

# A Few Facts on Supercharging

## WHAT IT IS AND HOW IT WORKS

The power output of any internal combustion engine is limited by its ability to take in air or breathe. In order to produce power, fuel must be combined with the correct weight of air to produce the energy necessary to push the piston. The unsupercharged engine depends on getting the fuel/air mixture to the cylinder through the suction created by the piston. Under this arrangement it is seldom that all of the cylinders are fully charged or completely filled with the explosive mixture. It is also seldom on an unsupercharged engine that all of the cylinders receive a uniform charge or the same quantity of mixture. As the speed on an unsupercharged engine is increased the time for each suction stroke of the piston becomes shorter and the quick, short sucking that is obtained at high engine speed is not able to fill the cylinder completely. For this reason the horsepower on an unsupercharged engine decreases after a certain speed is obtained.

The supercharged engine does not depend on suction or a vacuum to charge the cylinders with the fuel/air mixture, but the mixture is forced into the cylinder under pressure. A supercharger is simply a blower or compressor usually mounted between the carburetor and the intake manifold which places a greater quantity of the explosive mixture behind each power stroke of the piston thus increasing the power of the engine. The cylinders on a supercharged engine are always completely filled with the mixture and the engine does not lose its compression as the speed increases because the supercharger is pushing the vapor into the cylinder under pressure. When the valve opens the full charge is waiting to enter the cylinder. All of the cylinders on a supercharged engine are completely filled with the fuel/air mixture and each cylinder receives a uniform charge.

Supercharging increases the horsepower developed by an engine by increasing the torque. Increased horsepower is not obtained by increasing the speed or rpm of the engine. The engine develops more horsepower at the same speed. Basically the power output of any engine is limited by its ability to take in air; supercharging is a mechanical method of forcing the fuel/air mixture into the cylinder instead of using the piston to suck it into the cylinder. The increase in horsepower and improvement in performance obtained by supercharging are made possible by improv-

ing the efficiency of the engine. Because of this increase in volumetric efficiency, fuel economy is not affected to an appreciable extent. Better fuel economy is obtained with a supercharged engine than with an unsupercharged engine developing the same horsepower.

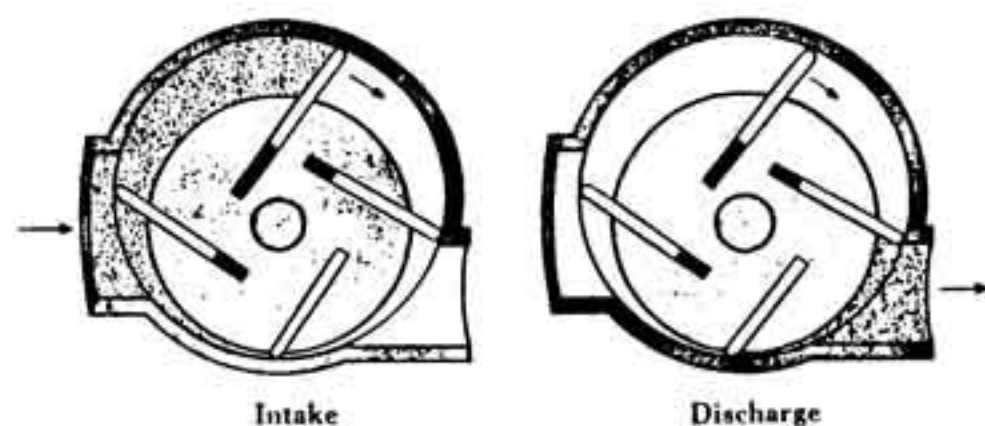
The amount of horsepower produced by an engine will increase in direct proportion to the amount of fuel/air mixture forced into the cylinder. This is not a theory but an engineering fact and is the basis of supercharging. A conservative supercharged pressure of 5 to 6 psi (lbs. per sq. in.) will increase the horsepower developed by an engine between 40 and 50 percent.

Supercharging, in addition to providing more horsepower, better performance, and a smoother running engine, also has other advantages. The power curve on a supercharged engine continues to rise with the engine speed beyond the point at which the torque of the unsupercharged engine begins to fall off. A supercharged engine is subject to less cylinder wear than is an unsupercharged engine as a wet mixture is never placed on the cylinder walls due to the increased atomization of the fuel. The vacuum used by the unsupercharged engine to fill the cylinder with the charge also exerts a suction which draws the oil past the piston into the combustion chamber. In a supercharged engine, however, this vacuum does not exist and as a consequence oil consumption is decreased. Supercharging also eliminates loss of power at high altitudes and high temperature. Due also to the increased atomization of the fuel a supercharged engine is much smoother running and easier to start.

