Drive axles

SMCO-DA-1.1

Advanced Wheelend Technologies

TRAINING AND PROCEDURE SHOP MANUAL

" Optimum - Contact "

New method of repair for air brake cam-bushings

(CAN Pat. Pend. # 2,275,480)

(U.S. Pat. Pend. # 09/576483)

THE EFFICIENT AND DURABLE SOLUTION FOR HEAVY VEHICLE AIR BRAKE CAM-BUSHING MAINTENANCE

Optimum Contact is a patented method of repair.

The method and its related products are subject to international laws on patents and trade marks.

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INTRODUCTION

Every year, road safety regulations, specifications and vehicle maintenance practices are reviewed, modified and improved. Although many in the trucking industry disagree on the righteousness of these measures, all agree that these standards will only get tougher in the years to come.

The POLYMAX 2000 Optimum Contact method of repair shown in this manual is intended to help resolve most cam-bushing related problems, regarding heavy vehicle air brakes.

Problems like:

- Excessive brake chamber pushrod travel (when applying brakes).
- Premature and unequal wear of the brake linings.
- Insufficient adjustment of the slack adjusters.
- Road safety inspection compliance problems.
- Premature ware of the cam & bushing assembly.

Following Extensive study of the cause of all these problems, it became clear to us at POLYMAX 2000 that they are all related to excessive side-play of the " S " camshafts in their respective bushings. It became obvious that, due to the exaggerated initial side-play obtained when replacing the cam-bushings, the dust seals cannot perform properly and thus allow contaminants to enter the cam-bushing assembly and contribute largely to its rapid deterioration. Among these contaminants are water, dirt, sand, salt or calcium, and other abrasives. These are collected from the road or from cargo spillage. All these contaminants have different effects on the cam-bushing assembly.

Because of it's higher density, water seeps in the cam-bushing assembly and causes grease to float out of the assembly. That's why we usually find these cam-bushing assemblies to be dry (lube-free) when we lubricate them.

Although water seems to be gone from the assembly when it dries up, it leaves the other contaminants contained in it and they remain in the cam-bushing assembly. This dirt becomes a grinding compound and contributes largely to the wear and tear of the assembly.

The repair method discussed in this manual removes all side-play between the camshaft and its bushings. This enables the dust seals of this assembly to perform properly, preventing contamination of the assembly and preserving the lubricant in it.

CONVENTIONAL CAM-BUSHING SYSTEM

A FIT OF .020" TO .050" IS COMMONLY USED

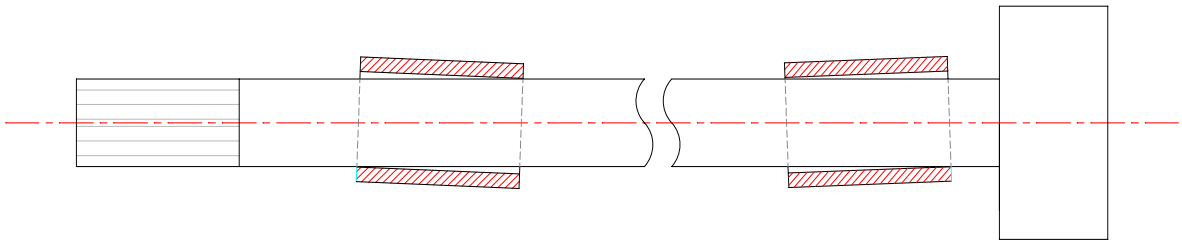


Fig. 1

It is necessary to provide plenty of inside clearance when manufacturing the cam-bushings in order to fit the camshaft regardless of any warping or bad alignment of the chamber bracket extension tube or the spiders due to loose fabrication tolerances or abuse. See fig.1 and 2.

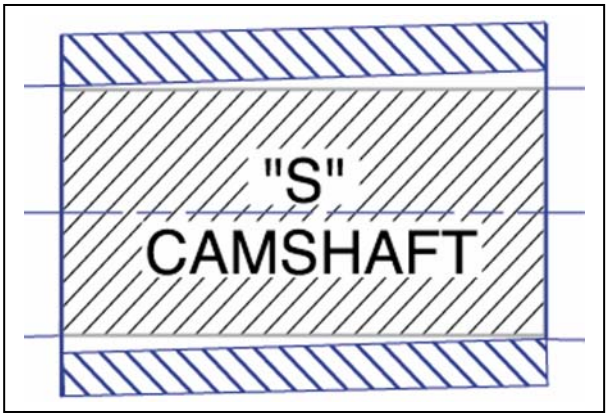


Fig. 2

Therefore, due to this loose clearance, we end up with a side-play of .020" to .050" right at the beginning of the cams service life. Sometimes the side-play seems to be less than .030" but that is only because the cam-bushings are offset in their bores and take up most of the slack in the bushings (see fig. 2). In this case, only the very tip on the side of the bushing is in contact with the shaft reducing play, and since all the friction pressure is concentrated in this very narrow spot, the cam-bushing will wear out very quickly until the shaft touches all across the bushing. We rapidly end up with a lot of slack.

HERE IS WHY THIS CONVENTIONAL METHOD OF REPAIR CAUSES PREMATURE WEAR OF THE CAMSHAFT AND THE BUSHINGS

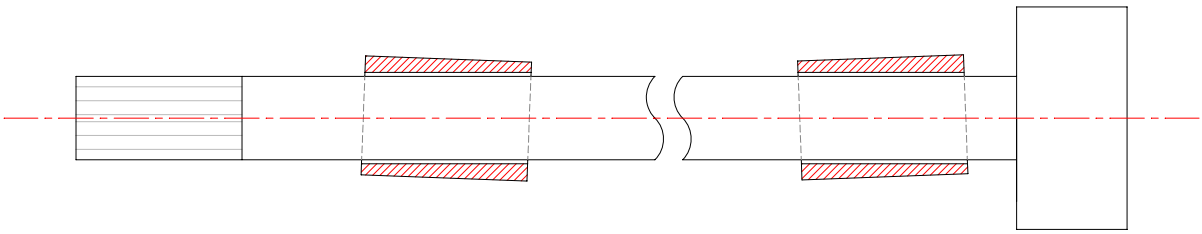
Ideally, dust seals can only allow a maximum side-play of .004" before they start letting water, dust and other contaminants in the cam-bushings. Water is heavier than petroleum grease and sets at the bottom of the assembly causing the grease to float its way out of the cam-bushings, leaving the abrasives and contaminants working in a grease less environment. This allows both the camshaft and cam-bushings to wear very rapidly. In a very short time, enough side-play is attained to cause many additional problems.

HERE IS A LIST OF PROBLEMS CAUSED BY EXCESSIVE SIDE-PLAY OF THE "S" CAMS AS THE CAM-BUSHINGS WEAR OUT:

- The more slack there is, the more water and contaminants get in the cam-bushings.
- Tests have shown that with only .035" play, the automatic slack adjusters' adjustment capacity starts to decrease rapidly.
- Brake chamber pushrod travel gets longer as the slack adjusters react less to their adjustment levers' action.
- Added friction in the cam-bushings reduces available power transmitted to the brakes
- Premature wear of the lower brake lining due to continuous friction in the brake drum after releasing the brakes.
- Damage to the rollers on the brake shoes caused by the percussion in the cam-bushing.
- Overheating of the brake components and the wheel bearings.
- Oil seal failure due to continuous overheat.
- Brake stroke compliance failure during road safety inspections or routine inspections.
- Brake noise such as "humphing" or "honking" and "hissing".
- Rise of maintenance costs.

"Optimum Contact" CAM-BUSHING SYSTEM

HERE IS HOW WE HAVE SOLVED THE PROBLEM

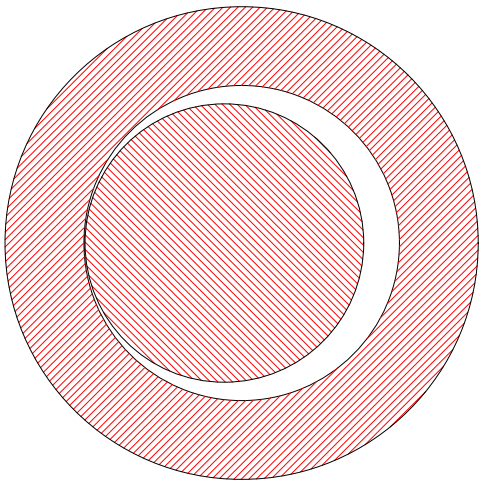


We have reduced the inside diameter of the cam-bushings, making them smaller than the actual camshaft size. This allows us to align-bore them after they are installed in their respective places. This excess material permits a perfect align-bore between the two cam-bushings enabling us to fit the camshaft with a very tight tolerance. See fig. 3.

