The man and his motor! Lee Root holds his latest mini-creation. The tiny version of the 350 small-block shocks Chevy owners, especially when they find out it's a fully operational engine.

Design and layout by Eileen Knickman

THE INCREDIBLE CHEVY MICRO-BLOCK!

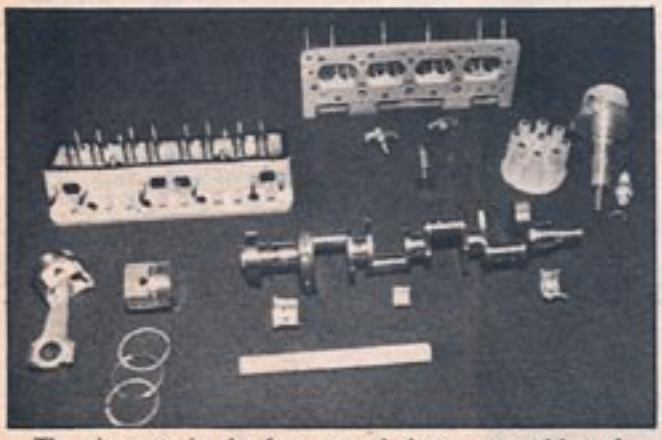
Is this REALLY the next step in Performance/economy engines??

Text by Dick LaFayette
Photos by Rich Carlson Photography

I first heard about it at the drags. Rich and I were up by the tower. He was shooting noise photos and I was talking to one of the Pepsi car's crewmen. He asked if I had seen the little Chevy engine. I wasn't paying enough attention and commented that small-blocks were like noses: They were everywhere and nearly everyone had at least one. "No. No! I mean a *really* little engine. You can hold it in your hands. It's neat. You oughta go see it!" I wasn't impressed. Plastic models turn me off.

If the Christmas tree hadn't taken ill, we wouldn't have gone back into the pits and seen one helluva piece of work. What I saw certainly was the most incredible engine at the races that day. You might say it was the smallest small-block ever. Even the racers, guys who have seen it all, were flat dumbfounded. It's that good!

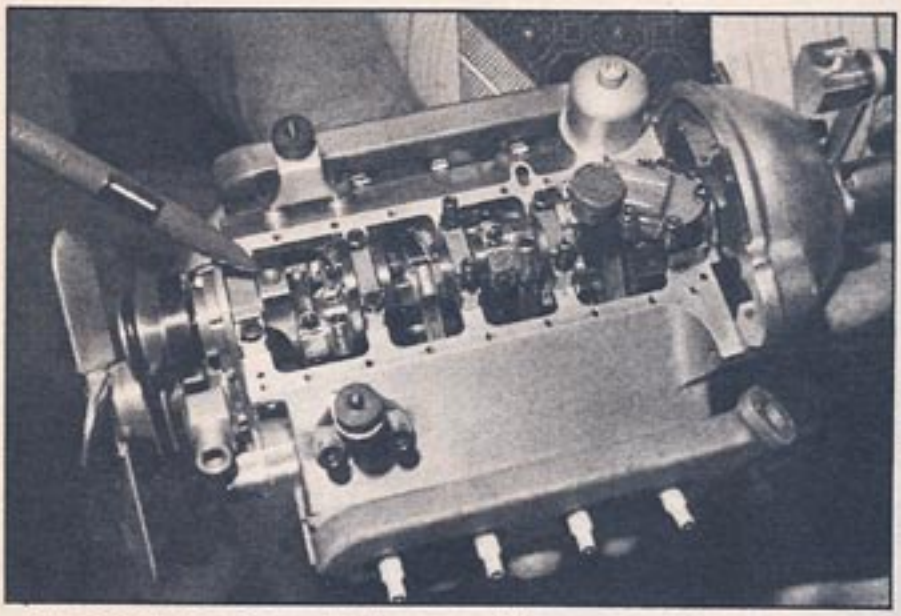
If you have cheated and looked at all the pictures accompanying these words, you know why it was that we were impressed. If I had seen the weeny little engine by itself, I would certainly have started looking for a little man and a '57 two-door gasser about 20" long. There in front of us was an absolutely perfect little aluminum Chevy V-8 engine, only 6 inches long. It looked exactly like the big ones which God gave Corvettes. It was *not* plastic! It was not die-cast, it was



