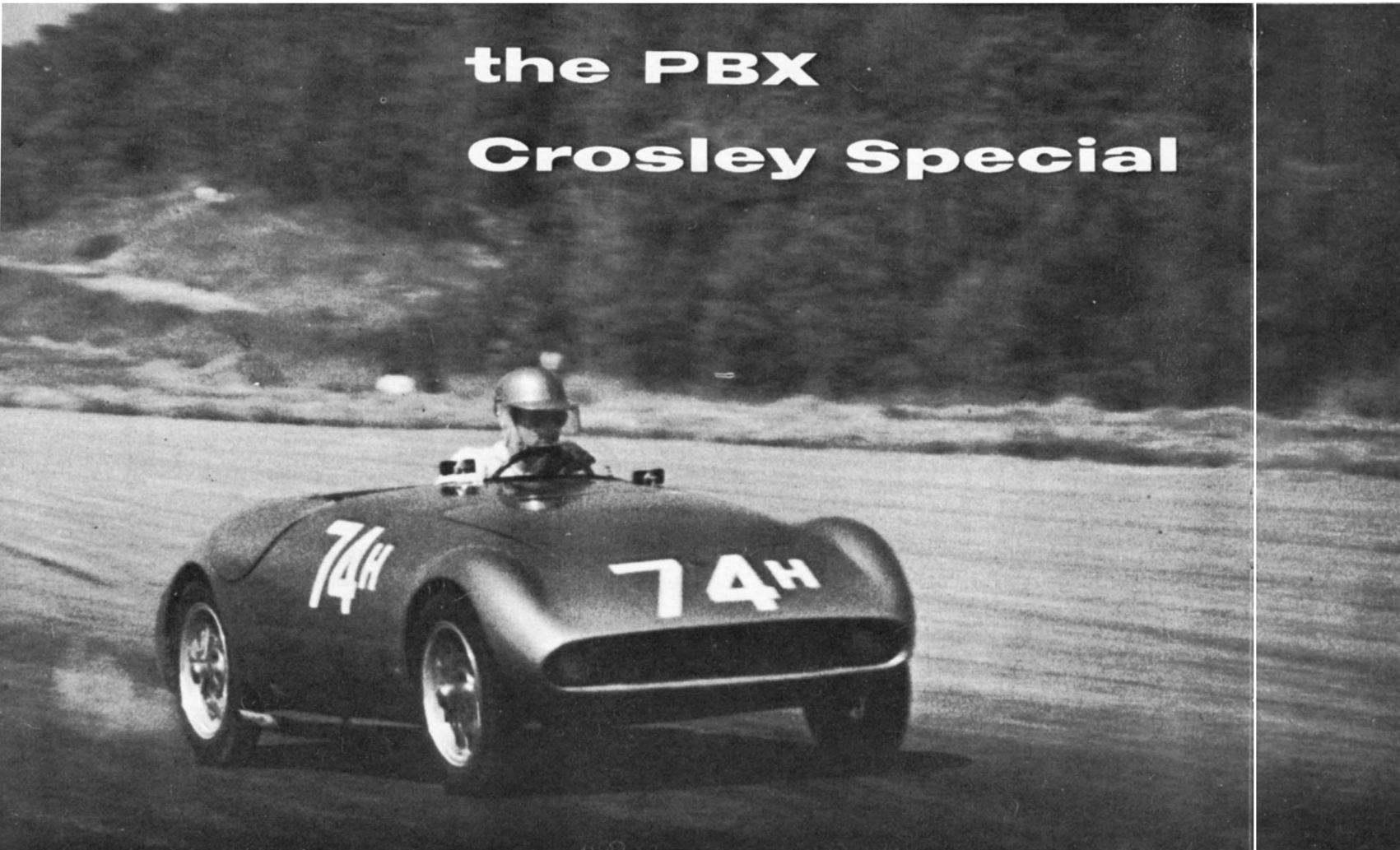


SCI Technical Report:

the PBX Crosley Special



"Candy" Poole at speed in his 750cc Crosley powered PBX Special. He took Modified class H honors in the Danvers Trophy Race at Beverly, Mass.

By **KARL LUDVIGSEN**

ONE day Candy Poole just plain got mad. Granted, the Hotshot chassis had all the stability of a wheelbarrow on the old Glen course, but it was kept in contention by sheer hard work under the hood. Poole knew that the little Crosley four-banger had a potential far beyond anything that was being realized in the shadowy days of 1952, but he also saw that he couldn't prove it until he was able to keep the car and the power on the road. When new-acquaintance Bob Bentzinger proved to be both a kindred soul and a qualified engineer, a partnership was formed, and as of Thanksgiving, 1952, PBX production was under way.

