

# Overhauling the Ford 9N Engine: Part 2 - Block Assembly

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The block assembly starts with all the engine components ready for installation. The disassembly and evaluation is covered in part 1. Most parts tolerances can be found in the I&T Shop Manual FO-4. This "how to" is not intended to replace a good technical manual like the I&T FO4, rather it's intended to be a companion with many more photos, tips, and a general assembly sequence. Technical specs were intentionally omitted as some of them vary by block design changes.

The engine shown here has been tanked (dunked in hot tank of cleaner), decked (top milled off to true up surface), and has been line bored. The crankshaft was recently re-ground. The rods were trued by the machine shop and new wrist pin bushings were installed and reamed. The pistons are used but in like new condition and most valve components and rings were replaced. This motor apparently had been recently rebuilt by the original owner who passed away. The previous (to me) owner purchased it and drove it home parking it where it sat many years before I bought it. While I got it to run the compression was poor as was the oil pressure. The compression problem was due to rusted exhaust valves and seats (from setting), and poor oil pressure due to a mismatched oil pump and rod caps. On the plus side the sleeves were like new and needed nothing.

Assemble the oil pump. In this photo the pump has already had a new bushing installed and reamed to the correct size. Reaming requires a Ford oil pump jig or someone with a machine shop. The new gear is being pressed onto the new drive gear shaft. This is not a place to re-use old parts. The 9n pumps are marginal at best and the engine blocks are now 60 years old and clearances aren't what they were new. The pumps must be rebuilt to help ensure proper oil pressure. The pump will be completed later. You should consider buying a newer pump 8n6603 with 3/4" wide gears and having the block line bored.



Valve lapping is a much debated topic. The idea is that an abrasive compound is applied to the valve face and the valve is rotated in place producing a pair of mated surfaces that provide for a better seal. Some believe that this is not needed with newly ground seats or when new valves are used. I personally lap any valves believing its cheap insurance for a good seal. Even older motors with decent looking valves and seats can benefit from a good lapping.



The valve seats are hardened and lapping by hand is very time consuming. I use a variable speed drill running moderately slow guided by my hand with a small amount of lapping compound. Valves are lapped until there is a continuous gray band around the valve.



This motor has newly ground seats and the seat face is narrow producing a narrow gray band. On older motors with worn valve seats the band will be wider. Once lapped the valves must be kept mated to their position. I use a center punch and punch dots on the tops of the valves indicating which cylinder they belong to.



One way of checking the seal is to place a liquid over the seated valve and see if it leaks. Here I've used mineral spirits as a test. After 5 minutes there has been no leakage.



This particular block is one where the valve seats were not ground, just lapped. The valve seat faces are wider from use and after lapping have a continuous gray color band which is also present on the valves. There should be no pitting in the valve seats or they should be ground.



With the valves lapped it's time to do a final cleaning of the block and crankshaft. Pick up a set of brushes at the hardware store. These came from Harbor Freight and cost less than \$10.00 for the set.





Block cleaning must be done prior to engine assembly. Both the crankshaft and block contain oil passages where debris and crankshaft grinding compound can reside. Before assembling your motor it is imperative that everything be spotless. Failure to clean the block and crankshaft can lead to premature bearing failure and loss of oil pressure. This picture is a damaged bearing with less than 1 hour of run time.



