly, grinding chatter marks show up as horizontal light and dark streaks.

**Figure 7, Ground Finish, Blackened**



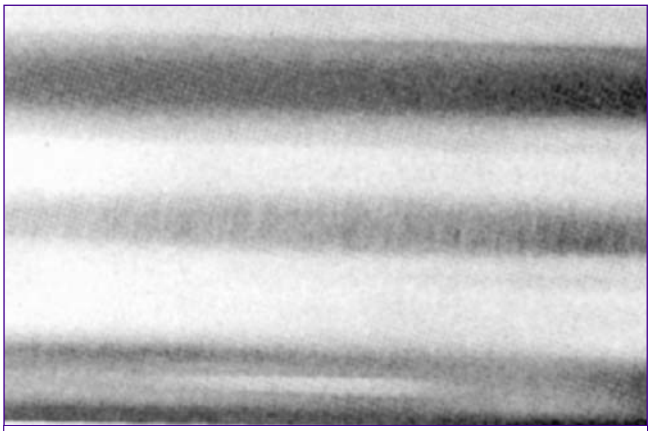
Small area of surface shown in Figure 7 magnified.

**Figure 8, Ground Finish, Magnified**



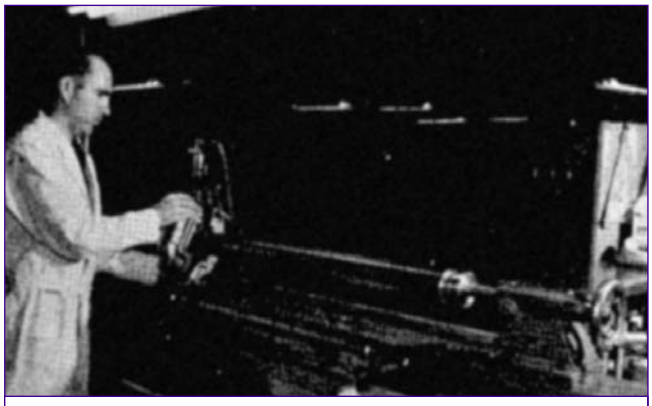
Finish honing has generated all dimensional and surface requirements specified. The part 0 now round and straight within .0001 in.

**Figure 9, Hone Finish**



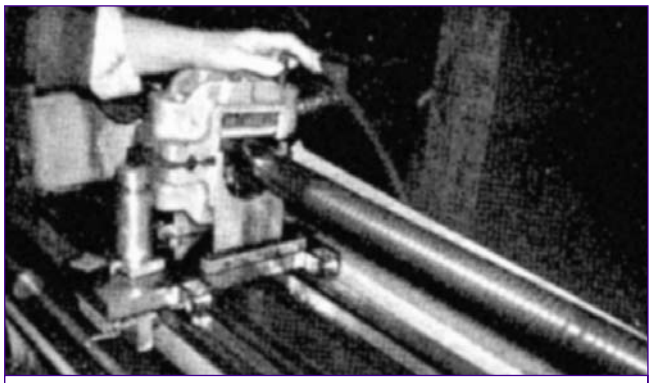
Magnified Portion of the externally honed surface shown in Figure 9. Perfect bearing contact with mating bar is assured by Sunnen External Honing.

**Figure 10, Hone Finish, Magnified**



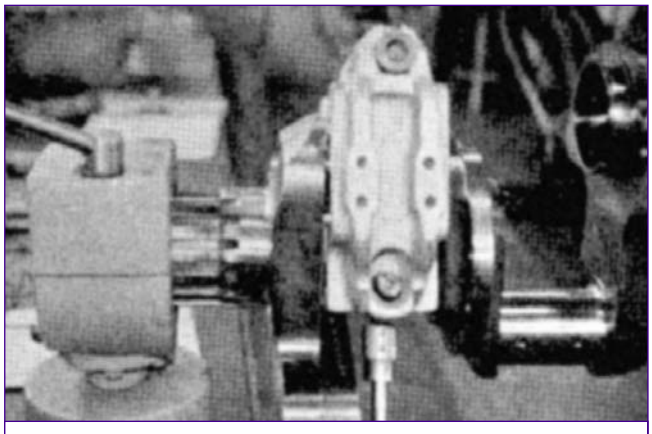
Honing the outside of an anodized aluminum tube for high precision and fine surface finish. Tube is the "snorkel" of an aircraft in-fight fueling apparatus. A small lathe has been extended to take these long tubes between centers. Filtered honing oil is pumped right into the hone body.

