

**shop manual**

**tune-up and maintenance guide**

# **PORSCHE 914/4**

## **1970-72**

**FUEL SYSTEM IGNITION COOLING ENGINE  
LUBRICATION SHOCK ABSORBERS INSTRUMENTS  
FRONT SUSPENSION STEERING ELECTRIC SYSTEMS  
TROUBLESHOOTING BODY SPECIFICATIONS  
CLUTCH TRANSMISSION DRIVE AXLE BRAKES**

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**\$7.95**

# PORSCHE 914/4

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### shop manual

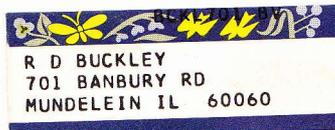
This manual is intended to provide the car owner and the professional mechanic with information necessary to perform the required service operations. The information, illustrations, and specifications in this manual are those available at the time of publication. No responsibility can be assumed for design or specification changes made to the cars by the manufacturer which in any way differs from that contained in this manual.

The index on this page enables the user to find any section by means of the black tabs on the edge of the manual. The tab on the first page of each section is in line with the section name in the index.

**CARBOOKS, INC.**  
Brooklyn, NY 11207

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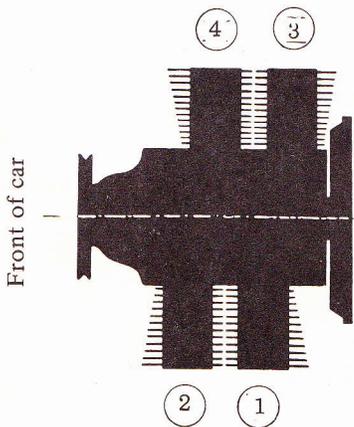
# TUNE-UP .. MAINTENANCE .. LUBRICATION 1

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### Distributor

Distributor maintenance is confined to periodic checks of the point gap, the condition of the inside of the distributor cap, the high voltage contacts, rotor and carbon pencil in the center of the cap. The inside of the cap must be clean, free of moisture and carbon dust and with no signs of cracking or the formation of carbon tracks. The high voltage pencil in the center must be unbroken and free to move in and out.

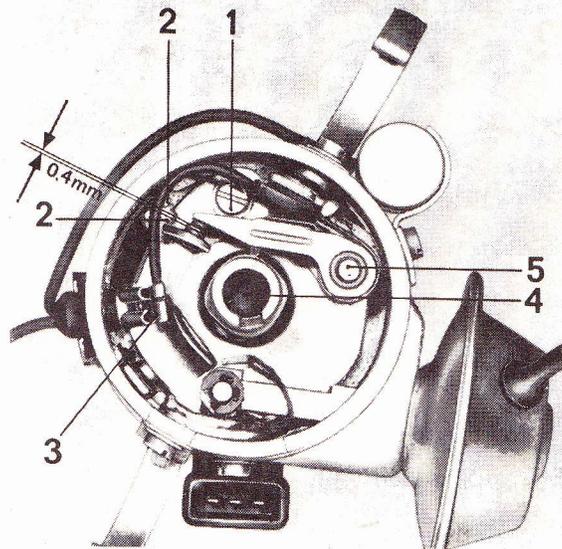


Cylinder Designation

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the base of the fixed contact and moving it to achieve the required clearance. The screw is retightened when the proper gap has been obtained. Recheck after tightening.

Point gap ..... 0.015–0.017 in.



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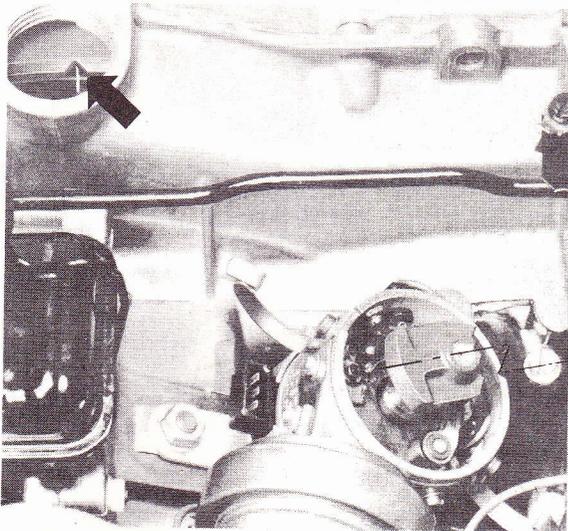
Distributor

- 1 - Locking screw
- 2 - Adjustment slot for screwdriver
- 3 - Electrical connection
- 4 - Felt lubricant
- 5 - Movable point pivot

### Ignition timing, static

Static timing is done with the engine off and points set to proper gap. Remove the distributor cap and turn engine over until the moving timing mark lines up with fixed timing mark. Loosen clamp at base of distributor just

The gap should be measured by a feeler gauge when the pad on the movable arm is on one of the peaks of the cam. The adjustment is made by loosening the screw on



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*Static timing marks*

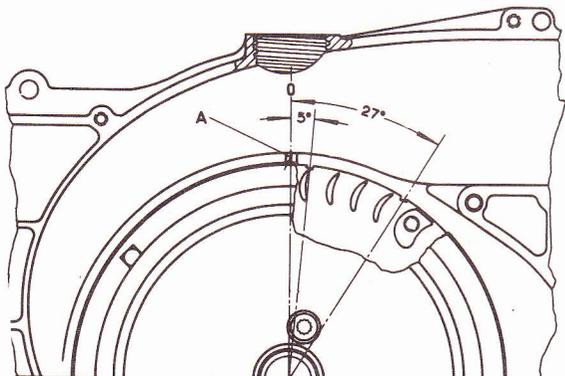
Rotor pointing to No. 1 cylinder position

enough so distributor can be rotated by hand. Rotate in same direction rotor turns, until points are fully closed, then rotate distributor in opposite direction until points just open. A test light across the points will tell the precise moment. When the light goes out, points have opened. Retighten clamp and replace distributor cap.

Fixed timing mark..... Notch in cooling blower housing.  
Moving timing mark ... Black notch (5° BTDC) on impeller.

**Ignition timing, with timing light**

Best results are obtained with a timing light (Stroboscopic light). Start engine and allow it to idle until it has reached normal operating temperature. Connect timing light and tachometer, run engine at recommended speed, and point timing light at mark. The moving mark and the fixed mark should line up. To adjust, loosen distributor clamp and slowly rotate it to bring marks together. Retighten clamp and check to be sure timing has not changed. Great care should be taken when using timing light.



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*Timing marks*

Fixed timing mark..... Notch in cooling blower housing.  
Moving timing mark .... Red notch (27° BTDC) on impeller.  
Test speed ..... 3500 rpm.  
Vacuum advance hoses..... removed.

**Dwell angle**

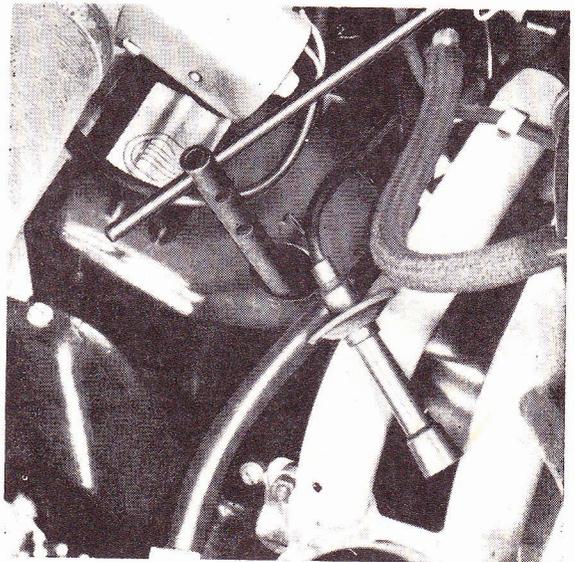
Dwell angle is the duration that the points stay closed. It is checked and adjusted with an oscilloscope or dwell meter, with the engine running at recommended speed. Adjust dwell by stopping engine, removing distributor cap and adjusting point gap. The smaller the gap, the bigger the dwell angle. Retighten the fixed point screw, install rotor and cap. Start engine and check dwell angle. Repeat adjustment steps, if necessary.

Recommended adjustment speed .....	1000-1200 rpm & 2000-2500 rpm
Dwell angle.....	44-50°
Dwell angle, maximum.....	42-58°

**Spark plugs**

The spark plugs should be cleaned and the gaps reset every 3000 miles. For maximum efficiency the spark plugs should be replaced every 12,000 miles. Check the plugs by eye for cracks, defects of any kind, indications of oil, carbon, or blistering. A black plug may indicate need for a plug of higher heat range, a very white plug may indicate need for a plug of a colder range.

Recommended spark plug .....	Bosch W175 T2
Spark plug gap.....	0.028 in.
Tightening torque.....	25 ft-lb.



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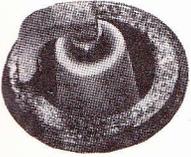
*Removing spark plug*

**Fuel injection system**

Adjustment of the idle speed should be done with the engine at normal operating temperature. Remove the air



**CARBON-FOULED PLUGS** show dry fluffy black deposits which may result from over-rich carburetion, over-choking, a sticking manifold heat valve or clogged air cleaner. Faulty breaker points, weak coil or condenser, worn ignition cables can reduce voltage and cause misfiring. Excessive idling, slow speeds under light load also can keep plug temperatures so low that normal combustion deposits are not burned off. In such a case a hotter type spark plug will better resist carbon deposits.



**NORMAL PLUGS** have brown to greyish tan deposits and slight electrode wear, indicating correct spark plug heat range and mixed periods of high and low speed driving. Spark plugs having this appearance may be cleaned, regapped and reinstalled.



**WET OILY DEPOSITS** may be caused by oil leaking past worn piston rings. "Break-in" of a new or overhauled engine before rings are fully seated may also produce this condition. A porous vacuum booster pump diaphragm or excessive valve stem guide clearances can also cause oil fouling. Usually these plugs can be degreased, cleaned and reinstalled. While hotter type spark plugs will reduce oil-fouling, an engine overhaul may be necessary to correct this condition.



**BURNED OR BLISTERED INSULATOR** nose and badly eroded electrodes are indications of spark plug overheating. Improper spark timing or low octane fuel can cause detonation and overheating. Lean air fuel mixtures, cooling system stoppages or sticking valves may also result in this condition. Sustained high-speed, heavy-load service can produce high temperatures which require use of colder spark plugs.

### Spark plug conditions

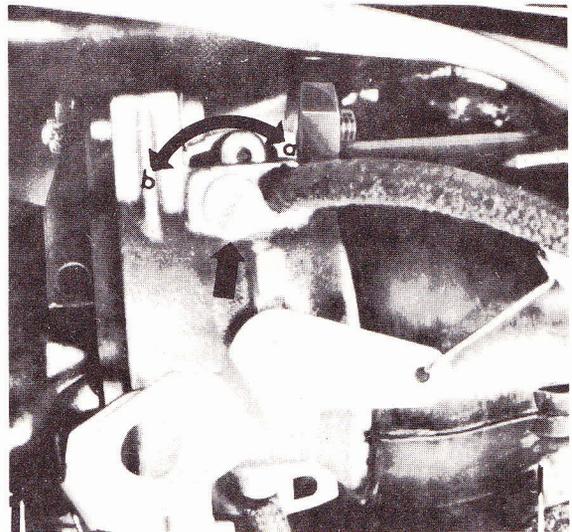
cleaner and check to determine if the auxiliary air regulator is completely closed. This is done by pulling off the hose between the air cleaner and the regulator and by covering the opening with a hand. The engine speed must not change much. If the speed does change, the engine is not warm enough, or the auxiliary air regulator is faulty.

Adjust idle speed by turning idle screw on throttle valve body clockwise to increase speed; counterclockwise to lower speed. Recommended idle speed is 900 rpm. If the speed cannot be lowered to this value, check the basic setting of the throttle valve switch.

The throttle valve switch may be adjusted with an ohmmeter across the two right hand plug connections (14 & 17) of the four found below the throttle valve. Turn the throttle valve switch clockwise as far as possible. Now turn it counterclockwise until the ohmmeter registers 0. Then turn the switch 2 degrees further (one graduation mark on the scale at the upper attaching screw) and secure the unit. Check to determine if, when the throttle valve is cracked open (2 degrees), the ohmmeter indicates it.

To check the setting of the throttle valve switch without ohmmeter, remove the hose between the air cleaner and the auxiliary air regulator. The engine should now "roll", that is change speed between approximately 900 and 1700 rpm. This indicates that the contacts in the throttle valve switch are closed and that the section of the control

unit which regulates closing the fuel supply during braking is functioning properly. Engine should be at operating temperature.



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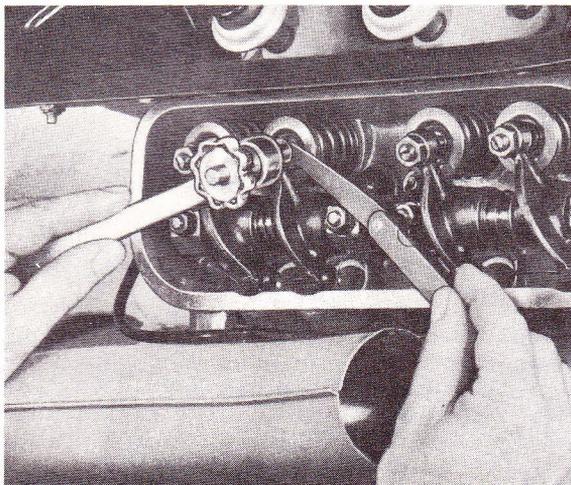
Idle speed adjustment

A - Increase speed

B - Decrease speed

**Valve adjustment**

The valves are adjusted from beneath the car. Remove the clip that secures the valve cover; remove the cover. From inside engine compartment, remove distributor cap and turn engine over until rotor points to # 1 cylinder (notch in distributor base). Check and adjust valves of # 1 cylinder. Turn engine over until rotor points to spark plug lead for next cylinder that side. Both valves are fully closed.



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*Checking valve clearance*

Adjust so feeler gauge moves smoothly between valve end and rocker arm. Check adjustment after tightening lock nut.

Valve clearance, intake & exhaust .....  
0.004 in. (cold)

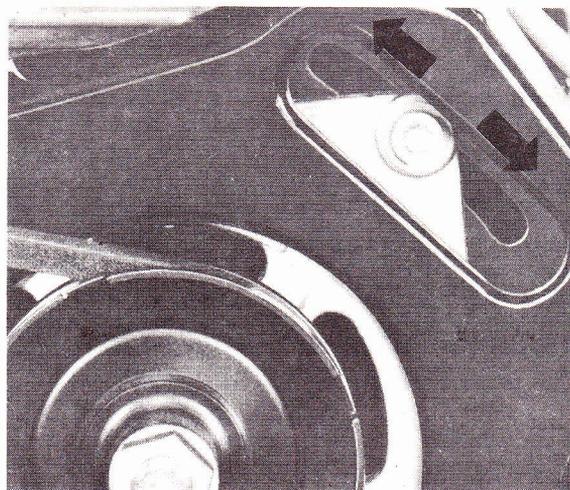
**Fan belt**

Remove cover plate above alternator pulley. Loosen the socket screw, but do not remove. Using arm pressure only, push alternator against force of belt. Snug up the socket screw. Check belt tension. If properly adjusted belt should deflect about 1/2 in. along longest straight surface under heavy thumb pressure. Tighten socket screw and replace cover plate. Do not use bar or other form of lever to force alternator.

**Battery**

Remove the battery filler plugs and check the fluid level. The electrolyte should be above the tops of the plates. Add distilled water to cover plates, but do not overfill, as this will dilute the battery acid. Tap water may be used, unless it has a very high mineral content.

Check battery state of charge. With battery temperature at 80 degrees F., the specific gravity should be at least 1.250 in every cell.



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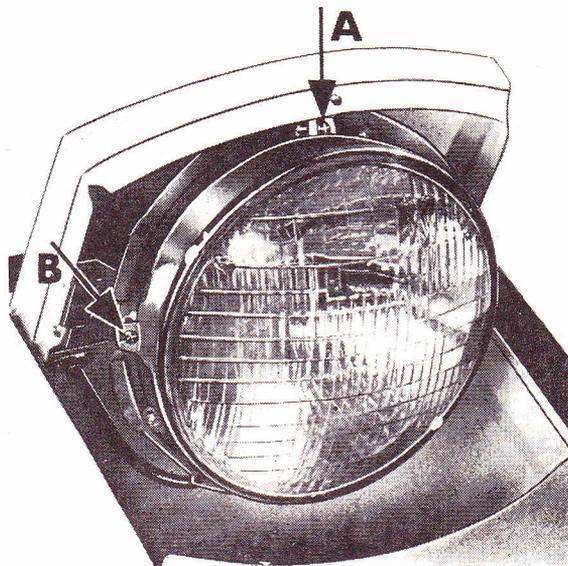
*Adjusting fan belt*

**Brake fluid reservoir**

Clean area around brake fluid reservoir cap. Unscrew cap and check level; it should be above center divider in container. Only add fresh brake fluid SAE 1703a as needed. Do not allow it to overflow.

**Headlight adjustments**

The headlights can be aimed with any suitable equipment, but, if it is not available the following procedure should be carried out.

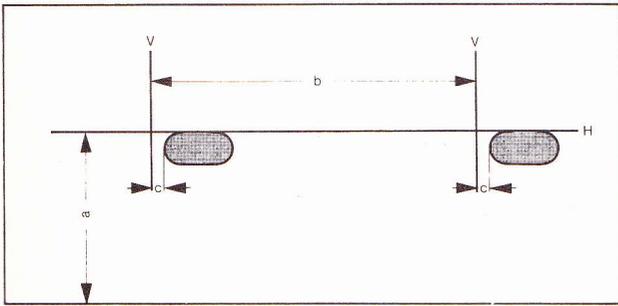


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*Adjusting headlamps*

A - Vertical adjustment

B - Horizontal adjustment



Headlight aiming target © Volkswagen

- H - Horizontal center of headlights on car
- V - Vertical center of headlights on car
- a = Height of headlight center from floor
- b = Distance between headlight centers
- c = 2 in.

Check tire pressure and park car on level ground facing a wall 25 feet in front of headlights. Driver should be in car. Measure height from ground to center of headlights and draw a horizontal line on the wall at this height. Opposite the center of each headlight, draw vertical lines intersecting the horizontal. A vertical line indicating the center of the car would be helpful.

Loosen the screw in the center below the headlight and take the trim ring off. Aim the headlights individually by turning the two aiming screws with the low beams switched on. The lights are correctly aimed when the top edge of the high intensity zone is on the horizontal line and the left edge is 2 in. to the right of the vertical line.

**Parking brake**

The parking brake is self-adjusting, and should require no attention. With the hand lever in the full down position, the actuating levers at each disc should be just off the pin stops. The cable rocker should be at 90° to pulling cable.

**Front wheel alignment**

When an abnormal wear of tires is noticed, the toe-in caster and camber should be checked. This should be checked with the car empty except for spare tire and filled gas tank. Bounce car up and down and move for several feet back and forth to settle suspension.

Toe-in is set with the steering wheel set in the straight ahead position. It is adjusted by loosening and adjusting the appropriate, right, left, or both track rods to obtain the recommended figure.

Total toe-in .....30' ± 10'

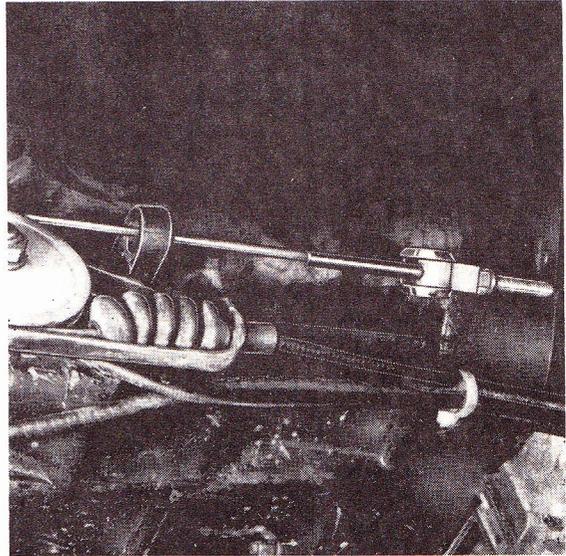
Camber adjustments are made by loosening the socket screws at top support bearing, after removing sealing compound. Before moving, mark existing position of plates. Note that changing camber also changes the caster angle. One mm travel of support bearing equals 6' angle change on shock strut.

Camber angle.....0° ± 20'  
Caster angle.....6° ± 30'

**Clutch pedal adjustment**

The clutch pedal linkage should be adjusted when the pedal free travel exceeds the recommended amount. Too much free pedal movement will prevent the clutch from fully disengaging. Too little can cause the clutch to continually slip and wear prematurely. The adjustment is made at the end of the cable, at the clutch. Grasp the cable with a pair of pliers and turn the self-locking nut out to increase pedal travel, and in to reduce pedal travel.

Recommended free pedal travel ..... 1/2-3/4 in.



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Clutch pedal adjustment

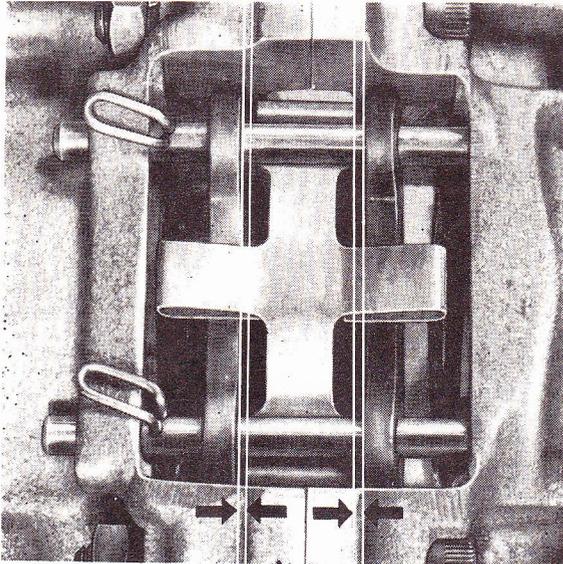
**UNDER THE CAR  
Brakes**

Check the brake fluid regularly; as the brake pads wear, the level will drop. Replenish as needed, but avoid overfilling. Check disc brake assemblies occasionally to see if they are wet. It would indicate a leaking cylinder.

The disc brake pads should be replaced when the friction material on them is less than 1/8 in. thick. Replace by jacking up car and removing wheel. Remove wire safety locks and retaining pins, depress spring and remove. If pads are to be reused, mark them with pencil before removing. Push pistons all the way in using a piece of wood for leverage. Watch the fluid reservoir as the fluid will rise when the pistons are forced back. To prevent spillage, drain some of the brake fluid before pushing the pistons back, or wrap reservoir in with a large piece of cloth to absorb the overflow.

Clean the pad seat, check dust covers and safety rings. Replace hardened or porous covers. Slide the new pads in and install spring, retaining pins, and safety locks. The brake pads should move freely in their wells.

Recommended brake fluid ..... SAE J 1703.



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*Brake pad thickness*

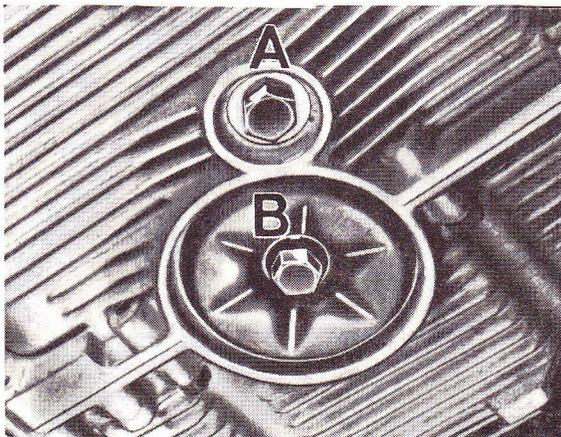
**LUBRICATION**

**Accelerator linkage**

Clean and lubricate the accelerator linkage at all pivot points with a few drops of engine oil. Check for any binding condition that may hinder smooth operation. Free up or correct as needed.

**Engine oil**

The car should be standing on level ground, with the engine off for several minutes. Withdraw the dipstick, wipe with a clean cloth, and push it back in as far as it will go. Remove and check height oil has reached on dipstick.



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*Oil drain plugs*

A - Oil drain plug

B - Filter cover screw

The oil level should be between the two marks on the dipstick. If necessary, oil should be added to bring it up to top mark. Never let the oil level fall below the lower mark. If in doubt, it is better to have a bit too much oil than too little. Avoid mixing oils of different brands, the additives may not be compatible.

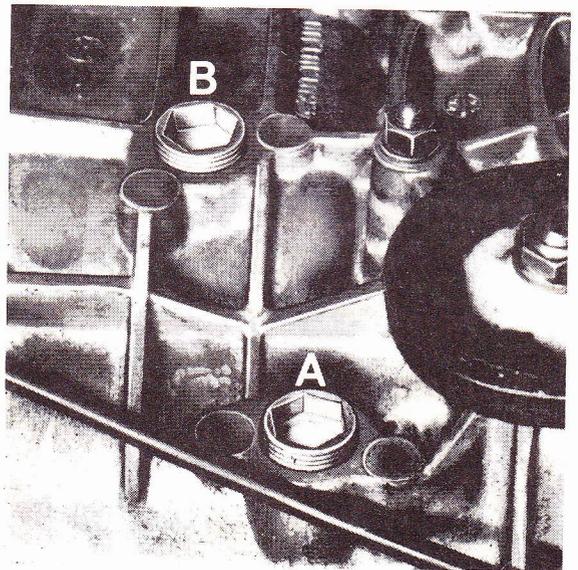
To change the oil remove drain plug when the engine is warm. When oil has stopped running out, remove strainer by removing center nut. When replacing screen use new gaskets and sealing rings. The center nut should be tightened to a maximum of 7-9 ft-lbs. Do not over-tighten. Refill with the recommended grade of oil.

Oil capacity, with oil filter change.....	3.7 qts.
Oil capacity, without oil filter change .....	3.2 qts.
Recommended oil,	
below 5° F .....	SAE 10
5-32° F .....	SAE 20
above 32° F.....	SAE 30
Multigrade, all temps.....	10W-40

**Transmission oil**

Both transmission and final drive are combined in one housing. To check oil level, remove filler plug, after cleaning area around it. Plug is located on side of transmission. Place finger tip inside hole. The oil should be just about level with the bottom edge of the hole. Add oil as needed, using a plastic syringe.

Recommended oil .....	SAE 90 hypoid
Transmission capacity .....	2-1/2 qts.



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*Transmission oil plugs*

A - Drain plug

B - Filler and level check plug

**MAINTENANCE SCHEDULE**

The time or mileage intervals indicated in this section are intended as a guide for establishing regular maintenance and lubrication periods. Sustained heavy duty or high speed driving or operation under adverse conditions may require more frequent servicing.

**Every 300 miles or 2 weeks, whichever comes first, perform the following service functions:**

- Tire pressure, check
- Battery water level, check
- Oil level in engine, check

**Every 3000 miles or 3 months, whichever comes first, add the following service functions:**

- Engine oil, change
- Oil strainer, clean

**Every 6,000 miles or 6 months, whichever comes first, add the following service functions:**

- Transmission and differential oil level, check
- Distributor point gap, check
- Spark plugs, check or replace.
- Engine idle speed, check
- Disc brake pads, check thickness
- Brake system, check for leaks
- Fan belt tension, check
- Distributor, lubricate and coat cam face
- Steering mechanism, check lubrication
- Oil filter, change
- Ignition timing, check
- Valve clearance, check
- Clutch pedal play, check
- Suspension components, check and tighten
- Wheels, rotate and check balance
- Electrical, check for loose or broken wires
- Fuel filter, replace

**Every 12,000 miles or 12 months, whichever comes first, add the following service functions:**

- Engine compression, check
- Crankcase ventilation system, check
- Fuel pump operation, check
- Battery, check specific gravity
- Alternator, regulator, starter function, check
- Engine mounts, check
- Distributor breaker points, replace
- Air cleaner, clean and change oil
- Air cleaner, replace filter element
- Exhaust emission system, check
- Steering mechanism, check and tighten
- Wheel alignment, check
- Transmission/differential nuts & bolts, retighten
- Door and lid hinges, lubricate
- Transmission oil, change
- Front wheel bearings, change grease and adjust
- Gear shift lever switch contacts, clean/adjust (Sportomatic)
- Control valve air filter, check (Sportomatic)

**Every 24,000 miles or 24 months, whichever comes first, add the following service functions:**

- Brake fluid, change
- Handbrake linkage, wiper motor linkage, window regulator, lubricate
- Shock absorbers, check
- Exhaust system, check for leaks

Carburetors, rebuild (914/6)

**Every 30,000 miles or 30 months, whichever comes first, add the following service functions:**

- Transmission/differential oil, change
- Wheel bearing grease, change
- Master cylinder & wheel cylinders, overhaul
- Headlight aiming, check
- Drive shaft splines & U-joints, grease

**CAPACITIES & RECOMMENDED LUBRICANTS**

**Engine fuel**

98 octane .....16-1/2 gallons

**Engine oil (MS service grade)**

Temperature range anticipated before next oil change, and recommended SAE viscosity numbers.

Below 10°F	5° to 75°F
10W,10W-30	20W,10W-30
32° to 90°F	60° to 110°F
30,20W-40	40,20W-50

Capacity, approx. . . .3 qts. w/o filter change, 4 qts. with change.

**Transmission with differential**

SAE 90 hypoid gear oil .....2-1/2 qts.

**Torque converter, Sportomatic**

SAE 20 HD oil .....6-1/4 qts.

Symbol	Amps	Equipment
	8	left headlight high beam
56a	8	right headlight high beam
	8	left headlight low beam
56b	8	right headlight low beam
	8	left parking lights
58	8	right parking lights
	8	license plate lights
	25	windshield wipers, cigarette lighter, turn signals, stop lights, back-up light
15	8	fan, horn
	8	(optional) fog lights
ZF	8	
	8	emergency flasher
	30	retractable headlights, interior light
30	25	

Fuse Sizes

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# TROUBLESHOOTING 2

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The basic design and construction of almost all cars built today is the same. Each has an engine that burns gasoline in a sealed combustion chamber. Fuel and air are fed into the chamber through a cam operated poppet valve. The burnt residue of combustion leaves through a similar valve. Fuel is supplied to the engine by a carburetor or fuel injection system. The fuel is ignited in the combustion chamber by a spark plug, which is fired by a distributor at the appropriate time. A pair of Tungsten points and a condenser in the distributor control the actions of the high tension coil which provides the current for the spark plugs.

Electric energy for the distributor and the coil comes from a wet cell battery, which is kept charged by a generator or alternator. The output of the generator, or alternator is controlled by a regulator.

The burning of the fuel in the combustion chamber pushes down the piston, which turns the crankshaft

through a connecting rod. At the end of the crankshaft is the flywheel, to which is attached the clutch (manual transmission) or fluid coupling (automatic transmission). The shifting of the gears in the manual transmission is done by hand, while those in the automatic are done by valves, oil pressure, and band brakes. From the transmission the power goes to the differential gear unit, which redirects it to each driving wheel.

The hydraulic brake system in most cars is designed or made by one of a very few brake component manufacturers. The operation and components are often the same though not necessarily interchangeable. Their problems, causes, and cures are basic.

When using this troubleshooting section, use a logical procedure to diagnose the cause of the condition. Start with the simplest cause first, and eliminate those components and causes which do not apply to your particular model.

### FUEL SYSTEM

Condition	Possible Cause	Correction
ENGINE DOES NOT START; FUEL PUMP NOT WORKING	(a) Wires to pump or relay defective (b) Fuse to pump relay defective (c) Pump relay defective.	(a) Check and repair or replace wires. (b) Replace 8A fuse. (c) Check with voltmeter; replace if necessary.
ENGINE DOES NOT START; FUEL PUMP WORKING	(a) Plug at pressure sensor disconnected, causing flooding.  (b) Open circuit to cylinder head temp. sensor. (c) Pinched fuel line or defective pressure regulator.	(a) Replace plug. Crank engine with injector plug disconnected to clear engine. (b) Check and correct. Check all plugs and connections. (c) Check fuel loop for 28 psi pressure with starter turning engine.
ENGINE STARTS BUT STALLS	(a) Plug at distributor loose or defective wiring. (b) Trigger contacts defective.	(a) Check and replace contacts if necessary. (b) Replace.
ENGINE MISFIRES AND STALLS	(a) Trigger contacts dirty or worn.	(a) Check, clean and replace if necessary.

Condition	Possible Cause	Correction
ENGINE MISSES ON ONE CYLINDER. WHITE EXHAUST SMOKE	(b) Plugs loose (c) No fuel pressure (a) One fuel injector sticking or windings defective.	(b) Check and press on securely. (c) Check pressure. (a) Replace.
ENGINE MISFIRES	(b) Plug connection loose	(b) Press plug on securely.
ENGINE LACKS POWER	(a) Loose connections. Poor ground at injectors. (a) Low fuel pressure. (b) Pressure sensor defective (c) Throttle valve does not open fully. (d) Pressure switch not working.	(a) Check connections and tighten ground screws. (a) Check pressure and correct. (b) Replace sensor (c) Check and adjust. (d) Check switch and wiring for open circuits.
EXCESSIVE FUEL CONSUMPTION	(a) Sensors not operating or voltage leaks in wiring. (b) Throttle valve switch (c) Excessive fuel pressure.	(a) Check hose connections and sensors. Check wiring. (b) Check and adjust. (c) Check regulator; replace if necessary.
RPM RISES AND FALLS (1000-2000 rpm)	(a) Hose between auxiliary air regulator and intake air distributor loose or broken. (b) Throttle valve stays open too wide. (c) Idle speed too high.	(a) Connect securely or replace. (b) Check and adjust (c) Adjust to correct speed.
ENGINE BACKFIRES DURING ACCELERATION	(a) Mixture enrichment in throttle valve switch not operating.	(a) Check with tester.
HIGH IDLE SPEED	(a) Leak in idle air system. (b) Rubber seals of injectors leaking. (c) Throttle valve needs adjusting.	(a) Check and correct (b) Replace seals. (c) Adjust.

## IGNITION SYSTEM

Condition	Possible Cause	Correction
BURNED OR PITTED DISTRIBUTOR CONTACTS	(a) Dirt or oil on contacts.	(a) If oil is on contact face, determine cause and correct condition. Clean distributor cam of dirt and grease, apply a light film of distributor cam lubricant to cam lobes; wipe off excess. See "Distributor Lubrication." Replace contact set and adjust as necessary.
	(b) Alternator voltage regulator setting too high.	(b) Test alternator voltage regulator setting, adjust as necessary. Replace contact set and adjust as necessary.
	(c) Contacts misaligned or gap too small.	(c) Align and adjust contacts.
	(d) Faulty coil.	(d) Test and replace coil if necessary. Replace and adjust contacts.
	(e) Ballast resistor not in circuit.	(e) Inspect conditions, and correctly connect the coil.
	(f) Wrong condenser or faulty condenser.	(f) Test condenser and replace if necessary. Replace and adjust contacts.
	(g) Faulty ignition switch.	(g) Replace ignition switch.
	(h) Bushings worn.	(h) Replace housing.

Condition	Possible Cause	Correction
IGNITION COIL FAILURE	(i) Touching contacts with the hands during installation.	(i) Replace and adjust contacts.
	(a) Coil damaged by excessive heat from engine.	(a) Replace coil. Inspect condition of the distributor contacts.
	(b) Coil tower carbon-tracked.	(b) Replace the coil.
	(c) Oil leak at tower.	(c) Replace the coil.

### ACCESSORY DRIVE BELTS

Condition	Possible Cause	Correction
INSUFFICIENT ACCESSORY OUTPUT DUE TO BELT SLIPPAGE	(a) Belt too loose.	(a) Adjust belt tension.
	(b) Belt excessively glazed or worn.	(b) Replace and tighten as specified.
BELT SQUEAL WHEN ACCELERATING ENGINE	(a) Belts too loose.	(a) Adjust belt tension.
BELT SQUEAK AT IDLE	(b) Belts glazed.	(b) Replace belts.
	(a) Belt too loose.	(a) Adjust belt tension.
	(b) Dirt and paint imbedded in belt.	(b) Replace belt.
	(c) Non-uniform belt.	(c) Replace belt.
	(d) Misaligned pulleys.	(d) Align accessories (file brackets or use spacers as required).
	(e) Non-uniform groove or eccentric pulley.	(e) Replace pulley.

### ENGINE

Condition	Possible Cause	Correction
ENGINE WILL NOT START	(a) Weak battery.	(a) Test battery specific gravity. Recharge or replace as necessary.
	(b) Corroded or loose battery connections.	(b) Clean and tighten battery connections. Apply a coat of petroleum to terminals.
	(c) Faulty starter.	(c) Refer to "Starting Motor".
	(d) Moisture on ignition wires and distributor cap.	(d) Wipe wires and cap clean and dry.
	(e) Faulty ignition cables.	(e) Replace any cracked or shorted cables.
	(f) Faulty coil or condenser.	(f) Test and replace if necessary.
	(g) Dirty or corroded distributor contacts.	(g) Clean or replace as necessary.
	(h) Incorrect spark plug gap.	(h) Set gap
	(i) Incorrect ignition timing.	(i) Refer to "Ignition Timing."
	(j) Dirt or water in fuel line	(j) Clean lines
	ENGINE STALLS	(a) Idle speed set too low.
(b) Incorrect choke adjustment.		(b) Adjust choke.
(c) Idle mixture too lean or too rich.		(c) Adjust carburetor.
(d) Incorrect carburetor float setting.		(d) Adjust float setting.
(e) Leak in intake manifold.		(e) Inspect intake manifold gasket and replace if necessary.
(f) Dirty, burned or incorrectly gapped distributor contacts.		(f) Replace contacts and adjust.
(g) Worn or burned distributor rotor.		(g) Install new rotor.
(h) Incorrect ignition wiring.		(h) Install correct wiring.