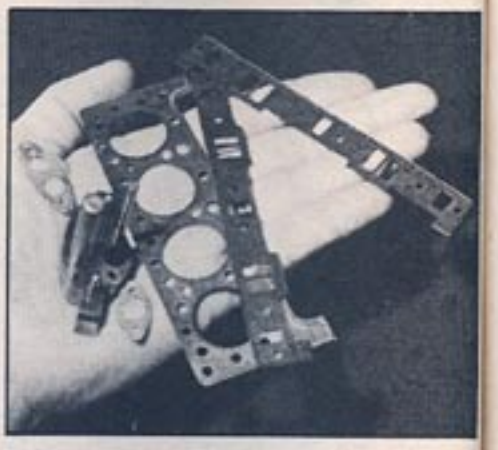
The cigarette in the foreground gives you an idea of the scale on which the parts were made. Heads were detailed to include even the factory "F.I." markings.

Clutch assembly and bell housing shown disassembled. Engine is started with a variable speed electric drill and one-way release. Half of small heater core is used for cooling the mini.

CHEVY MICRO-BLOCK!



Pen points to balancing point where material was removed. The prototype crank had screw-on weights so that Lee could work out balancing techniques.



You can't run without gaskets, and since the local parts stores don't carry stock head gaskets that are 3 inches long, the first step is to make up jigs.

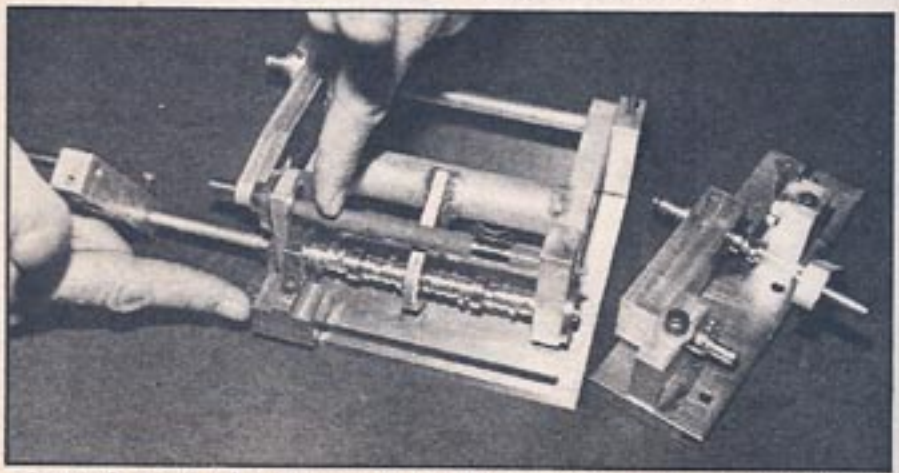
simply sculptured out of a block of aluminum. It was hair-splitting, perfect even to the little "FI" casting marks on the front of the cylinder heads.

Back at the starting line the fuelers were cackling again. It was time to get back, but I was determined to meet the man who could carve a block of aluminum into such a perfect V-8 statue. I say statue because I naturally assumed that what I was looking at was a statue. Remember, you have seen the photos with the article and know the truth; I still assumed that it was a solid block of aluminum. Anything else was just too unrealistic to have even been considered. At least for my slow French mind. It *couldn't* run! When one of the drivers turned to me and assured that the "damn thing even runs," I made a comment –something to the effect of "bull feathers!"

