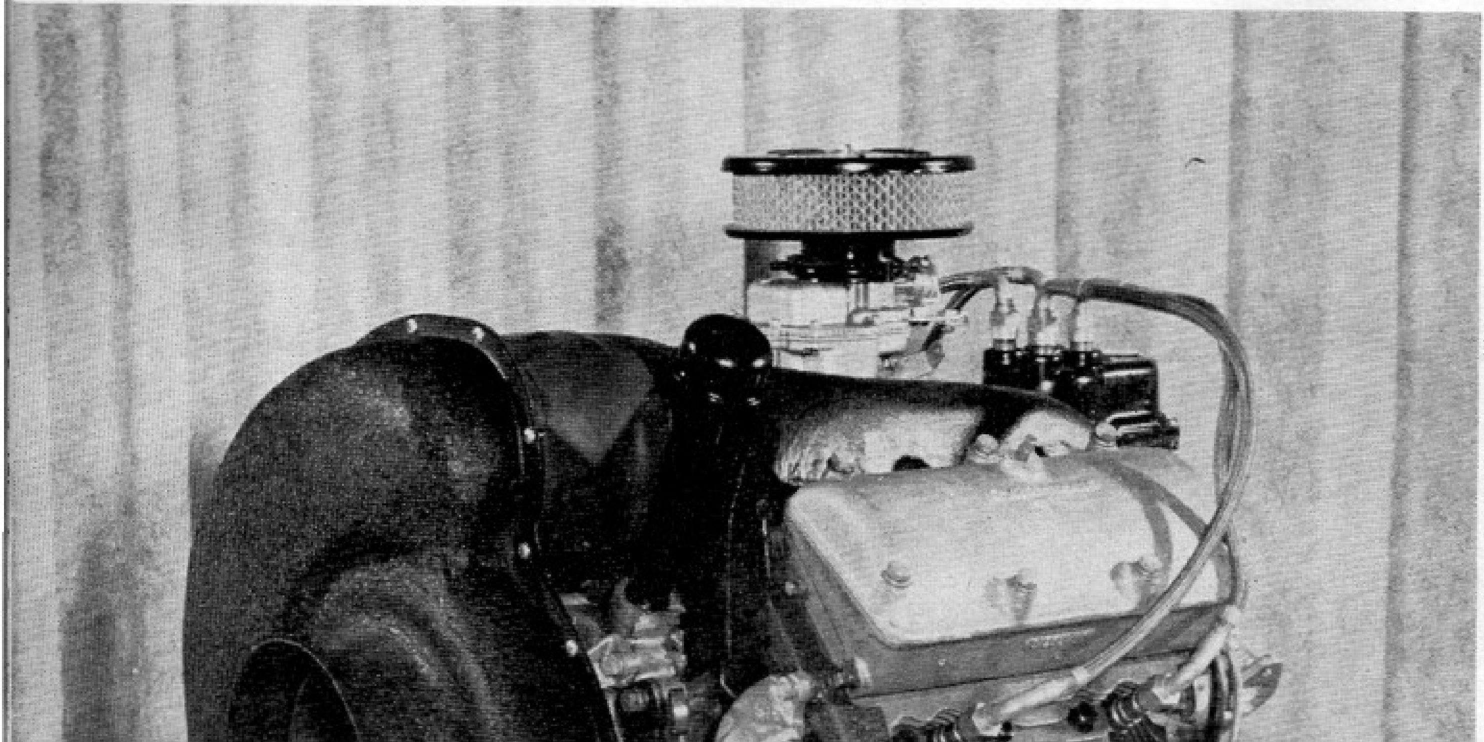
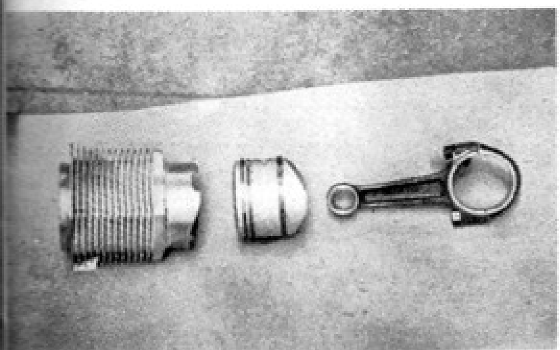
American Motors'



Military requirements dictated the heavily shielded ignition cables and oversized generator. Small elbows carry exhaust away. Visible on front cover are the dipstick and oil filter, while the transmission adapter plate can just be seen.

