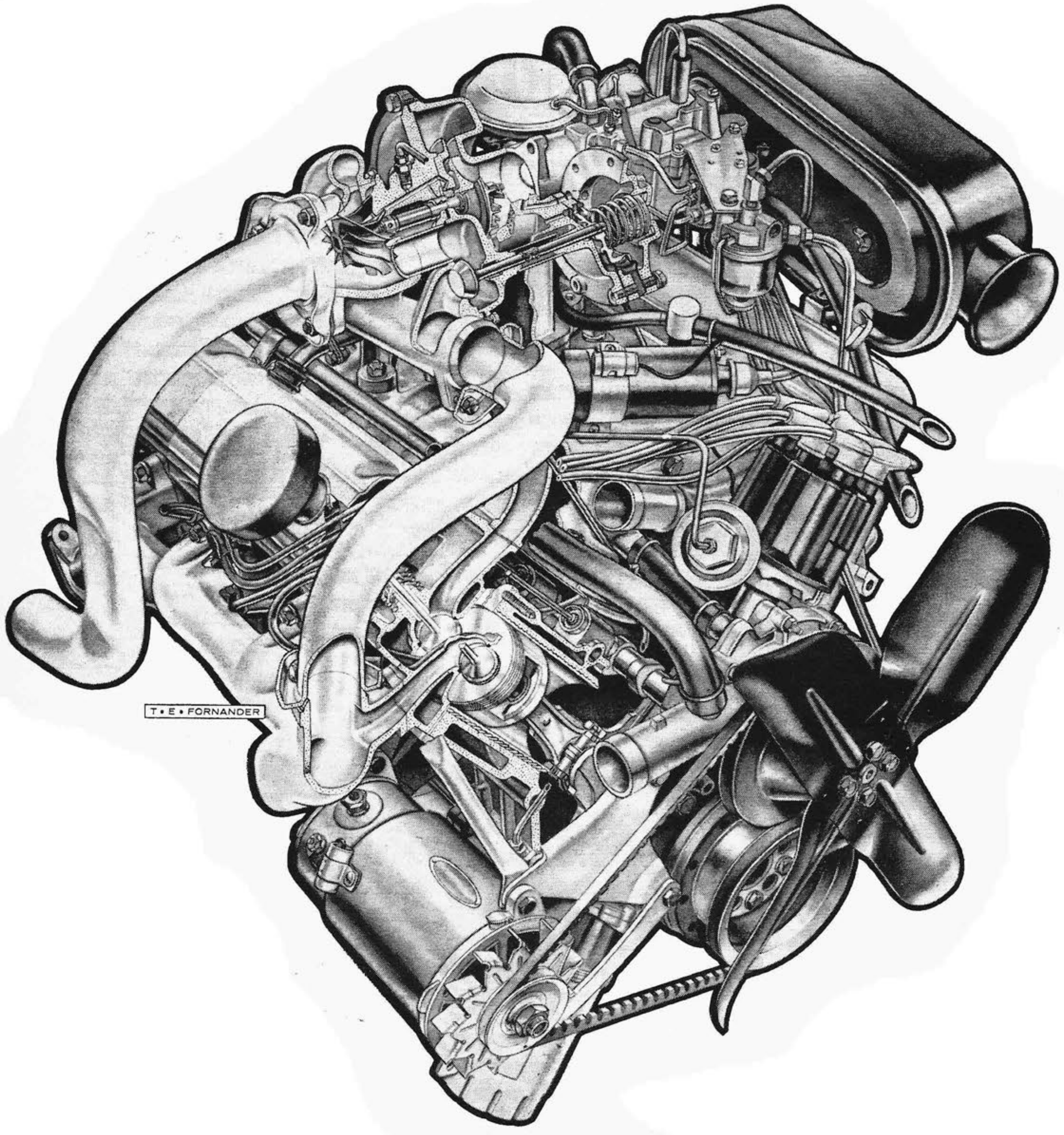
Turbo-Rocket Power For the Olds Jetfire

By Roger Huntington



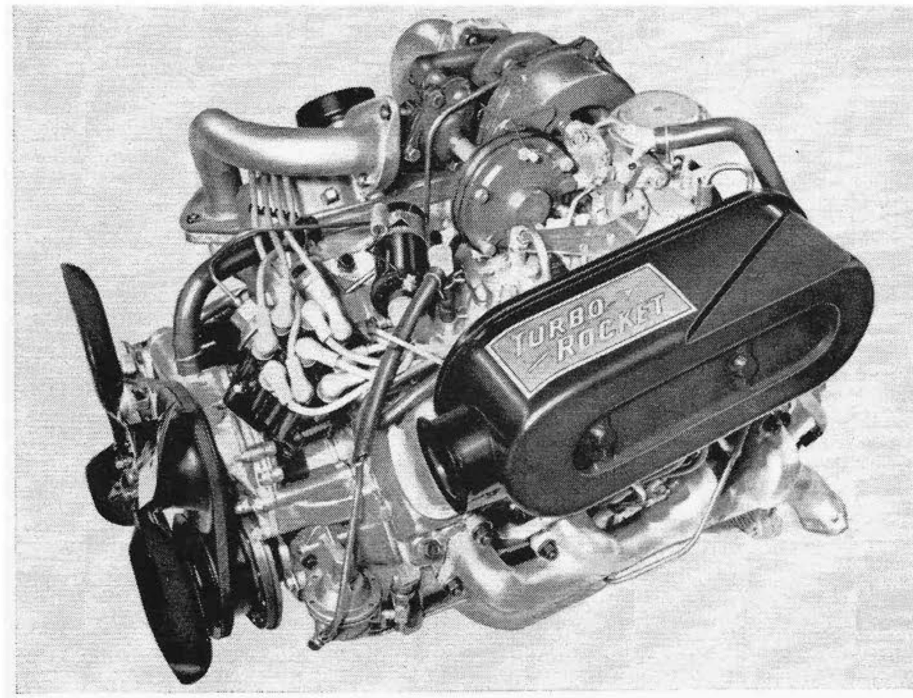
Based on the Rockette aluminum V-8 engine, the Turbo-Rocket develops 40% more power with no increase in fuel consumption.

Oldsmobile introduces the first turbocharged gasoline-powered passenger car

One of the major power losses in the internal-combustion engine is the waste of exhaust gas. The idea of recouping some of the energy stored in the exhaust gas is old, and the first supercharger driven by an exhaust-gas turbine was fitted to a Liberty aero engine by Jesse G. Vincent of Packard in 1918. The first automotive application was when Dr. Alfred Büchi mounted a turbocharger on a Saurer truck in 1938 and completed a test of over 60,000 miles on the road without major trouble. Through the Büchi patents, Saurer and Brown, Boveri & Cie were able successfully to apply turbo-chargers to rail-car and marine engines.

Just how important a step of progress this constitutes is hard to say at the moment of its introduction. But what the Olds technicians have succeeded in doing has never been accomplished before. They have boosted the mid-range torque of a basic engine by 40% without major retooling for the power plant, without in any way affecting low-end smoothness and flexibility or impairing the gas mileage. The whole project started before the original Olds F-85 was introduced towards the end of 1960. Faced with a growing sports-luxury segment in the compact-car market, Oldsmobile Division general manager Jack Wolfram called for some performance development. This put the head engine man, Gil Burrell, at the crossroads right away. He had been down this route many times—higher compression ratio, bigger bore and stroke, larger carburetors, hotter cams, bigger ports. He knew the old tricks meant