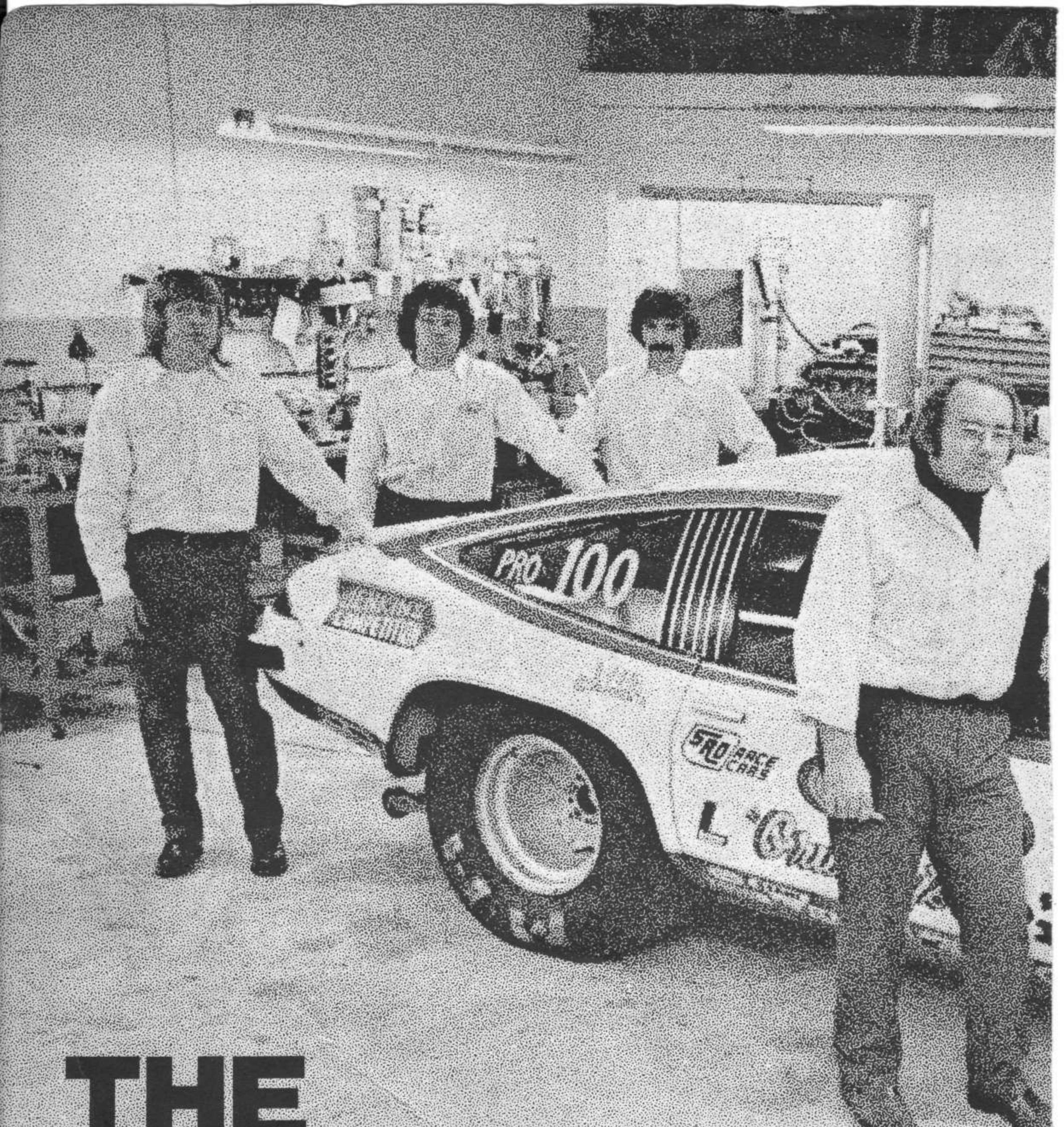
THE CHEVROLET RACING ENGINE

BY BILL JENKINS
WITH LARRY SCHREIB



THE CHEVROLET RACING ENGINE


HEADERS
Hays

ABOUT THE AUTHOR

In 20 years of racing Bill Jenkins has stretched, squeezed, welded, machined, broken, bent, twisted, torn and molded the parts and pieces of a fairly complex mechanical device — known in familiar terms as the small-block Chevy — until today it produces power levels beyond all reasonable expectations. Since finishing his mechanical engineering studies at Cornell University and establishing his first "tune-up shop" in 1961, the Jenkins' technique and style has brought drag racing from a backyard sport to a quarter-million dollar professional level. During this period the Jenkins Competition shop has grown in size and capability, but the innocuous gray brick building in Malvern, Pennsylvania, gives very little clue to the prestige it represents in racing circles.

