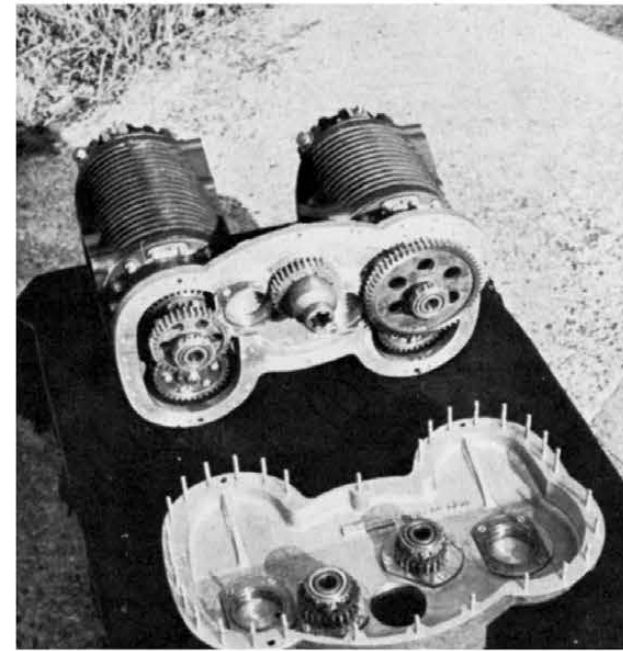


A Shorrock blower fitted to an A40 engine. Even the two-port Austin mill can be made to pack a wallop with this helper aboard.

Supercharging II

POSITIVE DISPLACEMENT BLOWERS

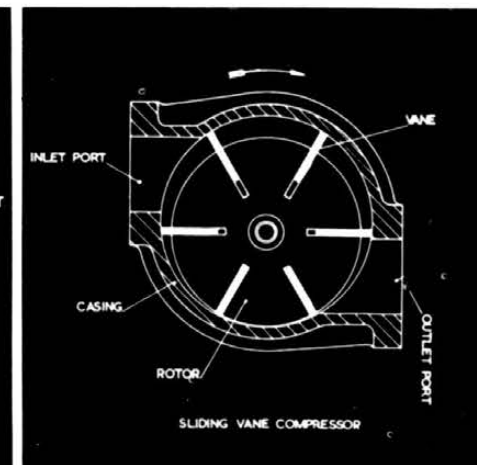
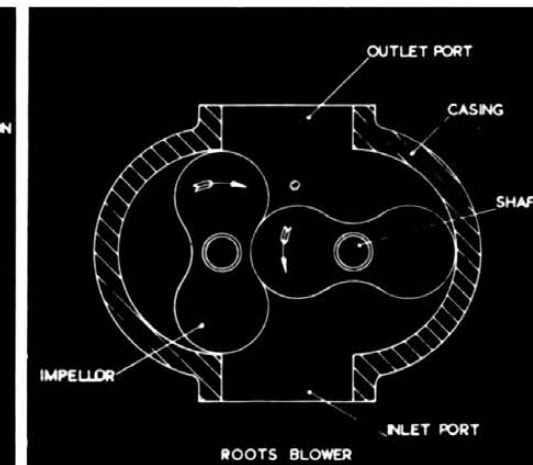
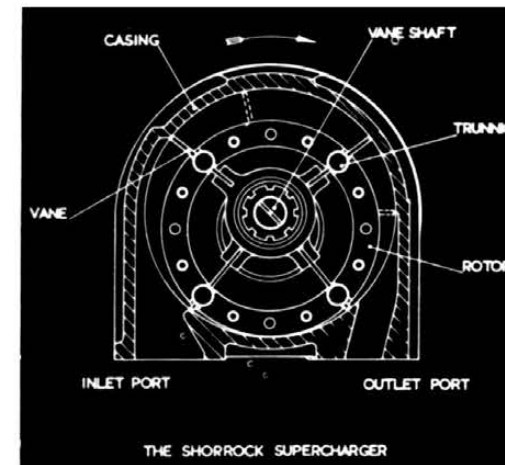


Wade two-stage supercharger for a 2-litre "B" type E.R.A. racing car. Usually Wade Engineering makes kits to fit British Fords, Morris Minor, and MG's.