After extensive testing we have come to the conclusion that a .005" clearance is ideal to prevent seizure at very low temperatures and to remove all side-play in the s-cam assembly.

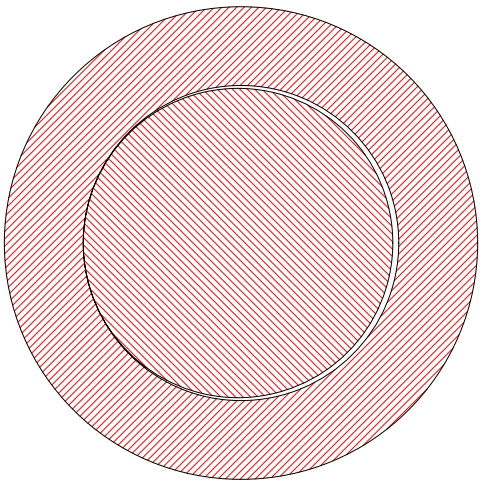
HERE IS WHAT WE GAIN BY USING SUCH TIGHT CLEARENCE IN THE CAM-BUSHING ASSEMBLY

REGULAR JOB



BACKLASH OF .20"
± 10% OF SURFACE CONTACT

"OPTIMUM CONTACT" JOB



BACKLASH OF .004"
± 40% OF SURFACE CONTACT

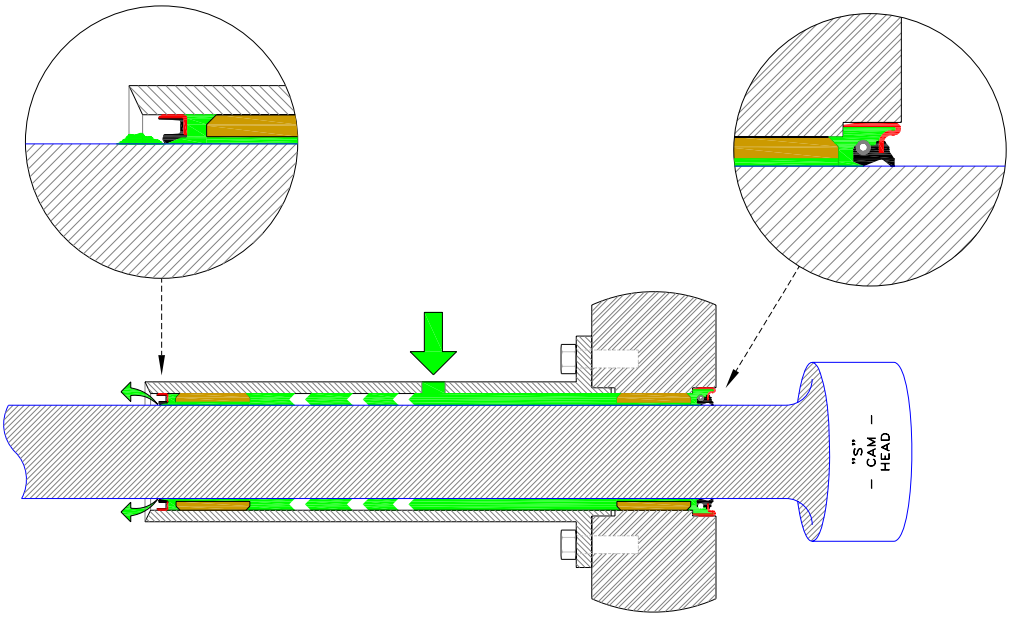
Figure 4

- ✓ Four (4) times more contact surface between the camshaft and bushing.
- ✓ Four (4) times more surface to distribute the friction pressure of the camshaft thus dividing the friction pressure by four (4).
- ✓ Four (4) times more material to wear out before any slack can be added.
- ✓ The grease filling the assembly acts as cushion between the camshaft and bushing and reduces friction in the assembly, and isolates the shaft from the bushing.
- ✓ This grease cushion eliminates all side-play of the camshaft in the bushing.
- ✓ Once side play is removed, dust seals can perform properly and keep the grease "in" and the contaminants "out" of the cam-bushing assembly.
- ✓ Bottom shoe will wear equally to top shoe adding 25% brake life to the brake shoes.
- ✓ Complete system runs cooler due to the absence of drag from the shoes.
- ✓ **"Optimum Contact"** bushings are made of a special bronze alloy to ensure maximum durability and prevent seizures at low temperatures
- ✓ **With "Optimum Contact" the camshafts and bushings will last at least 10 times longer than conventional cam-bushing systems ! ! !**

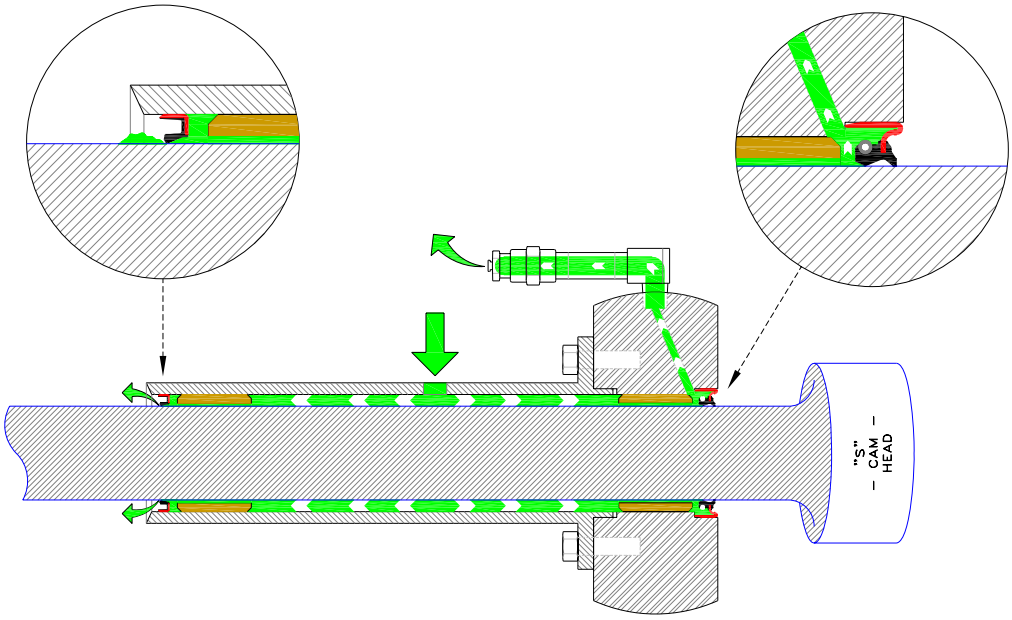
Drive axles supplement

Most drive axles use a spider bracket designed with a bolt-on tubular extension bracket, opposite the brake side, that supports the inner cam-bushing as well as the brake chamber mounting bracket. This design usually features a grease fitting mounted on the center of the extension tube, between the bushings.

This design fails to allow lubricant delivery to the outer bushing, because the grease seal at the brake side of this configuration is installed positively to prevent purge of the used lubricant into the brake foundation, preventing this purge by hydraulically locking in the grease also prevents flow of new lubricant to one side of the tube. The illustration below shows the flow path of the lubricant on such design configurations.



We have overcome this flaw by designing a purge system for the brake side of this foundation brake configuration to be installed as described in Service Bulletin # SBCO-102-DA.



" Optimum Contact " Cam-bushhing system

Installation procedure

STEP 1 : PREPARATION

VERY IMPORTANT

At this point we assume that all old brake components have been removed, including cam-bushings and grease fittings. Extension tubes and spiders have been properly cleaned and dried off if needed.

Cleanliness is essential to the success of this method.

Check the integrity of the spider & tube extension cam-bushing channels' inner bores. If there is no damage, we can proceed. If damage is present we must either repair the spider or replace it. **A loose cam bushing in the spider will not be tolerable for this method.**
The brake chamber holding brackets also need to be rust free and properly inspected.

