How potent is Packard's new V8?

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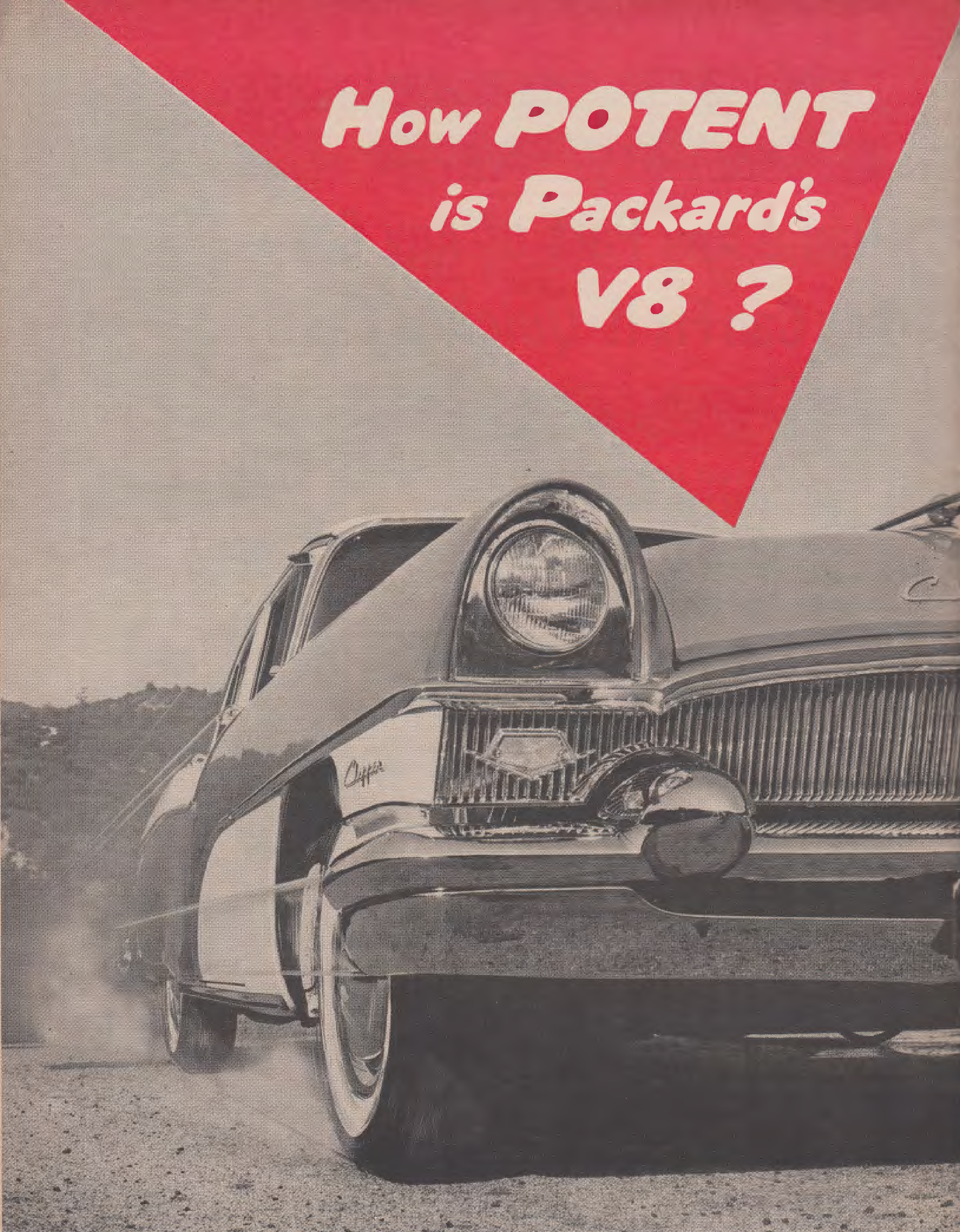
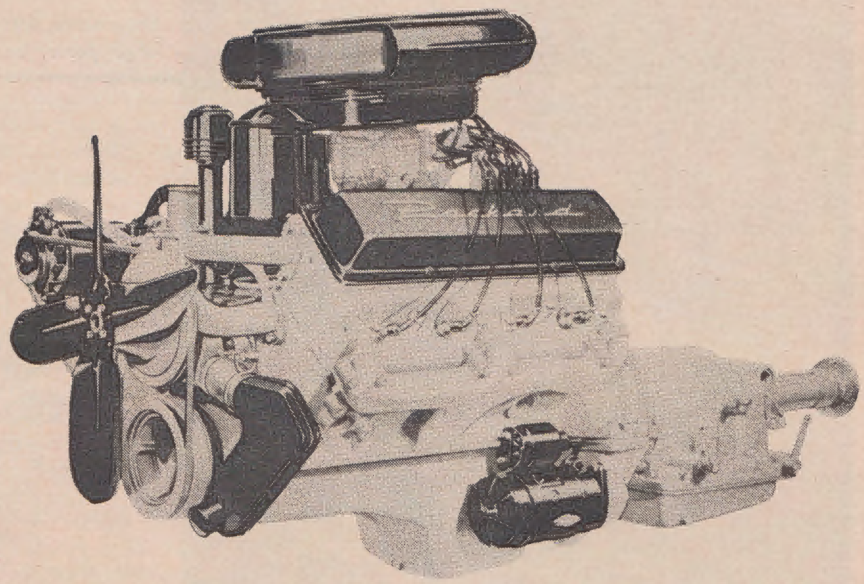
How POTENT is Packard's V8 ?



