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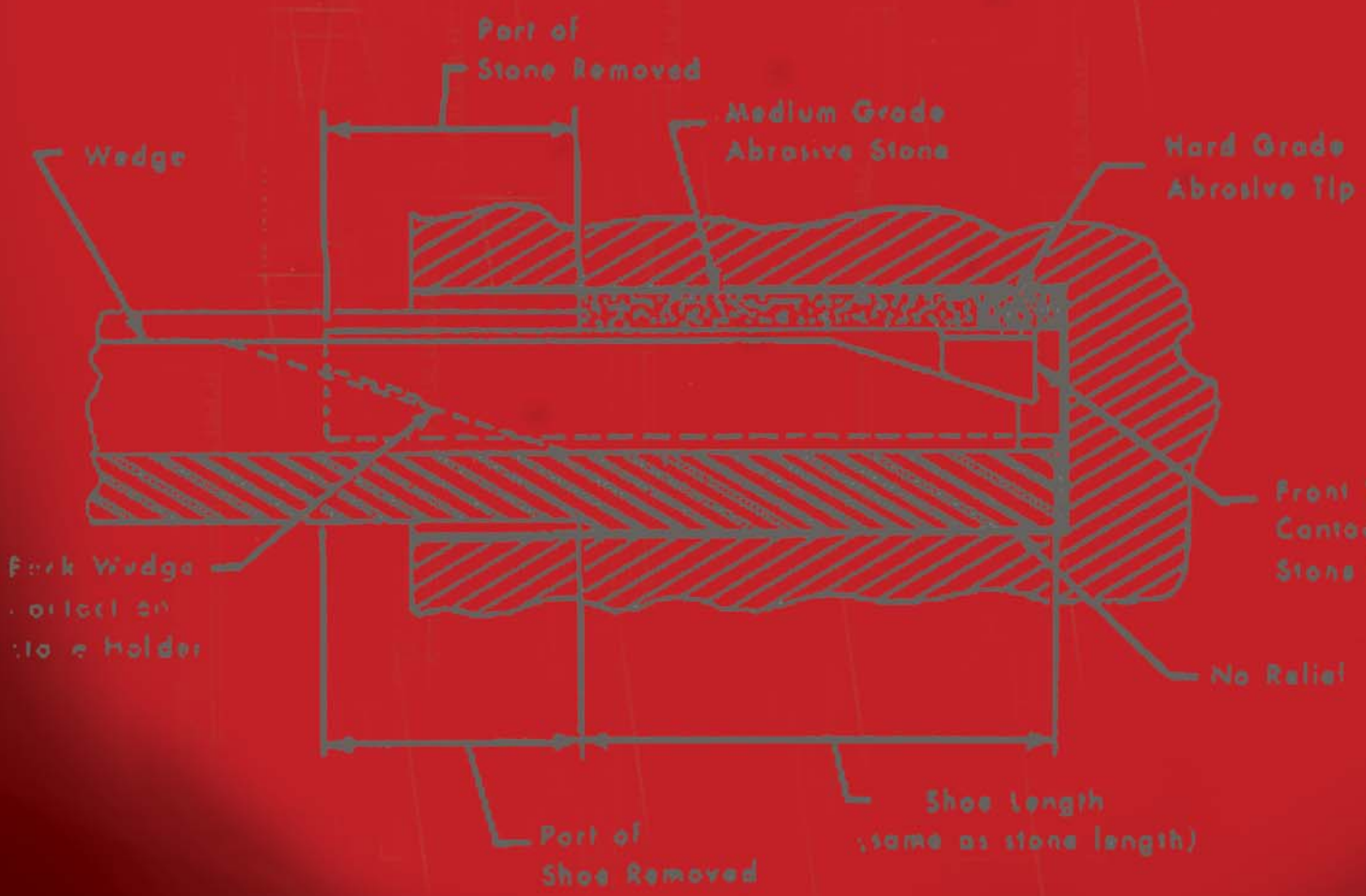
ABOVE AND BEYOND **HONING**

SUNNEN® HONING TECHNIQUES

DATA FILE: #103

HONING BLIND HOLES



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TECHNIQUES FOR HONING BLIND HOLES

WHAT IS A BLIND HOLE?