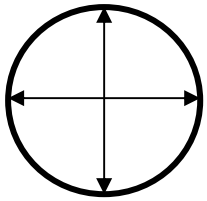
Common types of drive axles

	1a: Clean the spider bracket and remove any rust and dirt from the bushing channel, and the extension tube's bushing channel. Remove the grease fitting to allow proper cleaning of the grease channel and the bushing channel. Make sure that the seal cavities are clean on both components.
	1b: Inspect the brake spider for external damage as well as internal bushing channel integrity. Any damage in the bushing channel is unacceptable for this type of repair. If there is any damage you must rebuild the unit or replace it. Measuring the inner diameter of the bushing channel is the most efficient way to determine its integrity. Refer to fig. 4.1 for standard dimensions (page 10)
	1c: Verify the integrity of the extension tube. Check for cracks, especially near the welds at both ends of the tube. Measuring the inner diameter of the bushing channel is the most efficient way to determine its integrity. Refer to fig. 4.1 for standard dimensions (page 10)
	1d: Install lubricant purge relief valve as described in Service Bulletin SBCO-202-DA included at the end of this manual. Some axles may require installing cam bushings before this performing this procedure.

Prepare internal surfaces of the bushing channels to receive a sleeve locking agent by cleaning them with brake parts cleaner or other suitable solvents.

Measurements for cam-bushing channels

Size of camshafts used on axles	Dimensions of bushing channels
1-1/2" inch diameter	1.875" +/- .001"
1-5/8" inch diameter + Old Intraax 1-1/2"	2.000" +/- .001"



Be sure to take measurements both horizontally and vertically when checking bushing channels integrity.

Figure 4.1

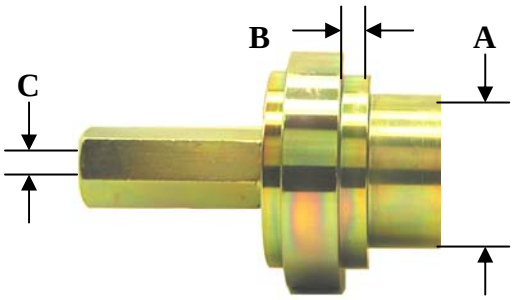
STEP 2 : BUSHING INSTALLATION

Optimum Contact bushings need to be installed in their respective channels using the necessary tools supplied with the system. A puller set is used to press the spider bushings in place for certain models.

Spider bracket thickness will vary with each different axle model and make.

There are three sizes of puller plungers to accommodate bushing installation for most popular models of 1-1/2" cams and another three for 1-5/8" cams. Here is a brief description of the six models supplied with the BDK-200 puller kit.

Bushing installation tool description



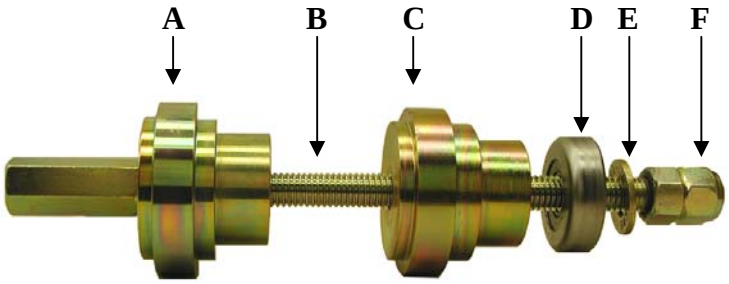
A: Bushing i.d. size or cam journal diameter

B: Bushing insertion depth shoulder

C: Thread size

Fig.5 ↑ Fig 5a ↓

Tool part #	Dimension A	Dimension B	Dimension C	In kit
RT-1500-250	1-1/2"	1/4"	5/8" X 11 U.N.C.	1
RT-1500-313	1-1/2"	5/16"	5/8" X 11 U.N.C.	1
RT-1500-375	1-1/2"	3/8"	5/8" X 11 U.N.C.	1
RT-1500-563	1-1/2"	9/16"	5/8" X 11 U.N.C.	Special order
RT-1625-188	1-5/8"	3/16"	5/8" X 11 U.N.C.	1
RT-1625-250	1-5/8"	1/4"	5/8" X 11 U.N.C.	1
RT-1625-313	1-5/8"	5/16"	5/8" X 11 U.N.C.	1
RTA-1500-250	1-1/2"	1/4"	Acme threads	Special order
RTA-1500-313	1-1/2"	5/16"	Acme threads	Special order
RTA-1500-375	1-1/2"	3/8"	Acme threads	Special order
RTA-1625-188	1-5/8"	3/16"	Acme threads	Special order
RTA-1625-250	1-5/8"	1/4"	Acme threads	Special order
RTA-1625-313	1-5/8"	5/16"	Acme threads	Special order

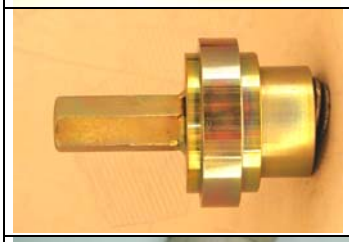


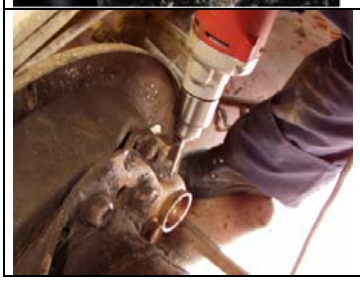
A	Bushing driver
B	Puller threaded rod
C	Centering flange
D	Thrust bearing
E	Tempered steel washer
F	Hexagonal drive

Fig.6

N.B. the pullers used in this procedure require proper maintenance like periodical cleaning and recommended lubrication intervals (see tool maintenance on page 32).

Step-by-step installation of the cam- bushings

	2a: Make sure the inner bore of the bushing channels are cleaned with brake parts cleaner or any suitable cleaner. **Apply a thin coat of sleeve locking agent in the spider bushing channels.**
	2b: Using a marker, make a recognition mark on the side of the bushing to indicate grease hole location in the bushing (if it is required for the type of axle being retrofitted). This will facilitate grease hole alignment when installing the bushing in the spider.
	2c: Select the appropriate bushing driver according to the thickness of the seal cavity wall. (ex. most spiders have a 3/8" seal cavity , in which case you need to use the .375" shouldered driver). See fig. 5a
	2d: Insert both bushings onto the puller traction flanges. **Apply a thin coat of sleeve locking agent to the outer surface of the bushings.**
	2e: Drive the puller's threaded rod through the spider and the extension tube and insert the rod in the second traction flange. Apply each bushing evenly on both sides of the spider and extension tube. Turn clockwise to assemble the puller.

		2f: Keep turning the threaded rod clockwise until both bushings are well seated at the entries of their respective channels.
	2g: Using a ½" square drive impact driver wrench along with a 6 point hexagonal ¾" impact socket, drive the ¾" hexagonal drive of the puller's threaded rod clockwise until the bushing drivers flatten out on the spider bracket and the end of the extension tube.	
	2h: Once both bushing drivers have flattened out on either sides of the spider assembly, installation of the cam-bushings is complete. Remove puller from the spider assembly.	
	2i: Check for proper seating of the bushings inside the spider bushing channel and in the extension tube's bushing channel. Verify installation for proper grease hole alignment (where applicable) and good centering of the bushing inside the channel. Clean off any surplus of sleeve locking agent from the seal cavities and inside the tube extension.	
	2j: If procedure required to install bushings before iinstalling the purge tube, make sure that the purge hole is outside the outer side wall of the bushing and in the seal cavity. If all is O.K. the installation procedure of the spider bushing is complete.	

Installation of the spider bushing is complete.

Repeat steps of the above procedure until all cam bushings are in place.

Be sure to check all bushings for proper centering and grease hole alignment (where applicable).

Correct any defect in installation before moving to the next step.

Service bulletins are made available to all customers upon request and are sent with each bushing ordered when the bulletins are relatively new. Also, this training manual has been updated with all previous and the latest service bulletins (located at the end of this manual). The perforated features of this manual allow you to add new service bulletins to your personal manual so it is always updated.

Notes

EX: Rockwell 46,000 lbs. = RT-1500-563 bushing driver

STEP 3 : MEASURING THE CAMSHAFTS

Every camshaft used in this method of repair must be measured very precisely for its diameter at the bearing journals, and each marked with its own measurements. This will allow us to select the proper cutting tool to fit each camshaft perfectly into its respective cam-bushings. It is also very important that each be attributed to one set of wheels (it will help recognize which cam goes where if their sizes are different). Please note that quality camshafts have little variation in size and so , the same reamer is usually used throughout the job.