Supercharging is not a new method of increasing the power developed by an engine. Its principles have been understood and used for many years throughout the world. Most automobile manufacturers in the world have at one time or another used a supercharger on a special or deluxe model of their cars. With only a few exceptions no automobile manufacturer has offered a supercharger as a standard item on a production basis. Other than on racing cars, on which superchargers have been used extensively since 1925, weight per horsepower developed has never been an important factor in the manufacture of automotive engines. For this reason the automotive manufacturer has always obtained

greater horsepower by increasing the size and the weight of the engine. Up to the present time the automobile manufacturer has based his engine design on the fact that economy was secondary to performance or that economy was not a factor to be considered in obtaining maximum performance. As a consequence, instead of increasing or improving the efficiency of the engine through supercharging, additional power was obtained by increasing the weight and size of the engine.

When a sufficient number of automobile purchasers demand good performance with good economy through increased engine efficiencies, supercharging will come into its own on a production basis and will be available to the average automobile purchaser. Superchargers are used on all engine applications where efficiency, power, and economy are important. The majority of ocean and transcontinental airliners are supercharged as are all locomotives, large trucks, and most roadbuilding equipment.



### TYPES OF SUPERCHARGERS

Basically there are three types of superchargers. Each type is different in construction, performance and general characteristics.

The centrifugal type of supercharger must operate at extremely high speeds in order to be effective or efficient. (25,000 to 30,000 rpm). This type of supercharger functions on the principle of velocity or a fan. The centrifugal supercharger is ideally suited for an engine that operates within a very narrow speed range so that the output of the supercharger can be matched with the requirements of the engine. It has no internal compression but the mixture or charge is compressed in the manifold from the back flow of the previously delivered charge. Because of this characteristic the temperature of the fuel reaching the cylinder is raised considerably, requiring a large quantity of fuel to aid in cooling. This characteristic also accounts for the ignition problems encountered in using this type of supercharger. A centrifugal supercharger is not ideally suited to an automotive engine which must operate over a wide speed range and where the increase in power is needed at slower engine speed.

The lobe type supercharger consists of a pair of rotors which mesh with each other similar to a gear. Like the centrifugal, the lobe type also increases the temperature of the charge reaching the cylinder resulting in ignition problems and additional fuel being required for cooling. Due to the constant torque reversals encountered on an automotive engine, the gears in a lobe type supercharger have a tendency to wear, accounting for noise and a loss of efficiency after a few thousand miles of service. The lobe type supercharger is best suited for a stationary engine application

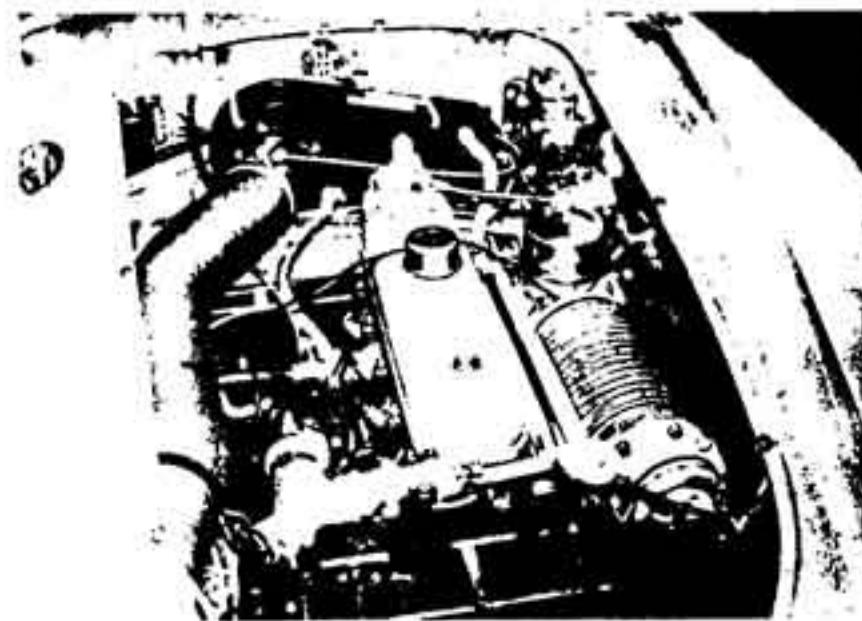
which operates within a narrow speed range and is not subject constant acceleration and deceleration.