Packard's bold bid for power includes a radical new chassis and the industry's biggest engine



By Racer Brown

The veil of secrecy that shrouded the new Packard V8 has been surpassed only by the Iron Curtain. Usually, new automotive developments are released to members of engineering groups and the press some time before the cars fill the showrooms, but this year Packard withheld specific information of two very significant innovations. Meanwhile, a few expert rumormongers had a field day. According to them, the new Packard V8 engine was a 400-cubic inch, two-cammed affair with an aluminum block. The actual result is slightly less spectacular, but nonetheless quite worthy of a detailed discussion.

In 1946, Packard instituted an engine development program to explore the possibilities of new and novel designs suitable for future production as successors to the venerable straight eight. To be sure, many unusual designs were tested and evaluated, as were new methods and materials (including aluminum cylinder blocks). By 1949, most of the details of the new Packard engine were established; that is, nearly everything except the piston displacement which was originally set at 269 cubic inches. The leaps and bounds by which other manufacturers increased piston displacement, power and torque prompted Packard engineers to reconsider and redesign, so they wouldn't be caught flat-footed with an engine that would be underpowered to sell the increasing numbers of performance-conscious buyers. So they went to the other extreme and made the production engines big, with provisions for going bigger whenever the need arises.

Currently, the Packard Division of the newly formed Studebaker-Packard Corporation is supplying 320-cubic inch V8 engines for both the '55 Hudson "Hornets" and the Nash "Ambassadors." Basically, these are "detuned" versions of the 320-cubic inch Clipper enginé, which, in turn, is a smaller edition of the engine used in the Clipper "Custom," Packard and the Packard "Caribbean" models.

Packard engineers have never shied away from building engines of mammoth proportions and their latest effort is automatically a unanimous choice for the world-famous (but mythical) organization, "There Ain't No Substitute for Cubic Inches" Club, of which I modestly proclaim I am mythically president. This 352-cubic inch monster has a four-inch bore and a 3½-inch stroke, which results in the favorable stroke/bore ratio of .88 to 1. The maximum advertised brake horsepower is 260 obtained at an engine speed of 4600 rpm and maximum advertised torque is 355 pounds-feet between 2400 and 2800 rpm. The same size engine in the Clipper "Custom" produces 245 brake horsepower at 4600 rpm and 355 pounds-feet of torque at 2600 rpm. The smaller 320-cubic inch engine (3^{13}⁄16-inch bore, 3½-inch stroke) in the Clipper "DeLuxe" and "Super" series yields 245 brake horsepower at 4600 rpm and 325 pounds-feet of torque at 2600 rpm. Both the Hudson and Nash versions put out 208 brake horsepower at 4200 rpm and 300 pounds-feet of torque at 2300 rpm. These values were obtained under the following conditions: The water, fuel and oil pumps were connected and operating; the generator was rotating but was not charging; the spark advance was manually adjusted for best torque; dynamometer exhaust collectors were used; intake manifold heat was blocked off; fuel was 93 octane Research gasoline; no fan or carburetor air cleaner was used. The dynamometer figures were corrected for a temperature of 68 degrees F. at 29.92 inches of mercury.

It should be realized that advertised power and torque figures do not represent "as installed" values. With the engine in the car and with the stock exhaust system hooked up, an air cleaner and fan installed, a "hot" intake manifold and a load applied to the generator, plus under-the-hood temperatures of around 100 degrees F., the power and torque will drop off on an average of about 14 and 12 per cent, respectively. Even so, the big Packard has the edge on all competitors in all departments; the displacement is 3.2 per cent larger than its closest rival, the advertised power is four per cent higher and the advertised maximum torque is 2.9 per cent more. This engine also scores in the matter of engine weight, the whole issue with all accessories except the air cleaner, tipping the scales at 698 pounds.

The 210-pound cylinder block is cast with the usual 90-degree span between cylinder banks from close-grained alloyed iron. The blocks for both engine sizes are identical except for the cylinder bore diameters and the coring of the cylinders. The upper half of the bell housing is an integral part of the block. Five transverse bulkheads separate the cylinders of each bank and are used as supports for both the crankshaft and the camshaft. The main bearing caps are located ⅛ of an inch above the oil pan surface in longitudinally broached recesses. The cylinders are surrounded by full-length water jackets, except at the inboard sides, where the jacket length is reduced to make room for the valve lifter bosses and two longitudinal oil galleries.