The required clearance between camshafts and bushings is .003" to .004" (thousandth of an inch).

For reamer selection charts refer to page 30 of this manual.

Step-by-step measurement of the camshafts

	3a: Clean and inspect camshafts visually for any apparent defects. One can use a degreaser or brake parts cleaner and a clean rag to achieve good results. In some cases one might need to blow dry, using compressed air.
	3b: Clean and inspect your digital micrometer, and calibrate it if necessary.
	3c: Using your digital micrometer, measure both bearing journals of the camshaft. During each journal measurement, rotate the cam 90 degrees to check for variations in size. Take the greater measurement of the two for each journal.
	3d: Using an ink marker, write the corresponding measurements of each journal on the camshaft. If both journals are of the same size, write only one measurement (e.g. if both journals are 1.492").

STEP 4 : Cutter selection according to cam size

Please refer to the cutter selection chart on **page 30** of this manual. This chart was designed to help you select the right cutter for each job. It is very important that all technicians respect these specifications in order to guarantee the proper results are achieved.

Once the cutter is selected, the align-boring procedure begins

DESCRIPTION OF ALIGN-BORING TOOL COMPONENTS

	Item A	Arbor
	Item B	Pilot shaft
	Item C	Sliding cone
	Item D	Reamer (cutter)

Fig.7

ASSEMBLED VIEW OF THE COMPONENTS

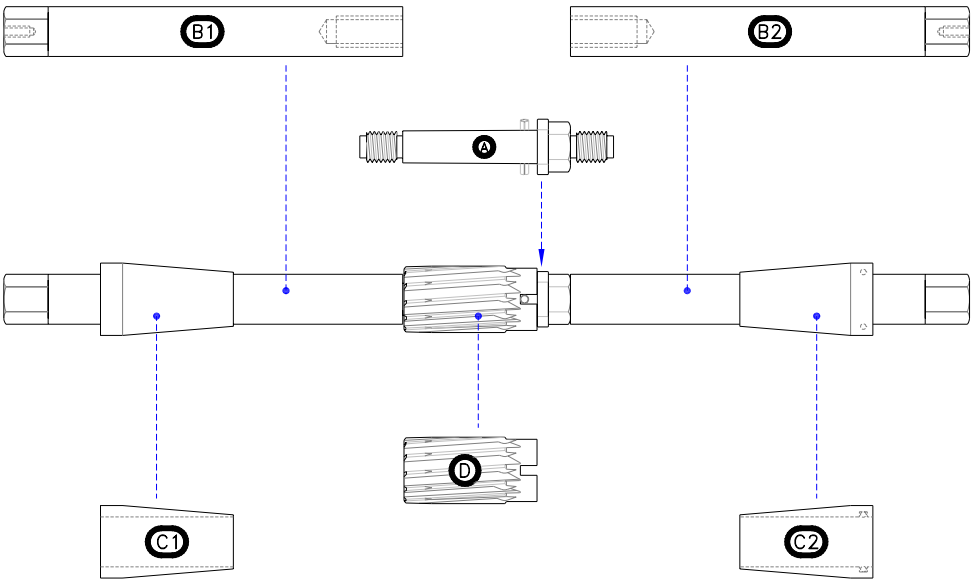


Fig.8

STEP 5 : ASSEMBLY OF THE ALIGN-BORING TOOL FOR DRIVE AXLES

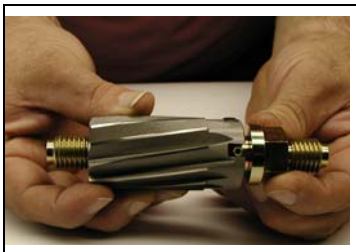
Assembling the tool to cut the spider bushing

Warning:

Make sure that all components are perfectly clean. The presence of metal particles or dirt can cause a misalignment of the reamer and may result in a tapered cut of the bushings. Also any dirt or metal particles in the bore of the shell reamer may result in breaking the shell reamer as it is tightened onto the arbor.

WARNING THE REAMER IS VERY SHARP AND MAY CAUSE INJURY, HANDLE WITH CAUTION !

Step by step assembly of the align-boring tool

	5a: Insert the shell reamer (D) you have selected according to shaft size onto the arbor (A) and slide it on the tapered shank of the arbor toward the drive pin. Apply pressure to engage the reamer's slot onto the drive pin to assemble both components snuggly together.
	5b: Then screw the arbor (A) into threaded hole of the pilot shaft (B1) and rotate the arbor clockwise until the frontal face of the reamer is fully seated on the corresponding face of the pilot shaft. Select pilot shaft length according to spacing between the bushings being cut. Refer to fig.8 for assembled view of tool.
	5c: Using two (2) 1" combined wrenches tighten this assembly to 10-15 ft. lbs. Torque. Then back of the pilot from the arbor and re-tighten by hand only. WARNING THE REAMER IS VERY SHARP PLEASE HANDLE CAREFULLY ! ! ! A clean shop rag will do fine.
	5d: Fasten a pilot shaft of equal or longer length to the back of the arbor on the threaded stud provided. Torque to 10-15 ft. lbs. Use the 6 point hexagonal drive of the arbor to torque the rear pilot shaft. The front pilot needs to remain hand-tight for easy dismantling during the align-boring procedure.

The tool is now ready to cut the cam-bushings

STEP 6 : ALIGN-BORING CAM-BUSHINGS ON DRIVE AXLES

Very important

Special note: All bushings with lubrication holes must be greased to prevent contaminating the lube pathways with metal debris produced while cutting the bushing. See service bulletin # SBOC-112

Align-boring of the spider bushing begins by entering the pilot shaft of the tool through the spider bushing, throughout the extension tube and the chamber bracket bushing. Then slide the "no-o-ring" cone onto the front pilot shaft of the tool, pointing toward the chamber bracket bushing until it is fully seated inside the bushing. Install the cone retainer (tool # CRP-1000) to secure the sliding cone in place. The cone will guide the pilot in it as the whole tool assembly is forced forward through both bushings until the reamer is fully seated in the spider bushing. The reamer centers automatically as it enters the bushing because of the tapered feature of its flutes (see fig. 9 below). A firm thrust forward along with a slow clockwise rotation is needed to align-bore the bushing.

The technician must make sure that the sliding cone remains snugly applied to the bushing at all times during these operations, if not, the centering of the pilot will be compromised. Note that the sliding cone is provided with an O'ring groove and for this particular use the O,ring is not required. Be sure to remove the O'ring if one is present in the cone. A SECOND CONE WITH O-RING IS USED IN ILLUSTRATION BELOW.

Hand driven toll configuration

We recommend the use of an 18-inch ratchet wrench with 1/2" square drive along with a 12-inch extension, at the end of which a universal joint is most important, and a 1" inch deep socket.

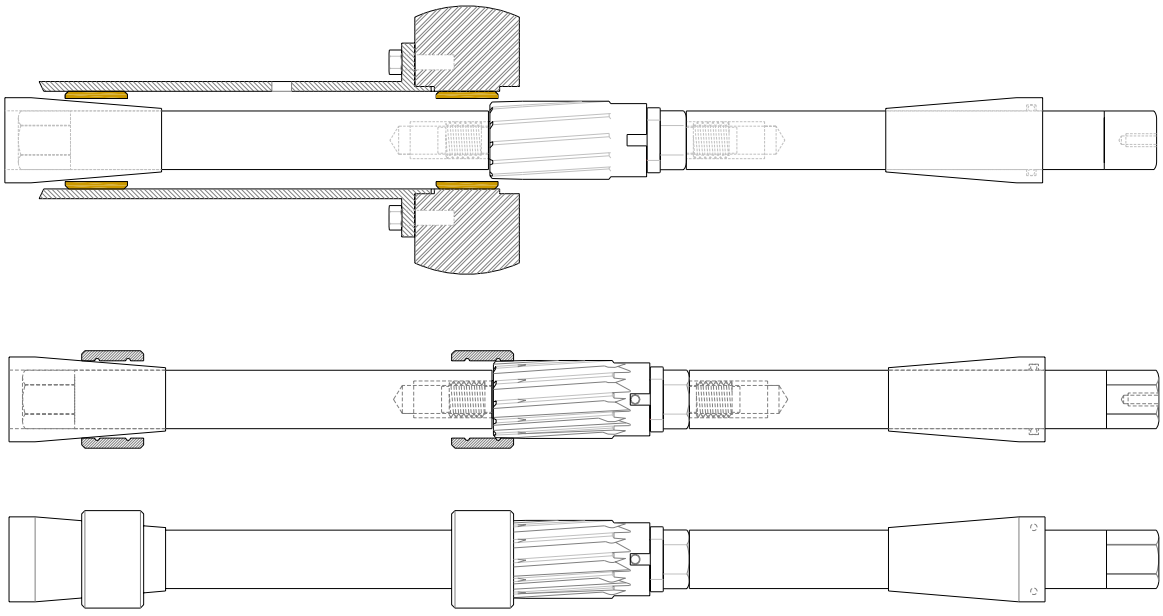


Fig.9

Align-boring the spider-mounted cam-bushing

Apply a gentle forward thrust to the wrench and start rotating the tool clockwise slowly, while keeping the extension and wrench as well aligned as possible with the align-boring tool. the cutter will vibrate slightly as long as the tapered entry feature of the flutes are making their entry into the cam-bushing. Once the finishing section of the flutes start cutting the vibration stops and the technician can apply a firm forward thrust on the tool. Continue this motion until align-bore is completed for the first bushing.