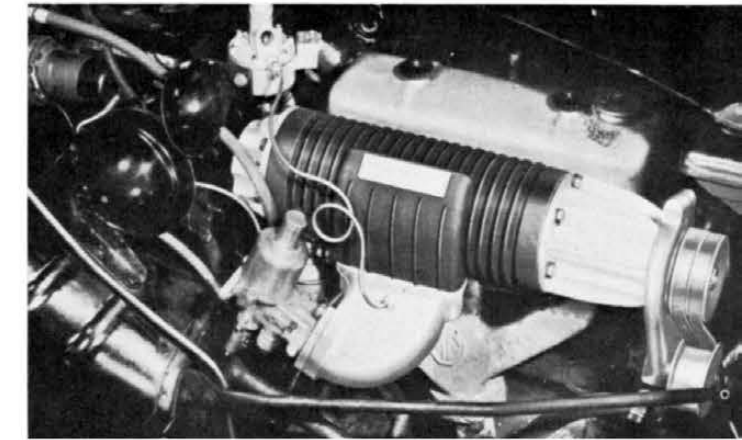
THE Roots-type positive-displacement blower has never been popular in America for passenger cars. We've used it extensively for commercial diesel engines, but noise, cost and bulk problems have kept it pretty much off the Detroit stuff.

Back in the late '40s, an Italian company (Italmecchanica) tried to promote a Roots blower kit for several popular U. S. stock cars (Ford, Chev, Stude, etc.), and a number were distributed. Quite a large proportion of those early I.T. units had defective gear trains, and the kickbacks ruined the venture. Shortly after, another Italian outfit (S.CO.T.) bought the I.T. facilities and attempted a come-back with the design, adding several new kits. The S.CO.T. version was a fair performer, but sales were small and this outfit quit in 1953. Quite a number of these I.T. and S.CO.T. blowers are still knocking around the country.

Meanwhile several small California specialty companies advertised semi-standard kits utilizing GMC truck blowers that could be adapted to certain U. S. stock engines. These included SpeedoMotive, Jack McAfee Motors, and Horns Equipment Co. Far as I know, any of these outfits will still take an order today (though prices for the low-volume work



By **ROGER HUNTINGTON**



Judson vane-type blower installed on MG. This positive displacement pump falls somewhere between the Roots and the centrifugal in low rpm efficiency.

are rough, of course).

Besides these, there are currently several companies in this country and Britain that manufacture small Roots blowers for low-powered overseas models that are widely used throughout the world. Pepco, Inc. of Akron, Ohio, supplies a small Roots pump for the MG and Volkswagen. Wade Engineering of Horley, England, makes standard kits for the British Fords, Morris Minor, MG, Triumph, Standards, and a kit for the late flathead Ford-Merc V-8 can be had on Special order. North Downs Engineering of Caterham, England, is another company that builds a good Roots blower for some small European cars (Marshall-Nordec trade name).

Actually, probably a large percentage of our readers are primarily interested in big-inch engines — and these small blowers don't offer a thing in the way of conversion possibilities. They can't be turned at a high enough speed to pump a useful boost on engines of more than around 150 cu. in. If properly set up they're quite effective in raising the acceleration of small road cars — and if you're happy with a 0-60 mph time in the 12-22 second range (along with the other benefits of an economy-type car), then I can

Wade Roots type blower for Diesel use. Angular inlet and outlet ducts reduce noise from sudden bursts of air between rotor lobes. Principle is same as helical gears.



recommend small-inch Roots supercharging. For big, 300-cu. in., engines our field of blower choices is limited.