**Figure 11**



Long shaft has been flame plated with tungsten carbide and then ground with a diamond grit wheel. It is now being finished with an external hone and fine grit diamond stone. Hone floats between "side boards" on a shop-made carriage on a converted machine-carriage is hydraulically stroked and torque hydraulically measured.

**Figure 12**



Journal surfaces on some aircraft engines are partly over-hung by counterweights, which the maintenance shops are not allowed to remove. A sight alteration of the hone body allows it to pass under the counterweight. Little or no stroking is possible, of course *(see Figure 14 for finish attained with no stroking)*.

**Figure 13,**

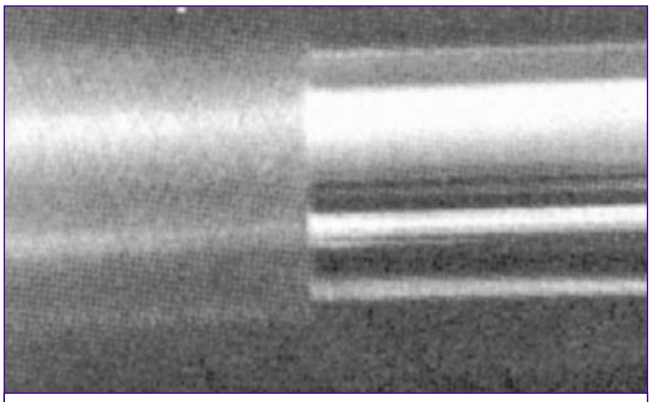
*Figure 11 & 12*. Note in both cases the honing oil is filtered and pumped right into the external hone body.

In the oil or chemical industry, or where machinery must work in dusty environments - such as road building or railroading - rods and shafting of great lengths are electrochemically or flame plated and then externally honed for desired precision and surface finish.

Also in machinery maintenance operations, many uses are found for external honing such as shown in *Figure 13* where an aircraft engine crankshaft journal is being resurfaced without removing an overhanging counterweight . . . the hone body passes under the weight on the revolving shaft.

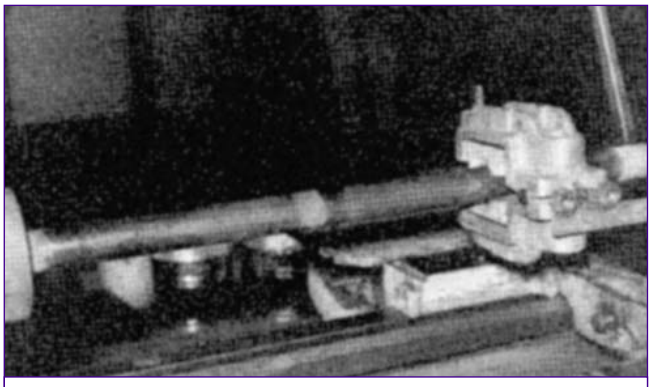
The finish pattern can be easily controlled from a steep high angle crosshatch to a circular pattern, as desired. Note two patterns on a part *(see Figure 14)*.

External honing is also employed in maintenance operations in many industrial plants. *Figure 15* shows an operation just getting under way in a large



Externally honed cold rolled bar stock. At left is normal type crosshatch while at right the stroking was stopped. Finish measures about the same when trace is taken lengthwise along the work.

