Supplemental Information & Instructions
for
433-388 Tappet Set, OE Type (flat bottom)
MG TC, TD, TF with 451-261 OE type Cam (non-tapered lobes)

About these tappets….

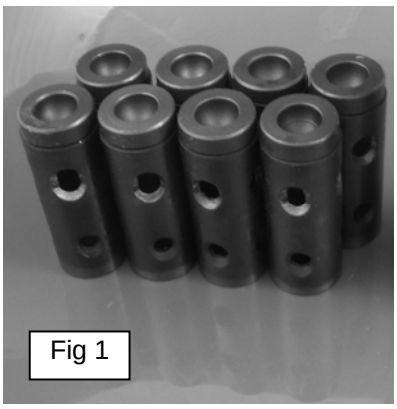


Fig 1

Moss Motors invested considerable time and effort coming up with what we feel are the best tappets you can buy for use with a non-original camshaft. Our 433-365 tappet set are specially prepared for use with the Crane Cam (451-260 or 451-270). That is all well and good, but there are many owners of T-Series cars that don't necessarily want to run a Crane cam. We found a supplier in England that makes an OE type cam, meaning the base circle is stock and the lobes themselves are not tapered. We sell this cam under 451-261. For this OE type cam, our 433-365 modified tappets absolutely ***will not work****. An OE type cam must be used with OE type flat-bottom tappets. Happily, the cam manufacturer makes OE type tappets to go with their OE type cam, and these are the tappets in our 433-388 Tappet set. We include all the information we have collected about T-Series cams and tappets, which will help ensure a successful installation.*

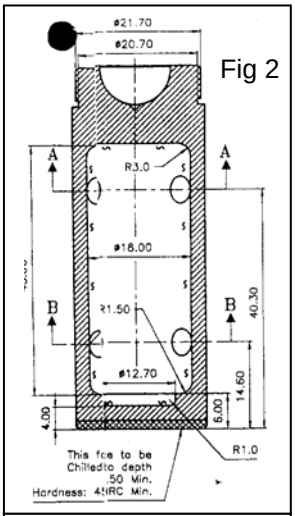


Fig 2

Section of an original Morris Garage blueprint for the T-Series Tappet.

Outside Diameter

Original specifications for the OD are 0.9049" to 0.9065". ***Your engine builder should measure the outside diameter in four places along the length of the tappet, offset 180 degrees from each other.***

Hardness

Skip Kelsey of Shadetree Motors felt any tappet that was 52-62 HRC was just fine, and we agree with him. The tappets we use are the same tappets we use to make the modified tappets for the Crane cam, and we have had hundreds of them checked over the last several years and 99% of them are within the specification. We don't test the tappets in the 433-388 set. Rockwell hardness may require a little explanation. The Rockwell method employs either a ball or a diamond cone in a precision testing instrument that is designed to measure depth of penetration accurately. The method employing the ball is designated as the Rockwell B test, and that using the cone, the Rockwell C test. ***For absolute confidence, you may want to have the tappets tested for hardness.***

Why a Flat Bottomed Tappet?

The original cam lobes were "flat", (Fig 3) meaning the lobe was not "tapered" or "crowned". The bottom surface of the tappet (the foot) was dead flat as well. The tappet rotates because it is offset with respect to the center of the cam lobe. Modern cams and tappets look like Fig. 4.

Fig 3

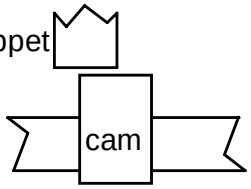
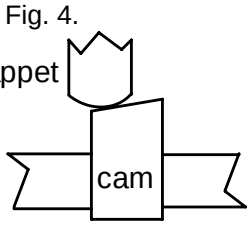


Fig 4



Oil Holes

The tappets used in the MG T-Series have holes in the sides. (Fig 2) The hollow body of the tappet fills with oil from the rocker gallery. As the tappet drops down in the tappet bore, the lower holes are uncovered, and oil drains out of the tappet body, flowing over the camshaft lobes. Because the 451-261 camshaft has the stock base circle, the normal oil holes are uncovered when the tappet drops down in the tappet bore as the cam rotates. No modification to the oil holes is required.