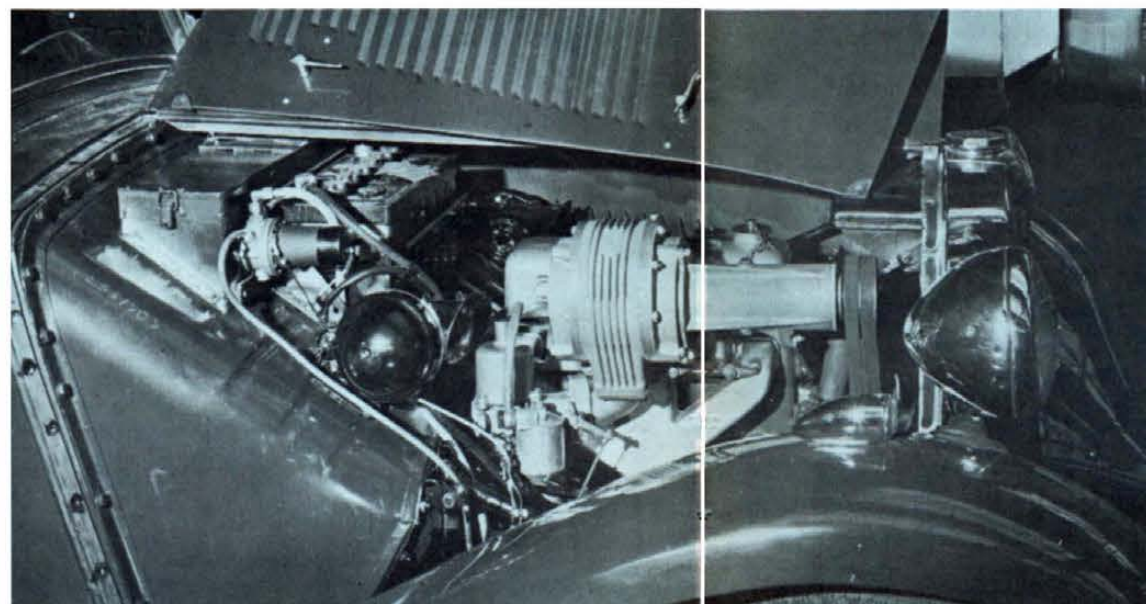
A Roots blower is what we call a "positive-displacement" pump — that is, it theoretically pumps a certain number of cubic inches of air each revolution. We have two interlocking rotors (with either two or three "lobes") revolving in an oval casing, with small clearances of .003 to .007 of an inch between the rotors and between rotor and casing wall. A gear train maintains the inter-rotor clearance. Air is scooped in at the inlet opening on one side of the casing, carried around by the rotors, and discharged into the outlet duct on the opposite side (see drawings). Obviously there is no internal compression here. A Roots blower builds up a manifold boost pressure by merely pumping more air than the pistons displace each revolution of the crank (at normal pressure). We select blower sizes by just comparing the blower displacement with piston displacement and gearing the blower to deliver the desired excess air.

Now this type of compression — engineers call it "isometric," or constant volume — is relatively inefficient: much more so than the "adiabatic," or variable compression process in the vane and centrifugal superchargers. This means that our Roots is going to absorb more horsepower in pumping a given weight of air at a given pressure, and it will heat up the air more during the compression process. For instance, suppose we want to compress 25 pounds of air per minute at an initial temperature of 75°F. to a gauge pressure of six pounds. An average-size Roots blower would require about 21 hp to drive it and would raise the temperature of the air to 170°F. . . . while a typical automotive centrifugal would absorb only 15 hp and deliver 145° air temperature. This may not seem like a big difference on paper, but I can assure you you've got two entirely different animals on your hands when you try to adapt them on a road or race engine.

When we try to get into really high boosts (over 10 or 12 pounds) with a Roots, especially with a large-displacement engine, the power requirement quickly gets out of hand, complicating the drive gear problem and subtracting that much power from the rear wheels. A power requirement of over 90 hp is entirely possible with a good-size Roots blower pumping 12 pounds on a big engine. And the 200°F. air temperature rise generated by this 12 pounds compression doesn't simplify combustion problems. Our fuel octane requirement at medium rpm is very high above about six pounds boost with a Roots.

Even the oft-quoted clinching "advantage" of the Roots blower — the good boost pressure at low speeds — has probably been overrated. Theoretically we should get a constant pressure at all speeds. In practice, though, due to the clearance between rotors and casing, we get a substantial leakage of air from the high-pressure side back to the inlet. This leakage is pretty much independent of blower speed, but depends mostly on the clearances and discharge pressure. Result is that full-throttle boost pressure drops off quite rapidly as rpm is reduced, since the leakage is a larger and larger proportion of the air pumped. (Some curves show the relationship.) The boost curve of the best Roots blower is still considerably inferior to that of the variable-speed McCulloch.

Admittedly, however, the drive and regulation of the latter are still far from rugged enough for full-bore competition, though they will stand up on the road. When the chips are down the Roots layout still scores over the straight