The Jenkins reputation first reached national prominence with an innocent-looking 1955 Chevy that dominated Stock Class drag racing in the early 1960's. It was a prelude to his unique approach of utilizing every component, every rule, and a full portion of imagination to build winning cars. In the following years he was to gain a small but dedicated following as various makes and models of national record-holding cars rolled out of his shop. In 1966 the first of the famous "Grumpy's Toys," an A/Stock 327-powered Chevy II appeared. As the stature of this awesome machine grew, the Bill Jenkins name became a household word among Chevy fans. It was soon followed by a string of incredible wheel-standing Super Stock Camaros. In 1970 the A/Super Stock number 6 car, one of the original legendary ZL-1 aluminum rat motor 1969 Camaros, began serving double-duty as a heads-up match race car with a dual-quad tunnel-ram induction. This car is considered to be the first "Pro Stock" racer ever to pass through the quarter mile timer. From this Jenkins-conceived heads-up match race formula the current NHRA and AHRA Pro Stock racing has grown. With the current "Toys" the Jenkins legend continues as a compelling force in the sport's most popular racing class.

Today the shop serves as home base for two fulltime racing machines. The Jenkins "Super Team" consists of seven specialists, and while Bill spends most of his time supervising the race car operations as well as personally preparing most of the research and development hardware, the Jenkins spectre is reaching even greater proportion. Each team member is hand-picked by Bill to fit a specific requirement. The right-hand man and shop foreman is Joe Tryson. Under his critical eye and personal touch the record-holding smallblocks are carefully detailed and assembled. With unwavering attention to endless fine points and organizational requirements, he juggles legal-competition engines with large displacement match race engines and highly-specialized test assemblies. During the racing season each of the race cars is supported by two men, a mechanic and a driver-mechanic. Putting in several thousand miles on the road each year, Ken Dondero and Ron Thacker keep the AHRA record books humming with one car, while Larry Lombardo and Rich Wright keep the Malvern-based machine ready for NHRA competition. During the heavy schedule each car races four to five times a week. To support the voracious engine and parts appetite generated by continuous competition, machinist George Areford and the team's newest member, Bob Rexrode, put in many hours of tedious behind-the-scenes work.

High on one side of the main shop a trophy shelf stretches several yards along the full length of a wall. It stands as quiet testimony to the full depth of the Jenkins reputation. From hundreds of trophies won over the years, the most prestigious crowd the shelf and spill over to the nearby bench. Interspersed among the brass and wooden statuettes are twenty coveted NHRA National Eliminator trophies. A few of these drag racing "Oscars" lie behind the bench covered with a layer of dust. While some men spend their lives struggling for one of these awards it is strange to see them treated in so casual a manner. But, it is an insight to the shop priorities. Not a single second is spent looking on past deeds — polishing, arranging and dusting trophies. All efforts, all thought, all imagination and creative energy, is turned toward winning. Every available resource is lavished on the all-important machines and toward creating their successors, the Grumpy's Toys that will carry the Jenkins Competition banner during the coming seasons.

Combined with seemingly unlimited personal energy, it is the ability to foresee, predict, evaluate new approaches and develop future techniques that is the essence of his success. From any viewpoint, the Bill Jenkins impact on drag racing will be measured for years to come.

THE EDITOR

The editor wishes to thank all the members of Jenkins Competition for their cooperation during the preparation of this publication.