The Judson Supercharger is a positive displacement rotary vane type unit and actually compresses the fuel/air mixture. The mixture is introduced into the supercharger by the carburetor at the intake port, actually compressed within the supercharger, and blown out the exhaust port into the manifold. This type of supercharger is recognized as the most efficient and the type best suited for automotive application. The temperature of the charge or mixture reaching the cylinder is not increased on the vane type supercharger due to a change in volume as the mixture leaves the supercharger and enters the intake manifold of the engine. Vane type superchargers usually operate at engine speed and perform throughout the entire speed range of the engine. The output of the rotary vane type supercharger, unlike the centrifugal, is not dependent on speed; nor are there any cams or gears to wear causing a loss of efficiency. Additional advantages of the vane type are that it requires 15 to 25 percent less horsepower to operate and is absolutely silent in operation. Also because of the lower operating temperature of the vane supercharger no basic modifications are required in the fuel pump or ignition system.

### SUPERCHARGING VS. MODIFICATION

Torque and speed determine the horsepower developed by an engine. As a consequence there are two ways to increase the horsepower of an engine: by increasing the torque or by increasing the speed (r.p.m.). Supercharging increases the horsepower by increasing the torque. Engine modification (multiple carburetion, special manifolding, high compression heads, special pistons, re-ground cam shaft, and other basic changes in engine design) generally increases the horsepower by increasing engine speed.

It is excessive speed (or reciprocating mass) that accounts for the failure of most mechanical devices. The amount of stress on engine components increases with the square of the speed. In other words, a crankshaft turning at 6,000 rpm has four times the load of a crankshaft turning at 3,000 rpm. Supercharging only increases the firing pressures, whereas it is the inertial stresses (speed) in a reciprocating engine which is the principal cause of engine failure. Engine modification kits, by increasing engine speed, will increase the horsepower by 15 to 25 percent. Engine modification usually results in a rough-running engine, an uneven idle, and a considerable sacrifice in engine economy.



Supercharger on MG-A shows compactness of installation.

## TECHNICAL DATA ON SUPERCHARGING

A supercharger is a mechanical device for increasing compression ratio and this is done by two-stage compression. The first stage is in the supercharger and the second stage is in the cylinder. The supercharger, in effect, builds the necessary higher octanes into the fuel, enabling the engine to operate on pump gasoline at a higher overall compression ratio than the unsupercharged engine.

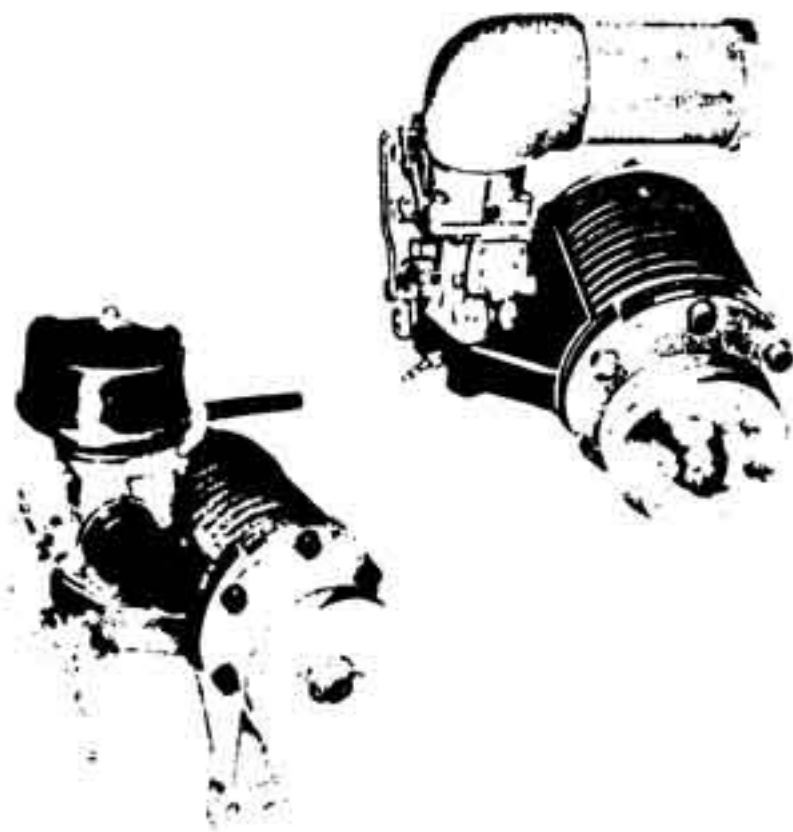
In an engine which is said to have a compression ratio of 8:1, the capacity of the cylinders with the piston at bottom dead center is eight times as large as the space at the top of the piston when the piston is at top dead center. Therefore compression ratio is somewhat theoretical and actual compression depends upon how completely the fuel/air charge fills the cylinder at the time the compression stroke is started. Only when the cylinder is completely filled can it be said that an engine is operating at its rated compression ratio. An engine with a rated compression ratio of 8:1 seldom operates at this compression ratio. This is due to the fact that the cylinder is not being completely filled with the mixture. The average automotive engine with a compression ratio of 8:1 actually operates most of the time with a compression ratio of approximately 4:1. A supercharger by forcing more fuel/air mixture into the cylinders or completely filling them, increases the effective compression ratio over that of the unsupercharged engine. Just as when we compress a spring tightly, its reaction will be greater, the more we compress the fuel charge the greater the force of its expansion becomes when the charge is ignited.