The story of a special differs from that of a factory car in that it is much more closely bound up with the man responsible for its creation. Since the original planning days, Candy

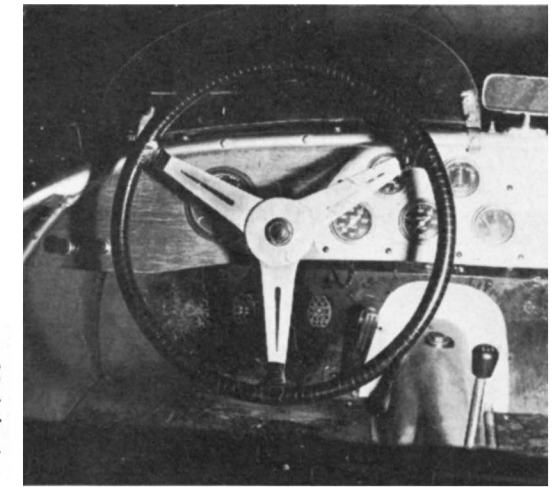
Poole has borne the burden of the PBX development work, and when it comes to testing and race preparation he is a man of single-minded purpose. His friends and fellow class H competitors will testify that Candy is probably the most thorough and at the same time the fastest owner-builder-driver-tuner around. More than a few snags have arisen, but he has always been able to eliminate them at their source and without stopgap measures. That this vigilance pays off is indicated by the incredible record of 26 class wins and 32 finishes out of 35 starts. Lest the car be thought a mere reliable plugger, recall that for three years running it has beaten all comers in both classes G and H on the very tough Brynfan Tyddyn road course, and for the same period has been the top under 1500cc Modified machine in the New

England region of the SCCA. Both the PBX and its record are great, and it all depended on Candy Poole.

Much of the interest in a special story also lies in what the car has been, rather than what it is now. A review of the latter would be superficial in that it would miss the many solutions that were tried and failed, and would avoid the valuable lessons of what NOT to do.

Candy's main concern, then, was showing what the much ridiculed Crosley engine could do. He knew in the beginning that it was operating nowhere near its potential, but the realization of that potential turned out to be a tedious process. Much of the value of the Crosley engine for competition purposes stems from its integral head-block

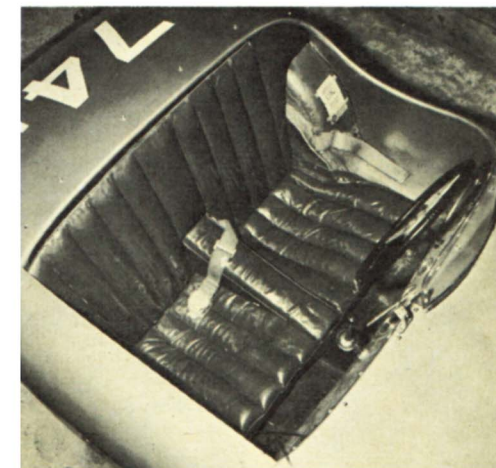
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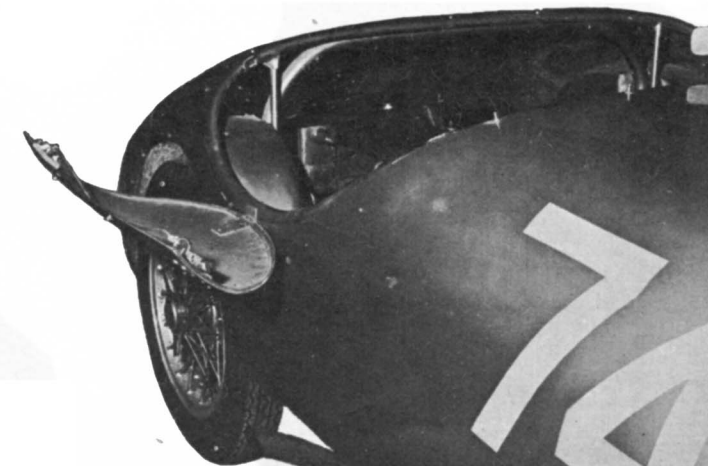
Instrumentation of the PBX cockpit is very complete, employing Stewart-Warner gauges and a Sun tachometer. Finish of the wooden panel-board is exceptional for a special — superior even to a production dash.

Special's cockpit seats two people with comfort and ease. Passenger side of compartment looks smaller than driver's side because of hinged door, but seating space is equal.

Wide nose shields headlights and radiator of PBX Special which was first scale-modeled and then sent to the Aeroform company along with the chassis for the aluminum shell.



Canopy-like metal hinged to passenger compartment folds upward and closes as a door. Entrance and exit may be inconvenient and impractical, but it complies with FIA regulations.