Condition	Possible Cause	Correction
ENGINE LOSS OF POWER	(i) Faulty coil or condenser.	(i) Test and replace if necessary.
	(j) Incorrect tappet lash.	(j) Adjust to specifications.
	(a) Incorrect ignition timing.	(a) Refer to "Ignition Timing."
	(b) Worn or burned distributor rotor.	(b) Install new rotor.
	(c) Worn distributor shaft or cam.	(c) Remove and repair distributor.
	(d) Dirty or incorrectly gapped spark plugs.	(d) Clean plugs and set gap
	(e) Dirt or water in fuel line, carburetor or filter.	(e) Clean lines, carburetor and replace filter.
	(h) Incorrect valve timing.	(h) Refer to "Checking Valve Timing."
	(j) Low compression.	(j) Test compression of each cylinder.
	(k) Burned, warped or pitted valves.	(k) Install new valves.
	(l) Plugged or restricted exhaust system.	(l) Install new parts as necessary.
	(m) Faulty ignition cables.	(m) Replace any cracked or shorted cables.
	ENGINE MISSES ON ACCELERATION	(n) Faulty coil or condenser.
(a) Dirty, burned, or incorrectly gapped distributor contacts.		(a) Replace contacts and adjust.
(b) Dirty, or gap too wide in spark plugs.		(b) Clean spark plugs and set gap
(c) Incorrect ignition timing.		(c) Refer to "Ignition Timing."
(e) Acceleration pump in carburetor.		(e) Install new pump.
(f) Burned, warped or pitted valves.		(f) Install new valves.
ENGINE MISSES AT HIGH SPEED	(g) Faulty coil or condenser.	(g) Test and replace if necessary.
	(a) Dirty or incorrectly gapped distributor contacts.	(a) Clean or replace as necessary.
	(b) Dirty or gap set too wide in spark plug.	(b) Clean spark plugs and set gap
	(c) Worn distributor shaft or cam.	(c) Remove and repair distributor.
	(d) Worn or burned distributor rotor.	(d) Install new rotor.
	(e) Faulty coil or condenser.	(e) Test and replace if necessary.
NOISY VALVES	(f) Incorrect ignition timing.	(f) Refer to "Ignition Timing."
	(h) Dirt or water in fuel line,	(h) Clean lines,
	(a) High or low oil level in crankcase.	(a) Check for correct oil level.
	(b) Thin or diluted oil.	(b) Change oil.
	(c) Low oil pressure.	(c) Check engine oil level.
	(d) Dirt in tappets.	(d) Clean tappets.
	(e) Bent push rods.	(e) Install new push rods.
	(f) Worn rocker arms.	(f) Inspect oil supply to rockers.
	(g) Worn tappets.	(g) Install new tappets.
	(h) Worn valve guides.	(h) Ream and install new valves with O/S stems.
CONNECTING ROD NOISE	(i) Excessive run-out of valve seats or valve faces.	(i) Grind valve seats and valves.
	(j) Incorrect tappet lash.	(j) Adjust to specifications.
	(a) Insufficient oil supply.	(a) Check engine oil level.
	(b) Low oil pressure.	(b) Check engine oil level. Inspect oil pump relief valve and spring.
	(c) Thin or diluted oil.	(c) Change oil to correct viscosity.
	(d) Excessive bearing clearance.	(d) Measure bearings for correct
MAIN BEARING NOISE	(e) Connecting rod journals out-of-round.	(e) Replace crankshaft or regrind journals.
	(f) Misaligned connecting rods.	(f) Replace bent connecting rods.
	(a) Insufficient oil supply.	(a) Check engine oil level.

Condition	Possible Cause	Correction
OIL PUMPING AT RINGS	(b) Low oil pressure.	(b) Check engine oil level. Inspect oil pump relief valve and spring.
	(c) Thin or diluted oil.	(c) Change oil to correct viscosity.
	(d) Excessive bearing clearance.	(d) Measure bearings for correct clearance.
	(e) Excessive end play	(e) Check thrust bearing for wear on flanges.
	(f) Crankshaft journal out-of-round or worn.	(f) Replace crankshaft or regrind journals.
	(g) Loose flywheel or torque converter.	(g) Tighten to correct torque.
	(a) Worn, scuffed, or broken rings.	(a) Hone cylinder bores and install new rings.
	(b) Carbon in oil rings slots.	(b) Install new rings.
	(c) Rings fitted too tight in	(c) Remove the rings. Check

## CLUTCH

Condition	Possible Cause	Correction
CLUTCH CHATTER	(a) Worn or damaged disc assembly.	(a) Replace disc assembly.
	(b) Grease or oil on disc facings.	(b) Replace disc assembly and correct cause of contamination.
	(c) Improperly adjusted cover assembly.	(c) Replace cover assembly.
CLUTCH SLIPPING	(d) Broken or loose engine mounts	(d) Replace or tighten mounts
	(e) Misaligned clutch housing	(e) Align clutch housing
	(a) Burned, worn, or oil soaked facings.	(a) Replace disc assembly and correct cause of contamination.
DIFFICULT GEAR SHIFTING	(b) Insufficient pedal free play.	(b) Adjust release fork rod.
	(c) Weak or broken pressure springs.	(c) Replace cover assembly.
	(a) Excessive pedal free play.	(a) Adjust release fork rod.
CLUTCH NOISY	(b) Excessive deflection in linkage or firewall.	(b) Repair or replace linkage.
	(c) Worn or damaged disc assembly.	(c) Replace disc assembly.
	(d) Improperly adjusted cover assembly.	(d) Replace cover assembly.
	(e) Clutch disc splines sticking.	(e) Remove disc assembly and free up splines or replace disc.
	(f) Worn or dry pilot bushing.	(f) Lubricate or replace bushing.
	(g) Clutch housing misaligned.	(g) Align clutch housing.
	(a) Dry clutch linkage.	(a) Lubricate where necessary.
	(b) Worn release bearing.	(b) Replace release bearing.
	(c) Worn disc assembly.	(c) Replace disc assembly.
(d) Worn release levers.	(d) Replace cover assembly.	
	(e) Worn or dry pilot bushing.	(e) Lubricate or replace bushing.
	(f) Dry contact-pressure plate lugs in cover.	(f) Lubricate very lightly.

## MANUAL—TRANSMISSION

Condition	Possible Cause	Correction
HARD SHIFTING	(a) Incorrect clutch adjustment.	(a) Refer to Clutch Group for corrections.

Condition	Possible Cause	Correction
TRANSMISSION SLIPS OUT OF GEAR	(b) Improper linkage adjustment.	(b) Perform linkage adjustment
	(c) Synchronizer clutch sleeve damaged.	(c- d-e) Causes noted can only be corrected by disassembling transmission and replacing damaged or worn parts.
	(d) Synchronizer spring improperly installed.	
	(e) Broken or worn synchronizer stop rings.	
	(a) Linkage interference.	(a) Inspect and remove all linkage interferences.
TRANSMISSION NOISES	(b) Gearshift rods out of adjustment.	(b) Adjust gearshift rods
	(c) Synchronizer clutch teeth worn.	(c) Disassemble transmission and replace parts as necessary.
	(d) Clutch housing bore or face out of alignment.	(d) Refer to Clutch Group for correction procedure.
	(a) Excessive end play in countershaft gear.	(a) Replace thrust washers.
	(b) Loose synchronizer hub spline fit on mainshaft.	(b) Inspect mainshaft and synchronizer hub and replace parts as necessary.
	(c) Damaged, broken or excessively worn gear teeth.	(c) Replace worn gears.
	(d) Rough or pitted bearing races or balls.	(d) Replace worn bearing.

## REAR AXLE

Condition	Possible Cause	Correction
REAR WHEEL NOISE	(a) Wheel loose.	(a) Tighten loose wheel nuts.
	(b) Spalled wheel bearing cup or cone.	(b) Check rear wheel bearings. If spalled or worn, replace.
	(c) Defective, brinelled wheel bearing.	(c) Defective or brinelled bearings must be replaced. Check rear axle shaft end play.
	(d) Excessive axle shaft end play.	(d) Readjust axle shaft end play.
	(e) Bent or sprung axle shaft flange.	(e) Replace bent or sprung axle shaft.
SCORING OF DIFFERENTIAL GEARS AND PINIONS	(a) Insufficient lubrication.	(a) Replace scored gears. Scoring marks on the pressure face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear axle to required capacity with proper lubricant. See Specification Section.
	(b) Improper grade of lubricant.	(b) Replace scored gears. Inspect all gears and bearings for possible damage. Clean out and refill axle to required capacity with proper lubricant. See Lubrication section.
	(c) Excessive spinning of one wheel.	(c) Replace scored gears. Inspect all gears, pinion bores and shaft for scoring, or bearings for possible damage. Service as necessary.

Condition	Possible Cause	Correction
TOOTH BREAKAGE (RING GEAR AND PINION)	(a) Overloading.	(a) Replace gears. Examine other gears and bearings for possible damage. Replace parts as needed. Avoid Overloading.
	(b) Erratic clutch operation.	(b) Replace gears, and examine remaining parts for possible damage. Avoid erratic clutch operation.
	(c) Ice-spotted pavements.	(c) Replace gears. Examine remaining parts for possible damage. Replace parts as required.
	(d) Improper adjustment.	(d) Replace gears. Examine other parts for possible damage. Make sure ring gear and pinion backlash is correct.
REAR AXLE NOISE	(a) Insufficient lubricant.	(a) Refill rear axle with correct amount of the proper lubricant. See Specification section. Also check for leaks and correct as necessary.
	(b) Improper ring gear and pinion adjustment.	(b) Check ring gear and pinion tooth contact.
	(c) Unmatched ring gear and pinion.	(c) Remove unmatched ring gear and pinion. Replace with a new matched gear and pinion set.
	(d) Worn teeth on ring gear or pinion.	(d) Check teeth on ring gear and pinion for contact. If necessary, replace with new matched set.
	(e) End play in drive pinion bearings.	(e) Adjust drive pinion bearing preload.
	(f) Side play in differential bearings.	(f) Adjust differential bearing preload.
	(g) Incorrect drive gearlash.	(g) Correct drive gearlash.
LOSS OF LUBRICANT	(a) Lubricant level too high.	(a) Drain excess lubricant by removing filler plug and allow lubricant to level at lower edge of filler plug hole.
	(b) Worn axle shaft oil seals.	(b) Replace worn oil seals with new ones. Prepare new seals before replacement.
	(c) Cracked rear axle housing.	(c) Repair or replace housing as required.
	(d) Worn drive pinion oil seal.	(d) Replace worn drive pinion oil seal with a new one.
	(e) Scored and worn companion flange.	(e) Replace worn or scored companion flange and oil seal.
	(f) Clogged vent.	(f) Remove obstructions.
	(g) Loose carrier housing bolts or housing cover screws.	(g) Tighten bolts or cover screws to specifications and fill to correct level with proper lubricant.
OVERHEATING OF UNIT	(a) Lubricant level too low.	(a) Refill rear axle.
	(b) Incorrect grade of lubricant.	(b) Drain, flush and refill rear axle with correct amount of the proper lubricant. See Specification Section.
	(c) Bearings adjusted too tightly.	(c) Readjust bearings.
	(d) Excessive wear in gears.	(d) Check gears for excessive wear or scoring. Replace as necessary.
	(e) Insufficient ring gear to pinion clearance.	(e) Readjust ring gear and pinion backlash and check gears for possible scoring.

Condition	Possible Cause	Correction
DRIVE SHAFT VIBRATION	(a) Undercoating or other foreign matter on shaft. (b) Loose universal joint flange bolts. (c) Loose or bent universal joint flange or high runout. (d) Improper drive line angularity. (f) Worn universal joint bearings or missing rollers. (g) Shaft damaged (bent tube) or out of balance. (h) Broken rear spring. (i) Excessive runout or unbalance condition.	(a) Clean exterior of shaft and wash with solvent. (b) Tighten bolt nuts to specific torque. (c) Install new flange. Tighten to specifications. (d) Correct angularity. See "Propeller Shaft Angularity." (f) Recondition universal joint. (g) Install new shaft. (h) Replace rear spring. (i) Reindex propeller shaft 180 degrees, reride and correct as necessary.
UNIVERSAL JOINT NOISE	(a) Shaft flange bolts nuts loose. (b) Lack of lubrication	(a) Tighten nuts to specified torque. (b) Recondition universal joint.

### SHOCK ABSORBERS

Condition	Possible Cause	Correction
SHOCK ABSORBER NOISY	(a) Loose bolt or stud. (b) Undercoating on shock absorber reservoir. (c) Bushing excessively worn. (d) Air trapped in system.	(a) Tighten to specifications. (b) Clean undercoating off shock absorber. (c) Replace bushing. (d) Purge shock absorber.
SHOCK ABSORBER DRIPPING OIL	(a) Worn seal. (b) Damaged crimp or reservoir.	(a) Replace shock absorber. (b) Replace shock absorber.

### STEERING

Condition	Possible Cause	Correction
HARD STEERING	(a) Low or uneven tire pressure. (b) Insufficient lubricant in the steering gear housing or in steering linkage. (c) Steering gear shaft adjusted too tight. (d) Front wheels out of line.	(a) Inflate tires to recommended pressures. (b) Lubricate as necessary. (c) Adjust according to instructions. (d) Align the wheels. See "Front Suspension."
PULL TO ONE SIDE (Tendency of the Vehicle to veer in one direction only)	(a) Incorrect tire pressure. (b) Wheel bearings improperly adjusted. (c) Dragging brakes. (d) Improper caster and camber. (e) Incorrect toe-in. (f) Grease, dirt, oil or brake fluid in brake linings. (g) Front and rear wheels out of alignment.	(a) Inflate tires to recommended pressures. (b) See "Front Wheel Bearing Adjustment." (c) Inspect for weak, or broken brake shoe spring, binding pedal. (d) See "Front Wheel Alignment Group." (e) See "Front Wheel Alignment Group." (f) Inspect, replace and adjust as necessary. (g) Align the front wheels. See "Front Suspension Group"

Condition	Possible Cause	Correction
WHEEL TRAMP (Excessive Vertical Motion of Wheels)	(h) Broken or sagging rear springs.	(h) Replace rear springs.
	(i) Bent suspension parts.	(i) Replace parts necessary.
	(a) Incorrect tire pressure.	(a) Inflate tires to recommended pressures.
	(b) Improper balance of wheels, tires and brake drums.	(b) Lubricate as necessary.
EXCESSIVE PLAY OR LOOSENESS IN THE STEERING WHEEL	(c) Loose tie rod ends or steering connections.	(c) Inspect and repair as necessary.
	(d) Worn or inoperative shock absorbers.	(d) Replace shock absorbers as necessary.
	(a) Steering gearshaft adjusted too loose or badly worn.	(a) Replace worn parts and adjust according to instructions.
	(b) Steering linkage loose or worn	(b) Replace worn parts. See "Front Wheel Alignment."
	(c) Front wheel bearings improperly adjusted.	(c) Adjust according to instructions.
	(d) Steering arm loose on steering gear shaft.	(d) Inspect for damage to gear shaft and steering arm, replace parts as necessary.
	(e) Steering gear housing attaching bolts loose.	(e) Tighten attaching bolts according to tightening reference.
	(f) Steering arms loose at steering knuckles.	(f) Tighten according to tightening reference.
	(g) Worn ball joints.	(g) Replace ball joints as necessary. See "Front Suspension."
	(h) Steering gear adjustment too loose.	(h) Adjust

## BRAKES

Condition	Possible Cause	Correction
DRAGGING BRAKES (ALL WHEELS)	(a) Brake shoes improperly adjusted.	(a) Adjust brakes.
	(b) Brake pedal linkage binding.	(b) Free up linkage.
	(c) Excessive hydraulic seal friction.	(c) Lubricate seal.
	(d) Compensator port plugged.	(d) Clean out master cylinder.
	(e) Fluid cannot return to master cylinder.	(e) Inspect pedal return.
	(f) Parking brake not returning.	(f) Free up as required.
	(g) Disc brake metering valve malfunction.	(g) Replace metering valve.
	(h) Contaminated brake fluid.	(h) Drain and flush system-replace all rubber parts in hydraulic system.
GRABBING BRAKES	(a) Grease or brake fluid on linings.	(a) Inspect for a leak and replace lining as required.
PEDAL GOES TO FLOOR (OR ALMOST TO FLOOR)	(a) Self-adjusters not operating.	(a) Inspect self-adjuster operations.
	(b) Air in hydraulic system.	(b) Bleed brakes.
	(c) Hydraulic leak.	(c) Locate and correct leak.
	(d) Fluid low in master cylinder.	(d) Add brake fluid.
	(e) Shoe hanging up on rough platform.	(e) Smooth and lubricate platforms.
	(f) Loose disc brake rotor	(f) Check wheel bearing adjustment.
HARD PEDAL (POWER UNIT TROUBLE)	(a) Faulty vacuum check valve.	(a) Replace check valve.
	(b) Collapsed or leaking vacuum hose.	(b) Replace hose.
	(c) Plugged vacuum fittings.	(c) Clean out fittings.
	(d) Leaking vacuum chamber.	(d) Replace unit.

Condition	Possible Cause	Correction
	(e) Diaphragm assembly out of place in housing.	(e) Replace unit.
	(f) Vacuum leak in forward vacuum housing.	(f) Replace unit.
EXCESSIVE PEDAL TRAVEL	(a) Rear brake adjustment required.	(a) Check and adjust rear brakes.
	(b) Air leak, or insufficient fluid in system or caliper.	(b) Check system for leaks.
	(c) Warped or excessively tapered shoe and lining assembly.	(c) Install new shoe and linings.
	(d) Excessive disc runout.	(d) Check disc for runout with dial indicator. Install new disc.
	(e) Loose wheel bearing adjustment.	(e) Readjust wheel bearings to specified torque.
	(f) Improper brake fluid (boil).	(f) Drain and install correct fluid.
	(g) Damaged caliper piston seal.	(g) Install new piston seal.
BRAKE ROUGHNESS OR CHATTER (Pedal Pulsating)	(a) Excessive out-of-parallelism of braking disc.	(a) Check disc for runout with dial indicator. Install new disc.
	(c) Excessive lateral runout of braking disc.	(c) Check disc for lateral runout with dial indicator. Install new disc.
	(d) Excessive front bearing clearance.	(d) Readjust wheel bearings to specified torque.
	(e) Rear brake drums distorted by improper tightening of nuts.	(e) Check drums for out-of-round and reface if necessary.
EXCESSIVE PEDAL EFFORT	(a) Power brake malfunction.	(a) Replace
	(b) Frozen or seized pistons.	(b) Disassemble caliper and free up pistons. Clean parts.
	(c) Shoe and lining worn below .180 in. (Lining only— .30 in.)	(c) Install new shoe and linings.
	(d) Brake fluid, oil or grease on linings.	(d) Install new shoe linings as required.
	(e) Incorrect lining.	(e) Remove lining and install correct lining.
PULL	(a) Loose calipers.	(a) Tighten caliper mounting bolts from 45 to 60 ft. pounds.
	(b) Frozen or seized pistons.	(b) Disassemble caliper and free up pistons.
	(c) Rear brake pistons sticking.	(c) Free up rear brake pistons.
	(d) Front end out of alignment.	(d) Check and align front end.
	(e) Broken rear spring.	(e) Install new rear spring.
	(f) Out-of-round rear drums.	(f) Check and reface drums if necessary.
	(g) Incorrect tire pressure.	(g) Inflate tires to recommended pressures.
	(h) Brake fluid, oil or grease on linings.	(h) Install new shoe and linings.
	(i) Restricted hose or line.	(i) Check hoses and lines and correct as necessary.
	(j) Rear brakes out of adjustment.	(j) Adjust rear brakes.
	(k) Unmatched linings.	(k) Install correct lining.
	(l) Distorted brake shoes.	(l) Install new brake shoes.
NOISE Groan—Brake noise emanating when slowly releasing brakes (creep—groan)	(a) Not detrimental to function of disc brakes—no corrective action required. (Indicate to operator this noise may be eliminated by slightly increasing or decreasing brake pedal efforts).	
Rattle—Brake noise or rattle emanating at low speeds on rough roads, (front wheels only).		
Scraping—	(a) Excessive clearance between shoe and caliper.	(a) Install new shoe and lining assemblies.
	(a) Loose wheel bearings.	(a) Readjust wheel bearings to correct specifications.

## Condition

## Possible Cause

## Correction

FRONT BRAKES HEAT UP DURING DRIVING AND FAIL TO RELEASE	(b) Braking disc rubbing housing.	(b) Check for rust or mud buildup on caliper mounting and bridge bolt tightness.
	(c) Mounting bolts too long.	(c) Install mounting bolts of correct length.
	(a) Residual pressure valve in master cylinder.	(a) Remove valve from cylinder.
	(b) Frozen or seized piston.	(b) Disassemble caliper, hone cylinder bore, clean seal groove and install new pistons, seals and boots.
	(c) Operator riding brake pedal.	(c) Instruct owner how to drive with disc brakes.
LEAKY WHEEL CYLINDER	(d) Sticking pedal linkage.	(d) Free up sticking pedal linkage.
	(e) Power brake malfunction.	(e) Replace
	(a) Corroded bore.	(a) Hone bore and replace boots and cups.
GRABBING OR UNEVEN BRAKING ACTION	(b) Damaged or worn caliper piston seal.	(b) Disassemble caliper and install new seal.
	(c) Scores or corrosion on surface of piston.	(c) Disassemble caliper and hone cylinder bore. If necessary, install new pistons.
	(a) Causes listed under "Pull."	(a) Corrections listed under "Pull."
	(b) Power brake malfunction.	(b) Replace unit.
	(a) Air in hydraulic system or improper bleeding procedure.	(a) Bleed system.
BRAKE PEDAL CAN BE DEPRESSED WITHOUT BRAKING EFFECT	(b) Leak in system or caliper.	(b) Check for leak and repair as required.
	(c) Pistons pushed back in cylinder bores during servicing of caliper (shoe and lining not properly positioned).	(c) Reposition brake shoe and lining assemblies. Depress pedal a second time and if condition persists, check following causes:
	(d) Leak past piston cups in master cylinder.	(d) Recondition master cylinder.
	(e) Damaged piston seal in one or more of cylinders.	(e) Disassemble caliper and replace piston seals as required.
	(f) Leak in rear brake cylinder.	(f) Hone cylinder bore. Install new piston cylinder cups.
	(g) Rear brakes out of adjustment.	(g) Adjust rear brakes.
	(h) Bleeder screw open.	(h) Close bleeder screw and bleed entire system.

## PARKING BRAKES

## Condition

## Possible Cause

## Correction

DRAGGING BRAKE	(a) Improper cable or brake shoe adjustment.	(a) Properly adjust the service brakes, then adjust the parking brake cable.
	(b) Broken brake shoe return spring.	(b) Replace any broken return spring.
	(c) Broken brake shoe retainer spring.	(c) Replace the broken retainer spring.
	(d) Grease or brake fluid soaked lining.	(d) Replace the grease seal or recondition the wheel cylinders and replace both brake shoes.
	(e) Improper stop light switch adjustment	(e) Adjust stop light switch
	(f) Sticking or frozen brake cable.	(f) Replace cable.
	(g) Broken rear spring.	(g) Replace the broken rear spring.
	(h) Bent or rusted cable equalizer.	(h) Straighten, or replace and lubricate the equalizer.

Condition	Possible Cause	Correction
BRAKE WILL NOT HOLD	(h) Heat set parking brake cable spring.	(h) Replace parking brake cable.
	(a) Broken or rusted brake cable.	(a) Replace cable.
	(b) Improperly adjusted brake or cable.	(b) Adjust brakes and cable as necessary.
	(c) Soaked brake lining.	(c) Replace the brake lining.
	(d) Ratchet or pedal mechanism worn.	(d) Replace pedal assembly.

## FRONT SUSPENSION AND STEERING LINKAGE

Condition	Possible Cause	Correction
FRONT END NOISE	(a) Ball joint needs lubrication.	(a) Lubricate ball joint.
	(b) ) Loose shock absorber mounting. Shock absorber inoperative or bushings worn.	(b) Tighten shock absorber mounting nuts. Replace bushings or shock absorber.
	(c) Worn strut bushings.	(c) Replace bushing.
	(d) Loose struts—Lower control arm bolts and nuts,	(d) Tighten all bolts and nuts.
	(e) Loose steering gear on frame.	(e) Tighten the steering gear mounting bolts.
	(f) Worn upper control arm bushings.	(f) Replace worn bushings.
	(g) Worn lower control arm shaft bushings.	(g) Replace worn bushings.
	(h) Worn upper or lower ball joint.	(h) Replace ball joint.
	(i) Worn tie rod ends.	(i) Replace tie rod end.
	(j) Loose or worn front wheel bearings.	(j) Adjust or replace bearings as necessary.
	(k) Steering knuckle arm contacting the lower control arm wheel stop.	(k) Smooth off the contacting area and lubricate with a water resistant grease.
	INSTABILITY	(a) Low or uneven tire pressure.
(b) Loose wheel bearings.		(b) Adjust wheel bearing.
(c) Improper steering cross shaft adjustment.		(c) Adjust steering cross shaft.
(d) Steering gear not centered.		(d) Adjust steering gear.
(e) Worn idler arm bushing.		(e) Replace bushing.
(f) Loose or excessively worn front strut bushings.		(f) Replace bushings.
(g) Weak or broken rear spring.		(g) Replace spring.
(h) Incorrect front wheel alignment.		(h) Measure and adjust front wheel alignment.
HARD STEERING	(i) Shock absorber inoperative.	(i) Replace shock absorber.
	(a) Ball joints-require lubrication.	(a) Lubricate ball joints.
	(b) Low or uneven tire pressure.	(b) Inflate tires to recommended pressures.
	(e) Incorrect front wheel alignment (particularly caster) resulting from a bent control arm, steering knuckle or steering knuckle arm.	(e) Replace bent parts and adjust the front wheel alignment.
CAR PULLS TO ONE SIDE	(f) Steering gear low on lubricant.	(f) Fill gear to correct level.
	(g) Steering gear not adjusted.	(g) Adjust steering gear.
	(h) Idler arm binding.	(h) Replace idler arm.
	(a) Low or uneven tire pressure.	(a) Inflate tires to recommended pressure.
	(b) Front brake dragging.	(b) Adjust brakes.
	(c) Grease, lubricant or brake fluid leaking onto brake lining.	(c) Replace brake shoe and lining as necessary and stop all leaks.
	(d) Loose or excessively worn strut bushings.	(d) Tighten or replace strut bushings.
	(e) Power steering control valve out of adjustment.	(e) Adjust steering gear control valve.

Condition	Possible Cause	Correction
EXCESSIVE PLAY IN STEERING	(f) Incorrect front wheel alignment (particularly camber).	(f) Adjust front wheel alignment.
	(g) Broken or weak rear spring.	(g) Replace spring.
	(a) Worn or loose front wheel bearings.	(a) Adjust or replace wheel bearings as necessary.
	(b) Incorrect steering gear adjustment.	(b) Adjust steering gear.
	(c) Loose steering gear to frame mounting bolts.	(c) Tighten steering gear to frame bolts.
	(d) Worn ball joints or tie rod.	(d) Replace ball joints or tie rods as necessary.
	(e) Worn steering gear parts.	(e) Replace worn steering gear parts and adjust as necessary.
FRONT WHEEL SHIMMY	(f) Worn upper or lower ball joints.	(f) Replace ball joints.
	(g) Worn idler arm bushing.	(g) Replace bushing.
	(a) Tire, wheel out of balance.	(a) Balance wheel and tire assembly.
	(b) Uneven tire wear, or excessively worn tires.	(b) Rotate or replace tires as necessary.
	(c) Worn or loose wheel bearings.	(c) Replace or adjust wheel bearings as necessary.
	(d) Worn tie rod ends.	(d) Replace tie rod ends.
	(e) Strut mounting bushings loose or worn.	(e) Replace strut mounting bushings.
	(f) ) Incorrect front wheel alignment (particularly caster).	(f) Adjust front wheel alignment.
	(g) Worn or loose upper control arm ball joints.	(g) Inspect ball joints and replace where required.

### STARTER—ELECTRICAL

Condition	Possible Cause	Correction
STARTER FAILS TO OPERATE	(a) Weak battery or dead cell in battery.	(a) Test specific gravity. Recharge or replace battery as required.
	(b) Ignition switch faulty.	(b) Test and replace switch if necessary.
	(c) Loose or corroded battery cable terminals.	(c) Clean terminals and clamps, replace if necessary. Apply a light film of petrolatum to terminals after tightening.
	(d) Open circuit, wire between the ignition — starter switch and ignition terminal on starter relay.	(d) Inspect and test all the wiring.
	(e) Starter relay defective.	(e) Test relay and replace if necessary.
	(f) Faulty starter.	(f) Test and repair as necessary.
	(g) Armature shaft sheared.	(g) Test and repair.
	(h) Open solenoid pull-in wire.	(h) Test and replace solenoid if necessary.
STARTER FAILS AND LIGHTS DIM	(a) Weak battery or dead cell in battery.	(a) Test for specified gravity. Recharge or replace battery as required.
	(b) Loose or corroded battery cable terminals.	(b) Clean terminals and clamps, replace if necessary. Apply a light film of petrolatum to terminals after tightening.
	(c) Internal ground in windings.	(c) Test and repair starter.
	(d) Grounded starter fields.	(d) Test and repair starter.
	(e) Armature rubbing on pole shoes.	(e) Test and repair starter.
STARTER TURNS, BUT ENGINE DOES NOT ENGAGE	(a) Starter clutch slipping.	(a) Replace clutch unit.

Condition	Possible Cause	Correction
STARTER RELAY DOES NOT CLOSE	(b) Broken clutch housing.	(b) Test and repair starter.
	(c) Pinion shaft rusted, dirty or dry, due to lack of lubrication.	(c) Clean, test and lubricate.
	(d) Engine basic timing wrong.	(d) check engine basic timing and condition of distributor rotor and cap.
	(e) Broken teeth on engine ring gear.	(e) Replace ring gear. Inspect teeth on starter clutch pinion.
	(a) Battery discharged.	(a) Recharge or replace battery.
RELAY OPERATES BUT SOLENOID DOES NOT	(b) Faulty wiring.	(b) Test for open circuit, wire between starter relay ground terminal post and neutral starter switch (automatic transmission only). Also test for open circuit; wire between ignition-starter switch and ignition terminal and starter relay.
	(c) Clutch start switch or neutral starter switch on automatic transmission faulty.	(c) Test and replace the switch if necessary.
	(d) Starter relay faulty.	(d) Test and replace if necessary.
	(a) Faulty wiring.	(a) Test for open circuit wire between starter-relay solenoid terminal and solenoid terminal post.

### ALTERNATOR-REGULATOR—ELECTRICAL

Condition	Possible Cause	Correction
ALTERNATOR FAILS TO CHARGE (No Output or Low Output)	(a) Alternator drive belt loose.	(a) Adjust drive belt to specifications.
	(b) Regulator Base improperly grounded.	(b) Connect regulator to a good ground.
	(c) Worn brushes and/or slip rings.	(c) Install new brushes and/or slip rings.
	(d) Sticking brushes.	(d) Clean slip rings and brush holders. Install new brushes if necessary.
	(e) Open field circuit.	(e) Test all the field circuit connections, and correct as required.
	(f) Open charging circuit.	(f) Inspect all connections in charging circuit, and correct as required.
	(g) Open circuit in stator windings.	(g) Remove alternator and disassemble. Test stator windings. Install new stator if necessary.
	(h) Open rectifiers.	(h) Remove alternator and disassemble. Test the rectifiers. Install new rectifiers if necessary.
LOW, UNSTEADY CHARGING RATE	(a) High resistance in body to engine ground lead.	(a) Tighten ground lead connections. Install new ground lead if necessary.
	(b) Alternator drive belt loose.	(b) Adjust alternator drive belt.
	(c) High resistance at battery terminals.	(c) Clean and tighten battery terminals.
	(d) High resistance in charging circuit.	(d) Test charging circuit resistance. Correct as required.

Condition	Possible Cause	Correction
LOW OUTPUT AND A LOW BATTERY	<ul style="list-style-type: none"> <li>(e) Open stator winding.</li> <li>(a) High resistance in charging circuit.</li> <li>(b) Shorted rectifier. Open rectifier.</li> </ul>	<ul style="list-style-type: none"> <li>(e) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.</li> <li>(a) Test charging circuit resistance and correct as required.</li> <li>(b) Perform current output test. Test the rectifiers and install new rectifiers as required. Remove and disassemble the alternator.</li> </ul>
EXCESSIVE CHARGING RATE TO A FULLY CHARGED BATTERY	<ul style="list-style-type: none"> <li>(c) Grounded stator windings.</li> <li>(d) Faulty voltage regulator.</li> <li>(a) Faulty ignition switch.</li> </ul>	<ul style="list-style-type: none"> <li>(c) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.</li> <li>(d) Test voltage regulator.</li> <li>(a) Install new ignition switch.</li> </ul>
NOISY ALTERNATOR	<ul style="list-style-type: none"> <li>(b) Faulty voltage regulator.</li> <li>(a) Alternator mounting loose.</li> <li>(b) Worn or frayed drive belt.</li> <li>(c) Worn bearings.</li> <li>(d) Interference between rotor fan and stator leads or rectifiers.</li> <li>(e) Rotor or rotor fan damaged.</li> <li>(f) Open or shorted rectifier.</li> <li>(g) Open or shorted winding in stator.</li> </ul>	<ul style="list-style-type: none"> <li>(b) Test voltage regulator. Replace as necessary.</li> <li>(a) Properly install and tighten alternator mounting.</li> <li>(b) Install a new drive belt and adjust to specifications.</li> <li>(c) Remove and disassemble alternator. Install new bearings as required.</li> <li>(d) Remove and disassemble alternator. Correct interference as required.</li> <li>(e) Remove and disassemble alternator. Install new rotor.</li> <li>(f) Remove and disassemble alternator. Test rectifiers. Install new rectifiers as required.</li> <li>(g) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.</li> </ul>
EXCESSIVE AMMETER FLUCTUATION	<ul style="list-style-type: none"> <li>(a) High resistance in the alternator and voltage regulator circuit.</li> </ul>	<ul style="list-style-type: none"> <li>(a) Clean and tighten all connections as necessary.</li> </ul>

# FUEL SYSTEM .. EMISSION CONTROL 3

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3

### DESCRIPTION

The fuel is drawn by the fuel pump from the tank via the filter and is delivered into the ring line. To eliminate the transmission of noises, a damper has been connected to the pressure line. The pressure regulator at the end of the ring line restricts the fuel pressure to 2 kp/cm<sup>2</sup>. The electro-magnetic injection valves are connected to the ring line via distributors. The pressure regulator serves to return excessive fuel into the tank via a second line.

The overflow line coming from the fuel pump also enters this line. The fuel pump is provided with a pressure relief valve which responds when the pressure rises considerably above the rated value. A check valve in the pressure connection of the fuel pump prevents the pressure in the ring line from dropping the moment the pump is cut out.

The control unit opens the injection valves electrically in two groups (I and II). As a result of constant fuel pressure, the fuel is injected when the valves are opened. The ejection duct of the injection valves is accurately calibrated; for this reason and because the fuel pressure is kept constant, the injected fuel quantity depends only on the length of time the valve is opened.

This injection time is "computed" by the control unit. The information which the electronic system processes in the control unit, arrive from the individual information transmitters on the engine.

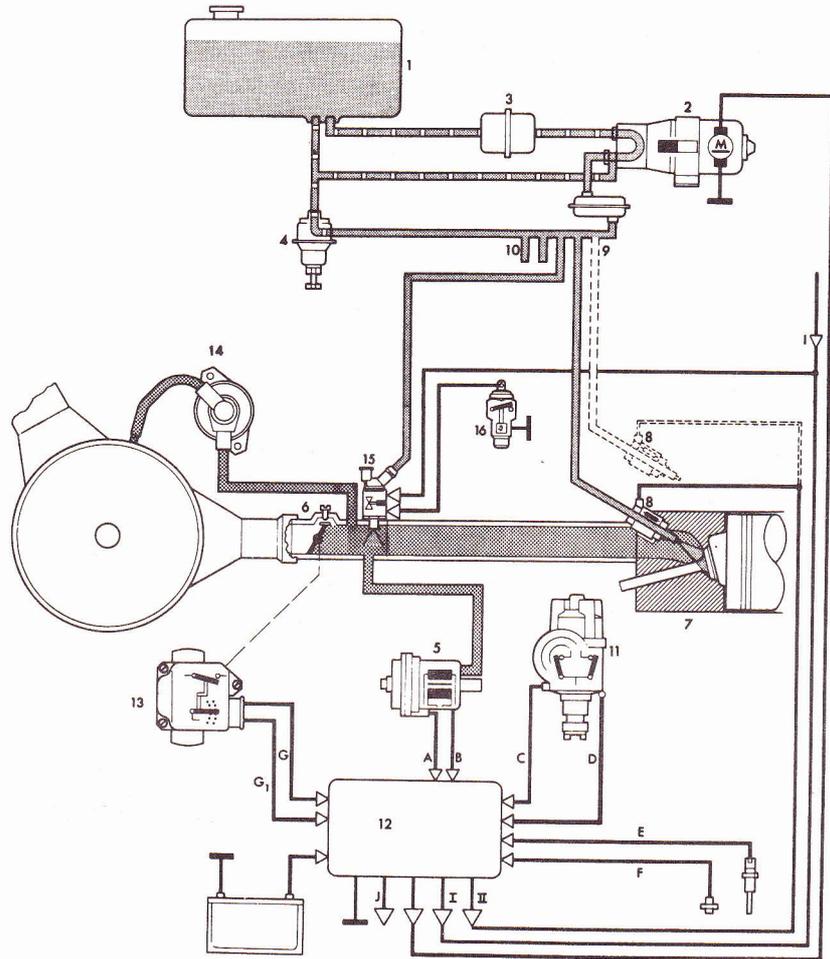
In addition to the basic fuel requirements, an additional

fuel quantity must be injected when starting at low temperatures, when warming up the engine and under full load (warming-up enrichment). The warming up enrichment depends on the temperature of the engine. It is electrically measured by two feelers, in the intake distributor and on the cylinder head.

