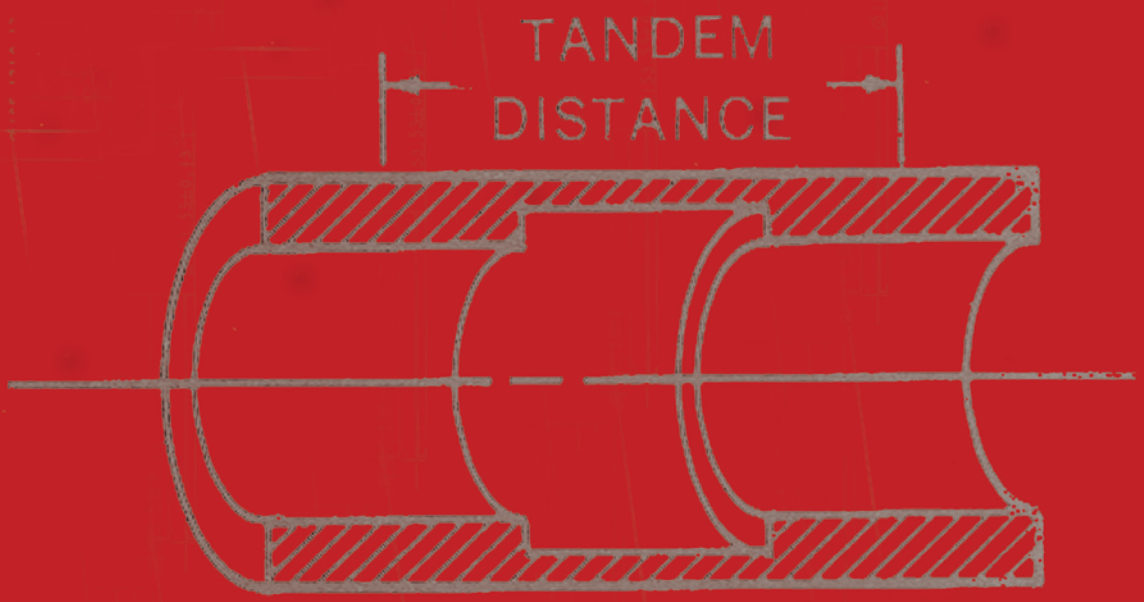
SUNNEN®

ABOVE AND BEYOND **HONING**

SUNNEN® HONING TECHNIQUES

DATA FILE: #106

HONING TANDEM BORES



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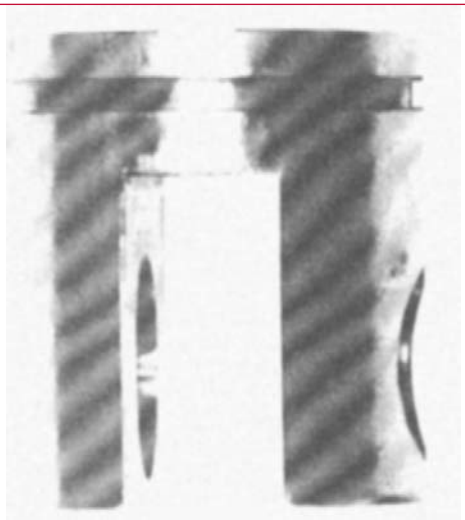
NOTES

HONING TANDEM AND MULTIPLE "IN-LINE" BORES

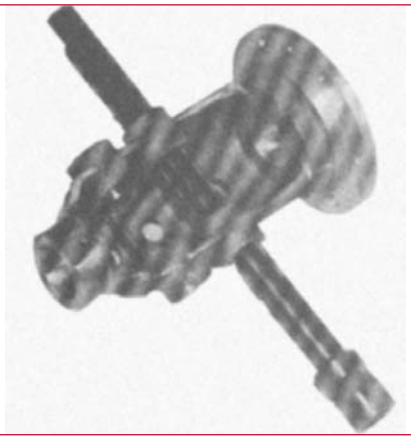
Note the six narrow lands widely spaced. Not only must the multiple bores be of exact diameter, but they must also be exactly in line.