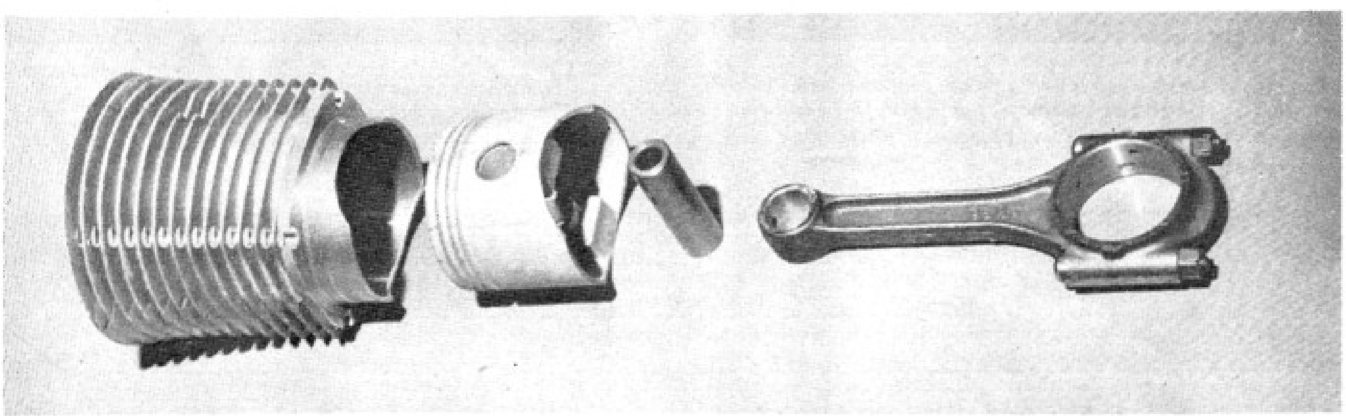
New V-4...



Porsche cylinder group resembles AMC parts below. Rod big ends differ.

. . . the first U. S. built automotive air-cooled engine since the day of the Franklin. Here is an exclusive SCI report on the newcomer.

BY KARL LUDVIGSEN

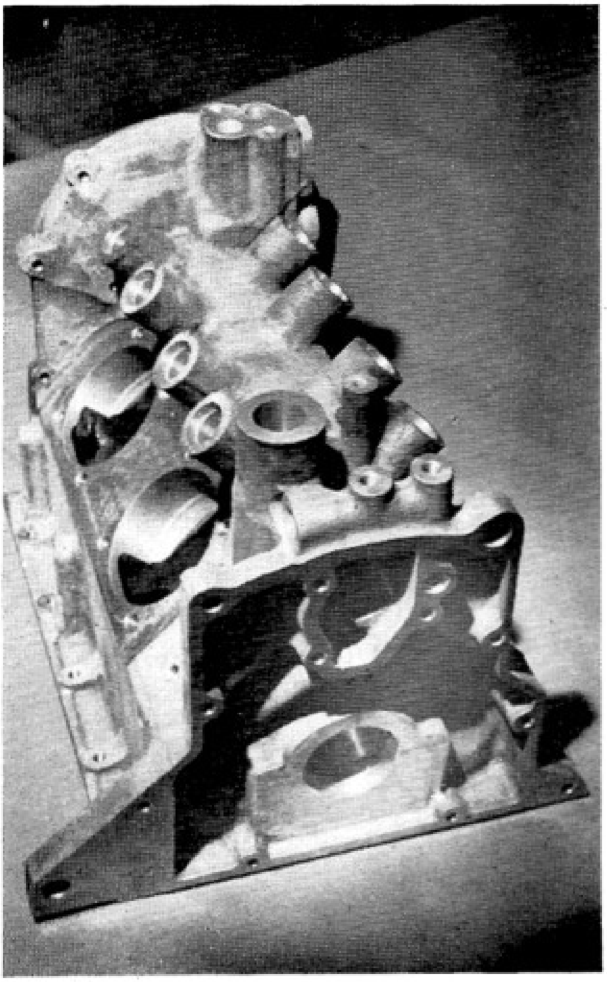


Con rod shank is a shade slender in relation to length, but bearing cap is healthy. All rings are above wristpin hole, in which circlip groove can be seen. Cylinder fins are drilled for hold-down studs, and are deep at top.

