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CLYMER

# VOLVO

242, 244, 245,  
DL, GL, GLT, & TURBO  
1975-1983  
SHOP MANUAL

HIGH  
PERFORMANCE  
HOW-TO



## CHAPTER TWELVE

### PERFORMANCE MODIFICATIONS

The Volvo is one of the world's great cars in terms of reliability, ruggedness, and practicality. It is a car that you can depend on to get you from point A to point B in safety, comfort, and with reasonable quickness — no matter how foul the weather or how bad the roads.

Volvo owners, however (like any other loyal marque devotees), are constantly searching for ways to improve the handling and performance of their cars. The result is an almost staggering array of high performance bolt-on components that will transform the somewhat dowdy-looking Volvo into a Swedish rocketship, capable of delivering far more acceleration, top speed, and handling than the average driver would have dreamed possible.

This chapter has been prepared with the street-oriented modifier in mind. While there is a considerable array of high performance equipment available for racing applications, few of you will ever actually enter your car in competition. Therefore, the following information has been organized in a logical order of progression so you can start small and build toward a goal — the “ultimate” street sedan.

Of course, how far you go is up to you, and that is the joy of having so much equipment to choose from. Up to a certain point, chassis and

engine modifications make a car more enjoyable to drive. However, if this is carried too far the end result is a car that, because of excessive horsepower, too harsh a ride, etc., becomes a nervous, high-strung machine that is anything but pleasant to drive.

A happy medium is obviously the answer, and that is well within your grasp. Without spending a fortune, and with just a reasonable amount of mechanical know-how, you can build a street car that will be exactly what you're looking for.

It is obviously impossible for us to show you how to install all of the components shown in this chapter — it would take another entire book — but we will show you what is available, tell you why you should install it and what will happen if you do, and supply you with the addresses and other vital information to get you going.

The modifications described in this chapter are not, as stated earlier, intended for the racing-oriented owner, but rather for the enthusiast who is looking for a bit more performance, in every department (acceleration, handling, braking, etc.).

**Table 1** at the end of this chapter gives accessory sources.



## PERFORMANCE STAGES

Most of the accessories in this chapter are of the "bolt-on" variety. Bolt-on equipment materials and designs change frequently. We cannot control how the equipment will be installed, or how the car will be used. Good judgement and common sense will help you avoid disappointment. "Bolt-on," as used here, means accessories which you can add to your car with ordinary hand tools and a reasonable degree of mechanical expertise. Generally speaking, if you can carry out the procedures outlined in the main body of this service-repair manual, you can also install the bolt-on, high-performance accessories illustrated in this chapter.

### CAUTION

*Clymer Publications cannot guarantee or be responsible for performance, possible damage to the car, or personal injury resulting from the performance modification procedures given in this manual.*

## Chassis Modifications

Without question, the chassis should be modified first. It is foolish (and dangerous) to modify an engine for more horsepower if the chassis is incapable of handling it.

Chassis modifications are generally less expensive (and easier to make) than engine modifications, and you can add various bits and pieces (heavy-duty shocks, stiffer sway bars, etc.) as you get the money. Therefore, if for no other reason than economy, the chassis-first approach makes sense.

Quite possibly, in view of today's 55 mph speed limit, you may simply decide to modify the chassis *only*, and leave the stock engine alone. Chassis improvements will make your car safer (blow a tire on a weak-sprung car with tired shocks and you have a major problem on your hands; blow one on a tautly-sprung car with firm shocks and equipped with heavy-duty sway bars, and you have a far less chance of crashing).

Europeans have known for years what the American automotive community has only found out recently — a small-engined car with a

well-balanced chassis is easily capable of beating a large-engined, overweight, and poorly suspended car from point A to point B, and it will do it with less dramatics (body lean, wheel hop, etc.).

When it comes to modifying your car, make no mistake about it — chassis modifications must come first.

## Engine Modifications

As mentioned previously, you should not even consider modifying the engine until you have modified the suspension. Of course, this does not apply to the addition of such items as a more efficient exhaust system, etc., which will make your engine perform better and give added gas mileage without raising the horsepower to a level where it is too much for the suspension to cope with.

*NOTE: The stock engine should always be checked for soundness, then tuned perfectly before attempting any modifications. Raising the horsepower on a "tired" engine is a sure way to destroy that engine.*

It is possible to modify your engine to almost any horsepower stage that you wish. "Conventional" engine modification components are available (high-lift cams, lightweight pistons, exhaust systems, etc.), as well as turbocharger kits, so you are free to pick and choose, using your own mechanical (and financial) capabilities as a guide. See *Engine Modifications*, Stages 1, 2, and 3, later in this chapter.

## Body Modifications

Body modifications are the last step in the modification process. When your chassis has been properly set up (stiffer springs; heavier sway bars, front and rear; modified shock absorbers; wheel spacers for a wider tread, etc.), and your engine has been modified and tuned to the proper degree, the only area of modification left to explore is the body.

Air-flow devices such as front spoilers (which provide more down force on the chassis at high speed) are not as effective at legal speed limits as they are at high speeds, but they are still worthwhile.

Replacing heavy steel body panels (fenders, hoods, doors, etc.) with lightweight fiberglass components makes a great deal of sense, as reducing overall weight is the same thing as adding horsepower. With less weight, your car will accelerate faster without additional horsepower; it will corner better, as there will be less weight that wants to continue in a straight line when the front wheels are turned to the left or right to negotiate a curve; and it will stop faster, since less weight wants to continue going forward when the power is cut off and the brakes applied.

Fiberglass body components are also an ideal replacement for damaged or rusted steel body panels.

### ACCESSORY SOURCES

There are two major manufacturers and/or suppliers in the U.S. who offer a complete range of Volvo accessories (everything up to and including complete engines), plus a few additional manufacturers or distributors of Volvo accessories. Refer to **Table 1**.

Volvo does not compete in serious competition of any type — but they used to. In fact, ten to fifteen years ago they won the European Rally Championship three times (in 1958 and 1963 with Gunnar Andersson, and in 1964 with Tom Trana). After that, they withdrew from active participation.

However, Gunnar Andersson was hired by Volvo to head up a small department producing sports and competition accessories. These accessories have been supplied to Volvo customers ever since, through Volvo Competition Services in Gothenburg, Sweden.

Since it is a bit impractical for U.S. enthusiasts to order their parts from Sweden, a U.S. branch of Volvo Competition Services was set up in Torrance, California. Any of the Volvo factory high performance items illustrated in this chapter come from that source (however, you must order them through your local Volvo dealer).

The second source of high performance components for the Volvo is Ipd of Portland, Oregon. This company is made up of ten or so avid Volvo enthusiasts whose dedication to the marque matches that of the Volvo Competition

Service group. Ipd offers a remarkable array of competition proven items.

### CHASSIS MODIFICATIONS

The following chassis modifications will result in a noticeable improvement in handling. For the most part, items such as heavy-duty shock absorbers, stiffer coil springs, sway bars, etc., are installed exactly the same as their stock counterparts. Refer to the appropriate chapters in the main body of this manual.

Ipd offers supplemental information sheets on most of their items, for 10 cents or so each (the supplements are all listed in their catalog). Each sheet contains a wealth of tips which you would not find in an ordinary instruction sheet. (These sheets are, of course, packed with each component sold by Ipd.)

#### Sway Anti-Roll Bars

These bars reduce body roll during hard cornering, resulting in a flatter cornering attitude and better control and tire adhesion. **Figure 1** shows Volvo Competition Service's 21mm front and 25mm rear sway bar kit. Ipd and Addco also offer sway bars.

It is necessary to "balance" the car by carefully matching the diameter of the rear sway bar to that of the front one. A rear sway bar should definitely not be installed without increasing the diameter of the front sway bar.

#### Front and Rear Springs

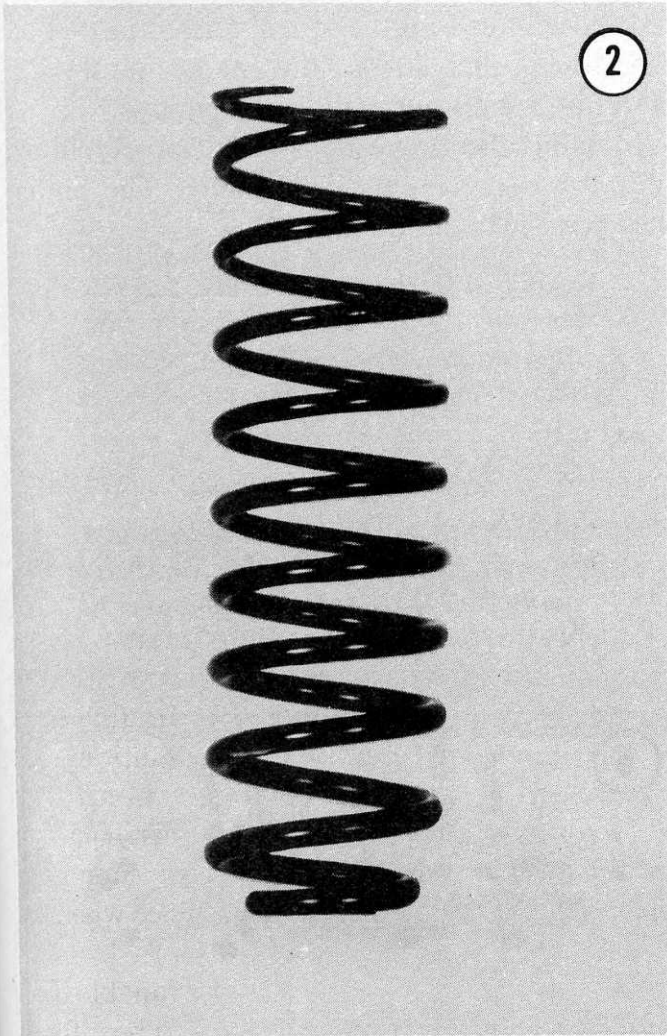
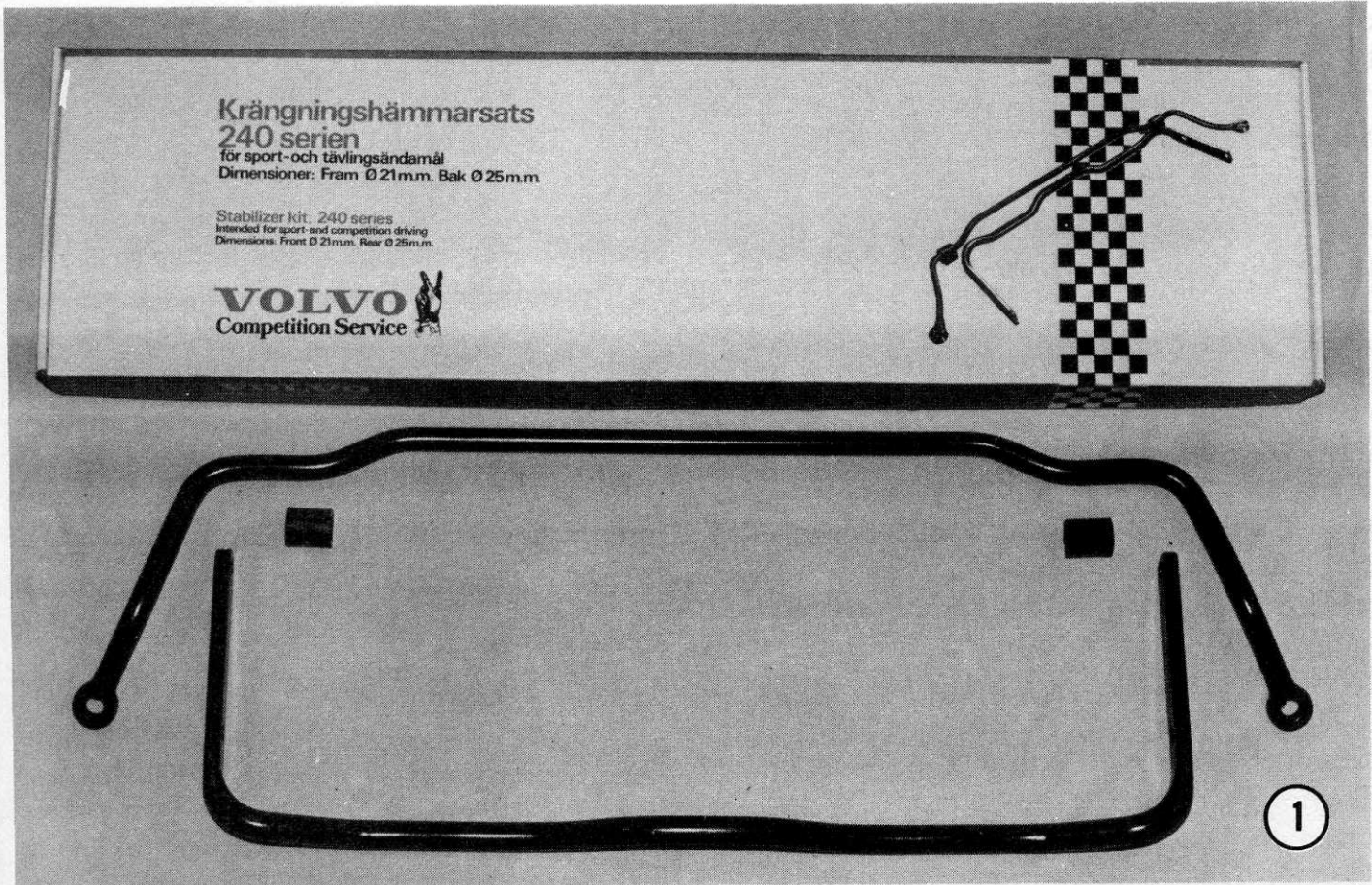
Heavy-duty front and rear springs are available for street, rally, or race conditions. **Figure 2** shows a typical coil spring.

Coil spring installation is straightforward. Refer to the appropriate chapters in this book for removal and installation procedures.

"Air-lift" springs are not new, having been around for years. However, after testing them on the Volvo under heavy load conditions, Ipd recommends them without reservation. Refer to **Figure 3**. They fit inside the rear coils and can be filled with air when extra support is needed, and deflated and left in place when not needed.

An Air-lift "Tee" hose is also available from Ipd which enables both rear bags to be inflated





or deflated from a single valve mounted in the trunk.

### Shock Absorbers

The installation of high performance shock absorbers is an absolute necessity if you choose to install heavy-duty front and rear springs. They are, of course, desirable even if the stock coil springs are retained.

Bilstein gas shock absorbers are highly recommended over other major high performance shock absorbers by both Ipd and Volvo. As noted earlier, Volvo does not enter factory-sponsored cars, rather providing parts and advice to their customers (who race), instead. Ipd, on the other hand, races Volvo cars under the Ipd name — both manufacturers offer Bilsteins to their customers over the others.

These shock absorbers seem especially effective on choppy roads. In addition, they seem to have a very long life span.

Ipd offers a less expensive alternative to the Bilstein. They manufacture a "De Carbon" gas-pressure design shock absorber, which is a heavy-duty replacement shock absorber for the Volvo 240 (Figure 4).

### Wheel Spacers

Wheel track can easily be increased by one full inch (25.4mm) per wheel (a 2-in. total track increase) by adding Ipd's cast aluminum spacer kit (Figure 5). The kit comes complete with 10 longer-than-normal replacement studs.