Due to the fact that all Judson superchargers are furnished as a complete kit designed for a specific stock engine, we do not recommend making any basic changes in engine design when installing our supercharger. Additional horsepower can be obtained from an engine by modifying it or by supercharging it but both methods should not be employed on the same engine unless it is being specifically set up for competition or racing. Our installations are engineered for the stock engine with a factory-rated compression ratio, cam, ignition system, etc.

Supercharging increases the performance of the car by lowering the weight to power ratio. It is the weight to power ratio or the amount of horsepower available per pound of vehicle that determines performance. It is a high weight to power ratio that can make a sluggish performer out of a 300 horsepower automobile. In most instances a properly engineered supercharger will add 45% more horsepower and less than a 20 lb. increase in weight. This reduces the power to weight ratio considerably, providing the tremendous improvement in performance.

The condition or miles of usage on the engine is not a determining factor in installing a supercharger. The increase in performance is in direct proportion to the performance of the engine before it was supercharged.

Many of the world's speed records have been established with supercharged engines. A supercharged MG equipped with a vane supercharger holds the world's speed record for its class. (203 mph with a 66 cu. in. engine). In 1937 Bernd Rosemeyer engaged the clutch on a 16 cylinder Auto-Union and less than 26 seconds and four shifts later he passed the mile post. Within one mile from a standing start, he had done better than 200 miles per hour and had averaged over 158 miles per hour over the mile from a dead



stop. The Auto-Union engine which established this record weighed 540 lbs. and developed 520 horsepower. Only a supercharger could provide the weight to power ratio necessary to produce this amazing performance.

### DEPENDABILITY

The Judson Supercharger has been proven by over 50,000 supercharger installations throughout the world. It is manufactured by America's foremost supercharger manufacturer and is acknowledged by automotive engineers everywhere as the standard of quality and performance. The Judson is a precision piece of equipment manufactured in their own factory to the highest standards. All components are accurately finished for high speed, heavy duty performance. Precision bearings and the best of material assure efficient and dependable service. Each part is checked thoroughly before assembly, and the assembled unit is tested completely—*as assurance* that the owner will get a supercharger that will do the job. Many Judson superchargers have in excess of 65,000 miles of hard service on them without ever having been removed from the engine.

### THE JUDSON SUPERCHARGER

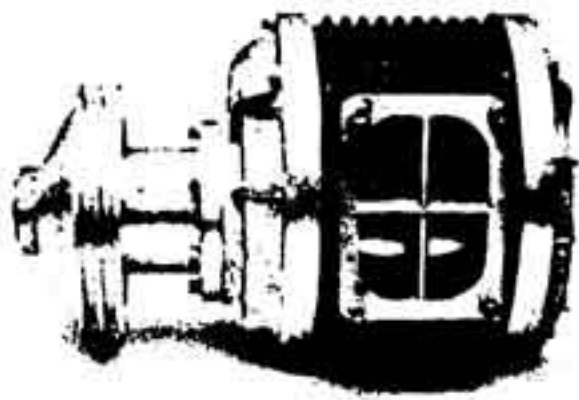
The Judson Supercharger is a positive displacement rotary vane type unit. This is the principle used in most aircraft fuel pumps and many industrial compressors. The fuel/air mixture enters the supercharger through the carburetor and is compressed. The pressurized mixture is then forced into the intake manifold and when the valve opens the full charge is waiting to enter the cylinder. The Judson Supercharger has no gears to wear, no highly stressed parts. The rotary vane type supercharger is noted for its high efficiency, long life, and silence of operation.