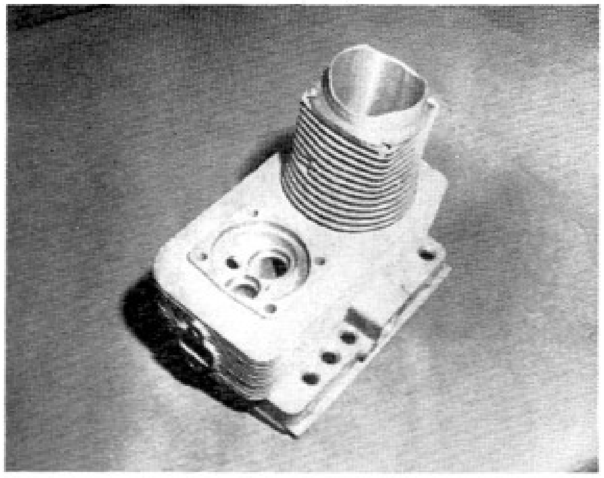
ONE of the things the American automotive industry lacks is a good small-displacement sports car engine. The AMC V-4 isn't it yet—but it might be. England lacked one too, not so long ago, and a rough silk purse was hewn out of a very fine sow's ear in the form of the Coventry-Climax four. Germany had the same problem after the war, and was rescued by Ferry Porsche's clever development of his father's rugged VW engine. In neither case (excluding the ultra-ultra four-cam Porsche and a possible DOHC Climax) was the end result the ultimate, but they kept a lot of sports cars going fast enough for long enough to encourage their makers to turn wide the taps on full racing versions.

Both the above engines were first conceived as hard workers over long hours with minimal fuel costs and upkeep; light weight being an additional goal. This gave them high strength/weight ratios to begin with and left a lot of room for improvement at the top end. Intended mainly for military and industrial use, American Motors' new V-4 fits right into the pattern. Their engineers see these power-plants showering from the skies inside Marine "Mighty-Mites" and similar airborne vehicles, as well as donning civvies to turn pumps and generators.

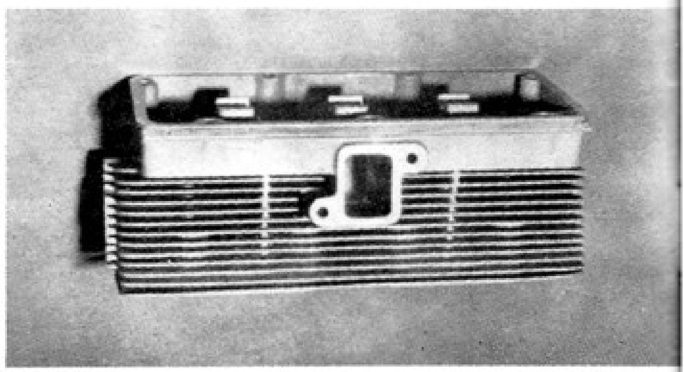
AMC Engineering has taken over from Research for detailing and dyno testing, and the present Third Series engine winds up experimentation that began before the war. In cooperation with Alcoa, aluminum has been used extensively, with all such parts except the pistons and the intake manifold being adapted to die casting techniques. This has dictated some design details, as have the very



Rear main bearing cap is brutally massive, and seals crankcase from clutch housing. Opening above bearing houses oil pump and feeds adjacent connections.



Combustion chamber has good "squish" & turbulence contours. Heavy counterbores await both valve seats and cylinder top end.



Head finning is close-spaced and deep. Single intake port is modest in size, and warms charge while limiting peak power.

specific and rigid Ordnance requirements.

Basic module of this clever lightweight is a single-cylinder assembly, or, more correctly for this application, a 90 degree vee assembly of two cylinders. These are offset enough to allow separate assembly of two cylinders. Stroke/bore ratio is squared up at 3.25 x 3.25 inches, or 82.5 x 82.5 millimeters. In V-4 form the displacement is 108 cubic inches or 1770 cc, and V-2, V-6 and V-8 mills are projected. In order, these would contain 54, 162 and 216 cubic inches, or 885, 2655 and 3540 cc. Since the V-4 is the only unit that's materialized into any hardware, we won't worry about the others except to mention that only seven basically new parts are needed for each one: rocker cover, rocker shaft, head, camshaft, crankcase, crankshaft and sump.