Another wheel spacer from Ipd is available for stock Volvo wheels, in  $\frac{1}{4}$  in. thickness. They are commonly used to gain additional needed brake caliper clearance when installing special alloy wheels. They also offer this kit in  $\frac{3}{16}$  in. and  $\frac{1}{8}$  in. thicknesses for a  $4\frac{1}{2}$  in. bolt

circle. (They can be installed on late model Volvos with a  $4\frac{1}{4}$  in. pattern, too, but the bolt holes will have to be deepened with a round file.)

Increasing tread makes the car more stable in corners, much the same way that you can increase your own stability by standing with your feet spread slightly farther apart than normal.

### Heavy-duty Suspension Components

Volvo Competition Service offers special heavy-duty suspension parts for high stress applications (Figure 6). These are available through your local Volvo dealer.

### Brake Linings

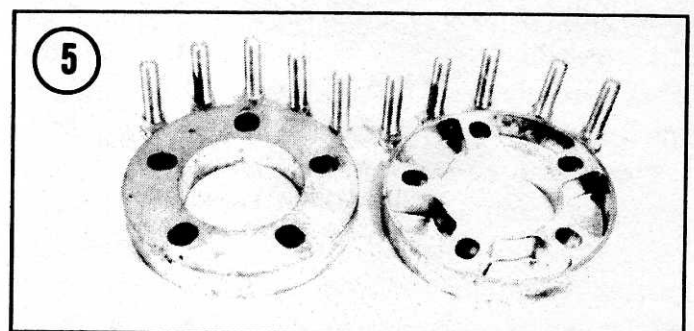
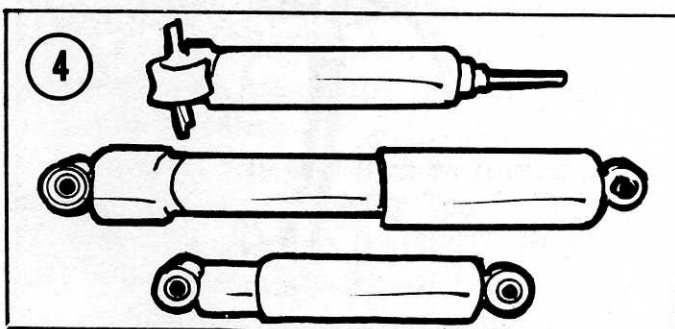
Repcos brake pads are available from Ipd as replacement units for the stock Volvo disc brake pads. See Figure 7. More consistent control during heavy braking, plus more resistance to brake fade and less brake dust, make these replacement units desirable. The Repco replacement units come in two grades: BMXA material, guaranteed not to squeal and to last up to 50% longer than stock Volvo pads; and BMXB material, for all-out racing applications.

Metallic disc brake pads are also offered by Ipd, for racing applications only. The hotter they get, the better they work.

**NOTE:** A high quality brake fluid is recommended for use with metallic disc brake pads, such as the new silicone fluids, Wagner racing fluid, etc.

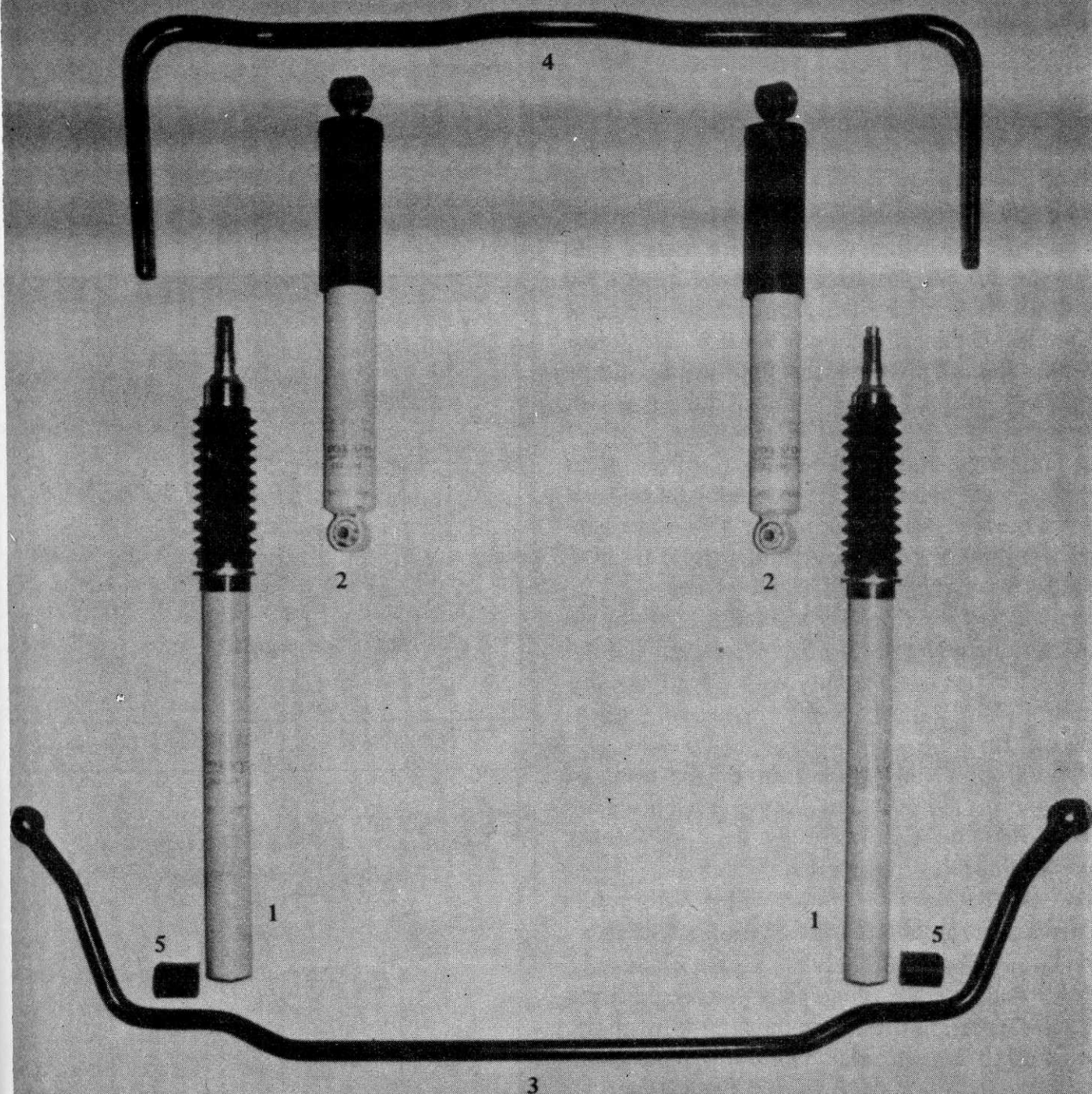
### CAUTION

Switching to silicone fluid requires that the brake system be completely drained and flushed. The system should also be completely rebuilt.





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1. Roadsport gas pressure front shock absorber
2. Roadsport gas pressure rear shock absorber

3. 21mm front sway bar
4. 25mm rear sway bar (does not fit 1977-1978 models)
5. Rubber bushing

## Wheels and Tires

Ultimately, the tires must sustain any cornering or acceleration forces. In fact, nearly all handling difficulties and peculiarities can be traced to the characteristics of tires. If the tires are inadequate, you can't possibly benefit fully from other suspension or engine improvements.

Two of the most important characteristics of a tire are its coefficient of friction and slip angles. Coefficient of friction describes the ability of a tire to resist sliding when subjected to a force. Most automobile tires have a coefficient of 1. In other words, a tire loaded with 500 pounds can sustain a resultant force of 500 pounds. If loaded with 1,000 pounds, the same tire can sustain 1,000 pounds force. This maximum force a tire can sustain without sliding may be described as the "limit of adhesion" for that tire.

To prevent sliding, the resultant of all forces acting on a tire must be less than the limit of friction. The forces acting on a tire are centrifugal force; side (cornering) forces; traction forces (rear wheels); and braking forces.

In order for a tire to be steered, i.e., maintain a desired course, it must be rolling, not sliding. A sliding tire has absolutely no directional discretion. It will slide sideways just as willingly as forward.

Friction is only important at the limit of adhesion. Obviously, at that point it assumes overwhelming importance as the tire "breaks loose." But tire friction does not explain any of the handling characteristics of an automobile *below* the limit of adhesion of the tires.

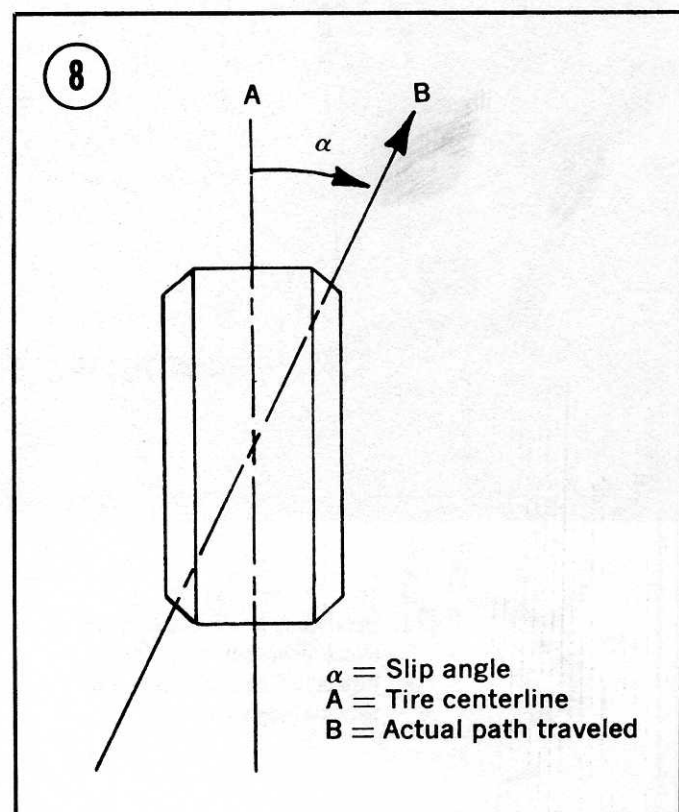
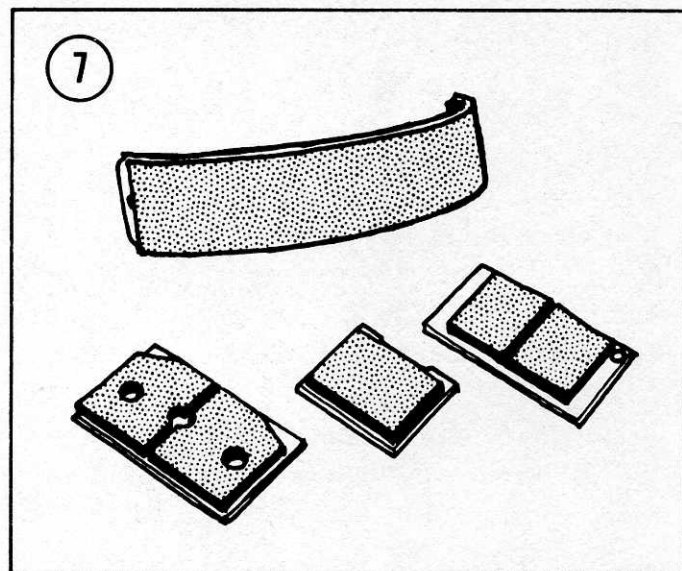
To explain handling behavior such as understeer and oversteer, we must understand another important tire characteristic — slip angle.

A rolling tire normally follows a path in line with the direction of the tread. But if the tire is subjected to a side force, e.g., during cornering, the tire deflects and its path diverges from the path in line with the tread. The tire actually travels in a direction at an angle to the direction the tire points. This angle is called a "slip angle." See **Figure 8**.

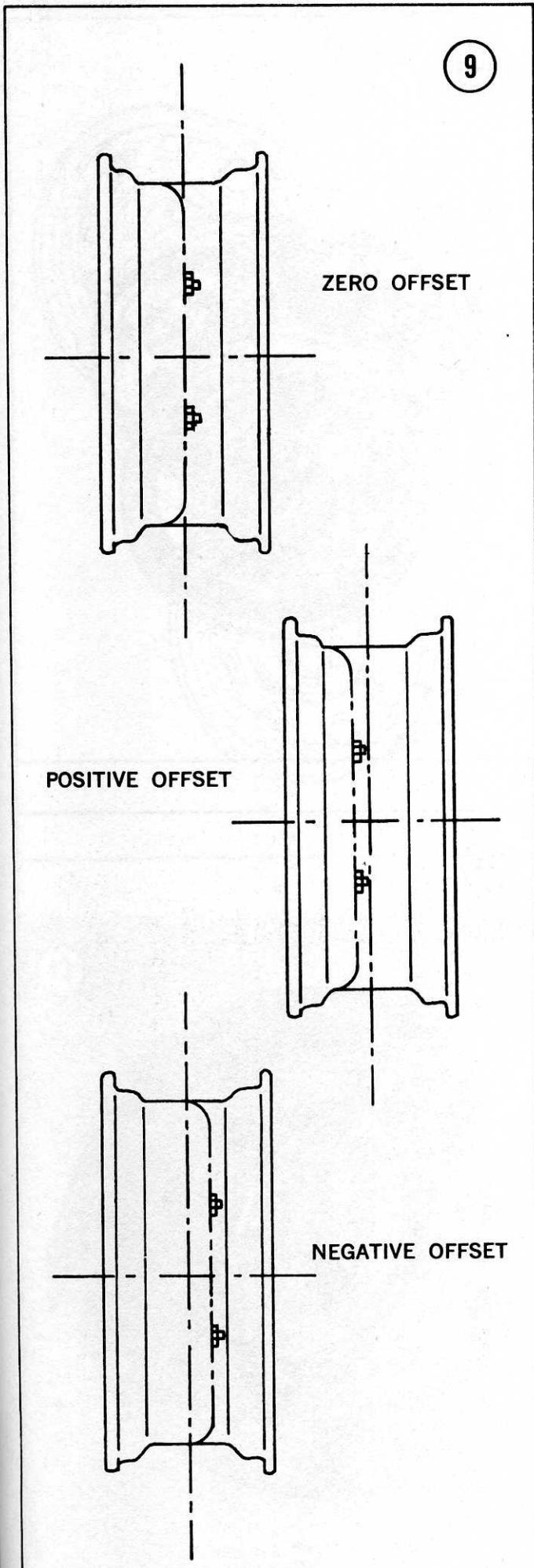
Slip angle is one of those unfortunately misleading terms we are stuck with. It does not mean the tire is sliding. The tire does not have to be anywhere near its limit of adhesion to

operate at a slip angle. Slip angle causes the familiar effects of understeer, oversteer, and neutral steering.

Oversteer occurs when the slip angle at the rear tires changes more than at the front tires. This steers the car into a smaller circle than intended and increases centrifugal force. Increased centrifugal force in turn causes the tires to operate at even higher slip angles making the car steer into an even smaller circle, and so on. It is a vicious cycle which could continue until the car becomes entirely uncontrollable, even in the hands of a skilled driver.







Understeer occurs when the slip angle at the front tires changes more than at the rear. The car steers into a larger circle than intended, reducing centrifugal force. This decreases the tire slip angle and further increases the circle, thereby decreasing centrifugal force, and so on. The car automatically seeks a turning circle which balances tire forces with no correction from the driver.

