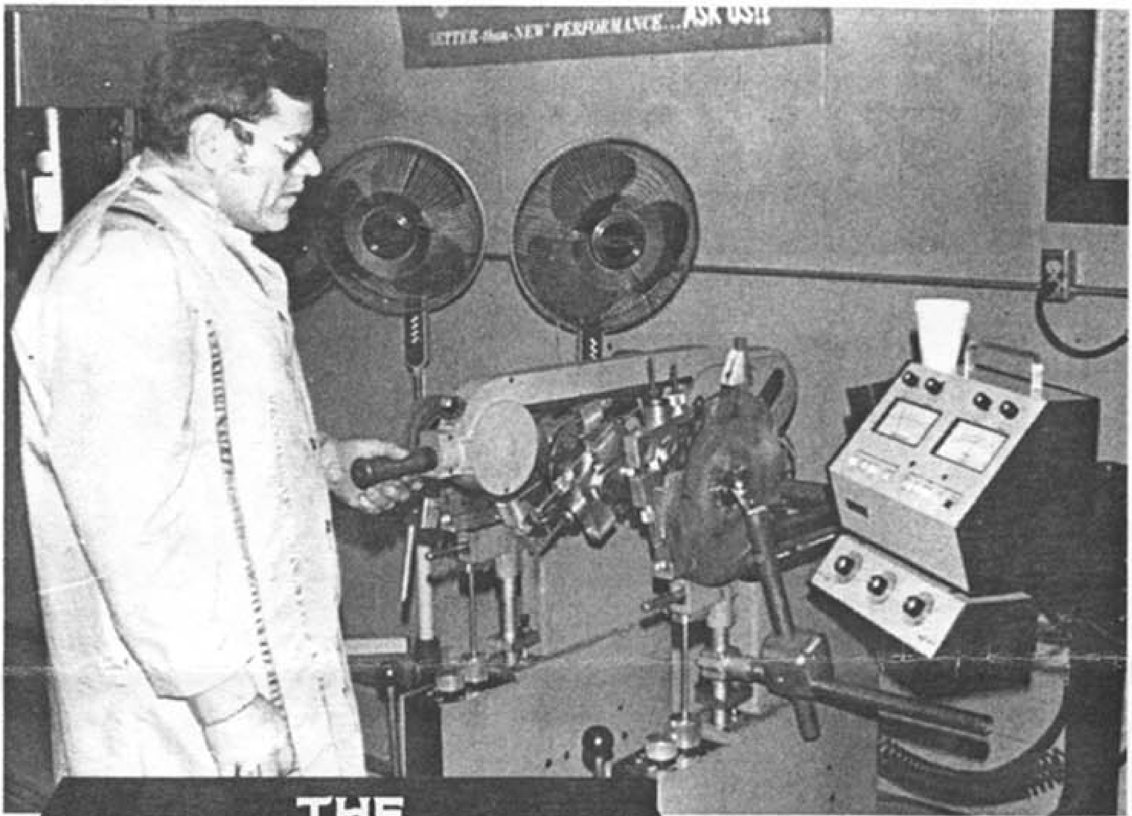
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THE RESURRECTION OF VICKY

Balancing an engine

PART 14


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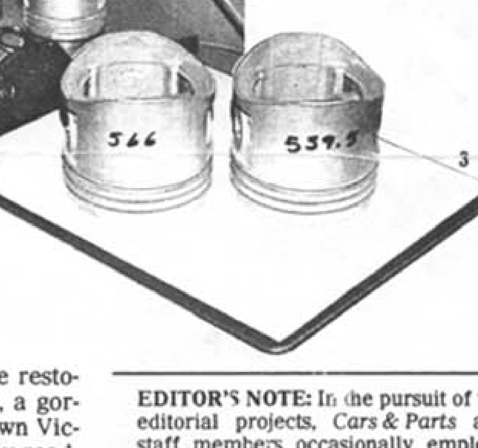

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Photos by the author

1. *More efficient fuel use, smoother operation, increased horsepower and 100% longer engine life are benefits derived when an engine is balanced. Terry Hygema, Classic Car Centre's machine shop supervisor, balanced Vicky's reciprocating and rotating engine parts to within half a gram.*

2. *The balancing process began by weighing the eight pistons individually on an extremely accurate Stewart-Warner digital component scale.*

3. *The heaviest piston pushed the scale to 566 grams while the lightest weighed in at 559.5 grams for a 6.5-gram variance. Each weight was recorded on the piston with a felt marker.*

4. *Machinist Jim Roach fly cut the inside of the heavier pistons on a lathe to match the lightest piston at 559.5 grams.*

