Overhauling the Ford 9N Engine: Part 3 - Block Completion

by John Korschot - www.johnsoldiron.com (May 2010)

The block assembly starts with the engine block having the crankshaft, cam, and pistons installed (part 2). 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 provide a general assembly sequence. Technical specs were intentionally omitted when they 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 line bored. The crankshaft was 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 in a field 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 and pistons were like new.

Install the lifters. Use a little engine assembly lube on each one and place in the block. Earlier we backed out the adjusters and oiled them, then turned them back in. Failure to do this can lead to breaking the Johnson tappet tool during valve clearance adjustment.

A brief discussion on valve and springs. Study the picture closely. The valve on the left is a mushroom type valve and uses a split guide and the left spring is a 9n spring. The valve on the right is a new style spring with no shoulder at the top, the guide is 1 piece, and the spring is used in 8ns and with rotating exhaust valves in 9ns. Missing in the photo is the valve spring retainer for the new style valves. In my 9n motor I will use all new valves (non-rotating), and 9n springs (observe the wind, 9n is the same all the way up, 8n spring is tighter on one end).

According to reliable sources there was a change to the 8n block casting and the springs were changed accordingly. While its likely there are many 9n motors running with 8n springs one should always follow best practices and install the correct parts.

Since I'm not installing free rotating valves I wasn't able to photograph them but I have a few pix from a previous motor overhaul. If you buy new rotating valve assemblies the clearance at the end of the stem has to be checked. Out of the box the valve stem may be too long like these were. There has to be approx .002-.004 clearance at the end of the stem inside the retainer. This shoulder on this stem is too long sticking up past the edge of the retainer.

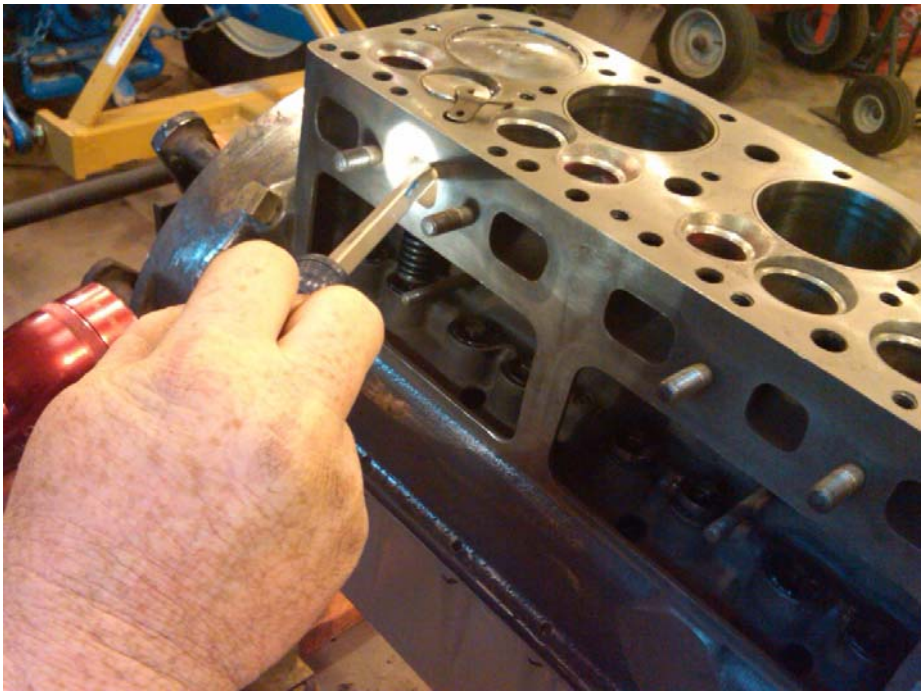
Here the stem has been ground off producing the clearance needed to allow the valve to rotate when assembled. Refer to the I&T manual for more information. If you assemble your valves and they do not rotate this is likely the problem.