While the design of the Judson Supercharger is based on the four vane principle, many features have been introduced which improve the overall performance and reliability of this unit. The most important of these is the use of non-metallic vanes moving on a film of oil through the use of balanced centrifugal force. Metal-to-

metal contact is eliminated and friction is reduced to an absolute minimum, lowering operating temperature and raising efficiency. Utilizing the exclusive and patented principle of balanced pressure with nonmetallic vanes, the Judson Supercharger is efficient, dependable, silent, and subject to less wear than other accessories now on the engine.

### THE JUDSON IS AUTOMATIC

The Judson Supercharger is an automatic device that replaces the vacuum in the manifold instantly and automatically in proportion to the load placed on the engine. The engine is supercharged only when and as you want additional power. This is determined by the load placed on the engine and the position of the throttle. The additional horsepower afforded by the supercharger is not required at idle, in city traffic, or in normal highway cruising. When the throttle is suddenly opened by depressing the accelerator, however, the engine immediately becomes supercharged. This is done instantly and automatically and thus the additional power afforded by the supercharger is made available for quick acceleration, extra passing ability, and maintaining power when required. The engine is not continuously supercharged but only when additional power is required. Although the engine is not continuously supercharged, the supercharger itself is always in operation providing improved volumetric efficiency even at idle—allowing for a much smoother and more efficient running engine. This automatic feature of the Judson Supercharger provides the driver with 45 to 50 percent more horsepower on an optional basis and it is immediately available.



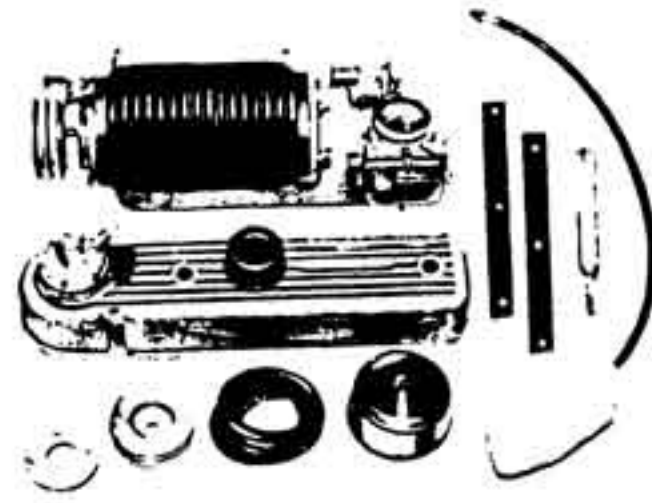
Judson Supercharger used on 350 cubic inch aircraft engines.

### PERFORMANCE

The Judson Supercharger is guaranteed to increase the horsepower delivered to the rear wheels by 45% to 50% depending upon the model supercharger and the engine on which it is mounted. This increase in horsepower provides a higher cruising speed, immediate throttle response, reduces gear changing by as much as 40%, increases maximum speed by 20% and reduces acceleration time (0 to 60 mph) by as much as 50%. The difference in performance between the supercharged and unsupercharged car is amazing and immediately apparent.

### FUEL CONSUMPTION

Average fuel consumption is increased by approximately 5%. The increased power afforded by the Judson Supercharger is provided for by improved engine efficiencies. This slight increase in fuel consumption is a small price to pay for the additional power made available.



All Judson Superchargers are furnished as a complete installation in the form of a kit.

### INSTALLATION

The Judson Supercharger is furnished as a complete supercharger installation in the form of a kit. Everything is furnished to make the installation on the engine and there is nothing else to buy. Complete and illustrated installation instructions are furnished with each kit which can be installed on the engine using standard tools. Installing the supercharger on the engine is an extremely simple matter and consists of bolting the parts furnished with the kit to the engine in accordance with the instructions.