**Figure 14,**



Used shaft has had weld build-ups turned to size at two points and mounted in lathe for honing over its entire length. A short length of square bar clamped in tool post of lathe has two spaced nuts welded on outer end so "tail" lathe's carriage travel strokes the hone back and forth.

**Figure 15**

steam power plant's repair shop- refinishing a weld build-up on a long shaft.

To summarize external honing is not a high stock removal process. Its principal benefit is its ability to refine external cylindrical surfaces with respect to both finish and waviness. The secondary benefits are clean up with minimum stock removal, easy portability, fast setup, and low cost.

While external honing does not replace external grinding, R does provide increased capability for better finishes and roundness. This is important not only on critical ODs but also where limited quantities or salvage operations cannot justify more expensive equipment.

## EXTERNAL HONING ON SUNNEN HONING MACHINES

Previous examples in this data file show the external hone being used on various shop-made rigs. These are exceptional cases; actually, most workpieces can be conveniently honed on either the manually stroked or the power-stroked Sunnen Honing Machines.

*Figure 16* shows a workpiece being honed manually; *Figure 17* shows a workpiece set up on the power stroker.

When power stroking, hold the workpiece in an adapter chuck *(see Page 9)* and use the KKN-700 Universal Honing Fixture to stroke the Sunnen External Hone. Four fingers without carbide pads *(see Figure 18)* are included with the KKN-700 for use with the External Hone.