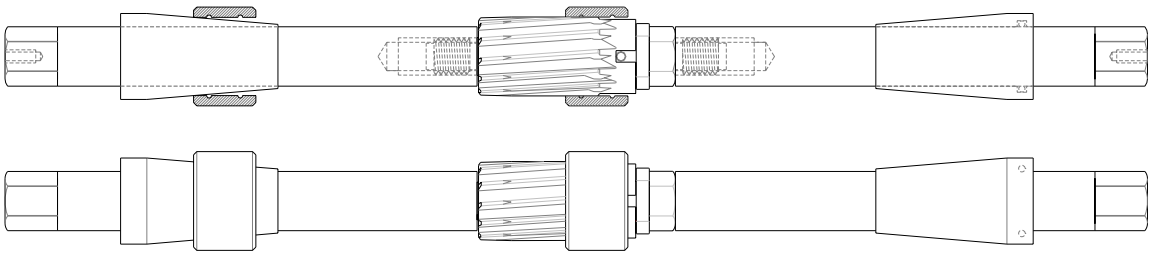


Fig. 10

Loosen the front pilot shaft while holding the arbor in place in the bushing that was just cut. Remember that the front pilot is only hand tightened for easy removal. Remove the cone from the front pilot shaft. Unscrew the front pilot shaft from the arbor. See fig. 11

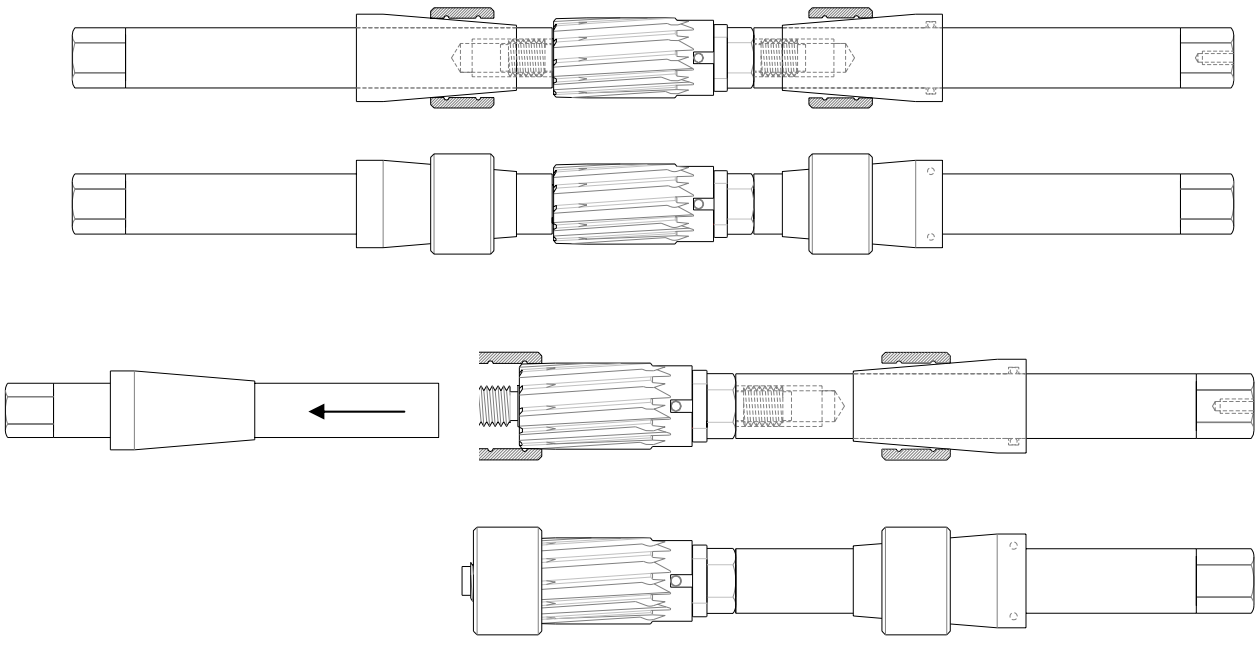


Fig. 11

Insert the sliding cone (with O-ring in inner groove) onto the rear pilot shaft with the narrow end in the facing the spider bushing. Push the cone close to the arbour (about 1 or 2 inches).

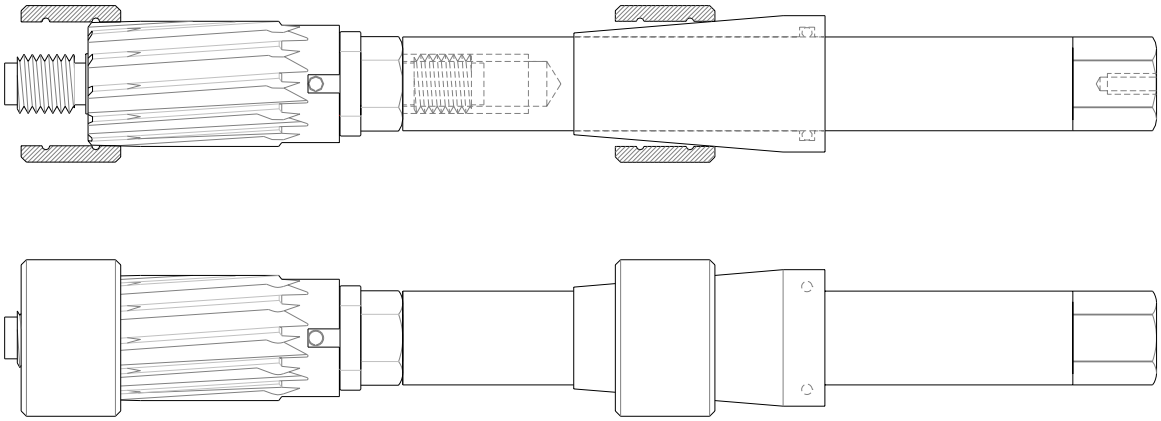


Fig. 12

Advance tool forward until the cone's narrow end is well seated in the spider bushing and the cutter's tapered edge in centred in the extension tube bushing. See fig. 12

Using the appropriate wrench (described on page 17), apply firm forward thrust and slow clockwise rotation to the tool until the extension tube-bushing cut is completed. Remove tool from spider assembly. See fig.13

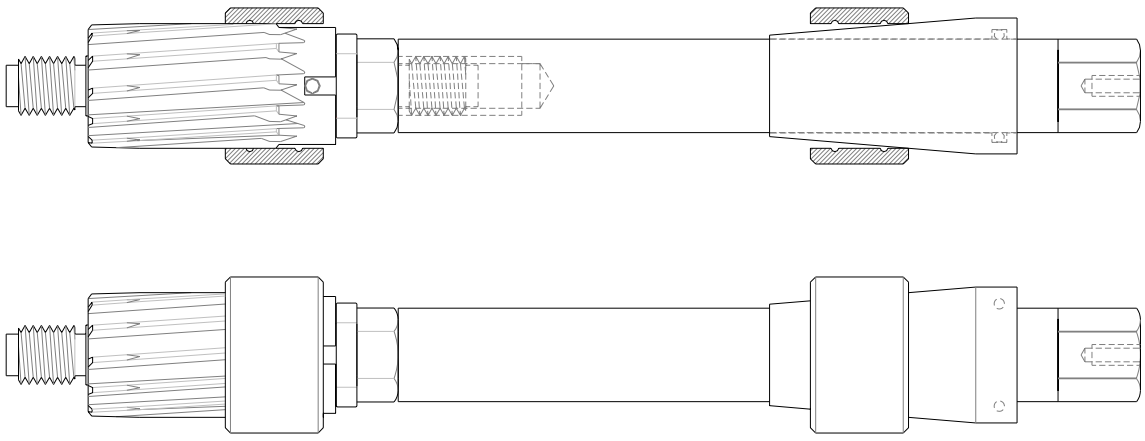


Fig. 13

VERY IMPORTANT

If backing out the cutter through the cut bushing

When removing the align-boring tool, it is very important that the sliding cone remain well seated in the inner bore of the cam-bushing.

