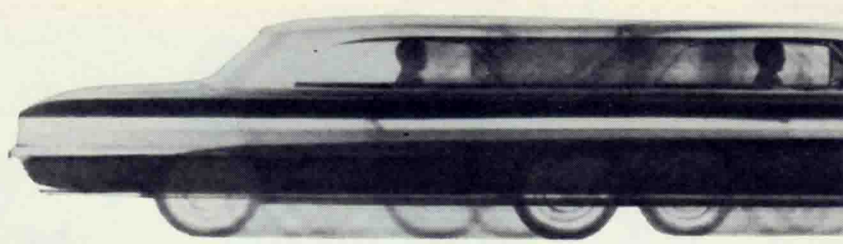
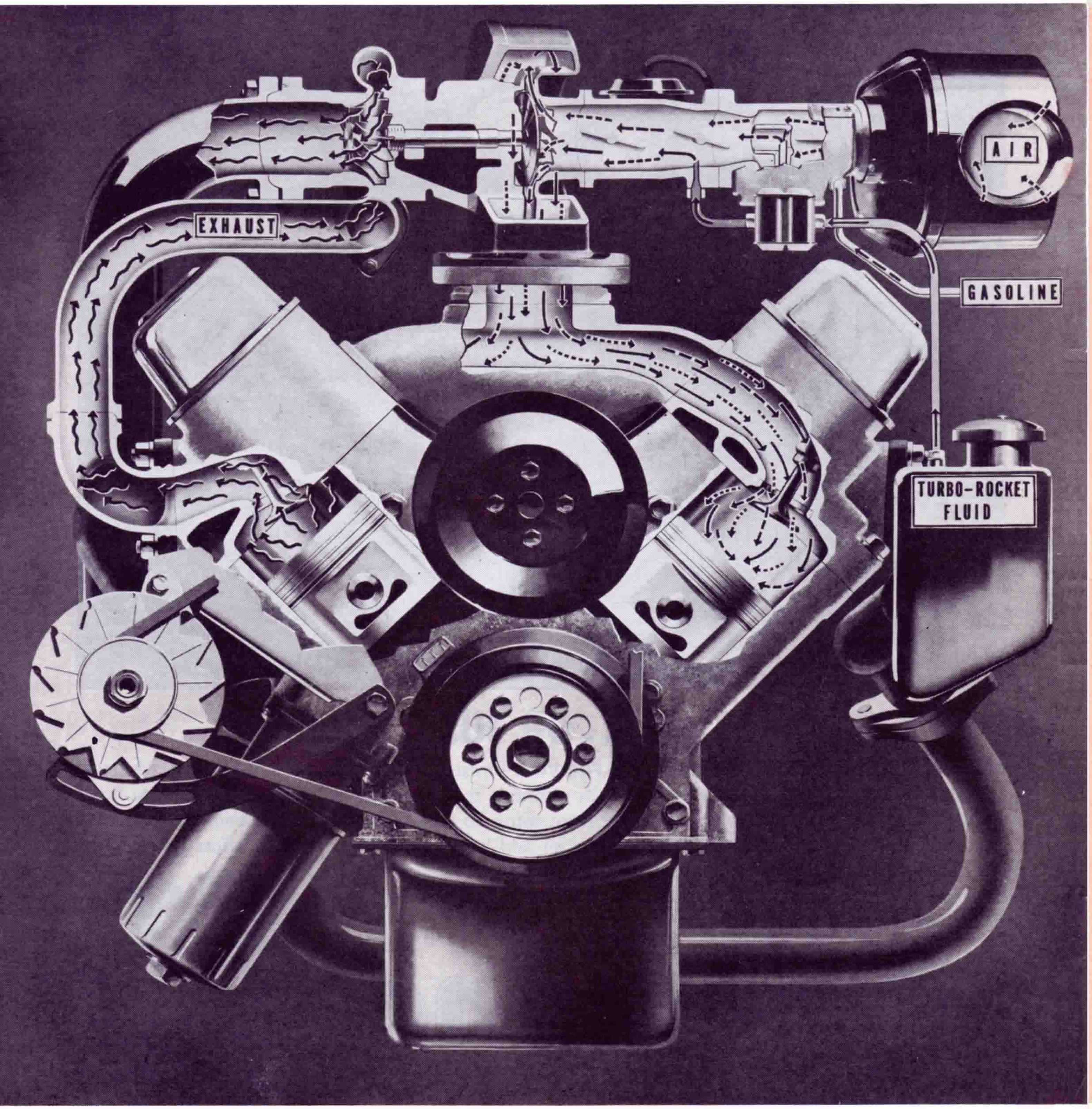
TURBOSUPERCHARGED OLDS F-85





Oldsmobile engineers have put exhaust gases to work driving a supercharger which gives the aluminum F-85 V8 a rating of one horsepower per cubic inch

by Ray Brock

Late last fall, we took a trip to Lansing, Michigan, home of Michigan State University and the Oldsmobile Division of General Motors. Our trip didn't coincide with any of the home games of MSU's football team so we missed seeing their highly rated eleven in action but we did find some excitement on the other side of town at Oldsmobile. Turbosupercharging was the interesting subject we'd come to Lansing to inspect and after a day of listening to, asking questions of and riding with Oldsmobile's engineer in charge of this project, we were convinced that turbocharging was definitely going to earn a niche in the modern American automotive scene.

Gib Butler was the engineer who had been given the assignment of developing a supercharger for the aluminum F-85 V8. Gib not only filled us in on the F-85 Turbo-Rocket 215 horsepower engine but also gave us some background on the project development. The project started in October, 1959, but at that stage of the game an exhaust-driven supercharger was not even considered.