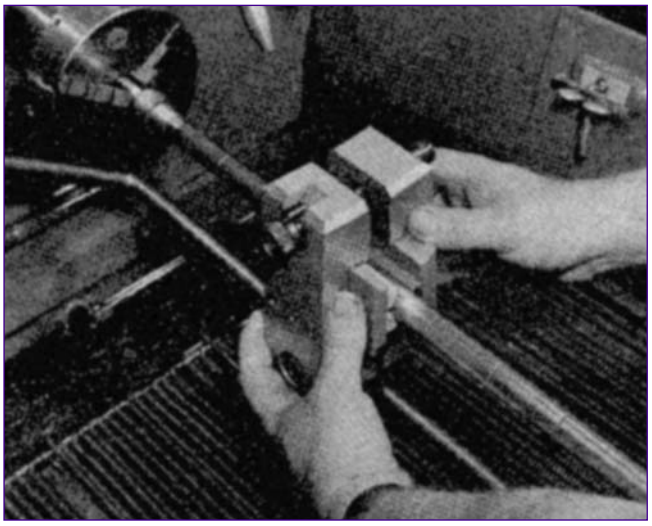


Figure 16

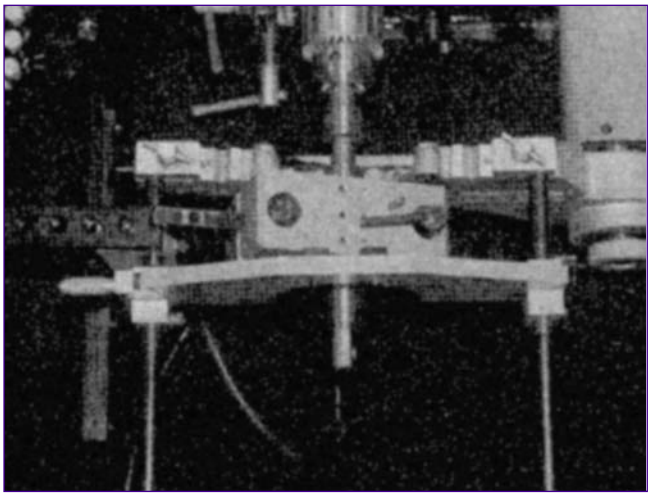


Figure 17

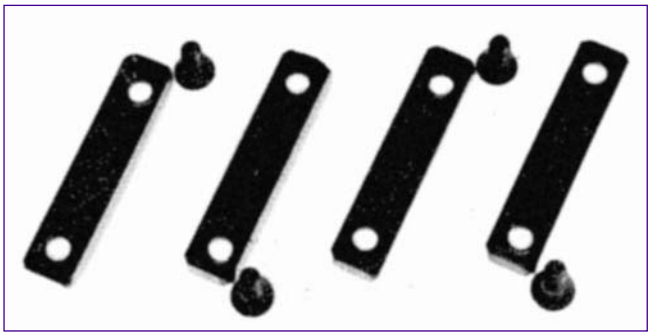


Figure 18

# HOW TO SELECT THE CORRECT EXTERNAL HONING TOOLING

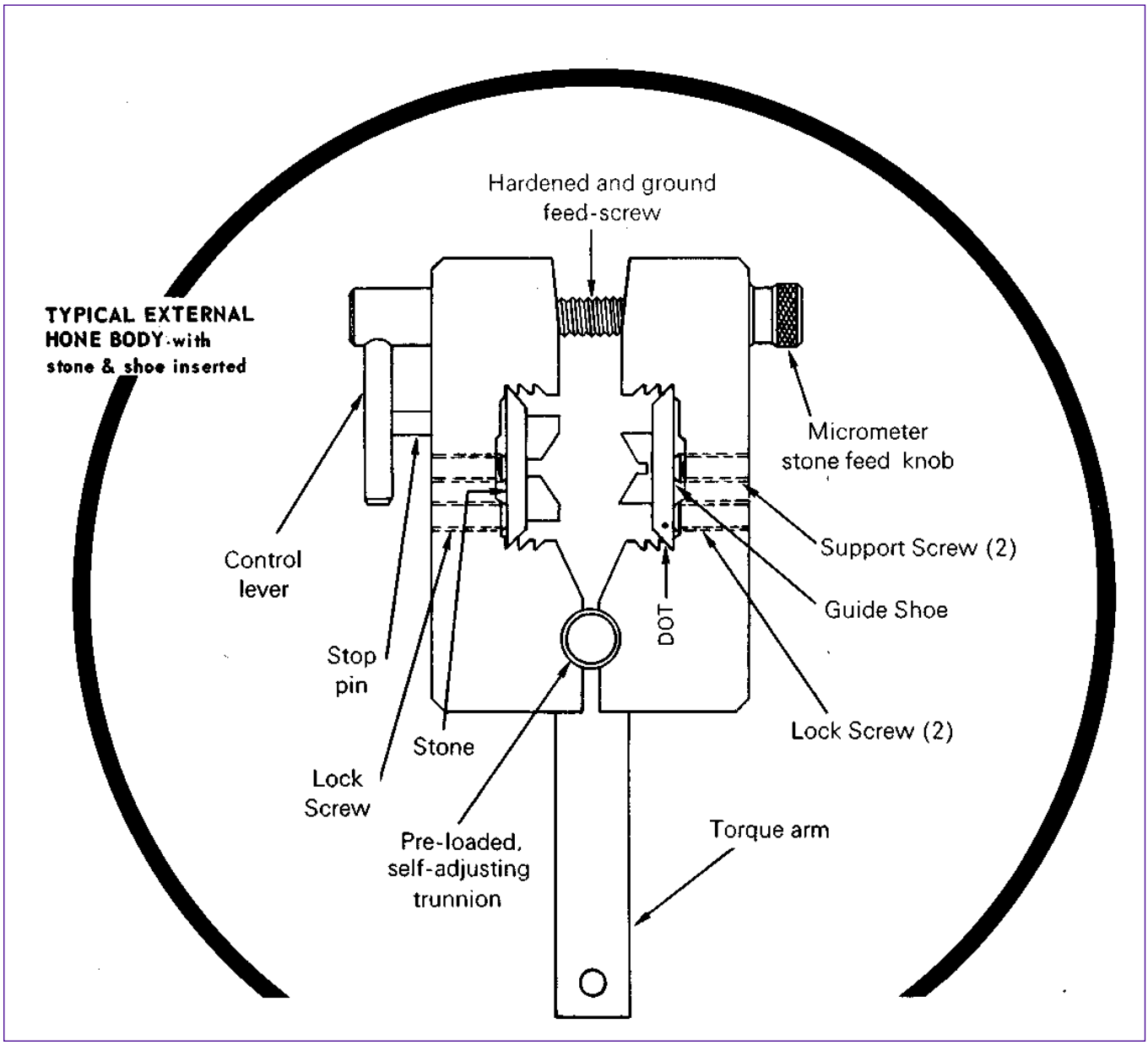



**Figure 19, External Honing Tool**

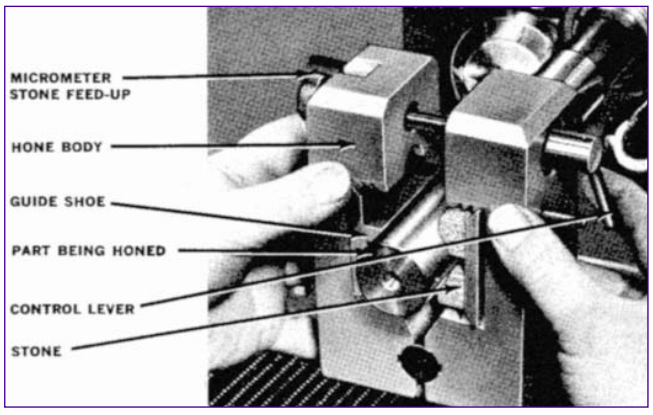



**Figure 17**

- Range: .120 - 4.500 in., in five ranges
- True geometric roundness
- Accuracy to .0001 in. and better
- Surface finish to 2 microinches
- Removes "cloverleaf" grind pattern and chatter marks
- Corrects waviness and "rainbow" warpage, barrel, taper, and out-of-round
- Cleaner, more convenient, and many times faster than lopping
- Recommended for almost any material, including hardened steel

When surface finishing or precision sizing, select a single-length stone and guide shoe in the proper hone body from the Sizing and Finishing Table below.

†When you use diamond stones to hone carbide, ceramics, and glass, use guide shoe as listed for that application. This guide shoe is twice as wide as the regular guide shoe for greater stability.

When correcting bow or waviness, select tooling from Bow Removal Table. The stone and guide shoe length should be 1-1/2 times the length of the work, if possible.