Under overrunning conditions (braking with engine while running downhill) no fuel should be injected, when the speed is above 1,800 rpm. The throttle valve switch will switch off the fuel delivery. When the speed reaches 1,250 rpm under overrunning conditions the fuel delivery is again switched on and the transition into idling operation is ensured.

These signals are also processed by the control unit in the proper ratio with regard to the basic fuel requirements and are transmitted electrically to the valves. To keep the structural requirements of the control unit small and the costs of the system low, two valves each are connected in parallel (valve group I = cylinders 1 and 4; valve group II = cylinders 2 and 3). The two valves of one group inject simultaneously.

While driving, the air volume is controlled by a throttle valve installed in front of the intake air distributor. At idling speed the throttle valve is completely closed. The idling air arrives at the intake air distributor through the idling air duct in the throttle valve connection. The idling speed is adjusted by changing the cross section of the idling air duct by means of an adjusting screw on the



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Basic circuit diagram

- |  |  |
|--|--|
| 1 - Fuel tank  |  |
| 2 - Fuel pump  |  |
| 3 - Fuel filter  |  |
| 4 - Pressure regulator   |  |
| 5 - Pressure feeler  |  |
| 6 - Intake air distributor   |  |
| 7 - Cylinder head  |  |
| 8 - Injection valves   |  |
| 9 - Fuel distributor   |  |
| 10 - Fuel distributor  |  |
| 11 - Ignition distributor with releasing contacts<br>(ZV - contact I, ZV - contact II) |  |
| 12 - Control unit  |  |
| 13 - Throttle valve switch with acceleration enrichment                                |  |
| 14 - Supplementary air valve   |  |
| 15 - Cold starting nozzle  |  |
| 16 - Thermal switch for cold starting device   |  |
|  | A + B - from pressure feeler (signal load condition)                                       |
|  | C + D - from ignition distributor contacts<br>-(signals speed and release)                 |
|  | E + F - from temperature feelers<br>(signal warming up—)                                   |
|  | G - from throttle valve switch<br>(switching off fuel delivery under<br>overrunning cond.) |
|  | G1 - (Acceleration enrichment)   |
|  | H - from pressure switch<br>(signal full load enrichment)                                  |
|  | I - from starter, terminal 50 solenoid switch<br>(signal start enrichment)                 |
|  | II - Bridging of full load safety device   |
|  | I - to injection valves cylinder 1 and 4   |
|  | II - to injection valves cylinder 2 and 3  |

throttle valve connection.

The engine which is not yet fully warmed up, requires additional air. This is controlled by the supplementary air valve. It will change the effective cross section of the supplementary air line in accordance with the engine compartment temperature and the temperature of an electric heater installed in the supplementary air valve

housing. The rotary valve is turned by a bimetallic spring which reacts on the temperature components. The electric heater of the supplementary air valve is connected to the pump relay.

**Cold starting device**

At 5°C and below, additional fuel is injected directly into the intake air distributor to keep the mixture at max.

efficiency. For this purpose, a cold starting valve is installed in the intake distributor.

**Air system**

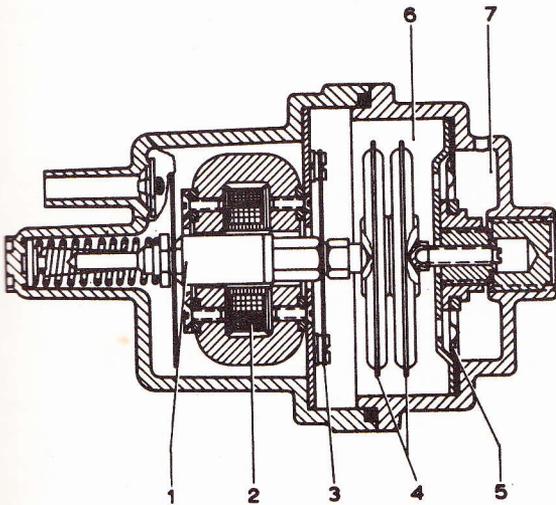
The four cylinders are supplied with air via four intake pipes which are connected to an intake distributor. The input of the intake distributor is provided with an intake connection and throttle valve. The throttle valve is actuated by the accelerator pedal by means of a bowden cable. The intake connection is connected to the air filter by means of a rubber elbow. The idling air system is in the shape of an idling air duct in the intake connection which ends behind the throttle valve. The effective cross section can be adjusted by means of the idling air adjusting screw (idling speed adjustment).

**ELECTRONIC COMPONENTS OF THE SYSTEM**

For a better understanding of the function of the fuel injection system, the individual electric or electronic parts are described in detail here.

**The pressure feeler with full load enrichment**

This controls the basic fuel quantity in accordance with the pressure in the intake distributor and thereby of the load imposed on the engine. The feeler consists of a set of bellows, for moving an iron core in a coil arrangement, to change the inductivity of the coil arrangement.



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*Pressure switch*

- 1 - Armature
- 2 - Winding
- 3 - Leaf springs
- 4 - Bellows
- 5 - Diaphragm for full load enrichment
- 6 - Space with absolute pressure
- 7 - Space with atmospheric pressure

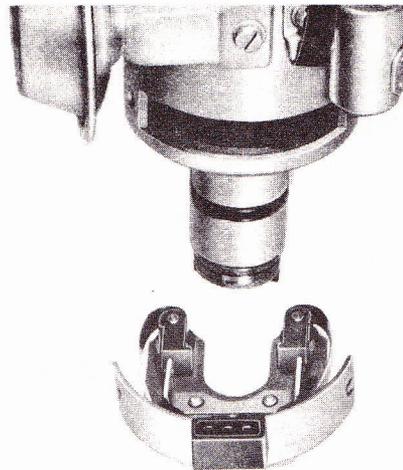
An additional diaphragm, which reacts to the difference between the pressure in the intake pipe and the atmospheric pressure, will also move the iron core to provide the enrichment required under a full load. The iron core is guided in two leaf springs. The bellows are in a chamber

connected to the intake air distributor by means of a hose line. This chamber is sealed, air-tight, against the outside air by another diaphragm. The space behind the diaphragm is connected to the outside air by a hole in the housing and is subject to atmospheric pressure.

The pressure in the intake air distributor acts on the bellows length and determines the position of the armature in the coil arrangement. The pressure feeler is therefore converting a change of the pressure conditions in the intake pipe into a change of the inductivity of its coils. This change of inductivity can be read by the control unit.

**The release contacts**

In the ignition distributor, the contacts determine when fuel is to be injected. Two sets of contacts, offset by 180° at the lower end of the ignition distributor, are actuated by an additional cam. The position of the cam and the position of the contacts in relation to the cam shaft position are set so that the start of the fuel injection is timed with the opening of the intake valves.



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*Fuel injection timing contacts*

Since both contacts are actuated by a single cam, the time span between the opening of the first and the opening of the second contact is a measure of the engine speed. The contacts also serve the speed-dependent control of the basic fuel quantity.

**The temperature feelers**

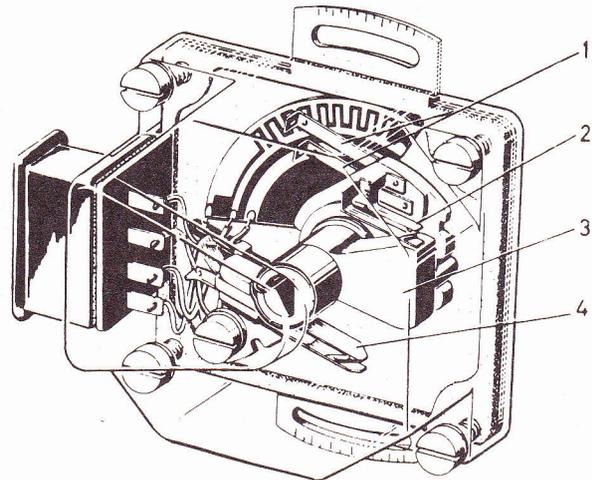
The temperature feeler I in the intake air distributor and the temperature feeler II on the cylinder head, control the enrichment while the engine is warming up. The temperature feelers are essentially resistors which change their resistance based on temperature.

**The throttle valve switch with acceleration enrichment**

This switch serves the purpose of locking the fuel supply under overrunning conditions by means of a contact

which is closed when the throttle valve is in an idling position. When the throttle valve is moved out of this idling position, by 2°, the throttle valve switch will open.

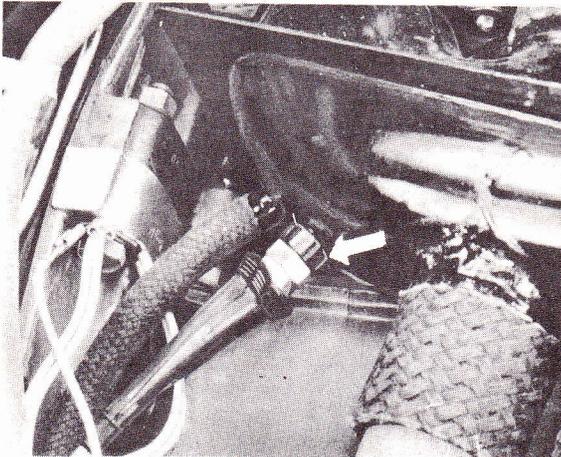
In addition, the throttle valve switch is provided with two contact decks with 10 contacts each (contacts for acceleration enrichment). Another contact (trailing contact) assures that the contact decks for acceleration enrichment will be operative only when the throttle valve moves from its closed position into its open position.



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*Throttle valve switch*

- 1 - Slip contacts
- 2 - Switch pair for acceleration function
- 3 - Connection with throttle spindle
- 4 - Switch pair for fuel shut-off function

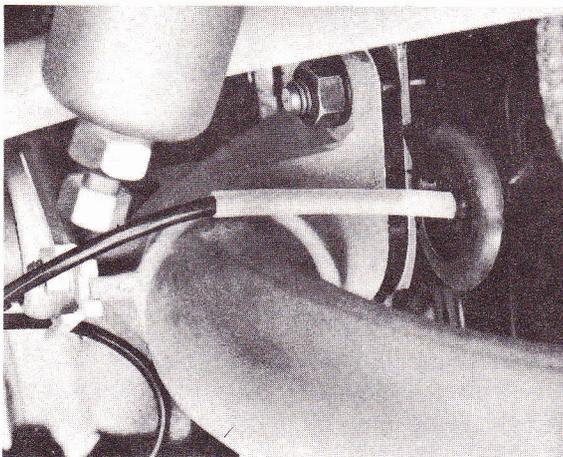


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*Temperature feeler I*

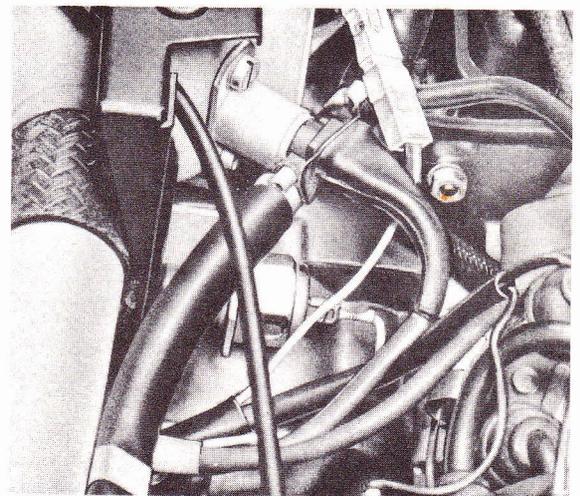
**The temperature switch for the cold starting device**

This switch connects the electro-magnetic cold starting valve to the chassis ground when the engine compartment temperature is below 41°F (5°C).



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*Temperature feeler II*



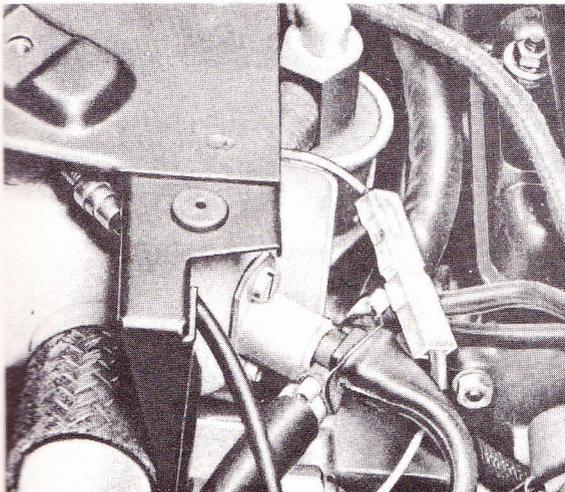
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*Temperature switch/cold starting device*

The function of the acceleration enrichment consists in the coverage of 9 – 10 contacts per contact deck during a movement of the throttle valve from zero to full. This transmits electric impulses to the control unit to determine the fuel quantity required for acceleration.

**The cold starting valve with a swirl nozzle**

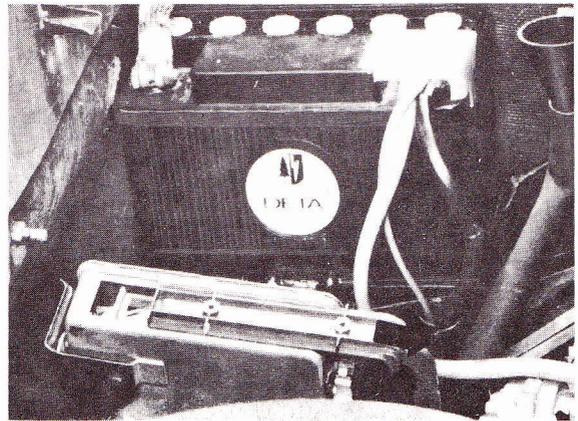
This controls the additional fuel quantity required during a cold start. It is an electro-magnetic valve which receives its operating voltage from the starter. This assures that the cold starting device is switched on only during a starting operation.



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*Cold starting valve*

plug, with the assistance of a wire hook.

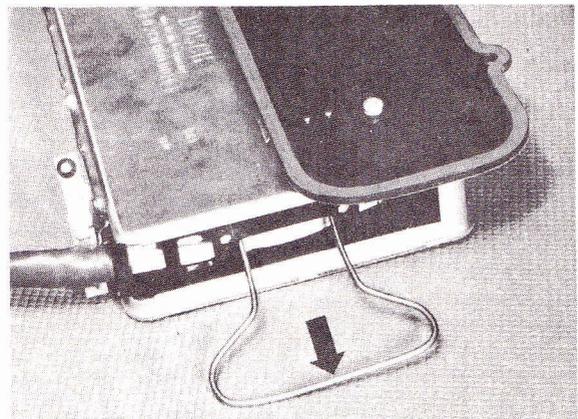


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*Control unit removal*

**Installation**

Install in reverse sequence of removal. Install the angle bracket and the slotted screw first.



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*Removal hook installed*



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*Removal hook*

**CONTROL UNIT**

The control unit consists essentially of the two end stages (switching transistors E I, E II), the switching logic (SL) and the time stage (ZS). The time stage is a monostable flipping stage, which has the tendency of flipping back to its stable position without requiring a new releasing impulse. The stable position is the "off" position.

Whenever an impulse comes from one of the two releasing contacts in the ignition distributor, the time stage is switched on. Simultaneously, the same releasing impulse induces the switching logic to energize the end stage of the appropriate valve group. For example, this would open the injection valves for cylinders 4 and 1. They will remain open until the time stage has flipped back to its stable position (off position). The time between the switching on and its flipping back to its off position determines the quantity of fuel injected.

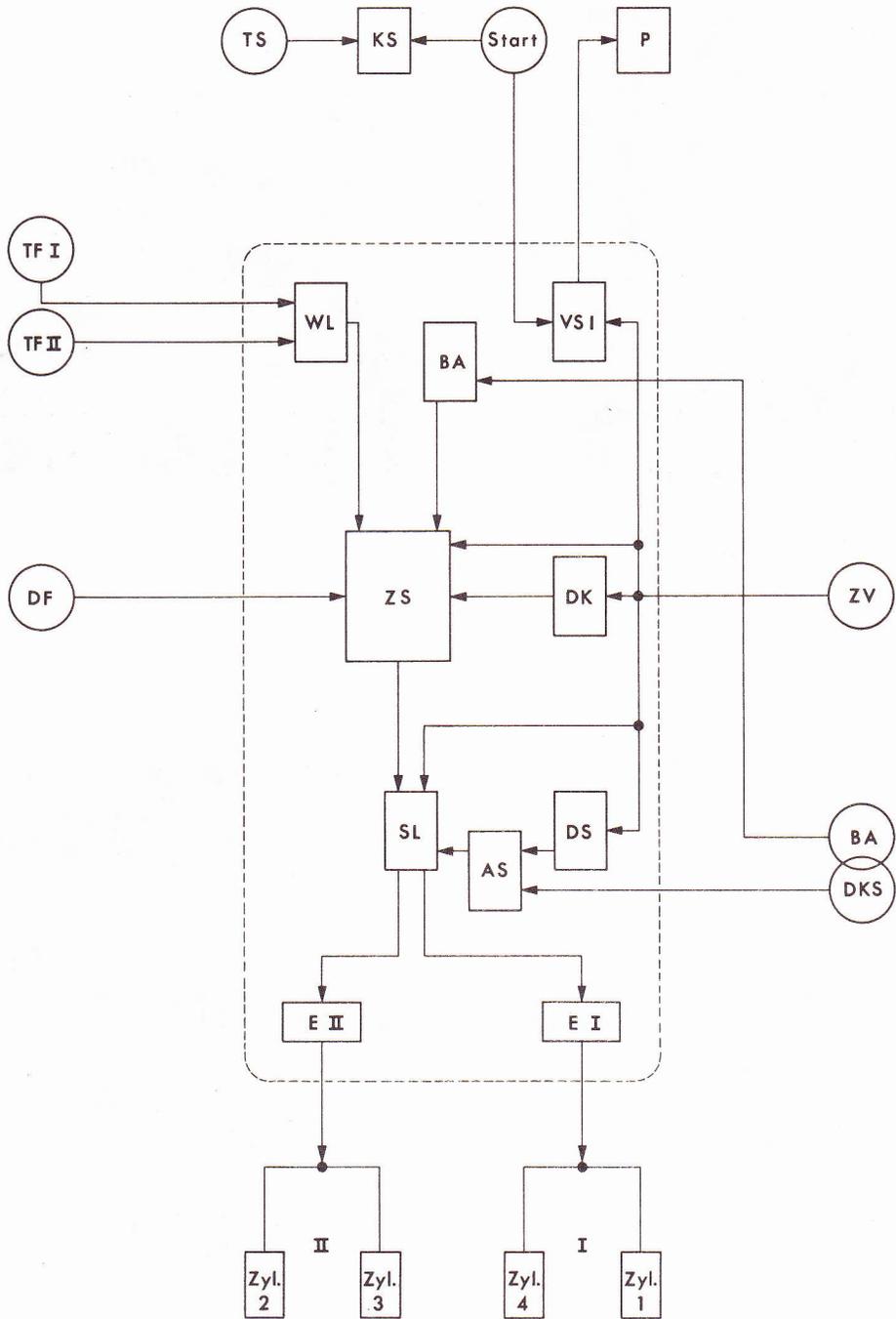
The control is also provided with a time circuit which permits operation of the fuel pump only when the starter is actuated or when the engine rotates at a speed above 100 rpm. As a result, the combustion spaces cannot fill up with fuel in the event of a defective engine or a fault in the injection system.

Starting enrichment, which is temperature dependent, is controlled from outside of the control unit. The switch logic is inside the control unit to guarantee that, in the event of contact bounce at the releasing contacts, double releases will not trigger the wrong valve group.

**Removal**

The control unit is screwed to a bracket in the engine compartment at the right, behind the battery. Pull off the hot air guide hose at the bottom right. Unscrew the two socket screws, and loosen one slotted screw. Pull the control unit out toward the left, together with the angle bracket.

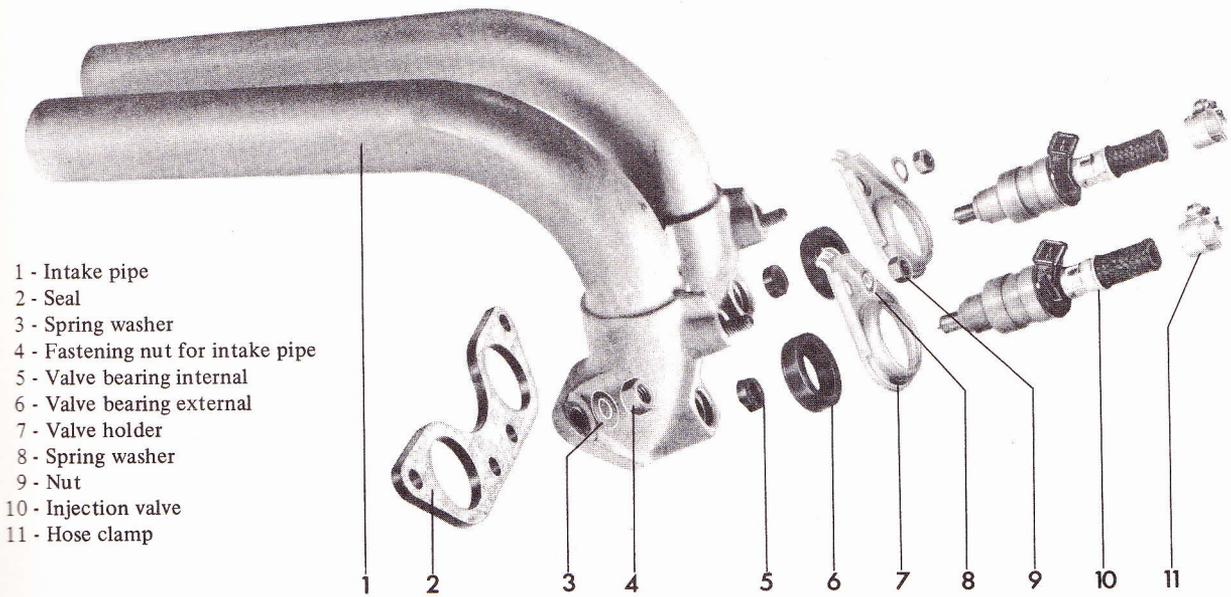
Unscrew the angle bracket. Open the cable clamp and pull out the valve for the control unit. Pull out the multiple



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Block circuit diagram of control unit

- |           |  |       |                                      |
|-----------|--|-------|--------------------------------------|
| St        | - Start signal                         | Zv    | - Ignition distributor contacts      |
| VSi       | - Overflow safety device               | BA    | - Acceleration enrichment            |
| BA        | - Acceleration enrichment              | DKS   | - Throttle valve switch              |
| WL        | - Warming up enrichment                | TF I  | - Temperature feeler I               |
| Zs        | - Time switch                          | TF II | - Temperature feeler II              |
| DK        | - Engine speed correction              | DF    | - Pressure feeler                    |
| DS        | - Engine speed switch                  | Zyl 4 | - Injection valves for cylinders 1-4 |
| AS        | - Shutoff function                     | KS    | - Cold starting valve                |
| SL        | - Switching logic                      | TH    | - Thermo switch                      |
| E I, E II | - End stages for valve groups I and II | P     | - Fuel pump                          |



- 1 - Intake pipe
- 2 - Seal
- 3 - Spring washer
- 4 - Fastening nut for intake pipe
- 5 - Valve bearing internal
- 6 - Valve bearing external
- 7 - Valve holder
- 8 - Spring washer
- 9 - Nut
- 10 - Injection valve
- 11 - Hose clamp

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*Injection valves*

**INJECTION VALVES**

**Removal**

Loosen the fastening nuts of both valves on one side. Check the valves for proper function (eject) and leaks. Replace damaged valves.

**Installation**

During installation note the following: Place the internal valve bearing prior to installation, into the pertinent holes of the intake pipe. Place the valve holder on the valve first. Then insert the external valve bearings. Be sure of the correct connection of valve plugs. Grey protective caps at the front, black caps at the rear (seen in driving direction).

**INTAKE PIPES**

**Removal**

The intake pipes of both sides can be separately removed and installed.

Remove the valves. Unscrew the four nuts. Unbend the fastening plates for the fuel valve line, on the front intake pipe. Remove the intake pipe, making sure that none of its parts drop into the cylinder head.

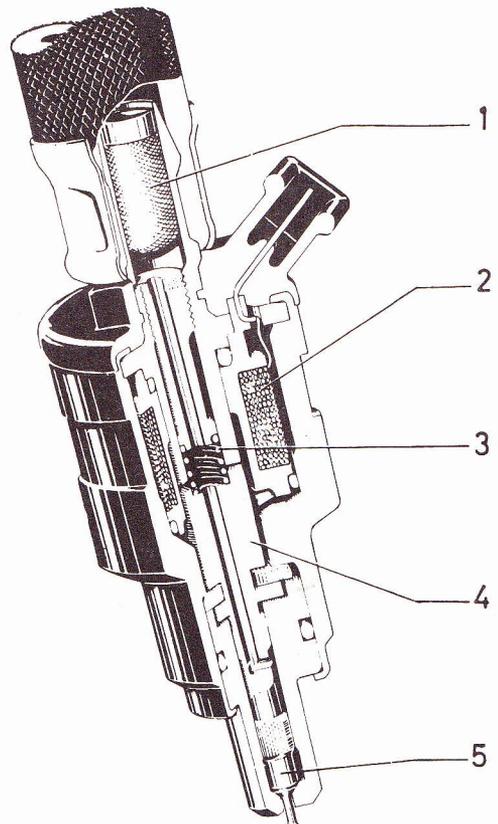
**Installation**

Install in reverse procedure of removal. Check the seal between the intake pipe and the cylinder head for damage.

**FUEL PUMP**

**Removal**

Remove the hose for guiding the hot air. Shut off all hose lines leading to the pump by means of clamps. Remove the pump. Be sure that the two rubber metal bearings, serving for attachment, are not damaged.



*Injector*

- 1 - Filter
- 2 - Magnetic winding
- 3 - Return spring
- 4 - Magnetic armature
- 5 - Sealing needle

**Installation**

Check the plug connection for corrosion and replace if required. Do not distort the rubber metal bearings. Connect the hoses and remove the clamps on the hoses. Check the hose connections for leaks.

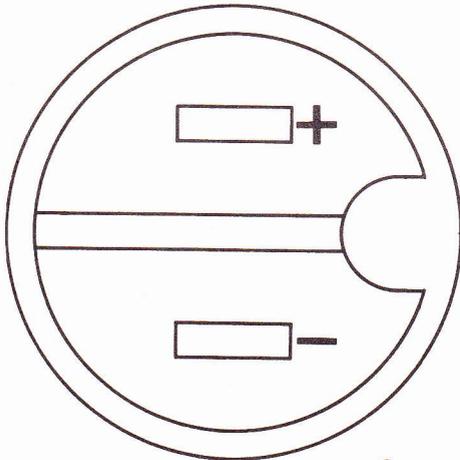
**FILTER**

**Removal**

Disconnect both lines leading to the filter together with the hose clamp and remove the hoses. Pull out the filter, toward the left.

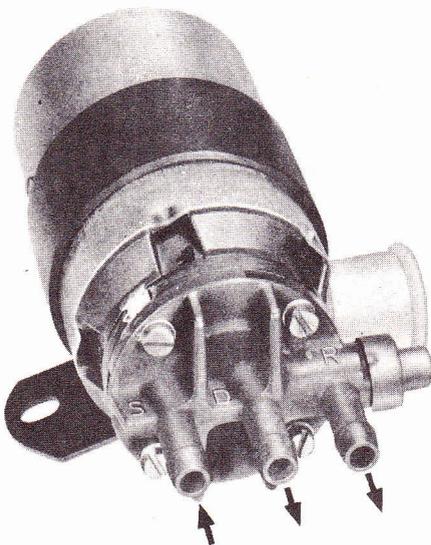
**Installation**

Be sure that the arrow on the filter points in the direction of the flow (upwards). Be careful when inserting the filter into the welded holder. Do not damage the bead of the filter.



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*Fuel pump plug*



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*Fuel pump connections*

S - Supply - D - Distributor - R - Return

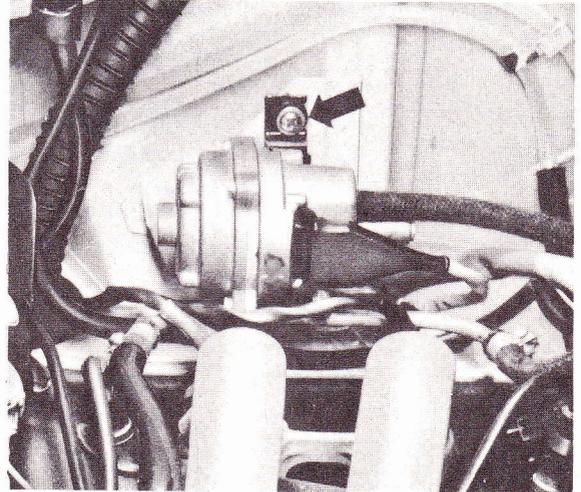
**PRESSURE FEELER**

**Removal**

The pressure feeler is attached in the engine compartment, at the right, on the body.

**Installation**

When installing a new pressure feeler, the protective cap on the pressure connection may be removed only shortly prior to the fitting hose.



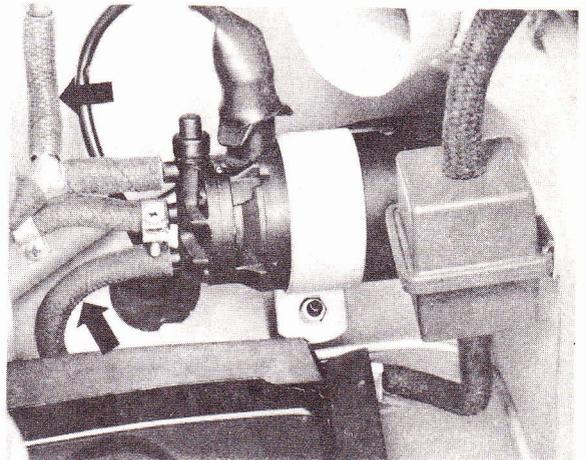
© Volkswagen

*Pressure feeler removal*

**TEMPERATURE FEELER I**

**Installation**

Care should be taken to not tighten to excess during installation.



© Volkswagen

*Fuel pump*

**TEMPERATURE FEELER II**

**Removal**

Loosen the cable connector and remove the rubber gasket on the cylinder jacket with a tubular socket wrench.

**Installation**

Check to see that the rubber cover is properly seated. Install the rubber cover in such a manner that the cast-in letters are on the outside.

**PRESSURE REGULATOR**

**Removal**

Cut up the tube hose clamps. Unscrew the fastening nuts and remove the pressure regulator.

**Installation**

Install the pressure regulator in a reverse sequence, using new hose clamps. Measure the initial fuel pressure and correct, if required.

**Checking and Adjustment**

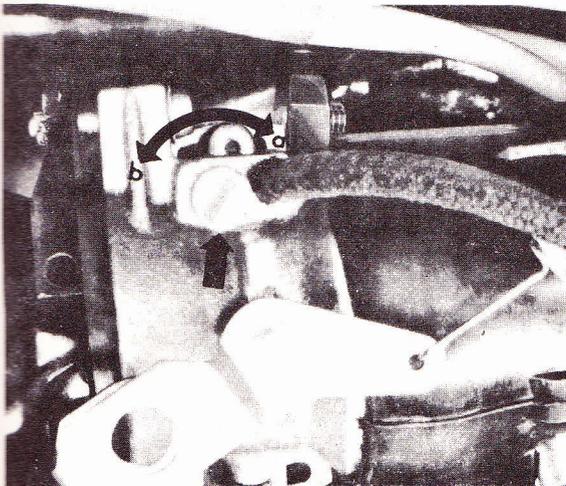
Connect the pressure gauge. Switch on the ignition and pull off the wire between the ignition distributor and the ignition coil

Operate the starter and read the pressure on a pressure gauge. The rated value is 28.4 psi. Adjust the pressure regulator only when the rated value is exceeded or is not attained.

**IDLING SPEED**

**Adjustment**

Remove the air filter. Turn slotted screw at throttle valve clockwise to increase speed, and counterclockwise to lower idle speed. Set the speed to 900 rpm.



© Volkswagen

*Idle speed adjustment*

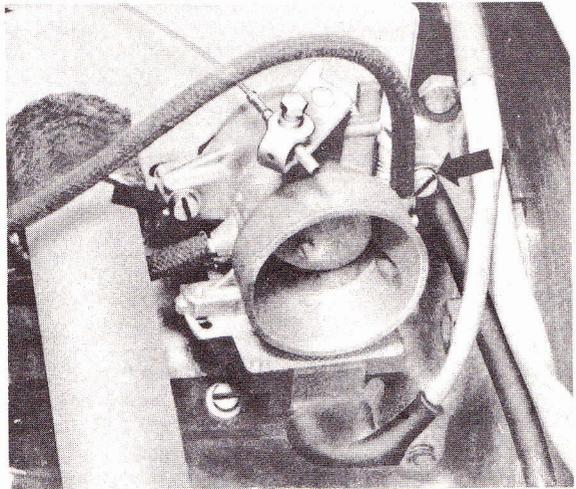
a - faster - b - slower

**THROTTLE VALVE SWITCH**

**Removal**

Remove the air filter and disconnect the return spring for

the throttle valve. Remove the intake connection, but do not remove the bowden wire for the throttle valves and the connecting hoses to the ignition distributor. Remove the throttle valve switch.

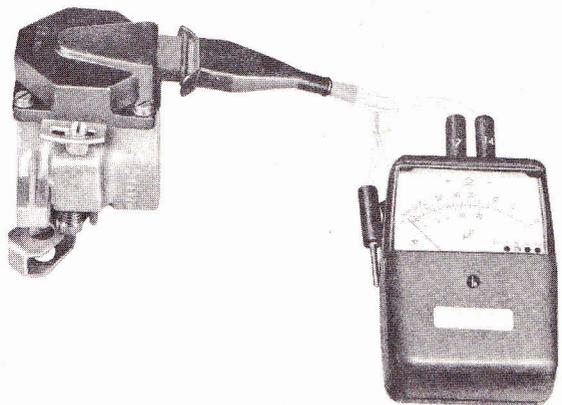


© Volkswagen

*Air intake removal*

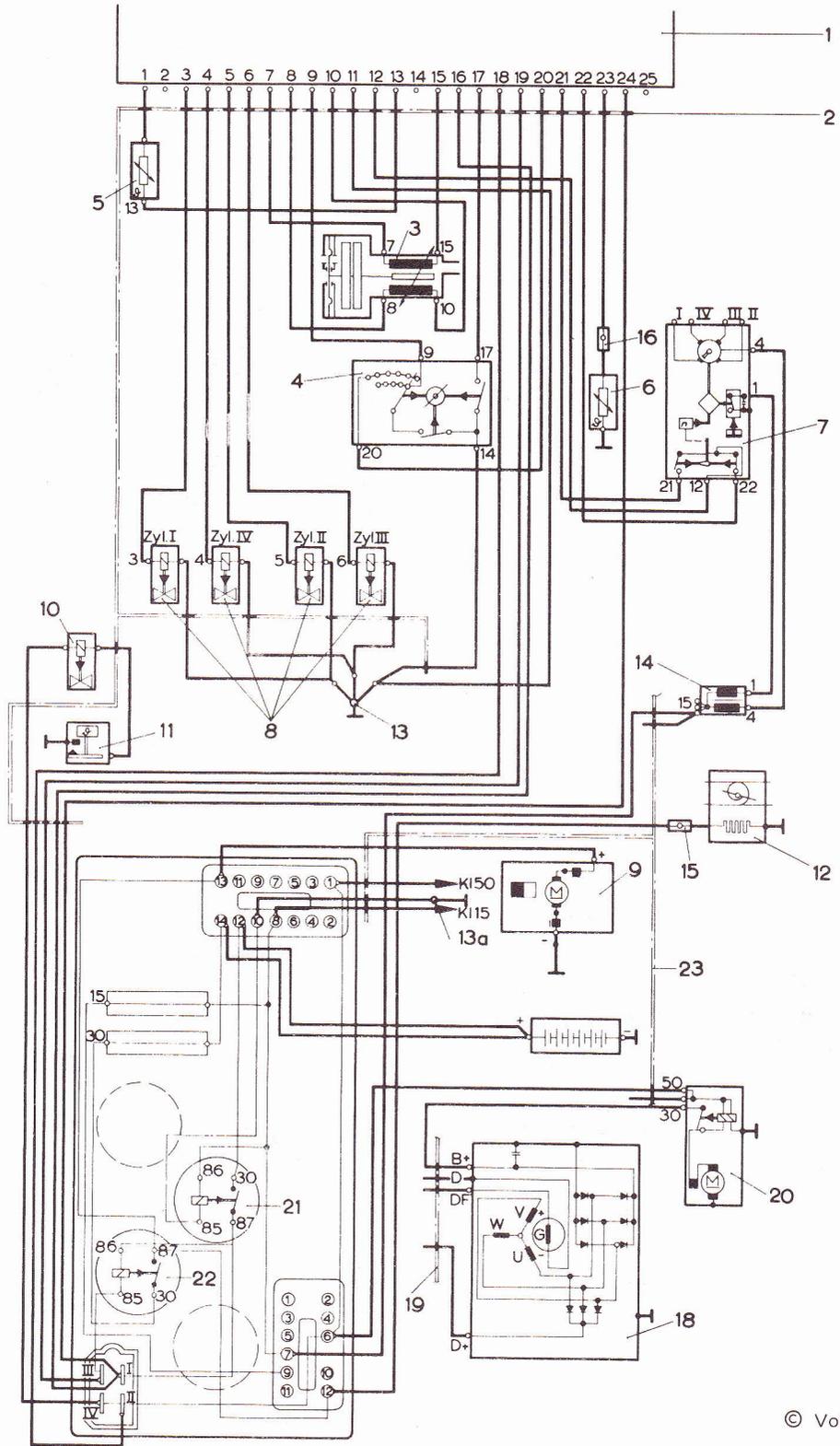
**Adjustment**

The switch contact on the throttle valve switch should open when the throttle valve is opened by 2° from its closed position. Connect the tester and close the throttle valve. Turn the throttle valve switch in direction of arrow A until the ohmmeter indicates 0. Then turn it another division mark (2°). Tighten the fastening screws.