Figure 1, Hydraulic Valves



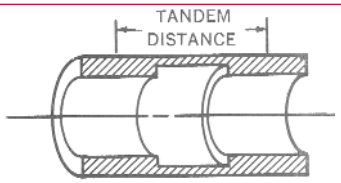
This piston is typical of parts that have tandem bores, and requires precision alignment of the piston pinholes.

Figure 2,Tandem Bore



.The four short cross bores have equal diameters, and were honed in pairs using standard tooling. The two large bores also have equal diameters and were honed together.

Figure 3, Unaltered Tooling



Tandem distance is the center to center length of two bores, as shown.

Figure 4, Typical Tandem Bore

TANDEM BORES ARE QUITE COMMON

One of the most important and useful of honing applications is the in-line honing of multiple spaced bores. A new common examples are journal bearings for revolving shafts, valve bodies for sliding hydraulic controls *(see Figure 1)*, and wrist pin holes in pistons *(see Figure 2)*. The problem is to get the tandem (or "in-line") bores to the same diameter and in perfect alignment, without bellmouth at the ends of the lands and without any binding when the mating part is inserted.

Some valve bodies will have bores with as many as six or eight lands spaced unevenly over the length. The lands may be less than a quarter-inch long, or more than a half-inch. Although not quite as common, some parts will have only two bores in line, with the bores having different diameters. This requires special handling and will be discussed later.

TANDEM HONING TECHNIQUE

Each individual bore or land offers the same problems as a single bore in an ordinary part. Sunnen honing tools will correct misalignment of tandem spaced bores and will maintain alignment while sizing the bores simultaneously *(see Figure 3)*.

STANDARD TOOLING. The need for tandem and multiple bore sizing with positive alignment influenced the basic design of Sunnen tooling years ago. The need has steadily increased with modern component design, hydraulic control valves being good examples. The majority of such jobs can be done with standard stock tooling, although some of this work requires alteration of the tooling to get the best *(see Figure 4)*.

When you have two in-line bores, tandem distance is defined as the distance from the middle of one land (bore) to the middle of the other land. If the standard honing unit has stone surface at least twice as long as the tandem distance, the standard honing unit will usually do the job. With a series of lands, if the lands and intervening spaces are nearly equal in length and the lands are not too far apart, the job can usually be handled with a standard honing unit *(see Figures 5 & 6)*. The several lands act as one long bore. Such designs are common to many hydraulic and pneumatic control valves.

There are many Sunnen honing tools that have long stone surfaces. As diameter increases, rigidity also increases and permits the use of longer honing surfaces. Standard stock tooling is available with from one stone length to five stones end to end, depending upon the diameter. Special honing tools can be made considerably longer for certain applications. It is usually more economical to use standard honing units whenever possible.

ALTERED HONING UNITS. If the stone length is less than twice the tandem distance, there will be a section midway of the stone and shoe that will fail to pass through either bore during stroking. This unused section will not wear down and will gradually form a "bump" that will generate bellmouth in the inside end of each bore.

In this case it is necessary to alter the honing unit so that it, too, is a tandem, with two spaced sections of honing surface. This alteration removes the unusable center section that would develop into a hump *(see Figure 7)*.

There are also occasional designs where the spacing and land widths are such that special honing tools are needed for most efficient production. When quantities are limited and the need to get the job hone is urgent standard tooling altered in your own shop can be the answer. On the other hand, if it is a production run with odd dimensions, it may be more economical to have factory alterations or to have special tooling made. Sunnen maintains a Special Products Department devoted exclusively to the design and manufacture of such tooling. Your Sunnen Field Engineer can help analyze your problem.