Please note: anything going into an engine needs to be thoroughly cleaned. Cast iron tappets of this design will always have some grit inside the body; this must be cleaned out before you use them. Most machine shops dealing with modern steel tappets will be unaware of this and may simply use them as supplied. Any grit left in the tappet will wind up in the sump and if picked up by the oil pump, it will be trapped in the oil filter. Nevertheless, you want these as clean as possible before you use them.

Things to Think About as you Rebuild the Engine

The information below comes from Crane Cams, Dimitri Elgin of Elgin Cams, and Skip Kelsey of Shadetree Motors, a longtime T-Series specialist.

Tappet to Tappet Bore Clearance

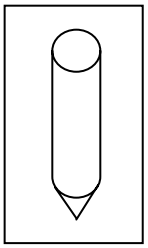
Skip always used 0.001 to 0.002"

Crane was very specific: Clearance should be 0.0005 to 0.0035" Below 1/2 a thou there is not enough clearance for the tappet to move when the engine gets hot. Over 3.5 Thou, it's too loose. If the tappet is too tight, they may not rotate properly when the engine gets hot, even though they are moving up and down. This can greatly increase the pressure on the foot of the tappet and it will quickly fail. If the tappet is too loose in the bore, or the bore is ovalized, the tappet can rock in the bore, and both the tappet and the cam lobe will fail.

Tappet Bore Alignment to the Cam

The bores must be checked for orientation; they must sit at 90 degrees to the long axis of the camshaft. This must be done by a competent machinist.

Cam Lobe & Lifter Bore Alignment



Crane: The lobe of the cam never sits directly under the lifter. (Fig 1 & 2) The cam lobe is always offset (either toward the front or rear). That is why the wear on a cam lobe is always to one side, and part of the lobe will appear untouched. The 451-261 OE type cam we offer has been designed to address some of the problems with original cams. First, the lobes are a little wider, and the center of the lobes has been offset to the rear a little. These two modifications increase the likelihood of the cam lobes and the foot of the tappet being properly offset with respect to each other. Dimitri Elgin (Elgin Cams) has developed a way to check this that works well. He machines a long “dummy lifter” from aluminum, with the same outside diameter as a tappet. One end is turned down to a point on a lathe. Coat the lobes of the cam with machinist’s blue, then install it. Drop the dummy lifter in the first lifter bore, and rotate the cam one revolution. Repeat this for every lifter bore. Remove the dummy lifter, and carefully remove the cam. There will be a line on each lobe where the point touched. Every line should be off set with respect to the center of the cam lobe. If any of the lines are in the center of a lobe, that tappet will not rotate and it will fail quickly. The lifter bore will have to be bored out and a suitable insert with an offset bore will have to be pressed in to move the center of the lifter bore off the middle of the cam lobe. This is expensive, and you might be better off looking for another block. The lifter bore position in a T-Series engine is not all that precise, and this problem is easily overlooked, especially by a machine shop with little experience working on vintage engines.

Valve Spring Selection

Skip always preferred the Moss 423-410 valve spring set for the MG TC-TD. These springs have less spring pressure than the TD MK II / MG TF springs (Moss 423-420). Skip maintained that the later springs had more spring pressure that you need. Crane suggests that you should have 45-50 lbs seat pressure as a maximum. We have also heard that there are those who prefer the stiffer valve springs; it depends on your experience and what you intend to do with the car.

From other sources: Never install springs without checking the installed spring height and the spring pressure. Too much pressure can overload the cam and lifter, which will make it impossible to break them in properly. For a mild street cam, spring seat pressures should be 85 – 105 lbs. Radical or high performance cams may call for 105-130 lbs. There are two problems with high spring pressures. First, the load on the tappet foot is increased. Second, higher spring pressures will impede the proper rotation of the tappet during break-in. If the tappets do not rotate properly during the first ten minutes of the break-in, the damage is irreversible. If you plan on running higher spring pressures, don't do it during break-in. Use a shorter ratio rocker arms to reduce valve lift. If you are using dual valve springs, consider removing the inner spring during break-in. The valve springs must be checked to ensure that coil bind does not occur at maximum lift. One company says there must be a minimum clearance of 1mm between the valve spring coils. Another says there must be 0.060" (1.5 mm) travel left in the spring when fully compressed by the action of the cam. Make sure the springs are fitted at the correct installed height. It is important to ensure that the valve spring fits the retaining cap correctly and in some instances the cylinder head may need machining. Once the valve springs have been installed check both inner and outer springs for coil binding and ensure that the bottom face of the spring retaining cap does not contact the top of the valve guide or valve stem oil seal. Minimum clearance at full lift is .060. (1.5mm). If this clearance cannot be achieved the top of the guide may need to be modified.