A hole or a bore having a bottom, a shoulder, or any kind of-a surface obstruction which would prevent a tool from going all the way through, is termed a blind hole *(see Figure 1)*. A blind hole may be "dead blind" or it may have some surface relief at the bottom. Sometimes a blind hole may appear to be "dead blind" but the tolerances for accuracy, finish or size may not be required to be held clear to the bottom of the hole. In the case illustrated, honing could be done quite readily, even though a taper condition might develop in the area where close tolerances are not required.

No one, who is responsible for production, tooling and machining, relishes a job of precision finishing blind holes by any available method -- be it boring, reaming, grinding or honing. With any kind of an abrasive tool, it is not feasible to produce an absolute sharp corner in the bottom of any bore. Some radius, however small, will always be present.

Many designs call for dead blind or shouldered (stepped) holes with no bottom relief, - sometimes without real need. Designers could be of great help to their colleagues in Methods and Production if they would always provide a relief in the bore's surface at the blind end of bore *(see Figure 2)*. It would greatly simplify the operation of honing (and other processing, too) as well as reduce over-all cost.

LIMITATIONS TO HONING BLIND HOLES

In most cases, blind holes can be finished satisfactorily by boning. As with any other machining process, there are always some limitations. There will be a radius of some sort in the bottom corner of the blind hole. The amount of this radius will depend on many things, such as the diameter of the hole being honed and the length of the bore, the type of material, the tolerances required, the condition of the hole prior to the honing operation and the amount of stock to be removed. Again, it cannot be emphasized too strong-ly that any relief, however slight, in the bottom surface of the bore will greatly facilitate the honing op-eration. There may be some fear that such a relief may weaken the part or set up stresses. While this relief should be as long as possible, it can be very shallow, so shallow in fact, that the relief disappears as finish size is reached.

DESIGN OF HONING TOOLS FOR BLIND HOLES

Many years ago, when Sunnen Honing was in the development stage, a large percentage of the automobile engine cylinders were blind bores, head and barrel cast integral. Naturally then, blind holes were of paramount importance and a consideration affecting the design of honing tools. Hydraulic brake cylinders, many having blind or shouldered bores were becoming standard automotive equipment, calling for blind hole tooling in the smaller diameters --- such tooling was designed by Sunnen.

Now let's take a look as to how the requisites of this blind hole honing problem has influenced honing tool design in general - and Sunnen tooling most specifically *(see Figure 3)*. Surely, it can be taken for granted that in some cases the bore will end up against a flat flush bottom, devoid of any relief. This allows no over-run whatever of the surface's end at the bottom of the bore. This concept then requires a tooling design, which will meet all the following fundamentals.

The bottoming ends of stone and mandrel must be flush so that the tool will be effective clear to the very bottom of the bore. Any pilot or nose on the mandrel must be sub-ject to removal by alteration without affecting the tool's precision or efficiency.

The stone raising wedge must not, as the stone expands, protrude beyond the mandrel's front end even when stone and mandrel shoes are worn down. The stone raising wedge must contact the stoneholder at two widely separated points to insure the stone's