an inevitable loss of low-end flexibility and a substantial increase in fuel consumption. Then Burrell happened to remember an old report filed by GM Research in the middle Fifties. The project had investigated turbochargers to boost the output of a basic engine to make possible its use in a heavier car.

The report quoted numerous test figures to prove that the turbocharger would *not* be adaptable for such use. But Burrell dug it out anyway and started to do some studying and figuring himself. He went through the field of available commercial turbochargers, studying their operating characteristics and installation details. He found that with one of the several types of exhaust by-pass or "waste-gate" systems he could get full boost pressure as low as 2,000 rpm and hold it steadily up the whole speed range. This would give the big torque increase in the mid-range that was wanted while retaining the stock camshaft for low-end flexibility. It would be oversimplifying to say that the Oldsmobile turbo project had clear sailing after Gil Burrell got interested. A lot of work was done on it before the front office agreed to go ahead with production design and tooling. Designer Gibson Butler took over the details and nursed the scheme for several months, and Jim Buckley spent hundreds of hours testing in the dyno labs. The times when the turbocharger looked better on paper than on the street or on the dyno were frequent. But thanks to these men, with the aid of assistant chief engineer Jim Lewis and experimental engineers Ed Rosetti and Ted Loukas, the AiResearch blower made by the Garrett Corporation has been adapted to an automobile now in limited production at Lansing.



The turbocharger is essentially a bolt-on kit, but these production engines have reinforcements to give reliable operation and long life with higher horsepower.

