Restoration of a Wisconsin Model TFD Engine

by

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Ever since first seeing and hearing a 2-cylinder Wisconsin engine run, I've had to have one. My initial encounter took place when I was about 10 years old. I was at a county fair and a 2-cylinder Wisconsin was running the chain drive for a small roller coaster amusement ride. The sound of that engine, working to pull the cars to the top of the hill, was music to my ears. I've had other encounters with these neat old engines over the years, always enjoying their distinctive sound.

My engine was obtained through Joe McCarthy, a good friend and colleague, who purchased it at an auction for me. As received it was in well-used condition, originally being a power source for a New Holland hay bailer.

All of the parts seemed to be in place and the crankcase was filled to the proper level with oil. Compression was a bit weak though, and favored one cylinder over the other. The Wico magneto provided a healthy spark, thus a test run was in order.

With gasoline supplied from a remote tank, the engine started right up using the handwheel starter. Gas dripped from the carburetor and some light blue smoke was visible in the exhaust, but it ran and I was encouraged. My plan was to do a partial tear-down, inspecting things as I went, with hopes that nothing major was required. It was anticipated that a good cleaning, blasting, and painting could be done without any internal work. This proved to be wishful thinking.

Removing the sheet metal shrouding from the cylinders indicated that I was probably the first to perform this operation since the engine left the factory! All cooling fins around the cylinders, and those fins on the head, were virtually blocked solid with dirt and chaff. It was amazing that it could still operate.

Removing the valve spring covers proved that this engine had been running hot – black, carbonized oil was present.

Pistons were so loose in their bores that they would rock from side-to-side as the engine was rotated over TDC. The cylinder walls were glazed to a dull mirror finish. The intake valves were so worn on their seating surface that they weren't worth regrinding. The exhaust valves however, were in perfect shape!


With the poor condition of these top-end parts, it was obvious that a rebore with new pistons, rings, and intake valves had to be done to put this great old engine back to first-class shape.

With a complete teardown now in order, the next thing to be removed was the oil pan. While the previous owner was not attentive in cleaning the cooling system, it appeared that he faithfully changed the oil as the crankcase internals were remarkably clean.


The massive Timken tapered-roller crankshaft main bearings were impressive and attest to the durability that these engines are renowned for.

Next, the pistons and rods were removed for inspection. The long, forged steel rods with babbitt main bearings have a touch of antiquity about them. The aluminum pistons are fitted with three compression and one oil control ring. The pistons also have slotted skirts to minimize slap, but this feature had long since

given up its function due to heavy skirt wear, most likely caused by running too hot. I was amazed that none of the rings were stuck in their grooves.

Inspecting the con rod crankpin bearings showed some cracking in the babbitt material, probably caused by the engine running in continuous detonation due to lack of proper cooling.

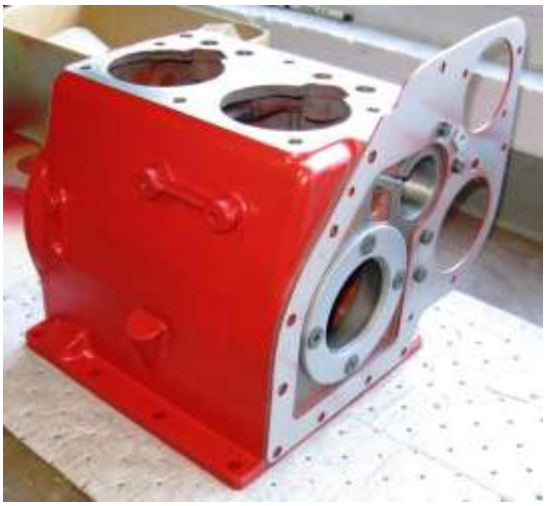
Measuring up the crankpin journals revealed that virtually no wear was present…they were perfectly cylindrical with a bright and uniform surface finish. Finally – a part that won't need reconditioning!

With the engine now completely disassembled, I began the restoration of each individual component. First parts to get cleaned, adjusted, and polished were the magneto, fuel pump, and governor. These all proved to be in fine shape internally.