SPECIFICATIONS PBX SPECIAL

ENGINE

Type 4 cyl., in line
 Bore and stroke..... 2.54 in x 2.25 in (64 mm x 57 mm)
 Capacity 45 cu in (748 cc)
 Piston area 20.3 sq. in.
 Compression ratio..... 10.5 to 1
 Max. horsepower..... 55 @ 8000
 Piston speed at max.
 horsepower 3000 ft/min

Valves	<i>Intake</i>	<i>Exhaust</i>
Head dia.....	1.17 in	1.05 in
Stem dia.....	.314 in	.313 in
Seat angle.....	45°	45°

Camshaft
 Open..... 20° BTC 60° BBC
 Close..... 60° ABC 20° ATC
 Lift..... .350 in .350 in
 Carburetion..... 2 sidedraft Amals

Plugs
 Type..... Champion J2
 Gap..... .018 in
 Oil capacity..... 3.5 qts
 Water capacity..... 1.25 gal

CLUTCH 7.25 in dia. Borg and Beck single dry plate

GEARBOX

Ratios.....	4th	1:1
	3rd	1.36:1
	2nd	1.95:1
	1st	3.38:1
	Rev	3.38:1
Oil capacity.....	1.5 pints	

REAR AXLE

Ratios..... 4.875, 5.125, 5.17, 5.27, 6.00, 6.12
 Oil capacity..... 1.75 pints

WHEELS

15x3 1/2 K Borrani light alloy wire

STEERING

Turns lock to lock..... 2 1/2

Turning circle..... 30 ft

CHASSIS

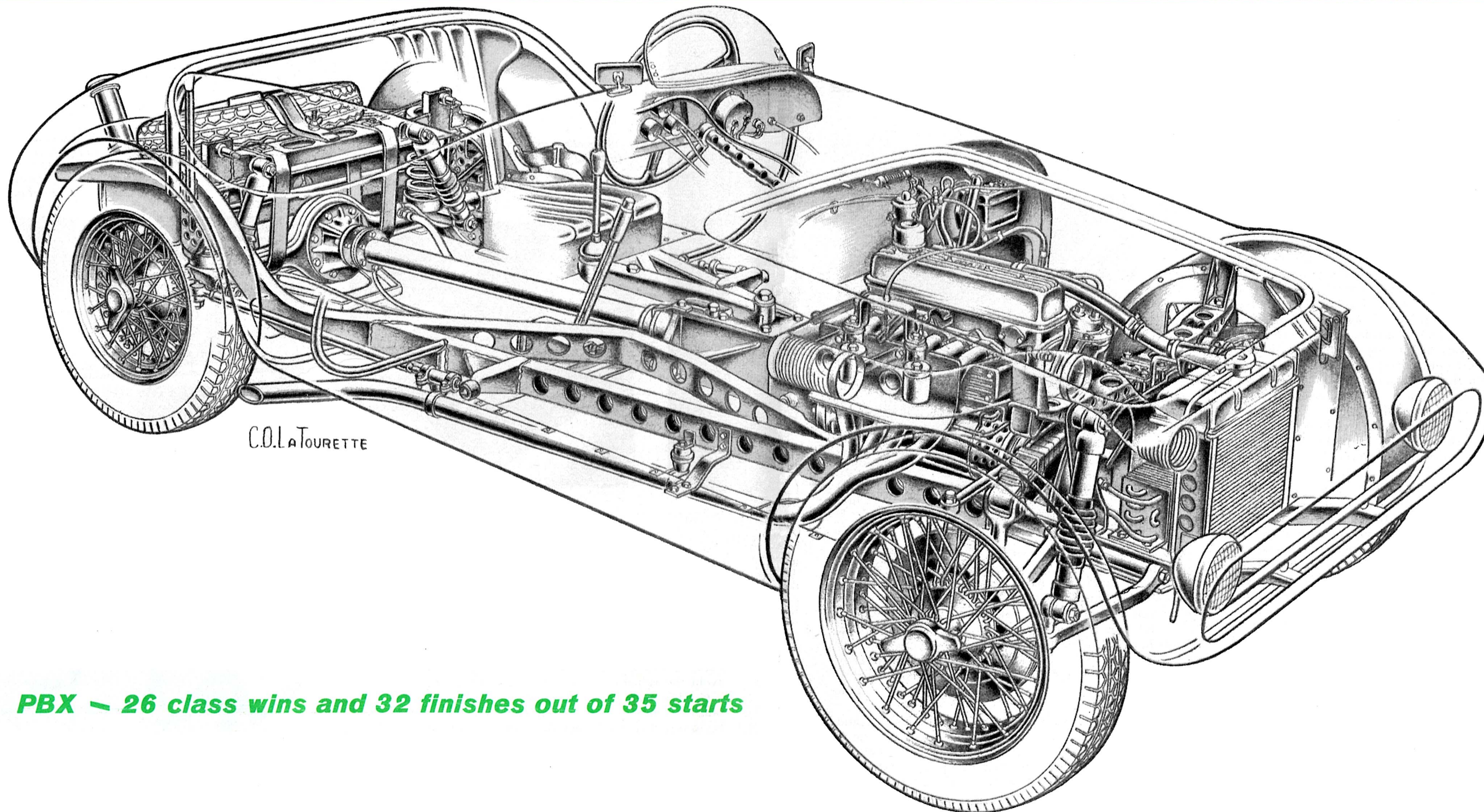
Wheelbase..... 82.5
 Front tread..... 46 in
 Rear tread..... 45 in

OVERALL

Length..... 138 in
 Cowl height..... 33 in
 Curb weight..... 1000 lbs
 Fuel capacity..... 8.75 gal

PERFORMANCE

Acceleration..... 0-60 in approx. 8.5 sec
 Top speed..... Timed, 1953 108 mph
 Potential, 1955 118 mph



PBX — 26 class wins and 32 finishes out of 35 starts



For three years running Poole has sped his backyard boomer to unmatched victory in modified class H races.