The new F-85 Turbo-Rocket engine is practically equivalent to a standard four-barrel power pack (185 bhp) with the turbo-compressor-carburetion unit bolted on. The main differences that had to be undertaken with the basic engine were reinforcement of the main-bearing caps, installation of Moraine aluminum bearing shells, modification of the spark-advance curve, use of cooler spark plugs, reinforcement of the piston crown to take the higher temperatures and loads, and installation of a larger radiator. The turbocharger's aluminum intake manifold uses the same passages as the four-barrel setup, but has a special mounting flange and support bosses to carry the complete turbine unit. The fuel-air mixture discharge from the compressor enters the manifold through two 1 1/16-inch openings in the mounting flange. The turbo unit fits neatly crossways.

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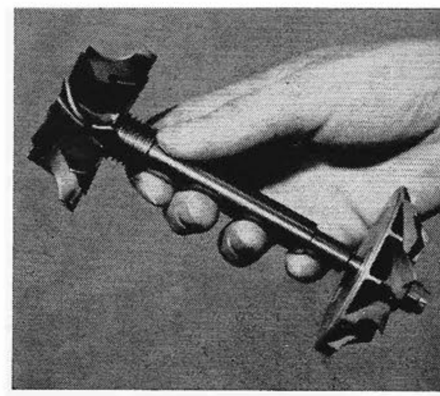
The basic principle may be simplicity itself but the solution is complex

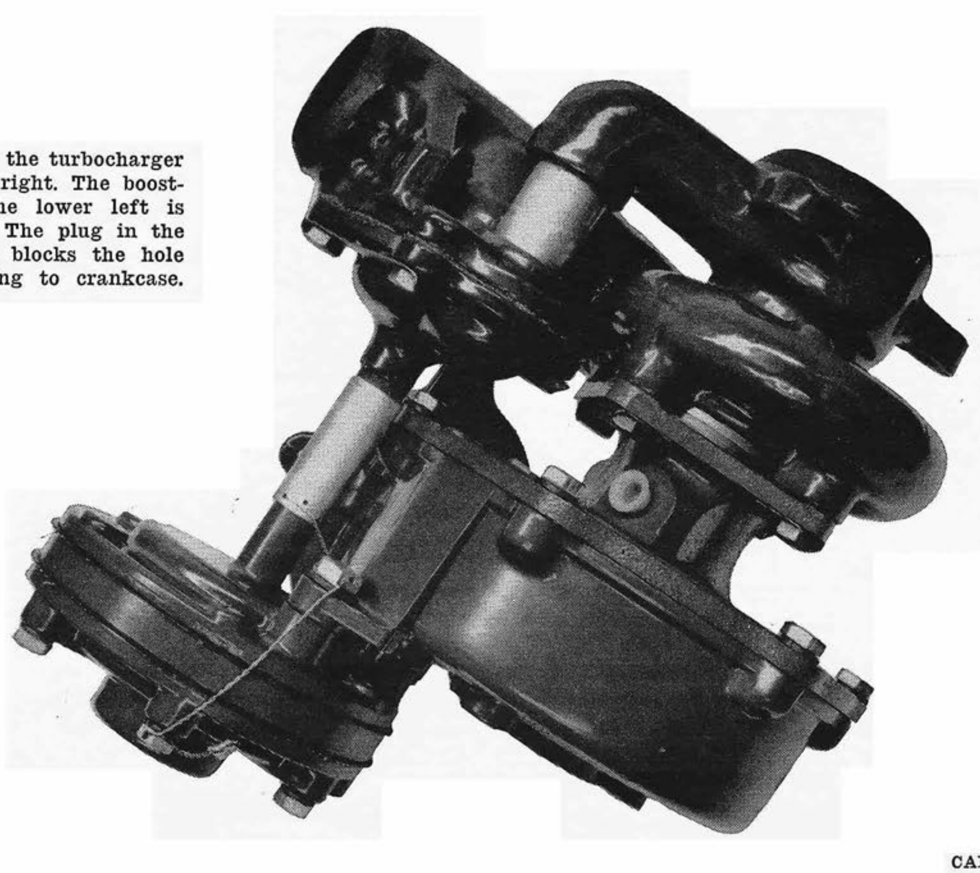
The single-throat horizontal carburetor was especially made by Rochester for this engine. The use of a horizontal barrel was a necessity for reasons of space availability, and there were no really suitable small side-draft carburetors available commercially. The new Rochester design is quite conventional, with the usual internal jetting layout and a 1½-inch venturi. Coupled to the carburetor is the injection system for the "Turbo-Rocket" fluid. This fluid is a 50-50 mixture of methyl alcohol and distilled water, with a small amount of anti-corrosion additives. This fluid will be available in plastic containers from all Oldsmobile dealers, and fluid consumption in ordinary use is estimated at 8,000 mpg.