Using compressed air clean the align-bored bushings and their grease holes. Clean all debris from the tool.

Some drive axle configurations are too compact and may present difficulties and / or obstacles interfering with alignboring tool pilot operation, rendering the Optimum Contact procedure impossible in place. In such cases the spider bracket must be removed from the drive axle and securely mounted in a vise to perform the procedure on a work bench.

If the spider assembly is equipped with only a single grease fitting in the extension tube (or brake chamber bracket) refer to service bulletin

SBCO – 202 -DA Breather installation on drive axles

at the end of this manual.

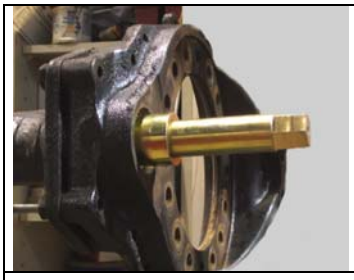
If the installation method described above does not fit the axle model you are working on, look for the proper service bulletin at the end of this manual.

Although most drive axles are built very similarly regardless of the suspension used, some axle designs may vary accordingly with some special applications, but most of the spider configurations are similar to the one discussed in step 6.

For a sequential description of this process please refer to the following step-by-step guide.

Step-by-step align-boring of the cam-bushings on DRIVE AXLES.

	6a: Make sure the bushings are well in place, that there is no damage to the inner walls of the bushings (especially where the cone and the flutes of the reamer contact the bushings, and that the whole assembly is clean.
	 6b: Insert pilot shaft of the tool through the spider bushing, throughout the extension tube and the chamber bracket bushing and push it forward until the pilot protrudes to the other side of the assembly.
	6c: Then slide the guiding cone (do not use friction O-ring in cone) onto the pilot shaft of the tool, pointing toward the chamber bracket bushing until it is fully seated inside the bushing.
	6d: Install the cone retainer (tool # CRP-1000) to secure the sliding cone in place. The cone will guide the pilot in it as the whole tool assembly is forced forward through both bushings until the reamer is fully seated in the spider bushing.
	6e: Apply forward thrust on the hexagonal drive on the pilot end of the tool to move it forward until the reamer is fully seated into the spider bushing. The reamer centers automatically as it enters the bushing because of the tapered feature its flutes (see fig. 9 on page 17).
	6f: Using the appropriate wrench (described earlier on page 17), apply firm forward thrust and slow clockwise rotation on the tool until the cut is completed.
	6g: Loosen the front pilot shaft while holding the arbor in place in the bushing that was just cut. Remember that the front pilot is only hand tightened for easy removal. Remove the cone from the front pilot shaft. Unscrew the front pilot shaft from the arbor.

	6h: Insert the sliding cone onto the rear pilot shaft with the narrow end in the facing the spider bushing. Push the cone close to the arbor (about 1 or 2 inches). It is preferable to use the friction O-ring in the cone to keep it centered during the rest of the procedure..
	6i: Advance tool forward until the cone's narrow end is well seated in the spider bushing and the cutter's tapered edge""s in centred in the extension tube bushing.
	6j: Using the appropriate wrench, apply firm forward thrust and slow clockwise rotation to the tool until the extension tube-bushing cut is completed.
	6k: Remove tool from spider assembly by first separating the arbour from the remaining pilot, and gently sliding out pilot from the cam-bushing assembly. VERY IMPORTANT When removing the align-boring tool, it is very important that the sliding cone remain well seated in the inner bore of the cam-bushing
	6l: Using compressed air clean the align-bored bushing and its grease hole. Pump a small amount of grease through the lube pathways of the bushings to remove metal debris. Clean all debris from the cam-bushing.

Repeat steps 6a through 6l for each wheel.

VERY IMPORTANT

If you must back out the cutter through the bushing you have just cut, DO NOT rotate tool counterclockwise. Rotate tool clockwise while backing out slowly, making sure that the sliding cone remains seated in the adjacent bushing to guide the reamer during extraction.
It is preferable to dismantle the tool outside the cam-bushing assembly to prevent removing the reaming tool backwards through the bushings.

Some drive axle configurations are too compact and may present difficulties and / or obstacles interfering with alignboring tool pilot operation, rendering the Optimum Contact procedure impossible in place. In such cases the spider bracket must be removed from the drive axle and securely mounted in a vise to perform the procedure on a work bench.

Dismantling the tool

	Step 1: Unscrew and remove the arbor (A) from the pilot shaft (B). If you are cutting the center bracket bushing to the same size as the spider bushing, go directly to step 7. If you are cutting to a different size follow all of the next steps.
	Step 2: Remove the cutter (D) from the arbor (A) by inserting the arbor loosely into a vise with the back of the cutter lying against the top the jaws of the vise, and with the forward stem of the arbor pointing upward.
	Step 3: Using a center punch and a 2 lbs hammer, Knock down the arbor through the cutter. To avoid any damage to the arbor and cutter insert the pointy edge of the center punch into the center point machined at the forward tip of the arbor. Hit with the hammer gently until arbor slides out from the cutter.
	Step 4: Separate all parts and clean them of all debris.

It is very important that all debris be removed from the bushings and that they be kept clean. If bushings with lubrication holes are being used, pump a small amount of grease in the cam-bushings to expel the metal debris left there from the align-boring procedure. Camshafts must also be clean. Any dirt or contamination will reduce durability.

STEP 7: CHECKING THE SIDE-PLAY OF THE CAMSHAFT

Insert a shim plate or spacer at the "S" end of the camshaft. Install the camshaft on the axle without any lubricant on either cams or bushings to be able to measure real slack of the cam-bushing assembly. Make sure this is done while seals and O-rings are installed.

Take extra care to handle the installation of the camshaft delicately to prevent damaging the inner bore of the bushings.

Once the cam is in place, check for proper seating of the spacer on the spider and then spin the cam rapidly by hand. Make sure that the cam spins freely through both bushings.

If the camshaft does not spin freely double-check for cleanliness.

If the camshaft is bent or distorted, it may be hard to spin it freely.

If the camshaft Is hard to insert through the inner bracket bushing, do not force it in because it may be bent or distorted. Try another cam of the same o.d. measurement and compare the fit.

We recommend that you verify the precision of your work, especially the first few jobs ! Once you are well experienced with the method, double-checking is less critical.

This procedure must be performed while O-rings and dust seals are not yet installed and without grease.

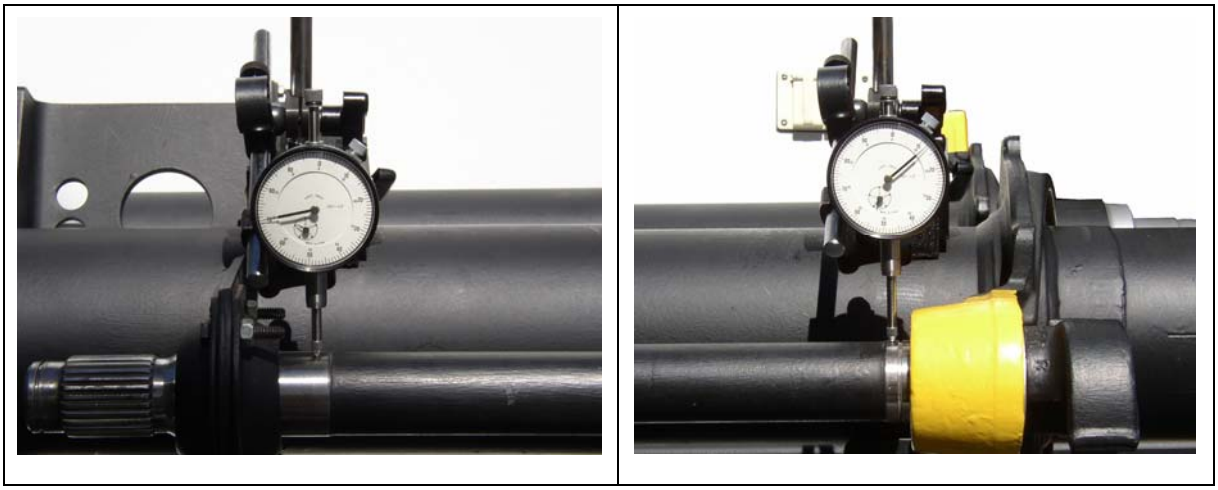


Fig. 14

Using a magnetic based dial indicator gauge, measure the side-play of the camshaft inside the cam-bushings. See fig.14

The reading you will get will differ from the clearance you initially fitted the bushing with. This is very normal, since no hole can be perfectly round and no camshaft can be perfectly round either.