(Continued from page 32)

construction, in the finest Grand Prix tradition. Though it hampers valve accessibility, this approach eliminates head gasket worries and eases coolant passage problems.

In line with current Mercedes-Benz racing engine practice, early Crosley blocks were brazed up from sheet pressings, but this proved impractical in production and a cast iron unit was standardized. Candy uses the later type of CIBA block which incorporates a small divider between the valve seats to promote turbulence. These are bored .040 inch over to bring the displacement right up to 748 cc, while the maximum possible overbore is .150 inch. Removable side plates allow sand removal and inspection of the casting interior around the cylinders.

Another invaluable attribute of the Crosley engine is its single overhead camshaft, which is carried in five aluminum alloy bearings and driven by a vertical shaft at the front. The cams attack the in-line vertical valves through long-skirted thimble tappets and adjustments shims. Standard Crosley valve timing kicks the intake valve open five degrees before top center and closes it 50 degrees after bottom center, giving a duration of 235 degrees. Exhaust timing is symmetrical, and also lifts the valves .235 inch. This provided decent low speed torque with early carburetion setups, but as induction was improved a move was made to a Harman and Collins cam with 20°-60° timing and a lift of .400 inch. With its duration of 260 degrees this is still a very popular stick among the Crosley-powered sports car fraternity, but as Candy learned more and more about breathing and ignition he looked around for means to stretch the useful revs even higher than the limit then of around 7500.

Experiments with hotter H & C and Weber grinds came to naught. So Poole finally worked out a contour that duplicates the opening and closing points of the Harman cam while altering the full open characteristics and reducing the lift to .350 inch. This pushed the output peak up to 8,000 rpm and improved the readings on Candy's dyno accordingly. Valve clearances are set to provide perfect timing at around .014 inch and left there for all occasions.

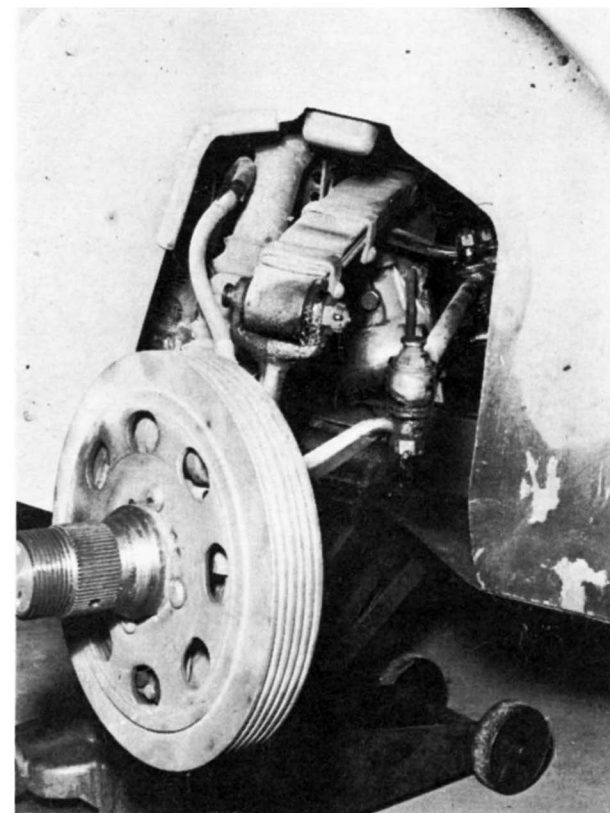


Borrani wire wheels carry either Pirelli or Dunlop tires. Note exhaust is deflected away from rear tires and into slipstream.