Understeer may seem more desirable than oversteer, but if the equilibrium turning circle is larger than the curvature of the road, the driver may helplessly watch his car head for the bushes.

Neutral steer means that slip angles change at the front and rear at the same rate. The vehicle tends to follow the curvature of the road without a tendency to increase or decrease the turning circle.

Slip angle is not fixed for any tire. Factors that change it are centrifugal force; wind gusts; road plane (level, banked); wheel plane (camber, toe, deflection); and vertical forces (acceleration, braking, lateral weight transfers).

Since the slip angle at which a tire operates is constantly changing, there is no such thing as a "state of understeer," for example. A car which understeers under one set of circumstances may oversteer under another set. Neutral steer is simply the transition between over- and understeer; it is not a condition which can be set up and maintained by chassis tuning.

The fantastic variety of tires available makes recommendations nearly impossible. Semperit, Veith, Michelin, Goodyear, Pirelli, and Goodrich all produce good radial tires for the Volvo. These tires, in a 185/70 x 15 in. or 14 in. size, and mounted on any wheel that is up to 6 in. wide with a negative offset of  $\frac{1}{2}$  in. or more, will work nicely, and will fit into any Volvo fender well with no problems.

NOTE: *Wheels have varying amounts of offset (refer to Figure 9). If the mounting surface of the wheel is at its centerline, it has no offset. If the rim is moved out (positive offset), the track is wider; if the rim is moved in (negative offset), the track is narrower. Too much offset (particularly positive offset) can cause interference between tire and fender.*

Careful screening of the many “mag-type” wheels that are available on the market will reveal that some are suited to the Volvo 240 series cars, even if they are not advertised as such. Be sure that you try the wheels for fit before you purchase them.

#### CAUTION

*Aluminum or magnesium cast wheels are quite brittle and should be handled with care during tire changes. They will chip easily if improperly handled.*

Your Volvo dealer can supply you with aluminum GT wheels in 15 x 5½ in. size (**Figure 10**), and Ipd offers “100+” aluminum alloy wheels in 14 x 6 in. and 15 x 6 in. sizes (**Figure 11**); snow tire or replacement wheels in 14 x 5½ in., 15 x 5 in., and 15 x 5½ in. widths (**Figure 12**); and rally wheels in 14 x 6 in., 14 x 7 in., 15 x 6 in., and 15 x 7 in. sizes (**Figure 13**).

### STAGE 1 ENGINE MODIFICATIONS

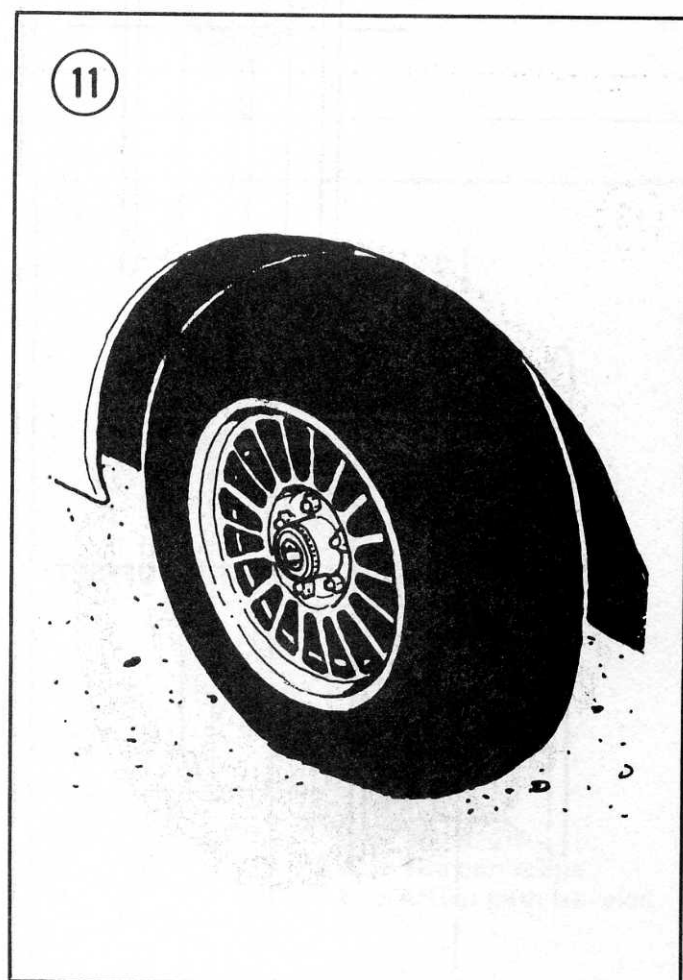
Engine modifications should be carried out in a logical sequence in order to extract the most benefit from each component. The recommended modifications are given in stages, starting with components which we feel will be most beneficial to your engine without spending an enormous amount of money, and which will let your engine live longer in addition to delivering additional horsepower.

Stage 1 modifications include the addition of a more efficient header/exhaust system, a flexible fan for the cooling system, and improvements in the ignition system.

#### Ignition System

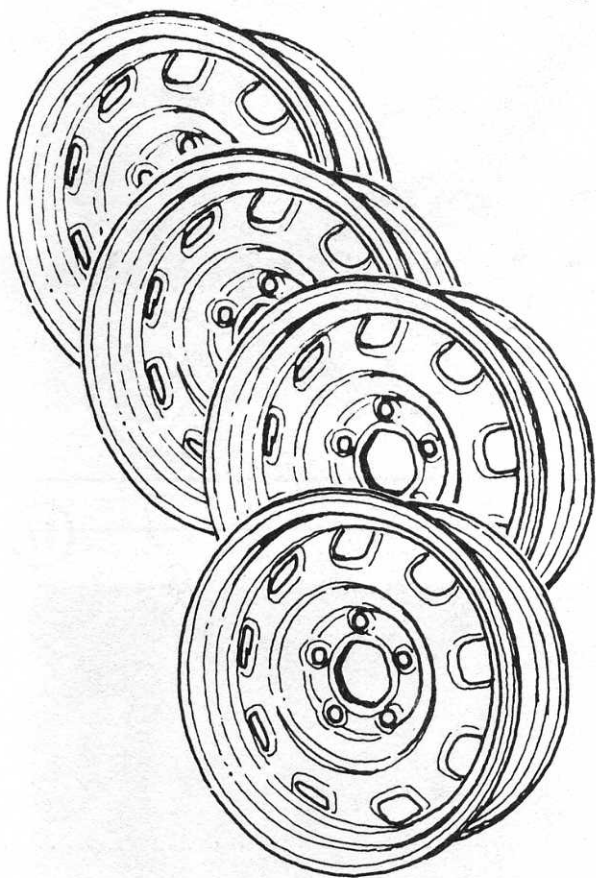
If your Volvo has a breaker point ignition system you should install an aftermarket electronic system (Mallory, Allison, etc.). A stock electronic system should be left unmodified.

It is a good idea to replace your stock spark plug wires with high-energy capacity, high-performance spark plug wires such as the Thunder-volt “Fire Wire,” offered by Auto World (see





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**Table 1).** This metallic wire is made up of 19 strands of silver-plated copper (finished size is 16 ga., 7mm in diameter), and covered with special silicone rubber that is immune to ozone, corona, moisture, corrosion, cracking, and hardening. The rubber is self-extinguishing and resists extreme heat and cold (+600°F to -100°F with a temperature rating of 550°F).

With this type of electronic ignition and high-performance ignition wire setup, plus spark plugs which are properly gapped and cleaned, your ignition system will deliver the kind of performance you want, with very little maintenance.

### Exhaust System

Replacing the stock exhaust system with an efficient header and complete free-flow exhaust system will probably do more for your engine than nearly any other single high-performance item. "Back pressure" (the accumulation of exhaust gas in the exhaust system which has not found its way out of the engine from the previous exhaust stroke at the time the intake stroke takes place) can rob an engine of 15-20% of its horsepower. By simply providing a smooth, uninterrupted path for this exhaust gas to be expelled from the engine, the maximum fresh charge of air and fuel can be drawn into the cylinders, providing all of the horsepower that your engine was designed for.

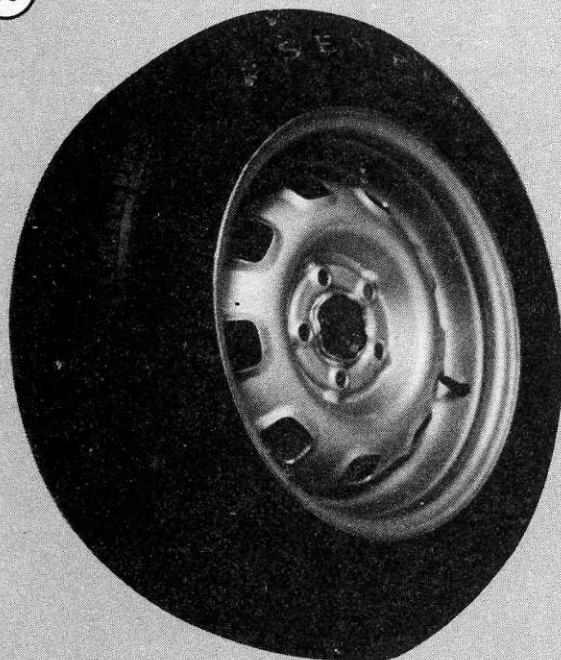
*NOTE: As incredible as it seems, the addition of a more efficient exhaust system is occasionally against the law, due to Federal smog regulations. Check the laws in your state to see if they apply.*

Volvo Competition Service offers an extractor exhaust manifold (**Figure 14**) and a complete rally exhaust system (**Figure 15**). Ipd offers the following: a 4-into-1 exhaust header (**Figure 16**); big bore exhaust kit (**Figure 17**); and a special manifold stud and nut assortment (**Figure 18**).

### Flexible Fan

Ipd offers a lightweight cooling fan with blades made of stainless steel, which flex and

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straighten out at higher rpm, thus reducing power loss from drag (Figure 19).

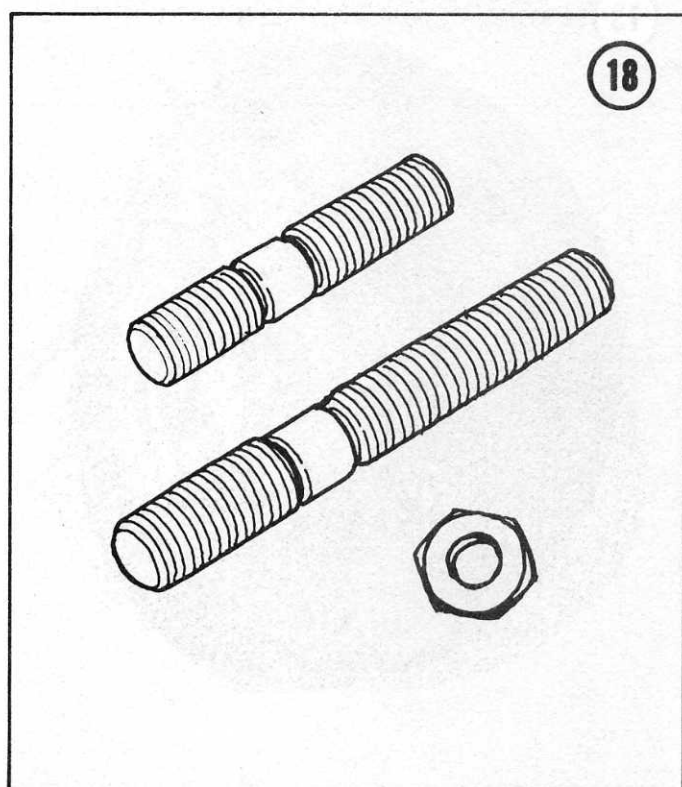
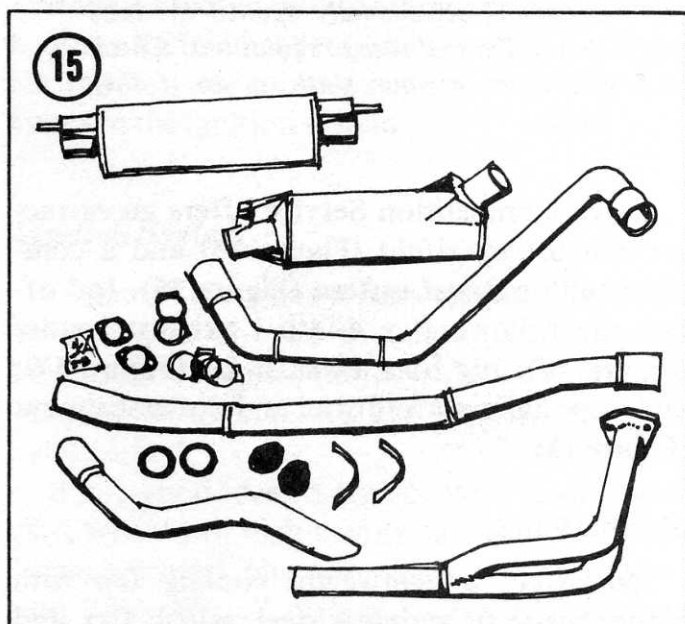
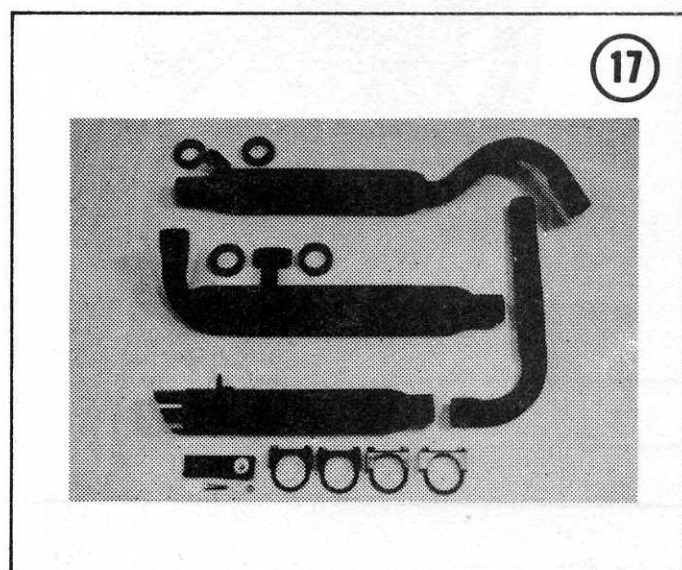
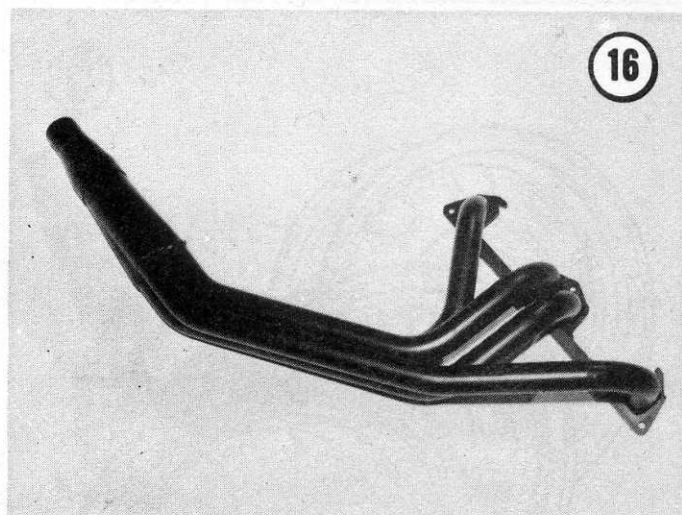
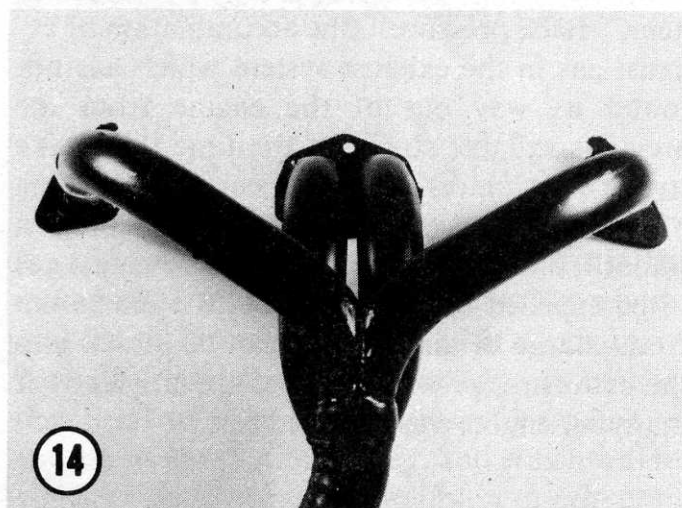
## STAGE 2 ENGINE MODIFICATIONS

Stage 2 modifications include all Stage 1 modifications, plus the addition of an oil cooler; lightweight flywheel; and heavy-duty clutch.