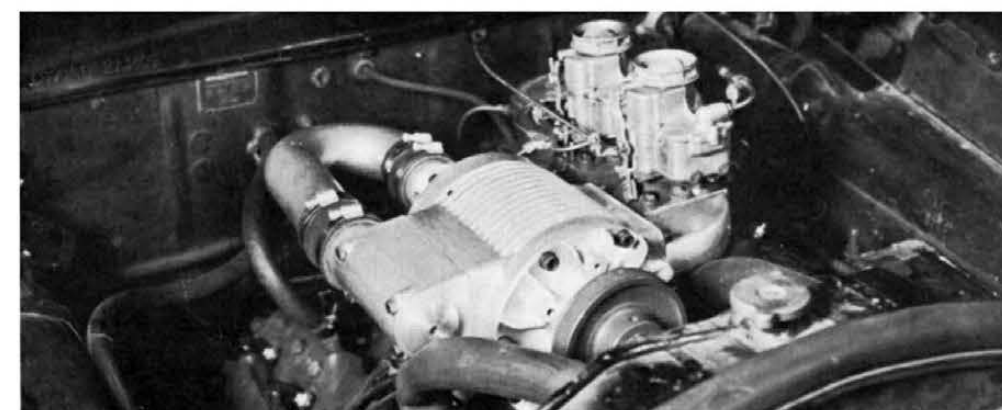
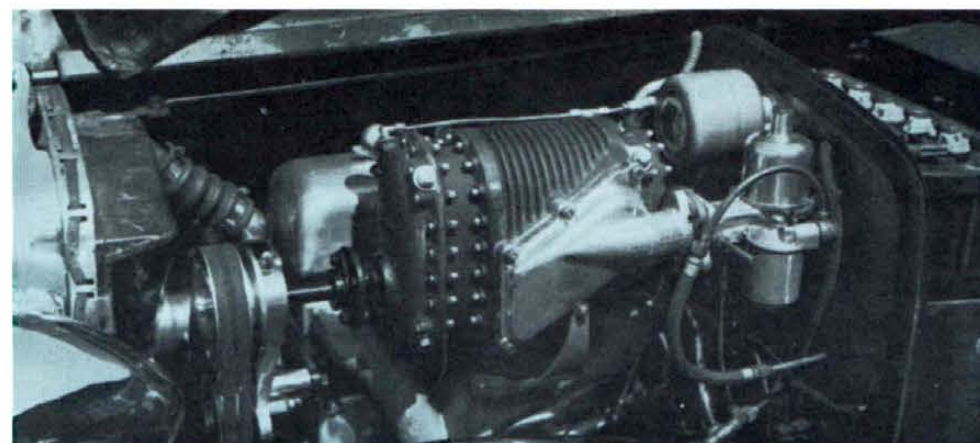
centrifugal in bottom-end boost and diminished "shock" drive loadings, while it's also free from the internal lubrication problems of the vane-type blower. Its bearings and gearing can be made to live, and it's relatively easy to do your own experimenting with clearances and drive ratios.

The fact that a large number of various sizes and models of Roots blowers units are available around the country as junk or used equipment, at very reasonable prices, is bound to attract a continuing stream of supercharging enthusiasts. Here are a few hints for those who want to adapt non-standard Roots installations.

The selection of a drive speed ratio with a Roots blower is a simple matter of arithmetic, involving only three factors — engine piston displacement, desired boost pressure, and the theoretical displacement of the blower (per revolution). I've wracked my brain to think of a way to save you this little bit of pencil-and-paper calculation by presenting the data on a single graph; but the graph could only show drive ratios for one boost pressure and you'd have to correct for other boosts by arithmetic anyway . . . so let's just work from a single formula.

First, though, we must express our boost pressure in terms of a "pressure ratio," relative to atmospheric. (That is, atmospheric pressure — average 14.5 pounds/sq. in. — would be a pressure ratio of 1.0, and a gauge boost of 14.5 pounds would be a pressure ratio of 2.0.) So let's work with these standard pressure ratios:

RIGHT: Single stage Wade Roots-type installation gives Triumph 1800 much needed energy. BELOW: Shorrock supercharger (vane type) fitted to T-series MG.



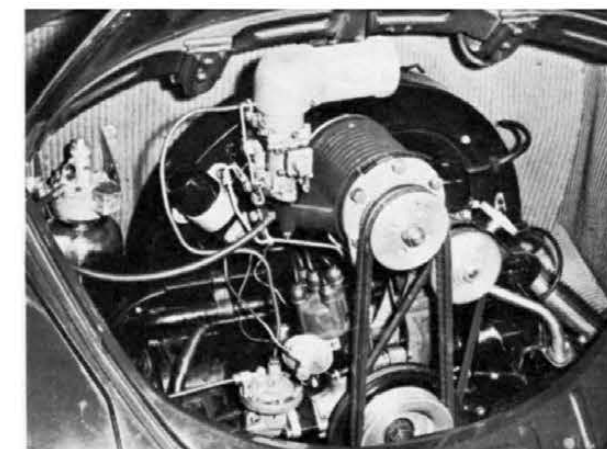
One of the latest Judson blowers, anchored to a flathead '50 Ford, is fed by two Holllys. This neat setup can be adapted to a later overhead valve engine, but should not be used on plants much exceeding 250 cubic inches.