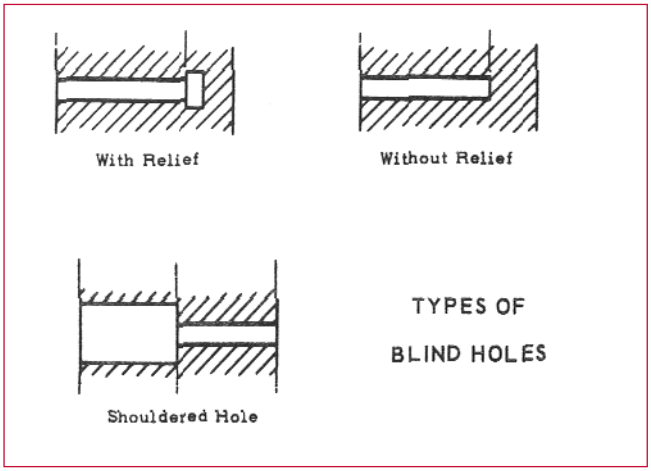


Figure 1, Types of Blind Holes

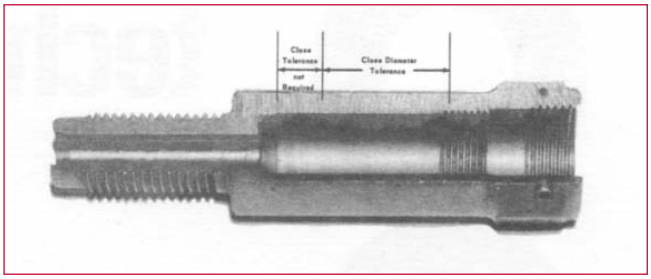


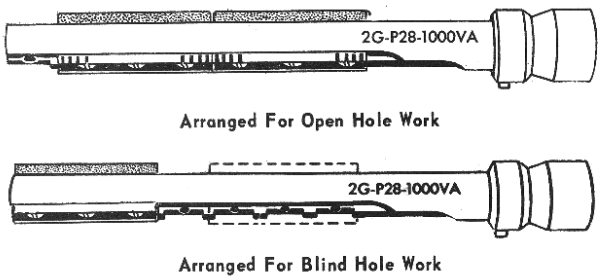
Figure 2, Bore Design

end to end stability -- even under variable loading pres-sures and position -- these separated, two-point supports being assurance against any longitudinal stone "tilting" or "rocking". The stones, in expanding, must not overhang the front end of the mandrel shoes.

The honing tool must have a three-point radial contact with the work bore to assure stability (like a three legged stool on an uneven floor.) of the work on the tool, maintained by the constant, set internal pressure of the expanding mandrel type of honing tool, maintaining this stability as the work radius increases with stock removal.

The radial three points of contact between the tool and work bore's surface must not be evenly spaced in relation to each other but must be spaced on the well known principle of centerless cylindrical genera-tion in regard to the direction of rotation of the tool within the work circle. This spacing quickly breaks up any out-of-round patterns in the bore with a minimum of stock removal.

Two of the three contact lines must be of metal or other bearing material, not readily perishable -- these two lines to be parallel to each other and to the work axis, thus in operation they will force the third con-tact line, the stone, which is slowly perishable, to always wear down parallel to the more enduring metallic mandrel shoes. This action automatically keeps the stone trued up in perfect alignment.



The replaceable shoe mandrels, (P28 series, 1'' diameter and larger) can be adapted for blind hole honing through the use of an R28 Wedge, R28 stones and blind hole guide shoes.