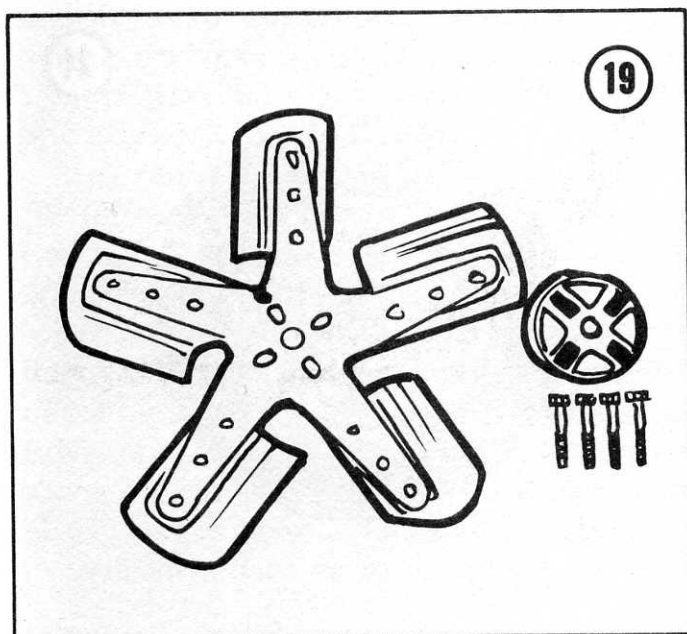
### Oil Cooler

In the interest of making your engine live as long as possible while putting out all of the horsepower you require, it is a good idea to install an engine oil cooler.

Accessory oil coolers are bolt-on items, easily installed. These multi-finned alloy coolers keep the oil from reaching extreme temperatures







which can eventually destroy an engine (**Figure 20**, Ipd model illustrated).

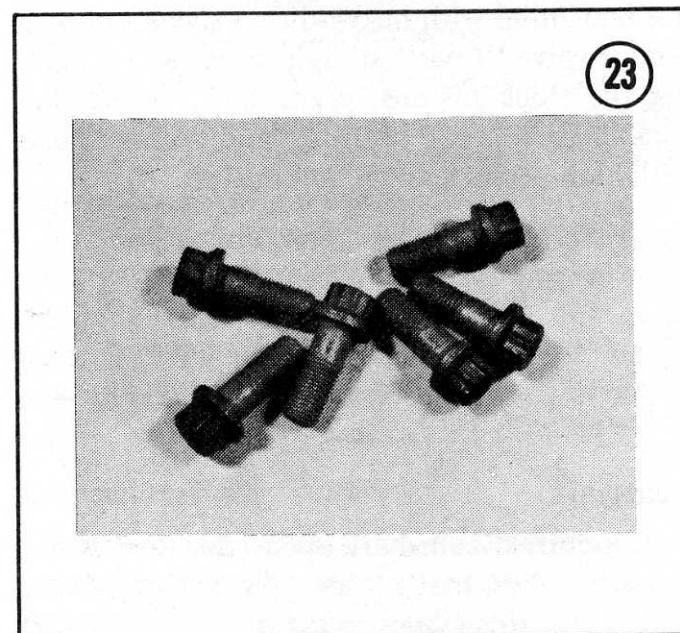
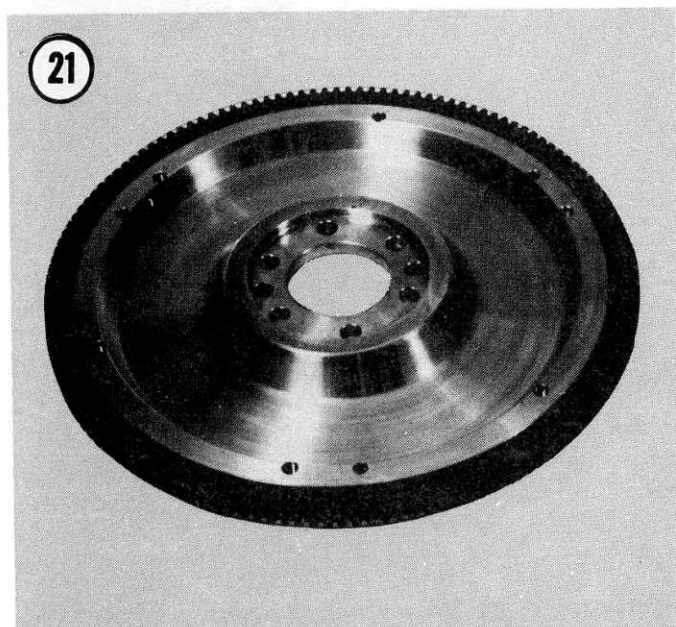
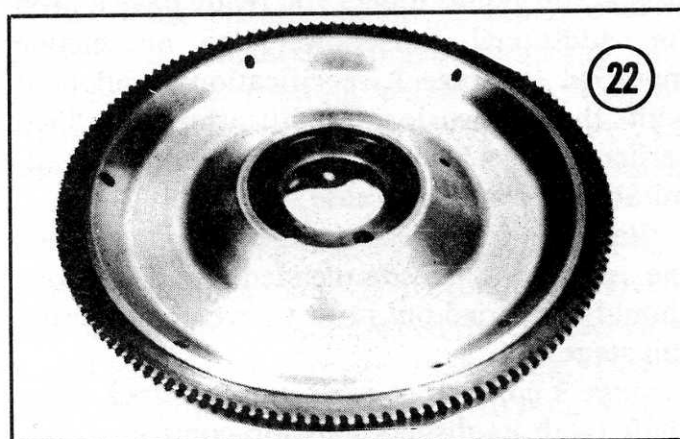
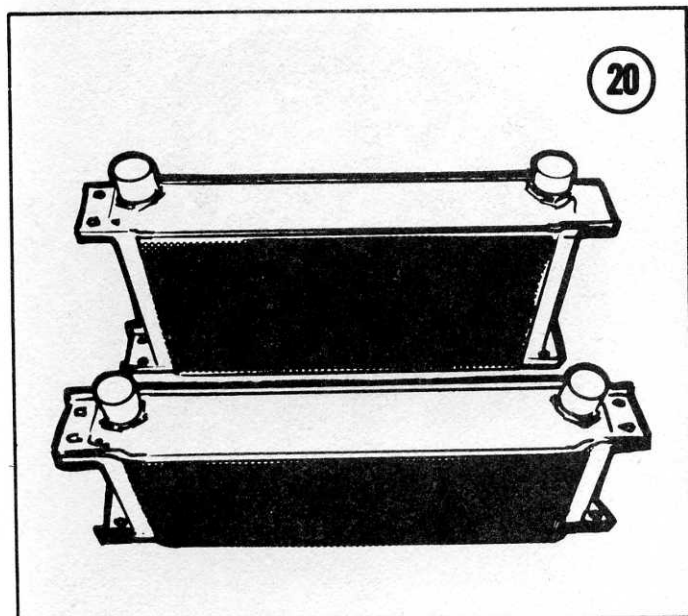
### Flywheel

The stock flywheel is quite heavy. By replacing it with a lightweight flywheel the engine reaches its maximum rpm much faster due to the reduction of flywheel mass. Also, the engine returns to idle very quickly when you let up on the gas, as there is no heavy flywheel that wants to keep on rotating.

These high-performance flywheels are also dynamically balanced to reduce vibrations at high speed.

Replacing the stock, heavy flywheel with a lightened one will result in an immediate gain in acceleration.

Ipd offers an 8-lb. aluminum flywheel (**Figure 21**), and a stock, lightened flywheel weighing in at 16-17 lbs. (**Figure 22**). Special flywheel bolts are available too (**Figure 23**).



## Clutch

Most stock clutches are not capable of handling increased horsepower without slipping. Before you really dig into the engine's internal parts (as in Stage 3), it is wise to replace the stock clutch with a heavy-duty, balanced clutch.

A special reinforced clutch and disc are offered for rally use by Volvo Competition Service (**Figure 24**). Ipd offers a heavy-duty clutch cover (**Figure 25**); a super clutch cover for racing or extra heavy-duty street use (**Figure 26**); and a heavy-duty clutch disc (**Figure 27**).

### STAGE 3 ENGINE MODIFICATIONS

The modifications which you have performed in Stages 1 and 2 provide a healthy, much-quicker-than-stock engine which is still very much understressed. Quite likely you can stop at this point, unless you really have a need for additional horsepower, as an engine modified to Stage 2 specifications, and used with the suspension modifications outlined earlier, will get your car over the road with admirable quickness and ease.

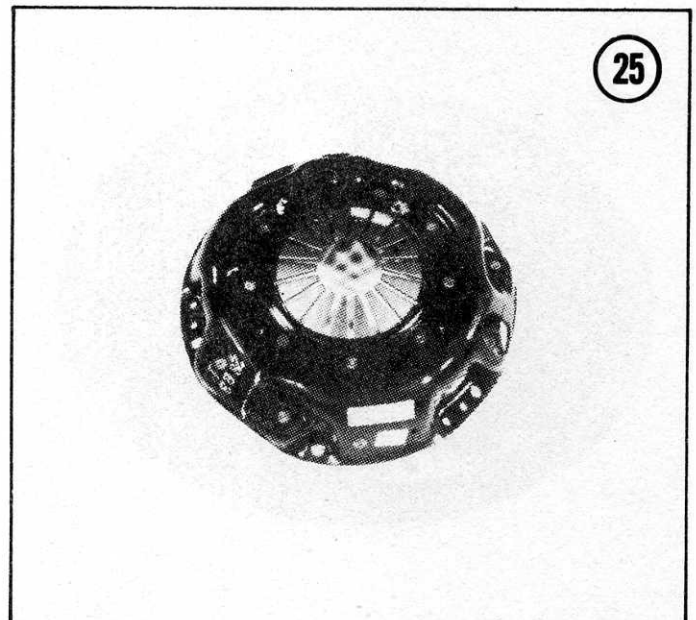
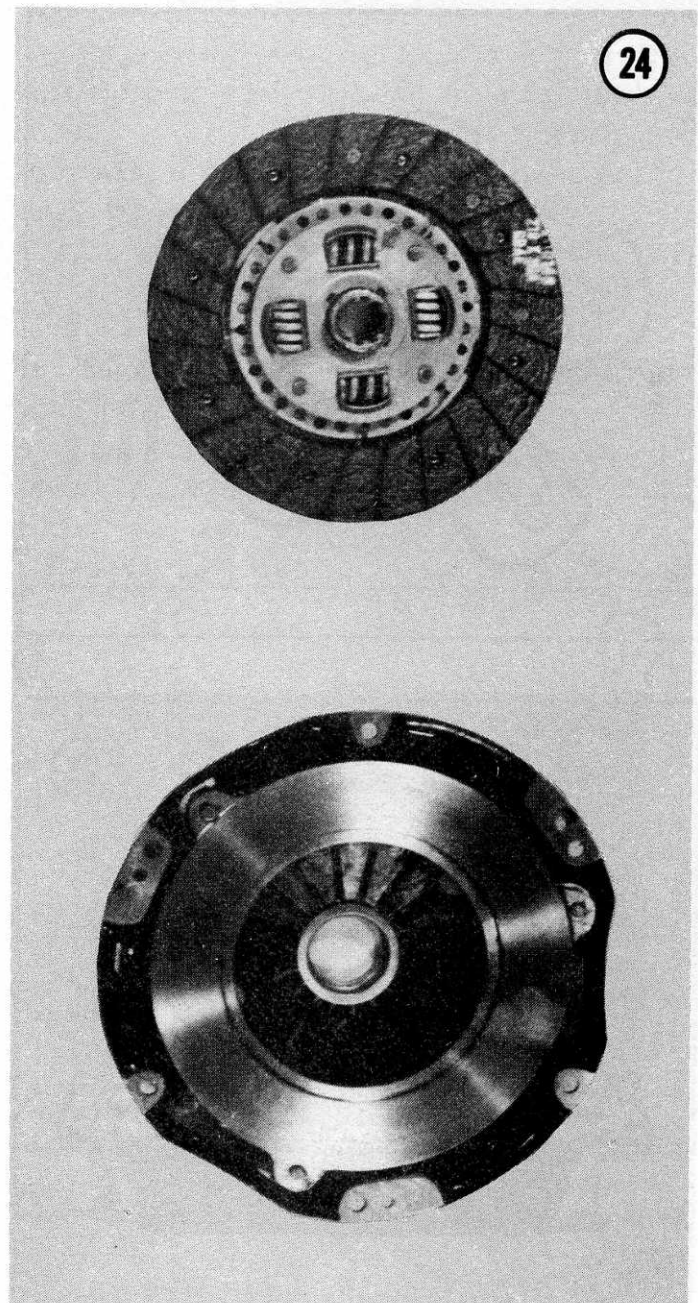
Stage 3 is for serious enthusiasts only. All of the previously recommended modifications should be carried out prior to even considering this stage.

Stage 3 consists of replacing the stock camshaft (with its dismal emission-controlled timing) with a camshaft modified for street or rally use and fitted with heavy-duty valve springs to reduce valve "float" at high speed; and replacing the stock pistons, crankshaft, connecting rods, main and rod bearings, and cylinder head with high-performance components.

*NOTE: Engine modifications, as mentioned earlier, are sometimes in conflict with Federal and/or state emission laws. Check with your local authorities before performing any of these modifications.*

## Camshaft

A modified camshaft opens the intake and exhaust valves earlier than a stock camshaft, and closes them later. This allows more fuel





and air to enter the cylinder, because the intake valve is held open longer, and more exhaust gas to clear the cylinder because the exhaust valve is also held open longer.