The next component to tackle was the carburetor. The Zenith cast-iron body carb was disassembled, blasted, and thoroughly cleaned. A rebuild kit, including throttle shaft, was installed. I had decided to paint the engine International Harvester Red and this color appears on the carb body as shown.

The crankcase was the largest single casting so I tackled that next. The case was bead blasted on its exterior, then thoroughly washed in degreaser several times to clean out all traces of sand and grime. Oil passages were thoroughly flushed as well. The cylinder deck was flat-plate sanded for clean up. The inside of the casting was painted with orange Glyptol from the factory, a practice used to seal the surface and prevent internal rusting. You don't see this quality nowadays.


The appropriate surfaces were then masked and the external casting surface was primed and painted. Here the crankcase is shown with the accessory plate plus a few fittings attached.

The cylinder barrel was taken to a local automotive machine shop and bored .010 over. Both the top and bottom surface were decked .020 and the valve seats recut. New valve guides were also installed. I then did a mild port and rough polish on the intake and exhaust ports to clean up all casting flash. The finished component was painted in high-temperature flat black paint and is shown mounted on the crankcase with the valves, lifters and springs installed. It's starting to look like an engine again!

The camshaft was cleaned and inspected and showed no wear on cams or bearings. It was then installed in the crankcase.

New, .010 over pistons and ring sets were purchased and a good friend and Wisconsin engine expert, Mr. Bill Zubella, kindly donated a pair of brand-new connecting rods to my project. The crankshaft was in perfect condition – the large Timken roller main bearings were in like-new shape. The crankpins were polished with a Scotch-Brite pad to a mirror-like finish.

Pistons and rods were then installed into the bores and with the crankshaft fitted into place, the rod cap nuts were properly torqued. Valve lash was then set and the valve spring covers fitted. The oil pump was then bolted in after disassembly, cleaning and a thorough inspection. With the painted oil pan screwed into place, the short block assembly was now complete.

The cast iron carburetor intake manifold was also given an internal polishing to get rid of the coarse, internal cast finish (I can't resist the urge to hot rod a bit!). Next, the carburetor and intake manifold plus exhaust manifold, were bolted into place, along with the governor and magneto. Getting the magneto timed correctly was easy – I just followed the instructions in the manual. A set of silicone insulated, metal core spark plug wires were made up and installed. The cylinder head was decked .050 (very safe as the stock compression ratio in this engine is only around 5:1) and the finned surface bead blasted and left unpainted. This assists in good heat transfer to the cooling airflow. The head was then installed and torqued to proper values, along with a new set of AC spark plugs. I found some chain at the local hardware store for the oil filler cap that duplicated the original chain perfectly. All the original screws, bolts, nuts and washers were replaced with new cad-plated hardware. After all, it is to be a show engine.


The exhaust manifold had previously been bead blasted both internally and externally, and then painted with high-temperature flat black paint just as the cylinder assembly had. A threaded stub was left for attachment of a slide-on muffler or straight pipe. The air filter / inlet duct was bead blasted and left in its bare aluminum state. This part also contains the breather check valve, venting crankcase gasses directly into the intake air – very forward thinking for a 1940's design! The handwheel starting system was discarded in favor of a crank starter and pawl purchased from eBay. All of the cylinder sheet metal shrouding and blower housing was bead blasted down to bare metal. These parts required detailed dent removal and filling of rust pits with auto body filler, followed up by extensive sanding. They were then primed and painted with several coats of IH Red enamel.


The flywheel was blasted and painted red to match the rest of the engine. It was then placed on the crankshaft taper with valve lapping compound and lapped to the taper. This ensures that the taper (and not the key) takes the torque load. The flywheel was then removed and components cleaned of lapping compound. The shroud was then installed, followed up by the flywheel and key (kind of a backwards procedure compared to other air-cooled engines) and the pawl nut torqued to the proper value. I found some clear, wire reinforced tubing that replaced the stock corrugated rubber tube used for connecting the carburetor air inlet to the air filter duct casting. I like the looks and it provides a smooth internal surface so as to not impede air flow (thinking like a hot rodder again!).

The specification label was not in the best of shape, but some polishing and several coats of clear coat sealant were applied, improving the appearance. It was then screwed into place on the sheet metal shrouding.