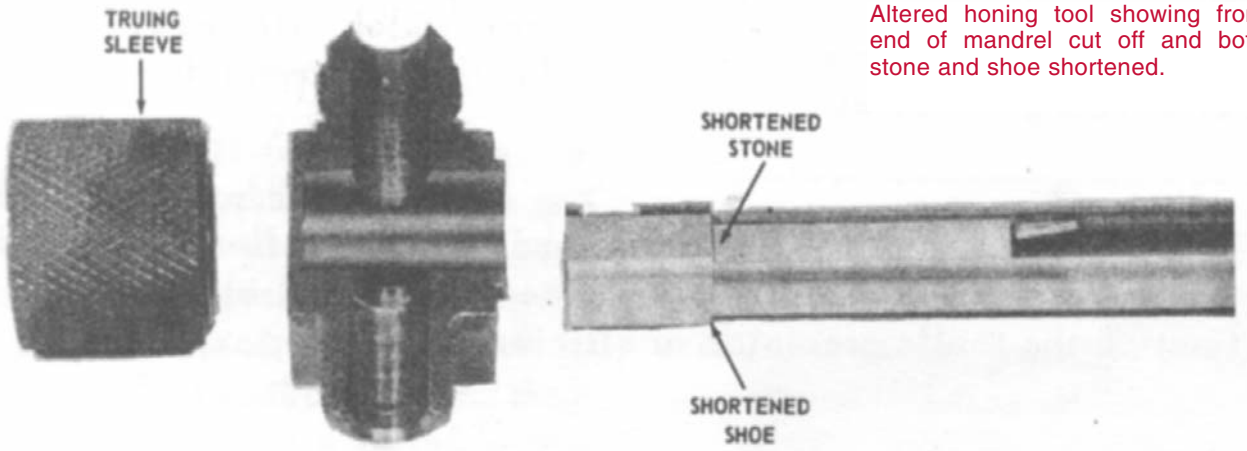
Figure 3, Honing Tools

The honing mandrel must be of a rigid material with very slow wearing metal shoes and the abrasive stone must be mounted on a rigid metallic holder, so that neither component can twist, rock, bend or weave during operation. The metallic stoneholder must be supported and actuated by a metal wedge through two divided and well-separated wedge contacts --near the front and back ends of the stoneholder. This, so as to prevent any tendency of the stone to rock under any variable fore or aft loading. The ac-tuating wedge must be precision machined and be fully supported lengthwise by the machined groove bot-tom in the rigid U section mandrel, preventing any wedge deflection from pressure.

ALTERATION OF STANDARD TOOLING

Because the great majority of honing jobs has long and open-through holes, Sunnen honing tools have been designed to provide the greatest honing length possible. In the smaller honing tools, K, L, and BL series, the mandrel's "nose" actually extends beyond the front end of the abrasive stone to act as a pi-lot when entering a bore. However, for blind hole work, this front-end tip must be cut off as illustrated *(see Figure 4)*. In the Sunnen "V" and "W" Series (over I" diameter) the mandrel itself needs no alteration. The use of a blind hole wedge, with blind hole stones and shoes, allows honing flush with the front end of the mandrel. The stone and shoes must be shortened from the back end for desired total length.

The stone length and the guide shoe length should be from 2/3 to 3/4 of the bore length. If alteration is necessary, the stone can be shortened by cutting



Altered honing tool showing front end of mandrel cut off and both stone and shoe shortened.

Figure 4, Altered Honing Tool

through the abrasive only with a hacksaw blade and breaking off the unwanted stone. The mandrel shoes may be turned, ground or filed away to provide the desired length.

Altered honing tool showing front end of mandrel cut off and both stone and shoe shortened.

Some assistance can be provided for honing a dead blind hole by using a "hard-tip" stone. This stone is manufactured with a tip of harder abrasive; to counteract some of the excessive wear it is exposed to.

For a small number of parts, alterations such as these can be made in your plant (except for Hard-Tip stones). However, when larger quantities are required, they can be supplied (altered) from the factory *(see Figure 5)*.

HONING TECHNIQUES

It is logical for any experienced engineer or machinist to recognize the fact that even with the best of equipment, blind holes are more difficult to process than are open holes.

The fundamental principle of precision honing is that to get a straight bore the honing tool must be straight -- in a blind hole this means the honing tool (shoe and stone) must be straight, clear down flush to its front (bottoming) end. Not only must the stone and the shoe be kept straight but they also must match the work radius to maintain stability. One rule to follow that will be of great help in honing blind holes is -ALWAYS KEEP THE AREA NEAR THE BOTTOM OF THE BORE SLIGHTLY LARGE UNTIL FINAL FINISHING STAGE IS REACHED.

The first thing to do is to free the bottom of the hole of any choke" and keep it that way. Blind hole honing always has a tendency to wear down the front end of the stone. Dressing the stone down on its back end with an abrasive stick, to keep it will not keep the honing unit straight for level with the front end long. The front end of the shoes will then also wear down. To prevent this condition always use a short truing sleeve and keep reversing the sleeve. Use it from the back and only occasionally run it clear over the front end of the stone and shoe. This will tend to keep both stone and shoes slightly full at the front end. For rapid truing with the sleeve, use some fine loose abrasive grits dusted on to the wet honing tool, then true with the honing oil turned off.