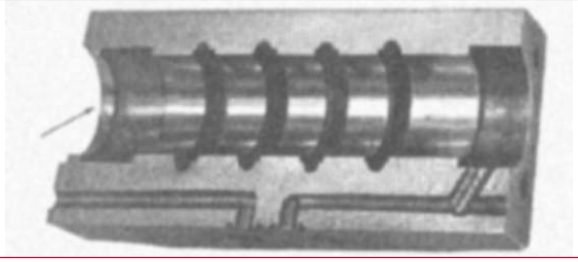
EXAMPLES OF TANDEM BORES

STANDARD TOOLING. *Figure 8* shows a tandem bore wit standard tooling (long stone type) being used. (The stone length - and guide shoe length - is more than twice the total tandem distance and there is no need for altering the tooling.)

Note that at the end of the outward stroke to the left, and the backward stroke to the right, one of the work lands overhangs the ends of stone and shoe while the middle section of both stone and shoe are well overstroked by the other work land. There is no unused stone section, and end for end work reversal of the part keeps the tool true. The tool and the work lands stay straight; and the bores are equal in diameter and in perfect alignment.

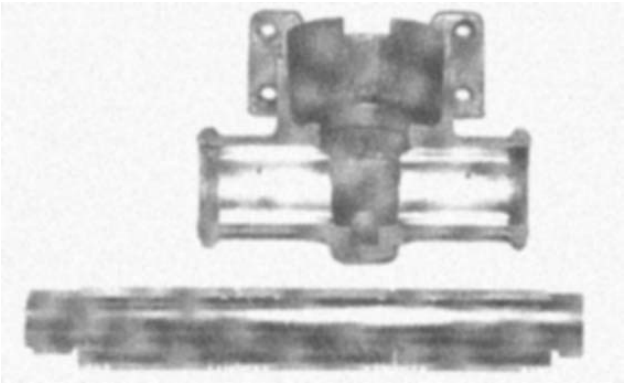
For the job illustrated, the tooling selection in *Figure 8* is efficient and economical. It assures long stone and shoe life with fast stock removal and high production rates.

There are exceptions; however, to the general rule that standard tooling is usually best when the stone length is twice the tandem distance. For example, if the two work lands are narrow and widely spaced stroking and reversing over a long stone surface will maintain size and alignment but can generate a slight bellmouth in the bore's ends, because the wide spacing makes it impossible to stroke over the entire stone length of the stone.



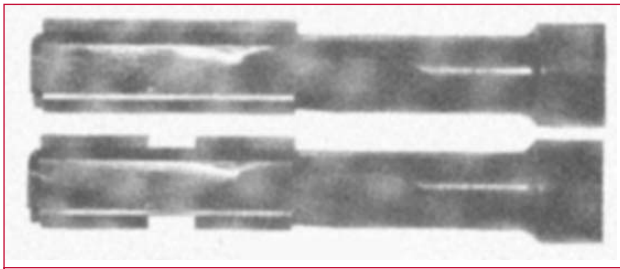
The narrow land indicated by the arrow (left) would have a tendency to go 'a few tenths oversize if it were stroked and reversed the some as the other lands in this valve body. Its smatter surface area is honed faster than the wide lands. As final size is reached, the part should be honed from the right end, with the narrow land only occasionally overstroked as needed to bring it to size and alignment.

Figure 5, Narrow End Land



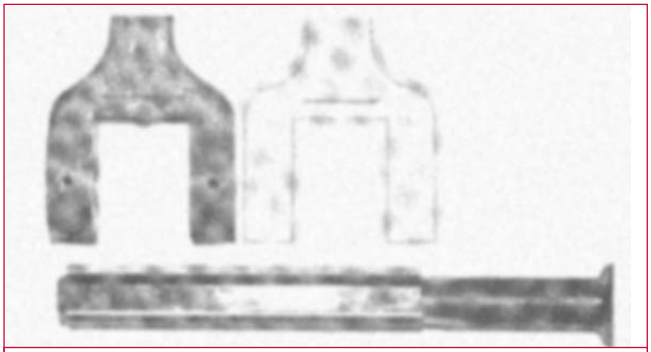
This type of work offers no problems. The honing too/ shown has enough stone length to meet the "twice tandem distance" requirement.