Assemble your valve spring assemblies. Note the intake valves use the rubber seal on the guides. Install the seal on the guide before assembling the valve. Notice that these are 9n springs. Because the new valves do not have a shoulder on the stem it's possible to assemble the valves without tools. Lube the stems with assembly lube. Ensure the valve retainer keys are properly seated in the groove on the valve stem

Prior to installing the valves I like to use a little assembly lube in the intake valve area where the guides are installed, and anti seize compound in the exhaust area. Do so sparingly. I like to run run a wire brush like that used for copper tube fittings in the valve guide area removing any foreign material prior to assembly.

Find top dead center for cylinder #1. Install the 2 valves. Using a ground screwdriver push down on the guides until you are able to install the retainer clips. You can install any valve where the piston is up (cam lobes are down).

Installing valves in cylinder #4. You may need a flashlight to see where to place the screwdriver pry tool. With the hook end on top of the valve guide, lift up pressing the guide down compressing the valve spring.



Roll the motor over on the stand and inspect the valve retainers. Look closely as the 2nd from the right valve retainer clip is not seated right. This would certainly come loose at some point and at minimum cause you to pull the head again.

With all the valves installed its time to set the clearance. Find top dead center on the compression stroke cylinder #1, both valves will be fully retracted. Slip a feeler gauge between the lifter and valve stem. Adjust the clearance using the Johnson tappet tools. Insert the tang into a hole in the lifter and hook the other end over the adjoining valve. An 1/8 turn is several thousandths. Intake clearance is .010-.012 and exhaust is .014.-016. Once Cylinder 1 is complete rotate the crank clockwise 1/4 turn until Cylinder #2 reaches top and repeat. Do this for cylinders 4 and 3 (firing order)

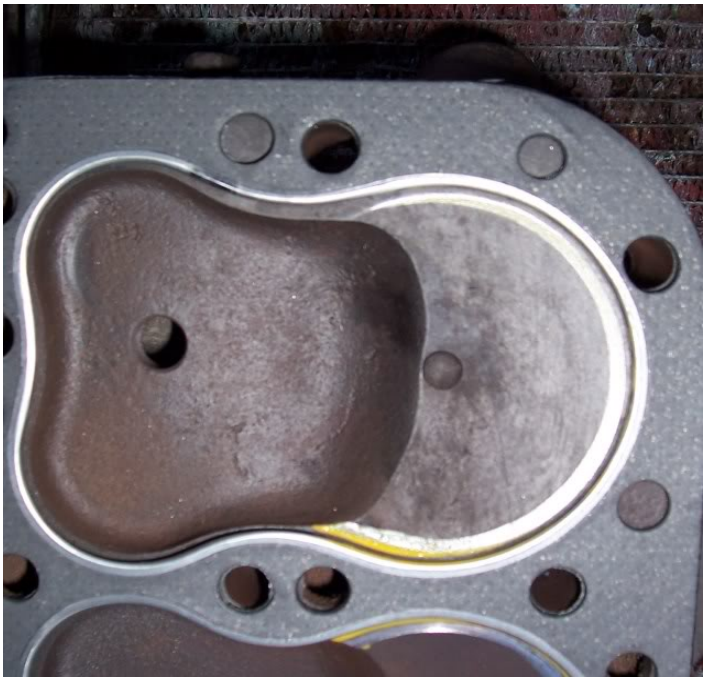
When done, rotate the crank a complete revolution and repeat the procedure. This time the valves will be off but will be much closer than the first time. When complete rotate the crank a complete revolution and check again. Keep doing this until everything settles in and the valves no longer need adjusting. Usually by the 3rd time everything is settling in. Properly adjusted, the valves are very quiet. My 8n has 70 hours on the overhaul and still does not have valve noise.