### ENGINE ADJUSTMENTS

Complete instructions for tuning the supercharged engine are furnished with the supercharger installation data. A Judson supercharged engine requires less frequent tuning and adjustment than does the unsupercharged engine.

### NOISE

Judson superchargers are famous for their silent operation and tests show that the noise of the engine is not raised by the installation of the supercharger.

### LUBRICATION

The Judson Supercharger has a positive lubrication system and clean oil is supplied to the supercharger from its own oil reservoir. One quart of oil is used in approximately one thousand miles. In addition to lubricating the supercharger, this oil acts as an upper cylinder lubricant, further increasing the life and performance of the engine. A standard grade of oil is used in the lubricator.

### CARBURETION

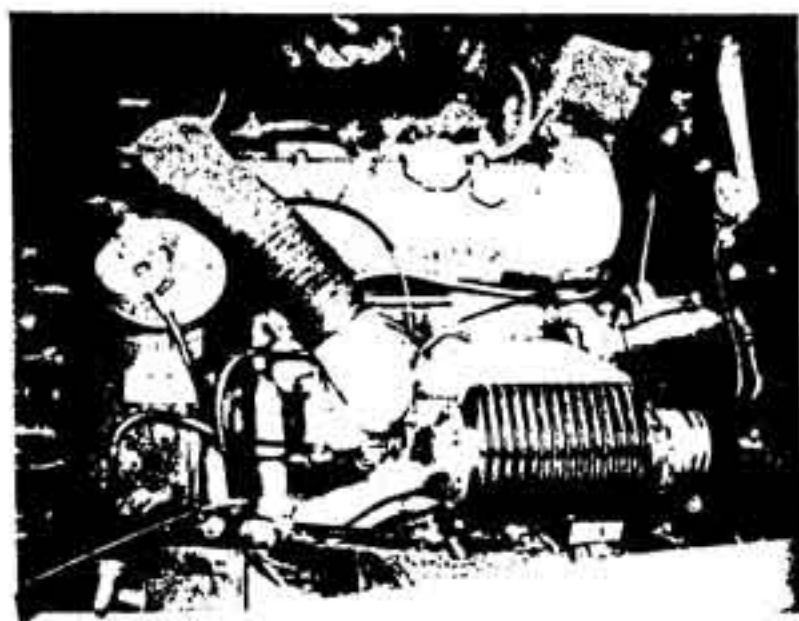
The carburetor on the supercharged engine functions as a mixing valve only. The supercharger itself atomizes and distributes

Supercharging, by improving the volumetric efficiency of the engine, increases the torque — resulting in an increase in horsepower without an increase in speed. The engine develops more horsepower at the same speed. With a conservatively supercharged pressure of only 6 psi, the average automotive engine will produce an increase in horsepower of nearly 50%, with a loss in fuel economy of approximately 5%. Engine smoothness and idle are not sacrificed in any way and the improvement in performance is throughout the entire speed range of the engine, if a positive displacement supercharger is used.

Engine modification requires that the engine be completely torn down and rebuilt using the components from the modification kit. With a properly designed supercharger installation, however, it is only necessary to bolt the parts furnished with the supercharger kit to the engine, making it even unnecessary to remove the engine from the chassis. A comparison in performance and costs of the two methods clearly shows that the mildly supercharged engine will outperform the modified engine by as much as twenty-five percent and cost one third as much.

### SUPERCHARGING AND ENGINE RELIABILITY

Low pressure supercharging — if properly done has no adverse effect on the dependability of the engine nor does it affect engine reliability in any way. The pressure involved is not great enough to place an additional stress of any consequence on the engine. As previously stated, it is high speed which usually leads to engine failure; supercharging increases the performance developed from an engine by increasing the torque, and not by increasing the speed. Peak bearing loads on the supercharged engine are actually decreased because the higher combustion pressure opposes the inertia forces which tend literally to throw the piston up into the cylinder head. Supercharging is a matter of degree. Extremely high boost pressures (15 to 30 psi) do place a considerable stress on engine components. These higher pressures should of course only be employed on engines that have been specifically designed for this type of supercharging. All automotive engines, however, are designed with a safety factor and the addition of a Judson Supercharger with its automatic feature and conservative boost pressure (5 psi to 6 psi) does not cause any of the engine components to exceed the safety factor as established by the engine designer and manufacturer.