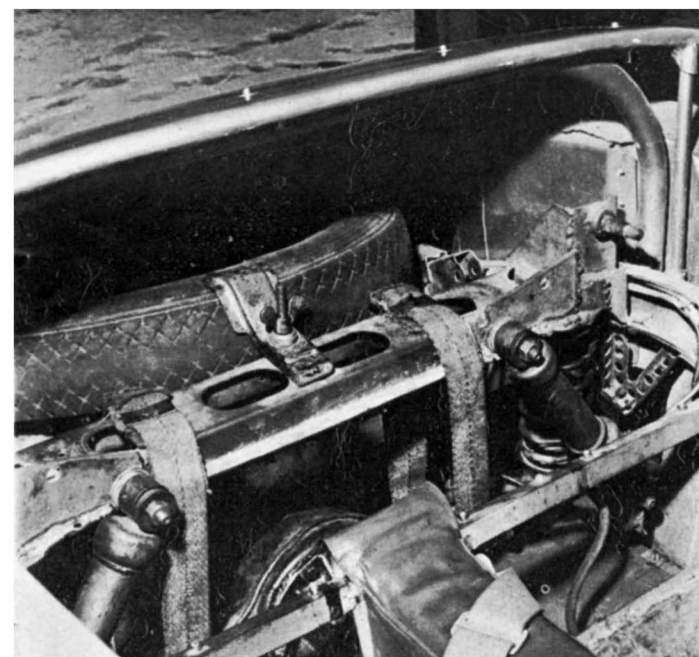
To keep the valves tied down at these speeds, studied return springing is required, and trials with heavy Crosley and special inner coils have yielded a dual-spring setup. All spring sets are fitted with Thompson Rotocaps to improve heat dissipation. Top-cylinder space is extremely limited, and thus far has kept the valves at standard sizes. Candy has a few ideas, however, which in conjunction with the .040-overbore should allow bigger heads to be accommodated. A valve seat angle of 30 degrees was tried but led to burned valves, so the stock angle of 45 degrees is now standard.

The PBX engine is not particular about its pistons, and Candy says the standard units are fine. At present he is using special cast aluminum pistons with flat tops and full skirts which carry three Grant rings. Compression ratio now falls between 10 and 11 to one, as a result of the overbore.

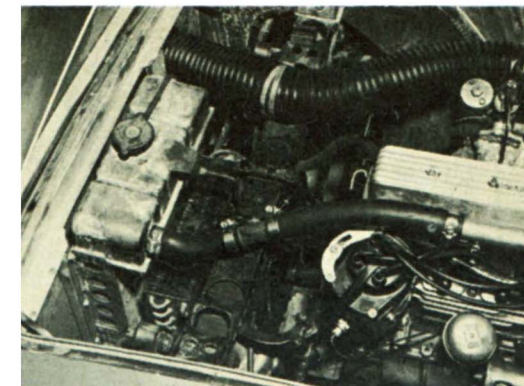
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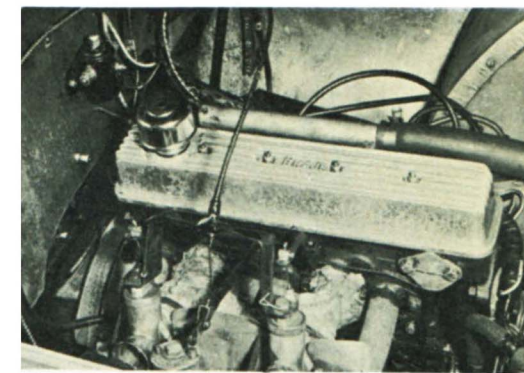
Front suspension remains Fiat in layout with wide transverse spring over two light forged wishbones. Note drums are drilled and finned for optimum cooling of brake shoes.



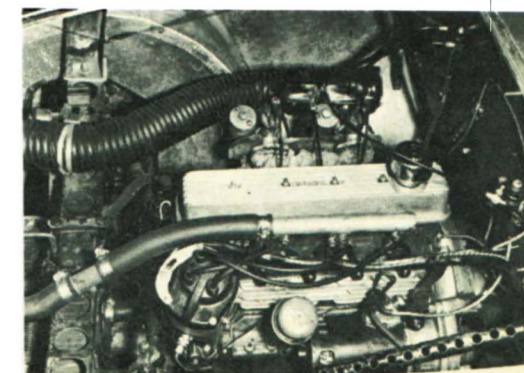
FIA regulations state that all competition cars must carry spare tires among other automobile accessories. To accommodate fifth wheel, Special carries it behind seats above fuel tank.



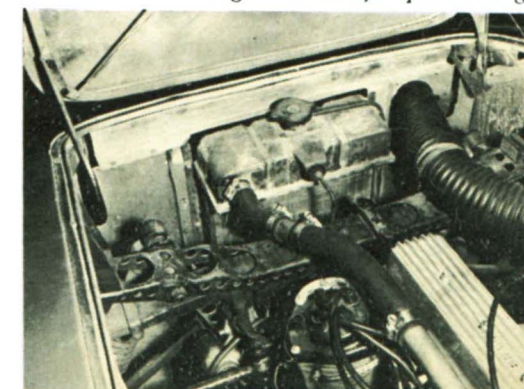
Small oil cooler mounted behind the radiator supplements the big cast aluminum Braje sump.



Twin Amal carburetors feed the potent little four. Equal linkage controls throttles.



The magneto is driven off the crank nose. Gil Knudson designed mount for quick change.



Steering column, frame and cross members were drilled out to lighten chassis weight.

PBX

(Continued from page 37)

A run on the dyno at 12 to one produced a supremely smooth-running engine, but one "with no guts at all." The standard Supersport ratio seems to remain the best for gas.