First, the various types of superchargers available were analyzed to weigh advantages and disadvantages. Centrifugal type superchargers which use a fixed ratio drive mechanism have the advantage of high boost potential in relation to power input but a disadvantage in the control of this boost. For the highly flexible American automotive engine which might be called upon to operate at speeds anywhere between idle and 5000-plus rpms for long periods as well as short bursts, a centrifugal blower with positive drive between engine and blower was considered impractical. Gearing the impeller for low speed boost pressure would result in prohibitive pressures at higher speeds and certain engine failures. Gearing for high engine speed boost would mean poor low speed boost in the most desired range. Variable drive mechanisms such as those used in some past designs offer a partial solution but cost, complicated pieces and reliability are other factors that had to be considered.

By May of 1960, Oldsmobile engineers had their first supercharged F-85 engine on the test stand. A Roots type positive displacement blower was being used. Positive displacement blowers deliver a set volume of air for each revolution of the unit, discounting losses due to restrictions in the inlet system, friction, etc. With this type of blower, driving ratio between engine and blower can be arranged for desired boost pressure and it will remain fairly constant from low engine speeds to high. Disadvantages outnumber advantages for a mass-production Detroit item, however. Initial cost is high, physical size is large, driving mechanisms are complicated and room-consuming, they are noisy and they produce excessive heat to the intake charge at high speeds.

The next type of supercharger explored by Olds engineers was the exhaust-driven centrifugal unit. American diesel truck and stationary engines have used this turbosupercharged method for quite a long time with great success but these engines do not require flexibility in operation range. They spend their entire lifetime working in a narrow band of 1000 rpm or so and boost is fairly constant at these speeds.

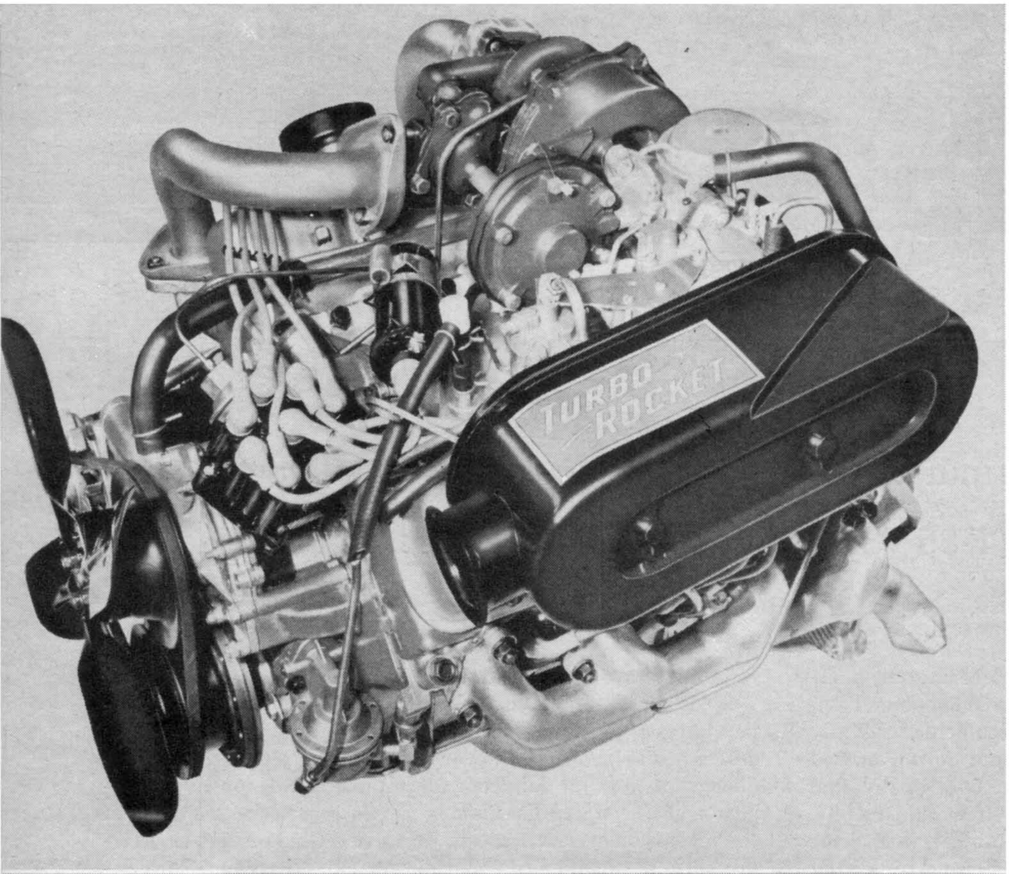
Aircraft engines use the turbosupercharger and although here, too, the engines operate at constant speeds, flexibility is required in the turbocharger due to extreme altitude changes. Aircraft blowers are thus fitted with bypass valves in the exhaust system to bleed off unneeded gases ahead of the exhaust turbine. This bypass, or waste gate, automatically opens at lower altitudes and closes down as the airplane rises into the thinner air at higher altitudes. As the waste gate closes, more exhaust gases pass through the supercharger turbine wheel, turning it faster, which in turn drives the compressor impeller at a higher speed and keeps the boost pressure at a pre-set level.