5. *Roach points to the piston skirt area provided for cutting away excessive weight. Since all piston designs aren't the same, location of pad for weight removal can vary from one design to another.*

6. *Only the lightest piston wasn't trimmed. All pistons matched within half a gram in weight after machining.*

By Ken New

Engine balancing is not a do-it-yourself procedure. To install a balancing machine in the average collector car owner's garage is rather absurd. Not only does a balancer take up a lot of precious room and cost an arm and a leg, operating such a sophisticated piece of equipment is far beyond the knowledge or ability of the average old car owner who may never own more than a half-dozen collector cars in his lifetime. Balancing an engine is a big job which should be left to a trained professional using top quality equipment and state-of-the-art technology.

Since the series of articles on the restoration of *Cars & Parts*' project car, a gorgeous red and white 1955 Ford Crown Victoria, began in the fall of 1986, many readers of the magazine have written to express opinions on the project, offer helpful advice and to praise the staff's efforts. Most wrote to say that they liked the series and that many of their questions about restoration had been answered.

But one writer challenged *Cars & Parts* to keep the Vicky restoration series "in the backyard" — away from the likes of a modern well-equipped machine shop. He felt that we were promoting the argument that "backyard mechanics have been wasting their time and money." Nothing could be further from the truth. It was never our intention to suggest that hobbyists leave car restoration to the professionals. We have always believed that the individual car restorer is the heart of the hobby, yet there are certain jobs for which he is ill equipped. He may not have the skills required to do a satisfactory job, nor the tools. We felt that watching professionals at work would offer an excellent way of providing much needed information to the backyarder as well as making him aware of "good buys" such as the value of a precision balanced and blueprinted engine. For instance, the estimated $120 spent balancing a V-8 engine ($80 for a six; $70 for a four) is money well spent. Of course, we didn't expect the reader to slip out to his garage and balance his engine after dinner. However, we did consider it worthwhile to tell him about the better performance and fuel economy synonymous with engine balancing.

Balancing an engine is beneficial to longevity. And, it is extremely important to build durability into vintage engines during a rebuild. With replacement parts becoming scarcer every day, it makes sense to take advantage of every available benefit.

Arguments in favor of balancing are pretty convincing. For instance, a one-quarter ounce of unbalance located four inches from the center of the crank creates a seven-pound force of unbalance at 2,000 rpm. That same force is multiplied nine times when the engine is revved to 6,000 rpm and up to 16 times at 8,000 rpm or the equivalent of 112 pounds. Our hypothetical example realistically could be one piston assembly one-quarter ounce out of balance. Imagine the destructive power of a full pound of unbalance, then translate that to the average hobbyist's wallet. Hundreds or even thousands of dollars can be wasted in no more time than it takes to open the garage door! Certainly, the average hobbyist can ill afford such a whirlwind of misfortune and should be advised of the pitfalls of assembling unbalanced engine components. The wise backyarder will perform the skills within his ability and means and use a competent engine rebuilder for tasks beyond his capabilities.

A basic understanding of engine imbalance will help him determine when the skills of a professional should be sought. Power impulses created by the engine set up torsional vibrations in the spinning crankshaft. If that imbalance is left uncontrolled, crankshaft failure is almost always guaranteed when the crank is taxed under the stress of high speeds. To control the force of the pistons and connecting rods, balanced counterweights are placed opposite the rod bearing journals and normally a balanced flywheel and harmonic balancer are found at opposite ends of the crank to assist in stabilizing any irratic rotations of the crankshaft.

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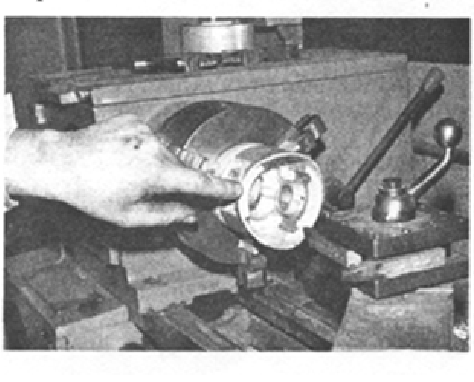

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The machine shop at Classic Car Centre, Warsaw, Ind., is well endowed with skilled personnel and modern equipment. In previous segments of the "resurrection of Vicky" series, the CCC pros performed a precision rebuilding of all major engine components necessary to make Vicky's engine "hum a precision tune" for a second 100,000 miles, or more. Machine shop foreman Terry Hygema has been closely associated with the massaging of the Crown Vic's venerable Y-block from the start, directing the replacement and rebuilding of most engine components. Hygema was anxious to "get Vicky's engine on the balancer and blueprint it."