Porting is a weak point of the Crosley layout, but is little worse than other stock engines. Siamesed intake porting is in part compensated for by the four-port exhaust, but has led to an exasperating search for the right carburetion equipment. Standard Tilotsons were tried, as were twin Carter 870-S carbs which were better in that they had accelerator pumps. Twin Morris Minor SU's were fitted but proved disappointing at the top end. For some time two downdraft Webers did the job, but through it all Poole had his eye on the compact, straight-through Amal motorcycle equipment.

Due to the totally different requirements of cars and cycles it took some time to set them up properly, and early trials were with Amals somewhat larger than the roughly $\frac{7}{8}$ inch bores now in use. The bigger ones were just too much, though, and thorough reworking of the small carbs did a better job. For the future there's a brace of the latest in one-inch Amals stashed away.

Surprisingly with the wild cam in use, the PBX is not fitted with tuned exhausts. It is still running the same welded-up bunch-of-bananas manifold that came with the Weber carbs. Perhaps future revisions will make better use of those four exhaust outlets. Porting? Candy leaves all the block passages just as they came from the factory. The intake "manifold" is fabricated, and consists of two straight tubes connected by a balance pipe. Fiberglass wrapping and aluminum shielding protect both manifold and carbs from exhaust heat. The always-

difficult problem of controlling the Amal slide throttles was solved by an equalizing linkage based on a Hillman cable system. A supply of cold air for the carburetors is assured by a large flexible pipe from the screened nose, and no attempt is made to induce a ram effect with this refinement.

Igniting this little firecracker at high speeds is an exacting task, which at first was performed by a modified Malory ignition system. As development proceeded a magneto was called for, but the regular Vertex had a tendency to shed rotors above 10,000 rpm. Matters looked bleak, until Candy came across a very special piece of equipment. Gil Knudson at Scintilla had designed and patented a magneto and integral control that provides a constant and predictable advance curved both up and down the speed range. Only a few prototypes were made, and Poole was fortunate in being able to sign one out of the laboratory. In use on the PBX, this magneto is advanced well beyond 50 degrees at the engine checkout speed of 7000 rpm.

At one time the stock spark plugs were satisfactory in the PBX, but now the coldest suitable Champion, the J-2, is a bit on the warm side. The snap here is the short reach of $\frac{3}{8}$ inch, which strictly limits the rate of heat transfer to the block. Special platinum plugs by BG are being made up to do the job right.

Like the block assembly, the cast aluminum crankcase is fundamentally sound in design but requires modifications for the high speeds and stresses of PBX operation. It carries the crankshaft in five main journals, of which all but the rear 1.500 inch bearing are 1.375 inch in diameter. The three center mains of .870 inch width are supported by simple transverse bulkheads, which received a much-needed boost in stiffness by being nearly doubled in thickness in recent factory alterations. Similarly the factory adopted the early hot-rodding practice of backing up the three center two-bolt aluminum main bearing caps with short steel channels. Two of the eleven block hold-down studs are threaded into the tops of the bearing bulkheads, and thus tie the structure up tightly.

A Crosley forged crankshaft is used, which is available at \$135 or roughly three times the price of the alternate cast part. The main journals run at stock clearances while the rod big ends are set slightly closer than stock. Until recently the standard nickel chrome steel rods have been used and have been perfectly satisfactory, but as an experiment the PBX is now running special aluminum rods which cut the individual weight by 25 percent from the standard 9.6 ounces. The splash-

lubricated wrist pins are fully floating, and turn without bushings in the aluminum rods. Drilled-out aluminum plugs locate them in the pistons.

Effective doubling of the Crosley revolution range has brought up a host of lubrication problems of the most remote type, which have been solved by hard work and Poole-Bentzinger brainstorming. For example, the drive gears to the front-mounted oil pump would starve and fail at speeds above 7000 rpm, and Candy had to devise a method of providing them with a constant oil stream while still maintaining pressure throughout the rest of the system.

SAE 1040 steel is used for the spiral bevel gears in the vertical shaft cam drive. These are fine if all clearances are properly maintained, but some snags cropped up in balancing out the oil pressures at the top and bottom of the engine. A surprising improvement was effected by reversing the position and thus the grain of the horseshoe shim at the front end of the camshaft. A small oil cooler was added just behind the radiator to supplement the big cast aluminum Braje sump.

The magneto is also driven from the crank nose, and with the standard layout its removal requires dropping of the pan and much interior fiddling. Candy, always in a hurry where the PBX is concerned, got mag-designer Gil Knudson to design a mount that would allow quick exterior switching of igniters.

Dynamometer testing early revealed that the Crosley engine tended to run much too cold for highest output, and it was actually a task to get the level up sufficiently high. Internal block modifications have been coupled with a new radiator, which uses the old Crosley top and bottom tanks of one foot width. Height has been cut by three inches from the stock 13, and the new core has $11\frac{1}{2}$ fins per square inch instead of the old 6 per square inch. Three-port hot water riser is an added refinement.