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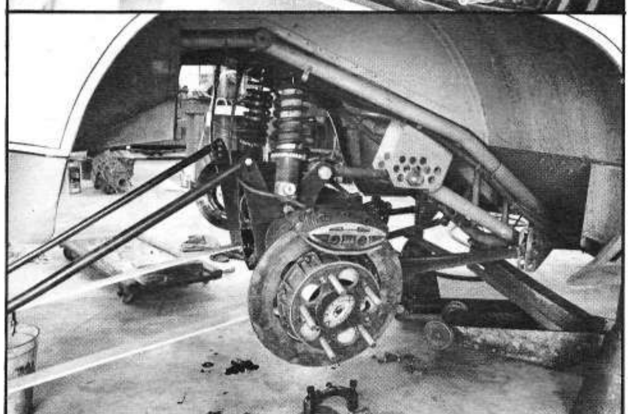

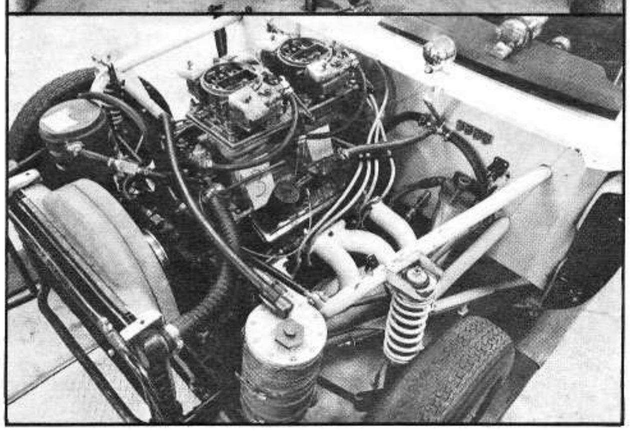

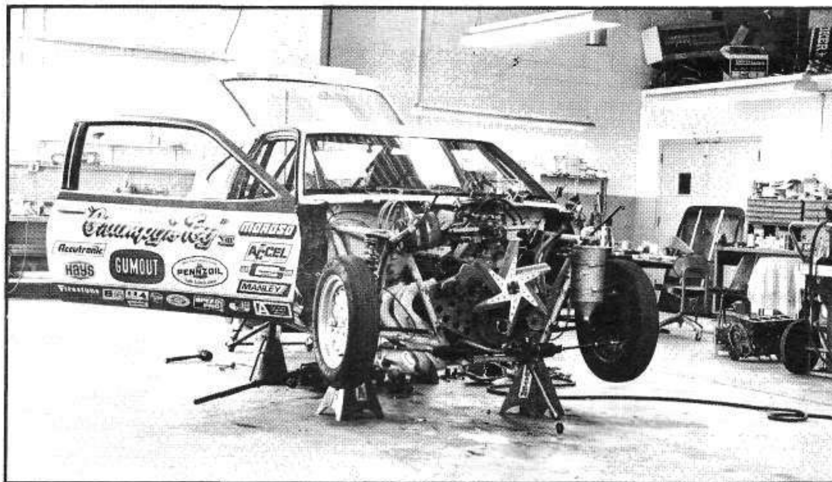
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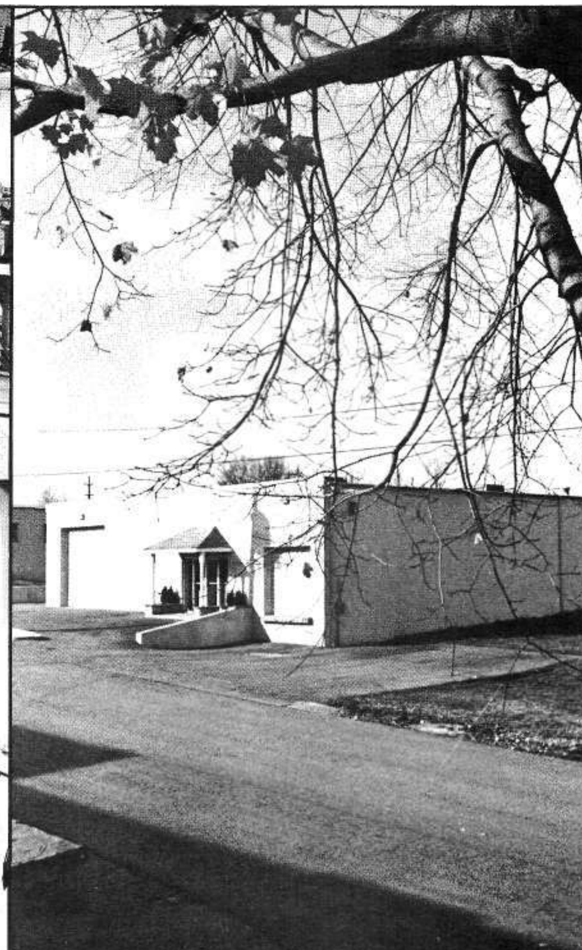
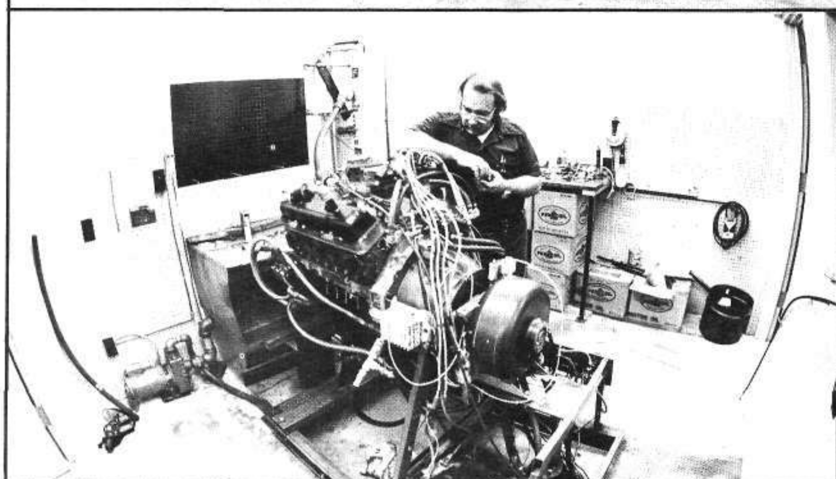