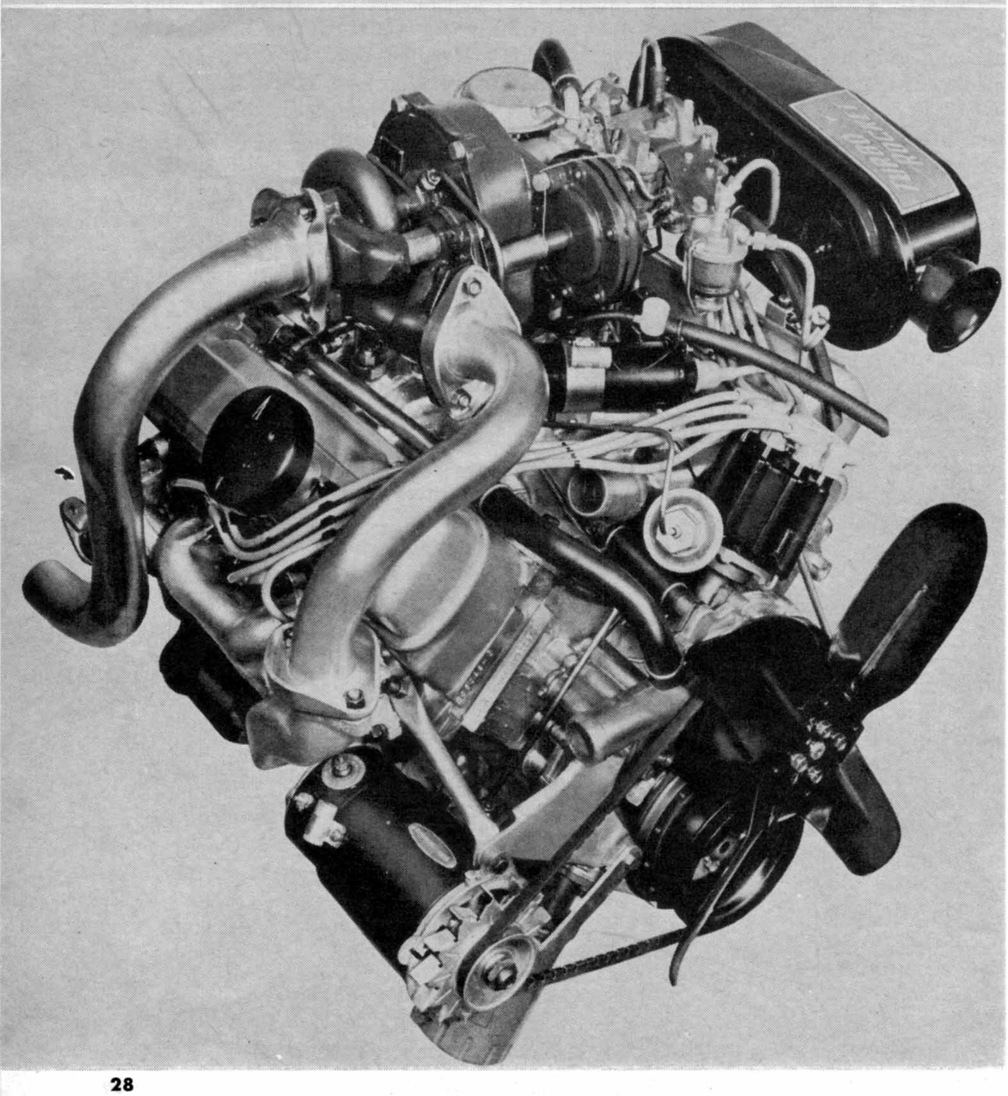
Oldsmobile engineers contacted the AiResearch Industrial Division of Garrett Corporation and development began on an automotive turbocharger which employed the waste gate principle of the aircraft turbocharger. By the time we arrived at Oldsmobile Engineering late in 1961, the problems were pretty well solved and a fantastic new high performance device was in operation.

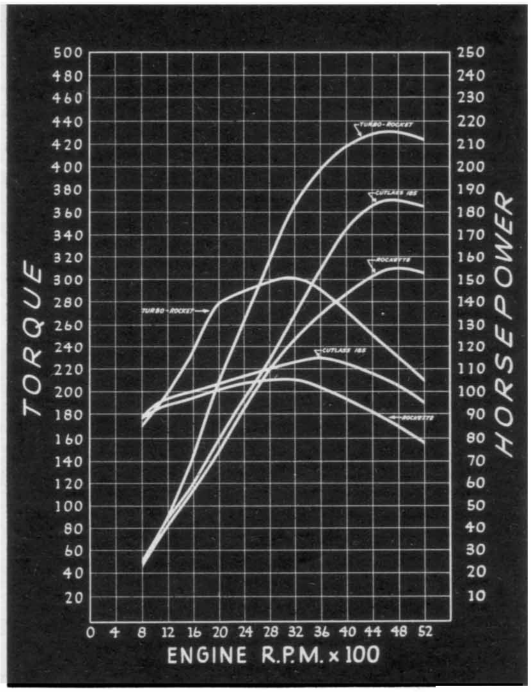
Beneath the turbosupercharger, Olds used the same basic engine that powers their Cutlass F-85 sports coupes and

(Continued on following page)

LEFT — Schematic drawing of Oldsmobile's Turbo-Rocket F-85 shows how the hot exhaust gases leaving cylinder at left side of the picture are routed through the turbine wheel and then out into the car's exhaust system. Turbine drives compressor impeller which pulls air/fuel charge through carburetor and throttle body, then forces charge into cylinders. Turbo-Rocket fluid prevents detonation with boost.







