SMALL ENGINES WITH BIG PUNCH

FORD'S 221 V8 WILL FIT THE FALCON & COMET

FORD'S objective in designing its latest V8 was to provide more power for the compact and intermediate line. This called for a husky lightweight engine able to fit within the confines of spring towers on the unit body of Meteors and Fairlanes. Since the new V8 is less than 20 inches wide measured across the exhaust manifolds, it will also fit a Falcon or a Comet, though it has not been released for production on those cars. Weight of the 221 is within 100 pounds of the 170 cubic inch Six, so that the two engines can be used interchangeably without unbalancing the car.

The results speak for themselves. A 3.5 by 2.87 bore and stroke allows low piston velocities, large valves, plus some piston and rod design similarities to the 170 cubic inch engine. Power, even with a small two-barrel, is a husky 143 hp at 4500 rpm. Torque peaks out at 2200 rpm with 216 pound-feet, but remains reasonably level through most of the engine's useable operating range, which requires a minimum of shifting. The 221, complete with starter, generator and a 10-inch clutch, weighs only 469 pounds. This is quite an achievement, since in spite of its cast iron block the engine weighs only 80 pounds more than an equivalent displacement aluminum V8 engine.

A number of cost, production, and service factors were involved in Ford's decision to stay with cast iron rather than switching to aluminum. Aluminum costs more than cast iron. Highest savings in weight can be aciheved through die casting, but the dies are very expensive, and so is the casting machinery. Ford, on the other hand, has extensive and ultra-modern cast iron foundries. The use of smart design features plus precision casting methods narrowed the weight advantage of aluminum over cast iron, at considerable savings in production costs. Staying with cast iron may also prove quite beneficial to the hot rodder, since a cast iron block costs less and lends itself to boring out much more readily than an aluminum one with cast iron sleeves. This eases repairs or increases in displacement on the 221.

Generally, the foundry must allow considerable excess metal to take into account core shifts and changes in the shape of the core due to handling. At Ford, the latest foundry practice is to blow in under pressure a mixture of sand and resin binder into a preheated "core box." There, the mix is baked into a readily handled shape. The new method of making cores provides accurate positioning, prevents core shifts, and has made it possible to reduce wall thicknesses, saving weight.

Even the most casual look at the bare 221 block makes one wonder how they crammed so much into so little space. Most noticeable is the 9.07-inch height, which obviously precludes the traditional deep-skirt crankcase which extends below the crankcase center line. Despite this, Ford Engineering considers this mill to be the most rigid one in their line-up, or at least the one with the highest natural frequency.

A number of design features contribute to greater block rigidity. For one thing, use of shell molding enabled the Ford engineers to build in accurate webbing and contours, putting metal to its most efficient use in critical stress areas such as main bearing webs. The section between the cylinder banks above the cam forms a rigid tie-in. Bolting an intake manifold of deep section to the heads, hence to the block, adds to overall stiffness. Ribs housing the oil passages to mains and cam in each main bearing web double as stiffening sections.

The width of the block is specified at 16.38 inches, again quite modest. Short exhaust ports and fairly stubby cylinder heads contribute to compacting the engine. Cylinders have been brought as close as possible to the crankshaft center line. As a result, overall engine width is only twenty inches, a full eight inches narrower than the 292 cubic inch Ford V8.

The shrinking process did entail some problems since the crankcase allowed room for only 70% of the full crank counterweighting. This was solved by adding external counterweights, one at the front, next to the crankshaft pulley, and the other at the rear, on the flywheel. Flywheels used in conjunction with a clutch have a cast-in pad acting as a counterweight. Since the bob at the flywheel swings about a much larger radius than weight which is part of the crank, less metal is needed, hence a weight saving. Flywheels used in connection with an automatic transmission consist of a simple slug of metal welded just inside of the ring gear lip.

Main bearing caps are located by milled recessess in the block. The crank is a nodular iron casting with 2.5 inch mains, .908 inches wide, and the rod bearings are 2.125 inches in diameter, .840 inches wide. Coupled with the short 2.87-inch stroke, this gives over 11/16 overlap (.692) between rod and main bearing journals, and excellent rigidity. Precision casting techniques allow the designer much more freedom in placing the metal at the counterweights than forging, a major factor in making the crank fit into the small 221 crankcase.