Distortion of the cylinder bores is minimized by tying the cylinder head screw bosses into vertical ribs. The center-to-center distance between adjacent cylinder bores is five inches, which leaves a minimum of one inch between bores (1^{3}⁄16 inches in the 320-cubic inch engine)

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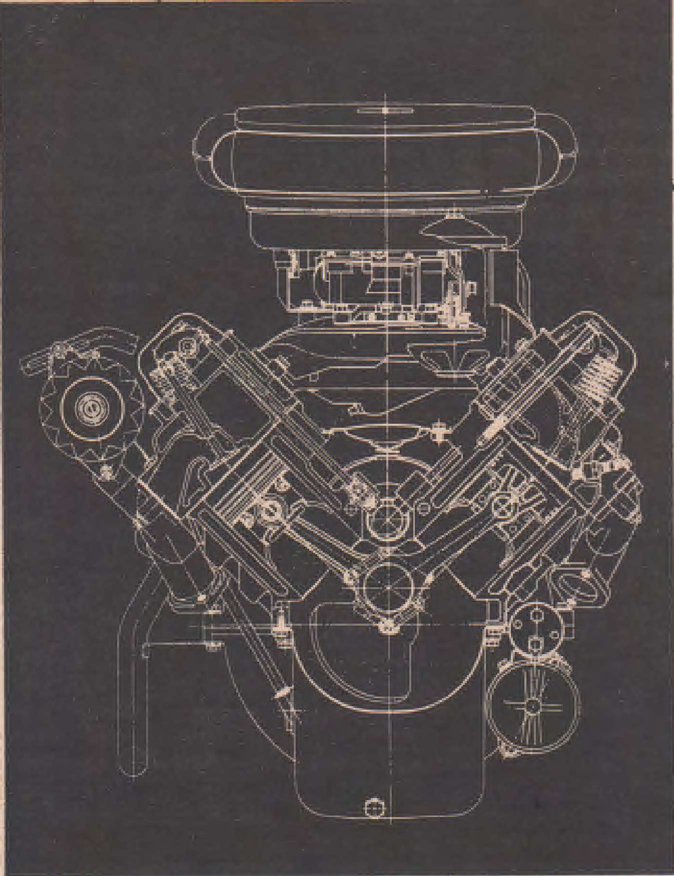

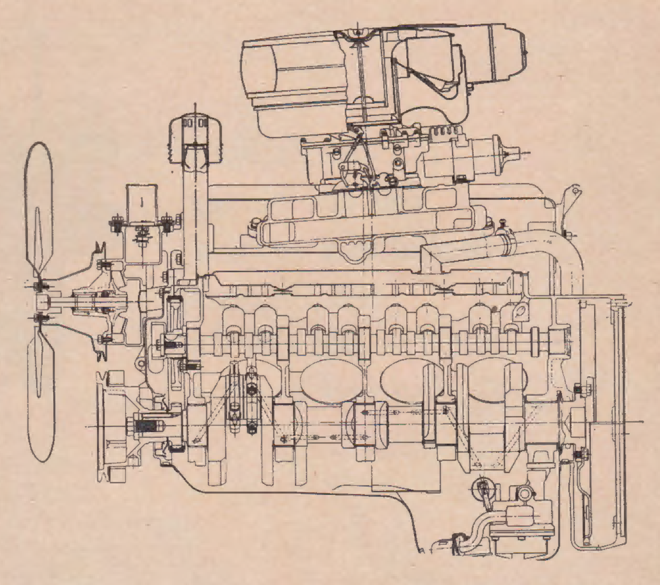

Transverse, left, and longitudinal sections of Packard V8. Note large ports, excellent water jacketing around critical areas.

PACKARD V8 continued

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for a head gasket seal. This little feature could and should be used by a few other manufacturers. This dimension also allows the bore diameters to be enlarged at a future date without scrapping the existing tooling. All that is required is a relatively simple and inexpensive change in the coring of the cylinders. Sufficient space in the underside of the block has been provided for a substantial increase in crankshaft stroke, when the need arises, without interference with the existing block casting or other parts. The overall length of the cylinder block is $27\frac{3}{4}$ inches. From all outward appearances, the block could be safely rebored to $4\frac{1}{8}$ inches with no particular danger from cylinder distortion or overheating; on Packard and Clipper "Custom" blocks, that is. The $3\frac{13}{16}$-inch bores of the Clipper "DeLuxe" and "Super" blocks, as well as those of the Hudson and Nash, could be bored to a maximum of $3\frac{15}{16}$ inches with reasonable safety.

Packard engineers went to considerable lengths to evaluate the relative merits of forged versus cast crankshafts. According to their findings, a steel casting provides a sufficiently high modulus of elasticity as well as material density to effect a lighter crankshaft without sacrifices in rigidity or stiffness. Also, a casting permits the counterweights to be more favorably disposed for balancing effectiveness, as well as coring of the crankpins to reduce the amount of unbalance and, consequently, the size of the counterweights. The finished Packard V8 crank is a heat-treated alloyed steel casting that weighs 56 pounds. The five main bearing journals are ground to a diameter of 2.500 inches and the crankpins are 2.250 inches in diameter. These dimensions are well within the realm of design conservatism shown elsewhere in the engine. With the $3\frac{1}{2}$-inch stroke, an overlap of $\frac{5}{8}$ of an inch is obtained between the crankpins and adjacent main bearing journals, which materially contributes to the torsional stiffness of the crank. The total connecting rod effective bearing area is 52.8 square inches and the total main bearing effective area is 38.6 square inches. A non-bonded rubber harmonic balancer is placed at the nose of the crank and 's effective in reducing the amplitude of torsional vibrations. The balancer is integral with the crankshaft pulley assembly. Fore-and-aft crankshaft thrust loads are taken by the flanged rear main bearing.