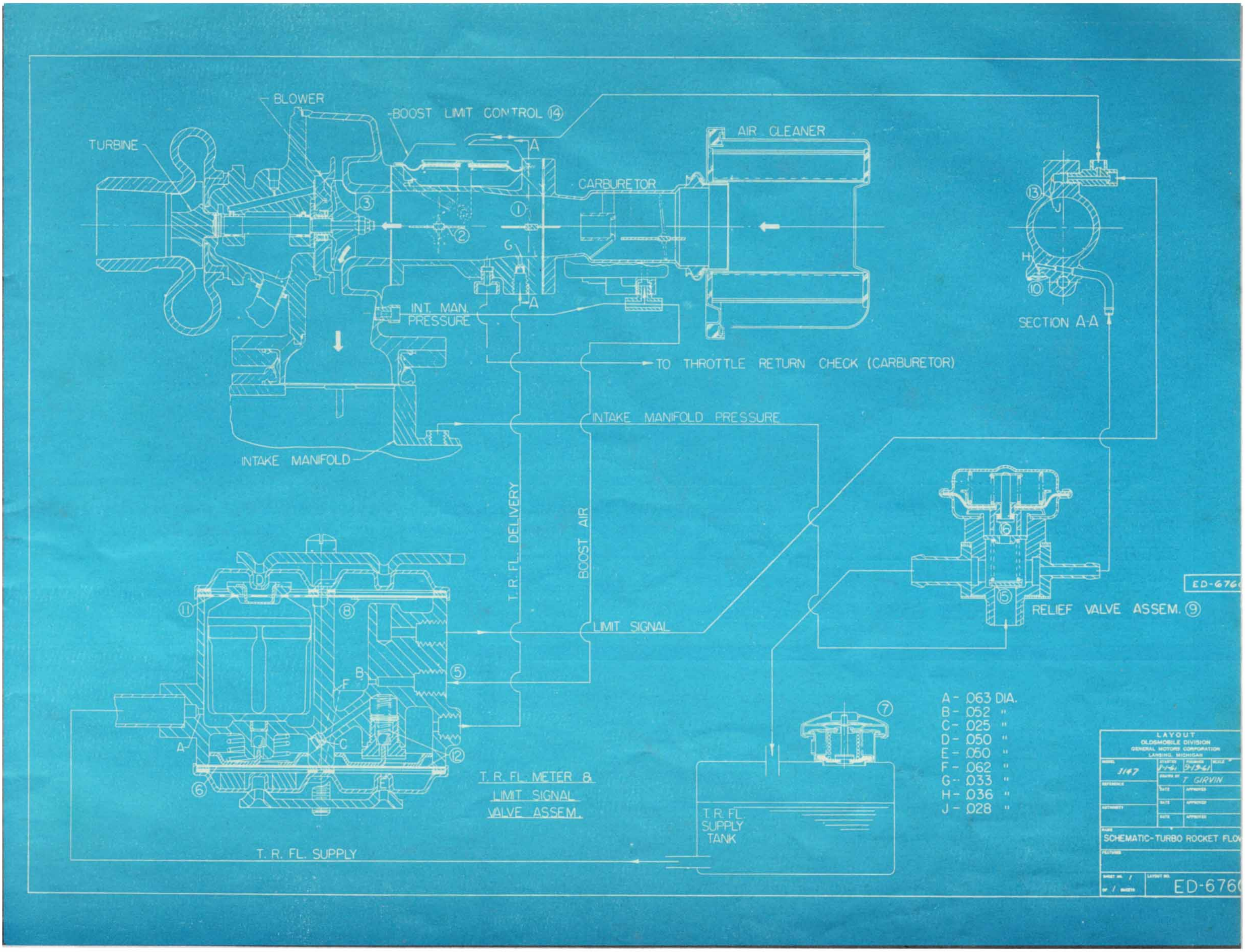
ABOVE—Comparative horsepower and torque curves show steep power gain with Turbo-Rocket engine as compared to four-barreled 185 hp engine and also to the standard two-barrel 155 hp F-85.

UPPER LEFT — Complete F-85 engine with turbosupercharger is complex in appearance with an assortment of tubing and valves on side-draft intake system.

LEFT — Exhaust gases from the left side manifold run through crossover pipe to the right manifold, then to the cast iron scroll around the turbine wheel. After leaving the center of the turbine wheel, exhaust gases pass on into the standard exhaust piping. Exhaust component and blower get hot in operation.

TURBOSUPERCHARGED OLDS F-85 continued

convertibles. This Cutlass 215 cubic inch aluminum V8 used a hydraulic camshaft, single four-barrel carburetor, 10.25:1 compression and has a 185 horsepower rating. Heavy duty pistons with a beefed top section were used to resist possible detonation. The high compression ratio of 10.25:1 was retained to ensure good low speed power as well as cruising economy. Heavier main bearing caps were installed and both main and rod bearing inserts were changed to the heavy-duty Morraine 400 type for precaution with the heavier loads of the turbocharged engine. Other changes made to adapt the turbocharger unit included: New exhaust manifolds and piping to direct gases to the turbine wheel; intake manifold with



Until a demand is made for boost pressure, the intake system on the Turbo-Rocket engine operates exactly as on a conventional engine with the impeller free-wheeling. Upon demand, the intake manifold pressure becomes positive and boost air activates the fluid meter and limit signal. Boost air also pressurizes the fluid tank and forces anti-detonant fluid into system.

Photos by Oldsmobile Division of General Motors

larger branches and blower mounting; side-draft Rochester carburetor and throttle body; positive crankcase vent; and anti-detonant system.