My Wisconsin engine was now far enough along that a test-run could be conducted. The crankcase was filled with the proper amount (3.5 quarts) of 30 weight oil and the engine hand-cranked over for several minutes (with spark plugs removed) to prime the lubrication system. This engine uses a directed spray oiling system which consists of a plunger-type oil pump delivering oil to a spray nozzle which is directed at the con rod big end bearings. With this operation completed, a remote tank was used to feed gasoline directly to the carburetor float bowl, bypassing the fuel pump.

The test run was conducted on the work bench. Throttle was cracked open just a bit and choke full on. Cranked through first compression stroke – nothing. Crank through second compression stroke and a cylinder fires! Choke off – crank through third compression stroke and the engine roars to life with that wonderful, Wisconsin bark! I let it run at a fast idle to warm up and obtain ample lubrication to the new internal components. After several minutes, and a few adjustments to carb idle mixture and speed, it was idling beautifully. A three-foot long, straight exhaust stack was fitted for this run, and several light blips of the throttle were done just to enjoy the authoritative exhaust note. The following picture was taken during this test, with the engine actually running in the photo.

I was encouraged with how easily the engine started after rebuild, and how nicely it ran…very good manners indeed!

A smaller oil bath air filter was obtained to replace the large original cyclone type filter as used on the hay bailer application. Also, a stationary flywheel screen was obtained that is compatible with the crank starter now fitted. My friend Bill Zubella kindly supplied these components from his Wisconsin engine parts collection.

The finishing touch was mounting the engine on a plywood base. A piece of 5/8 inch thick flooring was cut and sanded smooth, followed by cherry red stain and three coats of polyurethane finish. Garage door handles were mounted at all four corners so two persons could lift the 200-plus pounds of this iron monster.

This project took approximately one year to complete. It was all done during my lunch hours, working in 45 minutes per day intervals. I have about $800.00 in the project, which includes initial engine price, new parts, gasket set, paint and machining costs. I have gained a newfound appreciation for Wisconsin engineering expertise and design philosophy. This engine, while not technically sophisticated by today's standards, has beauty in its rugged design and high quality features that contribute to reliability, dependability, and long running time in service. The company logo of "Most H.P. Hours" and "Heavy-Duty" are certainly honest statements that I have respect for, after overhauling this classic, air-cooled masterpiece. It's a true privilege to work on such nice machinery.

The finished engine, ready for the show circuit, is shown below.

Wisconsin TFD Specifications

Type – 4-stroke cycle, L-head, in-line two-cylinder industrial engine
Bore – 3.25 in
Stroke – 3.25 in
Displacement – 53.92 in^3
Construction –

- Forged steel crankshaft and connecting rods
- Cast iron cylinder block, crankcase, oil pan, accessory gear housing and flywheel
- Aluminum pistons, cylinder head, governor and magneto housings, and air filter/inlet air duct

Serial Number – 2569704
Specification Number – 118261
Year Built – 1956
Rated Power @ rpm – 13.3 hp @ 2600 rpm
Firing Interval – Even firing @ 360 degree intervals
Cooling – Forced air via flywheel blower
Lubrication – Oil pump with directed spray
Ignition – Wico XH-2D magneto with impulse coupling
Carburetion – Zenith 161-7