Check the head for clearance. Regardless of the history its good practice to check the head for proper clearance. These motors are old and the heads and engines have been milled and its possible your pistons may hit the head. Place a couple of studs in the block (if yours are removed) and set the head in place without a gasket. Make a mark on the crankshaft pulley so you know where you are. Carefully, slowly, and quietly, rotate the crankshaft several revolutions and listen and watch for the head to move up and down indicating the pistons are hitting the head. If they do the head will raise slightly off the block. This is also a place to confirm that the head is not warped. The head should set flat and not rock if pressed on a corner.

If your head is moving, remove the head and place a small dab of grease on the top of each piston and repeat the process. Remove the head and look for signs that the piston has been hitting the head. Make note of which cylinders. Do not simply plan to add a second head gasket.

(photo courtesy of Hobo but he doesn't know it yet)

At this point you can either buy a new head or remove some material from the head for additional clearance. There is a lot of iron in the head to work with. Make note of the seal ring area from the head gasket. If yours is not visible lay a head gasket over and trace an outline for the head gasket around each cylinder . Staying inside the lines carefully remove material. I used a drum sander and some grinding stones mounted in an air tool. There are other methods.



(photo courtesy of Hobo but he doesn't know it yet)

This head is off my 8n and all 4 pistons were hitting the head following the engine block being "decked". Once you have the head finished and it tests ok, set aside. Note the ring left by the head gasket around the combustion chambers. Replace the head on the motor and test again.

At this point you can install the valve covers. This is my tried and true guaranteed no leak procedure. I hate oil leaks and this is my fix. First check that the valve covers are strait. If not straiten them out on the bench vice or suitable flat surface, they'll never seal if they are bent. Next, clean the block, studs, valve covers, and a pair of 1/4" flat washers using your favorite degreaser. You should use gasket cement to cement the cork gaskets to the covers, usually you apply a thin coat to the gasket and part, allow to tack up and install. In the absence you can you silicon products but you must proceed a little slower allowing the product to tack up so the gasket doesn't squish out.

Run a very small bead of sealer around the valve cover with no gaps. Allow to set then install gasket. Run a small bead of sealer around the gasket. While its setting place a small amount of sealer on the stud threads and on one side of the flat washers. Note these are 1/4" washers used on 5/16" studs so they fit tight.

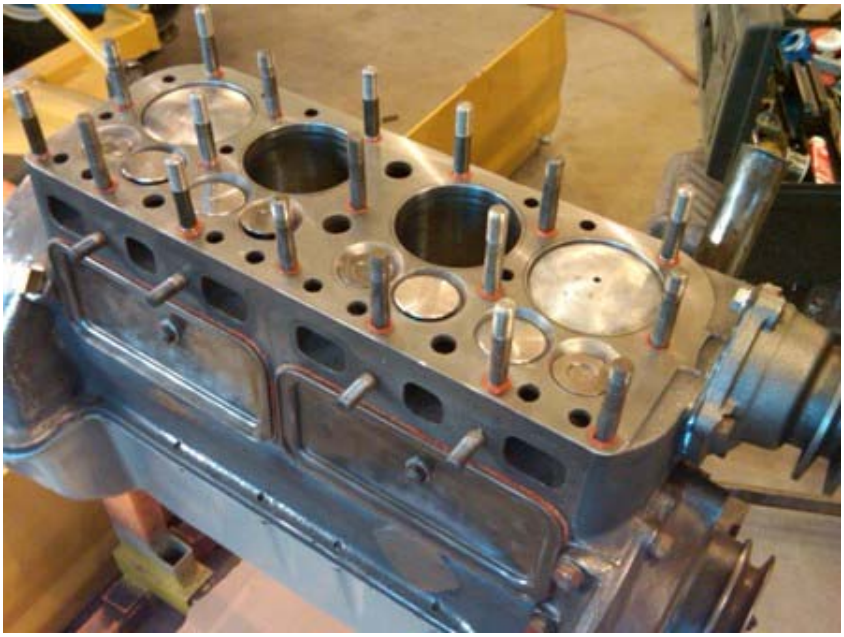
Install the covers followed by the flat washer (sealer towards the cover) followed by the nuts. Tighten slowly and allow to set, then tighten some more and watch so that the gaskets stay in place. Remove and excess sealer from the valve covers.