For bread-and-butter road engine.. 6 lbs.: 1.41 pressure ratio
Maximum on pump gas.....10 lbs.: 1.69 pressure ratio
Competition engine on alcohol.....14 lbs.: 1.97 pressure ratio

Then we need to know the displacement of our blower. In 99 cases out of 100 you'll be using one of eight models of Roots blowers, as they are by far the most widely available in this country, at least in the sizes we're interested in. (Most of these blowers are currently being used in truck or industrial diesel engines, and, incidentally, the models listed under the Borg-Warner name here are now being manufactured by Michle-Dexter of Racine, Wisconsin. Here's a run-down on available blower models and approximate displacements per revolution.

| MODEL | DISPLACEMENT PER REV. CU. IN. |
|----------------------|-------------------------------|
| I.T.-S.CO.T. | |
| 4500 | 180 |
| GENERAL MOTORS CORP. | |
| 3-71 | 200 |
| 4-71 | 250 |
| 6-71 | 310 |
| BORG-WARNER | |
| 2506 | 70 |
| 3208 | 150 |
| 3710 | 250 |
| 4012 | 350 |

(Continued on page 62)



A Judson vane compressor feeds enough vitality into the undernourished Volkswagen to give it the beans to cope with U.S. traffic.

NOW ON SALE

POPULAR PHOTOGRAPHY'S SPECIAL COLOR ISSUE!



When you buy that next roll of color film, be sure to pick up a copy of September POPULAR PHOTOGRAPHY, too—a big, Special Issue on COLOR!

You'll find articles like these go hand in hand with good summer picture-making:

- COLOR ERRORS AND THEIR CURES
- GLAMOUR IN COLOR
- COLOR PROCESSING WITHOUT A DARKROOM
- PROFESSIONAL SECRETS OF COLOR CORRECTING
- HOW TO MAKE FLEXICHROME FULL-COLOR PRINTS

BUY YOUR COPY OF SEPTEMBER
POPULAR PHOTOGRAPHY TODAY!

On sale at all newsstands and camera stores.

Highway Hi-Fi



FM-AM SHORT WAVE

The finest reproduction of sound can add even more zest to the joy of driving. If you have ever experienced hi-fi music in the home, and missed it in your car, Becker autoradios make music come alive—from the shimmer of the cymbals to the throb of the tympani. Add to this the superb tonal quality of FM and the adventure of short wave—there is a new experience waiting for you at your Becker dealer. Choose from the automotive tuning "Mexico" or the push button "Europa"—the "Reims" short wave adapter (6 band spread) can be added to either model.

becker
autoradio

BECKER AUTORADIO

Distributing Company

421 So. Western Ave., Los Angeles 5, Calif.
(West of Mississippi)

WITTE Import Distributors

125 So. 16th St., Philadelphia 2, Pa.
(East of Mississippi)

"The Sound with
a Personality"

Italian

BUS HORN

CONVERSION
KIT
FITS ALL CARS
695

NEW . . . A musical sound, in the delightful manner of Continental Italy!

ELECTRONIC . . . Conversion Kit, splits the stock horns of your car into two notes, one high, one low, about 4 times a second, at the touch of the horn button.

AUTOMATIC . . . Just 3 simple wire connections. Can be changed from car to car.

STATE 6 or 12 Volt system.



VILEM B. HAAN

P.O. BOX 54, BEVERLY HILLS, CALIFORNIA

Showroom & Offices:

10305 Santa Monica Boulevard

Los Angeles 25, California

Supercharging II

(Continued from page 45)

Okay. Now here's the formula that gives us our drive speed ratio (for four-cycle engines only):

$$R = P \times D$$

$$1.6 \times V$$

where R is the speed ratio; P is the pressure ratio; D is the engine piston displacement in cubic inches; and V is the blower displacement in cu. in./rev. Let's take an example. Suppose you have an engine of 331 cu. in. and want a boost of six pounds (1.41 pressure ratio) using a GMC 4-71 blower (250 cu. in./rev.). Our ratio would be $1.41 \times 331 / 1.6 \times 250 = 1.17$. In other words, the blower would have to run at 1.17 times crankshaft speed to give six pounds at peak rpm on this engine. And that's about all there is to it.