Steel camshafts, which will retain their profile for years, are recommended over cast iron camshafts, which wear quite quickly. Use a grind recommended for street or rally use.

Replace the stock valve springs with heavy-duty valve springs. Valves tend to "float" off of their seats at high engine rpm, because stock valve springs are not strong enough to snap the valves back down onto their valve seats completely before the rotating camshaft lobes start to push them back up to open them again on

the next cycle. This steals horsepower, as the cylinder is not completely sealed during its power stroke. Stiffer valve springs seat the valves immediately, even at high rpm.

**Figure 28** shows the camshaft and valve components available from Volvo Competition Service. Ipd offers the following accessories: A special cam available in a wide application range (not illustrated); lightweight pushrod and lifter kit (**Figure 29**); racing pushrods (**Figure 30**); heavy-duty valve springs (**Figure 31**); alloy valve retainers in aluminum and titanium (**Figure 32**); special valves in 35mm, 42mm, and 44mm sizes (**Figure 33**); racing valves, keepers, and retainers (**Figure 34**); lightweight valve adjusting nuts (**Figure 35**); hardened head bolt washers (**Figure 36**); bronze valve guides (**Figure 37**); and precision camshaft bearings. See **Figure 38**.

### Pistons

The stock pistons should be replaced with lightweight, balanced, forged aluminum pistons to reduce rotating weight. This will increase engine rpm and result in more power. In addition, these pistons are stronger than stock ones.

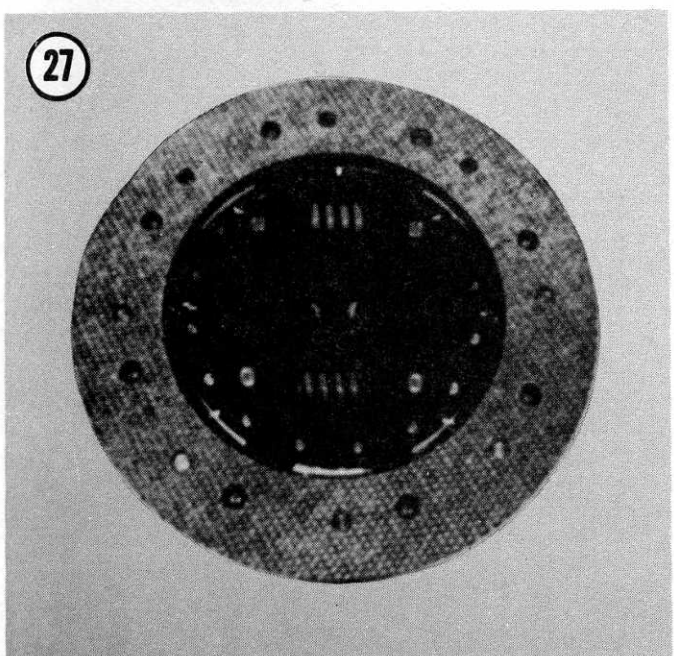
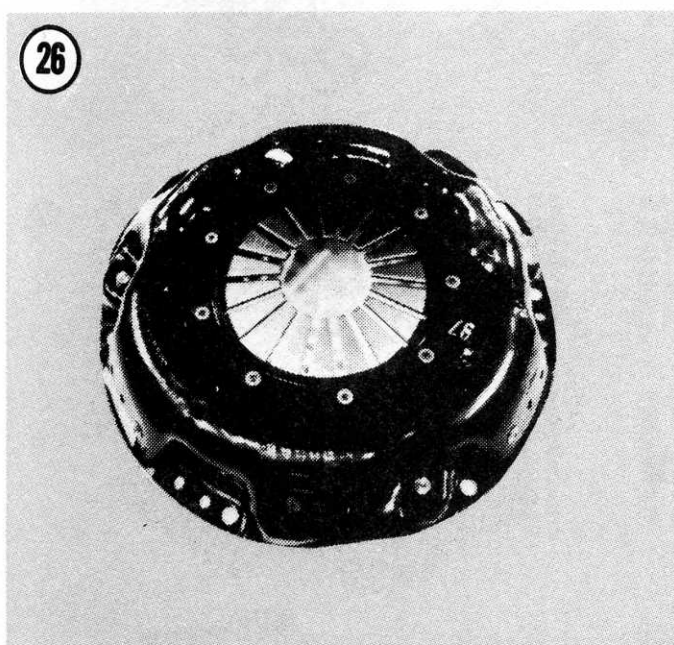
Lightweight, high-performance pistons are available in stock and oversize diameters. Oversize pistons must be used when the cylinders are bored to a larger diameter than stock. This is done when the cylinder is worn to a point where engine performance is affected. It is also done simply to increase the cubic displacement of the engine to produce more horsepower.

**Figure 39** shows Volvo Competition Service's piston lineup, available in standard and 0.030 in. oversize, in forged aluminum, complete with piston rings, circlips, and wrist pins.

Ipd offers the following piston lineup: **Figure 40**, "Mahle" pistons; **Figure 41**, forged alloy racing pistons (not recommended for street use); and **Figure 42**, a 2200cc piston kit to enlarge your B20F engine.

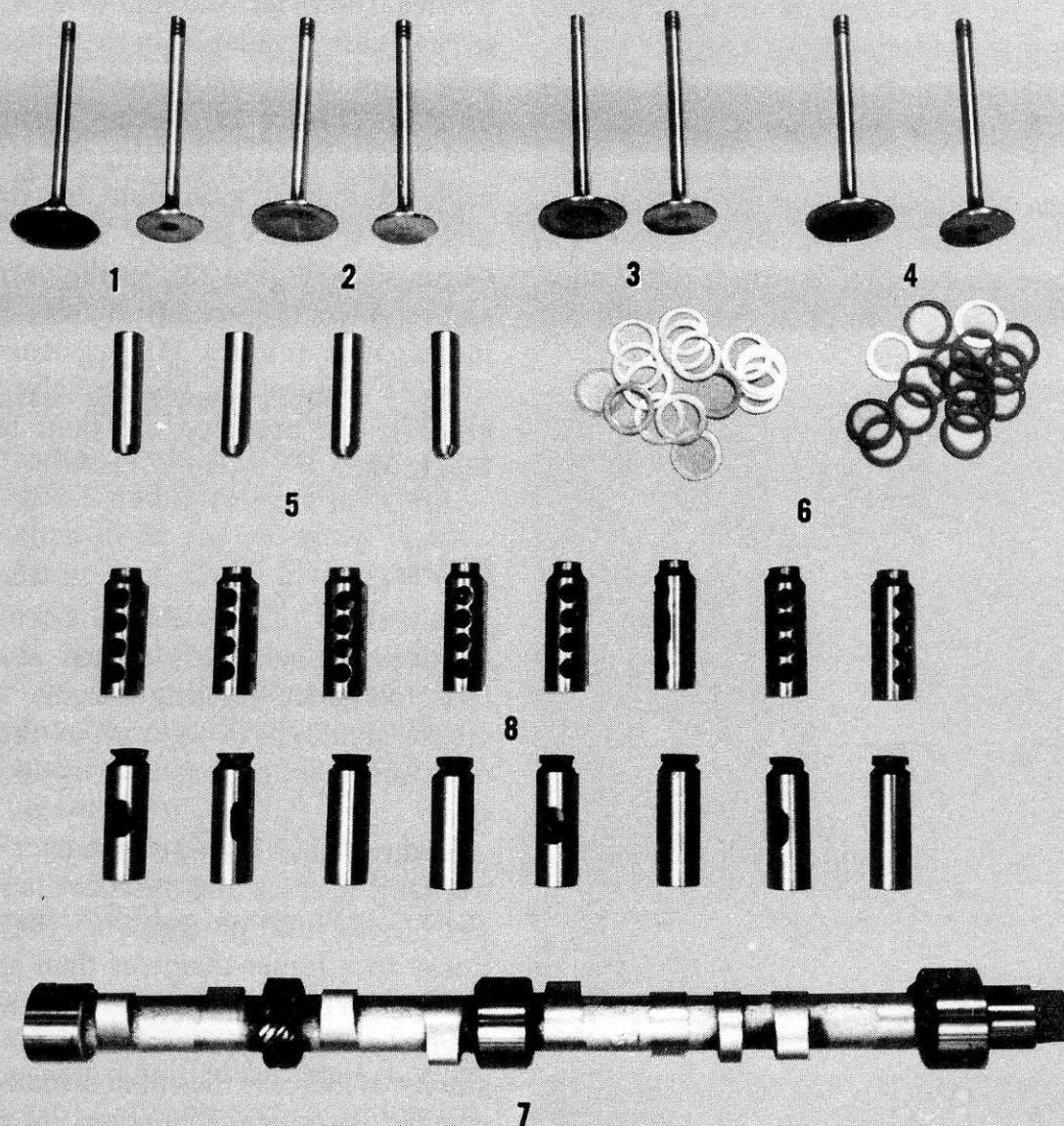
### Connecting Rods

Balance and polish stock connecting rods at the same time you have crankshaft assembly balanced (see *Crankshaft*, following).





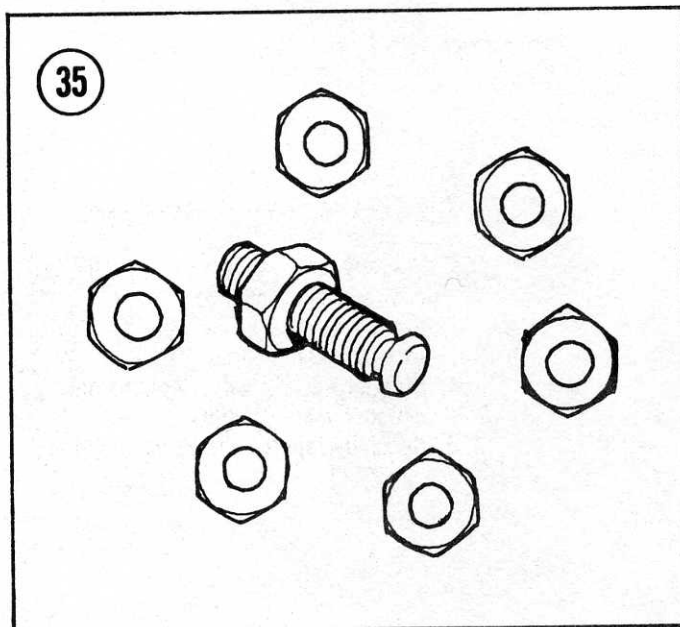
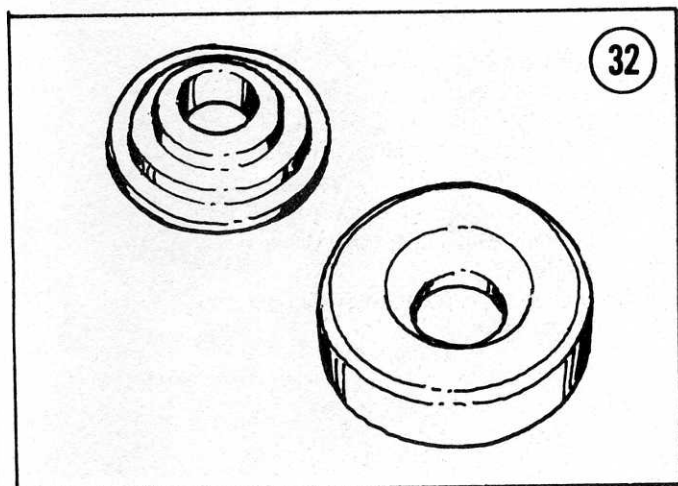
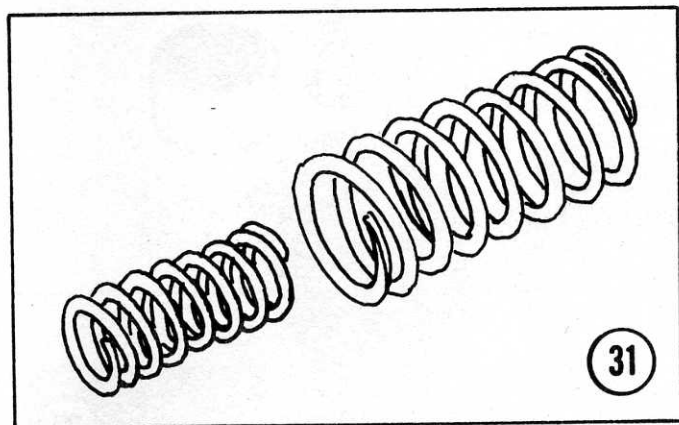
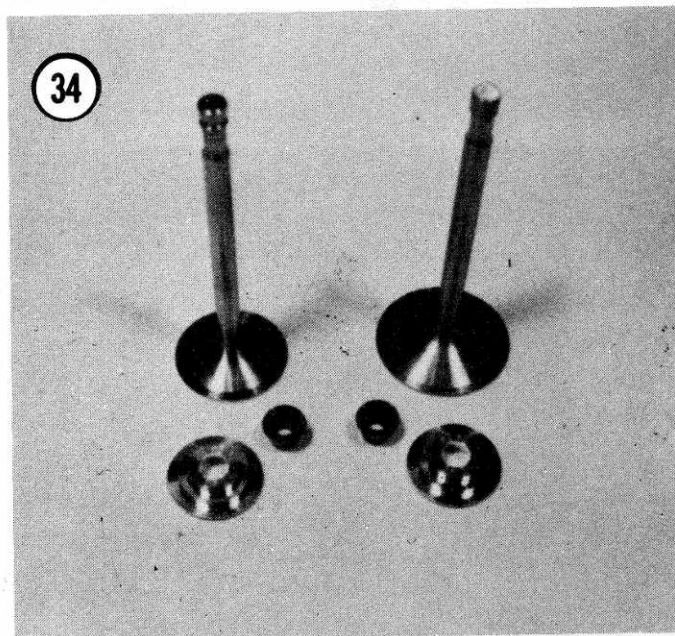
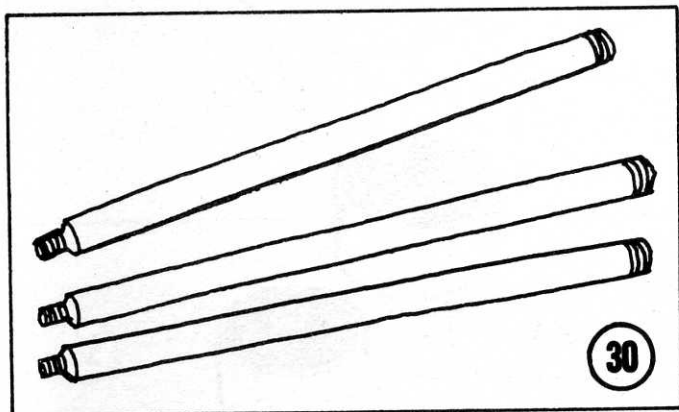
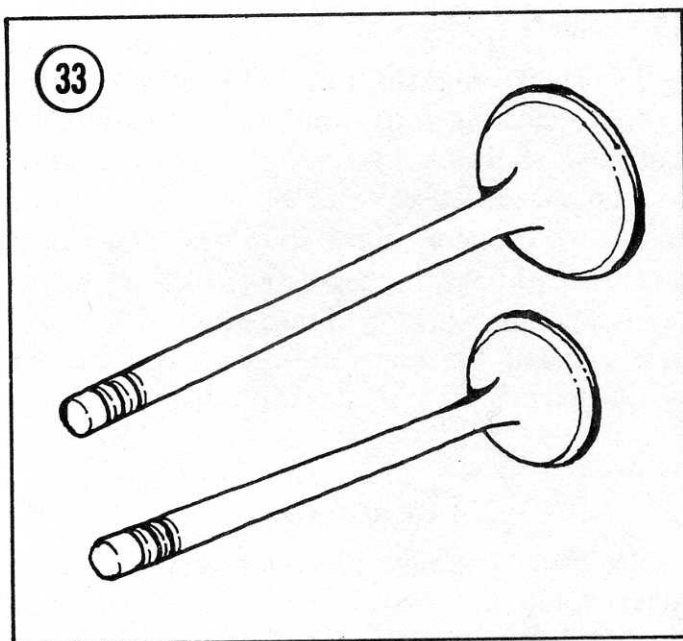
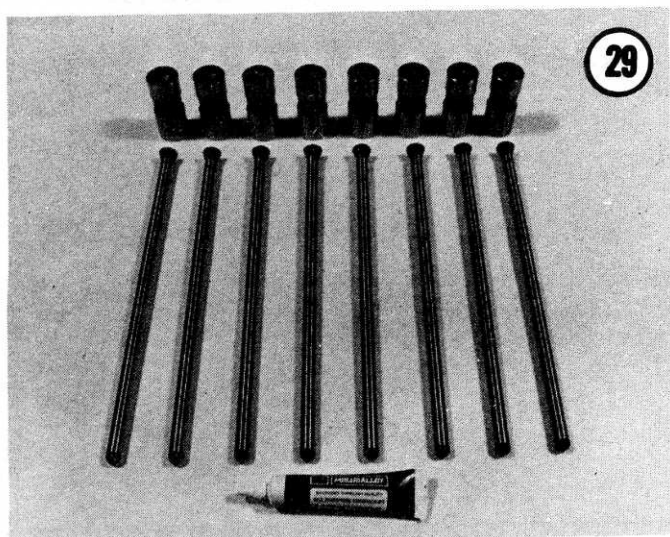
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1. Stage I intake valve (44mm) and exhaust valve (35mm)
2. Stage II intake valve (44mm) and exhaust valve (35mm)
3. Stage III intake valve (45mm) and exhaust valve (38mm)
4. Standard intake valve (45mm) and exhaust valve (38mm)
5. Specially tapered intake valve guide