Figure 6, Long Tandem Lands



If stone and shoe length are not at least twice the tandem distance, the honing toot must be altered by cutting a gap from the center of stone and shoe as shown. Otherwise the center area would fail to wear down and the resulting hump would bellmouth the inside ends of both lands.

Figure 7, Altered Tooling



Many tandem bore jobs can be honed with standard honing tools.

Figure 8, Typical Tandem Bore

ALTERED TOOLING. *Figure 9* shows the same tandem bore with a standard honing tool (short stone type) altered to remove the center sections of both stone and shoes.

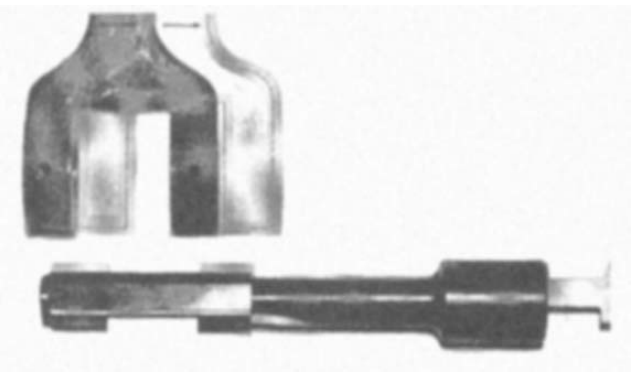
The workpiece in *Figure 9* is at the end of the outward stroke to the left. Both bores overhang the stone and shoe in that direction by half the land lengths or better.

The dotted part in *Figure 9* shows the same effect at the end of the reverse stroke to the right. Note that each end of the honing tool is overstroked by about half of the work land. The two short tool sections get equal use and wear and, as the work is reversed at intervals, they generate equal diameters in the work.

This method of altering and using short tooling produces tandem bore straightness, true alignment and controlled size. In the case illustrated in *Figure 9*, you will note the stone length before altering was considerably less than to alter the stone and shoe. The rule for such alteration is as follows: double the "tandem distance" and from that subtract the full stone length. The result is the length of material that must be removed from the center of the stone and shoes.

Any alteration to the honing stone's length must be matched by an identical alteration on the shoes. The surface of a stone in use will tend to parallel the surfaces of the shoes. If the stone overhangs the shoe, that end of the stone has a tendency to "build up". If the shoe overhangs the stone, the shoe end will build up and the stone end wears down. With either type of "build up", the accuracy of the work will be affected.

SPECIAL CASES ALSO CALLING FOR ALTERED HONING TOOLS. When several stones are used "in line" as in the honing unit of *Figure 6*, as each individual stone enters the ends of wide spaced work lands, and is put under pressure against the supporting wedge, the ends of the work lands will have a tendency to bellmouth very slightly. If the tolerance specifications will not allow the slightest bellmouthing, the honing tool should be altered to short stone and short shoe sections, in tandem.



In many cases a standard boning tool can be altered for use in tandem bores.

Figure 9, Different Tooling

For instance, the work illustrated in *Figure 3* had a tolerance allowance of half a thousandth, which permitted the use of long tooling. If the tolerance had been closer, say one or two tenths, it would be necessary to alter the tooling to a tandem. This, of course, would have slowed down the production rate, unless the parts were rough honed with long standard tooling and then finished with tandem tooling.

When standard tooling is of a single stone type and the stone is too short to alter into spaced tandem units, specially made tooling is called for.

TO SUMMARIZE:

1. If honing stone length is twice the tandem distance or longer, the honing tool can usually be used without change *(refer to Figure 8)*.