If you have studs and are replacing some or all of them, observe the difference between old studs and new replacement studs. These new studs (middle) have the 7/16 coarse threads cut farther up the stud than the originals. If when we install them we run them down tight these studs will not stick up as tall as the originals and if you are using the original type tall fine thread head nuts, the stud will no longer clear the nuts. Since I prefer the old tall nuts and not the shorter replacement type I decided to change how they are installed. I don't like it but we have no choice. One drawback to not bottoming out the studs is if we have to remove the head nut later, the stud may back out instead of the nut coming off.

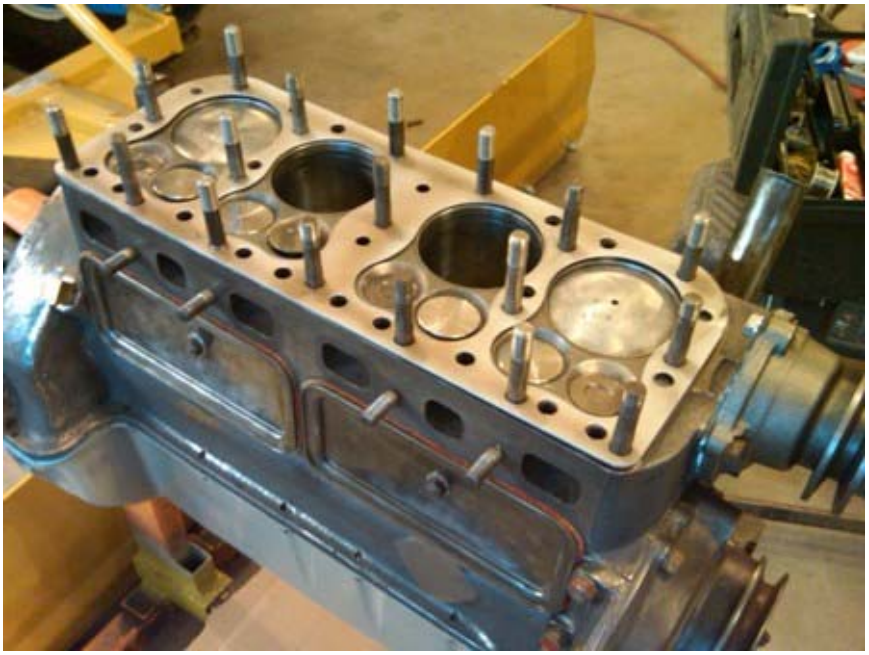
Since I only replace damaged studs I'll only be replacing about half the studs. For the old ones I run them into the block and simply snug with vice grips. For the new ones I'll stop with 2-3 threads showing. I clean and chase all the threads on the studs and head nuts prior to re-use.

The studs thread into the water jacket and must be sealed. Everyone has their favorite method and this is mine. Each studs gets a dab of hi-temp silicon sealer to act as thread sealer. I always start back a thread or 2 and use just enough material to fill 3-4 threads.