Engines built to these general specifications have consistently turned out a solid 55 brake horsepower at 8000 rpm on the dyno, and Poole usually takes it to around 8500 through the gears. He's not afraid of ten or eleven thousand on a downshift, though, and once in a hillclimb he shifted from a screaming second gear right into low instead of third by mistakes, and everything stayed together! This figured out at around 16,000 rpm, by the way.

All this urge emerges through a six-pod Harman and Collins steel-faced aluminum flywheel. Clutch troubles, so common in other hot Crosley rigs, have been avoided by rugged design from the start. A TC MG clutch and

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transmission were adapted through a special experimental bell housing which represents the extent of official factory backing of Candy Poole. Pre-PBX efforts used a reworked Austin A-10 clutch with satisfactory, but which would not be equal to the present MG pressure plate in sturdiness and heat dissipation. Spring pressures are moderate, since they are limited by the very narrow thrust surfaces on the rear main bearing. Excesses can even throw off the cam tower gear clearances.

Candy gives much of the credit for clutch reliability to the "Fused Fabric" lining specially supplied by Rusco of Middletown, Conn. These molded wire-base facings are attached to the disc by twelve rivets which are inserted from alternate sides and peened over on countersunk washers. By thus binding lining to lining through the disc, clutch shedding has been eliminated. The TC gearbox has remained as standard and in ratios, weight and strength are perfectly suited the PBX. Now used for starting is a Harman conversion of a GM starter which embodies an overrunning clutch. This is good but too heavy, and a compact little Fiat unit is about to go in.

The old Crosley torque tube drive and single universal joint have been retained and adapted to the Fiat 500B rear axle. Within the defenseless center section of this axle have taken place the kind of bold operations that win races. Poole has a garage full of differential carriers, each adapted and machined to take a given type of gear set, including 500B and 500C Fiat as well as pre-war and post-war Crosley. Gogs from the old two-cylinder Crosleys now and then gave trouble but Candy would put up with them to get their very useful 5.57 ratio. The 500C range provides a 6.00 ratio for Thompson Raceway and 4.875 for the new Watkins Glen course. Once in place in the carrier, each gear set is thoroughly safety-wired and run in on a lathe. The differential and half-shafts remain stock Fiat.

Indeed, in spite of the Crosley motive power the PBX might better be termed a Fiat Special, since it is structurally based on a 1949 Fiat 500B station wagon chassis. All the initial planning was done in chalk on a concrete garage floor, and began with a wheelbase dimension that was fairly arbitrarily set half way between the Fiat and the Crosley Hotshot. New welded plates boxed in the channel side members and were drilled with holes staggered from those already supplied by the factory, while a Z-ing operation just ahead of the rear axle lowered the frame without restricting

(Continued on page 59)

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(Continued from page 57)

wheel movement. The existing X-member was split and moved back to embrace the gearbox and bell housing, which are supported by a new hat-section crossmember just below the torque tube ball joint. The front channel crossmembers remain substantially Fiat except for enthusiastic use of the hole saw. Many small L-section channels stiffen the structure and carry seats and bodywork.

No effort has been spared to make the frame a stiff and consistent base for the suspension, even at the expense of a little extra weight. That this has been successful is indicated by the uncanny sticking qualities of the PBX, which has been tried by experts and proclaimed one of the sweetest handling cars in existence. The answer is again split between good basic design and Poole flexibility.

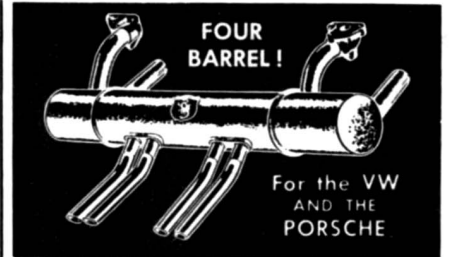
Front suspension remains Fiat in layout with a wide transverse leaf spring placed above two light forged wishbones. The spring itself has been much modified and heavily wrapped in the center, and by adjustments at the four-bolt center clamp Candy can alter the lateral weight distribution within ten minutes. Angled Columbus shocks with matched strokes take care of the damping.

Wholly standard Fiat worm and sector steering gear and unequal track

rod linkage are used. Left hand drive is retained, but be it noted that this provides the most accurate steering geometry for the left front wheel, which carries the burden of control on our predominantly right hand circuits. The steering column was re-angled and drilled out beyond recognition, and is now fitted with a tape-wrapped Nardi steering wheel which constitutes one of the very few non-essential expenditures on the car.

Experience with the old Hotshot helped develop the PBX rear suspension, which as mentioned before retains the Crosley torque tube. Since the Crosley coil springs are also used, additional axle location is required and supplied in abundance. Extending from frame left to the right hub, a Panhard rod handles lateral placing, while small-diameter radius rods run straight forward from each hub to mountings in the lateral plane of the ball joint. On the surface this arrangement is absolutely wacky, since it is redundant in many ways. Assuming tight ball joints and a stiff chassis, any movement of either rear wheel from a static position will produce a bending moment in the axle casing. The angles and distances involved are so small, however, that deflection is never marked, and the resultant effect is that of a very powerful rear. anti-roll bar.