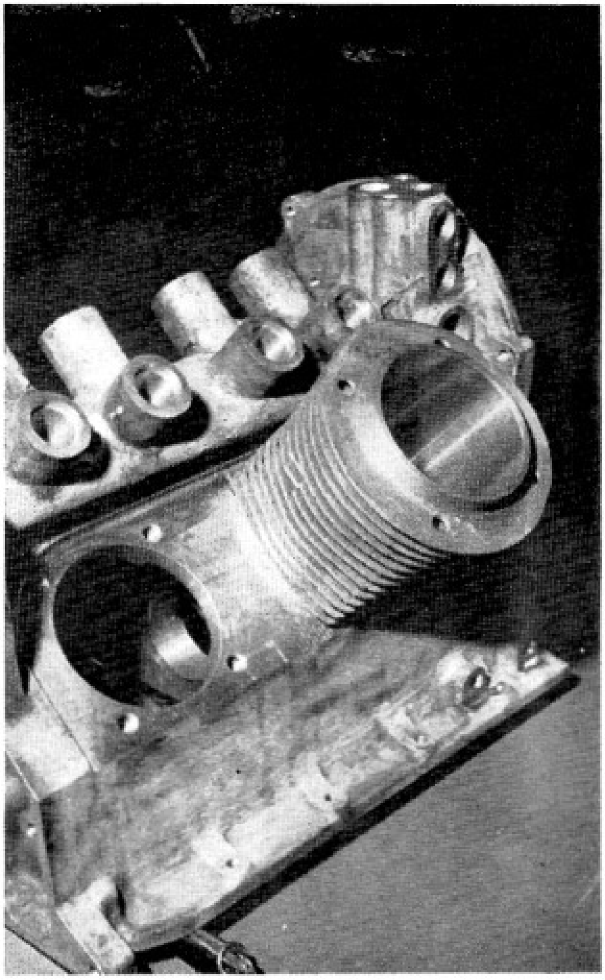
1770 cc. is a pretty discouraging figure, and a little slide rule pushing shows that a brutal destroking to 2.75 inches would bring it down into the 1.5 liter Class F and allow 7650 rpm. at a piston speed of 3500 feet per minute. This would call for a new crank, and it might be easier to turn up some new cylinders with a bore of 3.44 inches, to move up to the top of the two-liter class. It could be hot either way, so it's definitely worth some study.

Heart of the engine is the cast-aluminum crankcase, which is very compact and shaped like a squat house with a gable roof. The sides and ends extend down several inches below the crankshaft center, and with substantial internal bracing they give good support to the three main bearings. Deep aluminum caps for these are located at each side by small matching flats in the crankcase, and are tied in by two bolts. A U-section steel strap strengthens the center main. Projecting from the "ridge pole" at the center are eight cast extensions which house the cam followers, just above the single central camshaft.

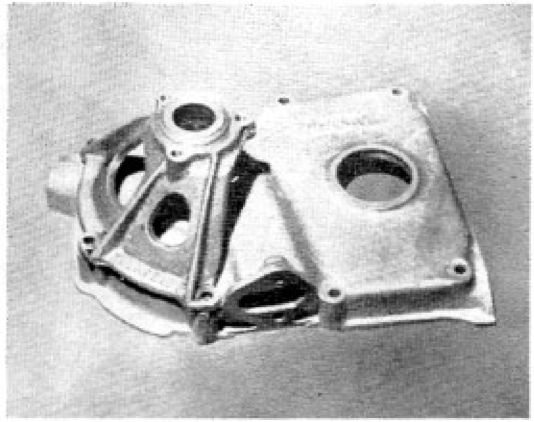
The cylinder construction is imaginatively simple, and will be familiar to students of the Porsche air-cooled designs. Each cylinder is an aluminum tube with cast fins which are shallow at the bottom end and deeper near the head joint. The bores are plated with from .003 to .004 inches of chromium and lightly finish honed. At the top the outer diameter is clear for 3/8 of an inch, and this fits a similar counterbore in the head around the combustion chamber. A small flange at the bottom meets the machined face of the crankcase through a thin copper gasket while a relieved extension spigots into a 3½ inch hole in the crankcase.

It's an interesting coincidence that the bore of this cylinder is identical to that of the 1600 Porsche and that the designs are very similar. This can lead to tantalizing conjecture—one chance being that the use of Stuttgart cylinders might help shrink the engine for destroking. If the 2.94 bore of the 1300 could be fitted, though, severe crank changes would not be a Class F necessity.