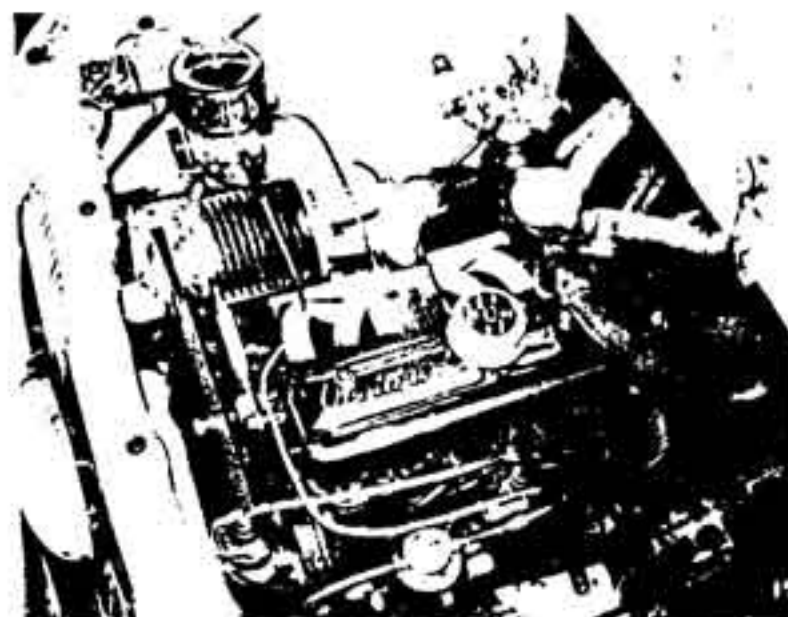


Installation on Mercedes 190 SL illustrates how each supercharger is designed for a specific engine.

In designing a supercharger for an engine various factors have to be taken into consideration — such as the amount of boost pressure to be employed, the fuel/air ratio, the temperature of the charge reaching the cylinder, the ignition system, and the general construction of the engine. For these reasons, Judson furnishes a complete supercharger installation in the form of a kit designed for a specific engine. Everything is furnished with the kit including the correct jet for the carburetor (complete carburetor in some kits), so that the correct fuel/air ratio can be obtained. The supercharger installation itself is kept as simple as possible, complete illustrated installation instructions and tune-up data are furnished so that, in effect, every Judson supercharged engine is a factory installation. Each supercharger manufactured by Judson is furnished as a kit which has been completely engineered and tested for the specific engine on which it is to be installed. Judson Research & Mfg. Co. will not furnish a supercharger for any engine unless it can be furnished in the form of a complete kit that has been engineered for the engine and has been thoroughly tested. No supercharger should be installed or adapted to any engine unless the manufacturer can furnish a complete kit including all of the necessary brackets, the correct drive ratio, the necessary carburetor jets (or carburetor) to provide the correct fuel/air ratio, and the required ignition settings. Judson Research & Mfg. Co. develops all of their superchargers on an engine set up on a dynamometer and then checks it out thoroughly by thousands of miles of road testing.



A Judson supercharger on the Volkswagen above and Renault Dauphine below provides big car performance with small car economy.



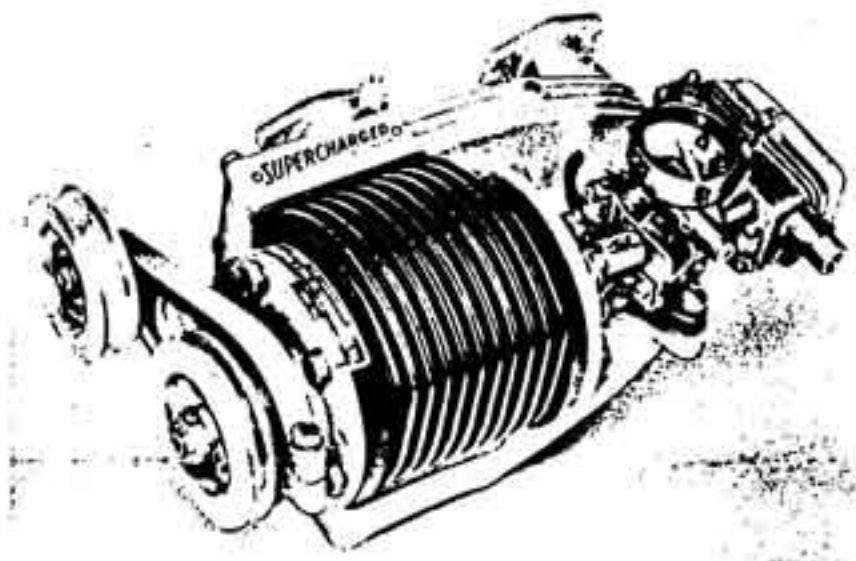
fuel to the cylinders under pressure. Because of the improvement in volumetric efficiency afforded by the supercharger, multiple carburetors or complicated carburetion is not required. The Judson Supercharger is furnished complete with either a special carburetor set up specifically for the supercharged engine or the correct jets for the carburetor to provide the proper fuel/air ratio throughout the entire speed range of the engine.