2. If stone length is less than twice the tandem distance, then the honing tool must be altered to remove the center from the stone and shoes *(refer to Figure 9)*:

Length of material to be removeled from center of stone and shoes } equals { Twice the tandem distance minus actual stone length

3. Certain unusual applications may require special honing techniques and perhaps special tooling as well.

EFFECT OF WORK MATERIAL HARDNESS

When tandem bores are of small diameter and are widely spaced, calling for long slender special tools such as that shown honing the bushings in the speed reducer motor's end plates, the work material's hardness is a consideration *(see Figure 10)*. The end plate bores have a common centerline when assembled. The bushings were, of course, concentric and slightly oversize on outside diameter for press fitting, and slightly undersize inside for in-line honing. During assembly to the motor frame, there could be a slight accumulated misalignment. Honing quickly corrected the misalignment and brought the bushings to size.

These bushings were of a material that required only a moderate stone pressure for honing. If such bushings were made of hard tool steel and also badly out of alignment requiring a high stone pressure for honing, and if considerable stock removal were also necessary, it would be possible for the mandrel to flex slightly under pressure. To avoid this condition, a softer bonded stone would have to be used which would cut with less pressure.

TANDEM BORES OF DIFFERENT DIAMETERS

There are two methods of honing two different diameters to size and alignment; with standard or altered tooling, and with special piloted tooling.

1. With standard or altered tooling (emergency or short run jobs). Hone the larger bore to desired size and bush it down to the small size with a hard, abrasive resistant material, Tandem hone the two equal diameters, then remove the bushing. This method has limita-tions where short lands are wide-spaced and very close tolerances are required.

2. With special piloted type tooling (production type jobs). Most Sunnen Honing Units have an unevenly spaced triangular contact with the work diameter, to generate the utmost ac-curacy in the shortest time with a minimum amount of stock removal. One corner of the triangle (the stone) can be expanded and con-tracted. The body or shank of the tool (mandrel) is never concentric with its work circle, and therefore cannot be piloted.

Sunnen has another type of tooling that can be piloted. This type is standard for large diameters and specially made for small diameters. It uses two opposed stones and two opposed centralizing shoes, generating a work circle concentric to the hone body, and therefore can be piloted. It is always made special for tandem work. The piloting must be substantial and resist axial deflection. Pre-machining should be accurate and stock removal by honing should be limited to just enough for generating a close tolerance and desired finish.

In honing a pair of tandem bores, always hone the largest one first and pilot from it to bring the other bore to size and in line.

Often, work designs containing tandem bores specify two different diameters just to make component assembly somewhat easier. The design can sometimes be changed to a common diameter tandem, to facilitate precision in-line production sizing by honing.

TRUING SLEEVES FOR TANDEM WORK

Honing with a standard mandrel has the advantage that a common, through bore type of truing sleeve can also be used if it has sufficient length; that is, a total length of from three-fourths to one and one-half the honing unit length. When the tooling is of a tandem type, then the truing sleeve must be twice the tandem length. Stock truing sleeves are often too short for such applications and special double land sleeves must be made. The tandem truing sleeve must have lands spaced to match the work.

HOW TO MAKE SPECIAL TANDEM SLEEVES

Special tandem sleeves for use when honing parts having wide spaced lands, can best be made by making two bushings and pressing them into the ends of a tube having the total length of the work, each spaced bushing to be as long as the work land. The bushing ID's should be made slightly undersize and then sized and trued up by honing after being pressed into the tube. Reverse the sleeve frequently during the truing process.

TRUING SLEEVE USAGE

Now and then the question comes up as to just how to get the best use out of a truing sleeve. Doing a lot of honing in the sleeves to "wear in" the stone and shoe soon makes the truing sleeve oversize - out of radius with the work diameter - and the sleeves are worn out.

The answer is - don't do - any more honing than necessary in a truing sleeve. Once a truing sleeve is honed to near work diameter and has been kept straight by honing reversal and proper stroking, it can then be used as a straight edge to just "spot" high places on stone and shoe.