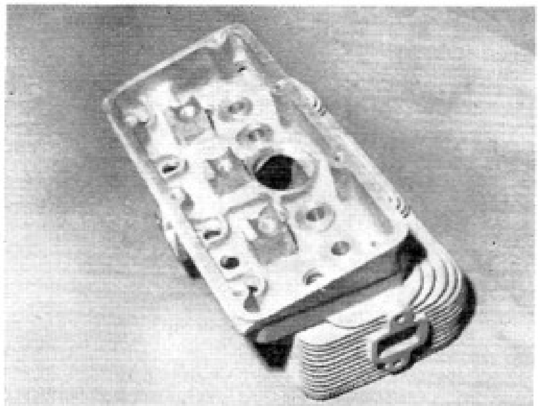
Head, cylinder and crankcase are three separate pieces, then. What holds them together? A classic solution. Four alloy studs undercut to a diameter of 3/8 of an inch surround each cylinder. They screw into the crankcase, pass



Alloy center main cap seen thru hole for cylinder spigot. Cam and follower housing is unique, does not need to carry oil.



Support bracket for cooling blower bolts to timing cover. Opening on near side is for fuel pump drive lever.



Far rocker support carries oil to valve gear. Center opening, normally closed, is ideal entry for new carburetor.

through holes in the cylinder fins and protrude above the head to accept nuts. The head and crankcase are thus directly tied together with the cylinder acting as a spacer. There's no head gasket now, though for higher outputs a copper ring compressed into matching grooves might help maintain the seal.

Also, small compression ratio increases can be made by carefully trimming the top end (instead of weakening the bottom flange), while more drastic shortening would go well with destroking. New through-studs for the AMC four shouldn't be necessary since the standard ones are carefully matched to the expansion characteristics of the aluminum cylinder. In any case a steel stud would expand less than the aluminum and only tighten things up excessively when they got warm.

Permanent-mold casting is used to form the aluminum pistons, which are flat-topped and full-skirted except for mild cutaways for the crankshaft counterweights. This would present problems when destroking. The skirts are cam-ground to a very slight taper and clear the walls by .0015 of an inch. Two iron compression rings are carried, each running in a groove .080 of an inch wide, while the single expander-type oil ring fits in a .189 of an inch groove. Just below these, the pistons are slotted on each side.

Spring circlips retain the 13/16 of an inch full-floating wrist pin, which is slightly offset and turns in a bronze bushing in the con-rod little end. The rod itself is drop-forged steel and measures 5.81 inches from center to center. The well-proportioned H-section broadens into a conventional two-bolt big end. No rod drilling is done, splash oil for the wrist pin and upper cylinder being supplied from a jet in one side of the big end.

A general impression of huskiness given by the piston and rod isn't belied by the steel crankshaft, which is a handsome piece of work for such a utilitarian engine. The three mains are closely spaced and the four rod journals are far from narrow, so some sections of the crank look "real racing" in their compact angularity. To add to this the AMC engineers wanted full counterbalancing, and the resulting design was too intricate for the drop forging process used. The body of the crank is thus forged and the two biggest counterweights are separately machined and tied in with two bolts each. This could be a big help to a later, more accurate balancing job. Healthy in size, the main and rod journals overlap slightly and are fitted with trimetal bearings.

Lying just above the crankshaft, the cam is driven from the crank nose by a phenolic gear. Forward of this is the drive cam for the timing-cover-mounted fuel pump. Placed between the gear and the cam, though, is the Gerotor pump that powers the engine's neat lubrication system. A fixed screened pickup draws oil from the center of the stamped steel four-quart sump. After leaving the pump the oil enters the drilled passages of a compact tower above the pump. In sequence, this tower contains the relief valve, connections for either a bypass (now used) or a full-flow filter, and the

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V-4—

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outlet to the oil cooler. Also in this area are the dipstick and the oil filler cap and breather.

The big oil cooler lies flat in the valley between head and cylinder. Air from the belt-driven nine-inch blower at the engine front is fed into a plenum chamber at the top of the valley. It is simple, with this layout, to duct cooling air directly to the heads, while the air to the cylinders has to go through the central oil cooler first.

This rig ensures that the heads and the oil cooler get the very coolest air, while the cylinders run somewhat warmer to minimize piston drag. Warm air is easily exhausted at both sides of the engine.