The top main bearing shells are grooved for oil distribution, but bottom half shells are plain, insuring a larger supporting area and greater load capacity. Steel backed microbabbitt bearings are used at the mains, and steel backed copper-lead onces at the rods. Use of the microbabbitt mains is indicative of the fact that stresses at the mains are considered fairly low at this time, and that more cubic inches may be in the offing. There have been rumors and talk of 260 cubic inches via increased bores, and the ample dimensions of the block certainly allow for this.

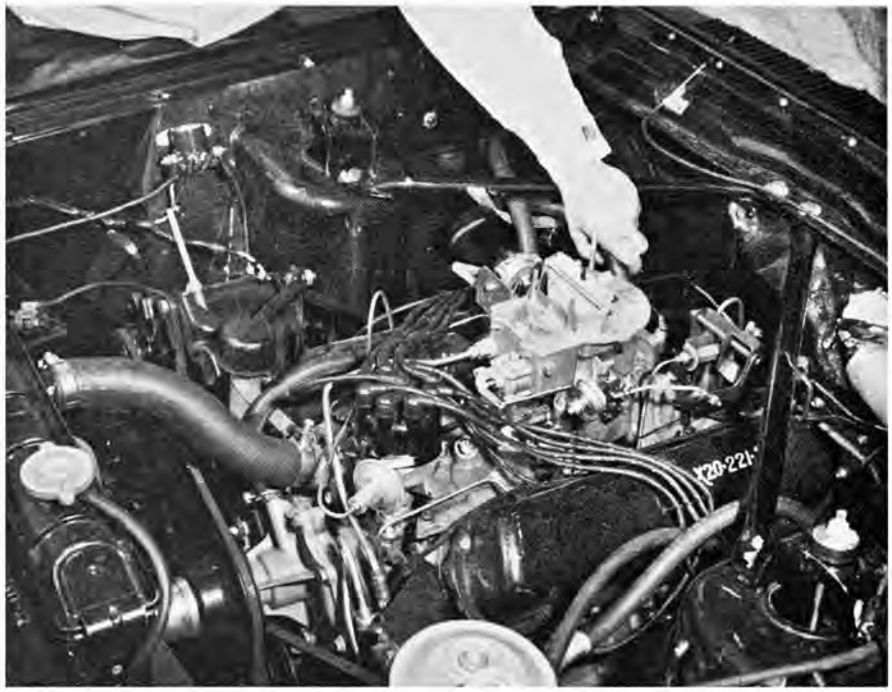
The forged rods are quite short, just 5.155 inches center to center. Ford has departed from floating pins and uses a press fit pin in the rod, eliminating retainers and a bushing in the process. Pistons are very close in design to those of the 170 cubic inch Falcon. They have slipper skirts, since every bit of clearance is needed for the crank counterweights' slots and steel inserts control hoop expansion. Balance pads are incorporated at the bottom of the wrist pin bosses.

An added feature is a groove placed above the rings to act as a heat dam. A considerable amount of heat flows from the top of the piston into the ring area. Comparatively little of this heat can escape via the lower portions of the skirt because of the slots, hence it must enter the cylinder walls by way of the rings. Without the dam, there is a direct path into the top ring which bears the brunt of the heat load. The dam breaks the heat path and diverts some of the heat to the other rings. This action continues even though the groove eventually becomes filled with carbon.