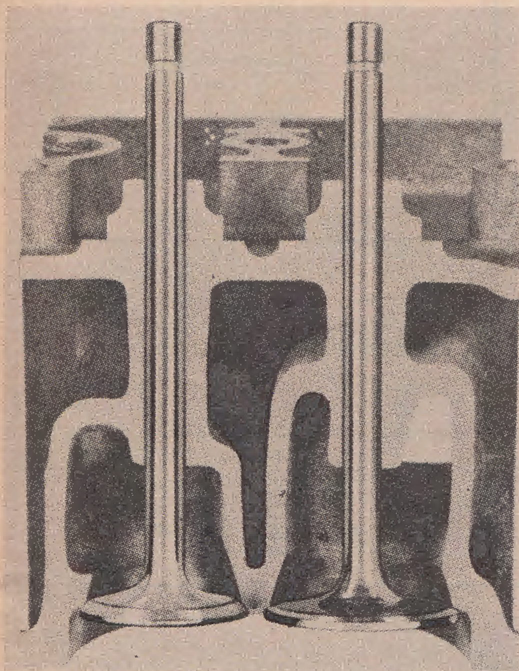
The main bearings are copper-lead, while connecting rod bearings are lead-babbitt, and both are of the steel-backed replaceable insert type. Both bearing materials are completely compatible with the heat-treated but unhardened steel crank. Each connecting rod has its own bearing that is locked in the rod and the crankshaft is drilled to oil each of the two bearings on the crankpins.

The healthy appearing connecting rods are drop forgings made from SAE 1041 steel. The beam is of "H" section design and the rods have a center-to-center length of $6\frac{23}{32}$ inches. Two specially formed high tensile steel bolts locate and secure the rod cap to the rod. A groove is machined at the juncture of rod and cap to provide lubrication from the rod bearings to the cylinder walls on the opposite bank. Balancing lugs form integral parts of the rod assembly, one lug at each end. A bronze piston pin bushing is pressed into the small eye of the rod and is bored to give .0002 of an inch clearance between the bushing and the pin. The connecting rod assembly has undergone very severe testing at loads and speeds far in excess of those encountered in any type of driving conditions. Each rod assembly weighs one pound 10 ounces.

Aluminum alloy "autothermic" pistons are used in which steel tension members control the amount and direction of piston expansion. The pistons "nest" about the crankshaft counterweights at the bottom of the stroke, which necessitates a "slipper" type skirt. Crown thickness of the flat-topped piston is .280 of an inch. Three ribs extend from the piston pin bosses to the crown for pin boss rigidity. The .980 of an inch diameter by $3\frac{1}{4}$ inch long piston pin is a full floating affair that is retained in the piston by snap rings and grooves in the pin bosses. The pin material is heat-treated SAE 1117 steel. The piston pin bores are offset $\frac{1}{16}$ of an inch in the direction of the major thrust face. Pistons are tin plated to minimize "scuffing" during the initial break-in period. Piston weight is one pound six ounces.

Two compression rings and one oil ring are used, all of which are located above the piston pin. The alloy cast iron compression rings are $\frac{5}{64}$ of an inch wide with a radial thickness of .200 of an inch and have tapered faces. The top ring is chrome plated to a thickness of from .004 to .007 of an inch for longer life and freedom from the effects of high temperatures and corrosive gases. The alloy cast iron oil ring is of open slot

Cutaway head shows generous passages, valve sizes and integral seat and guides.



design and measures 3/16 of an inch in width with a radial thickness of .166 of an inch, and uses a polygonally shaped light spring steel expander.

The hardenable alloy iron camshaft is driven by a one inch wide timing chain and sprockets on the crank- and camshafts. The cam is supported in the block by five removable steel-backed babbitt-coated bearings. The cam lobes are ground with a taper of six minutes and are positioned 1/16 of an inch in back of the valve lifter centers to avoid lifter overrun and insure positive lifter rotation. A helical gear, located ahead of the rear bearing journal, is an integral part of the camshaft and is used to drive the distributor.

Hydraulic valve lifters are used in all models, the bodies of which are Lubrite-coated hardenable iron. The lifter faces are ground to a spherical radius of 30 inches and the lifter body diameter is .904 of an inch. Lubriting the lifters and phosphate coating the camshaft is said to minimize initial break-in wear, which seems to be the period when cam and lifter wear is the most severe. In line with this, it is interesting to note that, although the cams in all the Packard engines are, to all intents and purposes, identical, cast steel camshafts are specified for the engines supplied to Hudson and Nash. Even more interesting would be a comparison of the wearing qualities of the two different camshaft materials, after each has been subjected to long periods of operational service. But this we won't know for a while.

The cylinder head castings are made from the same material as the block. They are interchangeable, left to right, and each head weighs 64 pounds. Very generous water jacketing has been provided around the ports, valves, spark plugs and combustion chambers. Each head is located on the block by two dowels and is secured by 15 capscrews, 7/16 of an inch in diameter, in a pattern that surrounds each cylinder with five capscrews. Cylinder head gaskets are of the embossed steel type, .025 of an inch thick.