© Volkswagen

*Testing throttle valve switch*



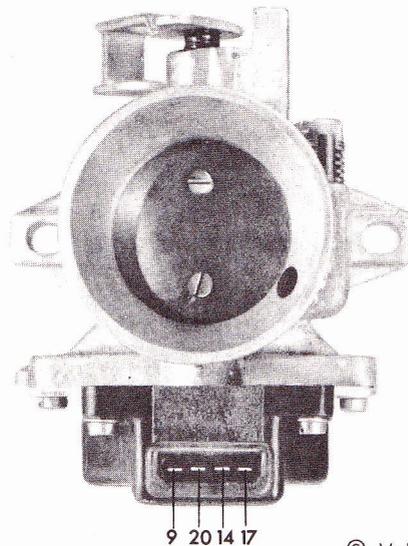
Fuel injection wiring diagram

### Checking equipment

The most significant piece of equipment for checking the injection system is the Bosch tester. It is used to test all the information transmitters as well as the pump and injection valves according to an accurately determined test program. Within this test program the fuel ring line is also tested for pressure and the presence of leaks. It is important that all these points are checked during a test.

Before starting the test, complete the following: Switch off the ignition to deenergize the control unit. Remove the control unit. Pull the multiple plug out of the control unit and connect the plug of the tester to the multiple plug of the cable line. Switch on the ignition and check all functions in accordance with the test program.

- 1 - Control unit
- 2 - Electronic cable line
- 3 - Pressure feeler
- 4 - Throttle valve switch with acceleration enrichment
- 5 - Temperature feeler I (intake distributor)
- 6 - Temperature feeler II (cylinder head)
- 7 - Ignition distributor with impulse release
- 8 - Injection valve
- 9 - Fuel pump
- 10 - Fuel valve
- 11 - Thermo switch for fuel enrichment
- 12 - Supplementary air valve
- 13 - Earth connection (on engine housing)
- 14 - Ignition coil
- 15 - Line connectors
- 16 - Regulator for alternator
- 17 - Alternator
- 19 - Cable line alternator
- 20 - Starter (starter motor)
- 21 - Voltage supply relay
- 22 - Pump relay
- 23 - Lines not included in main cable line



© Volkswagen

*Throttle valve switch connections*

### Installation

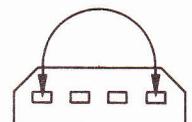
Install in reverse procedure of removal; note the following: Prior to installing the intake connections again, adjust the throttle valve switch.

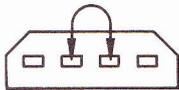
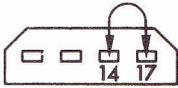
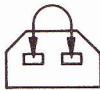
## FUEL SYSTEM 3-12

The fuel injection system can be checked accurately only with the tester. When testing acc. to the Check List, deviations from the rated value will be noticed. Whatever

has to be done in such cases in addition, is shown in the following list.

Check. step	Result	Possible Cause (remedy)
1 Voltage I	No indication	Interruption: terminal 85 on relay I no voltage (check whether terminal 15/ignition coil has voltage, check line), terminal 30 on relay I no voltage (check acc. to Wiring Diagram), terminal 86 on relay I no earth connection (check earth connection), connection between terminal 87 of relay I and terminal 16 control unit interrupted (check line 16).
	Voltage below 11 Volt	Transfer resistance in line 16/control unit or on relay contacts (check line, change relay I)
2 Voltage II	similar to checking step 1, but check line to terminal 24 control unit	
3 Voltage Starter	No voltage, starter is running	Line interruption from starter solenoid switch to control unit (check line 18).
	No voltage, starter is not running	Ignition starter lock defective, line interruption
	Voltage below 9 Volt	Battery discharged, voltage drop too high in line from ignition starter lock to terminal 50 of starter solenoid switch (check line with volt meter).
4 Align to $\infty$	If no full deflection is obtained on instrument, battery voltage in vehicle is too low. Also refer to checking steps 1 and 2.	
Pressure feeler earth connection	Resistor 0	Earth connection in supply line or on pressure feeler (pull plug on pressure feeler, if indication is then $\infty$ , exchange pressure feeler. If indication remains unchanged at 0, short circuit in line 7.8, 10, 15, exchange cable line).
	Indication under $\infty$ but not 0	Insulation damage (similar to 5, resistor 0).
5 Pressure feeler primary	Rated value approx. 90 $\Omega$ resistance considerably less	Insulating damage (pull plug on pressure feeler, if indication is then $\infty$ , exchange pressure feeler).
	Resistor 0	Earth connection, short circuit of primary line (pull plug on pressure feeler, if indication is then $\infty$ , exchange pressure feeler).
	Rated value approx. 90 $\Omega$ resistance considerably higher	High transition resistance (check plug and lines for corrosion or interruption).
	Resistor $\infty \Omega$	Interruption (Bridge on plug as shown in illustration. If indication is 0, exchange pressure feeler. If indication is $\infty$ , repair line).



Check. step	Result	Possible cause (remedy)
6 Pressure feeler secondary	Similar to 5 rated value but approx. 350 Ω	Similar to 5 at resistance ∞ , bridge the two other terminals. 
7 Ignition distributor contact I	Resistance higher than 0 or lower than ∞ Ω	If the needle of the instrument does not deflect during "Starting" or remain in one position -∞ or 0 - renew contacts. (Replace contact insert.)
8 Ignition distributor contact II		
9 Throttle valve switch I then throttle valve switch II	Needle remains at ∞ or needle remains not at ∞ when throttle valve is returned	Throttle valve switch defective (replace)
	Needle remains at 0	Short circuit (pull plug on throttle valve switch, if needle is then ∞ , replace throttle valve switch, otherwise cable line)
10 Throttle valve switch III	Resistance ∞ with throttle valve lever in position "Idling"	Throttle valve switch wrongly set or interruption in supply line. (Check adjustment, pull plug, bridge. If then still ∞ , replace cable line, otherwise replace throttle valve switch). 
	Resistance 0 Ω with throttle valve opened more than 2°	Throttle valve switch wrongly adjusted or short circuit in supply line. Pull plug, if indication is then still 0, adjust or replace cable line, otherwise throttle valve switch).
11 Temperature feeler I (in intake distributor)	Rated value 350 Ω resistance higher or lower	Rated value applies at 20°C (68°F). Resistance decreases with increasing temp. Feeler is in order, if no 0 or ∞ is measured.
	Indication ∞ Ω	Interruption. (Bridge, if indication is then 0, replace temperature feeler, otherwise cable line). 
	Indication 0 Ω	Short circuit. (Pull plug, if indication remains unchanged, cable defective. If indication is ∞ , replace temperature feeler).
12 Temperature feeler II (cylinder head)	Similar to 11 with the following deviations: rated value 2.5 k Ω , instead of bridging: hold plug of cable line to mass.	
13 Valves (Resist.)	Resistor 0 Ω	Short circuit in supply line or on valve. (Pull plug on respective valve, if indication is then ∞ , replace valve, otherwise replace cable line).
	Resistor ∞ Ω	Interruption in supply line or in valve coil. (Bridge contacts in valve plug, if indication is then ∞ , cable line defective. If then 0, valve defective).
	Rated value 2.4 Ω at 20°C, resistance higher, but not ∞	Earth connection of valves is badly connected to crankcase or flat plug connection is badly plugged (use contact spray, tighten earth connection screw).
	Resistor under 2.4 Ω but not 0	Interturn short circuits of valve (replace)

Check. step	Result	Possible cause (remedy)
<p>14 Pressure in ring line</p>	<p>Pressure above 2 kp/cm<sup>2</sup> (28.4 psi)</p> <p>Pressure below 2 kp/cm<sup>2</sup></p>	<p>Pressure regulator wrongly adjusted (adjust); if not adjustable, pressure regulator defective (replace).</p>
	<p>No pressure established (pump does not start)</p>	<p>Pump without power. (Pull two-pole plug on pump housing and measure voltage with voltmeter. Voltage should be indicated, when button "Pump" on tester is pushed.)</p> <p>Indication 12 Volt: Replace pump.</p> <p>Indication 0 Volt: Listen whether pump relay (under instrument panel) attracts.</p> <p>If yes: Line interruption from pump relay, terminal 87, to 2-pole plug or from 2-pole plug to mass connection, or pump relay defective.</p> <p>If no: Line interruption from terminal 87 voltage supply relay to pump relay, terminal 86 or 85, to line 19 in cable tree (line connector in engine compartment). If line in order, replace pump relay.</p>
<p>15 Pressure drops immediat. upon releasing button "Pump" slowly, but steadily</p>	<p>Leak in pressure system (from fuel pump to pressure regulator). Disconnect fuel ring line prior to injection valve with self-made clamp or suitable pliers. If there is no pressure loss, the leak is in the pressure line or pump; if there is a loss of pressure the leak is in the ring line connection to the injection valves, in the injection valves themselves or on the pressure regulator. Establish pressure several times during the test, if required.</p> <p>Sight test for leaking hose connections (also pressure gauges). If not; remove the two valve groups one after the other, also remove cold starting valve. Push button "Pump" and check for leaks by sight test. Valve opening may become wet. (But there should be nor more than 2 drops per minute). If not leak is found, replace pressure regulator.</p>	

## FUEL SYSTEM – 1971/1972 MODIFICATIONS

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### 1971 MODIFICATIONS

The overrun fuel cut-off device previously closed the throttle valve @ 1800 rpm. For 1971 the cut-off has been increased to 3100 rpm. The control unit part number is #022 906 021B.

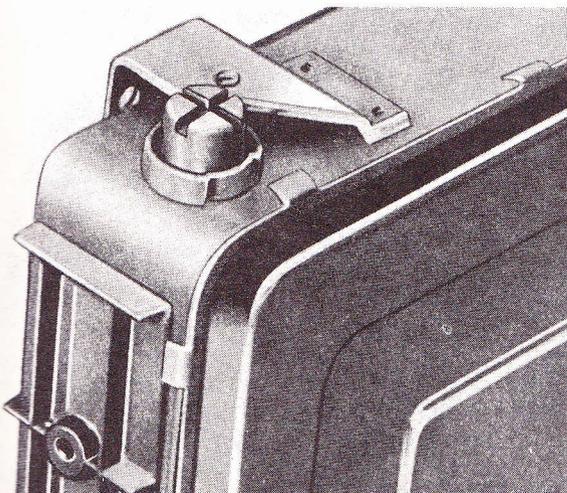
The pressure sensor has been changed to provide a leaner mixture at partial load. The part number is #022 906 051A.

### 1972 MODIFICATIONS

In order to conform to emission control regulations a number of changes have been made to the fuel system. In addition, an oil baffle plate to ensure the oil intake pipe remaining submerged when car corners sharply.

#### Description

From August 1971, a new control unit was installed. This control unit contains an external adjusting potentiometer. By turning the adjusting knob, the CO content of the exhaust gases can be varied. A protective cap is provided to prevent moisture from entering the control unit. The cap must be installed after the installation of the control unit.



© Volkswagen

Control unit with potentiometer

#### Adjusting, with CO meter

Set the ignition timing and adjust the valves. Adjust the throttle valve switch and connect the CO meter. Follow maker's instructions. Start engine and adjust idle speed to 800-900 rpm, with throttle closed. Oil temperature should be between 122 and 158°F. Turn potentiometer adjusting knob until emission level of 0.7% max. is obtained.

#### Adjusting, without CO meter

Set the ignition timing and the valve clearances. Adjust the throttle valve switch. Turn the potentiometer knob counterclockwise as far as it will go. Do not force it. Turn 12 clicks in a clockwise direction, for basic setting. Test drive the car. If the engine backfires on the overrun, the potentiometer should be turned clockwise, a maximum of three notches.

### THROTTLE VALVE SWITCH

#### Adjusting

Before adjusting, check with tester EFWA 193, with adaptor. Switch on the ignition. Select "throttle valve switch I" on the adaptor. Slowly open the throttle valve switch. The needle of the ohmmeter should fluctuate ten times between zero and infinity. Repeat with adaptor set to "switch II".

If less than 10 movements occur, the throttle valve switch must be adjusted. It is recommended that the intake manifold be removed. Loosen the two screws through base of switch. Close the throttle and carefully turn the throttle valve switch in a counterclockwise direction, up to the stop. Retighten base screws and re-install intake manifold.

### INCREASED AIR SUPPLY DEVICE

#### Description

At high engine speeds with the throttle valve closed (overrun condition) pressure in the intake air distributor is less than atmospheric. In this condition the pneumatic valve opens so air can pass from the air cleaner to the intake air distributor. The fuel/air mixture is thus leaned out with the additional air.

#### Checking

Pull off the hose between valve and air cleaner at the cleaner end. Start engine and increase speed briefly to approx. 3000 rpm. Quickly close throttle. Check that air

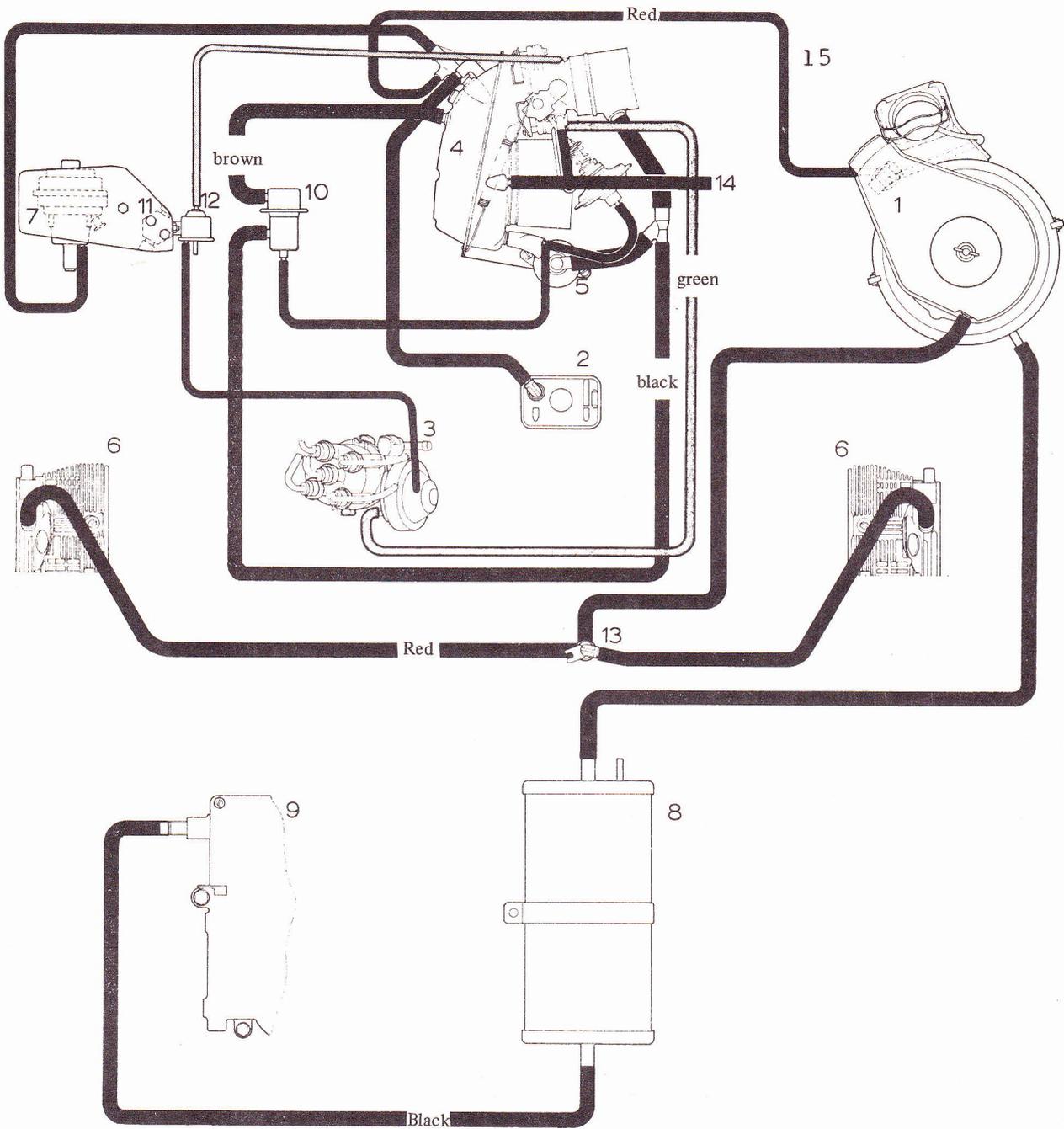
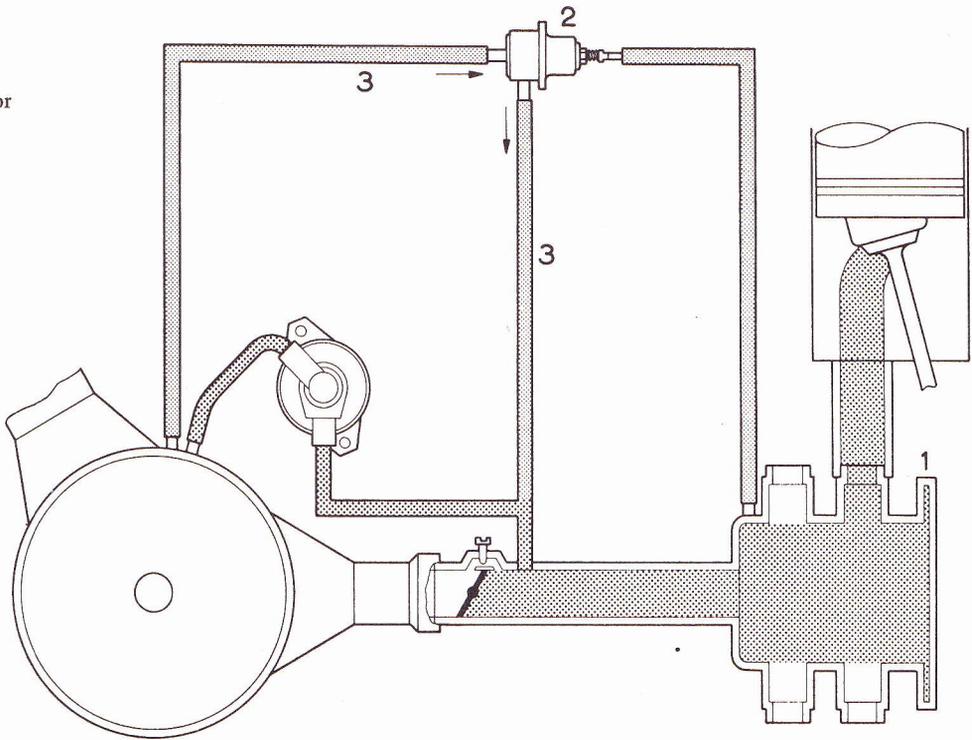


Diagram of hoses in engine

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| <ul style="list-style-type: none"> <li>1 - Oilbath air cleaner</li> <li>2 - Oil breather</li> <li>3 - Distributor</li> <li>4 - Intake air distributor</li> <li>5 - Additional air regulator</li> <li>6 - Cylinder head</li> <li>7 - Pressure sensor</li> <li>8 - Activated carbon container</li> </ul> | <ul style="list-style-type: none"> <li>9 - Cooling fan shroud</li> <li>10 - Pneumatic valve for overrun mixture adjustment</li> <li>11 - not applicable for type 914</li> <li>12 - Two-way valve for vacuum advance (California only)</li> <li>13 - Non-return device</li> <li>14 - not applicable for type 914</li> <li>15 - Pre-heating of air intake</li> </ul> |
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- 1 - Intake air distributor
- 2 - Pneumatic valve
- 3 - Hoses

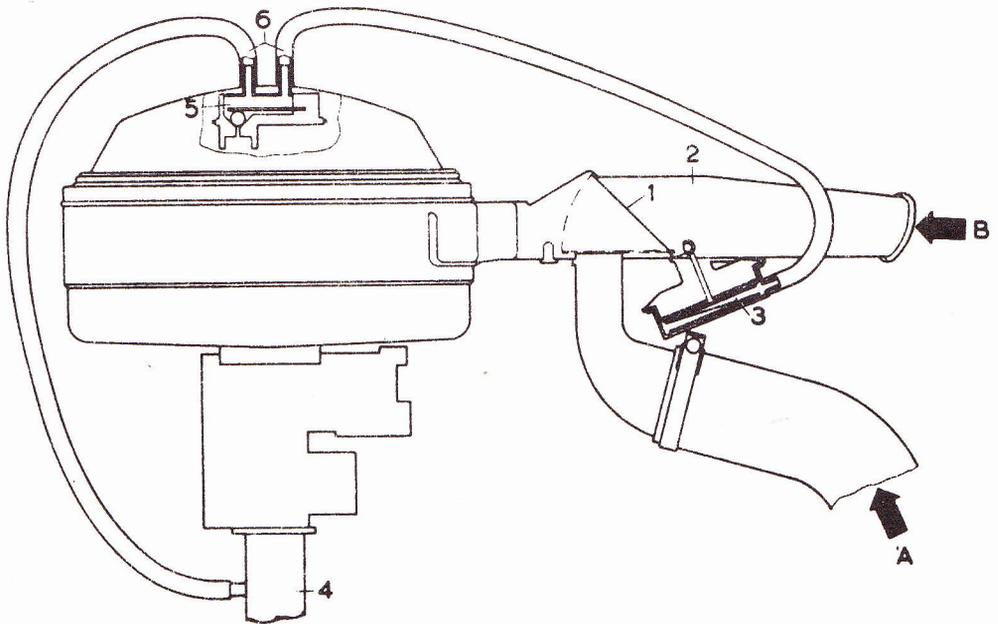


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*Intake air distribution*

- A - Release of hot air
- B - Intake of cold air

- 1 - Regulating flap
- 2 - Intake scoop
- 3 - Vacuum box
- 4 - Intake manifold
- 5 - Ventilating valve
- 6 - Hoses



© Volkswagen

*Thermo pressure air regulator system*

is being drawn into the hose (at the end removed from the air cleaner). If no suction effect is detected, replace the valve.

### **INTAKE AIR PRE-HEATING**

#### **Description**

A vacuum box is incorporated in the air intake scoop, with a diaphragm and lever operating flap. The vacuum box is connected by hoses to the intake manifold by a ventilating valve. It is thermostatically regulated. The load dependent control allows warm air to enter the intake manifold during periods of high vacuum; when the throttle is closed or only slightly open. The temperature control, ventilating valve, remains closed as long as the

incoming intake air is below 135°F., allowing the vacuum control to operate independently. When the temperature goes above 135°F the valve opens, allowing the outside air to flow in. The hot air supply is shut off regardless of throttle position.

### **CRANKCASE AIR SUPPLY AND VENTING**

#### **Description**

Crankcase breathing has been increased to prevent condensation build-up in the crankcase and icing of breather lines in cold weather. Air from the air cleaner enters the valve covers, and then through the pushrod tubes to the crankcase. Here the air mixes with the fumes. It is then drawn out of engine into the air distributor.

# IGNITION 4

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4

### DESCRIPTION

The ignition system operates as a battery ignition with an ignition coil and an ignition distributor with an automatic firing point adjustment. The battery voltage is transformed to the required ignition voltage in the ignition coil. The distributor shaft with the contact breaker cams, opens the breaker contact shortly before the piston has attained an upper TDC in the cylinder to be fired. As a result, the current in the primary winding of the ignition coil is interrupted.

The magnetic field established by the current, suddenly collapses and induces the ignition voltage in the secondary winding. This ignition voltage travels via an ignition cable to the rotor of the ignition distributor which, is exactly opposite the contact in the ignition distributor head to which the spark plug of the cylinder to be ignited is connected. A spark can jump at the electrodes of the spark plug to ignite the compressed fuel/air mixture in the cylinder.

#### Ignition coils

The ignition coil consists of a laminated iron core, which carries a primary winding and a secondary winding. The one end of the primary winding is connected to the battery together with the secondary winding via a terminal. The other end of the primary winding is connected to ground via a terminal and the contact breaker points. The secondary winding leads to the high voltage line connection.

#### Ignition distributor

The distributor serves the purpose of feeding the ignition

current to each of the four spark plugs in the correct sequence and at the accurate firing moment. A centrifugal and double-acting combination vacuum control installed in the ignition distributor will automatically adjust the most favorable firing point for each speed and load of the engine.

#### Centrifugal adjustment

Two weights on a supporting plate are forced outwards at increased engine speed. This turns the breaker cam in the direction of rotation (advancing ignition) via a lever. Return springs pull the weights back in position when the speed drops.

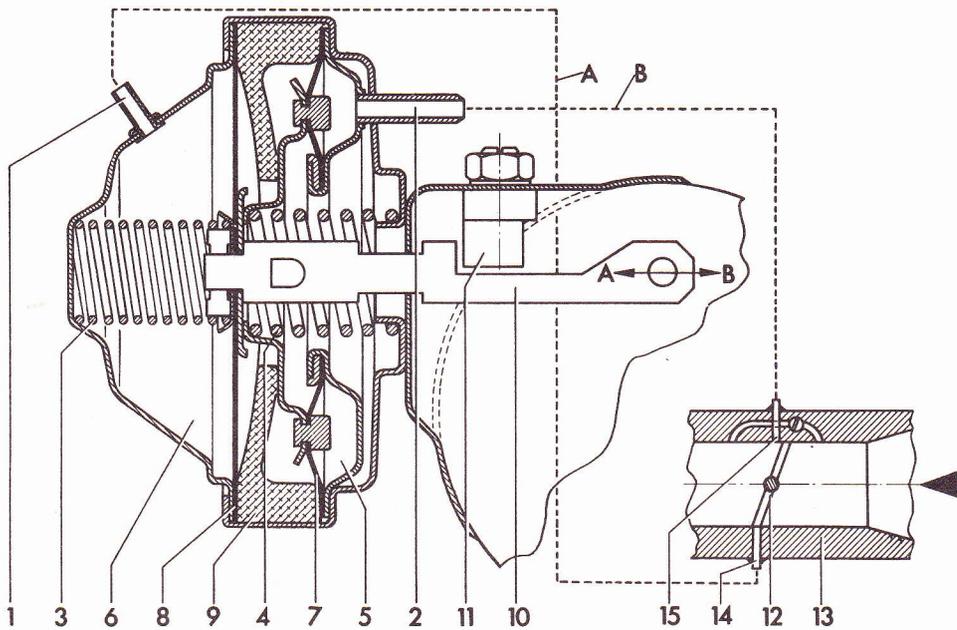
#### Vacuum adjustment

The vacuum from in front of and behind the throttle valve is taken in separate lines to the two vacuum chambers inside the vacuum unit of distributor. The diaphragm of these chambers actuate the contact breaker plate via a pull rod. The vacuum for the adjustment in the direction of "retarded ignition" required for idling speed, is from behind the completely closed throttle valve. It acts on the contact breaker plate via the angular vacuum diaphragm.

When the throttle flap is opened, the vacuum from in front of the throttle valve dominates and the contact breaker plate is adjusted in the direction of "advanced ignition".

#### Spark plugs

Since spark plugs are constantly subject to very high electrical, mechanical, chemical and particularly thermic stresses, the startability, the idling speed characteristic,



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Vacuum advance system

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>1 - Vacuum connection for advanced adjustment</li> <li>2 - Vacuum connection for retarded adjustment</li> <li>3 - Compression springs for advanced adjustment</li> <li>4 - Compression springs for retarded adjustment</li> <li>5 - Vacuum chamber (angular) for retarded adjustment</li> <li>6 - Vacuum chamber for advanced adjustment</li> <li>7 - Diaphragm for retarded adjustment</li> <li>8 - Diaphragm for advanced adjustment</li> </ul> | <ul style="list-style-type: none"> <li>9 - Supporting ring</li> <li>10 - Pull rod</li> <li>11 - Adjusting cam for restricting retarded adjustment</li> <li>12 - Throttle valve</li> <li>13 - Intake duct (intake distributor)</li> <li>14 - Vacuum tapping point advanced adjustment</li> <li>15 - Vacuum tapping point retarded adjustment</li> </ul> |
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the acceleration and the maximum output of an engine depend to a great extent on the selection of the proper plug. In addition to the mechanical and electrical properties of a spark plug, the thermal value is of considerable importance.

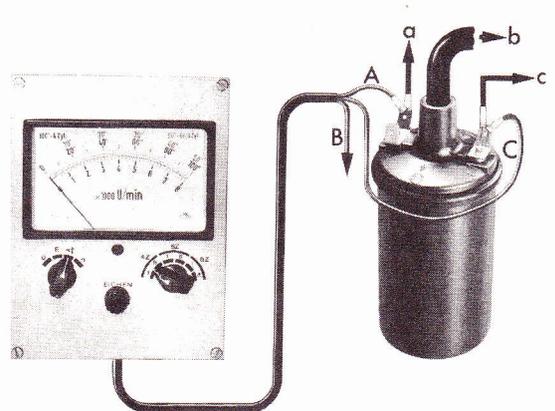
The thermal value indicates the heat-carrying capacity. The higher this capacity, the higher the resistance against spontaneous ignition (pre-ignition), and the lower the resistance against contamination. These characteristics are reversed in spark plugs with lower thermal values.

**CONTACT BREAKER POINTS**

**Testing and adjusting**

Contact breaker points are subject to burn-off, which develops in the shape of small humps and/or pits (contact creep with DC). This will generally not interrupt operation. But if the contacts are badly burnt, they must be replaced. Pits and humps with a bright contact surface, indicate normal wear.

Greyish color of contact surfaces may be caused by insufficient contact gap and/or contact pressure. If a bluish color appears on the contact surfaces, the ignition



© Volkswagen

Dwell angle meter

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>A - red clip</li> <li>B - black clip</li> <li>C - green clip</li> </ul> | <ul style="list-style-type: none"> <li>a - to ignition lock (15)</li> <li>b - to ignition distributor (4)</li> <li>c - to ignition distributor (1) (breaker contact)</li> </ul> |
|--|---|

coil or capacitor are defective. The appearance of yellow or black porous scars is caused by contamination (grease, oil or dust).

Prior to installing new contacts, blow out the inside of the distributor well. In addition, be sure that the distributor head is clean and dry inside and out, to prevent creeping currents.

**Adjusting breaker contacts with dwell meter**

Remove the distributor cap and the distributor rotor. Check the breaker contact points. Badly burned, soiled or heat-tinted contacts must be replaced. Set the contact gap to approx. 0.016 in. and make sure that the contact surfaces are parallel to each other. Contact surfaces should never be touched by grease or oil. Connect the dwell angle meter and calibrate.

Run the engine at 1000 to 1200 rpm and read the value. (Adjusting value: 44-50° or 49-55%; Wear limit: 42-58° or 47-64%). Wear limit means that the timing angle need not be adjusted as long as it is between 42 and 58° or 47 and 64%. Run the engine at 2000 to 2500 rpm and read values again.

Small contact gap gives a large dwell angle while a large contact gap gives a small dwell angle. Evaluation of measurement results: The contact gap should not be below 0.012 in. If the timing angle measurements show that a smaller gap would be required (measured with a feeler gauge), a mechanical fault in the distributor is indicated.

If the speed is raised during measuring (to approx. 2000-2500 rpm), the dwell angle indicated should not change considerably (max. ±1°). Larger deviations indicate a fault in the distributor, for example worn bearings or runout of distributor cams. Restless, jerky motions of the needle are generally caused by burned-out and unuseable contact breaker points.

Upon the adjustment of the breaker contact points, be sure to adjust the timing again, since a change of the contact gap by 0.004 in. corresponds to a change of the timing by approx. 3° crankshaft.

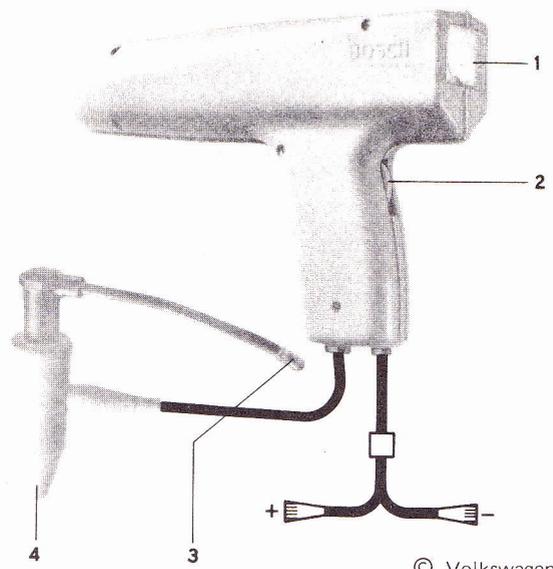
**TIMING WITH STROBOSCOPIC LIGHT**

**Adjustment**

Prior to each adjustment of the timing, be sure to check the dwell angle of the contact breaker points and adjust if necessary. Be sure that the engine oil temperature is between 60 and 70°C. Check whether the timing marks are easily seen (mark with a colored stripe, if required).

Connect the stroboscopic light and tachometer in accordance with instructions (into ignition line of cylinder no. 1). Pull both vacuum hoses from the vacuum unit on the distributor. Run the engine at 3500 rpm and direct stroboscopic light at the impeller. The timing is correctly adjusted when the red 27° mark on the impeller is in alignment with the reference mark on the cooling blower housing.

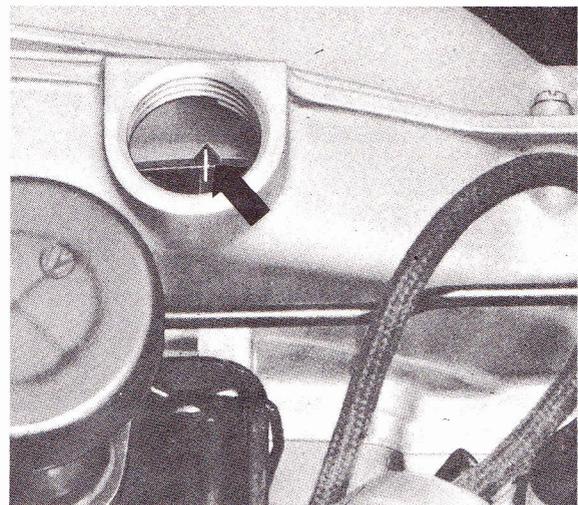
Correct faulty adjustments by turning the ignition distributor. The impeller has two notches. The black 5° mark serves for the static adjustment of the timing, with the engine stopped.



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*Stroboscopic light*

- 1 - Timing angle measuring instrument
- 2 - Adjusting wheel
- 3 - to ignition cable cylinder 1
- 4 - in ignition distributor cap cylinder 1



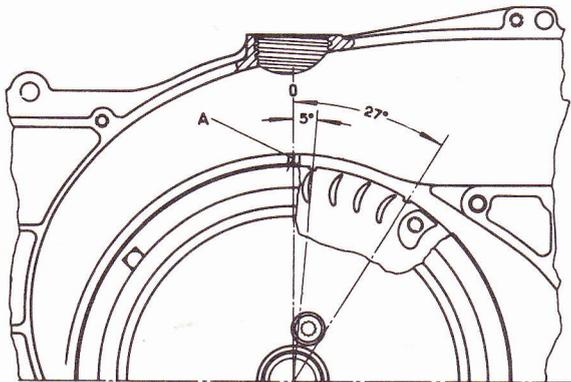
© Volkswagen

*Timing mark location*

**AUTOMATIC ADJUSTMENT OF TIMING**

**Checking the centrifugal advance**

The effect of the centrifugal advance can be observed by turning the attached distributor rotor manually and clockwise. Upon release, the rotor should automatically return to its starting position. If not, the centrifugal advance mechanism is either contaminated or the spring tension of the return springs has declined.



© Volkswagen

Timing marks

- 27° before TDC = red
- 5° before TDC = black
- A = notch in cooling blower housing

The centrifugal adjustment of the ignition distributor can be tested by means of an advance measuring instrument in combination with a tachometer and strobe light. Check the static adjustment of the timing and correct, if required.