## FOR•SIZING•&•FINISHING•USE 1, 2, 3

| DIAMETER RANGE | | 1 HONE BODY | 2 GUIDE SHOES | | 3 HONING STONE ONLY | LENGTH OF STONE OR GUIDE SHOES | |
|---|---|---|---|---|---|---|---|
| | | | FOR ALL METALS | FOR USE WITH DIAMOND OR BORAZON STONES | | | |
| INCHES | MILLIMETERS | | | | | INCHES | MILLIMETERS |
| .120 - .240 | 3 - 6 | FA-E | FA4-B*<br>*FFA4-B** | FA4-BB*<br>*FFA4-BB** | SEE TABLE NEXT•PAGE | 1/2<br>1 | 13<br>25 |
| .240 - .300 | 6 - 8 | | FA8-B | FA8-BB | | 3/4 | 19 |
| .300 - .400 | 8 - 10 | | FA10-B | FA10-BB | | 1 | 25 |
| .400 - .580 | 10 - 15 | FB-E | FB13-B | FB13-BB | | 1 | 25 |
| .580 - .800 | 15 - 20 | | FB19-B | FB19-BB | | 1-1/2 | 38 |
| .800 - 1.100 | 20 - 28 | FC-E | FC26-B*<br>*FFC26-B** | FC26-BB*<br>*FFC26-BB** | | 2<br>4 | 51<br>102 |
| 1.100 - 1.500 | 28 - 38 | | FC36-B | FC36-BB | | 2-1/2 | 64 |
| 1.500 - 2.000 | 38 - 51 | FD-E | FD48-B | FD48-BB | | 3 | 76 |
| 2.000 - 2.750 | 51 - 70 | | FD51-B | FD51-BB | | 4 | 102 |
| 2.750 -4.500 | 70 -115 | FD-E-N88X | FD64-B | FD64-BB | | 4 | 102 |

*When a choice of stone and shoe length is available, use stone and guide shoe closest to length of part to be honed.