The purpose of the fluid is to suppress detonation at the high boost pressure with 10.25-to-one compression ratio. Injection starts when the boost reaches one pound. The metering system is highly elaborate. The fluid reservoir is cleverly pressurized by manifold pressure. When cruising, there is a high vacuum in the intake manifold, even with a supercharger, so there is a check valve to prevent fluid from being sucked into the engine under this condition. When boost pressure goes above one pound, a diaphragm in the fluid-metering valve opens a ball check, and the pressure on the fluid tank forces the fluid through a quarter-inch jet. The fluid discharge nozzle is placed between the carburetor and blower in a part of the passage that forms a long venturi, putting a suction effect on the nozzle, the force of suction being proportional to the air flow. The fluel-fluid ratio remains fairly close to 10 to one throughout the rpm range. Although the chief reason for using alcohol in the fluid was its anti-freeze properties, enabling owners to use the same fluid all the year, it turned out that the alcohol content added six bhp to the engine's power output.

One may wonder whether the fluid injection is really necessary. The Olds engineers tried reducing the compression ratio until the engine would run without detonation when deprived of the fluid, and had to go down to 8.5 to one. With the engine in this form, there were heavy torque losses as well as an increase in fuel consumption. In production form, the Turbo-Rocket engine develops 215 bhp at 4,600 rpm, compared with 185 bhp at 4,800 rpm for the unblown four-barrel F-85 engine. Maximum torque has been raised from 230 lb-ft at 3,200 rpm to 301 lb-ft at the same crankshaft speed. The torque curve of the turbocharged engine starts to rise above the four-barrel's curve as low as 1,200 rpm, growing into a veritable power bulge by the time 2,000 rpm is reached. Blower pressure starts up at 1,000 rpm, and manifold boost reaches six pounds at 2,000-2,200 rpm, at which speed the by-pass valve starts to open. It will hold between four and six pounds right up to 5,000 rpm. Power falls off fast above 4,600 rpm because of the restriction of the carburetor and the



Both the small dimensions and the high precision of the turbine (left) and compressor (right) parts are clearly evident.