6. Shim set for B20 valve springs
7. Camshaft available in following styles: camshaft D (0.410 in. lift, 280° duration); camshaft F (0.425 in. lift, 300° duration); camshaft G (0.457 in. lift, 308° duration); and full-race cam (no specifications available)
8. Lightened, hardened valve lifters



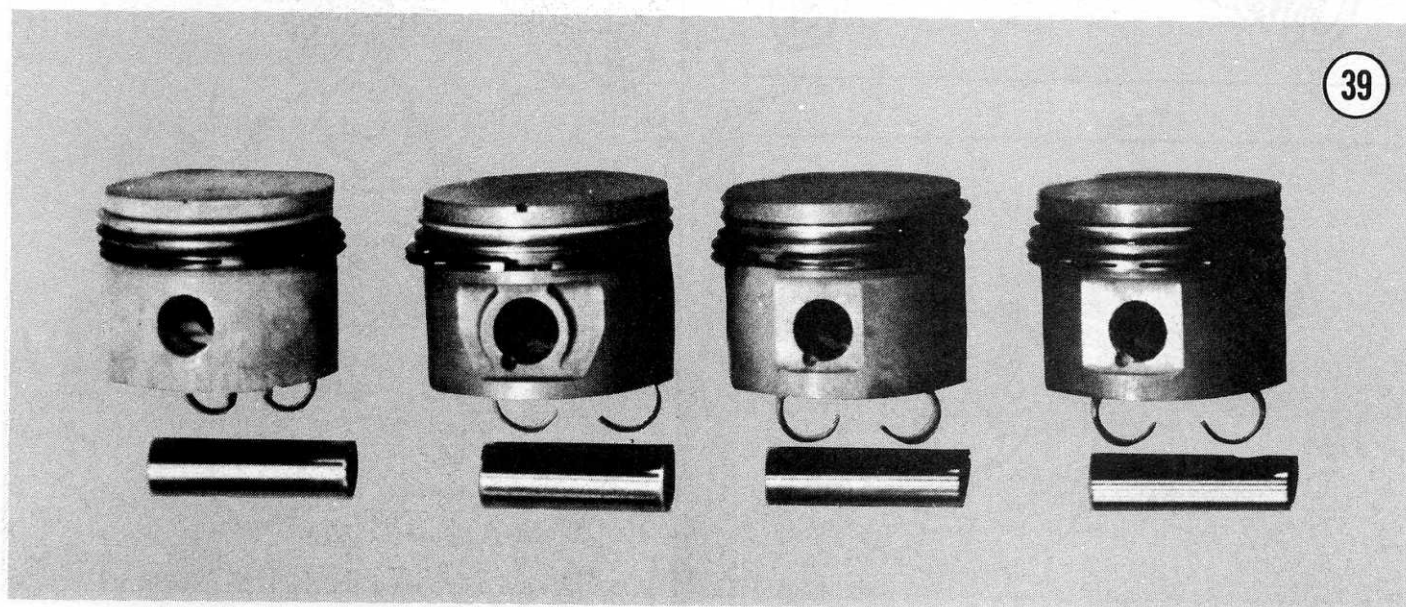
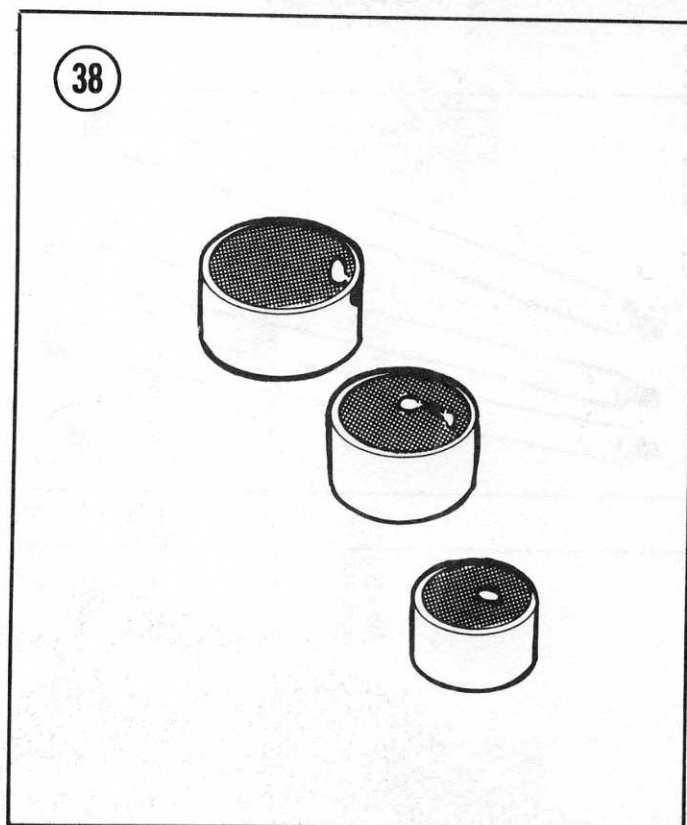
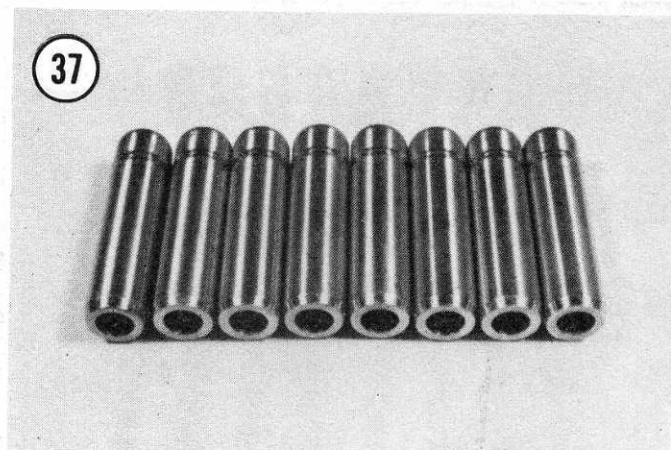
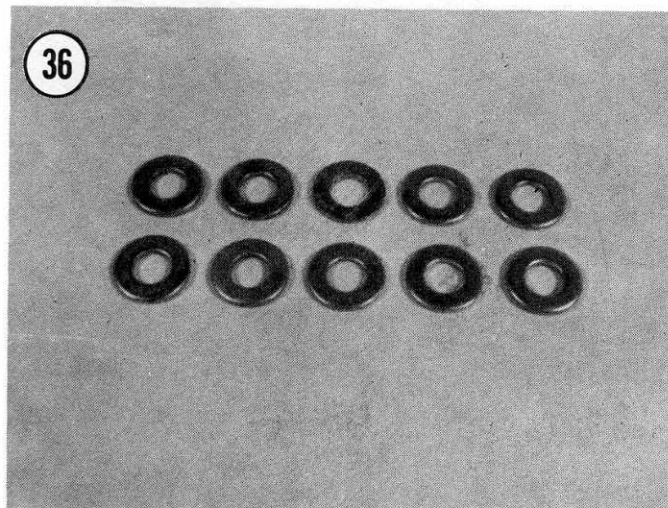


## Crankshaft

The stock crankshaft assembly (crank, bearings, connecting rods, and pistons) should be polished, shot peened (for additional strength), and balanced. Check the Yellow Pages of your telephone directory for a shop near you which specializes in engine balancing. Be sure to inspect and measure all dimensions with a micrometer and make any repairs necessary (such as journal grinding, etc.) prior to balancing.

## BEARINGS

Heavy-duty main and connecting rod bearings should be used whenever the engine is modified for more performance. Vandervell bearings are widely used in high-performance engines. Ipd offers these bearings (**Figure 43**) in their catalog.

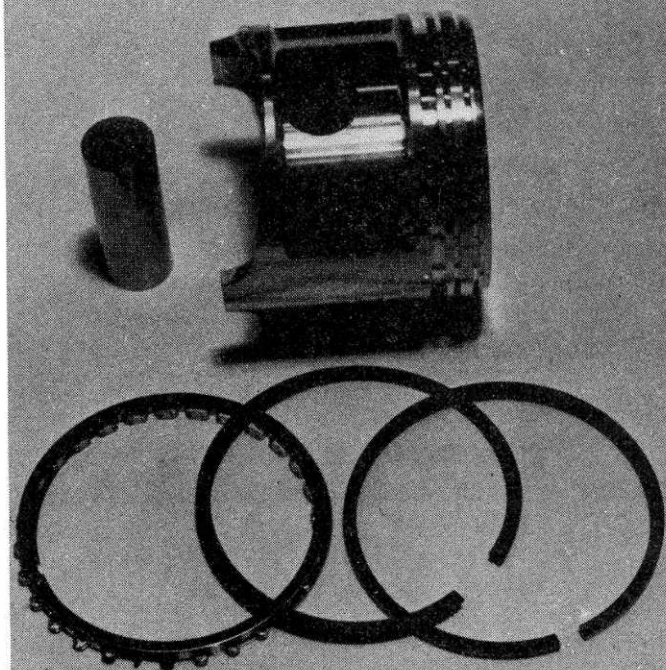




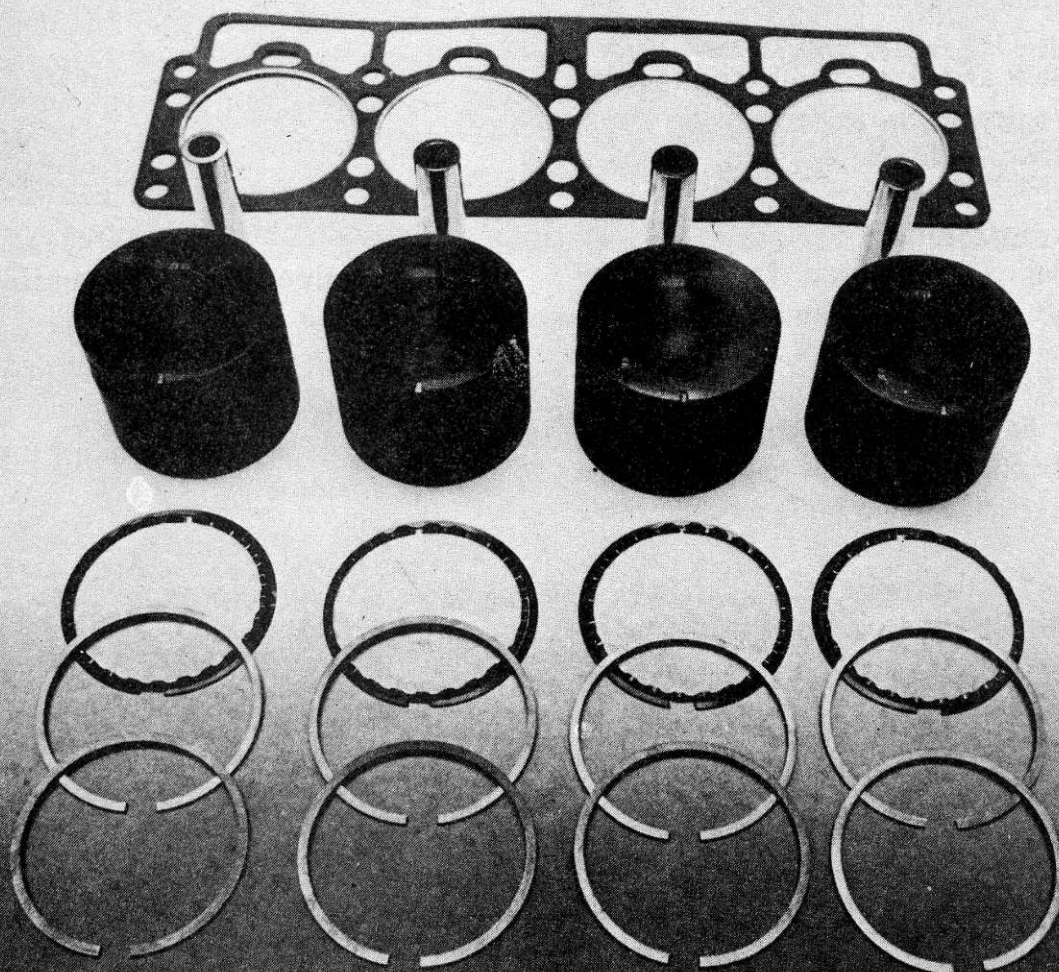
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## Cylinder Heads

Special cylinder heads increase horsepower due to larger intake and exhaust valves, polished and ported intake and exhaust ports, and "cc'ed" and polished combustion chambers.

*NOTE: "Cc'ed" means that the combustion chambers have been contoured so that each one has exactly the same capacity. This is done so that the shape of each combustion chamber is as close to identical as possible, which will result in increased horsepower.*

The use of oversize valves in any cylinder head (even a stock one, reworked to accept these valves), will result in more horsepower.