After playing with many different combustion chamber configurations, Packard chose the elliptically shaped, high turbulence "wedge" type chamber. Tests have shown that, at compression ratios of 12 to 1, this design provides a low burning rate of the fuel/air mixture charge and avoids a rapid pressure rise, thereby minimizing combustion roughness, and the chamber is quite insensitive to combustion chamber deposits usually incurred during low speed, light load operation. "Quench" and "squish" areas, formed by a .045 of an inch piston-to-cylinder head clearance, cover 20 per cent of the total piston area. Each combustion chamber is fully machined, which makes for a consistent compression ratio for all cylinders.

The valve head diameters are unusually large for this type of combustion chamber, being 1 15/16 inches for the intake valves and 1 11/16 inches for the exhausts. This accounts for what appears to be a slight "shrouding" of the valves at the ends of the combustion chambers. The spark plug is located about 3/8 of an inch from the lateral axis of the cylinder bore toward the intake valve on the deep side of the chamber. Due to the angular location of the plug in the head, a counterbored passage connects the firing end of the plug with the main combustion chamber cavity. The present compression ratio of the Clipper and Packard engines is a conservative 8 1/2 to 1, while the Hudson and Nash engines have an even more conservative ratio of 7.8 to 1. If one chose to use the heads of the 320-cubic inch Packard engine on the 352-cubic inch engine, a compression ratio of 9 1/4 to 1 would be obtained, which would be the upper limit for use with presently available gasolines. Or the heads may be milled .050 of an inch on the 352-cubic inch engine for the same result. The same amount milled from the heads of the Packard 320-cubic inch engine would result in a compression ratio of 9.1 to 1. To obtain a compression ratio of 7.8 to 1 on the Hudson and Nash, the heads from the 352-cubic inch engine are used. By milling the Hudson and Nash heads .065 of an inch, the compression ratio will be 8.7 to 1. When and if the heads are milled, each side of the intake manifold should be milled the same amount as the heads to maintain correct intake port alignment. Also, the pushrods should be shortened by the amount milled from the heads. As future fuels improve, it becomes a very simple matter of a coring and minor tooling change to increase the compression ratio of the Packard engine, which would undoubtedly be accomplished by lowering

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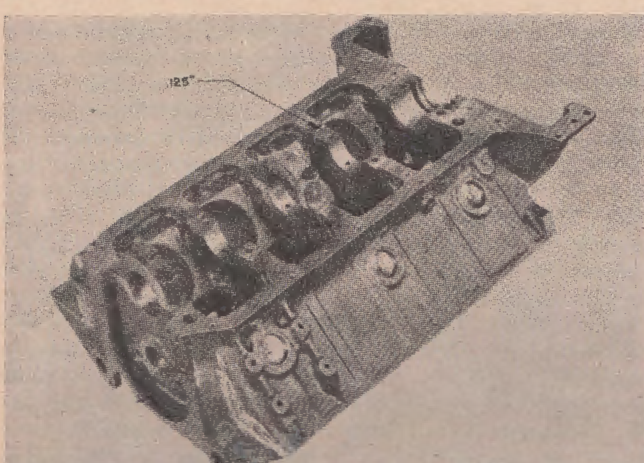
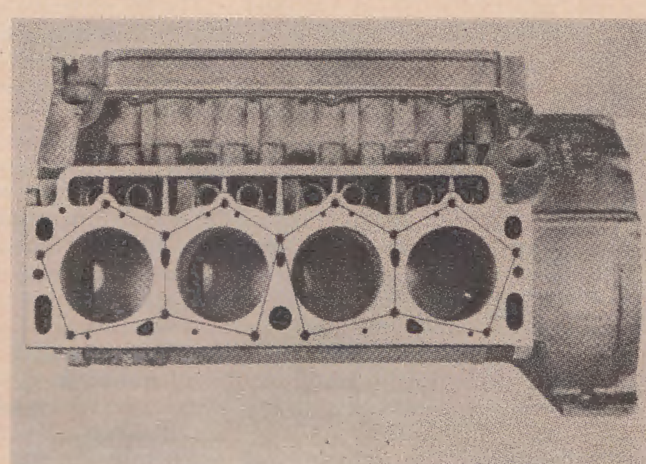


Bottom of sturdy Packard V8 block has broached recesses for the positive location of the five main bearing caps.



Cylinder head capscrew pattern and the widely spaced bores provide a good gasket seal with minimum block distortion.