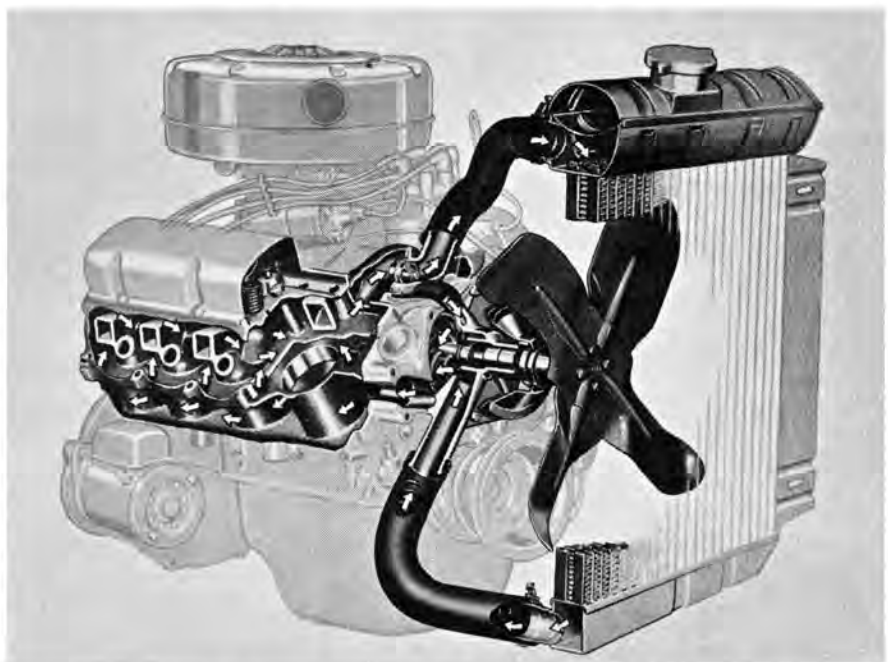
The cylinder head bolt pattern results in a four bolt tiedown per cylinder. In addition, each head is located by a pair of dowels placed concentrically with individual head bolts, eliminating any chance of a gasket slipping during installation. Small wedge-shaped combustion chambers are almost centrally located over the cylinders. Spark plugs are placed angled toward the exhaust valves to clear the exhaust ports. By using cast rather than machined surfaces, Engineering had more freedom in producing the most favorable combustion chamber shape. No two exhaust seats are adjacent, to avoid potential hot spots. The inlet valve head is 1.68 inches in diameter, and the exhaust one 1.39 inches, quite generous for the engine's present breathing capacity. One pleasant feature is that the valves are placed far apart and there is ample room for larger ones, should you decide to soup up the engine. The edges of the combustion chamber are close to the valve seats and to the bore periphery, but a little relieving should readily unmask them.

The valve train is certainly quite an innovation for Ford, since they have gone to ball socket rocker arms a la Chev or Pontiac. However, some characteristic Ford detail touches have been added. For instance, the rockers are cast of malleable iron, rather than stamped from flat stock steel. As a result, their wear life is considerably better. We looked at rockers that had been through complete durability tests, and could only detect a few shiny spots, but no wear at all. The rockers also seem quite easy on the valve stems.

Rocker studs are 2500-pound press-fit into bosses cast in the upper cylinder head deck. If you still have some doubts about their holding under higher spring pressures, you are of course welcome to pin them, as in the current hot rod practice on Chevys and Pontiacs. Ball sockets on which the rockers pivot are made of sintered iron, an ideal oil retaining material. The upper deck of the cyl-



Engine has been designed to fit between spring towers of a unit-bodied car. With cast iron block, it weighs just 459 pound with starter, clutch.



Coolant enters block at front, travels toward rear and up the head. Block-to-head transfer passages become progressively larger for cooling.

Ball socket rocker arm is made of malleable iron, shows remarkable wear resistance to even prolonged dyno tests. Oil supply is delivered through lifter and pushrod.

inder head is reinforced to withstand simultaneous installation of all studs prior to production.

The cast iron, induction hardened camshaft has been placed quite far up in the block, between the cylinders. This, coupled with the short stroke and squat design results in pushrods so short they will fit the length of your hand. The puhrods are tubular, with a hardened steel ball welded to each end. Only hydraulic lifters are available at the present, though mechanical ones will probably appear soon enough. Rotating valve caps have been eliminated in the interest of weight saving and revs. A taper across the cam keeps the lifters spinning to avoid uneven wear.

Oil is bled from the top of the lifter, through the pushrod, up to the rocker. A small drilling in the rocker supplies the ball socket, while oil splash is used to lubricate the valve stem and its tip. Rubber umbrellas riding on the valve stem prevent excess oil from reaching the guides. Along the lower edge of the head a substantial ridge acts as an oil trough and leads oil away from the valve guides, back to crankcase return holes at each end of the head.