The balancing machine at Classic Car is the latest model from Stewart-Warner — a 2000-D Dual Digital balance machine capable of reading a tolerance of imbalance (weight x distance) in microscopic amounts. According to Stewart-Warner's amiable service engineer, Gary Hildreth, it will indicate the exact amount of weight (either grams or ounces) to be corrected in a crankshaft. An impressive piece of equipment, the unit is capable of accepting a shaft 10 feet long and features an rpm scale ranging from 0 to 600.

A banner on the wall of the machine shop at Classic Car boasts: "Precision Engine Balancing Service. Up to 100% longer engine life. Unbelievable engine smoothness. Greater horsepower. Better than new performance." Too good to be true? Not really, according to the folks at Stewart-Warner, who work with engine restoration shops throughout the country. Hildreth claims, "We have many shops doing old cars — V-12 Lincolns and many cars from the 1890s even! All have shown smoother running, less vibration and higher gas mileage."

There are two types of unbalance: static and dynamic. Static unbalance involves dead weight while dynamic unbalance occurs only with motion. To balance an engine, weight is taken off the pistons and connecting rods to equalize the weight of each piston assembly.

Another fact that most shadetree mechanics may have never considered is that most engines fall into two general categories. The in-line type, such as an in-line six or straight-eight, requires no bobweights to simulate the crank's hang-on parts. In-line engines have balanced crankshafts. Those cranks can be readily identified by the location of the counterweights on each end of the crank. They are in line and on the same side of the crank. The second classification concerns V-type engines, such as Vicky's Y-block Ford V-8. V-type engines have unbalanced crankshafts with large

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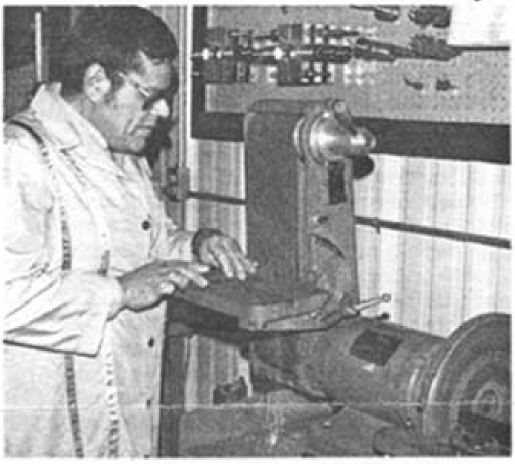

counterweights on the ends which are not in line, but rather at opposite sides of the crank.

Since it is impractical to hang pistons, connecting rods, etc., on a crank and spin them outside an engine block, bobweights must be made up to simulate the exact weights as closely as possible.

Bobweights are two-piece affairs which when held onto a crank provide the engine balancing technician with a means to simulate 100% of the rotating weight and 50% of the reciprocating weight. To many the selection of bobweights may seem complicated. A Stewart-Warner brochure on balancing manages to explain the selection in rather simple terms.

"On the standard V-8 engine, the bobweight total consists of 100% of the rotating weight and 50% of the reciprocating weight. You have two rod and piston assemblies per throw on the standard V-8. The rotating weight would be the crank end of both rods and the bearing insert. The reciprocating weight would be the weight of one piston, one piston end of a rod, one set of rings, pin and pin locks (if used). This gives you 50%, or half of the actual weight for the reciprocating part. Use of the following list will give you percentages and also ensure that you do not forget to weigh any of the parts."

To compute the rotating weight (100%) the following weights must be included: the weight of the two crank rod ends, two sets of bearing inserts, two sets of lock nuts (if separate), and the oil (estimate).

To compute the reciprocating weight (50%) these weights must be taken into account: the weight of piston, piston pin, piston pin lock (if used), one set of piston rings and piston end of connecting rod.

Balancing of Vicky's piston assemblies began by weighing the pistons.

Hygema determined the lightest piston by separately weighing all eight pistons on a precision Stewart-Warner #600175 digital electronic scale, which is accurate to within half a gram. As each weight was recorded on the piston castings with a felt marker, a 6.5-gram variance was found. The largest tipped the scale at 665 grams and the lightest at 559.5. Normally, piston manufacturers maintain relatively close weight tolerances when building production-run pistons, but for enthusiasts who demand absolute balance, those standards fall short and additional machining is required to produce equalized weights.

The other internal engine components involved in balancing are the piston rings, pins (plus locks when used), connecting rods and connecting rod bearing inserts. Piston pins and rings, unlike pistons, are manufactured under extremely close tolerances and normally one pin or a set of rings won't vary more than half a gram from each other.