Maximum safe rpm limits on various Roots blowers are not well established. The manufacturers "red-line" them at anywhere from 4000 to 10,000 rpm, depending mostly on rotor diameter. The critical situation here is due to a literal stretching of the rotors under centrifugal force; as speed is increased the lobes will "grow" until the clearances are soaked up and there is direct metal-to-metal rubbing contact. This can wreck the blower in a few seconds. Very small Roots blowers (under 100 cu. in./rev.) are generally safe up to 10,000 rpm in standard trim. Medium sizes from 150 to 250 cu. in. are generally okay to 8000. Large blowers of over 300 cu. in. should be red-lined at 6000 rpm. However, by shaving .008-.010 of an inch of stock off the outside edges of the rotor lobes you can safely extend these rpm limits at least 50 percent (though with a considerable loss in boost pressure at low and medium speeds). A good rule of thumb for absolute limits for competition engines is to limit rotor tip speed to 350 ft./sec. This would represent about 13,000 rpm for six inch diameter rotors. (The formula for calculating it is: Safe rpm = 80,000/rotor diameter.)

Like the Roots, the vane-type supercharger is a positive-displacement pump, and it has not been widely used in this country for internal-combustion engines (of course, there are many industrial uses for blowers except on engines). At the present time, only the Judson Research & Manufacturing Co.

of Conshohocken, Pa., is producing a vane-type blower for cars in this country. They have kits for the MG and Volkswagen, and they still stock their original kit for the flathead Ford-Merc, introduced in 1953.

Vane-type superchargers have been popular for small engines in Britain for at least 25 years. Gardner used a Shorrock vane blower pumping 30 pounds boost to get 200 mph out of his 66-cu. in. MG Special. Shorrock Superchargers, Ltd. are still very much in business in Coventry, supplying standard bolt-on kits for a number of smaller British cars — MG, Austin, Morris, Triumph, etc. They even claim to have a blower size that can furnish a usable boost on engines up to 270 cu. in. displacement. London houses Carburetors Ltd., who make the Arnott low-pressure vane pump in several sizes.

A good vane-type blower will fall somewhere between the Roots and centrifugal in overall efficiency. Essentially, we have an eccentric (off center) drum inside a cylindrical casing (see drawings). Four or more blades extend through slots in the drum and sweep the inside of the casing, scooping air from the inlet to outlet duct. The general principle of "positive displacement" is similar to that of a Roots blower, but with one important difference: Due to the eccentric location of the inner drum, the volume of the air channel from inlet to outlet is squeezed down as the vanes rotate. This gives a certain degree of internal adiabatic compression, which is a much more efficient process than the isometric Roots compression. Result: Less horsepower required to compress a given weight of air per minute to a given pressure, and less air temperature build-up.

The key to the success of any modern vane-type blower is the method of controlling the motion of the vanes relative to the drum and outside casing. In the early days, they just gave centrifugal force a free hand and let the vanes drag against the casing. Some real going racing engines were built under this setup, but it just wasn't practical for the road. Noise was excessive, there was a lot of friction, wear, the driver had to mix oil in his gas to lubricate the blower, and any appreciable dirt in the air would clobber the blower in a hurry.

Most modern vane blowers feature some form of controlled vane motion. Judson and Shorrock approach the problem from different angles. Judson constructs his vanes of a synthetic, non-metallic material and allows appreciable rubbing contact. But the vanes are restrained at an angular setting

(Continued on page 66)

Summer
Special

FLASH!



AUTO CLUB BADGES FROM AROUND THE WORLD

Over 33 Badges to choose from. Enameled in beautiful colors to add the extra look to your sports car.

AUTOMOBILE CLUB OF GENOVA
" " GERMANY
" " FRANCE
BRITISH AUTO RACING CLUB
MONTE CARLO RALLY

These are only a few — \$2.95 each or set of four for \$10.00. Send today for our free Photo Board and order blank. Will submit price quotation for your club badges or any special design you may wish.

COMBINATION GRILLE-GUARD/BADGE BARS

Constructed of steel tubing and heavily chrome plated. Maximum protection with beauty the key note. Complete easy-to-follow instructions with each unit.

Jaguar XK-120 \$16.95 ea.
Austin Healey 18.95 ea.
Thunderbird 14.95 ea.

SPECIAL DISCOUNT OFFERED TO CLUB GROUPS ORDERING IN QUANTITIES OF SIX OR MORE.

KEY RING CHAINS

Furnished in German silver for: Thunderbird, MG, Austin Healey, Jaguar. For orders of 100 key chains or more, we will make to your photo or drawing custom rings for club use, advertisement for your business, etc. Special discount prices for these orders. Allow 30 days for delivery.

Price
98c ea.

SEND CHECK OR MONEY ORDER TODAY! ALL ORDERS POSTPAID.