*NOTE: Always use the heavy-duty valve springs recommended earlier under Camshaft, when installing oversize valves, in order to realize the full potential of these valves.*

**Figure 44** illustrates Volvo Comptetion Service's cylinder head available with 44mm intake and 35mm exhaust valves (10.5:1 compression ratio); 44mm intake and 35mm exhaust valves, ported, polished and cc'ed combustion chambers (11.7:1 compression ratio); or with 45mm intake and 38mm exhaust valves, and ported, polished and cc'ed combustion chambers (11.7:1 compression ratio).

Ipd's special cylinder head for the B20F engine is shown in **Figure 45**, and is available in a wide range of street, autocross, and racing applications, or to the customer's request.

When you have modified your engine to Stage 3 specifications, you will have an engine which is truly efficient, and quite a remarkable performer.

There is yet another way to increase horsepower, and that is discussed in the following section.

## TURBOCHARGING

Turbocharging is an alternative to Stage 3, as outlined in the previous section. The modifications recommended in Stages 1 and 2 should still be carried out. Stage 3 modifications can be carried out also, providing that the compression ratio is kept down to that recommended by

the individual turbocharger manufacturers for their kits. (High compression ratios are definitely not compatible with turbocharging for street use.)

## Turbocharger Theory

The easiest way to obtain a large increase in horsepower is by turbocharging your engine. High-lift cams, high-compression heads, and tuned exhaust systems can't compare to simply forcing more air/fuel mixture into the cylinders with a properly designed turbocharger system. Furthermore, if properly maintained, a turbocharged engine seems to live approximately as long as a normally aspirated one.

The stock Volvo engine is a naturally-aspirated, 4-cycle, spark-ignition engine. Anyone reading this manual should be familiar enough with the basic operation of this type engine. On the intake stroke, the descending piston draws an air/fuel charge through the intake valve.

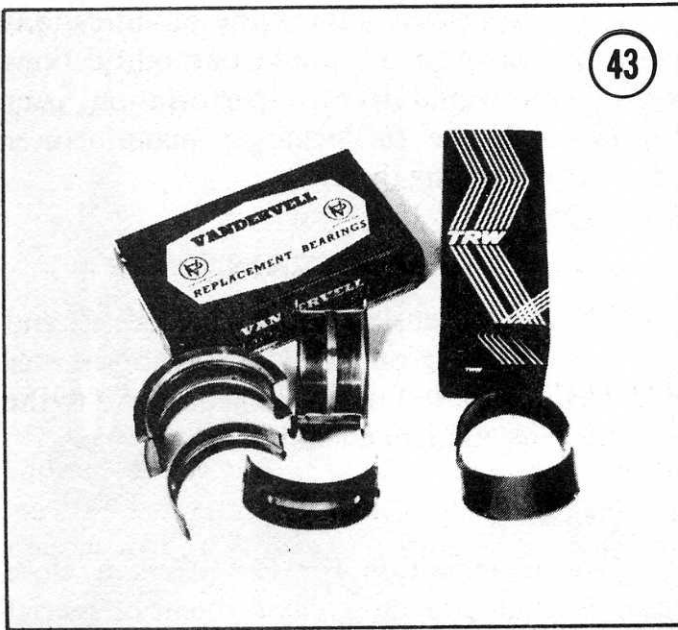
Theoretically, the volume of the incoming air/fuel charge should equal the volume of the cylinder at full throttle. In actual fact, this is impossible to achieve. The incoming charge volume is less than the cylinder volume. The reasons are:

- Small, but unavoidable pressure drop through the fuel induction system
- Restrictions in intake manifold ports and valves
- Incomplete exhaust of burned gases from previous cycle
- Exhaust valve and exhaust manifold port restrictions.

The ratio between induced air/fuel volume (at 60°F and 14.7 psi) and calculated cylinder volume (piston area x stroke) is usually expressed as a percentage and is called "volumetric efficiency." If the induced charge equals the cylinder volume, the volumetric efficiency is 100%; most engines have a volumetric efficiency of about 80%.

In order to increase power from an engine, all we have to do is get more air/fuel charge into the cylinder. One method is to design very low restriction intake and exhaust systems. This explains how some exotic racing engines with

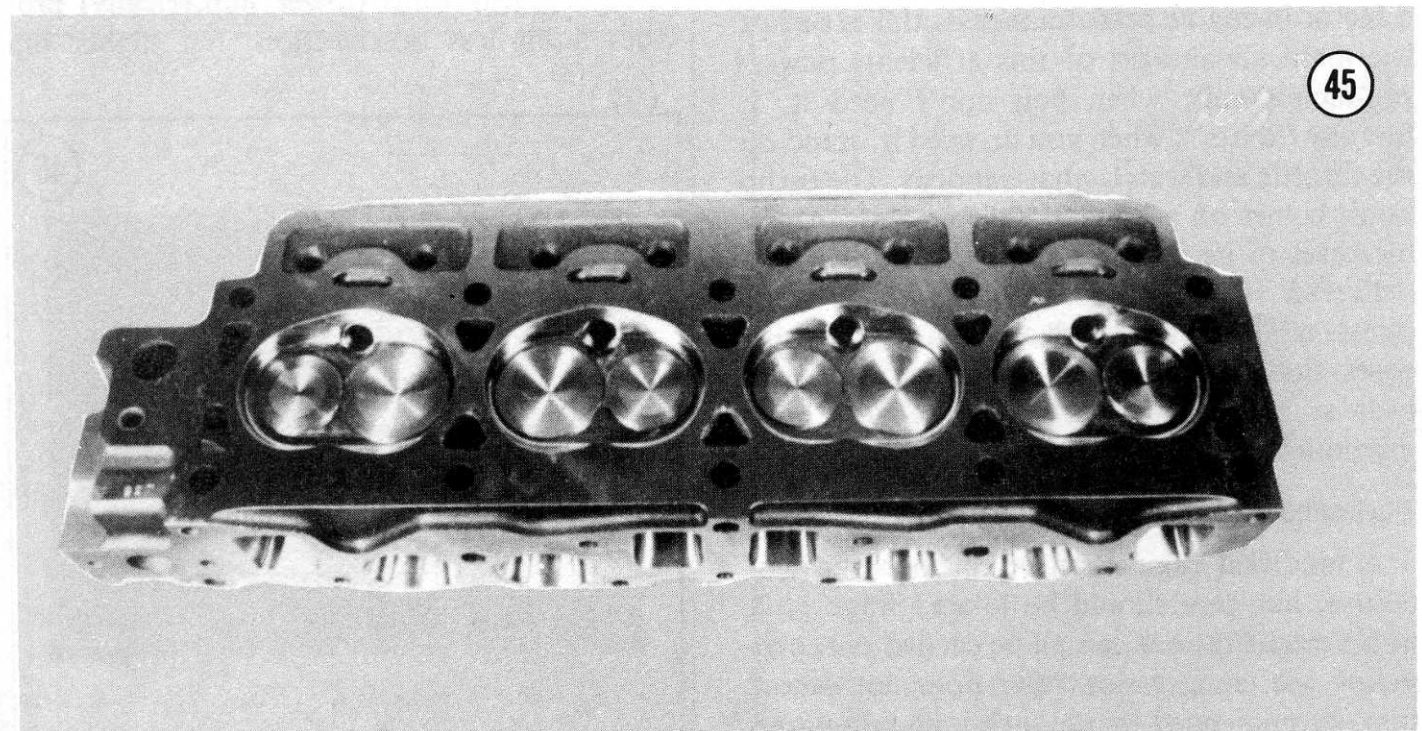
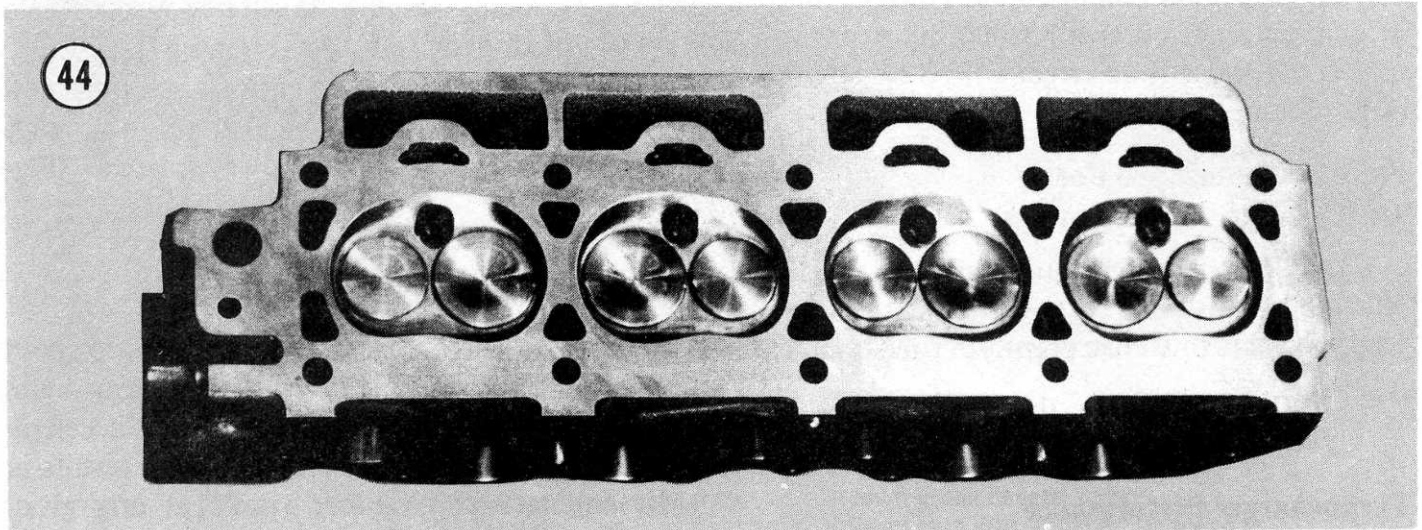




tuned intake and exhaust systems achieve near 100% volumetric efficiency over a very narrow speed range. However, they are not nearly flexible enough for everyday street driving.

Another method is to force the air/fuel charge into the combustion chamber under pressure, using a compressor. This will force more charge into an engine than is possible with low restriction and tuned intake/exhaust systems, and it will do it over a much broader speed range. This is how a turbocharger works.

A turbocharger consists of a turbine wheel and a compressor wheel. Exhaust gases from the engine drive the turbine wheel at speeds up to 120,000 rpm. The compressor wheel, in turn, pumps a tremendous volume of air to the en-



gine, under pressure. The turbocharger sucks through the standard fuel injection system. The compressor is sealed to ensure that oil is not drawn into the intake system from the turbocharger lubrication system.

### Turbocharger Installation

Most turbocharger kits come with complete instructions. Installation time depends upon your own mechanical skill, but an average time is approximately 12 hours, depending on your working conditions and tool collection (although no special tools are required other than normal mechanic's tools).

### Turbocharger Maintenance

The main maintenance item consists simply of changing the oil every 3,000 miles, in order to provide the turbocharger with a clean supply of lubricant.

### Fuels Recommended For Turbocharger Operation

Catalytic converter-equipped cars must use unleaded gasoline; non-catalytic converter-equipped cars must use premium fuel.

*NOTE: Always use the highest octane fuel (leaded or unleaded) you can buy.*

### Turbocharger Performance

Below 3,500 rpm, the turbocharger is hardly a factor in engine performance — this is one of the main advantages of this efficient, power-producing unit; when you don't need it, it literally "loafs"; when you do need it, stand on the throttle and watch what happens. The turbo boost comes on around 3,500 rpm and steadily increases to its maximum boost. The power is delivered smoothly, as the turbo just starts pumping air in increased volume as the exhaust gases flow faster. The "turbo-lag" that you hear so much about has been reduced to a minimum and presents very little problem.

### Turbocharging a Modified Engine

A modified engine can be turbocharged, of course, but care should be taken. Stage 1, 2, and 3 modifications can all be carried out, providing the compression ratio does not exceed that recommended by the turbo manufacturer.

It is best to discuss any engine modifications which you have already made, or modifications which you would like to perform on your engine, with the turbocharger manufacturer prior to purchasing the kit.

## DRIVE TRAIN

With the suspension system beefed up and the engine putting out the kind of horsepower you need, the object now is to get all of it to the ground in as efficient a manner as possible.

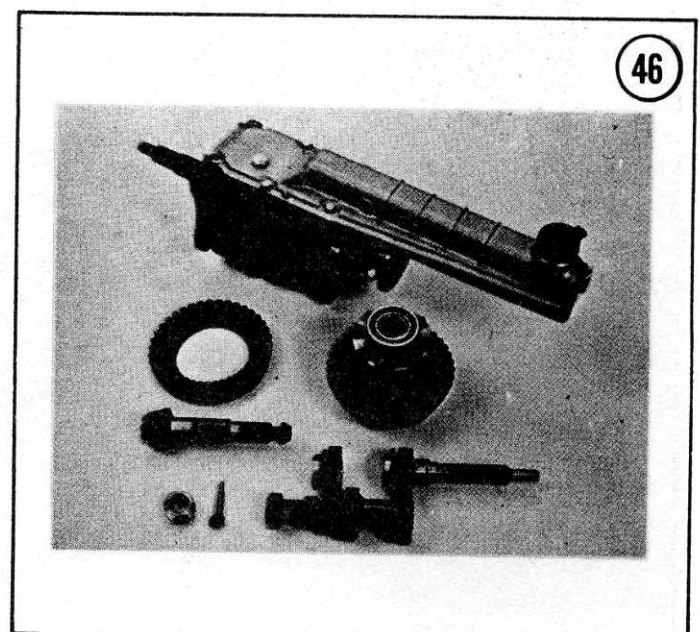
### Transmission

Volvo Competition Service offers a close ratio transmission and an assortment of special gears for every possible type of driving: street, rally, or racing (**Figure 46**). They also offer a variety of final drive ratios (**Figure 47**).