PACKARD V8 continued

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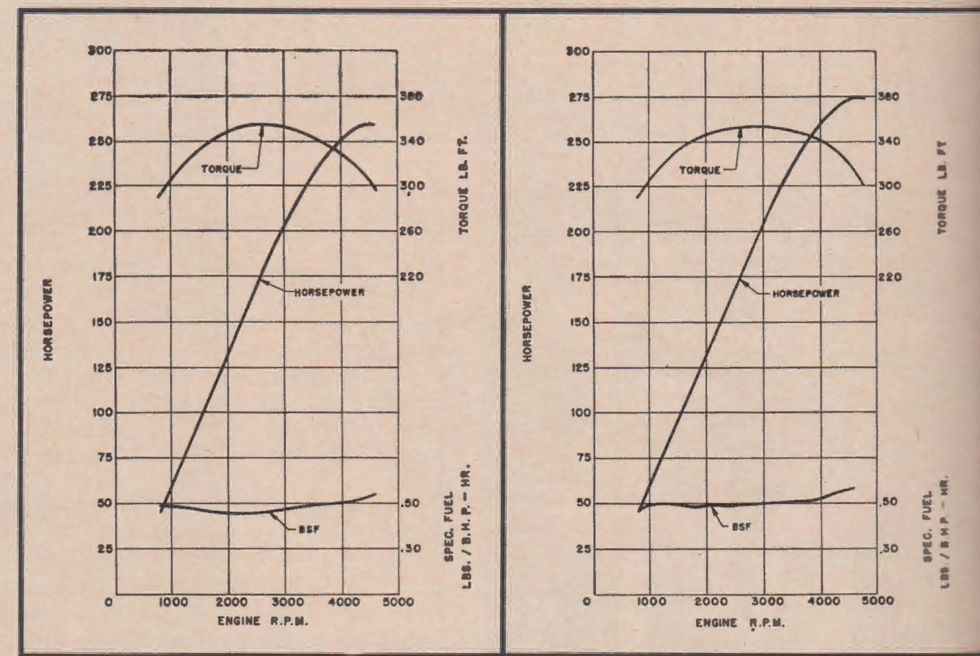

Brake horsepower, torque and brake specific fuel consumption curves of the standard 352-cubic inch Packard V8 engine, left, and the dual four-throat "Caribbean," right.

the "roof" of the wedge type chamber.

As previously mentioned, the valve sizes are quite generous, but much more important for a high volumetric efficiency, the ports are positively huge, especially on the intake side. As in other comparable designs, the intake ports of the Packard cylinder heads are rectangular in shape and arranged in pairs. Exhaust passages in the heads have been laid out so that the two end cylinders of each bank have individual ports, while the two center cylinders of each bank discharge exhaust gases into common ports. Each center port has a continuation extending upward and into the intake manifold pre-heat chamber. Both intake and exhaust valve guides are an integral part of the heads, which materially aid in reducing valve temperatures, not only at the valve stems but at the seats as well. In fact, tests involving the use of integral valve guides have shown that valve head temperatures can be lowered as much as 200 degrees F., with a corresponding reduction of valve stem temperature of 100 degrees F., as compared to the diminishing practice of using pressed-in guides, which erect a thermal barrier despite the similarity of metals and the proximity of the guides to the guide bores in the heads. Intake valves are made from Silichrome number one steel, while the exhausts are made from number 2112 austenitic steel. The valve seat angle is 30 degrees on the intake and 45 degrees on the exhausts. The longitudinal axes of the valves form an angle of 12 degrees with the longitudinal axes of the cylinder bores.

The valves are retained by conventional tapered split keepers, retainer washers and single valve springs. In an effort to obtain a satisfactory valve motion in the interests of good engine performance and yet not overload the nose of the cam lobes, the Packard cam lobe shape results in a relatively low rate of valve acceleration together with a low valve spring rate. The valve timing is as follows: Intake opens 14 degrees before top center, closes 56 degrees after bottom center, duration 250 degrees, lift at valve .375 of an inch. Exhaust opens 52 degrees before bottom center, closes 18 degrees after top center, duration 250 degrees, lift at valve .375 of an inch. The valve spring load is 82 pounds with the valve seated and 165 pounds with the valve open. The rocker arms are cast pearlitic malleable iron with flame hardened ends. These are located on a single longitudinal rocker shaft for each head, which is secured to the head by four rocker arm stands and four capscrews. The rocker arm lift ratio is 1.6 to 1. Pushrods are of steel tubing with an outside diameter of ⅜ of an inch and a wall thickness of .065 of an inch. These contain hardened steel tips that are ground to a spherical radius of ¼ of an inch and are pressed into the open ends of the pushrods. Hydraulic valve lifter "pump-up" speed is about 5100 rpm. Hm-m-m. With a little intelligent work on the valve train, together with faster valve action and more lift, one could more fully utilize the inherently good "breathing" capacity of these engines. This might require different cam and lifter material though.

In the carburetion department, there seems to be a great divergence of the engineering minds. Hudson and Nash specify a single Carter WDG-2231-S two-throat carburetor while the Clipper "DeLuxe" and "Super" models call for a single Carter WCFB-2232-S four-throat. Both Clipper "Customs" and Packards use a single Rochester 4GC four-throat. The "Caribbean," Packard's answer to a certain earth-bound space ship, employs two of the above Rochesters on a well-designed, balanced intake manifold, which, incidentally, will fit the other engines of the species. All of the carburetors contain a thermostatically operated automatic choke which receives heat from the intake manifold "stove." The intake manifolds of the series are made from cast iron and have been symmetrically designed in an attempt to equalize the lengths of the passages.

The carburetors receive fuel under a pressure of from 3½ to 5½ psi from a mechanical pump located on the right side of the engine front cover. The pump is driven by a chrome plated, hardened stamped steel eccentric that is bolted onto the front of the camshaft sprocket. The unbalanced condition caused by the eccentric is compensated for by the non-symmetrical openings in the camshaft sprocket. The fuel pump is one component that has been simplified in the Packard design, for it no longer contains an integral vacuum booster pump. But you'd never guess where said vacuum booster is hiding. It's in the pan!