S & S ENTERPRISES

BOX 13
SUNLAND, CALIFORNIA

Specialists in Service for
Jaguar - MG & Austin-Healey
Now Specializing in
LANCIA
OSSIE & REG
2800 So. Crenshaw, Los Angeles
RE. 2-0470

"AMERICA'S SAFEST HELMET"

SHOC-SHELL

Approved by SCCA, NASCAR, USAC drivers. Scientific design, maximum protection, 12 safety features.

Custom white

leather\$29.50 ppd.

Cust. col. leather.....\$31.50 ppd.

JOHN W. LOHRENZ
4417 E. Anaheim Street
Long Beach 4, California



THE **HOT MORGAN** IS NOW

EVEN "**HOTTER**" WITH

TR-3 ENGINE

Introducing the **MORGAN 4/4 SERIES II**

NEW LOW PRICE **\$1995.00**

LIGHT WEIGHT **1430 lbs.**

ECONOMY **1172cc. ENGINE**


PERFORMANCE **FAMOUS MORGAN SUSPENSION**

COMPLETE STOCK OF FACTORY PARTS

European Delivery on Request

WORLDWIDE IMPORT INC. • DISTRIBUTORS FOR THE WESTERN U. S. A.

1968 SO. SEPULVEDA BLVD., LOS ANGELES 25, CALIF.



AUTOSHOOES,

for discriminating drivers

These specially designed driving shoes of supple black leather have steel plates between the ball of the foot and the double sole in order to distribute the pressure from the foot pedals over a larger area, thus preventing undue fatigue. A layer of sponge rubber between the soles cushions the heel when walking. The outer sole is continued up the heel of the shoe, forming the counter and taking the wear that comes from driving. Its flat shape also holds the foot in the correct position for pedal operation. The shoes, which come in a plastic drawstring bag, are extremely light weight (18 oz. a pair) and exceptionally comfortable for long driving. Guaranteed to fit and to satisfy or your money cheerfully refunded. \$11.95 ppd in the U.S. Calif. add 4% tax.

Also Michelin "X" tires for fast drivers. Fantastic roadholding, outstanding mileage, silent cornering, increased comfort. Write

AUTOSHOOES
Box 34639, DEPT. S. LOS ANGELES, CAL.

NEW

Uni-syn Multiple Carburetor Synchronizer

Uni-syn, an instrument for balancing multiple carburetors of any type, down draft or side draft.

- Sturdy construction
- Positive float readings
- Fits all carburetor sizes
- Enthusiastically recommended by users
- No adaptors needed.

No C.O.D.'s — Price ppd. \$9.95
Rozye Carburetor Gaskets kits available for all cars.

ROYZE
Dept. 9, 1509 Centinela Ave., Inglewood, Calif.
OR. 8-7032



RAMCOTE FLEXIBLE FINISHES

Restores - Colors - Protects Leather, Leatherette and Vinyl Plastic

Is your leather or plastic upholstery faded or worn? RamCote restores the original color and texture to your car's upholstery. You can change color, too! Available in eleven standard colors and clear. Any shade obtainable by inter-mixing colors. Easily applied, brush or spray. Won't chip or peel. Waterproof—fadeproof. Use on Luggage, Sports Equipment, Lounge Chairs, etc. See your local dealer or write for FREE information and color chart.

RAMCOTE PRODUCTS, Dept. 5-96
1141 W. 69th St. Chicago 21, Illinois



(Continued from page 63)

relative to the inner drum, so that centrifugal force components tend to balance where the vanes pivot in slots in the drum. Rubbing pressure where the vanes sweep the outer casing is very low; at points where the pressure is higher the rubbing speed is low, so friction is not excessive. Drip-feed oiling is used. The Shorrock design (see drawings) has the radial vanes propelled around by the eccentric drum, but they are carried in a frame rotating on ball trunnion bearings. Their location does not depend on centrifugal force. There is light rubbing where the vanes pass through the slots in the drum, but there is theoretically no contact with the casing.

The general performance characteristics of a vane-type blower are quite similar to those of a Roots. We don't have quite as much back-leakage past the vanes, but there is definitely a radical drop in pressure output at low rpm. Power requirements for a given pumping rate and pressure will run about 15 percent less than a Roots. One definite advantage—we can pump higher pressures with a vane blower than a Roots, due to the internal compression. A Roots is not practical much above 15 pounds boost (due to excessive hp requirement and heat build-up), but a vane can push at least 25 pounds with fair efficiency.

The problem of calculating drive speed ratios here is the same as with the Roots, and we use the same formula presented in Part II (that is, $R = P \times D / 1.6 \times V$). Our usable boost or pressure ratios will be a bit different, though. Around six pounds (1.41 pressure ratio) is still good for our "bread-and-butter" road engine, but we should be able to get away with 12 pounds. (1.83 ratio) for racing on pump gas . . . and pressures up to 20-25 pounds. (2.4-2.7 pressure ratios) are practical with alkyl.