While a floating screen presumably picks up clean oil skimmed from the top of the pan, it doesn't always work that way. Instead, it can pick up foamy oil, become uncovered in fast cornering or harsh braking. Air leaks at the inlet side of the pump are also likely to develop. Instead, the 221 is fitted with a fixed screen, thoroughly immersed, at the deep end of the pan. Here, air bubbles have had the best chance to work out of the oil and there is less likelihood of leaks. Ribs stamped in the sides of the deep oil pan prevent drumming. However, there is no baffling.

More than ample capacity is insured by an oil pump, placed at the front of the engine, having the same size pump gears as the 352 and 390 engines. Oil is delivered through individual drillings in the main bearing webs to each main. From there, separate oil drillings lead to the camshaft bearings which, in effect, limits the pressure to the cam. Lifters, on the other hand, are supplied through separate galleries under full pressure. The car is delivered with a "shorty" type of filter cartridge which is then replaced by a full sized cartridge with a fine filtration cotton section and a sisal packing that insures an adequate supply of oil with coarser filtration.

Oil sealing forms an important part of any engine design. Since low oil consumption has been a Ford trade mark over the past few years, much effort was directed at curtailing the possibilities of leaks. For instance, the ordinary gasket tends to set. When the bolts are no longer under tension they loosen further and leakage problems really become serious. Instead, Ford uses an array of neoprene and rubberized cork gaskets which are much more resillient and do not pack down with time.

Front and rear mains are grooved to receive neoprene strips which form a tight seal with the oil pan. These strips also seal in the tips of the pan gasket. There seems to be an industry-wide shift to larger diameter seals at the rear main. On the 221, the rope seal rides directly against the flywheel flange. In addition, there is a king-sized oil slinger and the traditional oil drain groove.

The 221 timing case cover is a complex aluminum die casting that carries the oil filler pipe, dip stick, and fuel pump. It also serves as a backing for the aluminum water pump. Formed elbows at the outlets of the waterpump pilot it on the timing case cover and also provide a smooth transition for the flow of coolant.

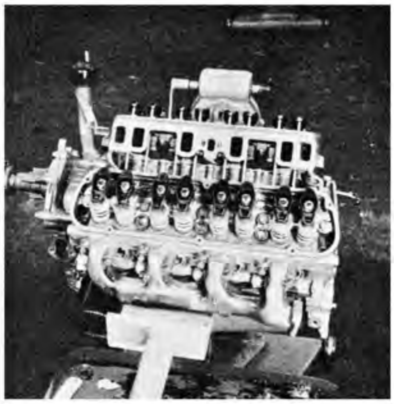
The timing case cover casting includes two passages that lead from the waterpump to the cylinder banks. To avoid the possibility of coolant entering the oil in the event of a gasket failure at this point, a groove has been cast to act as a drain channel between the water passages and the remainder of the timing case cover. It is not something you'll see advertized, just good engine practice. The coolant is routed through the block toward the rear of the head and then back through the head to outlet passages cast in the inlet manifold to the thermostat housing and radiator. A bypass is provided externally from thermostat housing to pump. The thought is to offer even cooling, and not to have the coolant short circuit around the rear cylinders. A series of small holes is drilled in the upper portion of the cylinder block decks to match corresponding openings in the heads. These holes vent the high side of the banks to avoid steam or air pockets but are too small to have any effect on coolant flow. The lower side of the cylinder bank decks do carry openings, ranging from small ones at the front to progressively larger ones toward the rear, again to even out flow.

After an initial tryout on the Falcon engine, the water-heated carburetor pad is gaining increasing popularity at Ford. It has since been adopted on the 352 and 390, and now makes its appearance on the 221. The pad provides a fairly level heat input to the carburetor base, enough to avoid icing problems and assist vaporization. This, in turn, made possible a reduction in the amount of exhaust heat supplied to the serrated underside of the manifold. In fact, the conventional heat riser valve has been dropped altogether. Only exhaust pulses supply heat to the manifold. A passage joining the exhausts of the two cylinder banks is essential to avoid a raucous exhaust and one added benefit of the crossover pipe is that it eliminates the need for an auxiliary balance pipe in the exhaust system. A cover keeps oil away from the exhaust crossover to avoid charring. Another plate baffles the breather passage. The intake manifold is held by six bolts, strategically located not to interfere with intake ports.