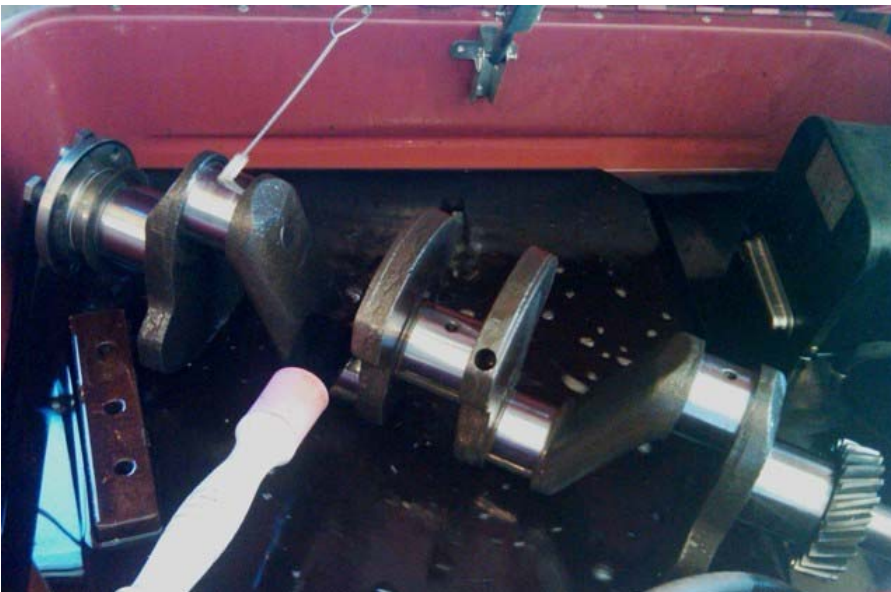
There are a number of people who use a garden hose and/or pressure washers to clean the block. I don't like using water to clean cast iron but the alternative is not good either. Here the holes for the valve guides and lifters are being scrubbed. Once cleaned, I wash the block down with solvent then blow with compressed air until dry. Keep the motor covered with a large trash bag at all times unless you are working on it.



You must also clean the oil galley and 3 passages to the cam journals and 1 passage from the oil pump to the relief valve hole.



The oil passages must be cleaned on the crankshaft. The crank is ground at the machine shop and an abrasive fluid can linger in the passageways even as its delivered back to the owner. Run a brush through all passages followed by a flush of solvent. Numerous motors have been ruined by failing to clean the cranks and having the crank grinding compound enter the new bearings and running motor. When complete blow dry with compressed air. Once cleaned and dried keep all parts covered unless you are working on them.



Final flushing of passage ways



In preparation I like to lay out all the parts prior to assembly. Set up a temporary work space and organize your parts. Keep them covered when not being installed.



Verify that the oil galley plugs are installed. Early blocks have 1 located behind the camshaft drive gear (shown), later blocks have a second one behind the flywheel. Engine startup is a bad time to learn about missing galley plugs.



If using adjustable tappets, back the adjusters out and add a couple drops of oil to the threads. These can be very tight and hard to break loose initially; it's easier here than in the block with the Johnson tappet tools. Set the tappets aside. You can place a screwdriver through the tappet to hold it while loosening the adjusting bolt.





Most machine shops stamp the crankshaft indicating how far undersize the journals have been ground. This crank has been ground to where the main and rod journals are both .010 undersize.



Verify that your bearings match the crankshaft. This bearing shows .010 meaning .010 undersize. It's nice to see it on the box but check the bearing.



With the engine block securely fastened on a motor stand, place 1 bearing shell in each of the main journals. Notice that the rear seal has not been installed yet. Lightly oil the bearing surfaces.



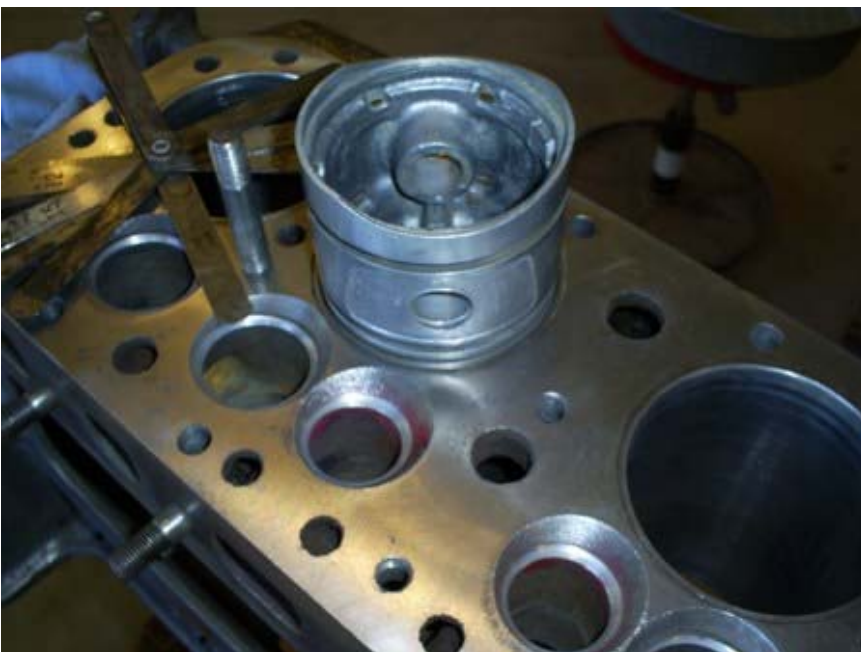
Carefully set the crankshaft in place. Cut a strip of Plastigage (.001-.003) the width of the each main bearing journal and lay on the crankshaft journals. Place the other bearing shells in the main caps and install in place with the arrows pointing towards the front of the block. Torque the bolts/nuts to the correct setting.



