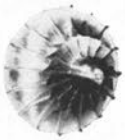


TURNPIKE TRUCK OF TOMORROW

A Whirl At The Wheel Of Ford's Turbine Test Truck

THE OPPORTUNITY to drive Ford Motor Company's gas turbine truck was a unique experience (even though the trip was restricted to a few laps around Ford's Engineering and Research Center in Dearborn), since none but company engineers had driven it before. The fact that the drive was delayed several times while operating problems were isolated and corrected emphasized that the vehicle is still only a test bed.

Interestingly enough, one of those problems was lubrication starvation of the turbine wheel bearings, occurring when the engine shut down. Yet, when the engine operates properly, Ford has a tractor-trailer unit so powerful that it dragged a 65,000-lb. load with locked trailer brakes—and the unknowing driver only wondered why acceleration wasn't quite up to par.

The interior of the C-1100 Ford tilt-cab tractor is rather conventional except for a 2-ft.-long recording oscilloscope protruding from the instrument panel between the driver and passenger seats. There was little else to suggest that below and slightly behind the driver was Ford's Model 704—a supercharged, 300-bhp gas turbine that has been under development for several years and was installed in this tractor last December.

After some preliminary instructions from the escorting engineer, the temporary choke on the steering column was adjusted, the ignition key starter was turned and the powerful engine immediately whirred into action.

Several sensations were felt at once. In addition to the feeling of surging power from this strange engine, there is a smoothness that is completely lacking in a conventional engine, which must endure the pulsating vibrations of the reciprocating pistons. Another sensation is that the engine noise, while not great, is quite different and rather high-pitched.

Since the turbine engine requires practically no warming up, the primary turbine gauge on the instrument panel indicated that the turbine was up to speed in a few seconds and that we were ready to roll. The next chore was to put the 6-speed Allison automatic transmission into "drive," and then the tractor began moving.

After being instructed to "step right down on it," we quickly found ourselves traveling 40-45 mph. This attracted quite a lot of attention both because of the unusual noise and the fact that the speed limit around the Engineering Center is 25 mph.

The tractor seemed to accelerate extremely well, particularly since it was not pulling the 65,000-lb. gross-vehicle-weight load that it had hauled around the Dearborn test track earlier. Ford engineers are confident that improved acceleration, especially after a slight lag in the first 20-30 feet, will be an important plus of the gas turbine truck. However, the experimental work on this tractor is far from completed and the engineers are not yet willing to make acceleration comparisons between it and a piston-engine tractor.

Despite the overall smoothness, there was a little roughness emanating from the transmission as it moved through the ranges. This slight disturbance is common among tractors without loads, but this turbine provides greater shifting smoothness under a heavy load. The transmission-caused roughness is one of the major problems of the turbine. It's caused by the great difference between the speed of the turbine output shaft and the speed of the driveshaft. This condition is partly compensated for on this vehicle by a larger clutch, better clutch facings and more careful adjustment of clutch.

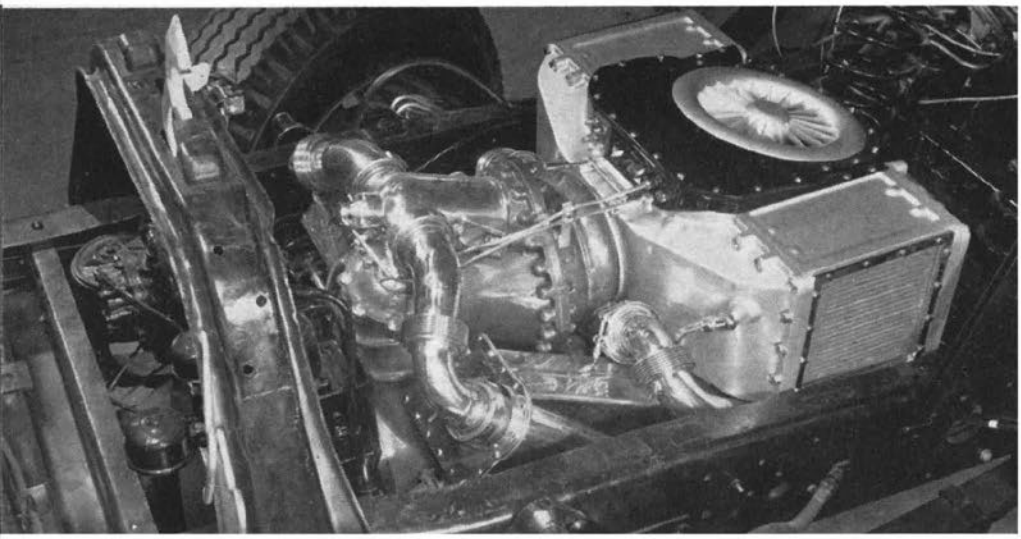
Because this engine supplies no engine braking, the driver must depend much more on the retarder that is built into the transmission. Used mostly on hills and other situations where extra braking is needed, this retarder is operated by a floor pedal just left of the steering column.

The retarder provides negative torque to the turbine, holding the horsepower for only 7-8 sec. The energy is absorbed in the torque converter, causing oil in the converter to heat up. This excess heat is partially drawn off by two fans next to the oil cooler. One fan is driven by a power take-off from the engine and the other is electrical. Should the oil get too hot for the fans to handle, an instrument panel light warns the driver to refrain from further use of the retarder.