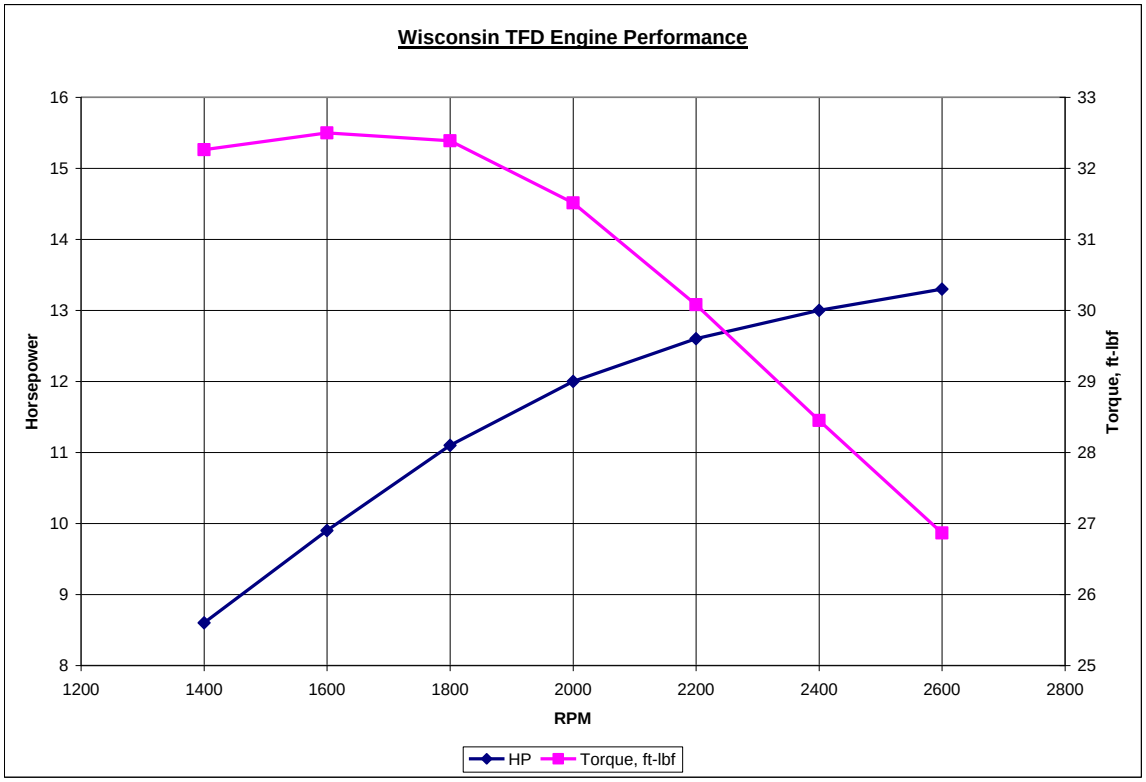
Fuel Requirement – Gasoline with an octane rating of 70 to 75
Weight – 220 pounds

Technical Notes

The Wisconsin Instruction Book and Parts List (see reference cited below) presents a chart listing horsepower at a given rpm. This chart is duplicated here, along with torque and BMEP (Brake Mean Effective Pressure) being back-calculated from the power and rpm values.

RPM	HP	Torque, ft-lbf	BMEP, psi
1400	8.6	32.3	90.23
1600	9.9	32.5	90.88
1800	11.1	32.4	90.58
2000	12.0	31.5	88.13
2200	12.6	30.1	84.12
2400	13.0	28.4	79.56
2600	13.3	26.9	75.14

The horsepower and torque values can now be presented in graphical form:



Note that the horsepower is still climbing at the 2600 rpm rated speed and the torque is still respectable at 27 ft-lbf. What is really impressive is the torque values at a relatively low 1600 rpm – a whopping 32.5 ft-lbf!

Engines of this vintage were usually very conservatively rated by the factory and thus these figures were most likely the minimum values that a new engine would produce. Later versions of this engine, notably the Model TJD, were rated at a higher engine speed (3600 rpm) and developed 18.2 horsepower. The TJD was of the same displacement (53.92 in^3) but featured a 180 degree crankshaft (unequal firing intervals) which appears stronger than the TFD counterpart, thus allowing higher speeds to be safely run. I would guess that the TJD had a higher compression ratio and more radical valve timing as well, to allow better breathing at the higher rated rpm.

So what does my slightly hot rodded TFD make for power? Well, the compression ratio has been increased by machining .040 off the cylinder assembly plus another .050 removed from the head. The port and polish job on the inlet system should help air flow. From experience, I'd say the BMEP at 2600 rpm should be increased by 10 psi to a total of 85 psi. Calculation shows that the engine would be making 15 hp at this speed. Of course, turning the engine faster would produce more power but I'd question the safety of doing this. The only way to test the power output is on a dynamometer and I don't have the capability at present. I'm content knowing that my engine runs well and is the proverbial low end torque monster!

References

"Wisconsin Air Cooled Heavy Duty Engines Instruction Book and Parts List Models TE-TF", Issue MM-249-A, Wisconsin Motor Corporation, Milwaukee 46, Wisconsin