Exhaust gases are collected by cast iron manifolds that are positioned so that one won't get scorched changing spark plugs on a hot engine. With the standard exhaust system, the left-hand manifold connects to a two-inch diameter crossover pipe that passes beneath the engine and joins to a 2¼-inch diameter header pipe that extends to a reverse flow muffler. Tailpipe diameter is two inches. With the optional dual exhaust layout, the header pipe diameter is two inches and the tailpipe diameter is 1¾ inches.

Positive lubrication of the Packard engines is handled by a spur gear type pump assembly with a built-in pressure relief valve. The pump is driven by an intermediate shaft that couples with the distributor drive gear. Oil entering the pump through a screened floating pickup is directed through a rather complex system of galleries, drilled passages and headers to all main, connecting rod and camshaft bearings, as well as valve lifter guide bores, rocker shafts and arms, the timing chain and fuel pump eccentric. Other parts are lubricated by splash or drain-back oil. A very sensibly placed partial flow type oil filter is located on top of the engine at the left front. This little gem of forethought makes changing the filter cartridge an absolute joy rather than a tragedy. A constant system pressure of 50 psi is maintained by the pressure relief valve under all normal operating conditions. The oil pump assembly isn't complete without an eccentric vane-type vacuum booster pump for windshield wiper operation under low vacuum conditions. The pump performs double duty when the engine is idling because the pump exhaust creates a pressure differential in the crankcase, which aids in the circulation of air through the engine.

To satisfy both the present and future electrical requirements, particularly those of the ignition and the starter motor, Packard has adopted a 12-volt system. Auto-Lite electrical systems are used on the small displacement engines, while the big 'un employs Delco-Remy. The ignitions contain centrifugal advance mechanisms as well as vacuum advance boosters. The starter motor and solenoid assembly is located at the rear of the engine on the lower left side. The ignition is positioned at the back of the engine to the left of center and is driven by a helical gear that matches the gear on the camshaft.

The pressurized cooling system makes use of a single, high capacity centrifugal type pump that is driven via pulleys and a ⅜ of an inch V-belt from the crankshaft. The pump is mounted in a casting that resembles an intake manifold for some strange four-banger. Coolant enters the pump from the single lower radiator outlet, through an oil cooler for the "Ultramatic" fluid. The pump discharges coolant into an equalizing chamber in the "manifold" that directs a balanced flow to each cylinder bank. After circulating around the cylinders, the coolant is forced upward into the heads through cored passages, after which it flows through the "manifold" outlets into a header, which contains a single thermostat, and back to the radiator by a single inlet. A 19⅞-inch diameter four-bladed fan, mounted on the coolant pump hub, draws air through the radiator. The heat rejection of the new engines to the coolant has been reduced by about 21 per cent, as compared with the '54 straight eight, which, in part, attests to the increased thermal efficiency of the V8's.

The method of balancing the engines is also of some interest. Before assembly, all of the rotating and reciprocating parts are individually balanced. This group includes the crankshaft, connecting rod assemblies, piston assemblies, flywheels and harmonic balancers. After the engine is put together, it is transferred to a special balancing machine, which motors the engine sufficiently to indicate the amount and location of unbalanced forces. The machine automatically stops the engine at this point and the indicated unbalance is compensated for by automatically drilling into the crankshaft pulley and welding a slug onto the flywheel. Packard claims that the stack-up of balancing tolerances that occurs during engine assembly is reduced to no more than ¼-inch-ounces by this method. Could be, but I'd like to know how the balancing machine compensates for the unbalanced forces that are absorbed by engine friction while the engine is being motored.

Oh, yes, almost forgot. The 352-cubic inch "Caribbean" engine is rated at 275 brake horsepower at 4800 rpm and 355 pounds-feet of torque at 2800 rpm. This engine uses the previously mentioned double four-throat manifold, carburetors and dual exhausts and is the most potent automotive engine currently being produced in this country.

Along with their new engines, the Clipper "Custom" and Packard cars (352-cubic inch only) contain the most significant American suspension development since independently sprung front wheels. I refer to the much-publicized "torsion level ride." In this layout, the suspension medium is a pair of 106 inch long fore-and-aft torsion bars that are connected to front and rear load arms on each side. At the front, the load arms extend outward from the torsion bar, while at the back, the arms extend inward. This automatically eliminates the need for stops, adjustments, etc. Each rear load arm is also connected to a 46⅛ inch long "levelizer" bar, which parallels the main torsion bar. The front end of the levelizer bar is linked to a two-way electric motor that is called the "levelizer" or "compensator" motor. The levelizer bars and motor automatically adjust for load variations in the car (extra passengers, baggage, spare engines, nitro drums, etc.). This is done by applying a torsional force to the main bars, through the levelizer bars, so that the height of the car will remain constant throughout the range of unloaded and loaded conditions. When the front wheels go over a bump or fall in a hole, the wheel action is transmitted as a torsional load to the main torsion bars by the front load arms. Because the front and rear wheels are joined by a common torsion bar, the rear wheels actually anticipate the magnitude and direction of the front wheel disturbance and the rear wheels are "set" for the same disturbance before it occurs because the bars are twisted in a direction opposite that of the disturbance. In this instance, the back end knows exactly what the front end is doing, which is a novelty in itself.