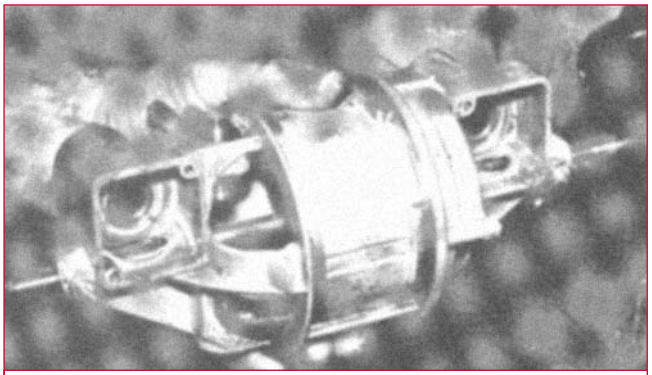
When it is necessary to true up a new stone or shoe, just barely dampen the stone surface by "dabbing" on a little oil. This will cause the truing sleeve to quickly glaze the stone on its high spots and polish the shoes on their high spots. Dress down the spots with a file and repeat until the stone and shoes are straight.

CONCLUSIONS

1. Standard tooling will do most tandem and in-line honing jobs, although it may require alteration.

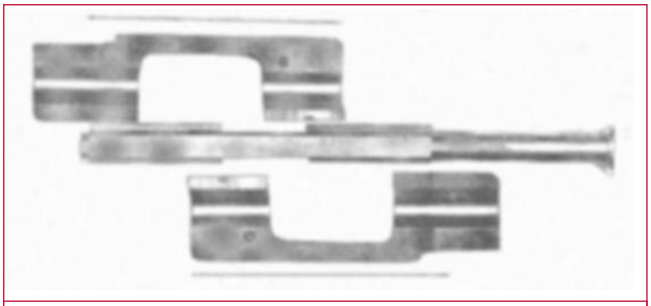
2. Hardness of work material, type of job, quantity, and tolerances influence tooling and stone selection.

3. When honing tandem bores of different diameters, both the tooling and honing technique must change.



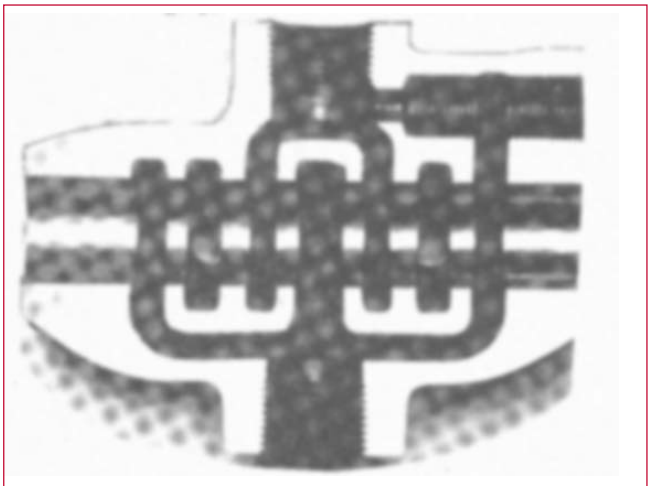
Small electric motor with speed reducer take-off has two 3/8" diameter armature shaft bushings, each 1-1/2" long with 6" center-to-center spacing. The tandem honing tool shown was espe-cially built for this job, since standard tooling in this diameter range does not have sufficient stone and shoe length to permit conversion into a tandem tool.

Figure 10,



This tandem bore part has one land a third longer than the other. The alteration of stone and shoe left a gap midway of their lengths, with both too/lands of equal length. Reversing the work end for end during honing will maintain size and alignment in the tandem bores.

Figure 11,



The multiple in-line lands of this hydraulic valve can be honed with standard through-hole, unaltered tooling, but may require a harder stone because the concentrated area of the narrow lands causes higher unit pressure on stone.

Figure 12,

4. Uniform wear is maintained on both ends of the stones and shoes by frequently reversing the work end for end, maintaining size and alignment in the tandem bores *(see Figure 11)*.

5. When tooling is altered, it will probably be necessary to alter the truing sleeve, too.

6. Special tandem tooling requires a special truing sleeve.

7. Improper truing technique will wear out a truing sleeve quickly.

8. Exceptionally narrow lands may require harder stones *(see Figure 12)*.

data files

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