THE CENTRIFUGAL SUPERCHARGER

By HAROLD HUSTED

THE supercharger is a relatively new development. Previous to the year 1928 military pursuit planes and machines especially designed for high altitudes were almost alone in its utilization. It was introduced and developed in order to reduce the drop in power resulting from engine operation at great heights. Basically it was an air compressor used to restore sea-level conditions to high altitude carburetion.

A centrifugal supercharger of modern design consists of a high tensile magnesium or aluminum alloy rotor enclosed in a water-jacketed cover and driven at a speed of about five times the speed of the engine. The fuel and air mixture from the carburetor is introduced into the rotor channel and subjected to tremendous centrifugal forces before being ejected under pressure into the intake manifold.

Three types of drive or combinations of them are in use. One involves an exhaust driven turbine which is usually mounted on the same shaft as the rotor. This type involves no clutch to cushion sudden speed changes since sudden changes can not occur. It has the disadvantage of high temperatures and for best results it should, in addition to having a good water-cooling system, be mounted out of the engine compartment. If well designed it should require little attention.

Another type makes use of gears to transfer the driving forces from the crankshaft. The complexities of this system are apparent. It is essential that the gears be of the highest quality in order to stand rotative speeds of more than 20,000 r.p.m. This requires careful selection of materials and exacting workmanship. The large dimensions of gear train and housing often create difficult construction problems. A slipping clutch is usually included to prevent injurious shock from sudden speed changes. Gear drive is expensive and cumbersome and requires periodic servicing.

By far the most practical is the use of V belts and pulleys. Here we have simplicity, economy and smoothness of operation. A three belt system is adequate for small units since a maximum of about 2½ horsepower is required to drive those commonly used on engines in the 100 horsepower range. Any desired speed may be attained merely by changing the ratio of pulley sizes. Replacement pulleys and belts may be obtained almost anywhere and the supercharger may be fully disconnected by anyone with a few tools.

Although progress in supercharger design has been rapid and advanced degree of efficiency has been attained, many perplexing problems are presented to men who would improve their performance. Different types must be separately engineered for application to the many kinds of engines. Problems in bearings, lubrication, and cooling have been met but many changes are to come.

As has been mentioned, the original purpose of the supercharger was that of furnishing a higher intake pressure. The importance of that function is as widely accepted today. For sea-level engines of the automotive type it has been found that a satisfactory pressure is four or five pounds above atmospheric as contrasted to several pounds below atmospheric in conventional engines. This increase in pressure promotes uniform fuel distribution and insures a full charge for each cylinder.

The value of even distribution of fuel is something which should not be treated lightly. When not supercharged the cylinders receive different quantities of fuel and different fuel-air ratios and the fuel volatility may vary widely among cylinders. Uneven and inefficient operation must result and can only be corrected by positive induction.

An effect unforeseen by early designers is the turbulence created by the rotating blades of the rotor. Anyone familiar with high speed rotative machines will appreciate the tremendous forces involved. These forces are utilized to the fullest extent in breaking up the fuel particles and mixing them thoroughly with the air. Ordinary carburetion is quite inadequate while supercharging delivers a smooth flow of a homogeneous explosive gas ready for complete combustion in the cylinders.

Experimental evidence seems to indicate that supercharging increases the useful life of an engine. This may be explained in part by the fact that there is created a pressure above the piston eliminating the usual reverse load bearing shock occurring at the intake stroke. Then the more complete combustion reduces spark plug fouling and carbon deposits. Although mean cylinder pressures are increased by as much as 20%, a relatively small change in maximum pressures occurs. Cylinder temperatures are raised but slightly and smoother combustion reduces vibration.

Why is the supercharger used? An automotive engineer made the statement that there would have been no room for payload in the famous China Clipper had its engines not been supercharged! Without positive induction aviation as we know it could not exist.

At sea-level the results of supercharging are equally amazing. Indianapolis race officials have found it necessary to impose greater limitations in engine displacement on drivers of supercharged racers. A power increase of from 15% to 20% may be ex-

pected at normal engine speeds. Not only is there an increase in torque but response to throttle changes is also quicker.

All of this points to the possibility of drastic reductions in size and weight of automobile engines. Not for long will the bulky engines of today be tolerated. The motorist is beginning to require more room for himself and less for the engine. Weight distribution problems will be nearer solution when engine weights are reduced and the smaller size of the supercharged engines will permit scientific location.

Power increase is not, however, achieved at the expense of fuel economy. As a direct result of better combustion we find an increase in thermal efficiency of up to 15% of original efficiency. Fuel consumption per horsepower is, of course, correspondingly reduced. For proof consider the annual American Automobile Association stock car economy run which for several years has been won decisively by supercharged automobiles. This fact alone is conclusive evidence that the supercharged engine more completely uses its fuel. It should be welcome news indeed to automobile designers as well as to potential customers and drivers.

Supercharging has found acceptance in the field of flying and should now enjoy wider use.