GUMOUT

INTRODUCTION

In the beginning we should make it clear what we intend to give to the readers of this book. The information herein is the result of more than twenty years racing experience with the smallblock Chevrolet V8 engine and it is intended as a basic study of racing engine design and assembly. The illustrations show typical techniques and hardware developed at Jenkins Competition for our own drag racing and Nascar stock car engines. Currently, we are talking about power levels of about 670 horsepower from our 330 cubic inch displacement Pro Stock drag motors and 580 horsepower from our Grand National four-barrel 354-inchers. In the original context we will be speaking entirely of very high horsepower "off-road" engines intended strictly for competition but the perceptive reader will find sound engineering principles which may be applied to any high performance internal combustion engine, regardless of make.

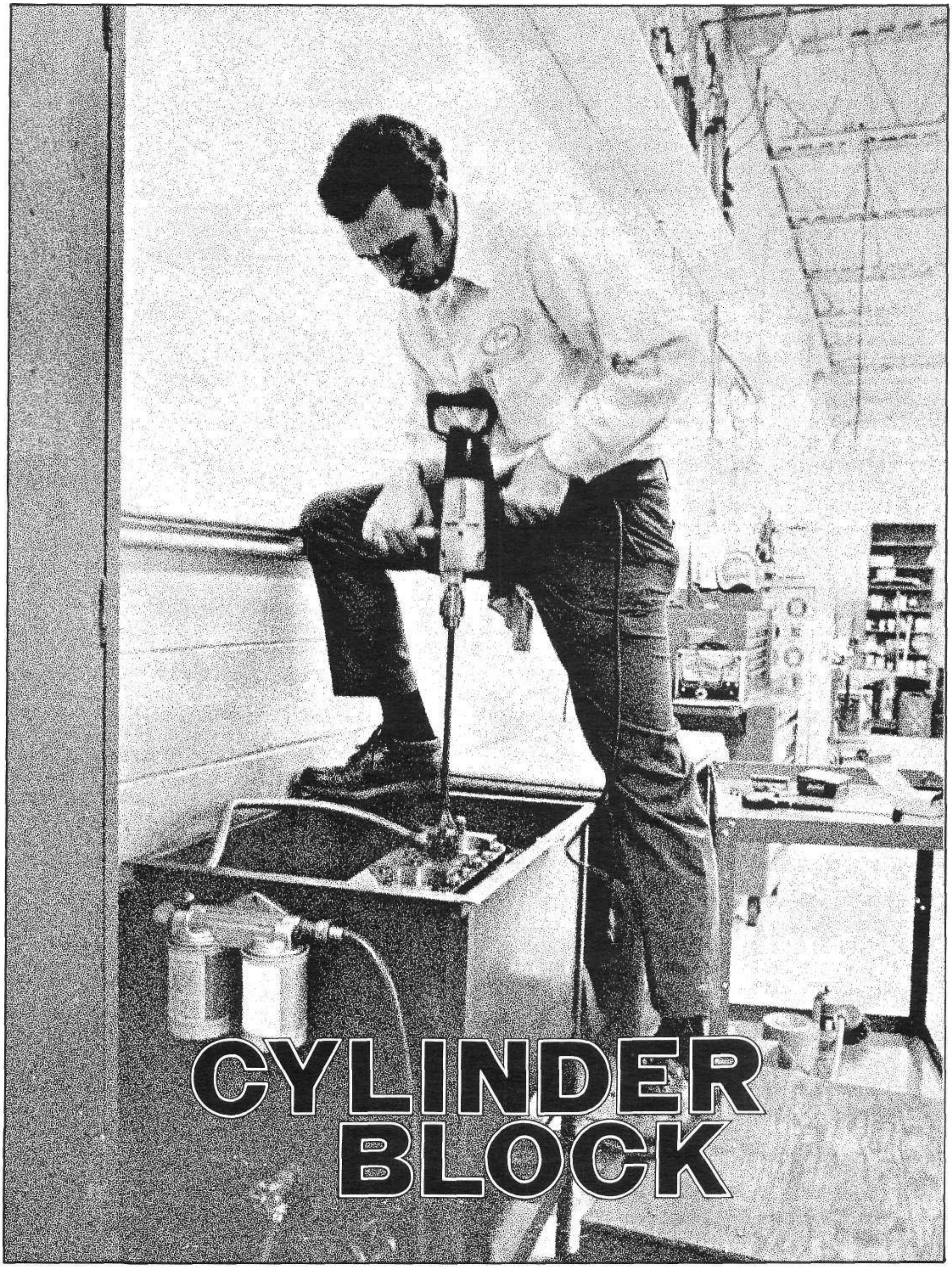
Historically, the development of the smallblock has been well documented in other publications. We won't cover old ground again, except for one comment. Considering the passenger car heritage of this engine we think the current power levels are incredible. Twenty years ago when we first started racing a showroom new '55 Chevy no one could have convinced us that the engine would eventually produce nearly 700 horsepower. We have discussed this phenomenal success with several knowledgeable people, some actually involved in the first design program, and the engine's long-lived reputation seems to be more a matter of good luck than engineering insight. Apparently such elusive factors as crank-to-block stiffness and the compatibility between component stiffness and weight factors has worked out better than anyone had expected or hoped. This is even more impressive when you realize that the basic block/heads run very nearly heads-up with engines like the late Cleveland Ford which was designed with the latest technology primarily as a racing engine and adapted for limited production passenger car use.