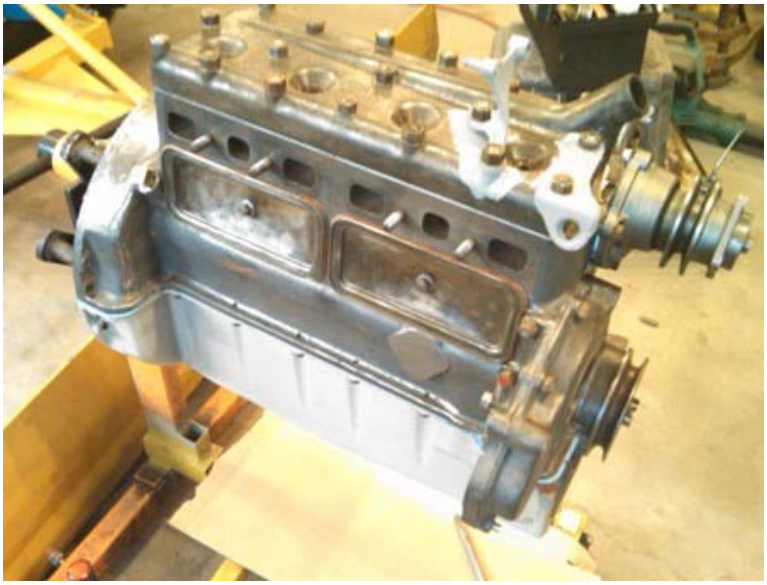
Install the studs. Notice the excess sealer. While I remove the excess sealer I don't lose sleep over a little sealer at the base of the studs. About the only place it can go is up the drilled hole in the head.



Install the head gasket. I use metal head gaskets. I spray 2 light coats of copper coat to each side of the gasket (instructions from the can) and allow to tack. Ensure the block and head are spotless and degreased prior to installing the gasket. Install the head gasket smooth side down (not clear in this photo). If you want to provoke a debate, start a thread on an internet forum asking which is the best gasket and sealer to use. :) If your gasket sealing surfaces are bad enough you have to consider what gasket to use they should be re-surfaced.



Install the head and torque to the proper setting. Don't forget the extra brackets used on different models. Note the 9/2n use a longer stud where the throttle shaft bracket is located.



At this point the basic engine is assembled. If you had access to it, a smoke machine could be used to pressurize the block and check for leaking gaskets. Since most hobbyists don't have one we need to rely on strict attention to all details during assembly like all gasket sealing surfaces and oil seals. If your motor is rebuilt by a professional mechanic he/she may perform this step. Remove the motor from the engine stand and prepare to install the flywheel and clutch.

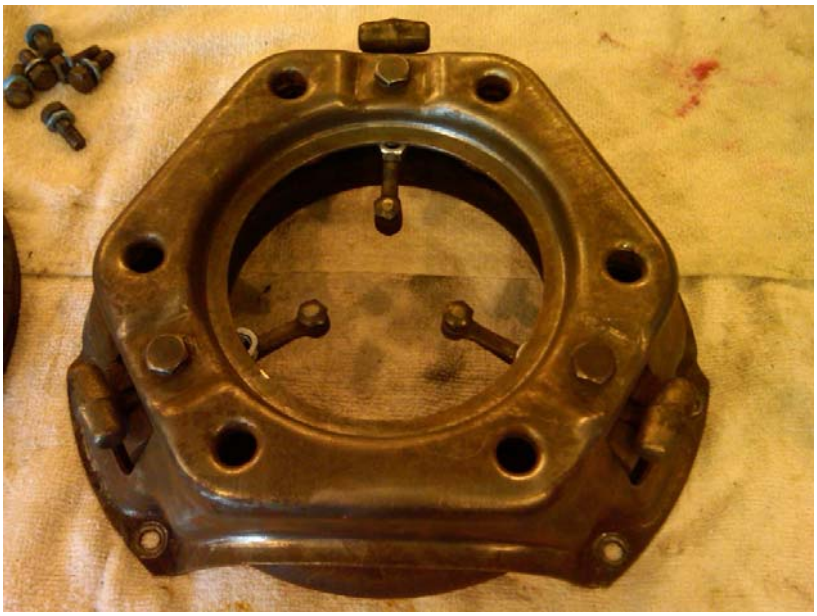
The flywheel can be checked for balance at home. Here its supported on a leveled 5/8 bolt in a bench vice and block of wood. The flywheel is rotated slowly and allowed to coast to a stop. Mark the lowest point (heavy spot) and repeat. If the flywheel is balanced it will stop at a random point each time. If not it will stop at the same place every time. If balanced proceed with assembly. If not take it to the machine shop for evaluation. In my case I installed a new ring gear and the flywheel was still balanced. It also has a new pilot bearing. (ring gear installation not covered in this doc)

Check the finger height on the clutch pressure plate. If you listen to internet forums you will think that this is beyond most people's ability and not needed, both are false. The finger height takes all of 5 minutes to check and leaves you with peace of mind. Why would you install a motor and then wonder if the pressure plate is right?