Pull both vacuum hoses from the vacuum unit of the ignition distributor. Run the engine at max. 900 rpm and flash black 5° mark. Determine the deviations from the basic ignition adjustment resulting from the absent vacuum connections by means of the adjusting wheel on the adjusting angle measuring instrument. Remember the difference. Increase the speed slowly. The beginning of the adjustment is indicated by the shifting of the notch.

Adjust the speed to the proper values. Use the adjusting wheel on the adjusting measuring instrument to "return the notch to the mark in the blower housing". Read the adjustment in degrees on the measuring instrument. Deduction of the difference above will show the centrifugal adjustment. If the test values are not in agreement with the rated values, repair the adjusting mechanism of the ignition distributor or replace the distributor.

**Checking the vacuum control unit**

The action of the vacuum control unit can be checked by placing the previously removed vacuum hoses back on the engine, now running at an increased speed. The engine speed should rise considerably. On double-acting vacuum control units, the advanced and retarded adjustment is checked separately, with the vacuum hose being pulled off the box.

**Vacuum adjustment "retarded"**

Connect the stroboscopic light with the adjusting angle measuring device and switch the vacuum tester between the "retard unit" of the ignition distributor and the vacuum line to the carburetor. Pull the vacuum hoses from the vacuum unit. Run the engine at 3500 rpm. Flash

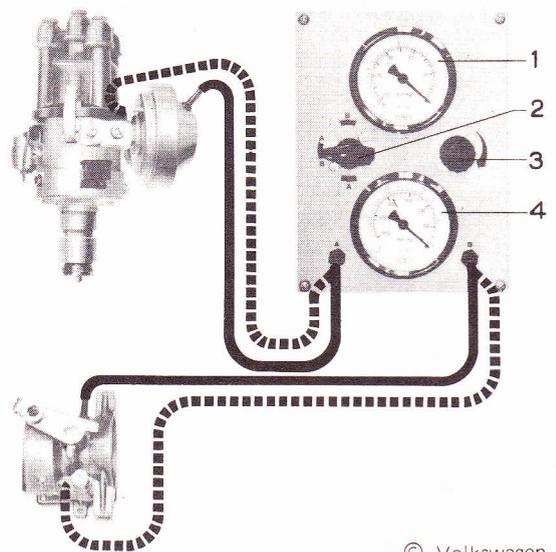
the black mark. Read the adjusting angle on the adjusting angle measuring device and remember it.

Place the vacuum hose for advance unit on the retard unit. The difference between the adjusting angle now indicated and the remembered value, is the vacuum adjustment "retarded".

**Vacuum adjustment "advanced"**

Connect the vacuum tester between the "advance unit" and the vacuum line. Pull the vacuum line from the "retard unit". Run the engine at 3500 rpm and flash the black mark (the vacuum control valve must be opened). Read the adjusting angle on the measuring instrument and remember it. Close the vacuum control valve.

The difference between the adjusting angle now indicated and the remembered value is the vacuum adjustment "advance". If the difference from the recommended values are exceeded during the test, proceed with the following checkup. First check the contact breaker plate for smooth operation, disassemble the distributor, if required, and make the contact breaker plate operable. Then check the vacuum line and the vacuum unit for leaks and replace it if required.



© Volkswagen

Checking vacuum control unit

- 1 - Vacuum indication 0-100 mm mercury
- 2 - Change-over valve
- 3 - Control valve
- 4 - Vacuum indication 0-600 mm mercury

**IGNITION COIL**

**Testing**

Clean the insulating cap and keep it dry to eliminate arcing and creeping currents. Check the flat plug for a tight seat to eliminate voltage losses. Check the ignition output with an ignition coil tester.

### Operation

The high voltage end of the ignition coil is loaded with a resistance and operated with a constant impulse sequence of the test instrument. The ignition voltage resulting from this load is measured. An approximate value is 18,000 V.

### Test in the event of faults

If no ignition coil tester is available, test as follows. First loosen the central cable from the terminal on the ignition distributor cap and hold it against a ground at a distance of approx. 0.394 in. The test should be made with insulated pliers. When cranking the engine with the starter, a spark should jump from the cable end to the mass. When there is no spark, first measure the voltage on the terminal of the ignition coil with a voltmeter. In a 12 volt system, the voltage should be at least 9 volts.

If the voltage is above that value, check with a voltmeter or an inspection lamp to see whether there is voltage available with the contacts open and no voltage with the contacts closed. If the voltmeter does not deflect even with the contact breaker points open, the ignition coil is interrupted and should be replaced.

### SUPPRESSION RESISTORS

#### Checking

The resistance of the ignition lines, with the copper core, is too low to suit the radio suppression regulations of some countries. For this reason, suppression resistors are installed into spark plugs and into distributor rotors. In addition, upon installation of an automobile radio the plugs of the ignition lines are suppressed in many cases.

These suppression resistors may be the cause of misfiring. Checking the distributor rotor with an ohmmeter: The suppressed distributor rotor has a cast-in resistor which may be as high as 10 k ohm. If a higher value is shown, replace distributor rotor.

Check the spark plugs and the ignition line plugs with an ohmmeter. The resistance rating of a spark plug or ignition line plug may be (max.) 5-10 k ohm.

### DISASSEMBLED COMPONENTS OF IGNITION SYSTEM

#### Checking spark plugs

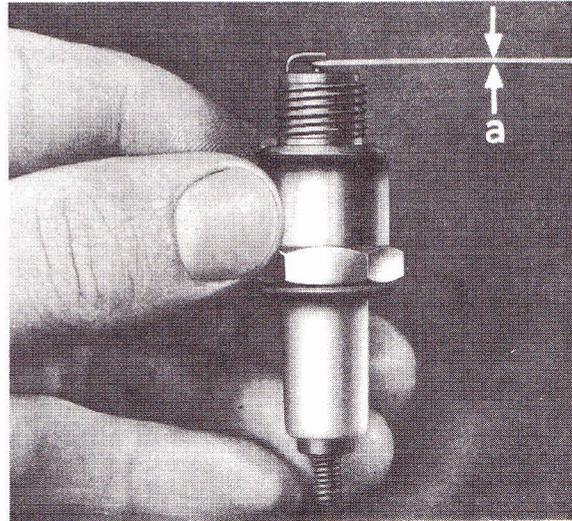
In operation, the electrode gap of the spark plugs will increase by natural burn-off. If the gap is too large, the plug may fail. In addition, there may be ignition trouble due to contaminated plugs. The electrode gap is measured with a spark plug gauge and the ground electrode is bent to the specified value.

Contaminated plugs may be cleaned only with a cleansing unit. Steel brushes and similar tools are not suited for cleaning spark plugs.

#### Checking the ignition distributor on test bench

The cam offset, the vacuum adjustment, the centrifugal adjustment and the timing angle can be checked on an ignition timer test bench. Various test benches of this type are available. The following equipment applies to all of them: Controllable drive motor, tachometer, vacuum pump and vacuum measuring instrument, which must have an additional measuring range of 0-100 mm mercury for ignition distributors installed in VW engines.

Attach the ignition distributor; check it for quiet operation. Test the timing angle. If required, adjust the contact gap and thereby the timing angle. Set the speed to 500 rpm, watching out that the centrifugal adjustment has not yet begun. Check the vacuum units for leaks. With the vacuum line closed, a vacuum of 100 mm mercury should remain constant for approx. 1 minute.



*Checking spark plug gap*

When the vacuum drops, check the advanced and retarded adjustments separately, keeping the connection of the untested box open. Adjust as many points of the vacuum curve as possible and read the actually attained adjusting values on the scale of the test bench. The measured values should be within the hatched fields of the adjusting curve. If they are outside, repeat the measurements with a new vacuum unit.

Check the speed-dependent adjusting curve. Here too, the measured values should remain within the hatched fields of the adjusting curve.

#### Adjusting curves for removed ignition distributors

The adjustment of the centrifugal force is measured starting from 1500 rpm with declining speed.

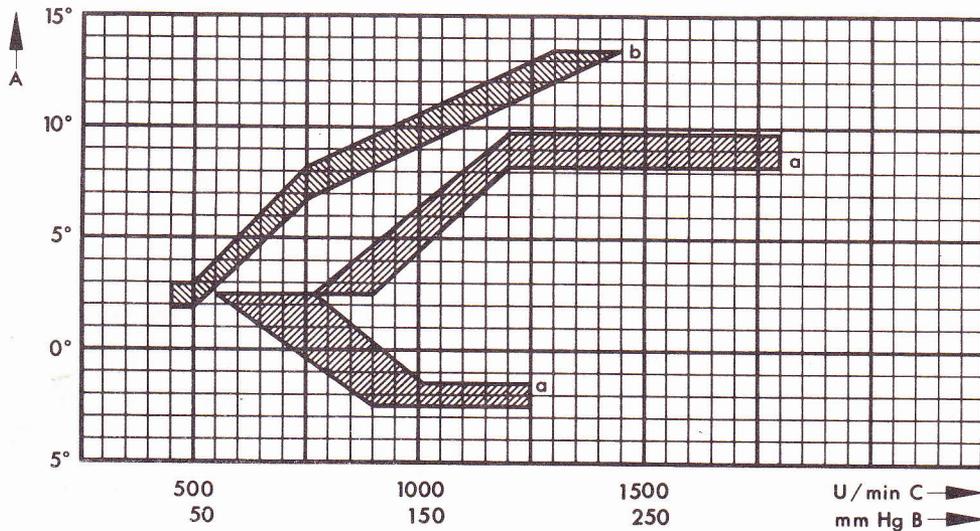
### IGNITION DISTRIBUTOR

#### Removal

Disconnect both cables between the ignition coil and the ignition distributor. Pull the vacuum hoses from the vacuum unit. Remove the distributor cap. Loosen the screw on the holder for the ignition distributor. Remove the ignition distributor. Cover the opening in the crankcase.

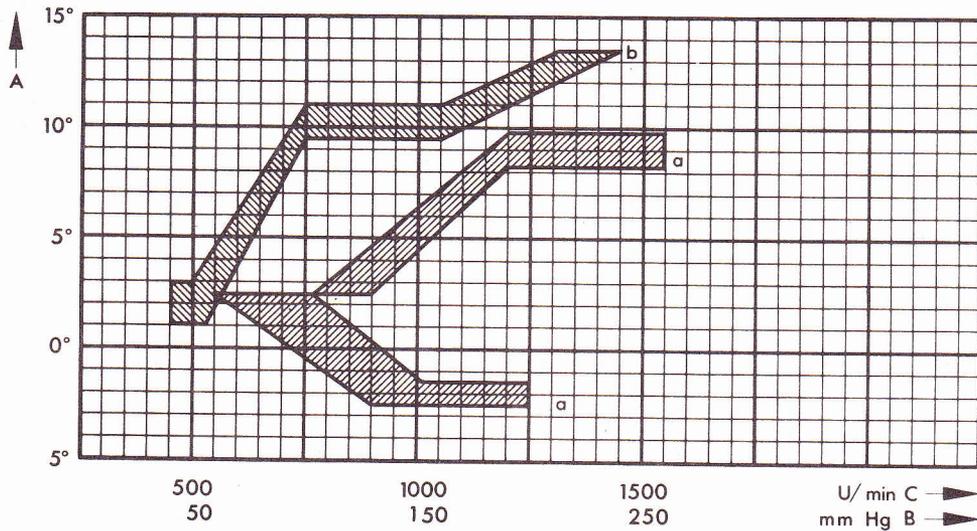
#### Installation

Adjust cylinder 1 to the firing point. The black notch should be in alignment with the reference mark, and the center-off-set slot in the head of the ignition distributor



Bosch 022 905 205 A

© Volkswagen



Bosch 022 905 205 B

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*Vacuum advance curves*

drive shaft should be at angle of approx. 12° in relation to the longitudinal axis of the engine. The larger sector is outside.

Turn the distributor rotor on the ignition distributor until it points toward the mark for cylinder 1 on the distributor housing. Insert the ignition distributor and adjust the ignition.

**Disassembly**

Remove the contact breakers and remove the vacuum governor. Remove the releasing contacts. Mark the installation position of the fly weights and mark the installation position of the driver claw in relation to the distributor shaft and the distributor housing. Knock out the pin for the driver claw with a drift. Remove the driver claw, noting the location and number of washers.

**Checking**

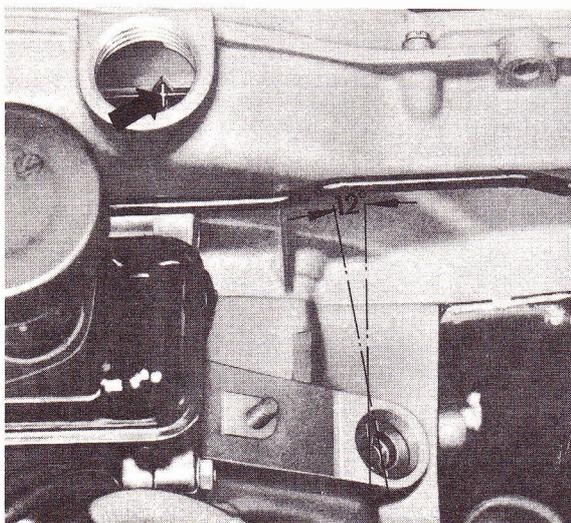
If the radial play between the distributor shaft and the distributor housing is too large, replace distributor shaft and correct the axial play by means of compensating washers. If the bushings of the distributor housing show too much wear, replace the complete distributor.

If the contact breaker plate shows too much tipping play, replace the contact breaker plate. If the wear is shown on the distributor housing itself, replace the distributor.

**Assembly**

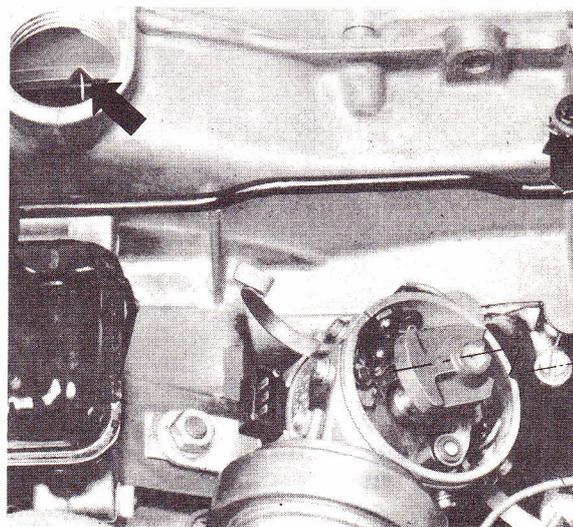
The following points must be observed. Lubricate the distributor shaft. Watch out for the correct position and the number of the steel and fabric washers on the distributor shaft. Compensate for axial play. Slide the driver claw on the distributor shaft observing its installation position. Attach the weights according to the





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*Position of distributor drive*



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*Rotor pointing to cylinder No. 1 mark*

installation marks.

#### IGNITION DISTRIBUTOR DRIVE SHAFT

##### Removal

Remove the spacing spring from the drive shaft. Pull the ignition distributor drive shaft out in an upward direction, using a puller, and turning to the left. Remove the washer from under the ignition distributor drive shaft.

On the installed engine, the washer can be removed with a magnet. On the removed engine, turn the crankcase by approx.  $180^\circ$  so that the washer will drop out.

##### Installation

Check the helical teeth of the ignition distributor drive

shaft for wear. If wear of the helical teeth is excessive, be sure to check the teeth of the ignition distributor drive gear. Check the washers under the ignition distributor drive shaft for wear; use new washers, if required. Adjust cylinder 1 to the firing point. At that moment, the exhaust valve on cylinder 3 will close and the inlet valve will begin to open.

Install the ignition distributor drive shaft. The center-off-set slot in the head of the ignition distributor drive shaft should be at an angle of approx.  $12^\circ$  in relation to longitudinal axis of engine and should point approx. to the rear fastening screw of the air filter support. The larger sector is outside. Insert the spacing spring.

# COOLING SYSTEM 5

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### DESCRIPTION

Cooling is by means of a radial blower. The impeller of the cooling blower is attached to the crankshaft hub by means of three screws. The blower sucks the air through the opening in the cooling blower housing, forcing it across the heavily ribbed cylinders and cylinder heads. The air flows through guide plates surrounding the cylinder heads and cylinders. Some of the fresh cooling air is used for the heating system and is heated on the exhaust pipes via heat exchangers.

A thermostat under cylinders 1 and 2 actuates two flaps in the inlet ducts of the front halves of the cooling blower housing via cable controls. The flaps control the cooling air volume, so that the cold engine will heat up faster and the operating temperature will remain as uniformly as possible under all loads. The air volume for the heating system is not influenced by these controls.

### V-BELT

#### Checking tension

The V-Belt tension is correct when the V-belt can be depressed in the center by approximately 1/2 in. by energetic thumb pressure. The belt should not show any traces of excessive wear, such as frayed edges or slit sides.

#### Adjusting tension

Remove the cover plate cover and loosen socket screw. Adjust tension of V-belt so that the belt can be depressed by approximately 1/2 in. by energetic thumb pressure. For this purpose, push the alternator to the left or right. Do not pry alternator with metal bar. Tighten screw.

### COOLING BLOWER HOUSING

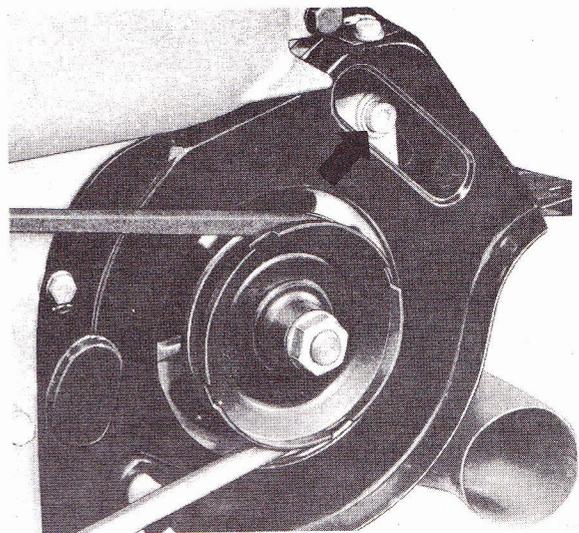
#### Removal

Unscrew three socket screws and remove V-belt pulley and blower impeller together. Remove spacing washer. Remove the alternator and cover plate. Note that the cooling blower housing can also be taken off without removing the alternator.

Disconnect the cool air control cable from the shaft. Unscrew four hex. nuts, and remove cooling blower housing halves, front and rear together.

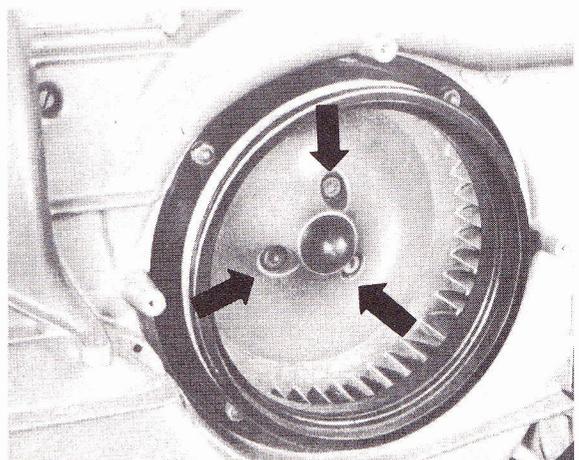
#### Installation

For installation, proceed as follows: Adjust throttle flap



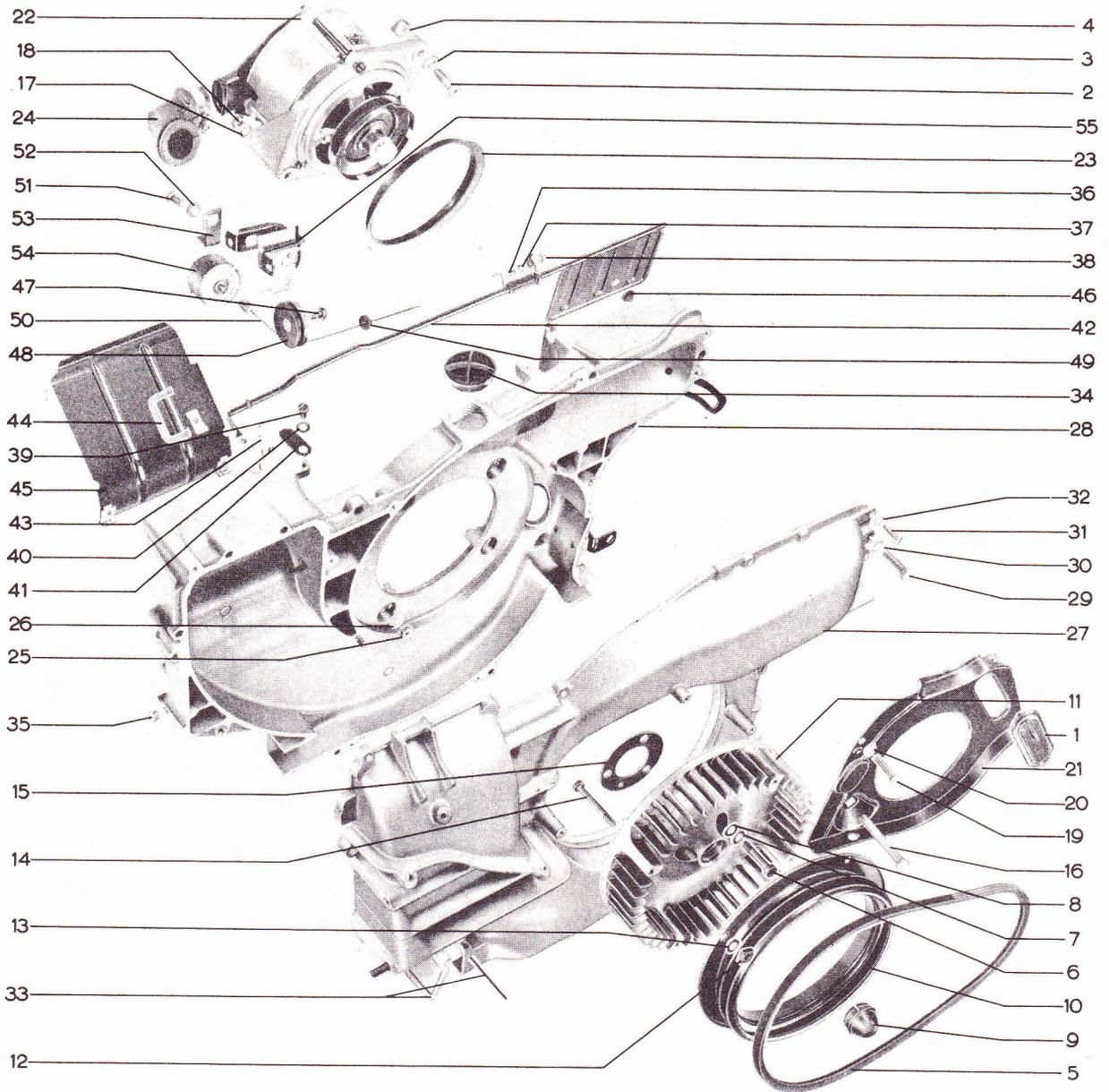
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*V-belt tension*



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*Impeller attaching screws*

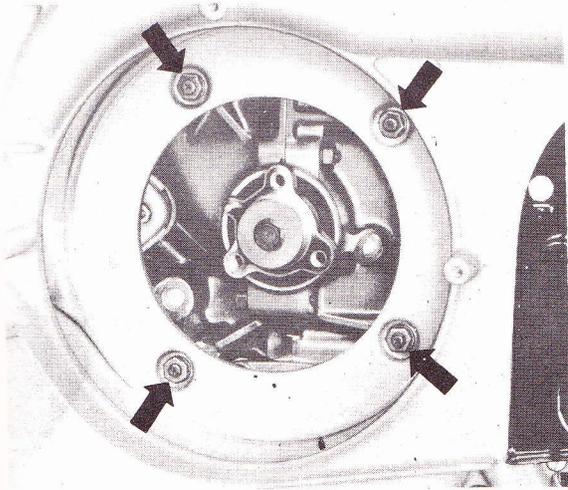


Exploded view of cooling system

© Volkswagen

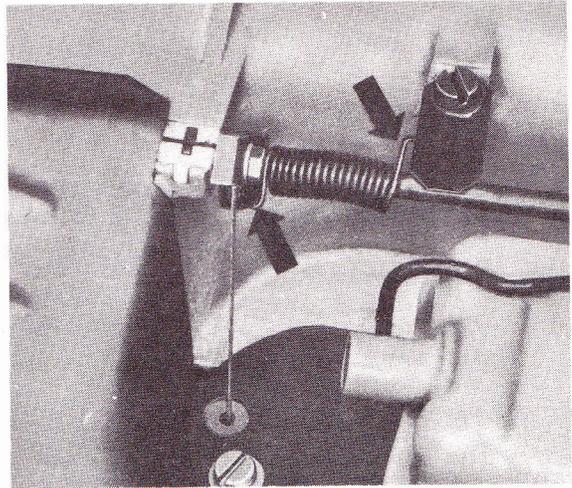
- |   |   |                                      |
|---|---|--------------------------------------|
| 1 - Cover for cover plate                   | 20 - Spring washer                      | 39 - Cheesehead screw M 6 x 10       |
| 2 - Multi-tooth socket head screw M8        | 21 - Cover plate for alternator         | 40 - Spring washer                   |
| 3 - Spring washer                           | 22 - Alternator                         | 41 - Holding spring for shaft        |
| 4 - Hex. nut M 8                            | 23 - Sealing ring for alternator        | 42 - Throttle valve right with shaft |
| 5 - V-belt                                  | 24 - Connecting elbow for alternator    | 43 - Bearing piece                   |
| 6 - Multi-tooth socket head screw M8 x 39   | 25 - Hex. nut M8                        | 44 - Handle for throttle valve       |
| 7 - Spring washer                           | 26 - Spring plate                       | 45 - Throttle valve left             |
| 8 - Washer                                  | 27 - Cooling blower housing half, rear  | 46 - Plug                            |
| 9 - Covering cap                            | 28 - Cooling blower housing half, front | 47 - Hex. screw M 6                  |
| 10 - Pulley                                 | 29 - Hex. screw M8 x 30                 | 48 - Roller for cooling air control  |
| 11 - Cooling blower impeller                | 30 - Spring washer                      | 49 - Sealing washer                  |
| 12 - Squarehead nut M 7                     | 31 - Cheesehead screw M 6 x 30          | 50 - Cable for cooling air control   |
| 13 - Spring washer                          | 32 - Spring plate                       | 51 - Hex. screw M 8 x 15             |
| 14 - Multi-tooth socket head screw M 7 x 52 | 33 - Closing flap for air return        | 52 - Washer                          |
| 15 - Spacing washer                         | 34 - Sight hole cover                   | 53 - Washer for thermostat           |
| 16 - Hex. nut M8                            | 35 - Plug                               | 54 - Thermostat                      |
| 17 - Spring washer                          | 36 - Hex. screw M 4 x 8                 | 55 - Holder for thermostat           |
| 18 - Hex. nut M8                            | 37 - Washer                             |                                      |
| 19 - Cheesehead screw M6 x 30               | 38 - Square nut                         |                                      |

for the cool air control. Attach elbow for alternator into front cooling blower housing half. Adjust V-belt tension.



© Volkswagen

*Removing cooler blower housing*



© Volkswagen

*Cooling control spring position*

**AUTOMATIC COOL AIR CONTROL**

**Removal**

After loosening holding springs, the righthand throttle flap with shaft can be removed and the lefthand throttle flap can be disconnected.

**Installation**

The return spring should rest with its bent ends against the holding spring lug and behind the cable guide.

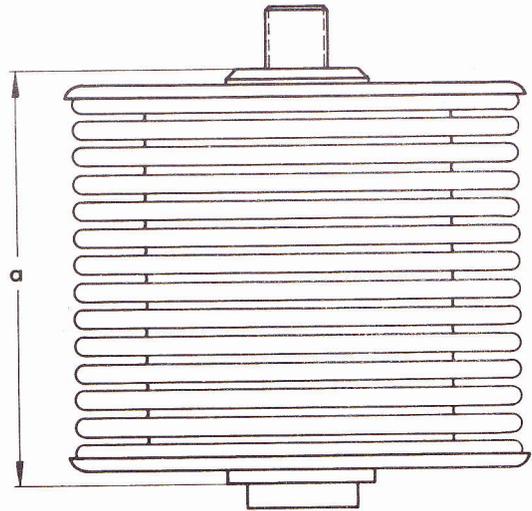
**Adjustment**

Assemble all control parts, lubricate joints and bearing points with molybdenum disulfide grease. Push throttle flaps into closing position and tighten cable control.

**THERMOSTAT**

**Checking**

Heat thermostat in water. At 149-158° water temperature, the pressure capsule length should be at least 1.81 in.



© Volkswagen

*Thermostat*

# ENGINE 6

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### DESCRIPTION

The engine installed in the VW-Porsche 914 is an air-cooled four-cylinder, four-cycle flat four engine with electronically controlled gasoline injection, horizontally opposed cylinders and overhead valves. Attachment to the gearbox is by means of four screws. The power unit, that is, the gearbox and the engine — is attached at the front to the body side members by means of an engine support screwed to the crankcase and at the rear to a cross member by means of rubber-metal antivibration mounts.

Two cylinders each carry a common, removable and heavily ribbed light metal cylinder head with shrunk-fit valve seat rings and valve guides. The valves are suspended overhead. The exhaust valves are clad with particularly high-grade chrome nickel steel.

The camshaft is mounted in the crankcase at three points in split steel bearings with babbitt metal running surface and is driven by the crankshaft via helical spur gears. Bearing 3 absorbs the axial thrust of the camshaft. The camshaft gear wheel is made of light metal alloy and is riveted to the camshaft. The valves are timed by cams via tappets, push rods and rocker arms. Each cam is alternately actuating one valve each of two opposed cylinders.

The four cylinders are special castings and of uniform design, permitting individual replacement together with the pertinent piston. The cooling air flows past cooling ribs for the required heat exchange.

The light metal pistons with steel inserts carry two compression rings and one oil scraper ring. A hose spring

is fitted between the oil scraper ring and the piston. The piston pins are floatingly mounted in the connecting rod eye and are laterally secured in the piston by means of locking rings.

The split crankcase is a light metal alloy die casting. Both halves are machined together and may also be replaced together only.

The crankshaft is a symmetrical forging, all bearing points are induction-hardened. The shaft is supported in the crankcase in four bearings. Bearings 1, 3 and 4 are aluminum bushings with lead-coated running surface. Bearing 2 - seen from clutch end - is a split three-component bearing. Bearing 1 simultaneously absorbs the axial thrust of the crankshaft.

The four connecting rods are steel forgings with I-shaped conrod shank. They are mounted on the crankshaft in replaceable three-component bearings and are provided with steel bushings with lead bronze running surface for the piston pins.

**ENGINE Removal**

The engine and transmission should be removed together. Mark installation position of trunk lid on hinges and remove lid. Disconnect the ground connection cable on the battery. Remove oil bath air filter and heating air hoses. Pull the cables from the fuel injection components and place the cable in high position.

Disconnect the throttle valve cable and push it through engine cover plate. Unbend the metal plate and separate fuel hoses on connecting points near to pressure feeler and

close. Unscrew hex. nut for attaching starter. Raise vehicle. Remove exhaust muffler molding, lower components for warm air flow, and the protective cab and unscrew shift rod holder.

Pull off the protective cabs, unscrew hex. bolt with ball and remove the rear shift rod. Remove the heater flap box with hoses and cables. Loosen adjusting nut and hex. nut for guide roller, bend holding plate and pull the clutch cable forward. Loosen the drive shaft for speedometer and pull forward.

Remove the starter and loosen against connection strap on luggage pan. Loosen the universal shaft on the transmission and suspend it with wire hooks from the body. Lower vehicle slightly. Place a garage jack with engine support VW 612/4 in combination with the transmission extension VW 612/3 under engine/transmission unit and raise slightly.

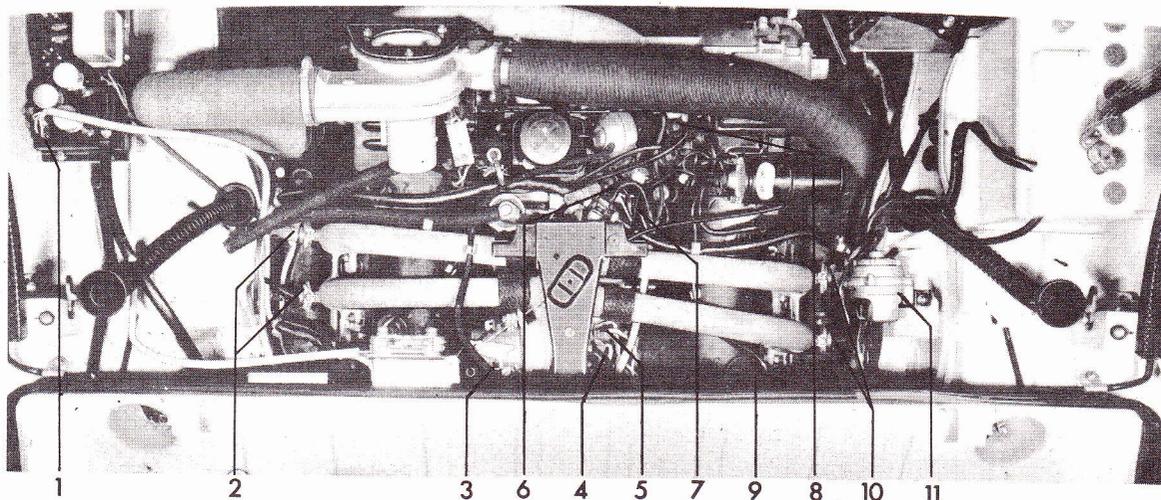
Unscrew 4 hex. nuts, on transmission support. Unscrew socket screws, left and right on engine mount. Carefully lower engine/transmission unit.

**Installation**

During installation, the following points must be observed:

Prior to attaching the transmission to the engine on cars with manual transmission check clutch throwout bearing for wear (do not wash out, only wipe off). Coat the guide bushing of throwout bearing, splining input shaft and bushing for starter shaft lightly with moly grease.

When positioning the engine/transmission unit, be sure



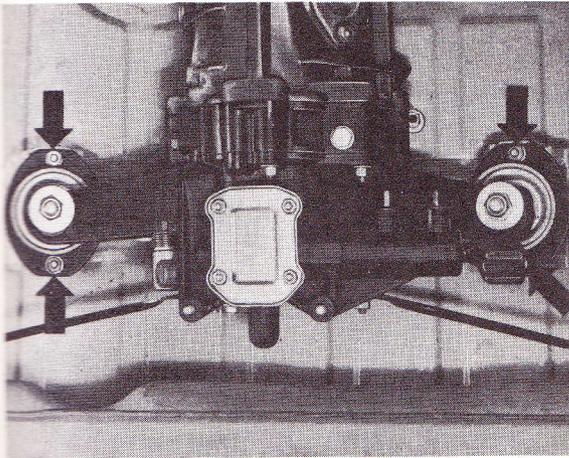
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*Engine compartemnt*

- |                                      |   |
|--------------------------------------|---|
| 1 - Voltage supply relay 4-pole      | 6 - Cold starting valve 2-pole                  |
| 2 - Two injection valves left 2-pole | 7 - Thermal switch 1-pole                       |
| 3 - One throttle valve switch 4-pole | 8 - Ignition distributor release contact 3-pole |
| 4 - Temperature feeler 1-pole        | 9 - Temperature feeler 1-pole                   |
| 5 - Mass connections 3-pole          | 10 - Two injection valves right 2-pole          |

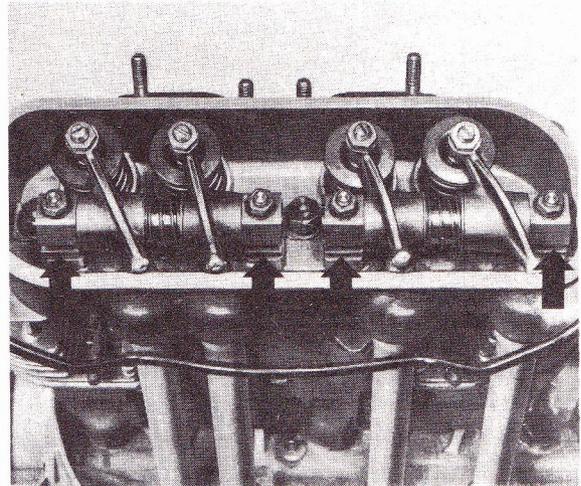
that the fuel lines near the injection valves are not squeezed in and that the hand brake cables are above the engine mount. Tighten socket screws on engine mount to 22 ft.-lbs., hex. nut on transmission support to 14-1/2 ft. lbs. and socket screws of the universal shaft attachment to 32-1/2 ft.-lbs. Use new lock washers.

Adjust free play of clutch. Pull the engine compartment seal into proper position. Adjust the throttle valve cable. Connect cable and protective rubber caps carefully.



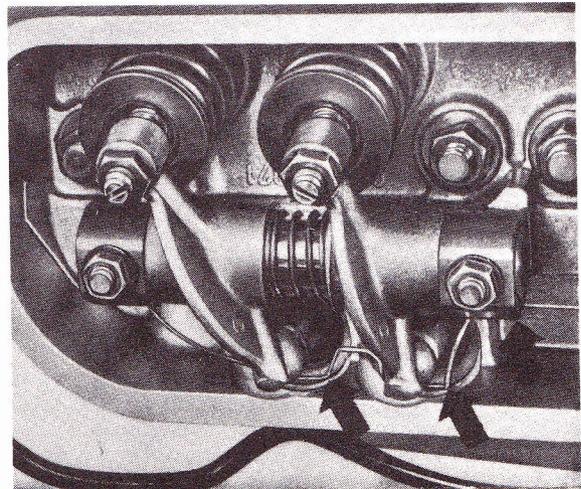
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*Transmission support screws*



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*Rocker arms supports*



© Volkswagen

*Securing clips*

## TAPPET

### Checkup

Check the tappet face and stem for wear and scoring marks. Tappet diameter .9433-.9441 inches. Wear limit to .9421 inches.