In terms of racing requirements the basic smallblock Chevrolet engine configuration provides excellent raw material. The overall outside dimensions are relatively small but the weight is not especially light in comparison to what could be achieved with the latest thinwall casting techniques. We have to remember that the basic block dimensions were established during research conducted by the Chevrolet engineers in the early 1950's. Construction requirements and techniques were different then. They introduced an engine with 265 cubic inches of displacement and developing approximately 195 horsepower. Today, the same basic engine block has been stretched 135 cubic inches to 400 c.i. and the power level has been multiplied by more than three times. At these levels the size and weight of the smallblock are truly impressive. The fact that substantial changes have not been made is very important, as far as we are concerned. The parts interchangeability and availability have kept overall costs relatively low and any racer who doesn't think replacement part costs are important either doesn't win too often or doesn't race very long. At Jenkins Competition we think it is one of the reasons we have been able to operate a successful racing enterprise, on the scale we do, for as long as we have.

This longevity is also important from another standpoint. Thousands of hours of research and development have been devoted to the smallblock Chevy by aftermarket parts manufacturers. In their zeal to produce new products to sell to Chevy enthusiasts they have helped little by little to extend the performance limits. At the same time, parts which can be sold to the huge number of Chevy racers and enthusiasts around the world result in cheaper production costs and lower retail prices. When you are watching the rev counter swing past the 9000 rpm mark every day this becomes more than just a side benefit—it can be the difference between success and failure. We know that only a small percentage of readers push an engine to this point but the same economic principles apply to the guy who swaps a carburetor or installs headers in his car while it's jacked up in the driveway as apply here at Jenkins Competition.