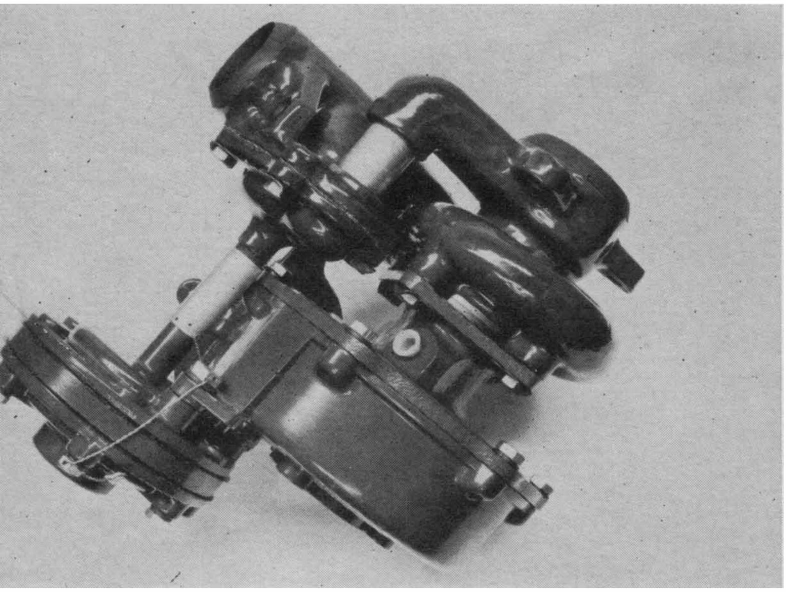
The heart of the turbocharger unit is a Stellite steel turbine wheel and shaft with an aluminum compressor impeller on the opposite end. Altogether the length of these pieces is 5¾ inches with both turbine and compressor impellers just under 2½ inches in diameter. This assembly spins at a maximum speed of 90,000 rpm, well below its design burst speed of 150,000 rpm. Needless to say, the assembly is precisely balanced.

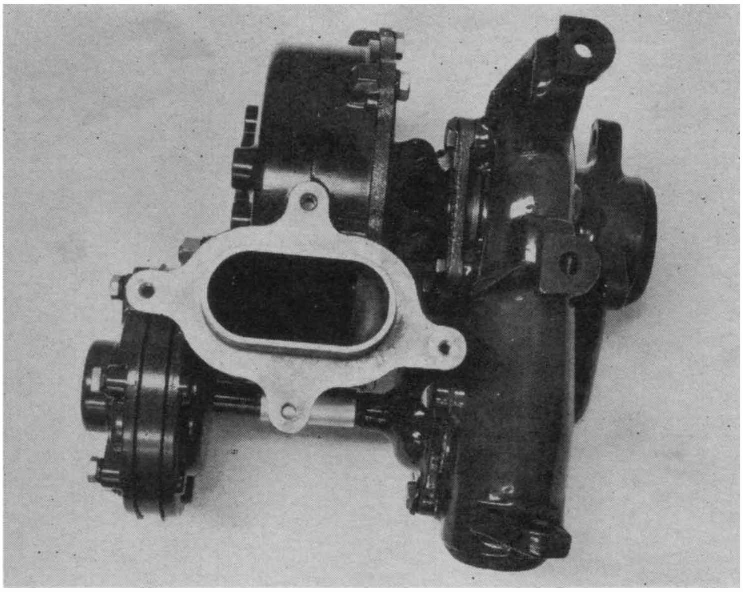
The turbocharger is made up of two basic types of metal. All parts which will be in contact with or effected by exhaust gas heat are cast iron or steel. The intake side of the unit uses aluminum components for the most part. The exhaust gases enter through a tapering cast iron scroll which directs the gases to the tips of the turbine wheel. These gases spin the wheel as they pass through the curved blades and out through the center. As the expanding gases leave the turbine wheel, the blades have a steep angle which gives a final "kick" to the wheel.

On the inlet side of the exhaust scroll, a side passage is sealed off by a poppet valve at low boost pressure but when boost pressure exceeds the desired maximum of 10 inches mercury or five pounds above atmospheric, a pressure diaphragm opens the poppet valve "waste gate" to bleed off enough exhaust pressure to keep the boost at five pounds. This waste gate merely bypasses the gases around the turbine wheel and into the outlet side of the scroll.

The turbine shaft is supported on either end by simple sleeve bearings which are fed by an oil line from the main engine oil gallery. Drainback is through a tube into the right rocker cover. On the turbine end of the shaft, a series of six heat dam grooves around the shaft plus a close fitting bore in the cast iron housing prevent the exhaust gases from entering the bearing housing. Under extreme full load conditions, the exhaust gases reach temperatures of 1500° F and the entire exhaust system, including turbine housing, reaches a cherry red condition. Surprising enough, this heat does not hurt