Remove the caps and inspect the Plastigague. The Plastigague package is printed with a scale on the edge. The scale is placed along side of the flattened material where it is matched to the same width on the scale. This then indicates the bearing clearance. This should be in the .001-.0025 range. While hard to see in the photo, this piece is wider than the .0015 mark but not as wide as the .002 mark. The bearing clearance is .00175 which is good. Anything bigger than .005 is a problem. Clean the bearings and crank of pastigague, install the caps w/bearing and lube them, and torque to proper setting and test rotate the crank. The crank should not bind and rotate with 10ft/lbs of torque or less. If the crank binds up loosen 1 cap at a time until the source has been identified. Once checked set all parts aside (remove crank).



Check the piston ring end gap. Place each new ring in its cylinder. You can use a piston upside down pressing on the ring to ensure its square inside the cylinder.





Measure the gap in the end of the ring and verify its correct. The rings are fragile so handle with care. All the ones I've checked were on the large end of acceptable out of the box but this is the only reliable way to know they are correct.



Assemble the pistons. Install the wrist pin keeper in one end, then slip the wrist pin in and the keeper from the other end. Use engine assembly lube on the pin and inside of the rod bushing. There should be virtually no play with the pin in the rod and should only move where intended. Side to slide movement is normal. Ensure that the keepers are seated properly in the pistons. If the keeper comes out the wrist pins will work loose and hammer the cylinder sleeve forcing a rebuild.





The rings come in packages indentifying each ring and its position on the piston. On the packaging there are instructions on how to identify the top side of each ring. Pay close attention to how the rings are to be installed. On this motor I'm using 4 ring pistons as I already owned the set.



Install each ring on the piston using ring expanders. The rings are cast iron and are easily broke, handle with care. Stagger the ends of rings. I stagger mine 180 degrees apart. Start with the oil rings(s) and work up. The rings are fragile and should only be expanded enough to get them over the piston.



**The following steps include installing the crankshaft, pistons, cam, and oil pan. Once started this procedure should be completed in its entirety due to working with the crankshaft rope seals and gasket sealing products. You should plan 2-4 hours work.**

The rear rope seal installation procedure is a hot topic on internet forums. There are several ways to install them, I've done them the most common way which involves soaking the rope seal prior to installation and cutting the ends long. I've had success with this method with only an occasional spot of oil under the tractor. There are also discussions around how long to soak prior to installation. I believe there are really only about 4 ways to do it and all will work, the most important part is attention to detail. You may use any method you like and modify the instructions accordingly. In this method the seal will be installed dry, the ends cut flush to just slightly higher than the block, the pan gasket will butt up to the rope seal, and silicon will be used to seal the ends of the rope gaskets as well as the pan gasket.

Apply a liberal amount of gasket sealer to the rear seal retainer and install in the block. I use Permatex #2 for this area as shown..



Prepare for rear seal installation. With the rear seal retainer in place set the pan gaskets on the block lining up with all the holes. Press on the ends where the gaskets overlap the rear seal groove leaving an indentation in the gasket. These marks will be used later for trimming.



With the retainer in place, work the rope seal into its groove. Use a large socket and work it in which is easier with a dry gasket (wet gaskets swell). Once in, trim the ends flush to just slightly higher than the block. Use a sharp knife producing a clean cut. With the seal in place carefully apply engine assembly lube to the crank side of the rear seal keeping it off the ends of the rope. Repeat the lube application after the seal has set for a while



Using engine assembly lube, lube all the bearing shells including the sides of the center bearing, this is the crankshaft thrust bearing. Place the crank back in the block and install the main bearing caps, note the center and rear cap have arrows pointing towards the front.