## FOR•BOW REMOVAL & ALIGNMENT OF TANDEM LANDS•USE 1, 2, 3, 4

| DIAMETER RANGE | | 1 HONE BODY | 2 MULTIPLE HOLDER (2 REQ.) | 3 GUIDE SHOES | | | 4 HONING STONES | | LENGTH OF STONE OR GUIDE SHOES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MAX. QTY. | FOR ALL METALS ONLY | FOR USE WITH DIAMOND OR BORAZON STONES ONLY | MAX. QTY. | | | |
| INCHES | MILLIMETERS | | | | INCHES | MILLIMETERS | | | INCHES | MILLIMETERS |
| .120 - .240 | 3 - 6 | FB-E | FB-FA | 5<br>3 | FA4-B*<br>*FFA4-B** | FA4-BB*<br>*FFA4-BB** | 5<br>3 | SEE TABLE NEXT•PAGE | 2-1/2<br>3 | 64<br>76 |
| .240 - .300 | 6 - 8 | | | 4 | FA8-B | FA8-BB | 4 | | 3 | 76 |
| .300 - .400 | 8 - 10 | | | 3 | FA10-B | FA10-BB | 3 | | 3 | 76 |
| .400 - .580 | 10 - 15 | FC-E | FC-FB | 4 | FB13-B | FB13-BB | 4 | | 4 | 102 |
| .580 - .800 | 15 - 20 | | | 3 | FB19-B | FB19-BB | 3 | | 4-1/2 | 114 |
| .800 - 1.100 | 20 - 28 | FD-E | FD-FC | 4<br>2 | FC26-B*<br>*FFC26-B** | FC26-BB*<br>*FFC26-BB** | 4<br>2 | | 8<br>8 | 203<br>203 |
| 1.100 - 1.500 | 28 - 38 | | | 3 | FC36-B | FC36-BB | 3 | | 7-1/2 | 190 |

*When a choice of stone and shoe length is available, the FFA4- and FFC26- are more economical.