There's just one little bug: Vane-type blowers are considerably more critical as to safe rpm limits than the Roots pump. This is because decent static and dynamic balance is next to impossible to attain on four vanes; so vibration forces are almost always rough — and they go up as the square of rpm. Shorrock red-lines their small blower at 6500 rpm, and that for only short bursts; the larger models must not exceed 5000 at any time. Apparently the Judson layout, using light synthetic vanes and a balanced mounting, is more comfortable at high speeds. He doesn't quote any rigid rpm limits for his blowers—and claims to have tested his small Model 26 unit for 2000 hours at 8000 rpm.

Anyway, if you're interested in ex-

perimenting with this type of supercharger, here are the displacements of the more popular units available:

| JUDSON | Cu. In. |
|----------|---------|
| "26" | 51 |
| "178" | 186 |
| SHORROCK | |
| S-75 | 46 |
| S-142 | 86 |
| S-250 | 151 |

Just a quick example: Suppose you have a Judson 178 blower model (186 cu. in./rev.) and you want to adapt it for 12 pounds boost (1.83 pressure ratio) on a 210-cu. in. Jaguar competition engine. Your drive ratio, from the earlier formula, would be

$$R = 1.83 \times 210 = 1.29:1$$

$$1.6 \times 186$$

This would mean, when you're winding the crank to its maximum 5800 rpm, the blower would be turning $5800 \times 1.29 = 7500$ rpm. Charlie Judson says it's okay . . . so maybe it is. #

ALUMINUM BODY FABRICATION AND REPAIR

Sports Car & Race Car Bodies
DESIGN & FABRICATION
MICHAEL SCOTT CUSTOM METAL SHAPING
1520 N. Ivar, Hollywood, Calif.
Hollywood 2-0372

Classified

RATE: 15¢ per word. Minimum 10 words. December issue closes September 10th. Send order and remittance to: SPORTS CARS ILLUSTRATED, 366 Madison Avenue, N. Y. C. 17.

SPORT Cars, Classic and Antique Automobile color slides. 2x2 mounted. Illustrated Catalog Free. Universal Slide Company, Box 779S, Beverly Hills, Calif.

"TWIN-SET" Precision Screwdrivers — Fits Watch To Automobile Screws. (9 Pieces). Shockproof — Underwriters Approved. \$1.00 Complete. Satisfaction Guaranteed. White Company, 1730-G Flatbush Avenue, Brooklyn 10, New York.

FREE. Complete illustrated catalog. Leathercraft kits, supplies. Also big Metalcraft catalog Write now for either or both. J. C. Larson Co Dept. 6254C, 820 S. Tripp, Chicago 24.

BUILD Your Own Supercharger — Complete Plans and Instructions. \$1.00. Alanne Products, Box 135, Watertown 2, Conn.

BINOCULARS repaired, all makes and models. Authorized Bausch & Lomb, Zeiss, Hensoldt, and Bushnell dealer. Tele-Optics, 5514 Lawrence, Chicago 30, Ill.

MAGNIFICENT full color prints World Famous Sports Cars. 6 large 12x14" suitable for framing, value over \$12, only \$1.50 postpaid. Borden Publishing Company, 3077 Wabash Ave., Los Angeles 63, California.

35 MM Color Slides. Sports cars in action, California road races. Send 50¢ for sample slide and complete listing. D. Burton, 1159 Almaden, San Jose, Calif.

JOB Information — High Pay. All trades. The Islands, So. America, U.S.A. Companies pay overseas fare if hired. Write Section 92R, National, 1020 Broad, Newark, N. J.

IMPORTED St. Christopher Badge for your car. Solid brass, 3/4" diameter. Bordered by 14 International Flags in brilliant baked colors. \$3.95 each postpaid. Send 25¢ for catalog of international auto club badges. Charmant Imports, Garden City 12, N. Y.

JAGUAR owners, Healey owners: Stainless Steel Flexible Exhaust Tubing Permanent replacement between exhaust pipe and muffler. Complete with heavy-duty clamps. Healey \$5.50, Jaguar \$5.95 (modified requires two) postpaid. Quantity inquiries invited from dealers. Wilco, P. O. Box 1128-S, Rochester 3, N. Y.

HICKOK Safety Belts. Write for specifications and illustrated literature on sports car installations. Wilco, P. O. Box 1128-H, Rochester 3, N. Y.