In honing open holes the approved technique is to make the work keep the shoe and stone straight and parallel (trued up) and to limit the required use of a truing sleeve. The truing sleeve, which is a dummy workpiece, when used in open hole honing, can be of a Honing Tool is kept true with full standard length, somewhat longer than stone and shoe. In honing blind holes it becomes essential to make use of a truing sleeve more often. However, for blind hole work the sleeve must be of just the right length compared to work bore's length. As a rule it should be approximately the same length as the hole being honed. Also, it is important that the diameter of the truing sleeve be very near to the diameter of the work. This requires replacement of the truing sleeve whenever the diameter becomes enlarged *(see Figure 6)*.

A "hard tip" stone will help in honing dead blind holes, but it is by no means a cure-all (see previous description). In addition to a possible "choke" left in the bore's bottom by previous machining, another cause of undue wear on the front of the honing unit is the difficulty of washing the abrasive grit and chips out clean from the bottom of a blind hole. A

Sketch shows altered mandrel and hard-tip stone in dead blind hole.

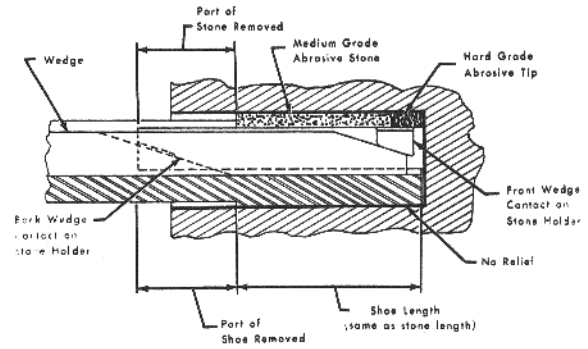


Figure 5, Altered Mandrel

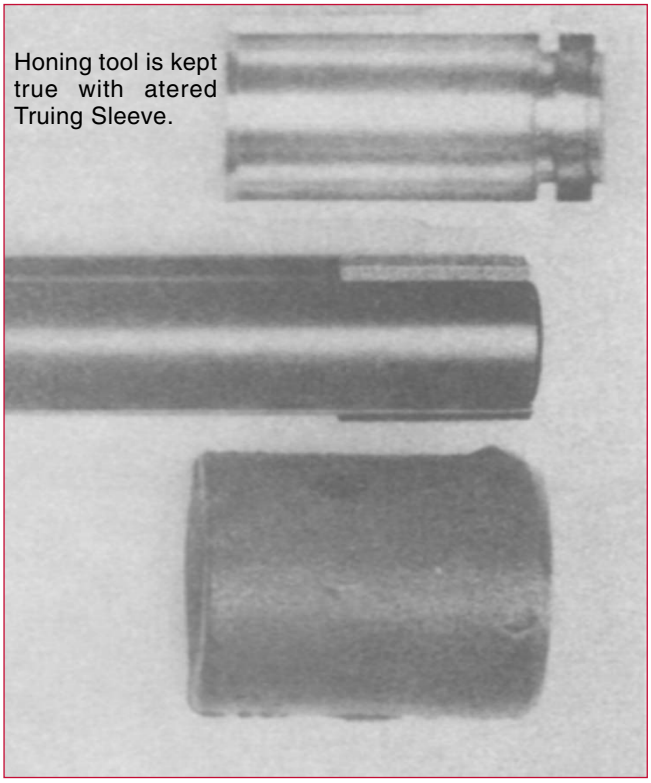


Figure 6, Altered Truing Sleeve

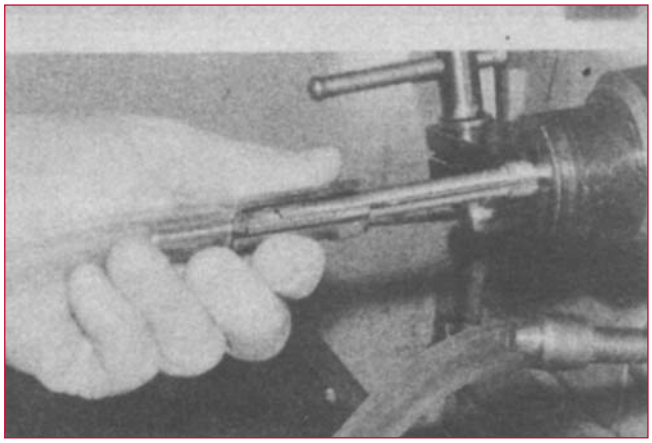


Figure 7, Honing Oil

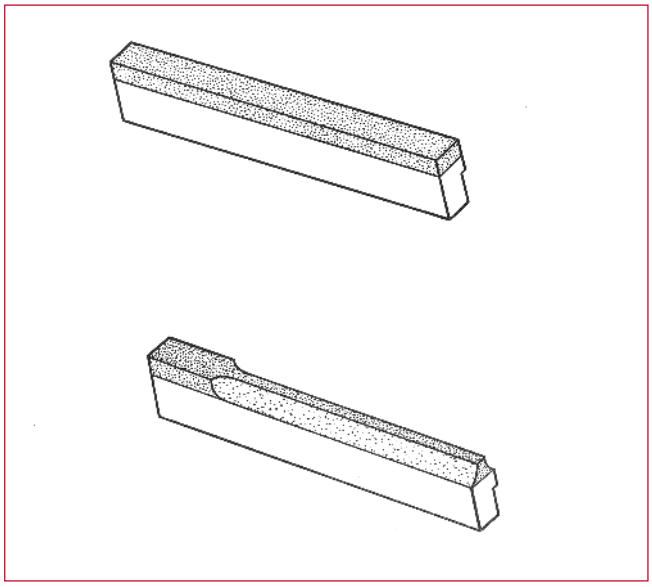


Figure 8, Stroking Technique

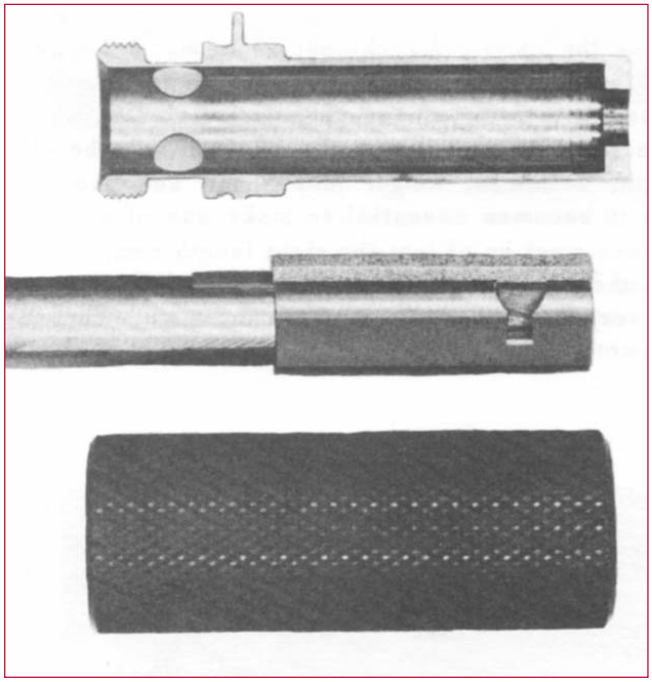


Figure 9, Stone & Mandrel Alteration

good flow of honing oil into a blind hole is essential. Always take advan-tage of any opening or any pipe or tube fitting orifice near the work's bottom and force the coolant into the blind end of the bore through this orifice with a flexible tube connection *(see Figure 7)*.

While Hard-Tip stones are available from the Sunnen plant on special order, a "customer made" alteration can achieve the same result. Select a stone considerably harder than one normally used for the job. As the illustration shows, leave the "tip" full width but make the remainder of the stone narrow by beveling from both sides with the LBN-700 dresser. Remaining stone should be 1/2 of original width. This will give the same effect as a hard-tip stone *(see Figure 8)*.