Valve Lift Considerations

Skip: The OE cam has 0.308 to 0.315" lift. It is not a high lift cam like the Crane, so coil bind should not be an issue.

Camshaft End Play

If the camshaft end play is specified, check it after the cam is installed and the bolts have been torqued. If it is excessive, the cam will move back and forth. In extreme cases, a cam lobe may come in contact with the adjacent tappet with disastrous results.

Reusing a "Good Used Cam"

While it is possible to use new tappets with a used cam that has been inspected by a machinist and given a clean bill of health, it is not recommended. Replace the cam and tappets together. For maximum life, they need to wear in together.

Connecting Rods

Most con rods have a hole at the big end facing the cam. Oil under pressure squirts out the hole and it splashes on the cam and tappets. On MGT Series con rods the hole is on the ***opposite*** side, directing oil toward the thrust side of the cylinder. We have been told that at least one T-Series engine builder is modifying the con rods to direct oil to the cam.

Assembly Lube

There are almost as many assembly lubes out there as there are oils. Increasingly, cam manufacturers are offering assembly lube either with new cams, or as a suggested product on their website. Any assembly lube offered by a recognized cam manufacturer will be good, and you should consider using one. There are two general types. One is oil based, the other is more like a paste or grease. The oil based lubes use a base oil with a blend of anti-scuffing and anti wear additives, just like a motor oil. Unlike motor oil, the concentration of additives is quite high. The thicker assembly lubes are like grease or a paste, and many seem to be based on molybdenum disulphide (MoS_2). or "moly" for short.
Moss offers Kent Cams "Cam Lube" (221-570). It is specifically a cam/lifter lube, and it is used to coat the cam/lifters liberally before assembly. It is like a thin grease and will stay where you put it. Kent does not provide technical information as to the composition. Kent provides it to minimize the chance of a failed cam.

Moss also offers Permatex “Ultra-Slick” assembly lube (221-565) is a tacky red oil-based lubricant gel that sticks to metal surfaces, forming a film that provides protection from scuffing and galling during start up. It is made from a base oil to which specific extreme pressure (EP) additives have been added. The technical information they have published does not specify the type and amount of any of the additives. It is used to coat all the moving parts in an engine - engine bearings, camshafts, lifters, valves, guides and rocker shaft assemblies - as it is assembled. It also has special rust inhibitors to protect all the metal.

We recently added a range of products that use zinc dialkyldithiophosphate (ZDDP) as the key ingredient. ZDDP has been proven to be essential for proper break-in and long life of the traditional “flat tappet” engine. ZPaste™ Camshaft & Lifter Assembly Lube (Moss 220-806) is specifically intended for the special break-in requirements of flat-lifter engines. ZPaste™ is a proprietary formulation of Zinc Dialkyl DithioPhosphate (ZDDP) types with a Molybdenum DiSulfide (MoS2) additive in a new formulation Calcium Sulfonate base. It’s extreme adhesion allows it to remain in place on critical engine parts for long periods of time. ZPaste™ is designed to be used along with ZDDPlus™ oil treatment (Moss 220-805) for initial engine break-in. Single use packets are enough paste for a single camshaft install. IMPORTANT! The paste is designed for use on cam lobes and tappets only.
This is the lube supplied with the 433-388 OE type flat bottom tappet set.

Oil Pump
Skip: Pack the pump with Vaseline so it will prime. If you don’t it takes for ever to build pressure.

Oil Pathways
The cam manufacturers are all in agreement that there should be no restrictions to oil flow in the block. You must have adequate oil flow to the rocker gallery, and adequate flow to the tappets. Anything that restricts that flow can create problems. For this reason, do not use oil restrictors, windage trays, baffles, and do not restrict or plug any oil return holes.