For all-around automotive use, AMC would probably fit a thermostatic shutter to the blower inlet. At present, it's sufficient to bypass the oil around the cooler (by thermostat) until the operating temperature is reached. The cooler and accessories are so mounted that no external piping is needed for the primary part of the system which pressure-feeds all the crank journals and the three babitt camshaft bearings. Two tubes are needed at the back, though, to pressurize the single rocker shaft in each head.

Yes, it's a simple rocker-box layout, with a few new touches. The cast iron rockers have cyanided tips and a pushrod/valve motion ratio of roughly 1/1.5. They are drilled from their shaft hole to the concave pushrod socket, and thus carry oil to the compact hydraulic valve lifters. Though such oil in the pushrods apparently adds to the mass of the valve gear, it seems likely that it more or less stands still while the rods move up and down around it—and, in fact, it helps a lot to damp out pushrod vibrations. Installation of solid lifters and adjustable rockers would still help to push the valve bounce barrier beyond a modified operating rev range.

Valves for each bank are placed in line and inclined toward the engine center to conform with the wedge shape of the combustion chamber. Both intake and exhaust valves are made of austenitic steel, and seat on very meaty Eatonite inserts. For fitting, these are cold shrunk while the head is heated. Present port diameters at the inserts are 1.31 inch for the intake and 1.06 for exhaust. There's plenty of space here for gouging out.

The pressed-in cast iron valve guides are flanged at the top to form working surfaces for the single valve springs. Lots of room here too for stiffening up.

Wedge-shaped in cross-section, the combustion chamber has a modified heart contour in plain view. The point of the heart is at the thick end of the wedge, and a rounded pocket at that spot faces the spark plug toward the swirl of the incoming charge. It's a good shape, for medium speeds, at any rate, and is now operating at a compression ratio of 7.5 to one. Die casting will eliminate any need to polish the stock chamber surface.

The intake ports are siamesed vertically at the center of the head, and a cast passage moves inward from their junction to a simple Y manifold at the engine center. To make die casting possible, an access hole roughly two inches in diameter is cast above the junction in the top surface of the head. It would be a cinch to pipe in a single carburetor here for each bank, and there may even be enough room to de-siamese each head. Porting below the normally sealed hole is big and clean, while the duct leading inward is a long and narrow rectangle, clearly intended to impart some heat to the incoming charge. This comes from a single Carter Type AS carburetor.

As yet unconnected by any standard manifold, the rectangular exhaust ports emerge from the ends of the heads.

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V-4 —

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This is a real challenge to the header builders, who'll have to use their imagination.

Ignition for the military version is all heavy-duty and specially shielded. Coil and distributor are combined by Auto-Lite into one unit called an "ignitor", which is vertically driven from the back end of the camshaft. Spark plug size is 14 mm., and the cylinder head threads are armored by Heli-coil inserts.

The back end of the crankcase is fitted with a circular steel plate, to which clutch housings are bolted. At present, a cast-iron flywheel, roughly 13 inches in diameter, is carried. The package size of the entire engine unit is an approximate two foot cube. Weight, exclusive of generator and starter, is about 200 pounds. This shapes up as a very attractive and versatile power package which, with its modest 62 horses, would be almost ideal for an "American VW". It's valid to infer, from its rugged lightness, that is would be an equally good basis for an "American Porsche".

Obviously, as in the VW, the power is deliberately restricted by the very modest provisions for breathing, and the peak output is obtained at 3500 rpm. The torque comes in between 1600 and 1800, and has a notably flat curve contour. It's not held to these figures by bottom-end or valve gear deficiencies, though, 4400 rpm being regularly reached on the dyno. A pilot installation in a Metropolitan operates within a 5000 rpm limit, and a few modifications from standard, as outlined, should result in a very "revable" unit.

Frankly, though, as we write the production picture is far from clear. We think that the Marines should jump for this and hope that they do, since that's about the only way it'll see quantity output in the very near future. Industrial and automotive uses would back up such an order, and American Motors representatives have indicated an eagerness to cooperate with the sports car movement when the time comes.

If you already have the urge to cast up a new head for this bomb (you need only one pattern), or to start lopping off those cylinders, we suggest that you drop a line to the Special Products Division, American Motors Corporation in Detroit, and let them know how much it would mean to us to have a raft of these V-4's to do exciting things with. If development is arrested, we'll have missed the very best bet yet.

—Karl Ludvigsen