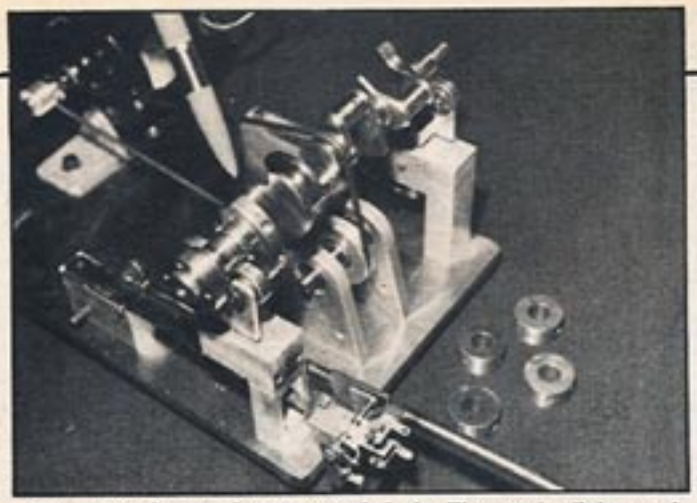
At this point I was introduced to Mr. Lee Root. A man of normal height who builds tiny engines that run. He immediately let the air out of my zeppelin and assured me that I had "better believe that it runs! It just wouldn't be any challenge making one that didn't." Maybe that one sentence tells you what kind of a guy Lee Root is. Seeing that I was still a little skeptical, he rummaged around in a box in the back of his Seville and came up with a spare cylinder head. As he handed it to me, he apologized, saying that this was a reject, but that I would be able to see the business side of the head. What he handed me was an FI head about 3 inches long. It was perfect. Water jackets, valves, rockers, the works! If that cylinder head was a reject, then I decided I simply *had* to see that little engine in the midst of a major teardown. It must look like a gasoline-powered Swiss watch, and I wanted to see the innards for myslef. At the same time, it occured to me that this would be a perfect article for *Chevy Power* magazine. Would he be willing to let us photograph a teardown? "Sure, I get a kick out of showing my little V-8 to the people who work on the big ones. They know more about what they are looking at when they see it."

Soon after, we spent an evening for *Chevy Power* with Lee Root and his family. Before we broke out the Allen wrenches and the film and strobe lights, he took us to his basement shop. The education started there. We didn't even unload the cameras for another two hours.

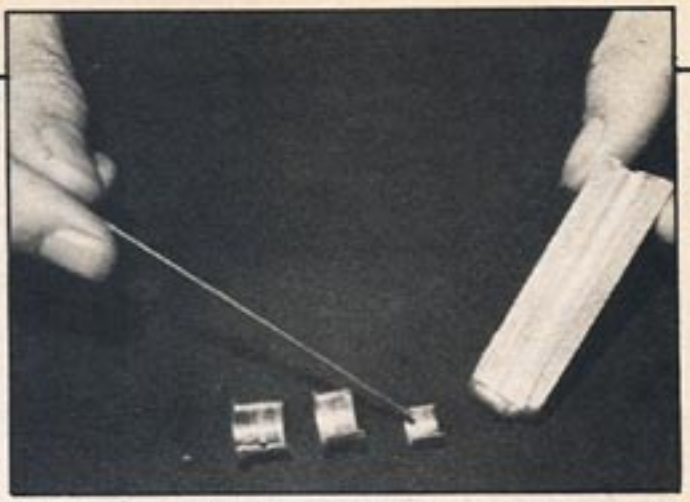
The "factory" was the right place for Rich and I to start. It gave us some insight into just what kind of smarts it takes to build a mini automobile engine. Not only were there drawers full of special hand-ground cutters, shapers and reamers, there were also some interesting "first attempts."



Camshaft grinding jigs. The one at the left converted a single-lobe pattern into 16 singles which were pinned together. Master was then used as a tracer for billet stock (simulated by ballpoint). Lee can now grind a cam in 15 minutes.



Balancing fixture for the crankshaft. The strobe light used in the full-size units is duplicated by using a timing light. Pen points to bolt-on weights used on prototype crank.