Getting the Engine Ready to Fire
The break-in procedure is essential to long life of the cam and tappets. Improper break-in can lead to catastrophic failure in 500-1000 miles. Cam and tappets wear in together during “break-in” very quickly. First 30 minutes of the break-in are critical. Once broken in, consider the individual cam lobes and tappets to be bonded pairs. You cannot swap tappets, even in the same engine.

Everything must be as close to perfect as possible, because it is essential that the engine fire quickly and run steadily at 1500 to 3000 RPM. Prolonged cranking on the starter and/or multiple restarts will lead to scuffing, and once that happens you are going to need another cam and a set of tappets. Do not think you will be able to “get it started and sort it out.” This is no time for assumptions and shortcuts. Think about the time, money and effort that has gone into the engine. Don’t blow it rushing the last step.

Ignition System
Have the distributor checked on a distributor machine to make sure it actually is working properly. Do not assume that the distributor is OK “because the car ran fine” 8 months ago. If the weights are sticking, the springs are broken, the shaft bushing is worn, or the diaphragm in the vacuum advance is damaged, the distributor must be rebuilt. With a known good distributor with the proper advance curve installed, set the point gap (or dwell angle), and install fresh plugs, properly gapped, with new or known good plug wires, Check the spark energy on all plugs. Make sure you have the proper firing order. Set the timing to the factory specification.

Cooling System
Fill the system with pure water and pressure test the system. Locate any leaks and correct them. Drain the system and re-fill with 50% antifreeze mixture. Pressure test again, just to be sure.

Fuel System
The fuel tank and all lines up to and including float bowls should have fresh, clean gasoline from a known good source. If the gasoline in your area has ethanol in it, be aware that it has a shelf like of 45-90 days. Go get some fresh gas if you have any question about the age of the gas in the car.

Oil

Select the break-in oil of your choice. Look for ZDDP at 0.14%- 0.15% by weight (1400 – 1500 PPM) If you prefer, mix an API SM oil (0.08% or 800 PPM ZDDP) with a ZDDP additive to get a ZDDP level of 0.14-0.15%. Fit a new, top quality oil filter. Crane suggests using straight 30 weight motorcycle oil for the break in period.

Priming Oil System with a Pressure Tank

Skip pressurized the oil system with an external tank, He did not spin the motor using the starter to build oil pressure. He had a metal tank that he connected to the oil gallery on the head. The tank had 3 quarts of oil and 90 lbs of air pressure. With the tank connected to the oil gallery, he opened the valve and waited until oil came out of the valve train (valve cover off). Pressure on the gauge at that point was about 80 PSI. Then he used the hand crank to rotate the engine 1/4, then 1/2, then 3/4 of a turn to make sure the oil managed to coat all the moving parts.

Priming Oil System - w/o a Pressure Tank

Skip: Spin engine with starter ***without*** the head on. Pour oil into exposed oil galleries. Install head. Leave pushrods out. If the carbs are attached to the head, stop the flow of fuel to and through the carburettors. Leave the spark plugs out. Spin engine again until you have oil coming out of the valve train (leave rocker cover off).

Crane: Leave the tappets out of the engine as you prime the oil system. Cranking RPM is not enough to cause the tappets to rotate. The tappet face may be scuffed by the cam turning over at low speed, even with assembly lube. Elgin: Never spin the engine with the starter to build oil pressure with the lifters in place. At the low cranking RPM, the tappets will not rotate, and the cam lobe will wipe the lube off the tappet foot. The tappet foot can easily be scored, and once that happens, the tappet will fail in 500 to 1,000 miles. Because it does not happen immediately, there will be no obvious link to the real cause. Once you have oil pressure and oil flow through the rocker arms, replace the tappets and the spark plugs.

Break In Procedure - Start the Engine

Once you have pressure on the oil gauge, coat the tappets in assembly lube and reinstall them along with the pushrods. Start the engine. If the engine does not start immediately STOP CRANKING! At cranking RPM, the tappets are not rotating. The foot of the tappet will be scored by the cam lobe. It will fail in short order. Figure out why the engine will not fire and correct it.

When the engine starts….

DO NOT LET IT IDLE! At idle, properly broken in tappets are rotating, but very slowly. New tappets may not rotate at all at that low RPM. Bring RPM up to 1500 and keep it between 1500 and 3000 RPM for 20 to 30 minutes. Immediately after the engine fires and comes up to 1500 RPM, verify that the pushrods are rotating. This indicates that the tappets are rotating, which is absolutely critical. You can see the pushrods rotating with valve cover removed. Some shops have special valve covers with a section of the top removed, which allows the pushrods to be seen while controlling some of the oil splash.