Check the push rod between the two holding devices for deformations. Out-of-true: max. .0118 inches.

Check the rocker arm, bearing pieces and rocker arm shaft for wear. Rocker arm: .7874-.7882 inches. Wear limits: .7890 inches. Rocker arm shaft: .7854-.7862 inches. Wear limit: .7846 inches. If the axial thrust surface of the rocker arms or bearing pieces are showing score marks, refinish with a fine emery cloth.

### Installation

Insert the tappet with engine oil. Slide the protective tubes with new sealing rings up to stop. Do not damage the sealing rings. Slide bearing pieces on rocker arm shaft in such a manner that the slots will face downwards and the broken edges outwards when settling on studs. The securing clip for the protective tubes should enter the slots of the bearing pieces and should rest on the bottom edges of the protective tubes.

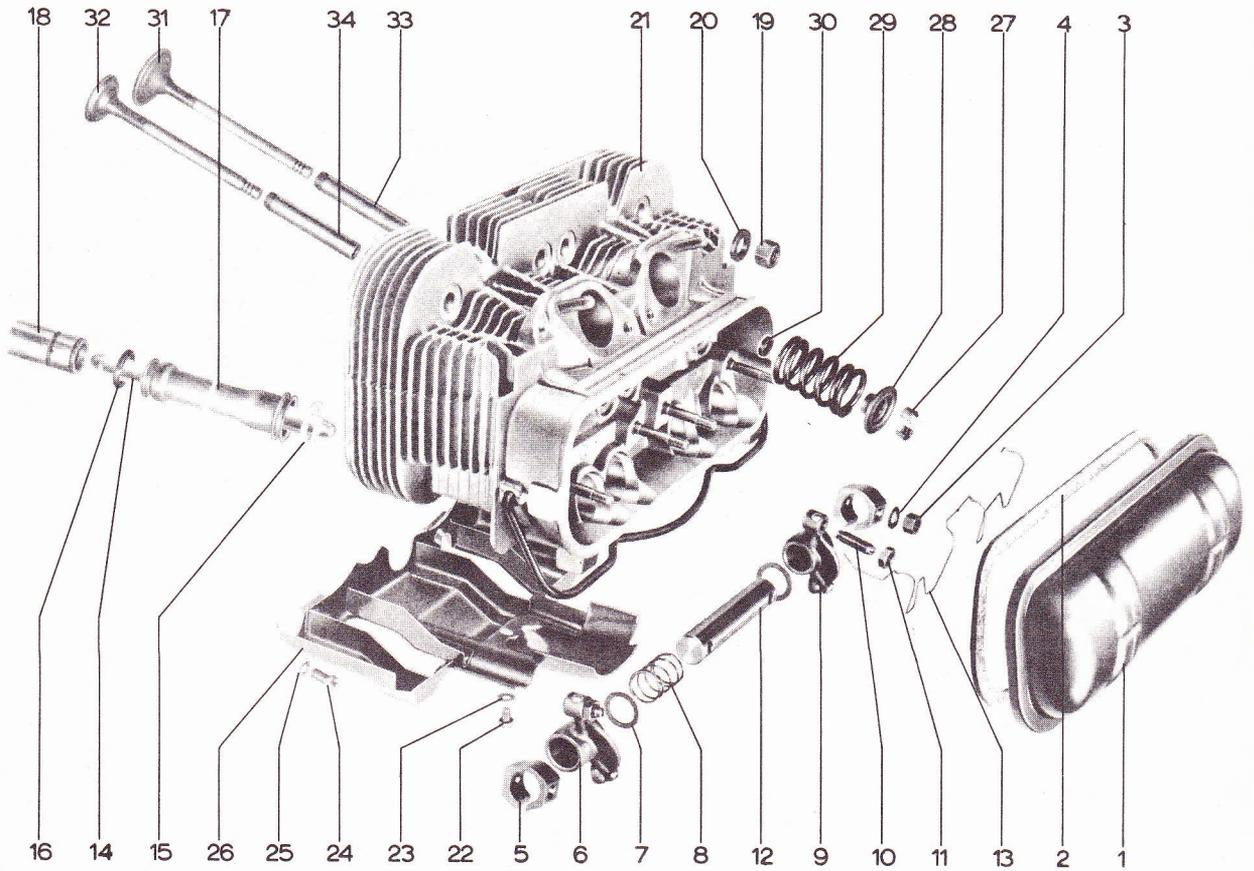
## CYLINDER HEAD

### Checkup

Check cylinder heads for cracks in combustion areas and exhaust ducts as well as for leaks on cylinder support. Replace damaged cylinder heads. Check spark plug threads and studs for damage and tight seat. Install helicoil thread inserts, if required.

### Installation

Replace the sealing ring for cylinder head. Pre-tension the cylinder head nuts slightly at first and then tighten well in correct sequence. Screw on the baffle plate.



© Volkswagen

*Exploded view of cylinder head*

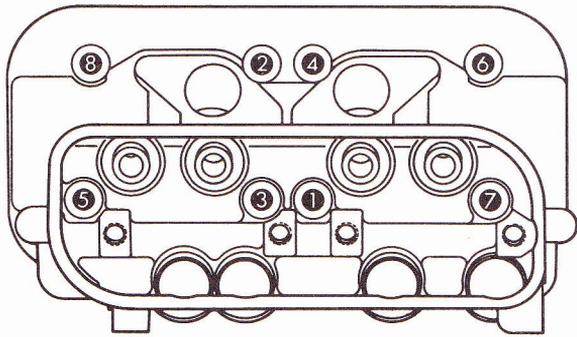
- |   |                                |
|---|--------------------------------|
| 1 - Cylinder head cover                 | 18 - Tappet                    |
| 2 - Gasket for cylinder head cover      | 19 - Hex. nut M 10             |
| 3 - Hex. nut M 7                        | 20 - Washer                    |
| 4 - Spring plate                        | 21 - Cylinder head             |
| 5 - Bearing piece                       | 22 - Cheesehead screw M 5 x 10 |
| 6 - Exhaust rocker arm                  | 23 - Washer                    |
| 7 - Thrust washer                       | 24 - Cheesehead screw M 6      |
| 8 - Spring                              | 25 - Washer                    |
| 9 - Inlet rocker arm                    | 26 - Baffle plate              |
| 10 - Valve adjusting screw              | 27 - Valve cone piece          |
| 11 - Hex. nut M 8 x 1                   | 28 - Valve spring disk         |
| 12 - Rocker lever shaft                 | 29 - Valve spring              |
| 13 - Securing clip for protective tubes | 30 - Oil deflecting ring       |
| 14 - Push rod                           | 31 - Inlet valve               |
| 15 - Sealing ring white                 | 32 - Exhaust valve             |
| 16 - Sealing ring black                 | 33 - Inlet valve guide         |
| 17 - Protective tube for push rod       | 34 - Exhaust valve guide       |

## VALVE GUIDES

### Checking

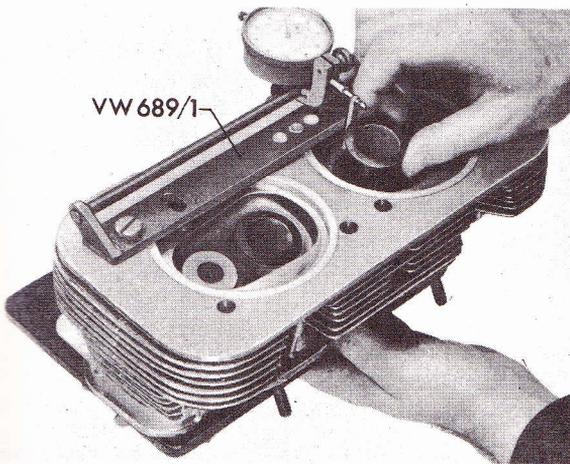
When repairing an engine with leaking valves, it is not enough to refinish or replace the valve seats and the valves, but it is also required to check the valve guides for wear and replace the guides, if required. This checkup is particularly important on engines which have been running for a long time and exhaust valve guides.

Remove residue with a cleaning tool. Place the cylinder head on the clamping plate for the cylinder head VW 689/1, with the combustion chamber ends up, and screw down together with measuring bridge. Insert the dial gauge into holder and attach the dial gauge extension. Place a new valve into the guide to be checked and hold it in such a manner that the stem end is flush with the guide. Adjust the dial gauge and determine the rocker play.



© Volkswagen

Cylinder head nut tightening sequence



© Volkswagen

Checking valve play

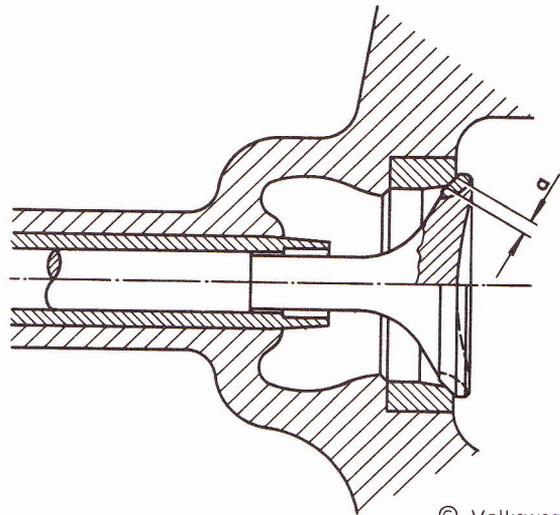
	Intake valve guide	Exhaust valve guide	Wear limit
Rocker play	0.45 mm (.0177")	0.45 mm (.0177")	0.9 mm (.0354")
ID	8.00- 8.02 mm (.3150- .3158")	9.00- 9.02 mm (.3543- .3551")	8.06- 9.06 mm (.3173- .3567")

The width of valve seats are, Intake: .0709-.0866 inches. Exhaust: .0787-.0984 inches.

Finish 30° surface for inlet valve. Finish 45° surface for exhaust valve. These seats must be finished with particular care, to guarantee a perfect concentric seat. The material removal should be restricted to a minimum to prevent early unusability of the rings. The refinishing must be terminated as soon as the entire seat surface has been covered.

Refinish 75° surface. Chamfer the bottom edge of the exhaust valve seat ring slightly.

Refinish 15° surface. Finish the upper edge of the seat ring until the specified seat width is obtained. The valve seat can be checked with a new valve.



© Volkswagen

Width of valve seat

- 1 - Width of valve seats (a):
- 2 - Intake 1.8-2.2 mm (.079-.0866 in.)
- 3 - Exhaust 2.0-2.5 mm (.0787-.0984 in.)

## VALVES

### Removal

Remove the valves with a valve spring compressor VW 311s. After extended operation, some burr may develop at the contact surfaces of the valve keepers, which must be removed with a smooth file prior to pulling out valve.

### Checking

Check the tension of valve springs. Length under load: 1.2 inches. Load: 160-184 lbs.

Check the valve keepers. Any valve keepers with score marks can be ground down at separating surfaces until the valve can be turned with the valve keepers compressed. Check all valves for wear, particularly the seat and stems. When no refinishing of seat on the machine is required, grind in valves on valve seat rings.

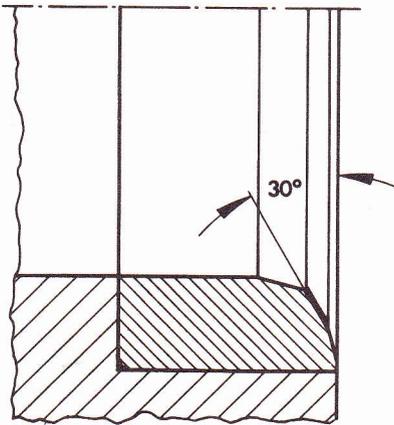
### Installation

Coat valve stem with molybdenum disulfide grease and

## VALVE SEATS

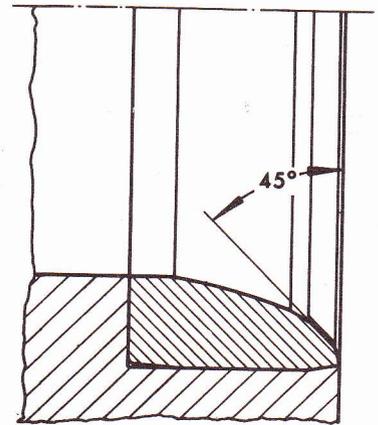
### Refinishing

Valve seats showing evidence of wear or burnoff can be refinished as long as the permissible seat width is maintained and the 15° chamfer at its outer circumference does not exceed the OD of the valve seat ring. If it does, replace the engine head. Exchanging valve seat rings is impossible with conventional shop means, since the rings have been inserted in a chilled condition.



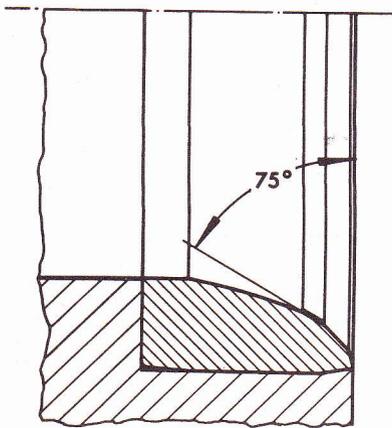
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*Intake valve seat angle*



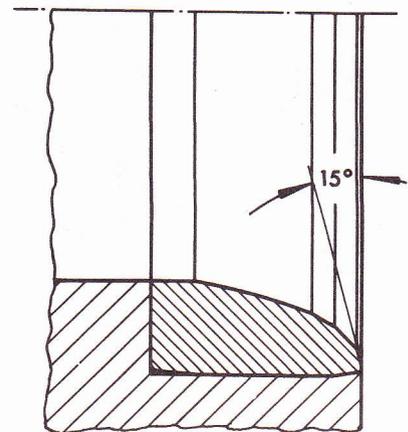
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*Exhaust valve seat angle*



© Volkswagen

*Top & bottom chamfer angles*



© Volkswagen

insert the valve into the guide. Slide the oil scraper ring on the valve stem. Install the valves with a valve spring compressor VW 311s.

**Refinishing**

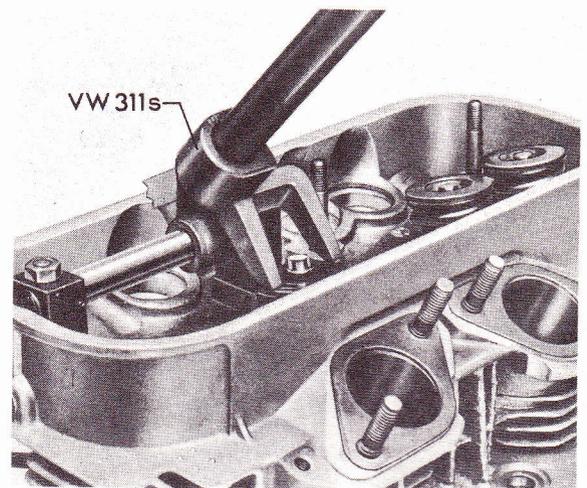
Valves on which the valve seat surface shows evidence of wear or burnout, can be refinished on a valve refacing machine or a valve grinder.

**Checking for leaks**

Valves can be checked for leaks by establishing a contact pattern: Coat valve face surface slightly with surface ink. Place the valve into valve guide and rotate under slight pressure on the valve seat by approximately 1/4 turn. Lift the valve from the seat. The contact pattern will then show which spot did not support the valve. Refinish valves, if required.

**Grinding-in**

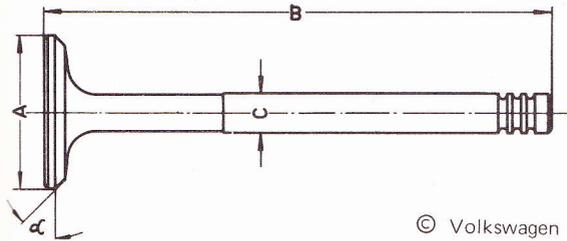
With perfectly finished valve seat rings and new valves, grinding-in is not necessarily required. To grind in, coat



© Volkswagen

*Compressing valve springs*

one valve seat with grinding paste and insert the valve into the guide. Place rubber cup with handle on valve disk and rotate valve while grinding. Score marks on seats can be prevented by constantly lifting and uniformly turning of valve during the grinding. It is imperative to carefully remove grinding paste following grinding operation.



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Valve dimensions

	Intake valve	Exhaust valve
A	39.1-39.3 mm dia. (1.5394-1.5472")	32.7-33.0 mm dia. (1.2874-1.2992")
B	116.8-117.3 mm (4.5984-4.6181")	117.0-117.5 mm (4.6063-4.6260")
C	7.94-7.95 mm dia. (.3126-.3130")	8.91-8.92 mm dia. (.3508-.3512")
d	29 <sup>0</sup> / <sub>30</sub> "	45 <sup>0</sup> / <sub>30</sub> "

### Clearance

Always check or adjust valve clearance when the engine is cold. The intake or exhaust should be 0.004 in. When the engine is warming up, the clearance will at first increase and will finally return to the set values when the operating temperature is attained. Inspections during the specified intervals must be completed with particular care. Adjustment of the valves will have the desired success only if the valves are perfectly sealing, if there is no unpermissible play on the valve guides and if the stem ends are not worn out.

Insufficient clearance may cause burning of valves or valve seats, distortion of valve stem, irregular performance by reduced compression, irregular running of engine or alternations to engine timing.

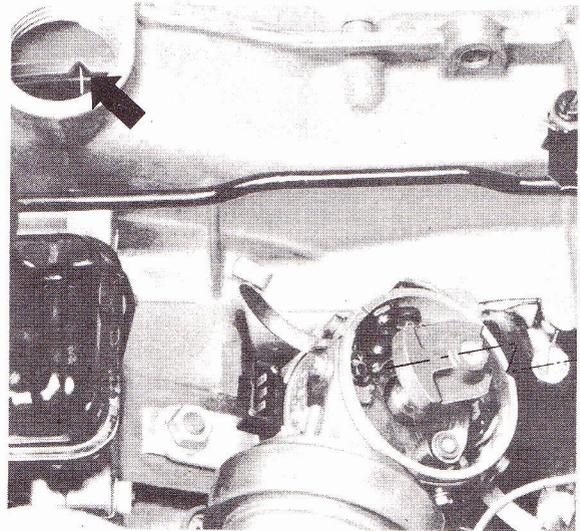
Excessive clearance may cause increase in noise from valve gear, irregular running of engine, alternation of engine timing or unsatisfactory performance of insufficient filling of cylinders.

Valve clearance is adjusted in the firing order, 1-2-3-4. The piston of the cylinder to be adjusted must be at TDC of the compression stroke, because both valves will then be closed.

Move cylinder 1 to firing point (black notch). Measure valve clearance with feeler gauge.

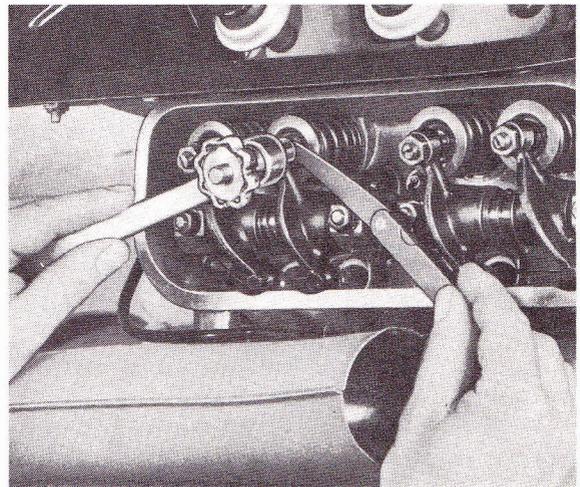
Adjust valve clearance with valve adjusting wrench and feeler gauge. The valve clearance is set correctly when the

feeler gauge can be smoothly inserted in between the adjusting screw and the valve stem. Inserting the feeler gauge with more or less force would be wrong.



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T.D.C. position No. 1 cylinder



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Adjusting valve clearance

Hold adjusting screws and tighten lock nuts. Check adjustment. For additional adjustment of valves on cylinder 2, 3 and 4, keep turning crankshaft to the left until the finger of the distributor rotor is offset by 90° in each case.

### CYLINDERS

#### Removal

Mark cylinders prior to removal to eliminate any confusion during installation.

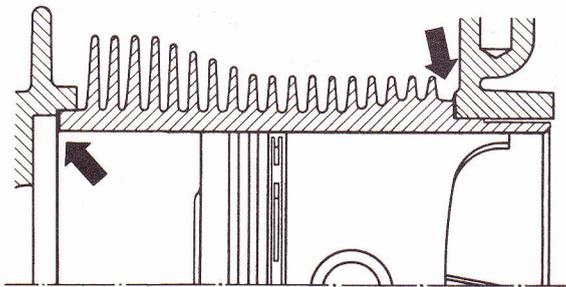
#### Checking

Check cylinder for wear. Cylinder seat in crankcase and

cylinder head, seat surfaces on cylinder and sealing rings must be kept absolutely clean during installation. Foreign bodies at such points may result in distortions of cylinders and leaks. The pairing size is indicated by colored dots (blue, pink, green) on top cooling fin.

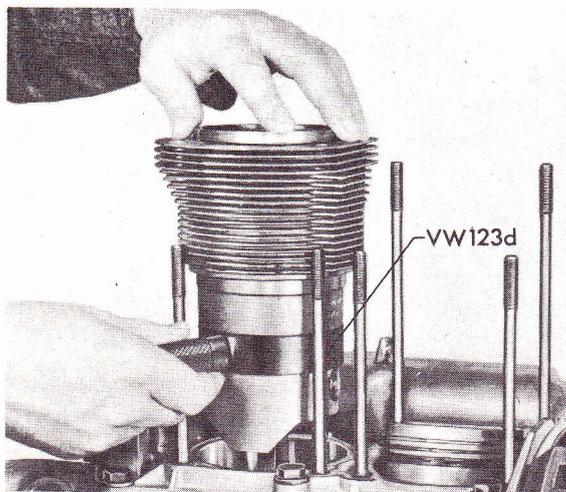
**Installation**

Lubricate piston and piston pin. Compress piston rings with piston ring strap VW 123d. Watch out for uniform alignment of gaps on piston ring. The gap of the oil scraper ring should always be on top. Fit cylinder with cylinder bore lubricated. The studs on the crankcase must not touch the cooling fins of the cylinders.



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*Location of sealing rings*



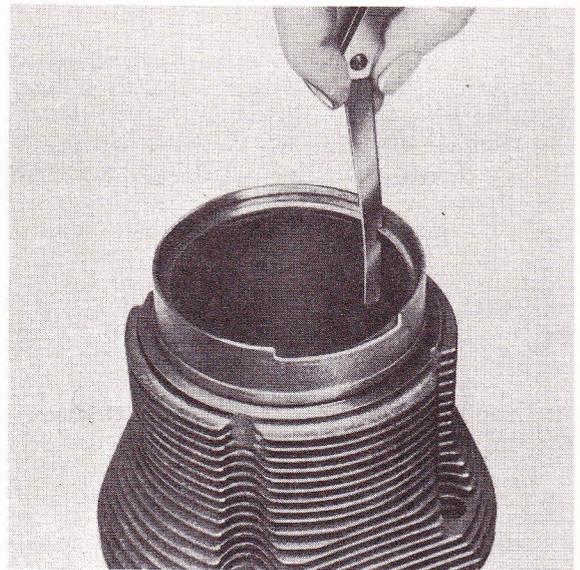
© Volkswagen

*Fitting cylinders*

**PISTONS**

**Removal**

Mark pistons to eliminate any shifting or confusion during reinstallation. Remove locking rings for piston pin with circlip pliers and the piston pin with mandrel VW 207c. If required, remove piston rings with piston ring pliers.



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*Checking ring gap*

**Installation**

Clean piston. Remove carbon residue in piston ring grooves without damaging metallic surface. Bad contact pattern and one-sided formation of residue on piston skirt vertically in relation to piston pin axis may be the result of badly angled connecting rods. Check piston for wear, use a new piston of pertinent size class, if required. The weight difference between pistons should not exceed a maximum of 10 grams.

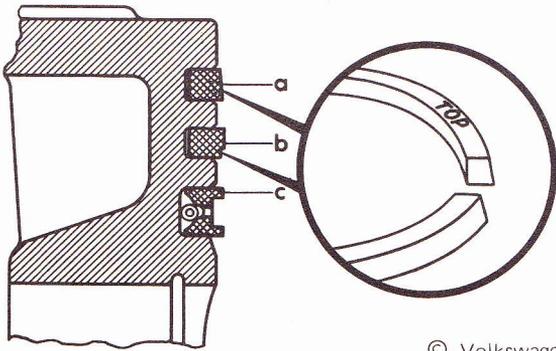
**Marking of piston**

The letter next to the arrow designates the index of the spare parts number of the pertinent piston and serves as a differentiating mark. Arrow (punched-in) indicates that the piston must be installed in the direction of the arrow towards flywheel.

Indication of paired size is by color dot (blue, pink, green). Statement of weight class (+ or -) punched-in or printed. Indication of weight class by color dot (brown = - weight, grey = + weight).

Fit piston and oil scraper rings. Check clearance on gap of rings. For this purpose, slide the ring at right angle into the bottom cylinder opening (BDC), approximately 3/16 in. from the cylinder rim, pushing it with the piston. Measure clearance with feeler gauge. Position the piston rings with piston ring pliers only. The designation "TOP" of piston rings should point to piston head. Check vertical clearance of rings in ring grooves with feeler gauge.

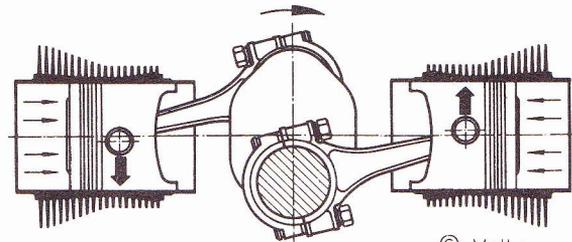
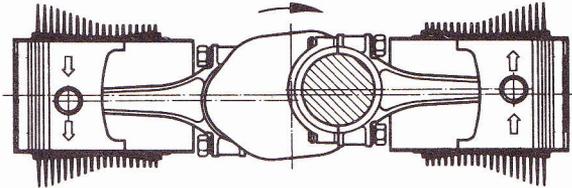
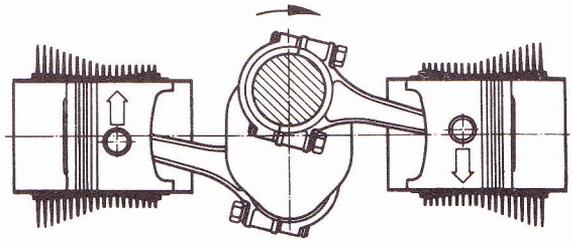
Insert the locking rings on pistons of cylinders 1 and 2 on side facing flywheel, on pistons of cylinders 3 and 4 on impeller side. The piston pin bores in the piston are offset 0.197 in. When installing the piston, be sure that the arrow or the letters "front" are facing the flywheel.



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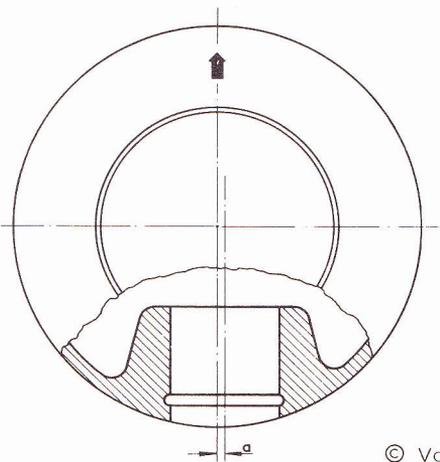
*Position of rings*

- a - Piston ring top
- b - Piston ring bottom (baffle ring)
- c - Oil scraper ring with hose spring



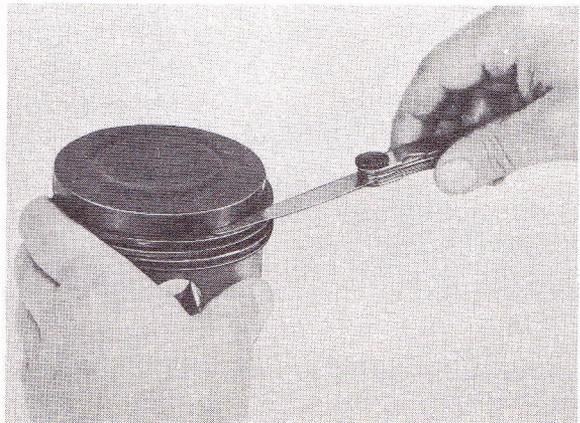
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*Placement of pistons showing pin offset*



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*Piston pin bore offset*  
A = 0.0197 in.



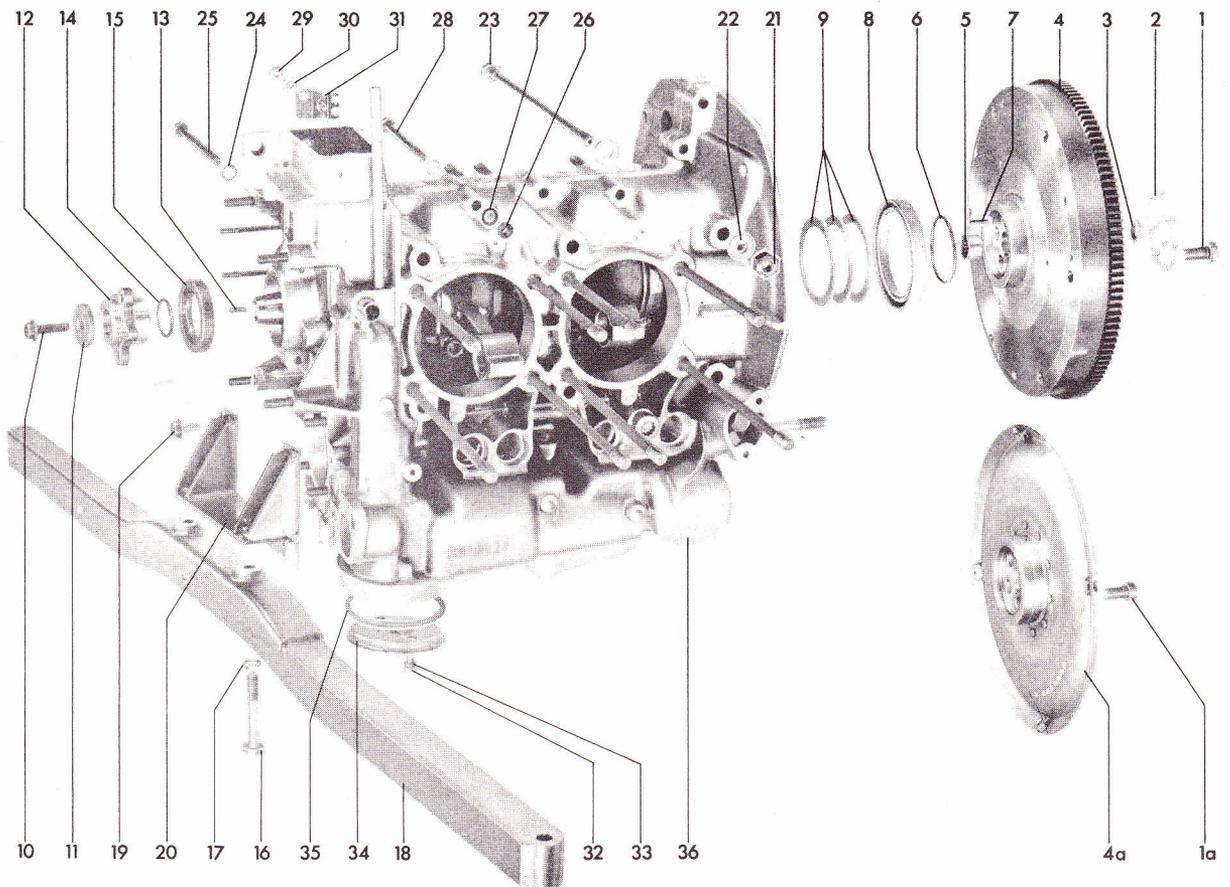
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*Checking ring clearance*

Check and fit piston pin. Depending on occurring tolerances, the piston pin may already slide easily by hand into the piston when it is still cold. This is absolutely normal, even if the piston pin should fall out by its own weight. There is no reason to replace the piston pin, the piston or both, in such a case.

If the clearance between the piston pin and the conrod bushing approaches the wear limit of .0016 in., replace piston pin and fit into a new conrod bushing. The piston should be heated, whenever a pin does not easily enter the piston. Heat the piston to approximately 176°F then, slide in piston manually with mandrel VW 207c and without stopping against stop on locking ring. Insert second locking ring. The locking ring should be seated perfectly and all-around in the pertinent groove of the piston pin eye.

	Vertical clearance in mm	Wear limit in mm
Piston ring top	0.06-0.09 (.0024-.0035")	0.12 (.0047")
Piston ring bottom	0.04-0.07 (.0016-.0028")	0.10 (.0039")
Oil scraper ring	0.02-0.05 (.0008-.0020")	0.10 (.0039")



Exploded view of crankcase & flywheel

© Volkswagen

- |   |  |   |
|---|--|---|
| 1 - Hex. screw M 12 x 1.5, self-securing          | 12 - Hub for impeller                              | 25 - Hex. screw M 8 x 113 oil tube attachment |
| 1a - Multi-tooth socket screw M 12 x 1.5          | 13 - Plate spring                                  | 26 - Hex. nut                                 |
| 2 - Washer  | 14 - Rubber sealing ring for hub                   | 27 - Spring washer                            |
| 3 - Felt ring for needle bearing                  | 15 - Sealing ring for crankshaft 62 mm dia. (2.4") | 28 - Hex. screw M 8                           |
| 4 - Flywheel                                      | 16 - Hex. socket screw                             | 29 - Hex nut M 6                              |
| 4a - Carrier plate                                | 17 - Spring ring                                   | 30 - Spring washer                            |
| 5 - Needle bearing                                | 18 - Engine mount                                  | 31 - Ignition cable holder                    |
| 6 - Rubber sealing ring for flywheel              | 19 - Hex. screw M 8, self-securing                 | 32 - Hex. screw M 6                           |
| 7 - Clamping sleeve                               | 20 - Support for engine mount                      | 33 - Sealing ring                             |
| 8 - Sealing ring for crankshaft 95 mm dia. (3.7") | 21 - Sealing nut M 10 x 1.25                       | 34 - Cover for oil pan                        |
| 9 - Spacing washer                                | 22 - Washer  | 35 - Sealing ring for cover                   |
| 10 - Hex. screw M 8 x 30 self-securing            | 23 - Hex. screw M 10 x 1.25 x 213                  | 36 - Crankcase                                |
| 11 - Washer                                       | 24 - Sealing ring                                  |   |

**FLYWHEEL**

**Checking**

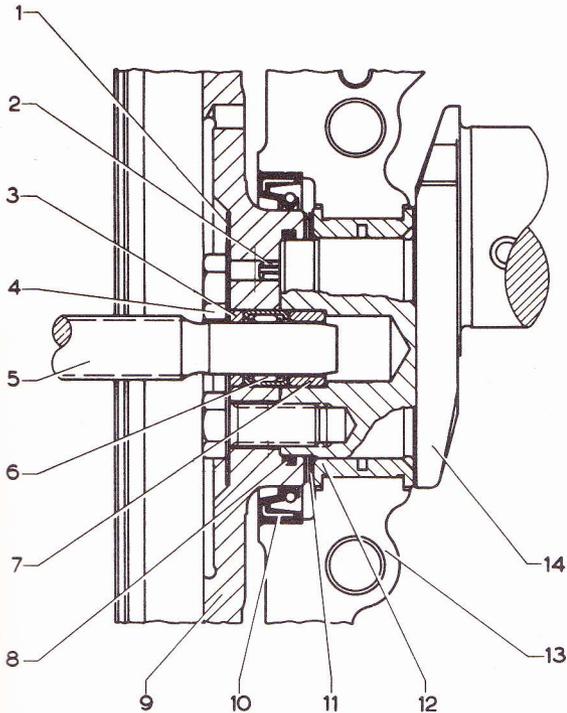
Check the flywheel for broken or damaged teeth. Damaged teeth can be turned off from the clutch end up to a maximum of 0.080 in. Following the deburring, chamfer tips of teeth again. Check bores for hex. screws and clamping sleeve. If bores are worn out, replace flywheel. Watch out for correct seat of needle bearing. The contact surface for the clutch lining must be free from oil, grease and preservation agents, clean, if required.

**Installation**

Grease the needle bearing in the flywheel only with approximately 0.012 cu. in. multi-purpose grease, if bearing has been washed. Moisten felt ring with engine oil. Wipe off excess lubricant.

When tightening hex. bolts, hold the flywheel with holding clamp VW 215c. Adjust axial play of crankshaft. Lubricate running surface for sealing ring.

On engines of vehicles with a Sportomatic transmission, the flywheel is replaced by a carrier plate screwed to the crankshaft with five socket screws. The felt ring and the needle bearing in the flywheel are also eliminated. When loosening and tightening socket screws, hold carrier plate with holding ring VW 184.