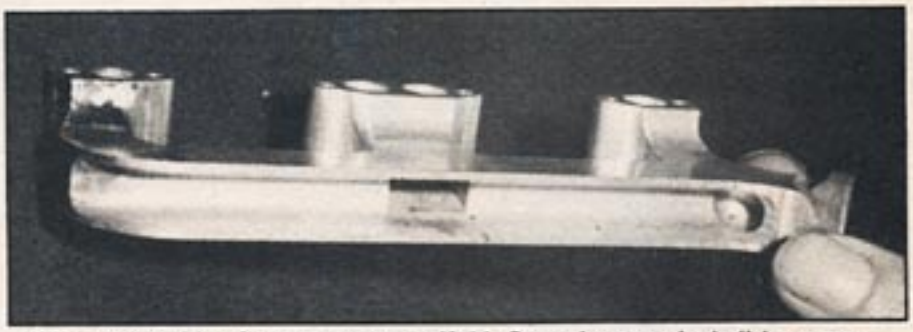
Bearings had to be cast from a special alloy, then the castings were machined to make perfect inserts and mains.

Nobody makes everything perfect the first time. There were exquisite little oil pans with paper-thin walls and manifolds with beautiful shaping, now imperfect because a cutter carved a pleneum tube a shade too deep. I would have heli-arced the hole closed and started from there. Lee just made a new one without the mistakes. Craftsmanship counts and I can tell you Nader will never recall a Lee Roots engine! In my opinion, even the first attempts are beautiful and successful.

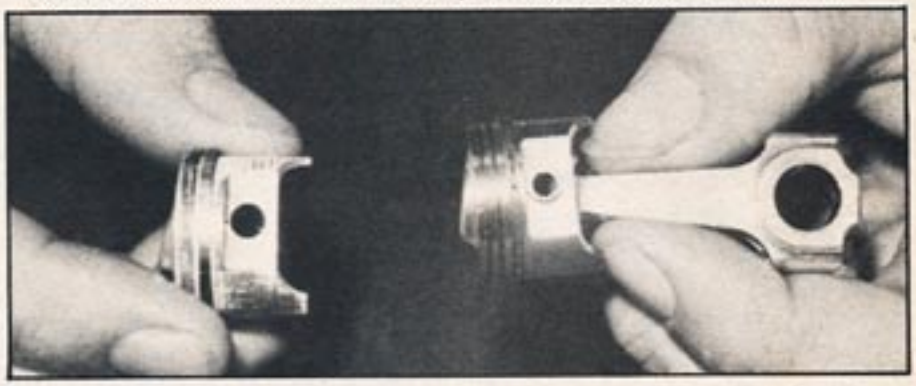
Since I knew that he was the general manager of Blazer Die Casting, it was reasonable to assume that the engine was originally a die casting. I suggested this. "Nothing doing, every piece is machined from solid stock. Die casting would be better for production, but this engine is a labor of love. Precision machine work is my thing and I did it my way!"

Lee explained that it wasn't just a matter of reducing the measurements and starting to drill and mill. First, you have to understand metallurgy and good old dirty-fingernail automotive engineering. Even after you have machined out a part, there is no guarantee that it will work like the big ones. You have to be a pioneer, testing every part along the way.

Stop and think. On a big engine, all the reciprocating parts have to be balanced. So do those in a mini-engine, only there is no balance shop for you to take a 6-inch-long crankshaft to. A little crank with the wobbles has the same shaky bearing future as its big brother. If you make little engines, you have to make little balancing shops too. If you have ever seen a balancing rig in a big shop, you will recognize the little one in our photos.



The bottom side of a prototype manifold. Once the ports had all been machined out of a solid block of material, the bottom surface was welded in.