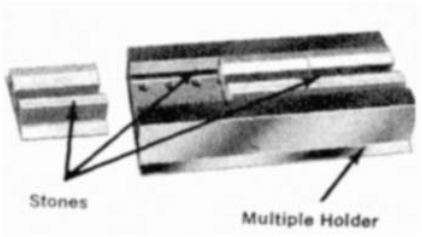
## STONES FOR EXTERNAL HONES

| DIAMETER RANGE inches | DIAMETER RANGE mm | HONE BODY *with MULTIPLE HOLDER* | HONE BODY (one stone reg'd) | FOR STOCK REMOVAL (Numbers listed with materials indicate approximate finish in microinches) Hard Steel* 10 Soft Brass 25 Cast Aluminum 25 | Soft Steel 15 Wrought Aluminum 25 Bronze 25 | Diamond Stones Carbide 20 Ceramic 40 Glass 70 | FOR FINE FINISHING (on previously honed parts) Hard Steel* 3 Soft Brass 12 Cast Aluminum 12 | Soft Steel 4 Wrought Aluminum. 12 Bronze 12 | Diamond Stones Grit 400 Carbide 7 Ceramic 20 Glass 30 | 600 3 15 15 | FOR POLISHING (on previously finish-honed parts) ALL MATERIALS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .120 - .240 | 3 - 6 | **FB-E** *with FB-FA* | **FA-E** | FA4-AA73 / FFA4-AA73 | FA4-AA75 / FFA4-AA75 | FA4-Z57 / FFA4-Z57 | FA4-AA93 / FFA4-AA93 | FA4-AA95 / FFA4-AA95 | FA4-Z87 / FFA4-Z87 | FA4-Z07 / FFA4-Z07 | FA4-CC05 / FA4-CC05 |
| .240 - .300 | 6 - 8 | | | FA8-AA73 | FA8-AA75 | FA8-Z57 | FA8-AA93 | FA8-AA95 | FA8-Z87 | FA8-Z07 | FA8-CC05 |
| .300 - .400 | 8 - 10 | | | FA10-AA73 | FA10-AA75 | FA10-Z57 | FA10-AA93 | FA10-AA95 | FA10-Z87 | FA10-Z07 | FA10-CC05 |
| .400 - .300 | 10 - 15 | **FC-E** *with FC-FB* | **FB-E** | FB13-AA73 | FB13-AA75 | FB13-Z57 | FB13-AA93 | FB13-AA95 | FB13-Z87 | FB13-Z07 | FB13-CC05 |
| .580 - .800 | 15 - 20 | | | FB19-AA73 | FB19-AA75 | FB19-Z57 | FB19-AA93 | FB19-AA95 | FB19-Z87 | FB19-Z07 | FB19-CC05 |
| .800 - 1.000 | 20 - 28 | **FD-E** *with FD-FC* | **FC-E** | FC26-AA73 / FFC26-AA73 | FC26-AA75 / FFC26-AA75 | FC26-Z57 / FFC26-Z57 | FC26-AA93 / FFC26-AA93 | FC26-AA95 / FFC26-AA95 | FC26-Z87 / FFC26-Z87 | FC26-Z07 / FFC26-Z07 | FC26-CC05 / FFC26-CC05 |
| 1.100 - 1.500 | 28 - 38 | | | FC36-AA73 | FC36-AA75 | FC36-Z57 | FC36-AA93 | FC36-AA95 | FC36-Z87 | FC36-Z07 | FC36-CC05 |
| 1.500 - 2.000 | 38 - 51 | *None Available* | **FD-E** | FD48-AA73 | FD48-AA75 | FD48-Z57 | FD48-AA93 | FD48-AA95 | FD48-Z87 | FD48-Z07 | FD48-CC05 |
| 2.000 - 2.750 | 51 - 70 | | | FD64-AA73 | FD64-AA75 | FD64-Z57 | FD64-AA93 | FD64-AA95 | FD64-Z87 | FD64-Z07 | FD64-CC05 |
| 2.750 - 4.500 | 70 - 115 | *N/A* | **FD-E-N88X** | FD64-AA73 | FD64-AA75 | FD64-Z57 | FD64-AA93 | FD64-AA95 | FD64-Z87 | FD64-Z07 | FD64-CC05 |

NOTE: If double length stone is used (FFA4- or FFC26-), you must use guide shoes with identical prefix. Example: Use FFA4-AA73 stone with FFA4-B shoe.
*Borazon CBN Stones are available for honing very hard materials such as High Speed Steels, 440C Stainless, Inconel 718, Nitralloy, 52100 Steel, etc.

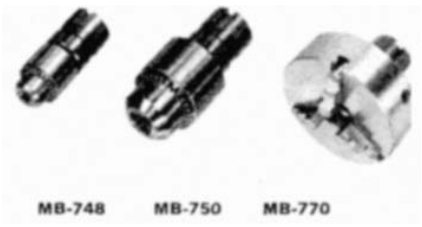
## EXTERNAL HONE ACCESSORIES

### MULTIPLE HOLDERS




For use on long work. Hold 2 or mom Honing Stones and Guide Shoes. Greatly increase "length of contact" of stone and guide shoe with the work. Essential for correct-ing rainbow or waviness. Require a Hone Body one size larger than normally used in any given diameter range. Not available for diameters over 1.500 in. (38 mm).