On the other hand, our current research has lead us to what we believe are the absolute physical limits of the basic block casting. The present 4-inch bore block is mass-produced for passenger cars and such things as manufacturing tolerance allowances, core shifts, material hardness and component strength limitations are problems the racer must overcome for his specialized use. We doubt that any future work will greatly increase the power output from this basic "case" as we are now using all the available inside space, strength and mass to the maximum. Of course, current work is concentrating on the lubrication system and the induction where more gains are to be had, whereas the most effective working mechanism of the block/crank assembly is fairly established at this point. Consequently, we are now looking at the possibilities of the 400 block which has a 4.125-inch cylinder bore. With success in this area we may find substantial gains in the future. Our research and development is an ongoing part of our race program and it is difficult to say exactly what will happen in the next six months or year. This publication, however, contains the essence of where we are—at this point in time. We hope all the readers find something of interest here.

BILL JENKINS


CYLINDER
BLOCK

BLOCK SELECTION

For all of our recent racing engines we have been using the late Chevy 4-bolt, 4-inch block. It can be obtained from local Chevy dealers as part 3970016. This block has the "good" features which are desirable for racing. The main webs which support the crankshaft are slightly thicker than on standard castings. The crank is supported from below by larger, wider, 4-bolt nodular main bearing caps. The rear crankshaft seal is made of neoprene rubber for improved oil control. At this point we prefer this over any other cylinder block casting. However, we usually want to use a case which has been run or "seasoned" in a previous application, like about 100,000 miles in a truck or something similar. A "green" block will move around quite a bit under racing stresses and in almost every instance the machined surfaces will not be true after a few hard racing passes, even if the case has been carefully prepped. This will hurt horsepower.

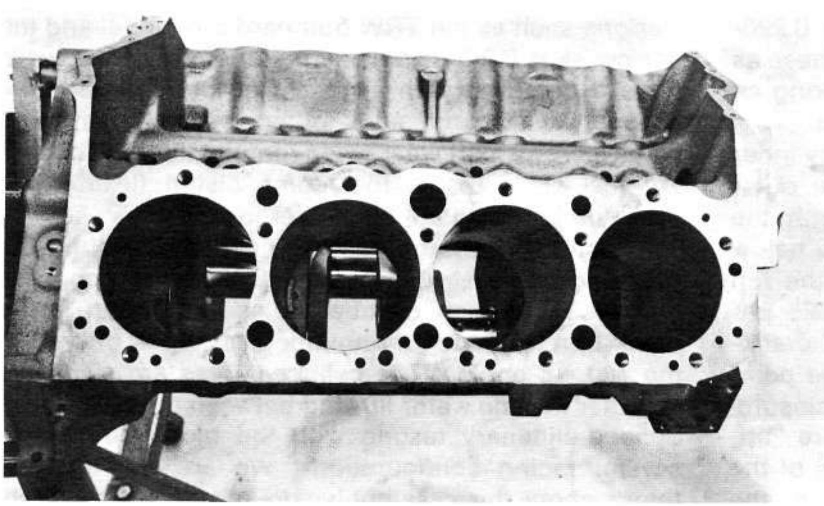
Before proceeding with further detailing we thoroughly clean the piece and examine for minor cracking or bore splitting. We seldom encounter any problems when the block has not been previously raced but a good "look over" is mandatory if you don't want to wind up spending money on a case that's already junk. This may sound a little trivial but it is the first step and is occasionally overlooked by people who really should know better. The cylinder bore condition is not important, as long as the lower portion does not have any cracking signs, because nearly all of our blocks are bored 0.020-inch oversize. It is particularly important that number 8 bore be closely examined.

If you are building an engine which requires a finish bore size smaller than 4 inches you must use an appropriate early casting. Most of these early cases had thicker cylinder bore walls and are therefore desirable. There are some oddball cases like the rare '57 number with a 0.250-inch thicker deck but these are no longer available and we feel the extra mass only adds weight as our current blocks hold the head gaskets in place quite adequately. The famous (or infamous) '62-'67 Chevy II Nova case with different filter pad location and unique clutch ball receptacle is also sought after by some but it does not have the 4-bolt caps. We feel searching for one of these cases is more trouble than it's worth.