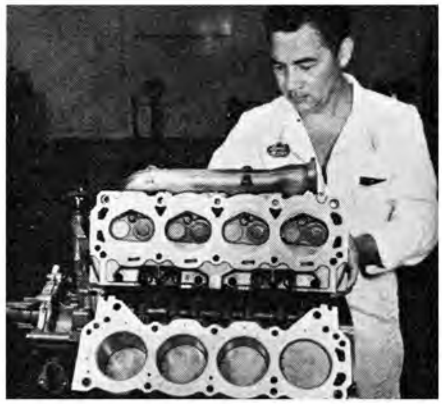
Except for the fact that cast iron was substituted for piping, the exhaust manifold looks like a well-studied header. Lack of space and need for turning the exhaust manifold bolts forced the use of a small pocket that projects into the ports. However, the area lost is negligible. A stove for hot choke air is cast into the right bank exhaust manifold.

Among the nice detailing in the 221 engine, you'll find an aluminum bell housing. Misalignment of the starter and ring gear is caused by a stack-up of tolerances in mating the engine, bell housing and starter. However, on the 221 the starter is piloted by an accurately stamped steel plate which is doweled between the block and bell housing. As you can gather from all of these details, the 221 is a noteworthy engine not only because of its design and execution, but also for its potential in specials and as hot rodding material on lighter cars. We think it is a comer.

Exhaust manifold is cast iron version of header. Note how angled plugs clear the ports.

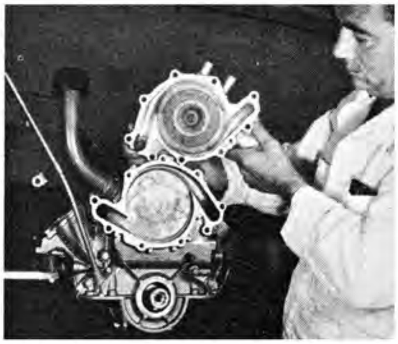


Rocker arm studs are 2,500-pound press fit into bosses cast integrally with head.

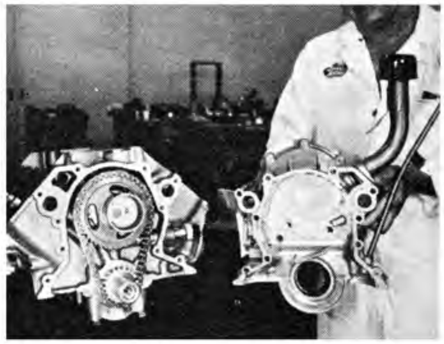


Coolant openings in head are same size so head can be used on either side of the block.

Groove in pistons, above rings, serves as heat dam; prevents heat from reaching top ring.



Curved pads at ends of water passages ensure smooth coolant flow transition on path from pump to block. Note drillings.

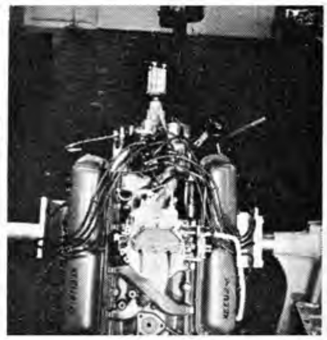


Timing case cover serves as part of water pump housing, carries oil filler pipe, fuel pump and the distributor.

External counterweighting supplements counterweights of crank, itself. One is next to the pulley.

At left is automatic's flywheel with counterweight at periphery. Clutch's flywheel is right.

Crank is cast, has 2.55-inch main, 2.125-inch rod journal diameters. There seems to be stroker room.



Front of intake manifold serves as water outlet. Full sheet metal baffle screens oil from heat.

Ribs at main bearing webs (below) house oil drillings to cam bushings and mains. Oil from main gallery (right) goes to main bearings then cams. Oil filter has fine and coarse sections.