### ADAPTER CHUCKS




Fit Sunnen Honing Machine spindles. Hold work being rotated for external honing operations.

| PART NO. | DIAMETER RANGE INCHES | DIAMETER RANGE MILLIMETERS |
|---|---|---|
| **MB-748** | 0 - 3/8 | 0 - 10 |
| **MB-750** | 3/16 - 3/4 | 5 - 19 |
| **MB-770** | 1/8 - 5 | 3 - 127 |

### HONING OIL

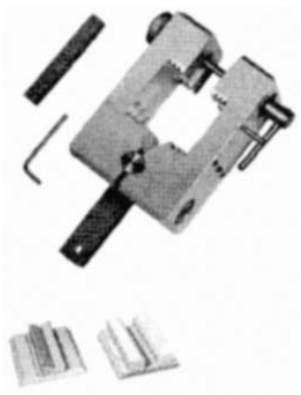
Use a continuous and ample flow of Sunnen Industrial Honing Oil for accurate, fast honing and the desired finish. Do not dilute the oil - Do not use lubricating oil, cutting oil, or water soluble oil - they will reduce cuting speed impair accuracy, and produce inconsistent finishes. Good, consistent results cannot be expected unless the proper oil is used:

**MB-30 HONING OIL**
5-gallons (18,925 liters) can . . . . . **MB10-5**

### POWER STROKING FINGERS

Four fingers without carbide pods are included with the KKN-700 Universal Honing Fixture for power stroking. For a replacement set of four fingers and four screws, order Part No. KKN-723A.

## EXTERNAL HONE SETS



Each set contains hone body, wrench, F-700 dressing stick, and two each of stones and guide shoes needed for stock removal and surface finishing. Ordering in Sets saves you approximately 10%.

| DIAMETER RANGE inches | DIAMETER RANGE mm | HONE BODY | HONING STONES FOR STOCK REMOVAL | | HONING STONES FOR FINISHING | | GUIDE SHOE (2 of each) | EXTERNAL HONE SET |
|---|---|---|---|---|---|---|---|---|
| 1/8 - 13/32 | 3 - 10 | **FA-E** | FA4-AA73<br>FA8-AA73<br>FA10-AA73 | FA4-AA75<br>FA8-AA75<br>FA10-AA75 | FA4-AA93<br>FA8-AA93<br>FA10-AA93 | FA4-AA95<br>FA8-AA95<br>FA10-AA95 | FA4-B<br>FA8-B<br>FA10-B | **F-1** |
| 13/32 - 13/16 | 10 - 20 | **FB-E** | FB13-AA73<br>FB19-AA73 | FB13-AA75<br>FB19-AA75 | FB13-AA93<br>FB19-AA93 | FB13-AA95<br>FB19-AA95 | FB13-B<br>FB19-B | **F-2** |
| 13/16 - 1-1/2 | 20 - 38 | **FC-E** | FC26-AA73<br>FC36-AA73 | FC26-AA75<br>FC36-AA75 | FC26-AA93<br>FC36-AA93 | FC26-AA95<br>FC36-AA95 | FC26-B<br>FC36-B | **F-3** |
| 1-1/2 - 2-3/4 | 38 - 70 | **FD-E** | FD48-AA73<br>FD64-AA73 | FD48-AA75<br>FD64-AA75 | FD48-AA93<br>FD64-AA93 | FD48-AA95<br>FD64-AA95 | FD48-B<br>FD64-B | **F-4** |

## NOTES

## NOTES

# data files

101 - Honing Bores With Keyways And Splines

102 - Honing Short Bores

103 - Honing Blind Holes

104 - Obtaining Specified Finishes By Honing

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106 - Honing Tandem Holes

107 - Making Manual Honing Easier With Workholders

108 - Fixturing Parts For Power Stroking

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112 - External Honing

113 - Fixturing Design Considerations For Automatic Krossgrinding® Machines

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The fully equipped Automotive and Industrial Technical Service Centers in St. Louis is available to help with any honing problem at any time without cost or obligation. Sunnen factory-trained Field Service Engineers cover the entire country and are always at your service - again, no cost or obligation. Call us whenever you have a bore-sizing problem.

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