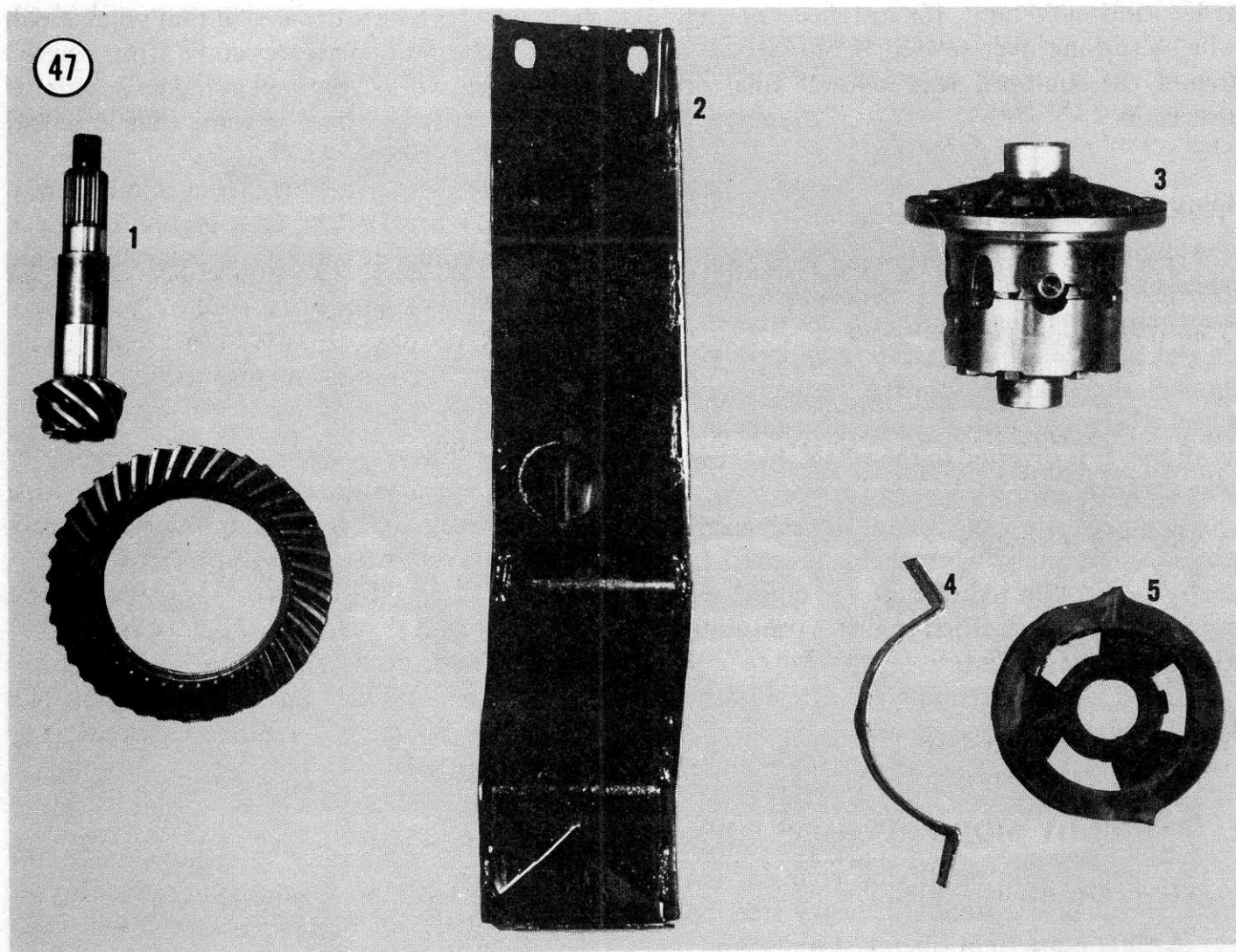
Ip'd offers special gear ratios too, plus new "J" type overdrive units (**Figure 48**), plus special heavy-duty overdrive springs (**Figure 49**).

### Ring and Pinion Gears

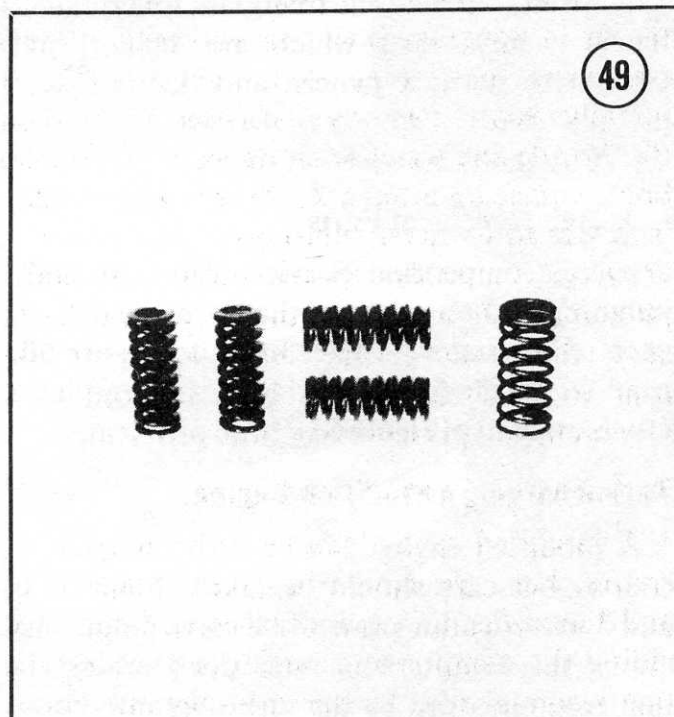
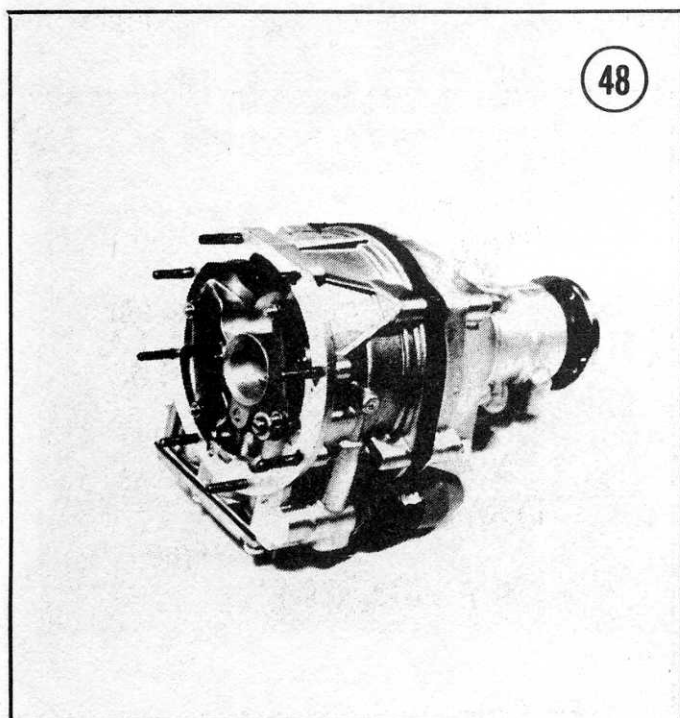
The final drive ratio determines the top speed and acceleration times. A lower gear ratio (higher numerically) provides faster acceleration and a lower top speed (and also results in the engine turning more rpm's at any given road speed than a higher final drive gear ratio). A higher gear ratio (lower numerically) provides a bit less acceleration, but higher top







1. Final drive gear (4.88:1) set
2. Extra strong gear crossmember for gearbox mounting
3. Limited slip differential
4. Extra strong steel collar for drive shaft center bearing support
5. Extra hard rubber support for center drive shaft bearing



speed, and at 55 mph, for instance, the engine will be turning over several hundred rpm less than a car equipped with a lower final drive gear ratio.

### Limited Slip Differential

A limited slip differential allows both rear wheels to apply power to the ground evenly under all conditions. When one rear wheel spins on wet pavement on a car not equipped with a limited slip differential, the remaining rear wheel receives no torque from the engine at all, as all power is diverted to the wheel that is spinning uselessly.

A limited slip differential is an absolute necessity, especially when the rear wheels have the job of trying to transfer the considerable power that your modified engine is transmitting to them, to the ground.

Limited slip differentials are available from Volvo Competition Service and Ipd.

## BODY MODIFICATIONS

The final step in modifying your car is the replacement of the standard, heavy steel body panels with lightweight fiberglass units; and the addition of aerodynamic devices called spoilers.

### Body Panel Replacement

Ipd offers lightweight fiberglass body panels (fender flares, etc.) which are lighter and stronger than stock panels, and they will not rust.

### Body Reinforcement Parts

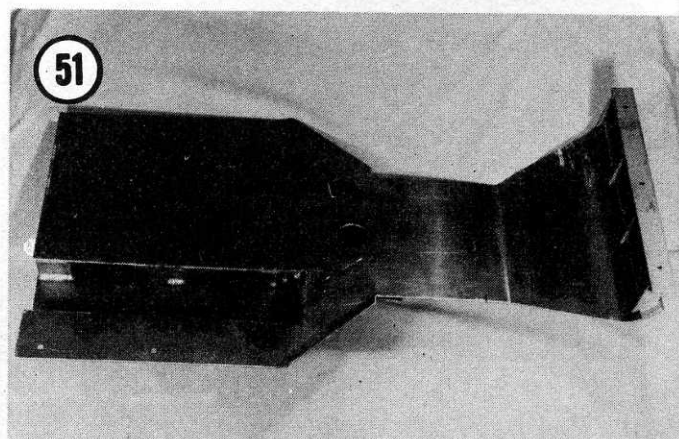
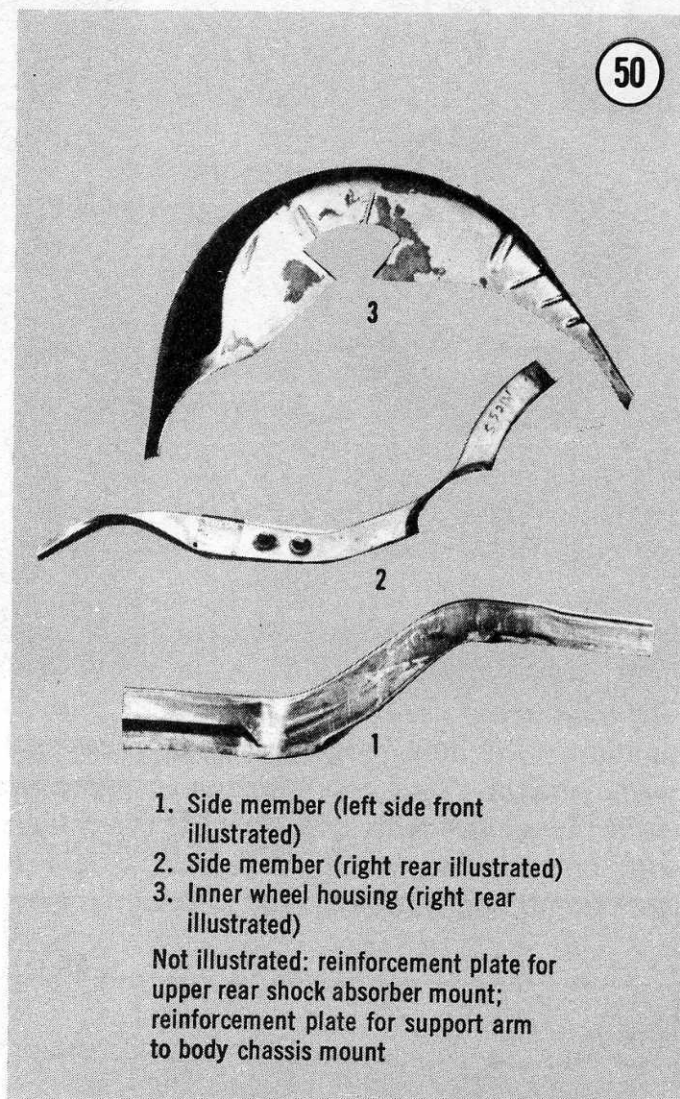
Volvo Competition Service offers specially designed body members that are welded in place to eliminate fatigue. Refer to **Figure 50**. In addition, they have special protection plates for off-road use (**Figure 51**).

### Spoilers

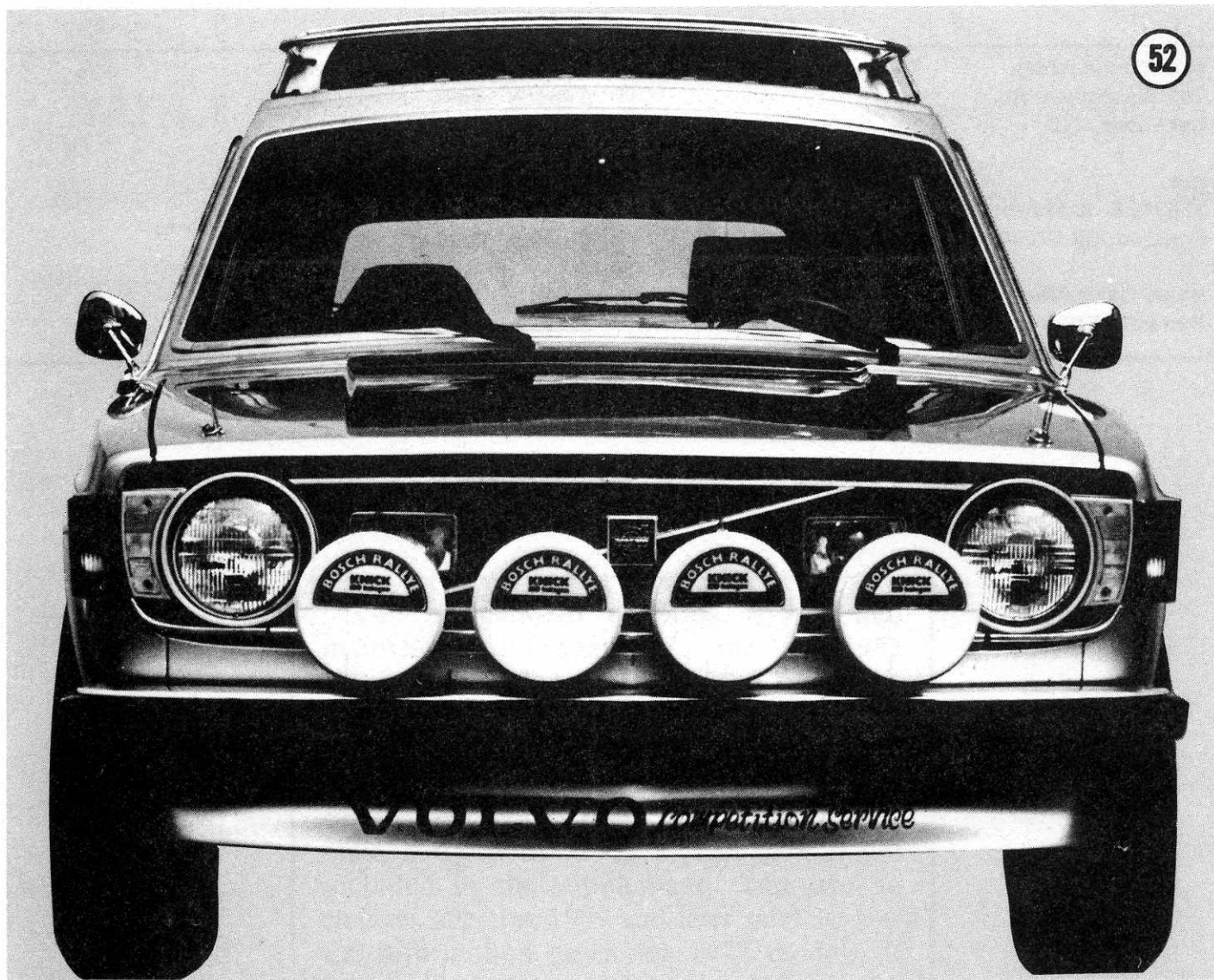
The prime objective of a front spoiler is to keep air from flowing under the car, which has a tendency to lift the car at high speeds. The spoiler directs the air up and over the hood,

creating a high pressure area at that point which actually creates downforce on the front wheels. This device works very well at higher speeds; at lower speeds the effect is somewhat lessened, but still worthwhile.

Spoilers are available from Competition Service (**Figure 52**) and Ipd (**Figure 53**). Each kit comes complete with the necessary hardware for mounting.







**Table 1 ACCESSORY SOURCES**

<b>ADDCO Industries</b> 701 Watertower Rd. Lake Park, FL	<b>Sway bar kits</b> Catalog free 33403
<b>IpD</b> 2762 N.E. Broadway Portland, OR 97232	<b>Volvo high-performance accessories</b> Catalog, \$3.00
<b>Volvo Competition Service</b> See your Volvo dealer	<b>Volvo high-performance accessories</b>