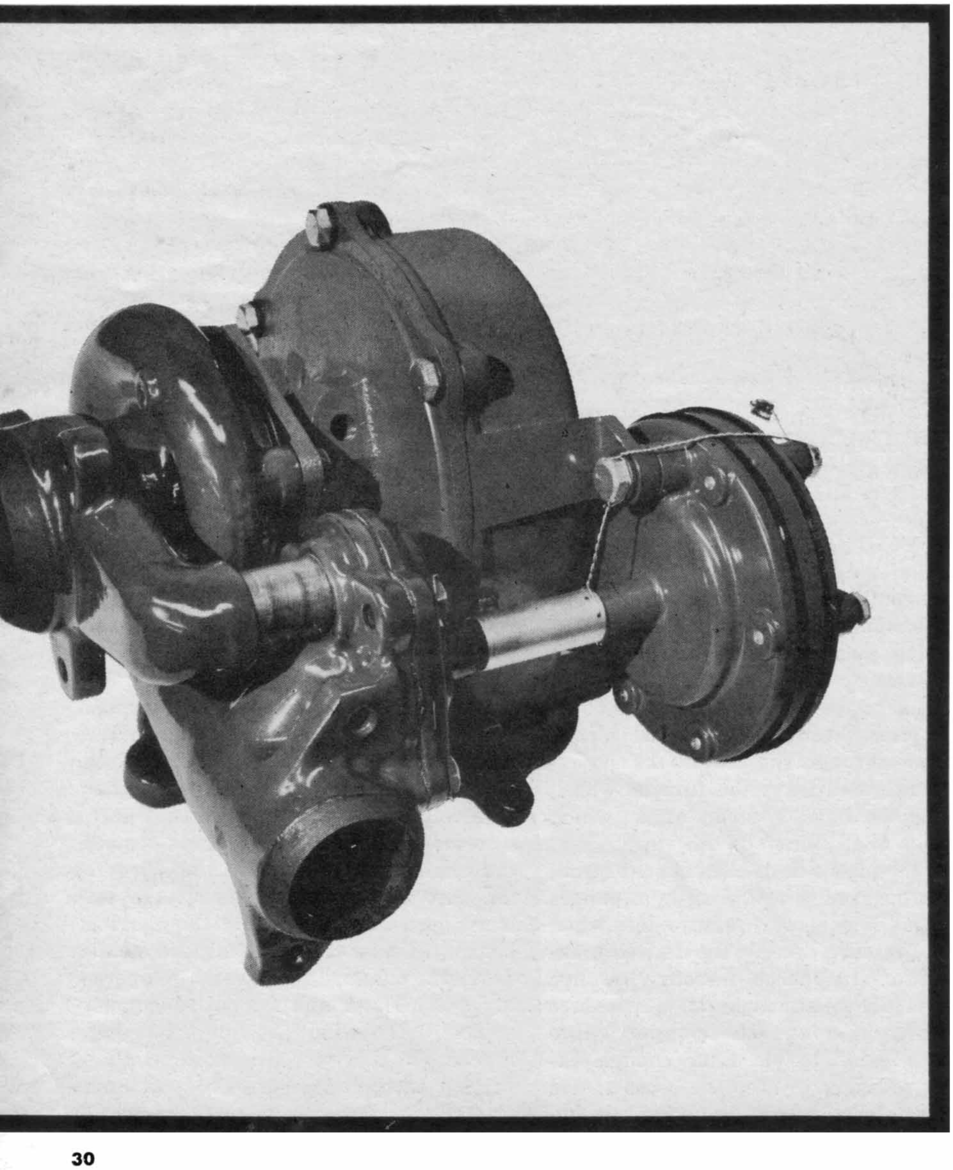
(Continued on following page)

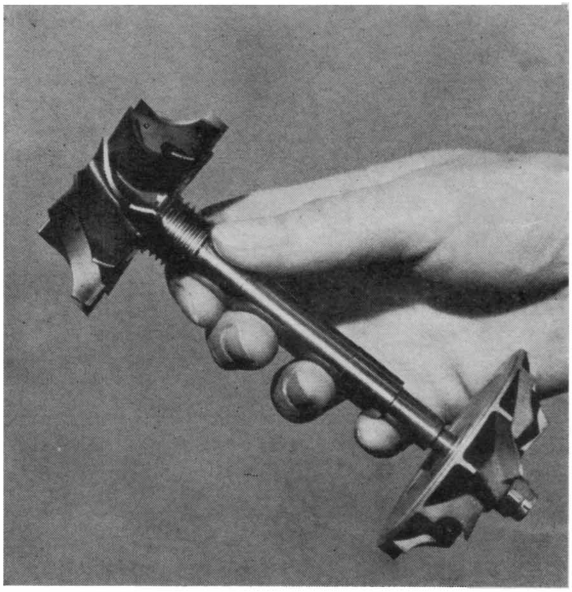




LEFT — In view, the lower part of the unit is intake with cast aluminum scroll and waste gate control diaphragm housing. Stem from diaphragm is activated by boost pressure to open poppet valve waste gate, partially bypass exhaust gases.
RIGHT — Bottom view of the AiResearch unit shows the outlet flange that bolts unit to intake manifold. Also visible is the flange for oil drainback fitting in the cast iron portion which houses the sleeve bearings for impeller shaft.