During decelerations, the tractor also behaved quite smoothly, although it was explained that this truck must be handled differently in this situation. The important thing to remember is to do a little more coasting.

Ford's test drivers report that the generally reduced level of vehicle vibration greatly reduced driver fatigue. ▶

TEST TRUCK is a 6-wheel tractor, with the dual-wheel tandem axles moved 18 in. forward to improve weight distribution. Turbine engine shows just above the beam axle.



TURBINE INSTALLATION in test truck takes up far less space than conventional engine.

TRUCK OF TOMORROW

Steering the gas turbine tractor was simple because of its hydraulic power-steering unit and the comparative lightness of the engine. This 300-bhp unit weighs only 850 lb., compared with 2300 lb. for a diesel engine of equivalent power. In addition, Ford engineers insist that, when and if such a truck goes into production, another 500 lb. of weight will be removed by lightening the drive line, engine mounts, truck frame and engine front cross-member. Truckers generally agree that such a 2000-lb. saving is worth about $2000 annually because of the extra pay load that can be carried.

As soon as the engine began operating the oscilloscope also began measuring and photographically recording seven different conditions of the turbine. Among these were the fuel flow and shaft speeds, as well as the temperature and pressure at several locations. The oscilloscope is merely a research tool used during development of the engine, however. When a failure or problem occurred, the engineers would examine the oscilloscope tape to discover any unusual temperature, pressure or other sign of distress.

Although temperatures in this engine's combustors reach 1750° F. or more, they reportedly produce no problems for the driver. (Some diesel temperatures exceed this.) However, in the 704-powered tractor, engineers sometimes found it wise to turn on the engine compartment blower to remove some of the heat from the engine compartment.

Probably the most unusual feature of this engine is its supercharger or secondary combustor. Ordinarily, anyone starting this engine automatically lights both the primary and secondary combustors. But the operator can light only the primary combustor, thereby saving fuel. This would be helpful when the tractor isn't pulling the trailer or only running the accessories. The secondary combustor is lit by turning a manual override switch on the instrument panel.

An extra advantage of this supercharged engine, in addition to supplying more power, is that it runs a little quieter for its size. This is because much of a gas turbine's noise comes from the large volume of air that's sucked into the compressor. Since this engine uses the air twice, its air requirements are only 50% for any given horsepower. Air intake noise on this engine is also reduced by means of a foam plastic inlet duct and a baffle in front of the compressor. The great volume of air is needed because the turbine is internally cooled.

Other principal sources of noise on the 704 are its exhaust and transmission. Much of the exhaust noise is captured by the heat recuperator in the engine. The remainder is channeled through a straight-through, double-walled exhaust pipe. The inner wall is perforated and there is insulation between the two walls. Incidentally, the exhaust from this engine is relatively cool and "clean," meaning that its hydrocarbon and carbon monoxide content are low.

Unless controlled, a gas turbine's transmission may also be noisy. This is handled on the Ford 704 by an acoustical lining on the outside of the gearbox and sound deadener in the engine compartment. Helical gears are employed for this purpose on the 600-bhp turbine Ford is developing for the Navy.

Ford will not reveal fuel consumption curves on its 704 turbine but one top engineer said the engine had come very close to its goal of a specific fuel consumption of 0.48 lb. fuel per horsepower hour at 50% load. At higher loads, the fuel consumption is even better. Ford officials are quite pleased with this situation, since heavy-duty trucks operate much more in this range than do passenger cars.

Fuel-consumption target is to meet (or beat) that of the Ford truck 534-cu. in. piston engine. The good economy of this turbine is attributed largely to the stationary heat recuperator and the supercharging combustor. Also, there is no "gulping" of fuel as deceleration begins. And turbines usually provide a precise metering of fuel such as is present only in a piston engine that has fuel injection.

Being unfamiliar with a gas turbine, we made a few mistakes in starting and stopping the tractor, but the engine refused to stall. This is because it's "unstallable," since the main power turbine is not connected directly to the transmission. The engineers also noted that vapor lock is quite unlikely because of the electric booster pump in the fuel tank and because the engine uses heavier, less volatile fuels. Naturally, there would be no carburetor icing.

This engine is not a multi-fuel engine and uses a No. 2 diesel oil. However, it has been run satisfactorily for brief periods on an adulterated oil that has a good percentage of sulphur, ash, sediment and sea water—the fuel prescribed by the Navy for the 600-bhp version. Ford engineers could easily convert the 704 to multi-fuel use by installing larger combustors and regenerators less likely to foul up.

Because of the amazing lightness of this engine, the tractor's wheelbase was shortened 18 in., resulting in a 93-in. wheelbase. The objective here was to place more of the existing weight on the rear wheels for adequate traction. Despite this modification, the tractor still frequently burns tire rubber during start-ups because maximum torque is available at that time (from zero rpm).

The 704 engine is 11 in. lower than the diesel engine used in the same tractor, thereby also lowering the cab 11 in.

Ford officials are confident that when turbine power is feasible for public use, it first will appear in heavy trucks. With their experience with this one, they should be ready. ■