Gradually torque the bolts/nuts to the proper setting while rotating on occasion, the crank should not bind up as the caps are tightened. The crank should be lightly tapped towards the rear and the end play checked at the center bearing.





Once the crank is in slip the front pulley and nut on and see that the crank will turn. It may be tight initially but will loosen up. Make sure the rear seal ends do not get lube on them. On my motor, the crank with the main bearings installed and top half of the rear rope seal required around 10 ft/lbs to torque to rotate. The initial rotate is a little higher and quickly lessens as the crank is spun. It should rotate freely with no tight spots or binding.

Install the pistons. When your motor was torn down you should have kept the rods with their respective caps and hopefully they were numbered. I took my block and rods to the machine shop to have them checked for line bore. This process re-bores (if needed) the mains and rods so that they are the correct size and all the bearings are perfectly aligned to one another. On teardown, this motor was carefully kept in order and taken to the machine shop where they discovered the front main (oil pump) was out of a different block and misaligned by .007. The shop also reported that the rod caps were all mixed up. This explains the bearing damage that was observed in this motor that had brand new sleeves in it. You should not assume that because it ran it was right. Additionally, this motor ran 30psi oil pressure cold and almost none when hot.

My block came back line bored, and the rods had been trued. The process is that the shop removes the caps and mills off several thousandths then bolts the caps back on. The openings are then re-bored to the correct size with the bulk of the material to be cut out coming out of the cap. My rods came back looking like new, numbered in such a way so that the caps could easily be installed in the correct orientation. On a new assembly it doesn't matter which rod goes where but if they are numbered it may help the next guy if rod #3 is really in cylinder #3. During the process of installing the pistons into the block it's critical that the caps be installed on the correct rods in the correct orientation. Note in this picture that the caps line up perfectly with the rods. It's imperative that this be done right as if the caps are mixed up you will end up with early bearing failure and poor oil pressure.





Ensure that the rings are seated in the grooves and that the end gaps are staggered, then lube the piston and rings liberally with motor oil. Once prepped install the piston ring compressor around the piston and carefully tighten it compressing the rings. Leave as much piston as possible out of the clamp to aid starting in the block while compressing all the rings. You can place rubber hoses over the studs on the rods to help prevent damage to the crank. Install the bearing shell in the rod end and lube with engine assembly lube. Verify that the bearing shells are stamped for the size of the crank.



Apply a little more oil to the cylinder bore using a narrow paint brush. Move the piston to the block and carefully tap the piston into the cylinder. Pistons are usually marked in some way to indicate forward. These pistons say FRONT on them. There is a "feels right" tension on the compressor that will allow you to compress the rings and still drive the piston in using a piece of wood or a soft mallet. You should not force the piston in. At the same time watch the bottom and guide the rod over the journals on the crankshaft.



With the connecting rod in, place a strip of Pastigague on the crankpin and install the bearing shell and cap and torque to specification. Remove the cap and confirm that the rod bearing clearance is correct. This is the only reliable way to know that the clearances are correct. Once happy, clean the Pastigague off, lube the other bearing shell and install the cap. Repeat the process for the remaining pistons



As each piston is installed, check the rod side clearance the same way you checked the crankshaft end play. Gently tap each rod to 1 side then check the clearance between the cap and crankshaft.



Rotate the crank following the installation of each piston. While new pistons/rings/sleeves will have some drag the crank should still rotate smoothly. On my motor with 2 pistons installed the torque required to turn the crank was around 20 ft/lbs.

Once all the pistons and rods are in re-torque the not/bolts to the proper settings. Use new nuts on the rods. When complete slip the front pulley and nut on and see that the crank will turn. It may be tight initially but will loosen up. On my motor the torque required to turn all 4 pistons was around 40 ft/lbs. Make sure the rear seal ends do not get lube on them. If your block had studs/nuts, install safety wire. This wire is found at Auto parts stores. Run the wire through a stud and give it a couple twists, run through the other stud and loop the wire back over. Grab the entire wire assembly with pliers and carefully twist the assembly removing the excess wire.

Add a liberal amount of assembly lube to the gears of the oil pump and install the pickup tube. This lube will aid in the pump priming on startup. Install safety wire the bolts on the pickup tube. Verify that the rear rope seal has not moved and the ends are still clean.