This needs to be done before o-rings and seal installation or this will take up some of the slack.

A reading slightly inferior to the clearance you gave the assembly is to be expected.
FOR EXAMPLE :

- If the camshaft measures 1.492", and you selected the 1.497" reamer to cut the corresponding bushing, this will fit the camshaft with .005" clearance inside that bushing.
- Once you have measured the side-play with the dial gauge, you will see that the reading obtained is approximately .003" to .004".
- It is very rare to have .005" or .006" side play.
- If you get a reading higher than that of the clearance you fitted the bushing with, then you probably misplaced a camshaft and some other assembly will be too tight.
- If the assembly is too loose or too tight, restart align-boring procedure as needed to correct the situation until you set the right results.

The point in this double-check is to avoid giving too much clearance to an assembly, because this will allow dirt and contaminants to enter the cam-bushing assembly and waste the efforts we just made. If the assembly is too tight, the lack of space for lubricant will cause it to grip (seize-up).

If the assembly is too tight or too loose, it is more cost-efficient to start over now, as you won't need to remove all the wheels and brakes to repair that mistake.

We would like to remind you that the success of our method lies in the tight fit we give to the cam-bushing assembly. Clearance must remain between .004" and .006" to ensure that success.

Step 8: Installation of the seals

Seals and O-Rings are installed the same way they are regularly installed in a normal procedure. The one difference being that the "OPTIMUM-CONTACT" system comes with a special seal installing tool that will enable the technician to install these ordinarily "hard to install" seals in a snap, every time.

Seal installer tool description

A	**TE-900** 9" hexagonal percussion stub	
B	**RJ-1500** 1-1/2" seal installer flange	**RJ-1625** 1-5/8" seal installer flange
C	**TE-275** 2-3/4" hexagonal percussion stub	

Fig. 15

Spider dust seal installation

It is very important to install the spider dust seals in a way that they will allow grease to purge easily from the cam-bushing assembly.

The outer seal must be installed with it's sealing lip pointing toward the cam-bushing (positive installation), in order to keep the grease from entering the brake shoes and drum assembly, during lubrication, thus contaminating the brake shoes and drum.

The inner seal must be installed with it's sealing lip pointing outward from the cam-bushing (negative installation), in order to let the grease escape from the cam-bushing assembly during lubrication.

Figure 16 shows proper seal installation .

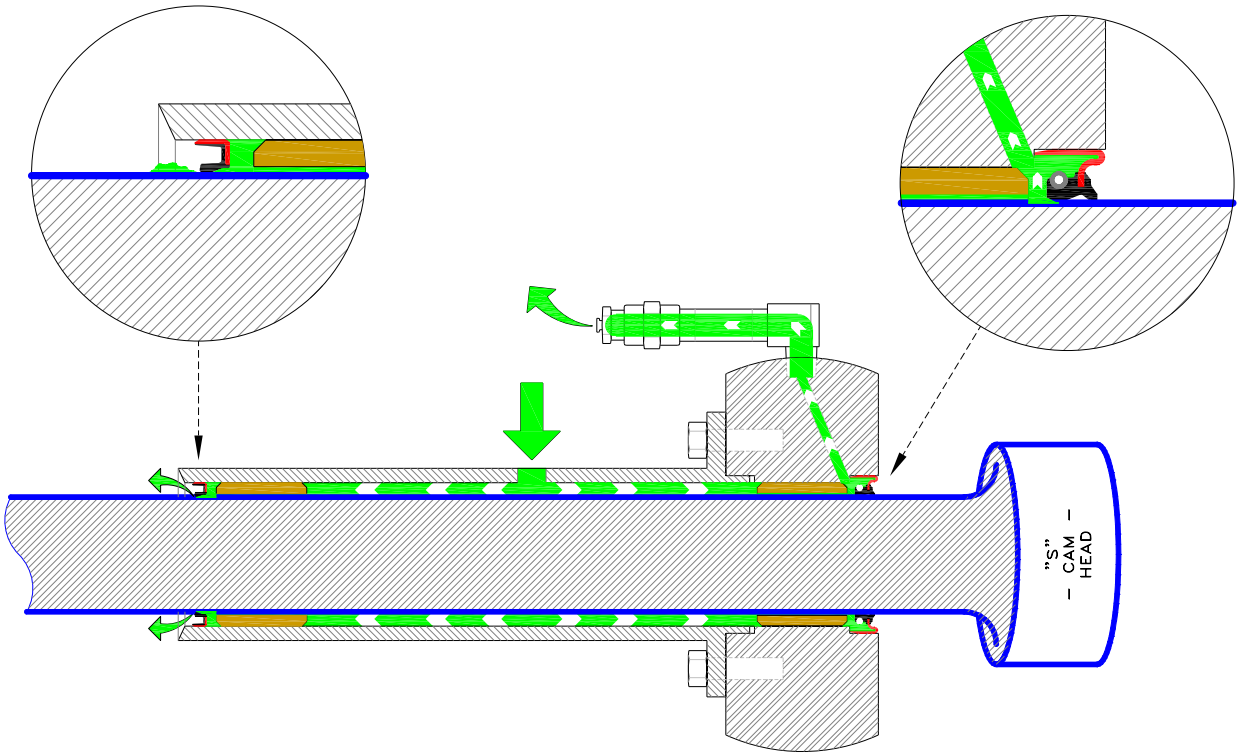
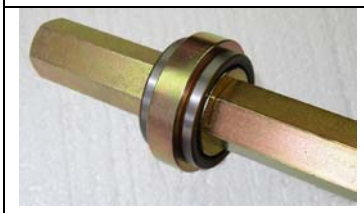


Fig. 16

Note: It is recommended to use a double lip seal, whenever available, to better protect the cam-bushing assembly from brake dust contamination

Step-by step installation of the seals

Make sure that the spider is free of metal debris and other dirt, then follow these steps.

	Step 8a: Insert the dust seal onto the 2-3/4" stub side of the installer flange making sure that the seal's lip is pointing outward (toward the 2-3/4" stub). Refer to fig.15 on page 25 for tool description.
	Step 8b: Insert the dust seal onto the other side of the installer flange making sure that the seal's lip is pointing inward on the flange (same direction as the other seal, toward the 2-3/4" stub).
	Step 8c: Insert the seal installer tool's short stub through the outer face of the spider to apply the seal evenly on the bushing channel, and then tap the seal in with a small hammer using the edge of the long extension to hold and drive the tool. Drive the seal in until the wide face the installer flange flattens evenly on the spider. Back out the tool.
	Step 8d: insert the long extension of the tool through the back side of the spider channel and apply the seal evenly on the bushing channel, then hold the tool in position by the long extension, tap the short stub with the hammer to drive the seal in position while holding the tool by the long extension. Remove tool once the seal installation is completed.
	Step 8e: Check for proper installation of inner and outer seals. Make sure that the outer seal is installed with the lip pointing toward the cam-bushing, and that it does not touch the bushing. Make sure that the inner seal lip is pointing away from the cam-bushing and that the outer shell of the seal is pushed all the way in.
	Step 8f: Check for cleanliness of the whole assembly and apply a thin coating of good quality grease to all parts.

Installation of the "Optimum-contact" cam-bushing system is complete.

Step 9: Re- assembly of brake components.

Re-assemble the camshaft and all other brake components EXCEPT FOR THE SLACK ADJUSTERS according the normal procedure and specifications of the axle manufacturer. Refer to service bulletin # SBOC-113 for slack adjuster installation procedure.