© Volkswagen

*Flywheel installation*

- |                     |                                      |
|---------------------|--------------------------------------|
| 1 - Washer          | 8 - Rubber sealing ring for flywheel |
| 2 - Clamping sleeve | 9 - Flywheel                         |
| 3 - Felt ring       | 10 - Sealing ring for crankshaft     |
| 4 - Hex. screw      | 11 - Spacing washers                 |
| 5 - Drive shaft     | 12 - Crankshaft bearing 1            |
| 6 - Needle bearing  | 13 - Crankcase                       |
| 7 - Spacing ring    | 14 - Crankshaft                      |

## CRANKSHAFT AXIAL PLAY

### Checking

The axial play of the crankshaft is .0028—.0051 inch. Wear limit is .0059 inch. The axial play is measured with the engine assembled and the flywheel screwed on.

Screw dial gauge holder VW 659/2 to an engine attachment stud of the crankcase. Move the crankshaft back and forth in axial direction. The axial play is indicated on a dial gauge.

### Adjusting

Install flywheel with two spacing washers (but without sealing rings for crankshaft and flywheel). Screw dial

gauge holder VW 659/2 with one dial gauge to crankcase. Move crankshaft back and forth in axial direction. Read axial play on dial gauge.

To compute thickness of third spacing washer: Measuring result - 0.10 mm mean axial play = 3rd spacing washer.

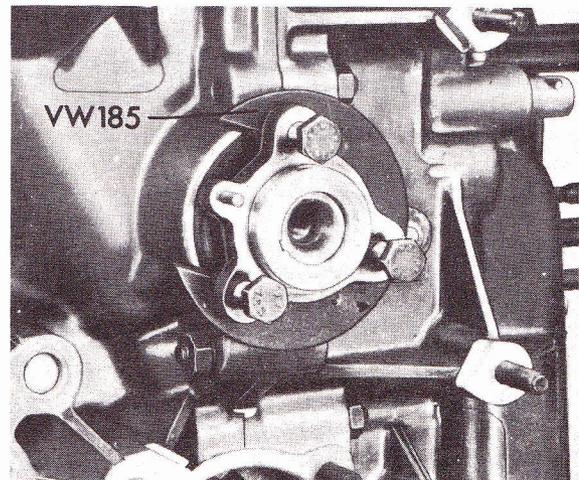
Remove flywheel. Insert sealing rings for crankshaft and flywheel, as well as felt ring. Install flywheel with all three spacing washers and new supporting ring. Check axial play again.

Spacing washers are provided in several sizes. The thickness of each washer is etched in for proper identification. Measure thickness with screw gauge, if required. Always install three spacing washers for the required total thickness.

## SEALING RINGS FOR CRANKSHAFT

### Removal

Prior to removing sealing ring on impeller end, force off impeller hub with the assistance of plate VW 185.

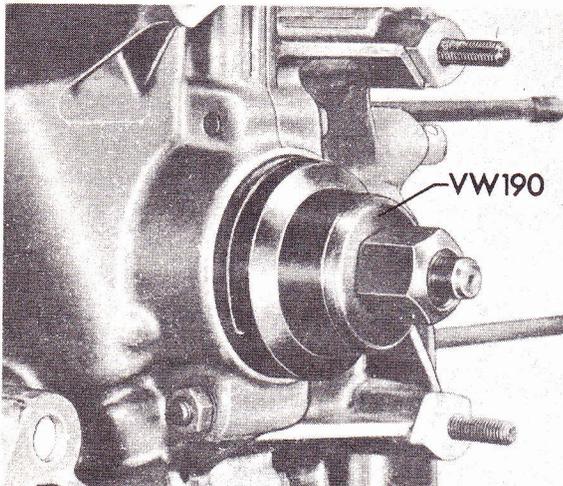


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*Removing crankshaft seal*

### Installation

Clean seats for sealing rings in crankcase and coat thinly with sealing compound. Chamfer outer edges with scraper, if required, so that the circumference of the sealing rings is not damaged. Remove clips. Insert new sealing ring on flywheel end with fitting tool VW 191. For this purpose, screw tool into crankshaft and tighten guide piece with the sealing ring attached. The sealing ring should be seated on the base of the recess of the crankcase and should not be out of alignment. Insert new sealing ring on the impeller end with fitting tool VW 190. Lubricate running surfaces for sealing rings on flywheel or impeller hub, respectively.



© Volkswagen

*Installing seal***CRANKCASE****Disassembly**

Loosen righthand crankcase half with assistance of a rubber hammer. The parting surfaces of the housing should not be damaged by sharp-edged objects, for example a screw driver.

**Checkup**

Check crankcase for external damage and cracks. Clean parting surfaces with solvent from residue of old sealing compound. Check parting surfaces for flatness and cleanliness. Lightly chamfer the edges of bearing bores, if required. Flush oil ducts and blow out with compressed air.

Check studs for tight seat. If tapped holes are worn out, Heli-Coil inserts may be screwed in. The tapped bores in the housing should be a diameter of .9449-.9457 inch with a wear limit of .9469 inch. Assemble the crankcase and tighten to specified torques. Check housing bores for crankshaft bearing with internal measuring gauge and screw gauge.

**Assembly**

Coat the parting surfaces of housing halves uniformly thin with sealing compound. Never permit sealing compound to enter the oil ducts of the crankshaft and camshaft bearings. Assemble housing halves and lightly screw down fastening screw for oil intake pipe with new sealing ring first. Then screw on sealing nuts with the sealing ring on the outside and tighten. Then tighten hex. nuts. Rotate the crankshaft to check for easy running.

**CAMSHAFT****Checking**

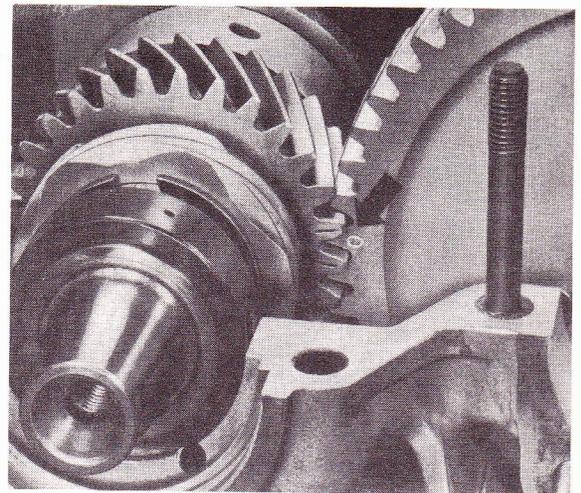
Check riveting of the camshaft gear and camshaft. Check camshaft for wear on bearing points and cams. Check camshaft for out-of-true. The maximum limit is .008 inch with a wear limit of .0016 inch. Check camshaft gear for wear and perfect contact pattern. Check axial play. The

axial play on guide bearing is, .0016-.0051 inch with a wear limit of .0063 inch.

Check backlash along the entire circumference of the camshaft gear. The backlash between the camshaft and crankshaft gear is .002 inch. The camshaft gear has the correct size, when the play is hardly felt and when the camshaft does not rise when the crankshaft is turned backwards. To facilitate establishing the specified play, camshafts with camshaft gears are available in several sizes carrying different part numbers. The gears are marked on the surface facing the cams by punched in numbers.

**Installation**

Install the camshaft gear in such a manner that the tooth marked with O is located between the two teeth of the crankshaft gear which are identified by a punch mark.



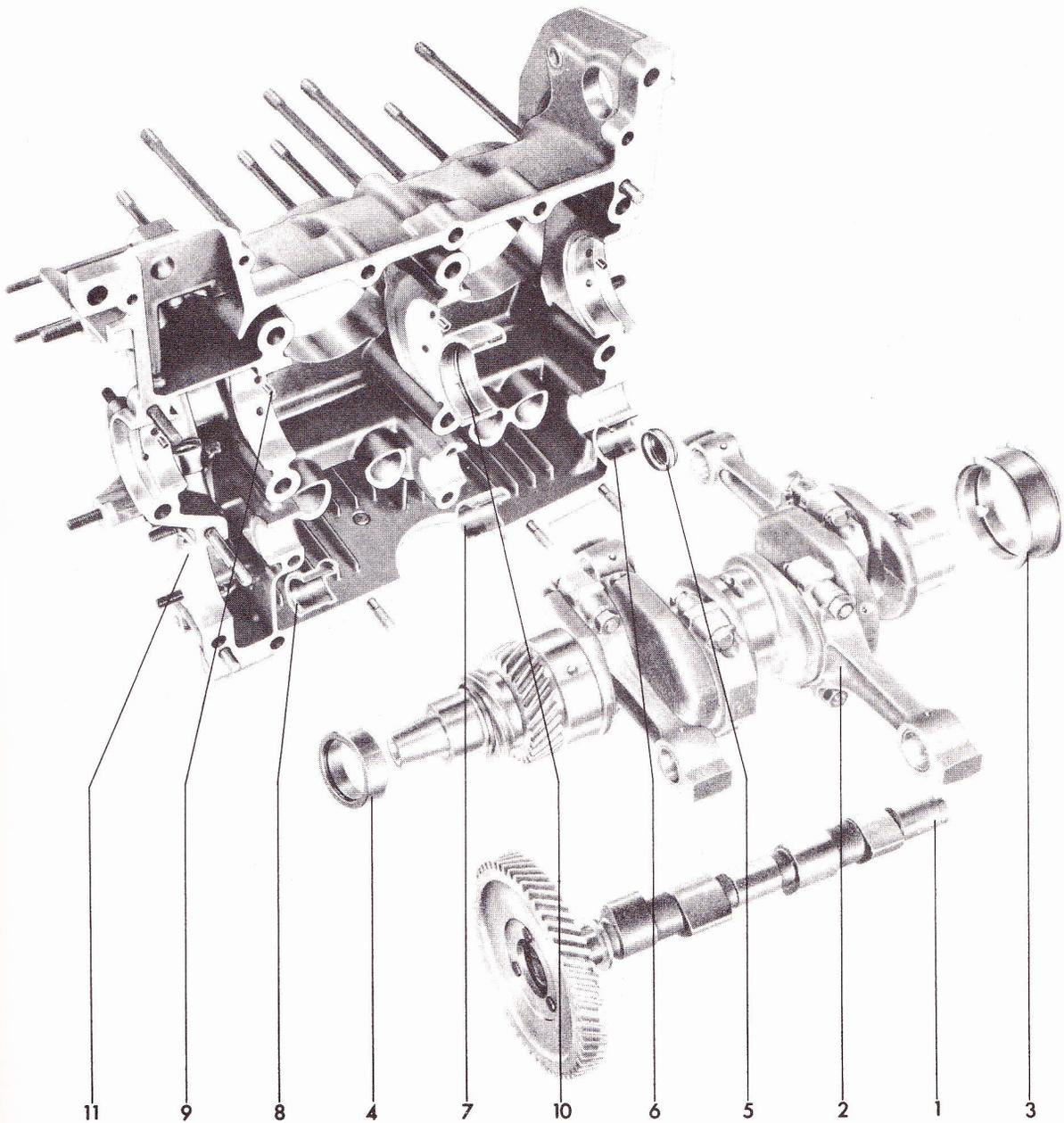
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*Timing gear marks***PREASSEMBLED CRANKSHAFT****Installation**

The oil outlet holes of the crankshaft bearing journals and the bearings should have no sharp edges. If metallic foreign bodies are embedded in the main bearings, remove with sharp scraper. Do not damage the bearing shell. Check set pins for tight seat and perfect fit in crankshaft bearings. Note markings of timing gears when installing the camshaft.

**CRANKSHAFT****Disassembly**

Remove the locking rings for ignition distributor drive gear with circlip pliers. Do not store removed crankshaft without coating of oil or grease. Remove the ignition distributor drive gear, intermediate ring and crankshaft gear on repair press in combination with holding rails from VW 457. Slight seizing marks may be carefully removed, but without impairing press seat.



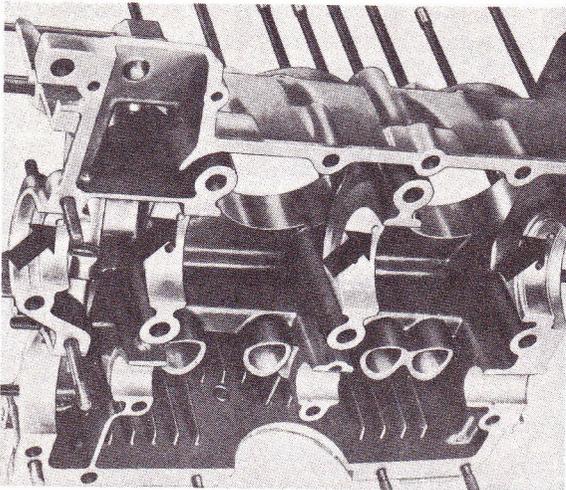
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*Disassembled crankcase & crankshaft*

- 1 - Camshaft
- 2 - Crankshaft with conrods
- 3 - Crankshaft bearing I
- 4 - Crankshaft bearing 4
- 5 - Closing cover for camshaft
- 6 - Bearing shell for camshaft bearing 1
- 7 - Bearing shell for camshaft bearing 2
- 8 - Bearing shell left for camshaft bearing 3 (with guide collar)
- 9 - Fitted pin for crankshaft bearing
- 10 - Bearing shell for camshaft bearing 2
- 11 - Crankcase housing left

Parts not shown in illustration which must be inserted into righthand crankcase half prior to assembly:

- 12 - Fitted pin for crankshaft bearing 2
- 13 - Bearing shell for crankshaft bearing 2
- 14 - Bearing shell for camshaft bearing 1
- 15 - Bearing shell for camshaft bearing 2
- 16 - Bearing shell right for camshaft bearing 3
- 17 - Oil intake pipe
- 18 - Sealing ring for oil intake pipe.



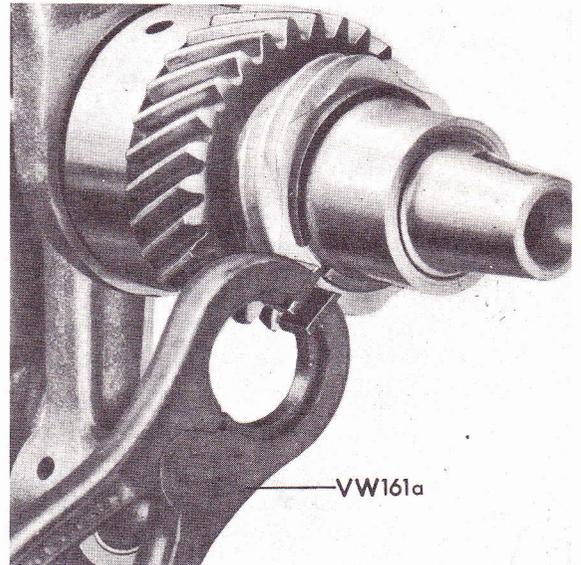
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*Bearing securing pins*

	During installation (new)	Wear limit
Crankshaft bearings 1+3	0.04-0.10 mm (0.0016-0.0039")	0.18 mm (0.0071")
Crankshaft bearing 2	0.03-0.09 mm (0.0012-0.0035")	0.17 mm (0.0067")
Crankshaft bearing 4	0.05-0.10 mm (0.002-0.0039")	0.19 mm (0.0075")

grams, which are also available as spare parts. Refinishing is therefore not required. The color coding is on the connecting rod cap.

Check conrod bushing. In a new bushing, the normally tempered piston pin should slip in easily under light finger pressure. Square connecting rod in testing fixture VW 214f/70; and straighten if required.



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*Removing ignition distributor drive gear*

**Checking**

Check the crankshaft for out-of-true, cracks (resonance test) and wear. If required, regrind the crankshaft or replace. Clean the crankshaft and blow compressed air through oil ducts. Inspect bore of crankshaft gear and ignition distributor drive gear for seizing marks and check contact pattern of teeth.

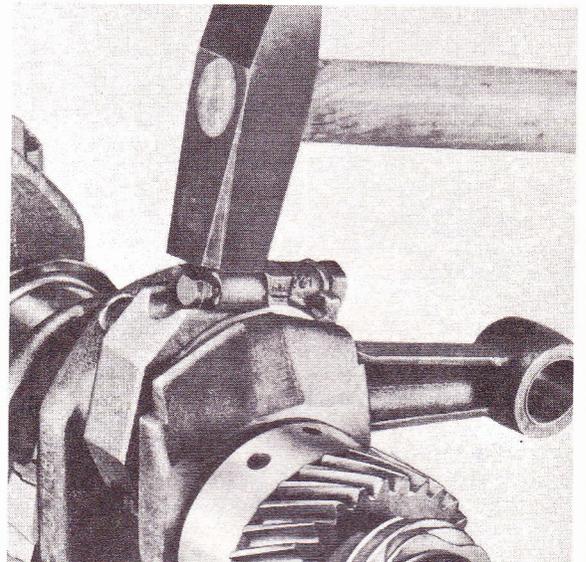
**Disassembly**

Heat the crankshaft gear in oil bath to approximately 176°F and fit in combination with VW 427 and VW 415a. The chamfer should face the crankshaft bearing. Fit intermediate ring. The ignition distributor drive gear is pressed on in the same manner. Slide on the locking ring in combination with VW 428 and VW 415a. The conical guide sleeve VW 428 prevents any damage to the crankshaft bearing pin. Check gears for tight seat when cold.

**CONNECTING RODS**

**Checkup**

Check connecting rods for external damage. Replace the entire connecting rod, even if only the bolts are damaged. Check connecting rod weight. The difference in weight of the connecting rods in one engine should not exceed 6 grams. Conrod weight = conrod complete, but without bearing shells. Two weight classes are available for installation, white = 746-752 grams, black = 769-775

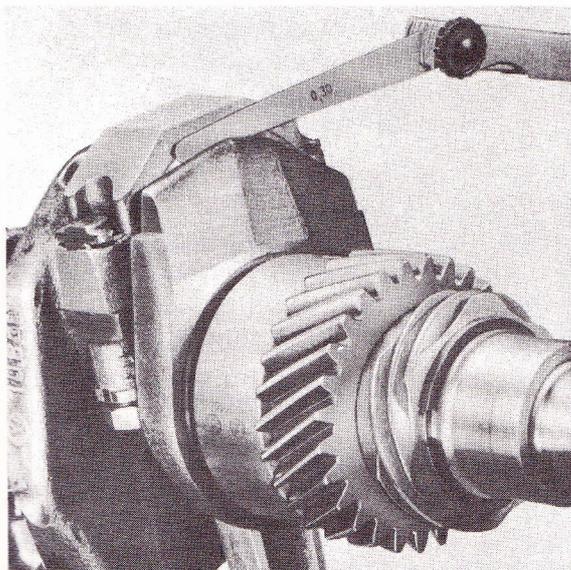


© Volkswagen

*Correcting slight distortions*

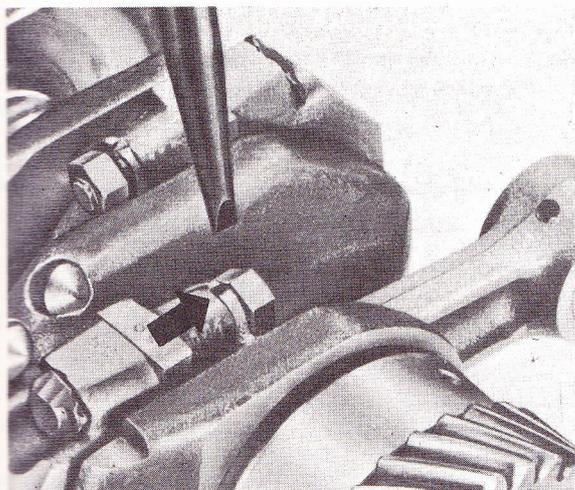
### Installation

The code numbers on the parting joint of the connecting rod top and bottom should be located on same side. Slight distortion which may occur when tightening the conrod bolts between the bearing halves may be removed by applying light hammer blows against both sides of the connecting rod. The connecting rod should slide under its own weight. Any refinishing or recessing of bearings is never permitted.



© Volkswagen  
*Checking conrod end play*

The axial play of the connecting rod, measured with a feeler gauge, should be .004-.016 inch, with a wear limit of .026 inch. Secure hex. nuts with peening punch.



© Volkswagen  
*Securing conrod bolt*

### Reconditioning

Connecting rods which are slightly bent or have worn bushings, must be squared and provided with new bushings. Remove small end bushings in VW repair press in combination with VW 402, VW 409, VW 416b, and VW 421.

Insert the connecting rod in fixture VW 214f/70. Turn the mandrel in such a manner that the milled surface is crosswise to the center axis of the connecting rod. After fitting washer, tighten locking lever only to the extent that the connecting rod is still movable in both directions. Support is loose.

Introduce bolt into the conrod eye and push with two fingers in the direction of mandrel in such a manner that no canting will occur between the receiving mandrel and the conrod bearing or between the conrod eye and the bolt. Check the connecting rod for distortion and parallel alignment. If there are deviations, tighten locking lever well and straighten the connecting rod with straightening mandrel.

Install small end bushing on VW repair press in combination with VW 402, VW 409, and VW 421. Drill oil holes (.14 inch). Place rod of reamer through the conrod eye and pertinent bore of fixture, with the conical guide bushing serving for centering the small end bushing. Tighten locking lever and support for holding the connecting rod.

Following the reaming, the inside surface of the bushing should be free of score and chatter marks. The piston pin should slide in easily under finger pressure and without using oil. If the bushings have been reamed too much by mistake, the excessive play between the piston pin and the bushing should not be compensated for by installing an oversized piston pin. Always use a new bushing and ream.

Check parallel alignment and distortion once again, this time with the piston pin inserted as described above. Any slight differences can be straightened out by introducing a mandrel into the piston pin.

### OIL PUMP

#### Removal

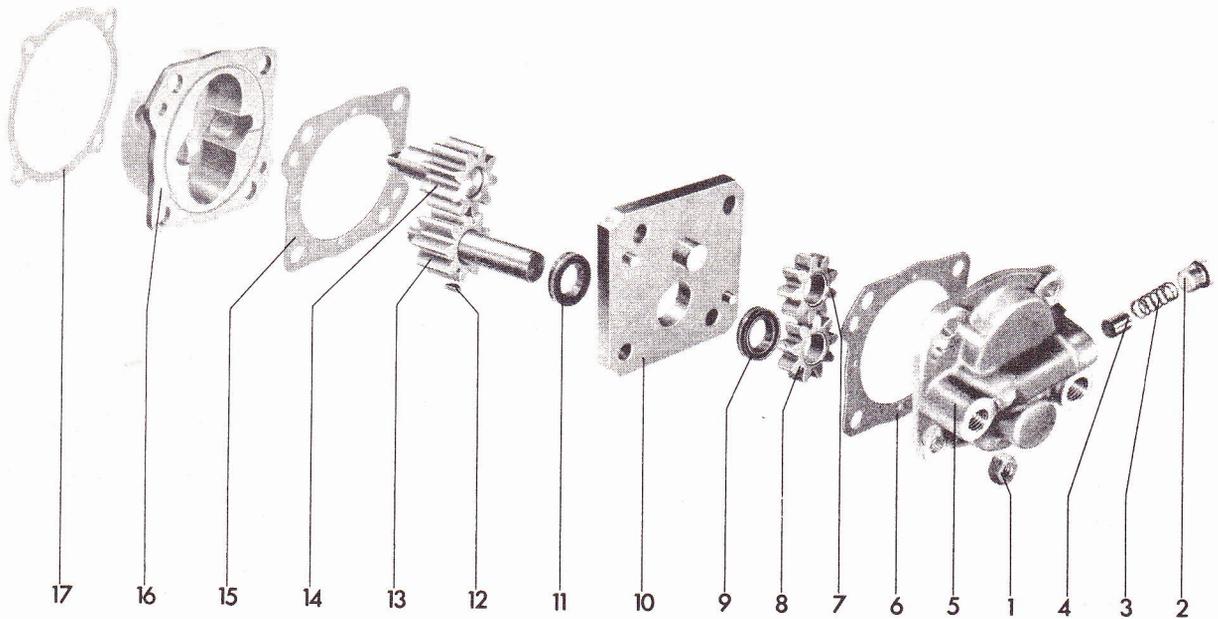
Remove oil pump with two mounting levers. Pull oil pump cover with puller VW 803.

#### Checking

Check the oil pump housing and the oil pump cover, in particular bearing points of gear wheels prior to installation, for wear. Scored parts will result in pressure losses. Check contact surface for oil pump on the crankcase for cleanliness and damage.

#### Installation

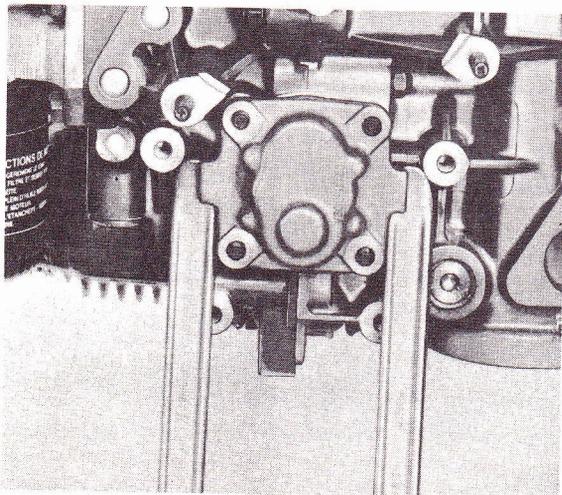
The following points must be observed: Lubricate the gear wheel and the drive shaft and insert into oil pump housing. Install oil pump cover with lubricated rubber sealing ring into the housing. Following assembly, check the gear wheels for perfect running. Install the oil pump with new seal into the crankcase. The journal of the drive shaft should be in alignment with the slot in the camshaft gear. Center oil pump by two crankshaft revolutions and tighten hex. nuts.



Exploded view of oil pump (Sportomatic)

© Volkswagen

- |   |  |
|---|--|
| 1 - Sealing nut M 8                       | 9 - Sealing ring for intermediate plate  |
| 2 - Closing screw                         | 10 - Intermediate plate                  |
| 3 - Spring                                | 11 - Plate spring                        |
| 4 - Piston                                | 12 - Shaft bottom with gear wheel inside |
| 5 - Cover                                 | 13 - Shaft top with gear wheel inside    |
| 6 - Seal for intermediate plate and cover | 14 - Housing for double oil pump         |
| 7 - Gear wheel outside top                | 15 - Seal for oil pump housing           |
| 8 - Gear wheel outside bottom             |  |



© Volkswagen

Removing oil pump cover

**Installation**

Check piston and bore in the housing for score marks. Remove score marks carefully and replace piston, if required. Check spring. To prevent any damage to bore in the housing, be sure that the upper end of the spring does not wipe against housing.

**OIL COOLER**

**Checking**

Check oil cooler for leaks and tight seat of all welded plates. Test pressure to 85 psi. Leaking oil cooler: check oil relief valve.

Check oil relief valve in the event of trouble in the oil circuit, but definitely if the oil cooler leaks. If the piston binds at TDC there is the danger that the oil cooler will develop a leak when the oil is thick. Binding at BDC will cause the oil to flow directly into the crankcase and lubrication of the warm engine will then be insufficient.

**OIL PRESSURE SWITCH**

**Checking**

The check is made with the engine at operating temperature, using a plain tester with pressure gauge and inspection lamp. Unscrew oil pressure switch and screw into tester. Insert the tester into the crankcase instead of the oil pressure switch, and connect inspection light to oil pressure switch on the one hand and to terminal 15 of the

**OIL PRESSURE VALVES**

**Removal**

A binding piston can be pulled out after screwing in a tap.

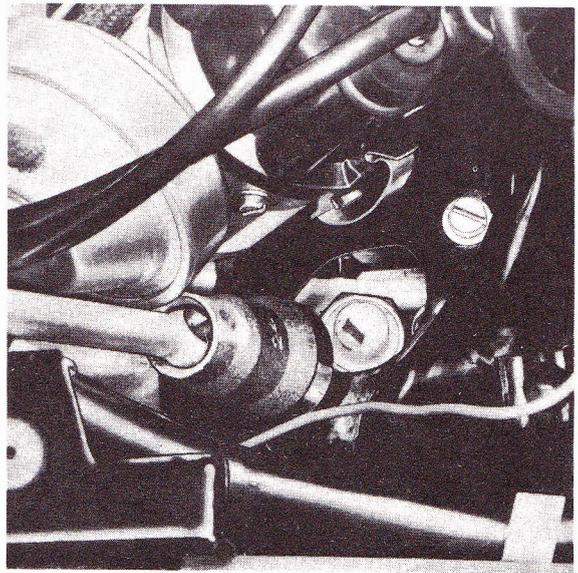
ignition coil on the other. Switch on the ignition, and the inspection light should go on. If the light does not go on, replace switch.

Start engine. Pressure rise on pressure gauge as the speed increases, while the light should go out. The contact of the switch should remain closed and the lamp should light up as long as the oil pressure is under 6.4 psi. Stop engine. The lighting up of the inspection light might be delayed somewhat, since the oil pressure drops slowly. The oil pressure switch is sealed by means of the tapered threads. Upon installation, the switch should not be tightened excessively to prevent any damage to threads.

## OIL FILTER

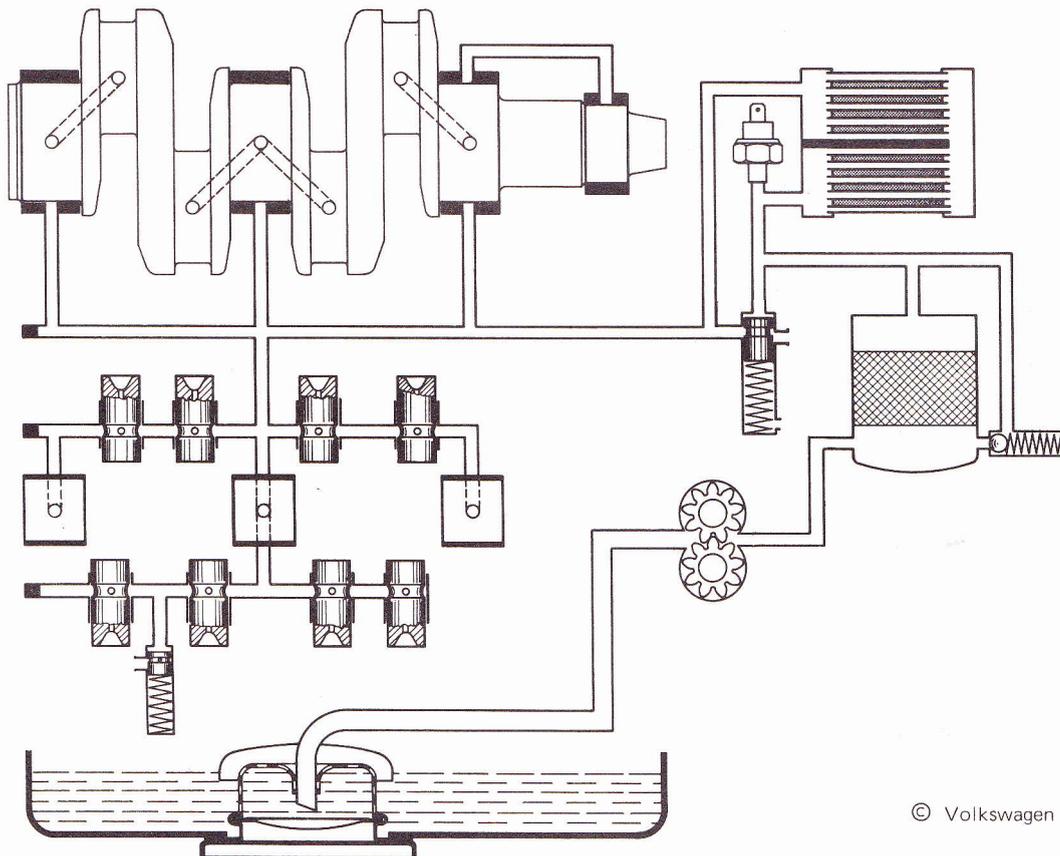
### Installation

Check the sealing surface on the flange of the oil filter for cleanliness. Lubricate rubber seal slightly. Screw the filter in manually until seal is seated. Tighten the oil filter with spanner. Fill up with engine oil. Start engine and check for leaks. Check oil level and fill up with oil, if required.



© Volkswagen

Removing oil pressure switch



© Volkswagen

Oil circuit diagram

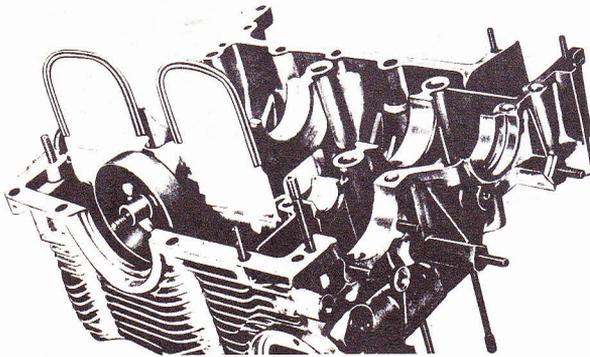
**1972 MODIFICATIONS**

**OIL BAFFLE PLATE**

**Description**

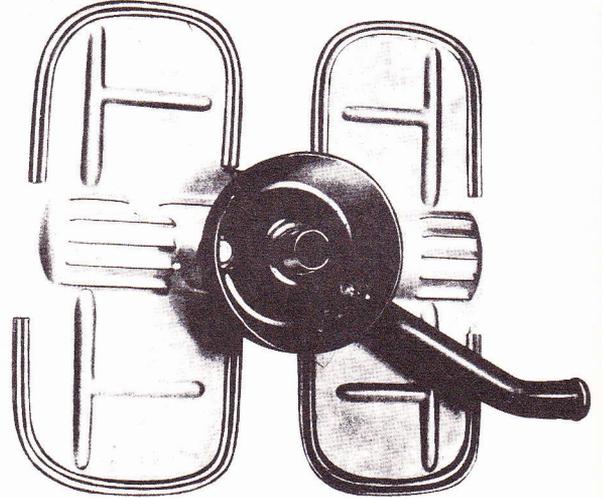
The engine is provided with an oil baffle plate to ensure the oil intake pipe remains submerged in oil when car corners sharply. A shaped seal around the baffle increases the baffles efficiency while preventing noise. The baffle, in conjunction with a new oil intake pipe, can be installed

in earlier engines, from engine # W 0 074 387. From this engine number on, the crankcase has been provided with the required special ribs.



© Volkswagen

*Oil baffle plate installed*



© Volkswagen

*Oil baffle plate*

# CLUTCH 7

## INDEX

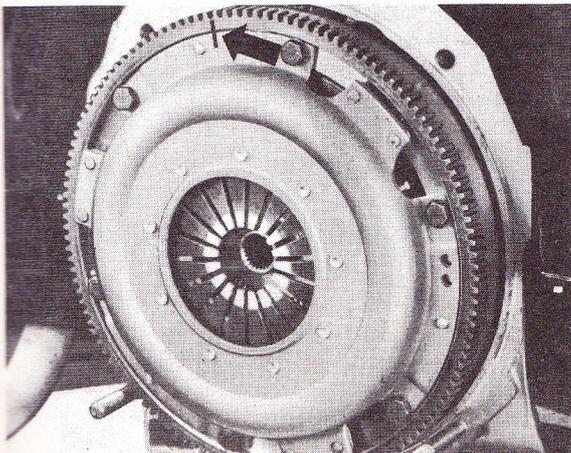
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### DESCRIPTION

The single plate dry clutch between the engine and the main gearbox is fitted to the flywheel. The clutch disk is lined on two sides and slides on the splined input shaft of the transmission in axial direction. The clutch cover, the clutch pressure plate and the diaphragm spring are concentrically screwed to the flywheel. In engaged condition, the clutch disk is pressed by the clutch pressure plate against the clutch facing of the flywheel by the spring force of the diaphragm spring. The power connection between the engine and the transmission is thereby established.

### Removal

The original position of the clutch on the flywheel should be marked, to eliminate a major unbalance during reassembly. Loosen the fastening bolts uniformly. Loosen the bolts alternately and crosswise, by one or two turns, until the spring action stops, in order to eliminate any distortion of the cover.

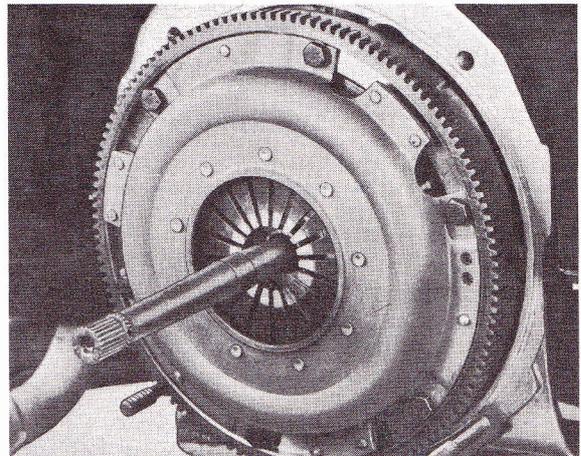


*Alignment marks*

© Volkswagen

### Installation

Clean the contact surface of the clutch disc in the flywheel and check it for wear. Surface cracks and score marks can be removed by grinding or machining. If required, replace the flywheel. Coat lightly the needle bearing in the flywheel with multi-purpose grease, only after it has been cleaned. Moisten the felt ring with engine oil. Wipe off the excess lubricant. Check the clutch and the clutch disc.



© Volkswagen

*Clutch with alignment shaft installed*

Check the splines of the input shaft and coat lightly with molybdenum disulfide powder. Apply the powder with a brush or a piece of non-fraying cloth. The clutch disc should slide easily without excessive radial play. Check the clutch throwout bearing. The throwout bearing requires no service. Do not wash or flush with cleaning gasoline or other cleaning agents, but only with a clean cloth.