Install the rear rope seal in the oil pan using the same method as the block. Again check the pan gasket when lined up with all required holes. This time carefully trim the excess off the rope seal slightly higher than the pan plus gasket. Trim the pan gasket to fit. There should already be marks from checking it on the block, trim a little long and check again. It's ok if it's still a little long. There should be no damage to the seal groove in the pan. If so replace it or repair it, if the seal is not entirely contained it will leak.



Prepare the front seal on the pan. Place the 1 piece neoprene seal in its groove and cut the pan gasket so that it butts up against the seal.



The next step is to confirm that the oil pickup tube lines up with the oil drain hole. The pan is placed into position and confirms that the oil plug will install without interference. If there was a problem you can remove the pan and gently align the pickup tube. The pan was painted as part of a test of different paint products and has no significance in the assembly. Once happy set the pan aside.





Install the camshaft. Lube the 3 journals where the shaft runs as well as the areas on the camshaft where it runs in the block. Ensure that the timing marks line up. This cam gear is stamped .005 which indicates its oversize for thrust wear.



Check the gear lash on the crankshaft and cam gears. Here I've cut a feeler gauge to fit between the teeth. If the gap exceeds the tolerance a new cam gear is probably in order.



The front timing cover holds the top portion of the front seal. Slip the seal over the end of the crank shaft with the lip pointing towards the rear of the motor. The front pulley needs to be in place but out far enough to get the cover on. Install the oil slinger, pulley, and nut ensuring that the pulley and slinger line up with the woodruff key on the crankshaft. The pulley will remain out a ways to enable installing the front cover. Lube the seal area on the shaft with a little assembly lube.



The governor plate and gasket are installed with sealant. Pay attention to mating lines keeping them flush and don't fully tighten the screws yet. Note that the camshaft thrust washer has been added.



Here the timing cover gasket has been installed using a light coat of Ultra gray silicon. Installing the cover requires 3 hands, once in place it slips over 2 dowel pins and the front neoprene seal and the pulley can then be moved into place. Ensure that the pulley and slinger line up with the woodruff key. I use a marker and place a line on the end of the crankshaft showing where the key is.



Add some sealant to the groove that holds the front crankshaft seal. With the seal spaced out from the motor, carefully lower the front cover onto the seal then work the cover back onto the motor lining up on the 2 dowel pins. Once located gently work the pulley back towards to motor. Install the crankshaft nut and tighten.





Once on your motor should look like this. Use a temporary bolt for the lower governor bolt hole to hold the parts in place as the sealant dries. Gradually tighten up all bolts that contain the timing cover and governor mounting plate.



Oil Pan installation. The rear seal was installed earlier. For the rear seal we are not overlapping the seal with the pan gasket so the rope seal is cut flush to slightly higher than the block, and slightly taller than the pan and gasket creating a slight interference. Lube the face of the rear seal with assembly lube keeping the ends clean.

On the engine block, locate the pan gasket 1 more time. Verify the fit at the rear seal for an exact fit butting up to the rope seal and set aside.

Apply a small bead of Ultra Gray silicone (high torque applications) beginning at the rear rope seal end of the block continuing to the front seal. Carefully lay the pan gasket into place butting up to the front and rear seals. With the gasket in place run a small bead again on top of the gasket from front to back including where the pan rope ends will land and over the front Neoprene seal. Ensure there is a dab of sealer on the rope ends and there are no breaks in the sealer end to end.

This is the rear seal with the pan gasket in place, ready for the sealer and then the oil pan installation.





This is the front seal with the pan gasket in place, ready for sealer and the oil pan installation.



Take one last look at the bottom of the motor as hopefully you won't be seeing it again for a long time.



Carefully set the pan in place by landing it in the right place requiring little wiggling. The pan will require a little force to set down as the crankshaft seals are compressed. Start installing all the pan bolts and work from end to end tightening gradually as you go drawing the pan down tight. Do not over tighten the bolts and do not try to tighten them in one move. The pans can be cracked if not installed correctly



Congratulations on the main engine block assembly. In part 3 we will begin with the valve train installation and continue the assembly. Allow the gasket sealer some time to cure before rotating the crankshaft



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