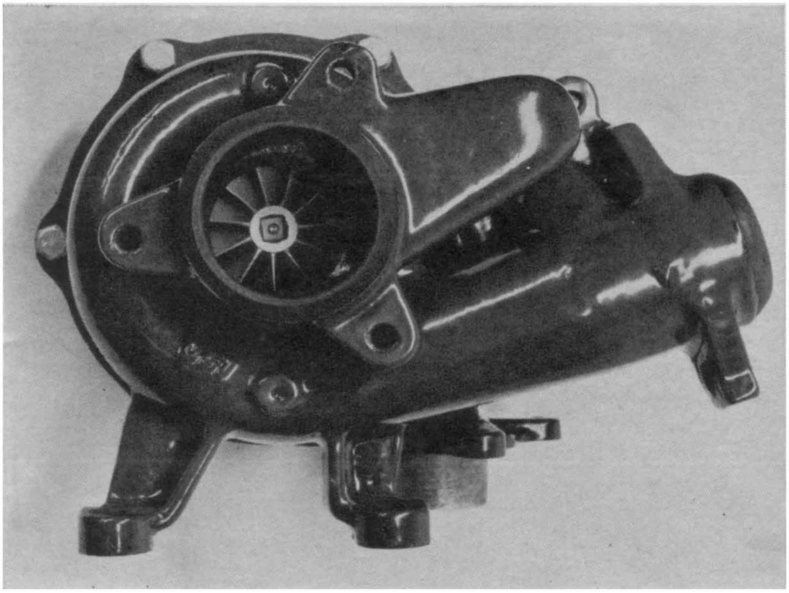
TURBOSUPERCHARGED OLDS F-85 continued

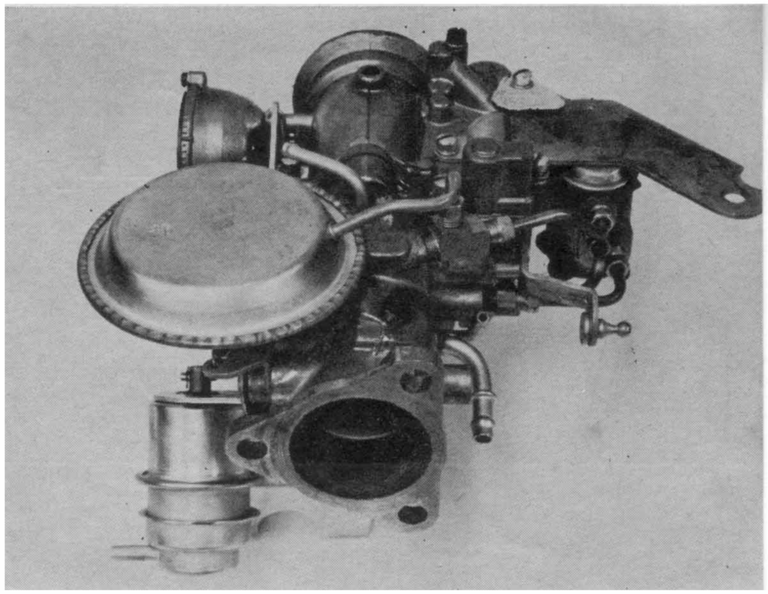




ABOVE – This is the vital working part of the unit. The Stellite turbine wheel, left, can operate in very high temperature exhaust gases. It drives the shaft mounted in sleeve bearings which in turn drives the aluminum compressor impeller. Maximum speed of this delicately balanced unit is 90,000 rpm.

LEFT — Hot exhaust gases enter the turbine scroll at the bottom, exhaust through center of turbine and outlet at left. Waste gate valve is located just inside inlet opening and bypassed gases go through the steel sleeve and into passage that leads into the outlet opening.





LEFT — End view of the exhaust side of the impeller shows tapering scroll housing which directs gases to the turbine. RIGHT — Throttle body and Rochester side-draft carburetor are shown bolted together. Butterfly valve visible just inside the throttle body is operated by the diaphragm unit at left to restrict intake should fluid injection system run dry or fail to operate. Unit hanging from the stamped steel bracket at the right side is the fluid metering and limit signal valve.

the unit; it's designed to take it. On the opposite end of the shaft, a thrust washer and seals keep lubricating oil from being pulled into the intake system during high manifold vacuum.

The intake housing is aluminum and bolts directly to the cast iron turbine housing. At the point of connection, however, there has been plenty of space allowed for air flowing through the engine compartment to cool the cast iron. Air and fuel from the carburetor are pulled through the center of the aluminum compressor wheel and centrifugally thrown into the gathering scroll which then directs the charge into the intake manifold. Boost is supplied to the intake charge only when the throttle setting demands. At light throttle the compressor turns at a relatively low idle speed, only 5,000 or 6,000 rpm.

When the throttle is opened, requesting additional power, intake manifold pressure drops from a partial vacuum to nearly atmospheric pressure. Should power be required beyond this point, the turbocharger starts supplying boost pressure. At full throttle, boost pressure actually starts at 1200 rpm and reaches its pre-set maximum of five pounds at 2200 rpm. Once manifold pressure reaches 1 pound positive, special anti-detonant fluid is injected into the throttle body to prevent detonation. As the pressure continues to rise, the design maximum of five pounds boost is reached and a passage between the compressor scroll and the waste gate control valve directs pressure to a diaphragm which opens the waste gate just enough to maintain the five pound boost. If engine speed and exhaust gas pressure becomes greater, the waste gate opens wider. After the power demand is past and the throttle closed, the pressure drops, anti-detonant fluid stops, the waste gate closes, the turbine slows to idle and the engine returns to normal operation just as it would be without a turbocharger.

A new Rochester carburetor is used for Oldsmobile's Turbo-Rocket engine. It is of the side-draft venturi variety but quite unusual in design for it has no throttle valve. The carburetor has bowl and float, idle system, primary system, secondary system, venturi, primary cluster and automatic choke butterfly but no throttle. A separate unit between the carburetor and the blower inlet contains two butterfly valves. One is for the throttle and the other is a boost limit control which restricts the inlet should the anti-detonant fluid run out. This limit butterfly blocks about two-thirds of the area in the throttle body when fully closed to prevent damaging operation until more fluid is added. When this limit valve is operating, the car can be driven at normal cruising speeds but acceleration and top end performance are restricted.