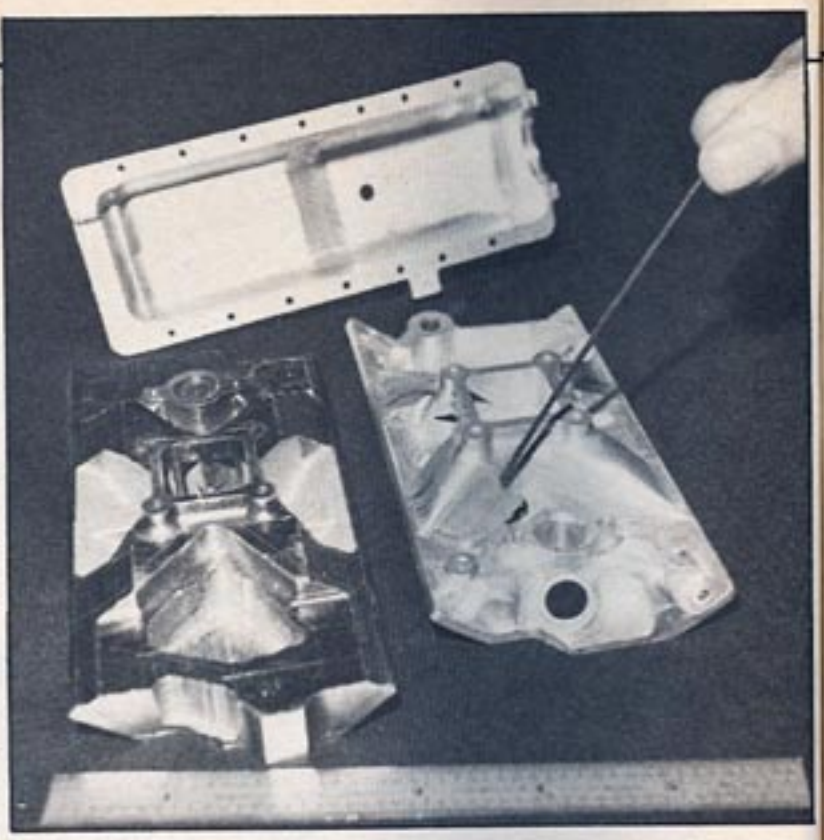
Prototype two-ring piston, left, lacked oil control ring and engine smoked. To remedy situation, Lee fashioned three-ringers and installed a windage tray.

Everything is there—bob weights and all. When you start with an unknown, you don't even know whether to add or subtract weight. The first crank was a prototype and had removable weights. The second crank was almost right-on to begin with.

Making a camshaft was another first. First, a single cam profile was plotted and made into a pattern. Then the pattern was repeated and the second lobe pinned to the first one. Eventually a whole camshaft was assembled. This was the tracing pattern. Once this was available, the completed pattern was fitted into a home-made fixture which gears the pattern to a billet positioned above. A tracer follows the pattern, like a key-making machine while the operator rotates the billet stock against the cutting wheel. Lee can now turn out Chevy cams in about 30 minutes. It's easy . . . once you have figured it all out!

The ignition system was something else which really impressed me. The distributor in the engine was a stock single-point unit with full mechanical advance capabilities. The points were adjustable and I thought it was just about as perfect a replica as you could ask for. It worked fine. The engine

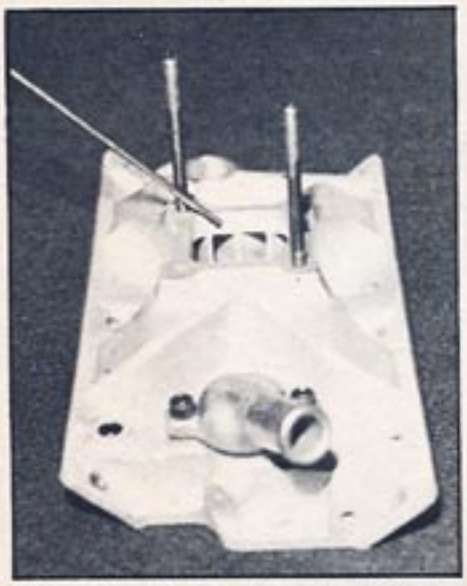
Electrical discharge machining (EDM), a process in which a male graphite electrode burns away material, was used to configure the insides of the pistons.



"Heartbreakers." Not every first try was a success, as these 3 parts show where cutters bit in just a little too deep. Wire points to spot in manifold that broke. Lee has some great paperweights, though!