If a push rod is not rotating, try rotating it by hand to get it started. (Use a glove).

If you cannot get it to rotate, SHUT THE ENGINE DOWN. You must find out why the tappet is not rotating, and correct the problem. There is no “fixing it later”. If the tappet does not rotate it will quickly fail, taking the cam with it. If all the pushrods are rotating, after 20-30 Minutes running between 1500-3000 RPM, shut it down. Perform the normal checks you would do at this point.

After the Initial Break-in Period: *Change the Oil*

Drain the oil and replace the oil filter with a new, top quality oil filter.

Which oil should you use after the initial 20-30 minute break-in period?

You have two options. You can use an oil formulated for vintage engines (Moss 220-810, 220-815). They have the appropriate levels of ZDDP (0.12% or 1200 PPM seems to be an average). They also have additional detergents and anti corrosion agents to help protect the engines that tend to sit for long periods of time. If you prefer, you can use an API SM oil with 0.08% ZDDP, and add ZDDP (Moss 220-805, 220-908) to it. Mix it carefully to obtain the desired 0.12% ZDDP by weight (1200 PPM). Remember that levels of ZDDP over 0.20% (2000 PPM) may cause chemical corrosion of the tappet and lead to increased wear over time.

Drive Your Car

If you can drive your car for 30 minutes with the oil between 170°F to 200°F once a week, and you change the oil and the filter every 6 months or 3,000 miles, you will minimize the corrosion pitting of the cam lobes and tappets due to moisture and acids in the oil. It is unclear what the minimum driving requirements are. Once a month may be enough, but we have not run across any data on this issue. If it is not practical for you to drive your car that often consider using oil formulated specifically for classic cars.

Checking for Wear

The oil in aircraft engines is checked periodically by looking for steel and iron particles trapped by the oil filter material, oil pump pickup screen, and the magnetic drain plug. Unless you are using an original canister type oil filter on your engine, checking the filter for wear particles is going to be difficult. If a magnetic drain plug is available for your application, use one. When you drain the oil, run a powerful magnet through it to pull all the iron and steel particles out. You can get a sense of how the engine is doing partly by the amount of material you find, and partly by the relative amount found from one oil change to the next.

Used Oil Analysis (UOI)

You can send samples of your used oil to a company that will check it for you, and you will receive a report detailing what they find. This is very useful if you are managing a fleet of taxicabs or commercial trucks. Because a company running a fleet of vehicles has lots of data and a series of reports for the same vehicle, something out of the ordinary will tend to stand out. It gives the technicians a chance to spot a problem before a catastrophic failure occurs. If you have had problems with previous rebuilds, you might consider this option, but you will need to be diligent about sending in regular samples. Unfortunately, UOI cannot effectively monitor the level of ZDDP in your oil for reasons already discussed.

Moss Motors is deeply indebted to Crane Cams, Skip Kelsey, and Dimitri Elgin of Elgin Cams for their contribution to the information presented here. Skip passed away in 2006, and the T-Series world lost a good friend. He will be missed.

Although every effort has been made to ensure the accuracy and clarity of this information, errors and/or omissions on our part are almost inevitable. Any suggestions that you may have that will improve the information (especially detailed installation notes) are welcome. Please use the simple email form on the ***"Contact Us"*** *page on the Moss website:* ***http://www.mossmotors.com/AboutMoss/ContactUs.aspx***
If you prefer, you may call our Technical Services Department at 805-681-3411. So many people call us for help that we are often not able to answer the calls as fast as we'd like, and you may be asked to leave a message. We apologize in advance for the inconvenience. We will get back to you within 2 business days.

Moss Motors, Ltd.
440 Rutherford Street, Goleta, California 93117
In the US & Canada Toll Free (800) 667-7872 FAX (805) 692-2510 (805) 681-3400
Moss Europe Ltd.
Hampton Farm Industrial Estate, Hampton Road West, Hanworth Middlesex, TW13 6DB
In the UK: 020-8867-2020 FAX:- 020-8867-2030