Lubricate the cam-bushing assembly thoroughly and wipe any excess lube. Install a CP-5-100 cap plug on each grease fitting after lubricating, to protect from damage and dirt.

RECOMMENDATIONS

We recommend the use of RTV silicone to seal the splines of the camshaft and the slack adjuster to prevent the infiltration of contaminants in the splines. This could lead to early wear of the splines and cause the brake stroke to extend. PLEASE REFER TO SERVICE BULLETIN # SBCO-113 FOR PROPER PROCEDURE IN THIS MATTER.

Your company will spend a considerable amount of money towards the modification of their fleet. The only way to secure a profit from this investment is to ensure the proper installation of the product which in turn ensures the success and durability of the Optimum Contact method.

It is very important to ensure the cleanliness of the grease fittings when lubricating the cam-bushing assemblies because any dirt or contaminants inserted in the assembly will contribute to reduce their durability. The tip of your grease gun coupler also needs to be clean to prevent introduction of contaminants in the cam-bushing assemblies.

This is not only true for lubrication of the cam-bushings, but it is also true for any mechanical movement requiring lubrication.

DIRT AND OTHER ABRASIVES ARE THE # 1 ENNEMY

OF ANY MECANICAL ASSEMBLY.

THE SUCCESS OF THIS METHOD RESIDES IN THE ELIMINATION OF ALL

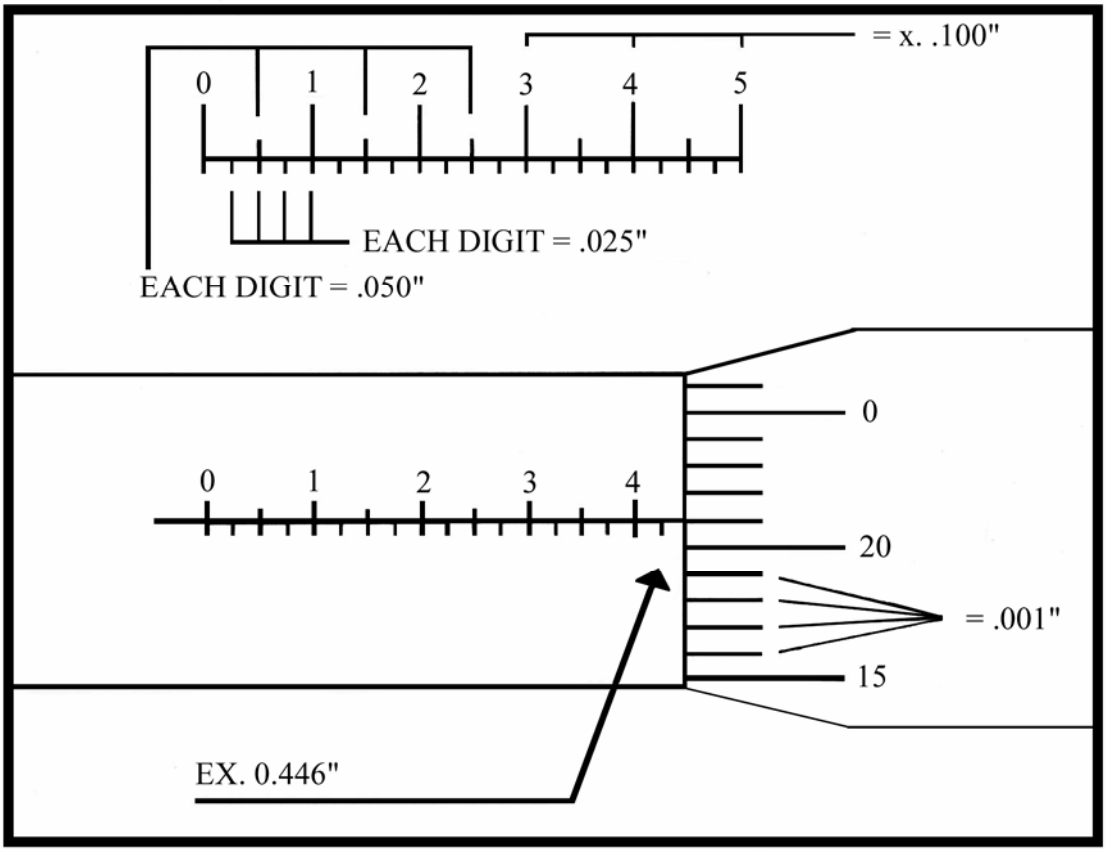
CONTAMINANTS INSIDE THE CAM-BUSHING ASSEMBLY

IF YOU INTRODUCE CONTAMINANTS IN THE CAM-BUSHING

ASSEMBLY BY WORKING CARELESSLY YOU COMPROMISE

THE EFFORTS DEPLOYED TO ACHIEVE THIS DURABILITY

Reading a micrometer



This micrometer readout scale is precise to 1 thousandth of an inch

REAMER SELECTION CHART

For North American Drive Axles

1 ½" CAMSHAFTS

For shaft 1.489 }
For shaft 1.490 } Use 1.493 reamer

For shaft 1.491 }
For shaft 1.492 } Use 1.495 reamer

For shaft 1.493 }
For shaft 1.494 } Use 1.497 reamer

For shaft 1.495 }
For shaft 1.496 } Use 1.499 reamer

1 5/8" CAMSHAFTS

For shaft 1.615 }
For shaft 1.616 } Use 1.619 Reamer

For shaft 1.617 }
For shaft 1.618 } Use 1.621 Reamer

For shaft 1.619 }
For shaft 1.620 } Use 1.623 Reamer

Cleanliness is essential to precise measurement. Please make sure that the parts you are measuring and your measuring tools are free of dirt or any other contaminants.

NOTES

Tool maintenance

Pullers:

Pullers must be kept clean by avoiding the threaded rod and the other components to touch dirty surfaces. If contact with dirt and contaminants is inevitable, clean the tools as soon as possible and lubricate the threaded rods & nuts .

Keep bearings and threaded rods well lubricated at all times, reload the threaded rods with grease frequently.

If you notice that tools run excessively hot, check for proper lubrication. Cool down the tools with water if necessary.

Boring tools:

All cutters (reamers) must never come in contact with any abrasive substance and have to be kept clean at all times. Do not allow the tools to lay on a concrete floor. The concrete is an abrasive and will damage the reamers.

Special note: Any metal debris on the inner surface of the cutters' tapered mounting journals will render the assembly of the cutter on the arbor very difficult, and if cutter is forced onto the arbor, it will break.

Proper assembly of the align-boring tools is critical to the success of this new installation method, and dirt or metal debris will surely compromise the alignment of the tool's components.

Tooling and shop supplies checklist

- ❑ Optimum Contact CO-1500 / 1625 CK reamer tool kit
- ❑ Optimum Contact BDK-200 Bushing installation puller kit
- ❑ 1" – 2" Digital Micrometer
- ❑ Magnetic based dial indicator gauge
- ❑ ¼" shank high-speed die grinder (20,000 + r.p.m.)
- ❑ 1 ½" diameter with ¼" shank flap wheel (80 – 100 grit)
- ❑ ½" square drive impact wrench
- ❑ ½" square drive extension (12" + long)
- ❑ ½" square drive universal joint (impact)
- ❑ ½" square drive hexagonal 1" deep socket
- ❑ ½" square drive hexagonal ¾" deep socket
- ❑ ½" square drive hand ratchet wrench (long handle 16" +)
- ❑ (2) 1" open and closed combined wrenches
- ❑ Blow drying air gun
- ❑ Wire brush
- ❑ 2lbs plastic hammer

Other necessary shop supplies

- ❑ Small quantity of clean good quality grease
- ❑ Brake & brake parts cleaner
- ❑ Shop rags
- ❑ Low strength thread locking compound (purple "Locktite")
- ❑ Black ink marker (large)

NOTES

Service bulletins

Service bulletins supplied with this training manual :

SBOC – 112	Greasing the bushings before align-boring them
SBOC – 113	Thread locking agent for cam splines and slack adjusters
SBOC - 117	Lubrication
SBOC – 202 - DA	Installing lube purge tubes on drive axles
SBOC – 215	PM 1600-DA bushing installation on Rockwell short cam drive axles.

Other service bulletins are available upon request.

Call the tech support line 1-877-765-9629

FOR ANY INFORMATION

DIAL TOLL FREE

1 877 765 9629

YOUR TRAINING INSTRUCTOR :

This training manual was last revised : March 29, 2007