Ignition on the right is the LED version which Lee recently completed. The "old fashioned" points unit wasn't enough challenge!

MICRO-BLOCK!



Tunnel porting is evident in this photo. All details are followed down to the finest point on all engine parts. How'd you like to start with a block of aluminum and a milling machine and make your own mini-Chevy?!

ENGINE METALURGY AND SPECIFICATIONS

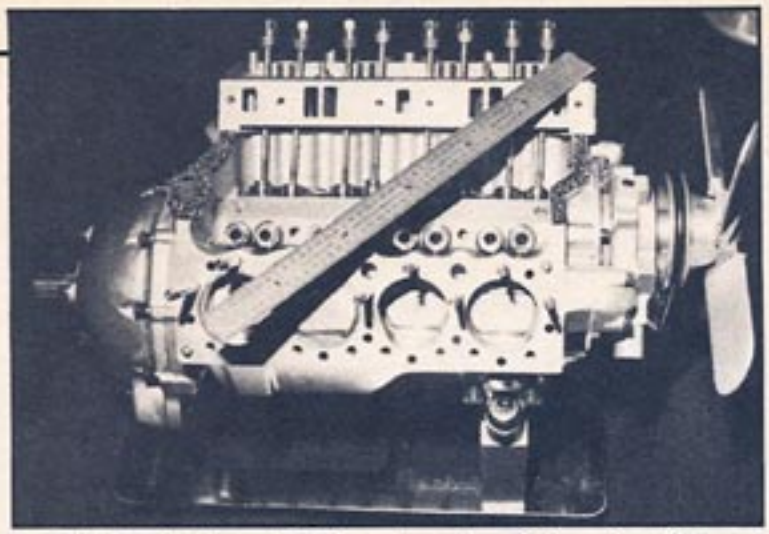
Before you dust off your drill press and hacksaw you may want to read this summary of what it takes to duplicate Lee's engine. After you have soaked this all in, you will know why it took almost 4 years to engineer this little Chevy.

ENGINE SPECIFICATIONS (Measurements in inches)

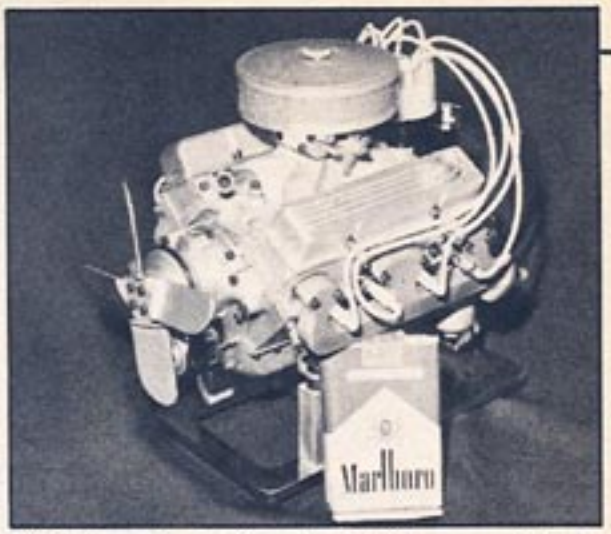
- Bore, .875; stroke, .740; disp. .445 x 8 = 3.5593 c.i.
- Estimated horsepower: 3
- Idle rpm: 1500; Top rpm: 9700
- Block, 6061 T6 aluminum alloy with cast iron cylinder liners.
- Heads and block are fully water jacketed.
- Water pump: impeller type.
- Lubrication system: pumps Mobile 1 through full pressure system and filter. Oil pump is gear type, with pressure relief set at 35 psi at 1000 rpm.
- Bell housing: 6061 T6 aluminum alloy.
- Clutch: 9-spring pressure plate, splined jack shaft and disc allow fully operational clutch. Flywheel: mild steel with hardened teeth.