Using a clutch alignment jig or an input shaft out of the transmission center the clutch friction plate on the flywheel and install the pressure plate. Tall side of the friction disk up, bolt down the pressure plate. Check the distance from the face of the flywheel to the top of the pressure plate and record this number. It's probably the same all the way around but confirm. If it's not, you will need to make a jig for checking. Diagrams for the jigs are readily available.

Take the first dimension and subtract the second. The correct number is 2" to the top of the fingers. Adjust if necessary. Now that wasn't hard and you know going in its right. Some pressure plates are non-adjustable.

Before removing the pressure plate, lay a 5/16 or 3/8 nut on top of each finger where they are under the pressure plate. This will speed removal and later assembly by not allowing the fingers to retract fully. (a tip from your uncle Hobo)

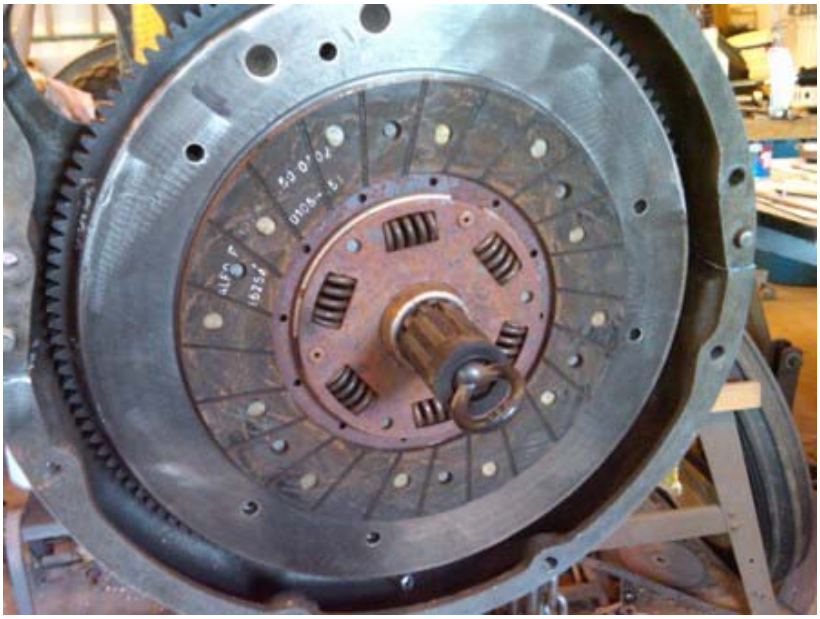


Before installing the clutch check the back of the block for the rear oil galley plug. If it has one its next to the welsh plug where the cam journals were bored. Make sure the plug is installed! This motor does not have a rear galley plug.