STROKING TECHNIQUE

Operators experienced in finishing blind holes develop methods of stroking which they vary to suit work conditions --with modifications this consists of a series of short rapid strokes at the bottom, alternating with an occasional stroke part way out the mouth, thus keeping the bottom slightly large until near finish size - then finish straight. -One word of caution: If an operator gets too enthusiastic about keeping the stone and shoe high at the front end of the tool he will soon find that he is generating a slight barrel shape in the work, larger at the point where his short strokes end away from the bottom.

The above suggestions are based on honing blind holes that do not have any relief in the cylindrical surface at the bottom. Most designers now recognize that this job can be made much easier by providing a relief at the blind end and make this provision when designing the part. But if worst comes to worst" and design limitations do not allow a relief, with patience and perseverance, such dead blind holes can still be honed with Sunnen tooling, but require more time per hole and more operator skill. There will always be some radius, however small, left in the bottom corner.

Where sufficient relief is provided, to allow an over-run of the surface's end - the longer the relief the better - the blind hole honing becomes a relatively simple job *(see Figure 9)*. The honing unit (both stone and shoe) must still always be shorter than the bore length (about 2/3 the length of the hole) and the truing sleeve should be about as long as the hole. The truing sleeve should always be used as soon as any indication of bore taper develops. Where a groove type of relief is objectionable, designs often are allowed with what is called a "shadow" relief, a very shallow, sloping relief, only a few thousandths deep - calibrated to disappear as the bore reaches finished size.

Regardless of the type of relief provided in the bottom of a blind hole the relieved portion should have sufficient length to allow the honing tool's end to well over-run the surface to be honed. Proper bottom hole relief will often cut the cost of honing in half.

COMMON HONING PROBLEMS

It is frequently difficult to provide an adequate flow of honing oil to a blind hole. Lack of an oil flow in the bottom of this blind hole can greatly reduce cutting action, cause poor surface finish and a tapered hole. Some blind and most "shouldered" holes do have a smaller bore going completely through the part or have pipe-fitting orifices near the bottom. In these cases you may flow the oil into the blind end of the hole directly. Lacking a bottom, opening then be sure to direct the flow of oil parallel to the man-drel and directly into the mouth of the bore. Wash the bore clean frequently with the part removed from the mandrel.

Short, blind holes can frequently be honed, using the KKN-75 Die Honing Guide. When the parts to be honed have bores, which are relatively short, have lengths less than diameters and have a flat face at the open ends at right angles to the bore, the honing guide may be an asset to the honing operation. This guide will provide stability in honing a short hole, maintain the bore perpendicular to its face and pro-vide the use of convenient adjustable stroking stops. *(Honing Short Bores -- Data File No. 102)*

CONCLUSIONS

1. Pre-machining should be more accurate and less stock left for honing blind holes than for- open holes. Open hole work can be used to true the honing tool - blind hole work cannot.

2. There should be a relief provided in the bottom of the bore, the wider the better.

3. The shorter the blind hole the more difficult it is to obtain extreme accuracy.

4. The longer the blind hole the easier it is to hold a close tolerance.

5. The longer the blind hole the more difficult to obtain a fine finish unless cuttings and grit can be washed out clean all during the honing operation.

6. The length of the stone and guide shoe should be 2/3 to 3/4 the length of the bore.

7. The use of a truing sleeve, one of the right diameter and length, is essential to successful blind hole honing.

8. Always try to keep the area at the bottom of the blind hole slightly large until final finishing stage is reached.

9. If blind hole work can be re-designed to an open hole type - it always pays off, open hole work can be held to a closer tolerance.

10. Be sure tooling alterations are carried out as to both stone, Shoe and truing sleeve. Make stone and shoe approximately 2/3 to 3/4 as long as the hole, not counting the length of the relief.

NOTES

data files

101 - Honing Bores With Keyways And Splines

102 - Honing Short Bores

103 - Honing Blind Holes

104 - Obtaining Specified Finishes By Honing

105 - Choosing the Right Stone

106 - Honing Tandem Holes

107 - Making Manual Honing Easier With Workholders

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112 - External Honing

113 - Fixturing Design Considerations For Automatic Krossgrinding® Machines

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