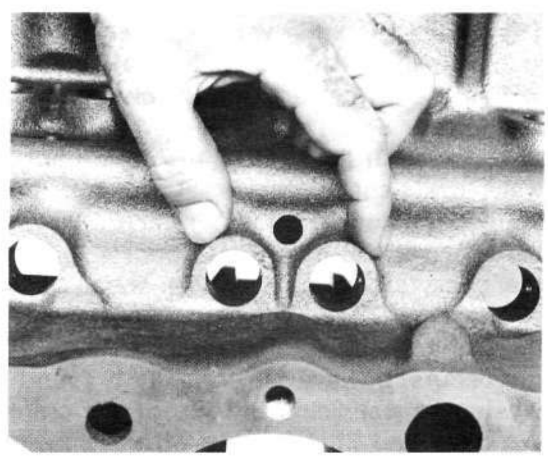
SONIC CHECKING

When seeking the best possible case for a race engine we do consider two important elements: *uniform wall thickness and material hardness.* Adequate cylinder wall strength to support the piston in a racing engine is absolutely essential. Current production methods and minor core shifting within the water jacket have made this a questionable matter. Since about 1970 we have been using an electronic instrument to sonic check the material depth of all our cases. The particular instrument we use has an ultrasonic probe which is held tightly against the metal surface and it gives a direct readout of the thickness on a dial gauge. When we receive a case for possible use in a race buildup we check the walls on the minor and major thrust side at a position about 2.5 to 3 inches below the deck. We want a case which has the thickest possible walls on the thrust side (passenger side) of each cylinder bank. We also like to see uniformity from front to rear and from one bank to the other. Thickness of the front and rear walls of the cylinder is less important, except to determine an unacceptable core shift.

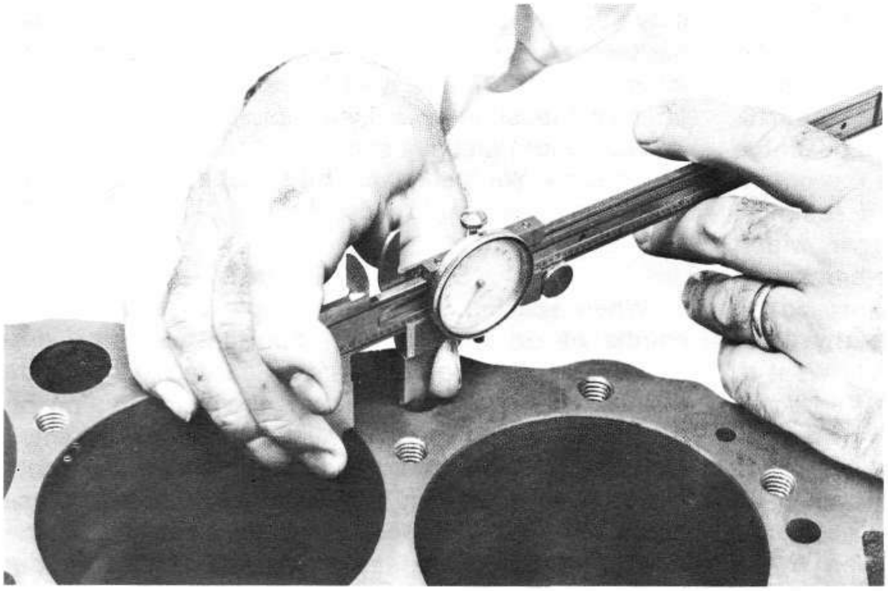
After about five years of checking cases we have found that the walls are generally thicker than the Chevrolet specification. According to our information they give an average spec of 0.223-inch on the thrust sides with a minimum of 0.125-inch allowed on the front and rear sides. We find an average reading taken on the minor/major sides of about 0.240- to 0.245-inch. We have located some which average as high as 0.270-inch and consider these pieces very desirable