RODS AND CRANKSHAFT ASSEMBLY

- Rods of 7075 T6 alloy.
- Bearings of high silver, babbit alloy.
  Small ends have bronze bushings and pins have teflon floaters.
- Pistons are 7075 T6 aluminum with 3-ring design.



That's a 6-inch machinist's scale on top of the engine. Note the steel sleeves in the aluminum block. Maybe Vega engineers would like to discuss this engine project with Lee!



"Marlboro Country" motor is built on a scale that might permit whole car to park inside the carton! Engine is only 6½ inches long, weighs 6½ pounds.

idles at 1500 and spins to about 9700 rpm. What else can you ask from an ignition? It was good enough for most of us, but Lee likes electronics and figured he could come up with a more modern ignition, so his latest ignition is a light-emitting diode unit. It's proven out in all circuity and in tests. As this is being written, the new LED unit will be firing model airplane spark plugs in the mini-engine.

When it was time to disassemble the engine, we were even more impressed. The insides were exactly like the "biggy's" only now they were tiny. What do you say about an oil pump that pumps Mobile 1 throughout a full-pressure oil system? Or little adjustable valve trains? Or what about the cooling system? A water pump the size of a quarter that pumps water through a completely water-jacketed engine.

There simply don't seem to be any shortcuts, either. After experimenting in the original mini-engine with two-ring pistons, and the engine had run once, Lee decided to completely redo the pistons. He made a new set with functional oil control rings and then added a windage tray to further control oil usage.

I had assumed that the aluminum rods rode directly on the rod journals. After all, who would know if you had inserts in the little engine that only has to run for 15 minutes or so at a time? Wrong again. As you can see in the photos, the inserts are used and necessary. They were machined from castings which Lee made from a high silver content, babbit alloy.

If you are into cars, just seeing this engine is an end unto itself. To be able to design and make something that no one else can do is a source of personal pride. Lee figures that he has 2000 hours of his life invested in this engine. That's spread over a four-year period of spare time and weekends.

Why does a guy do something like this? His very patient wife, Rose, says that when he comes home from a tough day at work he heads for the "factory." "That's his martini at the door—his way of relaxing."

Lee agrees that the challenge is important. It's pride of accomplishment. But, it's also a really great hedge against the future. He has plans. Retirement is not too far off, and he sees his days filled with a lot of time in the "factory." He would like making models for an extra income. Engines of all kinds would be the first choice. For instance, he is currently working on an aircraft radial engine. On the other hand, why not make a Gattling gun or a bulldozer? Making models full time would be the best of all worlds for Lee. The ultimate turn-on. And who would buy expensive models like this? People or companies with money who want the ultimate perfection in miniature. Who knows, maybe Mercedes will call next week and want a five-cylinder diesel for one of their executives. Lee is also eyeing the rotary engine. Maybe Mazda executives won't settle for a plexiglass model sitting on their desk. Regardless of who the customer is, however, he can be assured he's getting perfection!

If you have questions about Lee's little engine you might get a kick out of talking to the maestro himself. You can usually reach him at his Seattle number, 206—764-4400—on a full size telephone, at least for now!

- Crank is billet machined from 4340 steel, heat treated to a Rockwell hardness of RC-32-34. The journals are hard chromed and stress relieved. Rod journals are .375 and mains .500. Crank is drilled for full pressure oil and the entire assembly has been balanced.

VALVE TRAIN

- Heads are fully jacketed and have Amco bronze seats and guides.
- Rocker studs are screw-in type from heat treated 4340 steel.
- Rockers are machined from Nitroloy 135M. The rocker balls are Amco 45 bronze, threaded for adjustable valve lash.
- Camshaft is heat treated and nitrated 135M Nitroloy steel.
- Cam drive gear is from 52T bronze and the crankdrive gear that drives it is case hardened from 26T.
- Valves are from titanium alloy and are .375 diameter.

IGNITION

- Distributor is breakerless, solid state with infra-red diode and centrifugal advance.

AUTHOR'S COMMENTS

- This is the damndest thing you ever saw. Ya gotta see it to believe it!