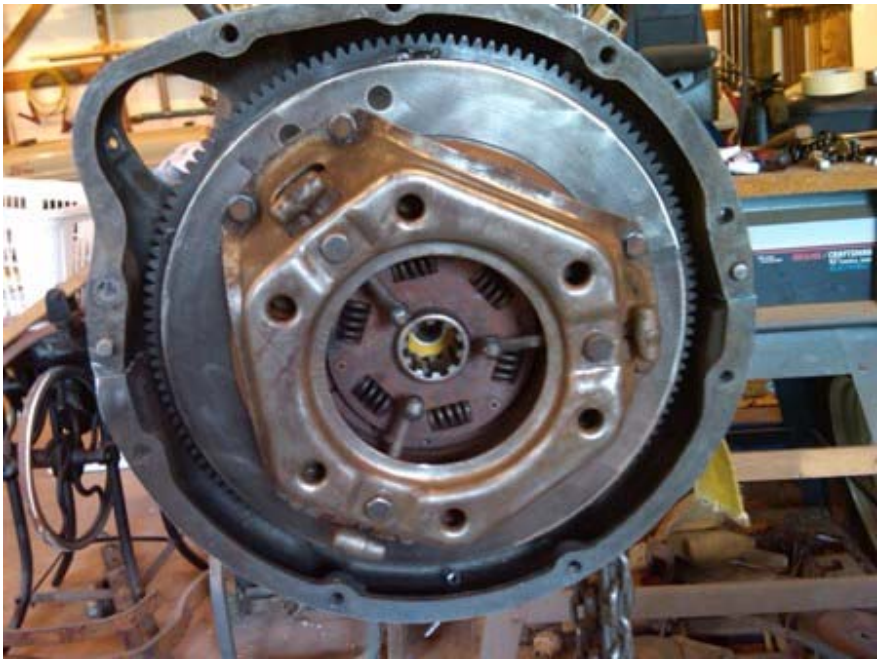
Find a couple 7/16 fine thread studs or bolts and cut the heads off. It's hard to start the flywheel as its inside the engine casting and there isn't enough room for your fingers. Be aware of the orientation for the 2 dowel pins. Here the studs are in and the flywheel has been slipped into place. Note the mark from the first balancing test.

Install the bolts. I use a couple of drops of Locktite blue. No one wants to split a tractor un-necessarily. Torque to the proper setting and safety wire both directions.

Using an alignment tool install the friction disk, tall side away from the motor. New disks are usually labeled.



Install the pressure plate. Most of the time the lock washers are worn out (flat), use new lock washers. Tighten the 6 bolts being careful not to snap them (common), this is another good place to use Locktite blue. As you tighten up the pressure plate remove the 3 nuts that we placed in there during checking. Remove the clutch alignment tool.



Find a couple 7/16 coarse thread bolts and cut the heads off. These will be used for guides for installing the motor. Here I am using 3. Run them into the block which you should be able to do by hand. While there is no gasket between the motor and transmission I run a thin bead of silicon around the bell housing so that if your input shaft seal starts leaking you won't have oil seeping out around the motor.

Move the motor into alignment with the tractor. Note the motor is lined up exactly and the back of the block is parallel to the transmission. Carefully guide the motor into position lining up on your temporary studs.

With the tractor in neutral and PTO shaft engaged, you may need to rotate the pto shaft so that the splines on the input shaft line up with the splines in the clutch friction disc.

Note: the motor should slide right in, if you have to fight it something is wrong but since you used an alignment jig it will not be a problem. Once in add a few bolts and pull the motor onto the alignment dowel pins. Remove the temporary studs and bolt properly.

Adjust the clutch linkage. I have always found them rusted tight and have to place them in the bench vice and free up using heat and penetrating oil. You can check to see that the clutch disengages by attempting to rotate the pto shaft and then pressing in on the clutch pedal. Adjustments vary by model refer to the I&T manual. 9n is 3/16" free play before the clutch yoke contacts throw out bearing.

Install the remaining block items if you haven't already. I like to cut off the generator mount for the 9/2n and early 8n water pumps. Trace around the pump and cutoff with an abrasive cutoff wheel and dress down.

With the motor installed you may want to prime it. Here the installed motor has had a final degrease and is being masked off for priming.

If you will be painting your tractor you may consider the following. For areas that are hard to get paint into when fully assembled, paint separately. The starter, oil filter, wire tube, and governor were all painted off the motor. The block was pre-painted where these items are installed. Here the governor has been installed after it and the block were pre-painted. Note the axle support and axle have been pre-painted as well.

Here the block was painted and the starter has been installed and the oil filter is about to be. Prior to final painting, the pre-painted parts can be surface prepped with Scotchbrite scouring pads in the areas that show or they could be wet sanded.

I went over the entire tractor with Scotchbrite pads prior to applying the final color coat.