The ride that is a product of this ingenious yet simple system borders on the fantastic. By my own standards, it is soft, yet the feeling of complete stability is there even at the highest speeds, unlike any other passenger car. The amount of body lean on turns is about par for a car of Packard dimensions, but this poses no threat to security. There is no floundering, wallowing or sashaying about on the worst kind of roads at speeds that

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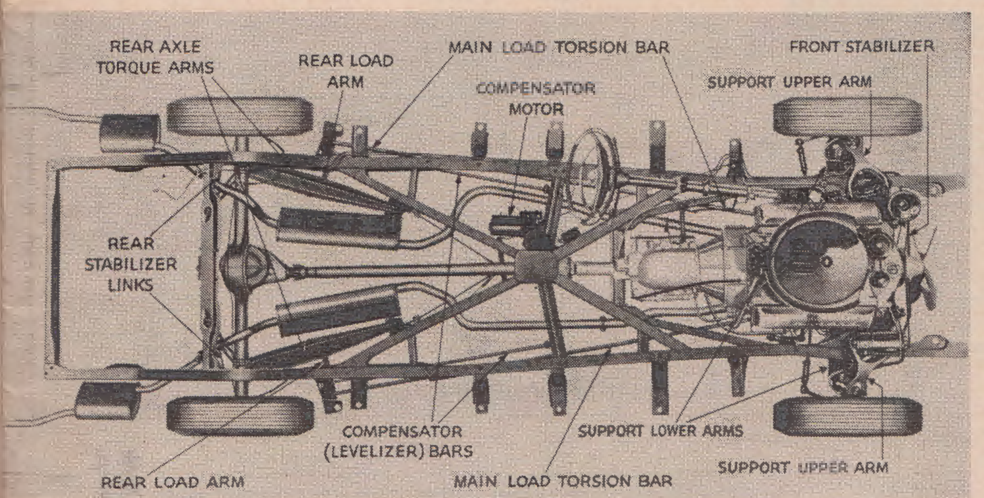
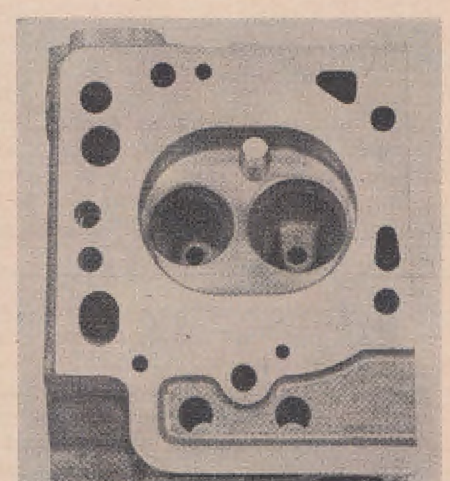


Packard's suspension medium is two full-length torsion bars. Shorter bars are connected to load compensator, which is necessary due to sensitivity of main load bars.



Fully machined combustion chamber has been tested at compression ratio of 12:1.

HOW POTENT IS PACKARD'S V8?

(*Continued from page 19*)

would otherwise be sheer insanity. I can't help but think one of these things would supply a lot of right answers in the Pan American road race, where the world's best suspension systems are reduced to mere adequacy.

The most unfortunate part of the story, and surely a frustrating experience to a performance-minded prospective buyer interested in an excellent chassis, is the fact that on all models except the Clipper "DeLuxe," "Super" and "Custom," the "Twin Ultramatic" is standard equipment. This is true of the Hudson and Nash V8's as well. Only on the above Clipper models is there a synchromesh transmission as standard with the option of an overdrive, and only on the Clipper "Custom" can one purchase a synchromesh or overdrive *and* the torsion suspension. The "Ultramatic" is undoubtedly one of the better automatics, but let's face it; in spite of their advantages, all of these new-fangled torque converters sop up engine power like a dry sponge in the low and mid-range speeds. As yet, there is no substitute for a good synchromesh transmission for mechanical efficiency and optimum performance in all speed ranges. Of course, the record *average* of 104.7 mph for 25,000 miles (including all pit stops) posted by a pre-production Packard earlier this year speaks for itself. But this was a top speed run, made with the converter mechanically and automatically "locked out" above speeds of about 60 mph. In acceleration, the "Ultramatic" equipped cars are only fair. The best one of the bunch is the overdrive equipped Clipper "Custom." However, past sales records have shown that the public favors the automatic transmissions, so Packard not only encourages this choice, but makes it mandatory on some models. You can't condemn 'em for recognizing the buttered side of the bread, but to my way of thinking, the full potentialities of the Packard engines can never reach the pavement.

In summarizing, and in answer to the question posed by the title, the Packard V8's are good, big and hot, but could be hotter with a more liberal transmission choice. These engines have been laid out with forethought and a great deal of consideration for the guy who twists the nuts and bolts. Only a fraction of their design potential is being used now. Just stand back if anybody ever hangs a bigger bore and stroke in one of these giants! The suspension developments rate nothing but the highest praise and are bound to start a chain reaction among other manufacturers. A Packard is a pretty expensive chug for a person in the "low-priced three" bracket, but if nothing else, it serves to stimulate and direct thinking toward the desirable goal of good engine performance with a chassis to match.