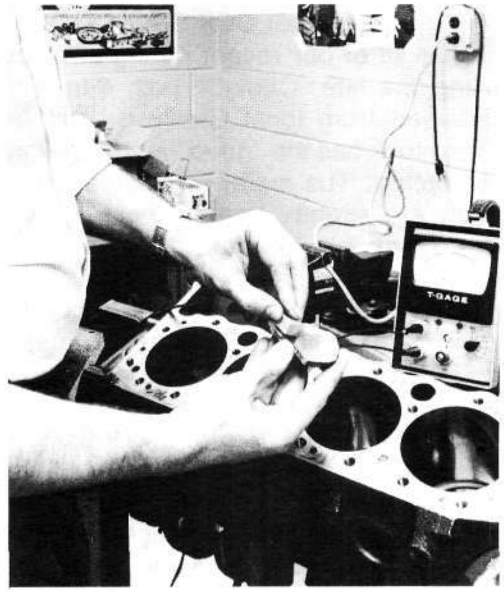
To build any racing or high performance smallblock engine with a finish cylinder bore diameter between 4.00 and 4.030 inches the best factory block casting to obtain is part 3970016. This case has the thick main webs and 4-bolt main caps for added crankshaft support.



The most desirable casting for a race engine will have a minimum production sand core shift relative to the machine finish. Visual inspection of the lifter bore drillings is a simple but inconclusive method for spotting shift. All drilled bores should be centered.



When absolute strength is not required some slight core shift is acceptable. Measuring between the as-cast core projection holes in the deck and the finished cylinder bores may locate severe shift. Hopefully, all of the measurements will be fairly equal. A wide variation indicates the cylinder hole axes are shifted relative to the water jacket coring and the thickness of the walls will vary at different points around the bore.



For absolute reliability we use an ultrasonic thickness gauge to inspect every block casting. A core shift toward the front or rear of the block is less important, but a shift sideways, along the major-minor thrust axis, can lead to wall distortion.

for racing. On the other hand, we have run some cases with a finish thrust wall size as thin as 0.205-inch on one hole and not had trouble with the engine but we prefer a minimum 0.215-inch (finished) major thrust wall in a race engine. One of the first places stress will show up in the 4-inch case is around the number 8 cylinder wall, therefore, we don't race any block which reads marginal in wall thickness at this location. For street use the finished walls may be as thin as 0.180-inch and will give good service.

When checking thickness of the walls in the area between the cylinders we usually get a smaller-than-average reading. In the 4-inch case the water jacket is designed with about 0.100-inch between the cylinder walls. There is a total of 0.440-inch between the nearest points of the waterside surfaces. This only leaves 0.340-inch total or about 0.170-inch per wall. The actual readings vary between 0.115- and 0.220-inch. Rarely are they as high as the latter but those as low as the former are still usable. That is, as long as the number 8 wall does not read thin.

Because of the draft in the coring box the cylinder walls are usually thicker at the top and the outer surface (water jacket side) tapers inward, with the thinnest section occurring about 4 to 5 inches below the deck, at the point where the wall joins the top of the crank box. The taper normally is 0.0025 per inch, and does not affect performance. If wall cracking occurs, however, it normally is found at the point where the wall joins the top of the crank enclosure. We have had little trouble with the jacket core "tipping" inside the case. In other words, the axis of the inner wall is very nearly parallel to the axis of the core wall. As a matter of interest, we found this to be a big problem on some of the Mark IV cases. The core would be tipped significantly and the walls would be, for instance, very thick on one side at the top and thick diagonally across the bore at the bottom while the walls diametrically opposite at the top and bottom would be thin. Needless to say, this is a bad condition and some of the big blocks we checked were very, very bad.

Some information we have received leads us to believe that Chevrolet production is presently making a concerted effort to reduce core shifting problems. Their work is very likely aimed toward gaining better control in order to reduce some section thicknesses. The resultant metal saving could be substantial over the production of thousands of smallblock castings.

In connection with this we will later discuss the importance of piston skirt design as related to cylinder wall endurance. Generally, the smallblock does not like pistons with extremely stiff, narrow skirts. Designs such as the TRW outboard pin model and the narrow skirt BRC or Manley pistons "push" the walls quite a bit. Even with a good wall configuration we have always found signs of severe wall distortion and excessive skirt wear when running this type piston. We feel, as a result, that some piston flexibility is essential for adequate block life!

Our latest research has been centered around the 400 block. It is virtually identical to the 4-inch case but has 4.125-inch cylinder holes and has a larger crank bore to match the unique cast crank offered in the 400 c.i. engine. The cylinder bores are siamesed together with no water flowing between them. We have done preliminary testing with the block built up to several racing configurations. We are still learning things about this case but we do know it is absolutely essential to sonic check them. Before race-prepping this block be sure to inspect the area around the steam holes between the cylinders very carefully.