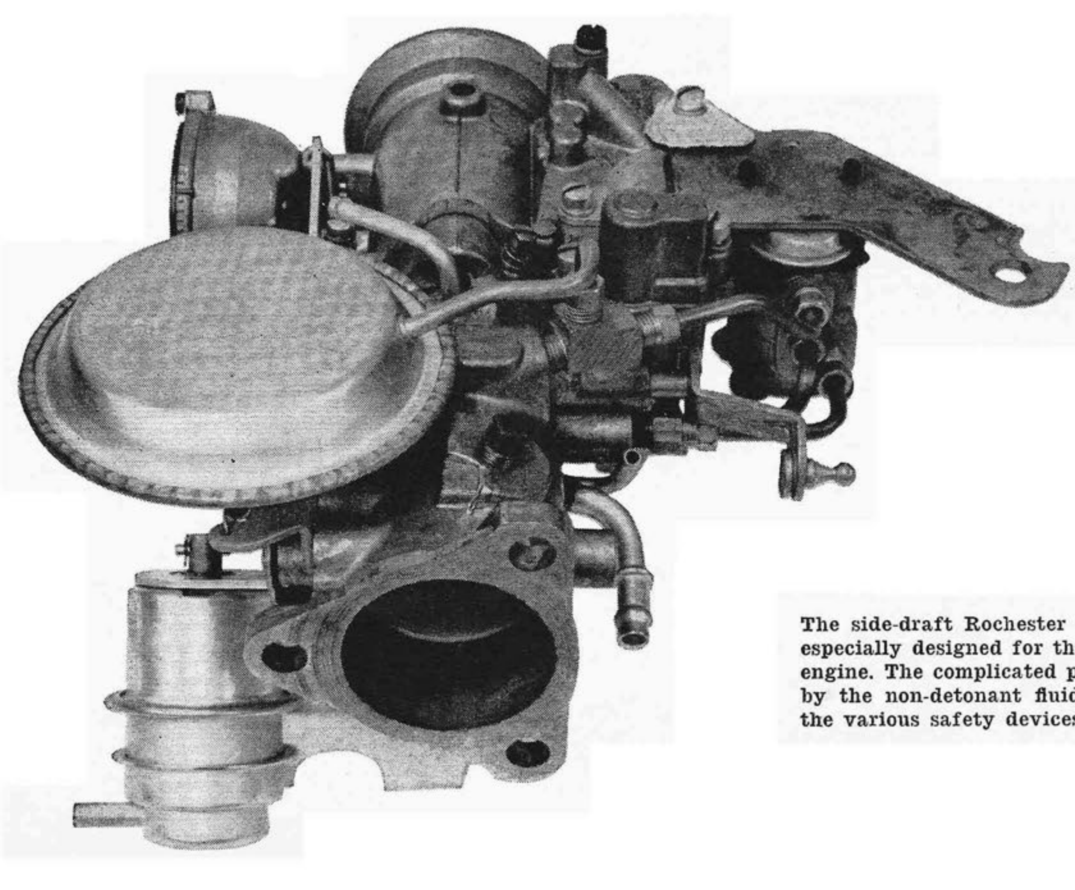


The compressor part of the turbocharger is shown at the lower right. The boost-limit diaphragm at the lower left is sealed at the factory. The plug in the compressor-shaft cover blocks the hole for the oil pipe leading to crankcase.

flow passages. Something over half of the exhaust gas is going through the by-pass at peak power. Both the turbine and the compressor have been designed for maximum efficiency in the 2,000-3,000 rpm range.

The diameter of the turbine has been cut down to an incredible 2.40 inches, and its speed range is from 6,000 rpm at 30 mph to 90,000 rpm at maximum speed. The small turbine diameter has cut turbine response time on kickdown to less than one second. This is a tremendous achievement, for it means an acceleration of approximately 40,000 rpm. The normal cruising speed of the turbine is about 40,000 rpm, from which speed it will, when the accelerator is floored, reach 80,000 in under a second. The turbine and the impeller are mounted on a single shaft, in separate housings, separated by bearings, seals and an oil sump. There is forced lubrication to the compressor shaft, which runs in aluminum sleeve bushings, and an oil-sump drain tube to connect back with the crankcase. The oil flow also carries off a lot of heat from the turbine section. A labyrinth-type seal is used on the turbine end of the shaft, with a plain carbon friction seal on the compressor end. The high heat at the turbine end prevents the use of conventional seals, but the exhaust-gas pressure in the turbine housing prevents any oil from leaking away there. The temperature rises as high as 1,450°F in the turbine, the vanes of which are an alloy of high-nickel steel, stellite and cobalt. The radial-inflow turbine works like a supercharger impeller in reverse. Gas strikes the tips of the blades, applying torque, then slips down the vane to escape at the hub. Generally a ring of nozzles is used to direct the gases against the turbine, but Oldsmobile gets a broader effective operating range by shaping the housing to act as a crude nozzle ring. The centrifugal compressor is 2½ inches in diameter and is precision-made of die-cast aluminum.

Oldsmobile has a tradition for leading the trend of technical development at General Motors. Olds had Hydra-Matic transmissions before Cadillac, and high-compression overhead-valve V-8 engines before the other divisions. The turbo-supercharger seems such a radical development that we hesitate to prophesy its introduction on the basically similar engines used by Buick and Pontiac. It is certain, however, that the Oldsmobile engineers have put as much effort into making the turbocharger safe and reliable as they have in developing performance. One of them expressed it this way: "It's 'safetied' to death." If, for instance, the by-pass valve sticks closed, so that all the exhaust gas is forced through the turbine, causing the boost pressure to rise beyond the limits of the design, there is a diaphragm in the fluid-metering valve body which opens at six pounds boost, venting the excess pressure to a "boost limit" control on the throttle body. This consists of a second diaphragm that operates a butterfly throttle valve in the air passage leading to the blower. The extra pressure would start to close this throttle, choking off the air flow and reducing the boost. The car will still run with this valve nearly closed, as it does not cover the passage completely, but the boost would be limited to about one pound, giving performance roughly equivalent to that of a standard two-barrel F-85. A light on the instrument panel comes on when the anti-detonant fluid level is down to one quart. But even if the warning is ignored and the reservoir runs dry, a float in the metering-valve body drops down and opens a vent that in turn opens the diaphragm for the boost-limit control, limiting the boost to about one pound and obviating the need for fluid injection. The Oldsmobile Jetfire with the Turbo-Rocket engine is now in limited production, and every engine is given a run-in on the bench and all functions of the turbocharger are carefully checked before installation. Oldsmobile has done everything in its power to assure that this piece of power equipment should work with complete reliability in the car.



The side-draft Rochester carburetor was especially designed for the Turbo-Rocket engine. The complicated piping is caused by the non-detonant fluid injection and the various safety devices needed for it.