(Continued on page 60)



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By MARION WEBER



Hil This month I'd like to say a word in favor of the seat belt . . . sometimes called safety belt . . . and express my gratitude for the invention of this device. A few months ago I was beelling along the Los Angeles Freeway (A long, narrow parking lot) and had just decided to turn off when I fainted . . . (no, it wasn't the smog, just something near-fatal). My Healey almost made the turn unaided, but not quite, and got pranged proper. I was somewhat shaken but unhurt at the end of the bumpy ride. . . thanks to my seat belt which I fasten at all times . . . even if I'm just warming up the motor for my husband. No joke, I would surely have been thrown from the car during its gyrations and likely have become a casualty had it not been for this ingrained habit.

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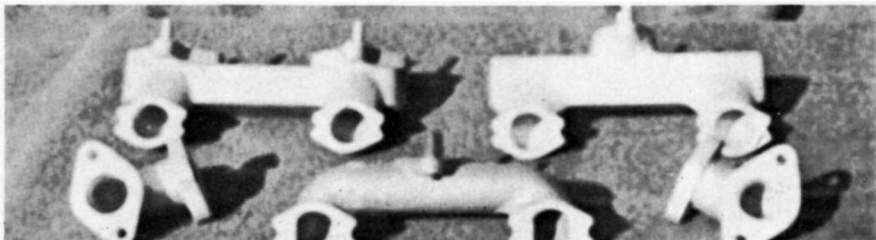
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(Continued from page 59)

The Panhard rod and radius arms are all fully adjustable for length, and thus allow the rear axle steering effect to be accurately adapted to the course requirements. They can also alter the amount of roll resistance mentioned above. Both these factors affect the steering characteristics of the car as a whole, and together with the front suspension adjustments they allow Candy to set the PBX up just the way he wants it. In fact, his regular practice is to balance it out so that side-to-side weight distribution is 50/50 with his 175 pounds in the driver's seat! This degree of finesse is rare, and obviously pays off.

The only real constructional boner that Candy made was the use of adjustable Ford lever-action shocks in the rear. These didn't do the job and were replaced by Columbus tubulars mounted vertically, which should have been the most effective position with that suspension layout. It was, all right, and to lessen the immediacy of their action the shocks were "sea-legged" in during 1955.



Poole experimented with various intake pipes & carbs before final choice was made.

Theoreticians will note that the unsprung weight at the back is on the high side, but Candy points out that the overall weight of 1000 pounds is high for that class of car, and the unsprung/sprung weight ratio is thus kept down. He quotes as a contrary example the much-touted Stanguellini, which with a live axle and a weight "sopping wet" of 850 pounds was a real handful on any part of the course.

Many SCCA drivers will admit to having blasted into a corner right to their all-stops-out cut off point, only to have Candy whistle by in the PBX, move over into correct line, and then apply the brakes. It is with these potent stoppers that he really starts to menace the class G boys in the later stages of a long race. The beautiful Fiat cast aluminum shoes are used, while the original drums were drilled for cooling and then farmed out to have aluminum muffins bonded on. On their return the muffins were lathe-turned down to cooling fins, and installed over Fren-Do linings. Incredible though it may seem, the original linings are still in the car, and require

adjustment only at the beginning of each season. Actuation is by a Crosley master cylinder.

Borrani wire wheels carry either Pirelli or Dunlop racing tires of very small section, which allow low pressures to be used for traction without prejudicing cornering power. 4.50 x 15 rears are sometimes worn to get just the right gear ratio. The spare is clamped down under the rear deck and over the Hillman gas tank, while the emergency brake system is built up of MG parts.

A balsa scale model went along with the PBX chassis to the Aeroform Company of New Haven, to help Sven Johnson wrap a body around all that hard work. Crafted in aluminum, the results are unparalleled among specials and equal to any manufacturer's prototype. It is full of unobtrusive good ideas, such as the 1/2 inch laminated aluminum honeycomb firewall, which is cemented into place, and the integral seat pans to augment frame rigidity. Curves, fittings, hinging, beading are all flawless. Baffles ensure that

all air entering the low snout passes through either the radiator or the carburetor cool air duct, and a full belly pan smooths off the bottom. Instrumentation is very complete, by Sun tachometer and Stewart-Warner.

That's roughly what goes together to make a PBX. Tempted to get out your pliers and have a go? It's not advisable unless you have the ingenuity to use a bicycle horn to cut weight, let alone the know-how to balance an engine statically and dynamically, or the patience to weigh the shavings when drilling for lightness. In short, unless it says "Chandler Poole" on your toolbox, you'd better try your own approach.

There's an easier way, though, since Candy has announced that he will part with this member of his family for surprisingly little more than the \$3500 cash investment that it represents. If it's still around for another season, there're still those bigger valves, which should boost the output to 60 bhp, and Candy is high on the list for a Crosley fuel injection rig being developed by Scintilla. Let's see now . . . if we exhaust-tune it, and use a little more overlap . . . #