### SERVICE

The only service required on the Judson supercharger is the occasional checking of the oil level in the automatic lubricator. One filling is sufficient for one or two thousand miles depending upon the capacity of the lubricator and the model supercharger. All drive belts are a standard size and available everywhere. Complete service data is furnished with every kit shipped from the factory. A Judson Supercharger can be completely overhauled by any competent mechanic by following this service data. All components are interchangeable and can be replaced without returning the supercharger to the factory. A parts list is included with the service data and all parts are shipped from the factory on the same day that the order is received.

### WARRANTY

Every Judson supercharger carries a standard manufacturer's 90 day warranty, the same as the car itself. In addition to this product warranty, the Judson Supercharger is guaranteed to increase the horsepower delivered to the rear wheels by 40% to 50%, depending on the model supercharger.



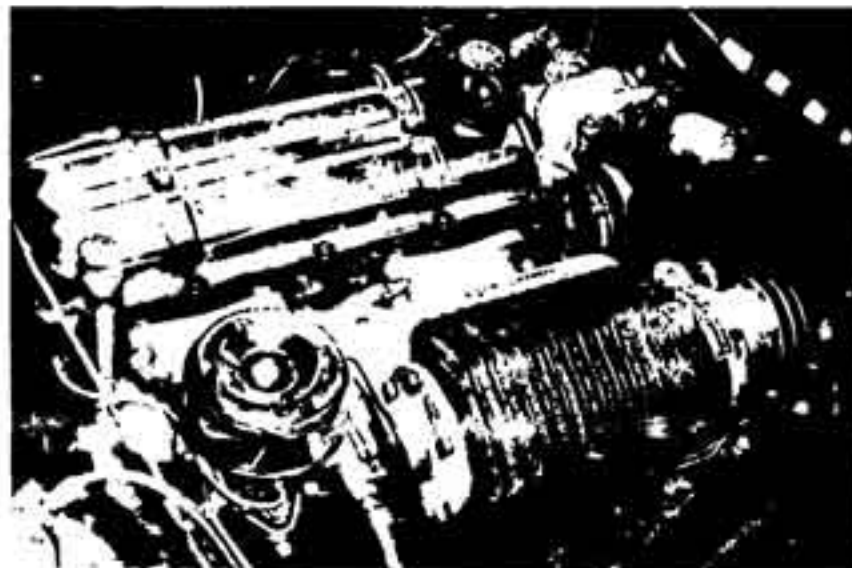
### TESTIMONIALS

Here is what the world's leading auto magazines say about the Judson Supercharger:

*Das Auto* (Germany) "The Judson Supercharger has greatly impressed us . . . it truly allows a new experience in motoring."

*Road & Track* "The car is completely transformed with absolutely no objectionable features."

*Auto Visie* (Holland) "The difference in performance between the supercharged and unsupercharged car is greater than one would believe possible."



*Motorsport* "After putting the car through its paces and comparing notes on its present vs. past performance, there can be no doubt about the value of supercharging."

*Sports Cars Illustrated* "This type is quite efficient at all engine speeds and also has the added advantage of being very compact. It produces a positive boost at all rpm's and is not subject to mechanical failure."

A few of the many unsolicited statements from owners:

"I would never have believed that the addition of anything could improve the performance of my car the way your supercharger has."

"I never knew what I was missing until I installed one of your superchargers on my Volkswagen."

"The increase in acceleration is positively amazing. I would never have believed it possible."

"It's just like adding two more cylinders."

"It's like getting a new car."

"Not only is the improvement in performance amazing but so is the smoothness of the engine and the absolute silence of the supercharger."

A supercharger gives you more than just improved performance . . . it gives you a thrilling new experience in motoring pleasure.

**JUDSON** RESEARCH AND MFG. CO.  
CONSHOHOCKEN, PA.