The anti-detonant system, which Oldsmobile refers to by the more exotic name of fluid injection, consists of a five-quart tank for the fluid, a fluid metering and signal valve, a relief valve and a spray nozzle in the throttle body. Looking at a blueprint on the system will drive you nuts but actually the fluid injection part is simple; it's the various safety devices which confuse the issue. In simple terminology, when manifold pressure becomes positive, the supply tank is pressurized and this pressure forces the mixture of distilled water, alcohol and anti-corrosive additives into the fluid metering and limit signal valve. At one pound positive manifold pressure, the metering valve opens and fluid is sprayed through a nozzle into the throttle body. This continues as long as the boost is above one pound. At wide open throttle and five pounds boost, the five-quart capacity of the tank is enough for 300-400 miles. Under normal driving conditions, the fluid should last as far as 8,000 miles.

Now we get to the safety devices which make the fluid injection system sound complicated. When building a car for the average Joe's all over the country, you've got to consider all possible things that could go wrong, either accidentally or through failure to service, and then devise a safety measure. On a supercharged engine this is particularly important since too much boost pressure or no anti-detonant fluid could result in a ruined engine in a hurry.

Probably the most common thing that will happen in years to come with the Turbo-Rocket engines is that owners will forget to keep the level up in their fluid injection supply tank. There is a float gage which will turn on a light in the instrument panel when there's still a quart left in the tank but should a driver ignore this, there's another safety device. If the tank runs completely empty, the float drops in the limit signal valve and opens a passage which directs manifold pressure to the boost limit control at the throttle body. Should full throttle be attempted at this time, the slightest amount of boost pressure will act on a diaphragm that controls the limit valve in the throttle body and close it, restricting inlet air. Normal operation is not restricted but full boost cannot be attained and maximum

(Continued on page 86)

TURBOSUPERCHARGED OLDS F-85 continued from page 31

power is cut. Should the driver not have a new supply of fluid immediately available, distilled water can be used in an emergency. The main reason for the alcohol in the fluid is to prevent freezing in cold weather and the anti-corrosives prevent stoppage of the small passages in the system. Should other than original Oldsmobile injector fluid be used, it should be drained and replaced with the original fluid as soon as possible to prevent deposits clogging the small orifices in the metering valve.

Should there be some malfunction in the waste gate control valve on the turbocharger, a safety device gives protection. This control valve is preset and non-adjustable. A spring exerts five pounds pressure on the waste gate valve and pressure above the setting is bypassed. If the valve is tampered with in an attempt to raise boost pressure, or if the valve should stick closed, a boost pressure of 7 pounds will cause the pressure cap on the fluid tank to pop-off and this stops fluid from reaching the signal valve. When the fluid stops, the limit control valve in the throttle body again comes into play to limit boost. A reset button of the filler cap can be pushed to reactivate the fluid system but of course the cause for overboost should be found and fixed.

After Gib Butler had spent quite some time familiarizing us with the turbocharger's innards and answering our questions, he took us out for a spin in a Cutlass coupe equipped with a 215 horsepower Turbo-Rocket engine, Hydra-Matic transmission and 3.36 rear axle ratio. After Gib explained the layout and maneuvered us out into the country where there was little traffic, he stopped and we changed places. From the passenger compartment, the only visible indication that this was an extra-special car came from the pressure gauge mounted on the console beneath the instrument panel. Varying shades of green on the fan shaped dial indicated the manifold pressure was less than atmospheric pressure while deepening shades of red past the midway point indicated boost pressure above atmospheric.

In normal driving, there was no possible indication that a small tornado was hidden beneath the hood. Idle was smooth and the engine was exceptionally quiet. Once you made the demand for power by stomping on the throttle, though, there was a different story. A smooth, quiet, but positive surge of power made itself known in a hurry. Response was almost instantaneous; just a fraction of a lag as the gauge flashed over to the red side of the dial

(Continued on page 88)

TURBOSUPERCHARGED OLDS F-85 continued

and the Cutlass darted forward. At lower car speeds, full throttle would cause the automatic transmission to downshift and during this downshift period, the blower would be supplying full boost. At higher engine speeds, there was no lag at all; transition to full boost was immediate.

Gib informed us that test drivers at GM's proving grounds had recorded zero to 60 times under 7 seconds with a standard transmission and even our car felt like it would do nearly as well with the Hydra-Matic. The most amazing thing to us was that the high 10.25:1 compression and full boost at 2200 rpm gave outstanding low rpm power and yet the car would still be accelerating rapidly when the speedometer passed the 100 point. Gib informed us that someplace on up the line, around 5500 rpm, back pressure within the stock exhaust system would probably restrict the engine so that it would be delivering about the same as the normally aspirated Cutlass engine with four-barrel carburetor.

We drove back to the plant, lifted the hood and tickled the throttle a few times while we placed our head as near the turbocharger as possible without getting a blistered ear. It was absolutely impossible to hear the turbocharger over regular engine noises. And, we might add that the F-85 engine was very quiet. During our test drive with full throttle starts, passing bursts at low speeds and high, we never once heard any indication of detonation from the engine. The combination of an aluminum engine with high mechanical octane rating, the automatic fluid injection and premium grade gasoline proved to be an ideal combination.

Frankly, we hadn't expected much from the new "gimmick" we'd heard about when we visited Oldsmobile last fall but when we left town later that day, we were a convert. Prices have not been announced as we go to press so we don't know how much extra Turbo-Rocket cars will cost but Oldsmobile's engineers confided that they were planning to sell several thousand units a year so the price must be planned fairly competitive.

The Turbo-Rocket is not intended just for a special high performance model either; it will be available in all models and every piece of optional equipment available for the F-85 line can also be ordered on the car. Boy, just think of the startled gas station attendants when they lift the hood of an F-85 to find power steering, power brakes, air conditioning *and* a turbosupercharger. What a hoodfull and what a compact this ought to make!