Machinist Jim Roach of the Classic Car Centre's staff carefully fly cut the insides of the seven heavier piston skirts on a lathe to match the 559.5 weight. Stewart-Warner warns that in extreme cases enough weight cannot be removed from the heaviest piston, thus either the lightest or the heaviest piston should be replaced with one which can be machined to the matching weight.

Pressing aluminum slugs into the piston pin of the lightest piston is another remedy yet it is not advised, under normal conditions, by Stewart-Warner. The balance equipment manufacturer also advises that the owner should be told when slugs are used since those two components (slugged pin and piston) should never be mixed with other piston assemblies or the engine will be out of balance.

Turning to the connecting rods, Hygema ground the balance pads on the big ends to matching weights on a belt sander. Then the small ends were equalized in a like manner using a rod weighing device in conjunction with the precision scale. Had pads not been cast into the rod design, all grinding would have been done along the length of the rods but not across the rods since grinding in that direction decreases rod strength and sets up focal points where internal stress can fracture rod castings.

Bobweights matching the piston assembly weight were assembled once all connecting rods were matchweighed. When bobweights spin they simulate the effect of the rod and piston assembly. Matchweights are small precision washer-like discs which permit one to add very small amounts of weight to the bobweights. Both bobweights and matchweights were stacked carefully in two equal stacks onto the digital scale until the exact piston assembly weights were matched. Four equal bobweights were required for Vicky's V-8 crank. The bobweights were then assembled onto the crank as it sat on trunnion bearing cradles and the balancing machine was actuated.

Within a short time Hygema was able to balance Vicky's crank assembly by taking metal from a couple of the crank counterweights, the torque converter plate, and the harmonic balancer. The crank spun smoothly at 6,000 rpm with the entire balancing procedure taking less than three hours total time, including a slight delay encountered when the rubber on the harmonic balancer was found to be loose from the metal. A quick trip to a local Ford dealer produced a new replacement part.

The V-8 engine is now fully and professionally balanced, and destined to run smoother, stronger and longer than even Ford would have thought possible.

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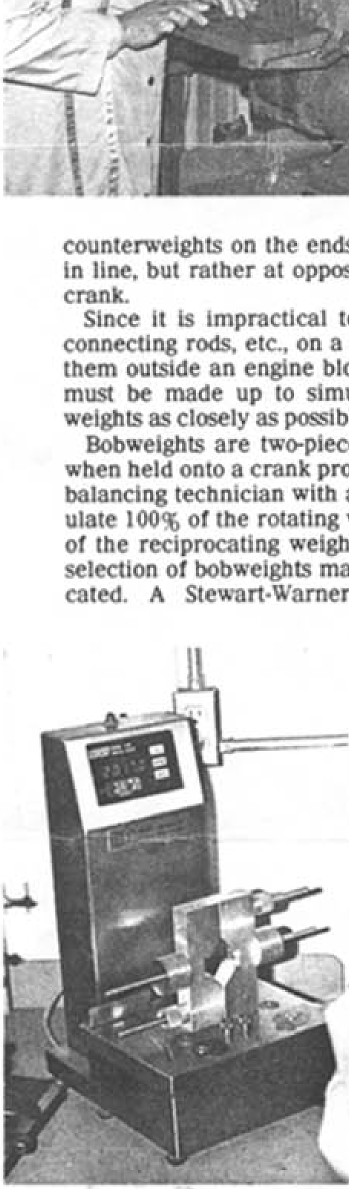

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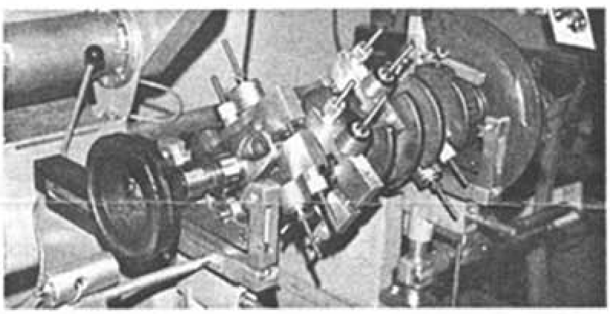

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7. Connecting rods were balanced by trimming appropriate amounts of metal from pads at both ends of the connecting rods.

8. A belt sander is recommended for removing weight from rod pads.

9. Bobweights at 2,017 grams were made up to simulate the piston assembly weights.

10. Each bobweight was set up across from its opposing counterweight.

11. Drilling was required on a couple of counterweights to get things into kilter.