## CLUTCH 7-2

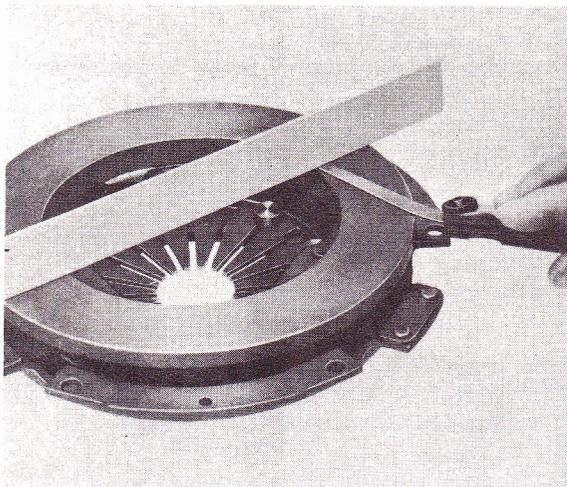
Replace the bearings which are contaminated or defective. Check to see that the holding springs are properly seated. Grease the guide bushing lightly with molybdenum disulfide paste. Now, insert a clutch with a clutch disc into the flywheel. Accurate centering of the clutch disc is performed with the assistance of an extra input shaft.

Check the balancing marks. When a new clutch is installed, the balancing marks on the clutch and the flywheel should be offset by 180°.

Tighten the fastening bolts uniformly and crosswise to 14-1/2 ft/lb.

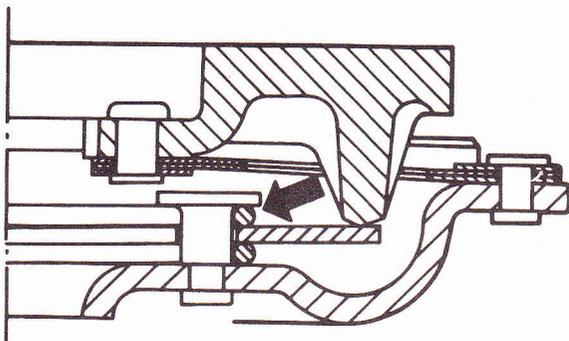
### Inspecting

The inspection of the diaphragm spring clutch is restricted to a thorough sight test. Any reconditioning or repairing of the clutch in workshops is not intended.



© Volkswagen

*Checking flatness of pressure plate*



© Volkswagen

*Mounting of diaphragm spring*

Check the ends of the diaphragm spring for wear marks (support of the clutch throwout bearing). Wear marks of

up to 0.012 in. are of no significance. Check the supporting surface of the pressure plate for cracks, burned spots and wear. Pressure plates which are bent inwards, up to 0.012 in. are still fit for installation.

Inspect the spring connections between the pressure plate and the cover for cracks. Check all rivet connections for a tight seat. The diaphragm spring is mounted on the cover between two wire rings by means of a rivet connection. Clutches with visible wear on the rivet head or the wire ring should be replaced.

### CLUTCH DISC

#### Inspection

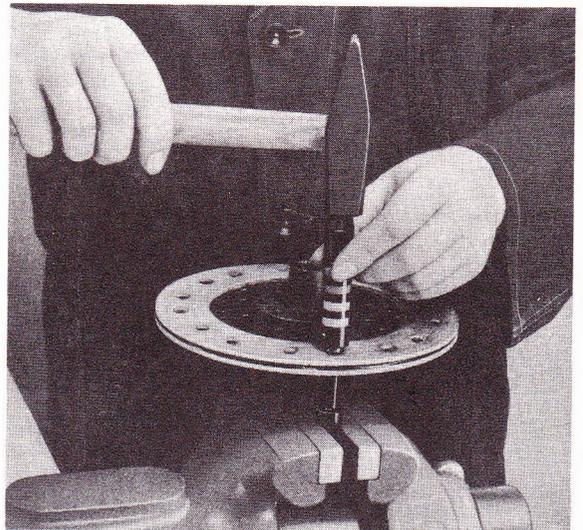
The clutch disc should slide easily on the input shaft without excessive radial play. Replace worn parts. Check all riveting; replace the clutch disc, if required. If the spring elements or the driver plate are cracked, completely replace the clutch disc.

Replace worn, cracked, oily or burned clutch linings. Check the clutch disc for lateral wobble. A max. of 0.020 in. at a 8.274 in. dia. is permitted. Straighten slightly distorted discs with a rubber hammer.

### CLUTCH DISC LININGS

#### Removal and replacement

Unusable linings may not be removed by tearing them off, but by drilling the rivets on the rivet head end. Use only linings that are approved by Volkswagen. — Flywheel end: Jurid or Textar; Clutch end: Textar. For attaching the clutch linings on the clutch disc, use 2 mm (0.078 in.) dia. rivets.



© Volkswagen

*Riveting on new clutch facings*

When riveting, be sure that the rivet shoulder is always inserted into the larger bore of the double lining spring. Riveting is done on the clutch lining. Riveting the clutch

linings on the clutch discs with a double lining spring is permitted only with the proper riveting tools.

Unsuitable tools may result in incorrect spacing between the two lining springs. When using riveting tools, clamp the riveting support into the vise. Split the rivet with a

rivet header, but be sure not to turn the header. Double-punch the individual rivet segments with a die.

Upon application of the lining, check the clutch disc for out-of-true. The maximum permissible lateral out-of-true (measured at 8.274 in. dia.) is 0.020 in.

# TRANSMISSION, MANUAL 8

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### DESCRIPTION

The Porsche synchromesh system uses servo-thrust forces to synchronize the transmission gears. Friction created between synchronizing ring is increased by the servo-lock component contained within the synchronizing ring.

All forward speeds of the transmission have identical synchromesh components with the exception of the 1st gear which is used for starting. Care was taken to ensure that this starting gear engages with the least amount of effort when the car is not in motion.

### Transmission removal & installation

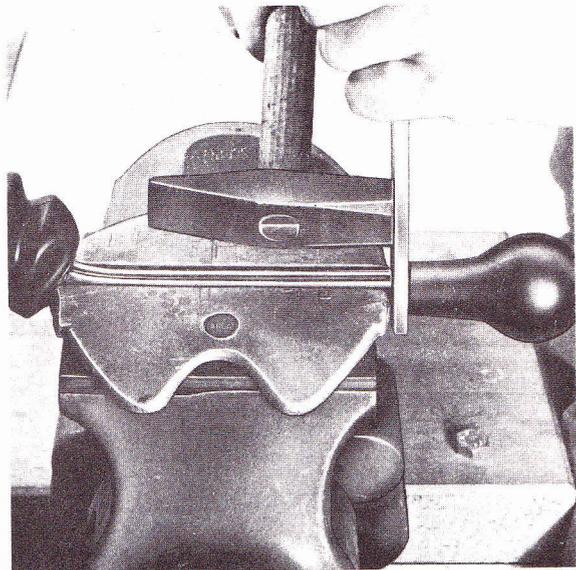
The transmission is removed complete with the engine. See engine section for details.

### SHIFT LEVER ASSEMBLY

#### Disassembly

Clamp the shift lever in a vise equipped with soft jaws. Pry off the shift knob using a self-made lever. Pull the retaining ring out of the shift knob with a hook. Remove the shift boot and pry the plastic ball socket off the shift lever with a screwdriver.

Clamp the shift lever mounting bracket into the vise. Use care when removing the bracket because the guide pin springs are under tension and may fly out. Remove the guide pin snap springs and the retaining parts.



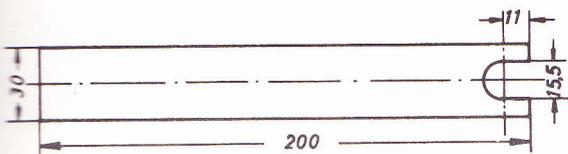
© Volkswagen

Removing gear shift knob

#### Assembly

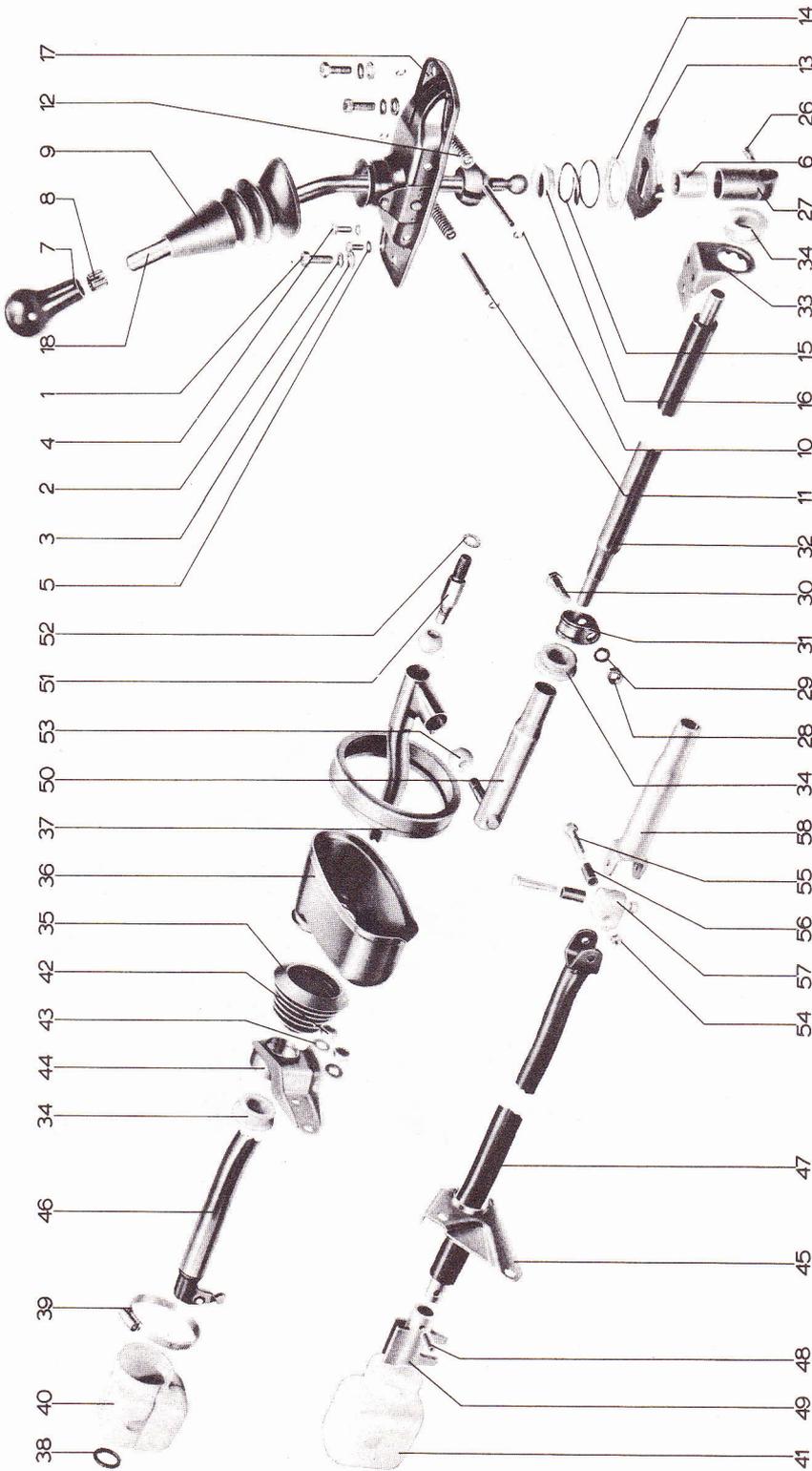
Push the lower spring seat on the shift lever compression spring until the spring is seated. Coat the lower part of the shift lever with moly grease and insert the lever into the shift bracket.

To install the guide pin springs, first position the stop plate to the shift bracket of the guide pins. Next, insert the second guide pin with the snap ring at an angle and slip the spring over the pin. Carefully push one end of the



Tool for removing knob

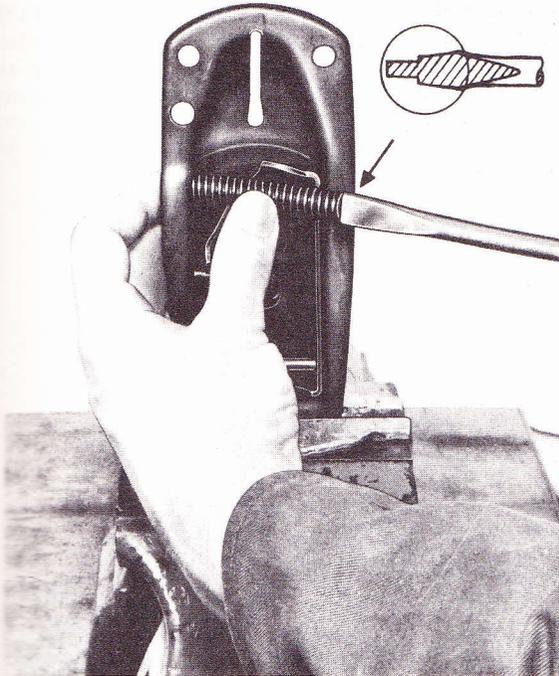
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- 1 - Bolt M 8
- 2 - Lock washer
- 3 - Flat washer
- 4 - Bolt M 6
- 5 - Spring washer
- 6 - Ball socket
- 7 - Shift knob
- 8 - Shift knob retaining ring
- 9 - Shift boot
- 10 - Snap ring
- 11 - Guide Pin
- 12 - Spring
- 13 - Stop plate
- 14 - Lower spring seat
- 15 - Spring
- 16 - Upper spring seat
- 17 - Plate
- 18 - Shift lever mounting bracket
- 26 - Tapered screw
- 27 - Shift rod head
- 28 - Nut M 8
- 29 - Lock washer
- 30 - Bolt M 8 x 32
- 31 - Clamp
- 32 - Shift rod, front
- 33 - Bracket for bushing
- 34 - Bushing
- 35 - Boat
- 36 - Case
- 37 - Rubber seal
- 38 - Seal for case
- 39 - Clamp
- 40 - Dust cap
- 41 - Dust cap 914/6
- 42 - Nut M 8
- 43 - Spring washer
- 44 - Shift rod holder
- 45 - Shift rod holder 914/6
- 46 - Shift rod, rear
- 47 - Shift rod 914/6
- 48 - Lock pin
- 49 - Selector
- 50 - Shift connector rod
- 51 - Bolt
- 52 - Star washer
- 53 - Ball
- 54 - Nut M 6 914/6
- 55 - Bolt M 6 914/6
- 56 - Bushing 914/6
- 57 - Adapter 914/6
- 58 - Shift connector rod 914/6

© Volkswagen

Exploded view of shift lever assembly



© Volkswagen

*Installing guide pin springs*

**LINKAGE**

**Adjusting**

The linkage can be adjusted at the front shift rod, the connector rod and the rear shift rod by either changing the lengths or by turning the rods. Loosen the clamp between the front shift rod and the connector rod. Move the shift lever into neutral. The lower end of the shift lever should be in the vertical position when seen from the side. Rest the shift lever against the left stop.

Remove the dust cap on the transmission for the rear shift rod. Move the selector lever into the neutral position and center the selector lever by sliding the rear shift rod. Tighten the clamp between the front shift rod and the connector rod.

Select 3rd gear with the gear shift lever. Check whether the selector lever, at the transmission, is correctly engaged. Adjust if necessary. Test drive and check to see that all gears engage smoothly.

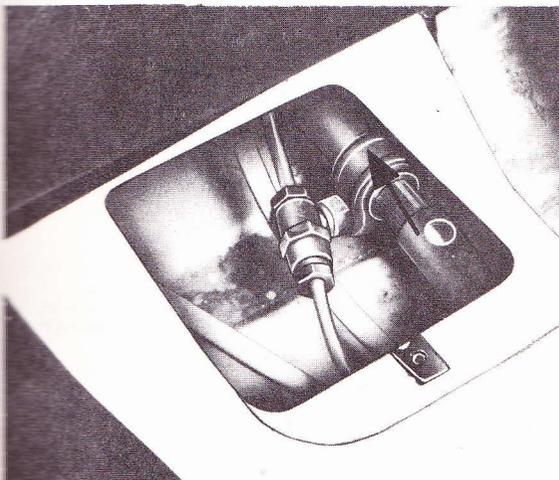
**TRANSMISSION**

**Disassembly**

Attach the transmission to a stand and drain the transmission oil. Loosen the nuts on the rear transmission cover. Remove the four nuts and take off the shift lever cover plate, on the bottom of the transmission cover. When removing the transmission cover, the components on the idler shift may fall out. Remove the rear transmission cover while turning the shift lever shaft slightly counter-clockwise. This disengages the shift lever from the shift rod.

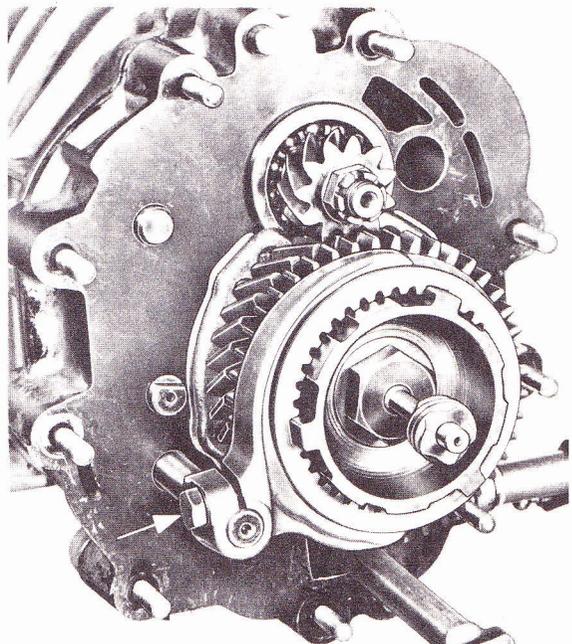
Loosen the bolt on the shift fork for 1st and reverse gear and remove the shift gear together with the shift fork.

spring into the cutout. Align the spring and push the pin in completely. Now, install the spring on the other guide pin in the same manner and then slide on the shift boot. Insert a new retaining ring into the shift knob. Place the shift knob on the lever so that the shift pin is in the correct position.



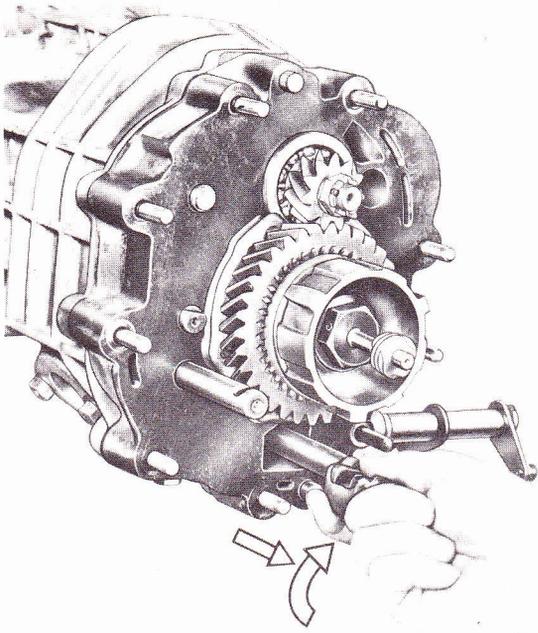
© Volkswagen

*Shift rod clamp*



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*First & reverse gear shift fork bolt*

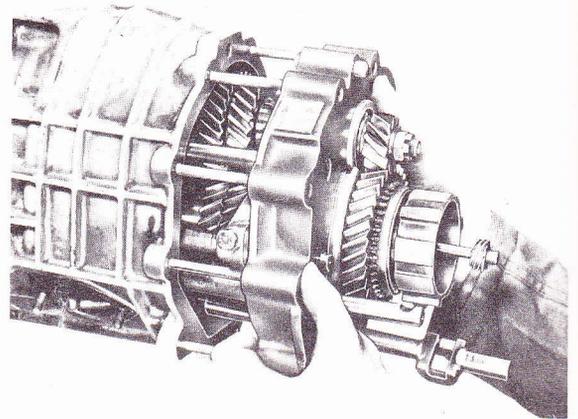


© Volkswagen

*Engaging 5th gear*

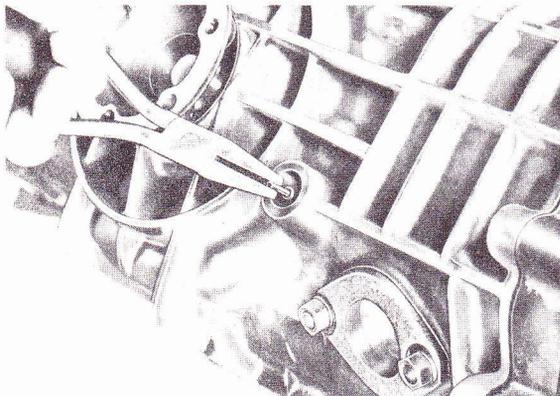
Engage 5th gear (turn the shift rod to the right and pull it out). Lock the drive shaft with a holding plate. Loosen the expansion bolt of the pinion shaft with an insert (do not remove it). Remove the spiral pin of the castle nut on the drive shaft with a mandrel and loosen the castle nut (do not unscrew it).

Withdraw the intermediate plate with the gear assembly from the transmission housing until it clears the studs. Then turn the intermediate plate assembly slightly to the right and remove it. (If necessary, tap the intermediate plate lightly with a soft mallet.) Note the quantity and thickness of the gaskets between the transmission housing and the intermediate plate. Place the intermediate plate with the gear assembly in a vise equipped with soft jaw caps.



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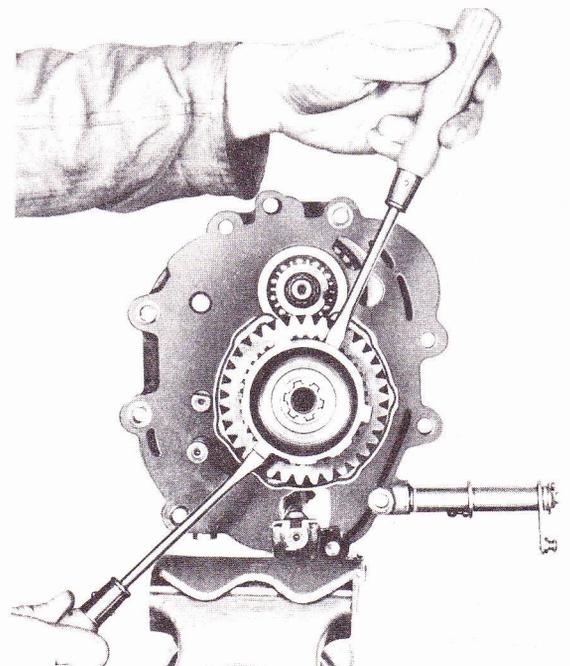
*Removing intermediate plate*



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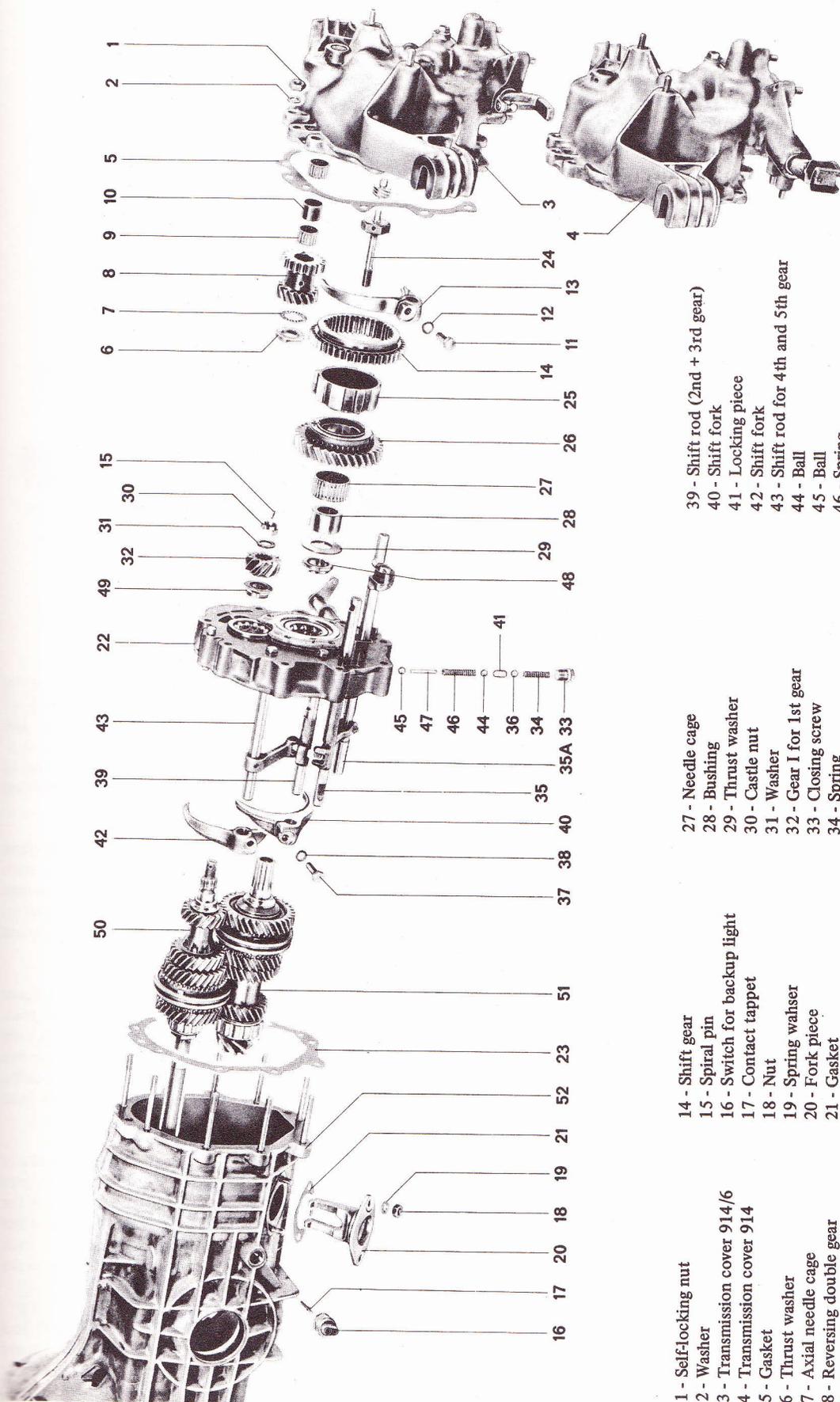
*Removing backup light contact pin*

Engage neutral. Unscrew the backup light switch and pull out the contact pin. Loosen the nuts on the fork piece for the internal shift lever and pull out the fork piece. Pull the internal shift rod out of its guide. Engage 5th gear, by placing a screw driver through the hole in the fork piece.



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*Removing guide sleeve, 1st & reverse gear*

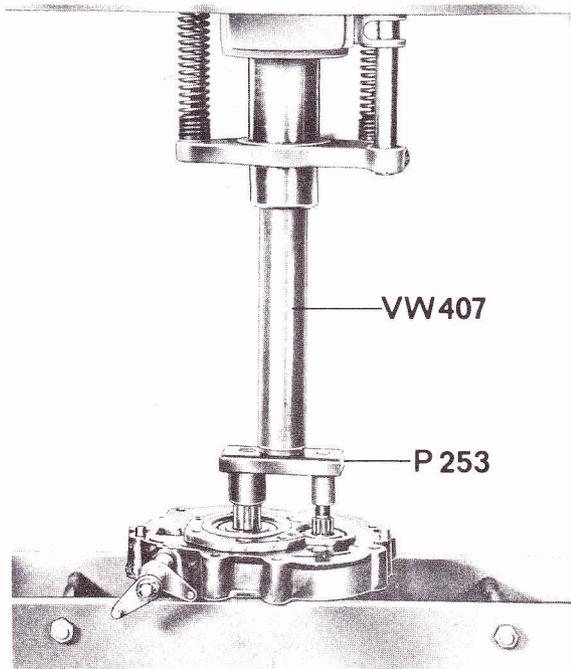


© Volkswagen

- |                              |   |                                     |
|------------------------------|---|-------------------------------------|
| 1 - Self-locking nut         | 27 - Needle cage                        | 39 - Shift rod (2nd + 3rd gear)     |
| 2 - Washer                   | 28 - Bushing                            | 40 - Shift fork                     |
| 3 - Transmission cover 914/6 | 29 - Thrust washer                      | 41 - Locking piece                  |
| 4 - Transmission cover 914   | 30 - Castle nut                         | 42 - Shift fork                     |
| 5 - Gasket                   | 31 - Washer                             | 43 - Shift rod for 4th and 5th gear |
| 6 - Thrust washer            | 32 - Gear I for 1st gear                | 44 - Ball                           |
| 7 - Axial needle cage        | 33 - Closing screw                      | 45 - Ball                           |
| 8 - Reversing double gear    | 34 - Spring                             | 46 - Spring                         |
| 9 - Needle cage              | 35 - Shift rod for 1st and reverse gear | 47 - Pin for gear interlock         |
| 10 - Sleeve                  | - Shift rod                             | 48 - Bearing inner race             |
| 11 - Bolt                    | 36 - Ball                               | 49 - Bearing inner race             |
| 12 - Spring washer           | 37 - Bolt                               | 50 - Drive shaft                    |
| 13 - Shift fork              | 38 - Spring washer                      | 51 - Pinion shaft                   |
|                              |   | 52 - Transmission housing           |

*Exploded view of manual transmission*

Remove the pinion shaft expansion bolt. Remove the guide sleeve and 1st and reverse gear using two screw drivers. Remove large first gear (gear II), the race, the needle bearing cage, and the thrust washer. Remove the castle nut and small first gear (gear I) from the drive shaft. Engage neutral. Loosen the gear interlock retaining bolt and remove the spring.



© Volkswagen

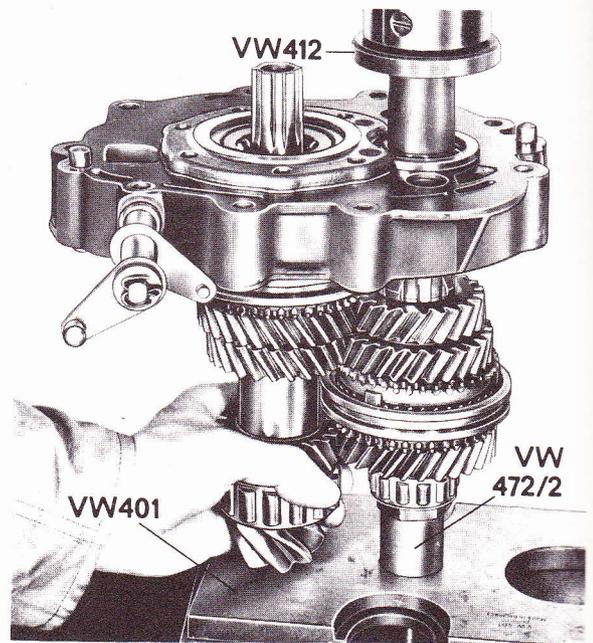
*Removing drive shaft from intermediate plate*

Remove the shift rod for 1st and reverse gear as well as the ball for the gear interlock. Put identifying marks on the assembly to ensure proper installation. Loosen the retaining bolts for the 2nd and 3rd gear shift forks. Remove the shift rod, the shift fork and the locking piece.

Loosen the retaining bolt of the 4th and 5th gear shift fork. Remove the shift rod, and the ball for the gear interlock. Remove the gear interlock, the ball, the spring and the locking pin. When pressing out the pinion and the drive shaft, ball bearings may fall out. Press out the pinion and the drive shafts from the intermediate plate using a thrust piece.

**Assembly**

Position the intermediate plate on the inner race halves of the pinion and the drive shaft bearings. Slide the tubing on the drive shaft. Position the shaft on the thrust plate. Press on the inner bearing race using suitable tubing. Hold the pinion shaft in position. Remove the tube from the drive shaft. Position the pinion shaft on the thrust plate and press on the inner half of the bearing race.



© Volkswagen

*Installing drive & pinion shafts*

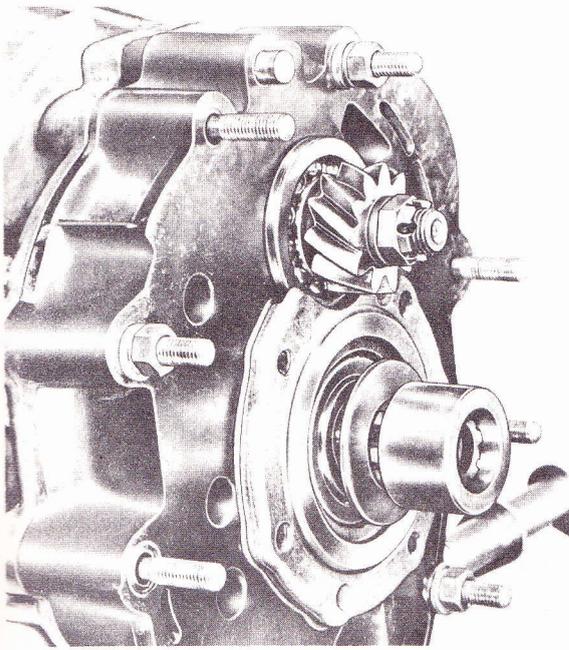
To prevent damage to the gears, make sure that the gears are properly meshed before pressing on the inner half of the pinion bearing race. Engage 5th gear, and install the intermediate plate assembly in the transmission. Temporarily fasten the intermediate plate to four of the housing studs (use spacer bushings). Hand tighten in a crisscross pattern.

Lock the drive shaft with a holding plate. Place small first gear (gear I) on the drive shaft. Install the castle nut with a washer and tighten to the specified torque. Then secure the castle nut with a lock pin. Slide the thrust washer, with the small collar toward the bearing, on to the pinion shaft, together with the race for the needle bearing.

Install the needle bearing and large gear of 1st gear (gear II). Install the guide sleeves for 1st and reverse gear. Lubricate the thrust surface of the pinion shaft bolt (with speedometer drive), and adjust to specifications. Remove the intermediate plate with the pinion and drive shafts. Clamp the intermediate plate with the gear assembly into a vise equipped with aluminum jaw caps.

Engage neutral. Install the shift rods and the shift forks as described below. Place the shift forks for 4th and 5th gear on their respective shifting sleeves. Slide the shift rods for 4th and 5th gear up into the hole of the intermediate plate. Attach the shift piece on the shift rod with a lock pin. Tighten the bolt for the shift fork with a wave washer.

Insert a ball into the connecting duct of the shift rod bores. Coat the lock pin and the long spring with grease and insert them at the same time. Next, insert another ball.

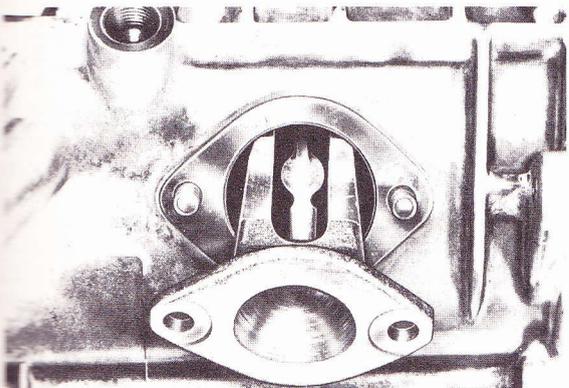


© Volkswagen

*Installing thrust washer*

Place the shift fork for 2nd and 3rd gear on to their respective shift sleeves and slide the shift rod for 2nd and 3rd gear up into the hole of the intermediate plate. The 4th and 5th gear shift rod should be in the neutral position. Push the 2nd and 3rd gear shift rod until the ball seats in the groove. Slightly tighten the bolt (with a wave washer) for the shift fork.

Insert detent for the gear interlock. Make sure that the 2nd and 3rd gear shift rod is in the neutral position. Insert the shift rod for 1st and reverse gear. Now, insert a ball and a short spring. Tighten the retaining bolt to the correct torque. Slide the shift fork and the shift gear for

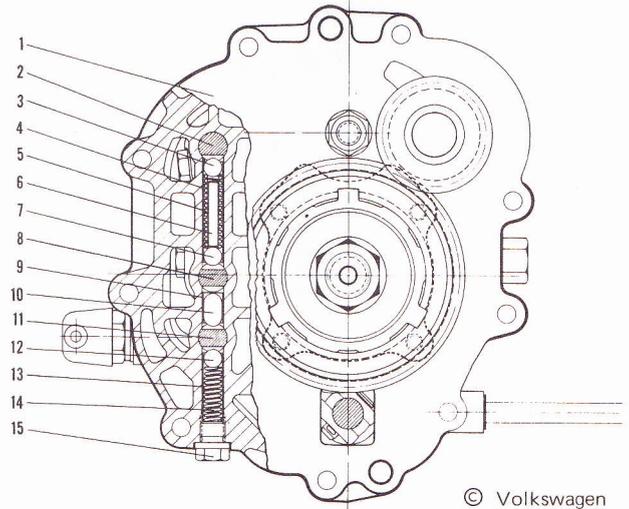


© Volkswagen

*Installing fork piece for internal shift lever*

1st and reverse gear, together, on to the guide sleeve and the shift fork. Slightly tighten the bolt (with a wave washer) for the shift fork. Adjust the shift forks. Check the interlock springs and replace them if necessary.

Attach the selector lever to the inner shift rod with a clevis pin. Make sure that the lever is properly positioned and fastened with a cotter pin. Place the correct number of gaskets on the transmission housing. When inserting the gear assembly, be careful not to damage the drive shaft seal. Replace the seal if necessary.



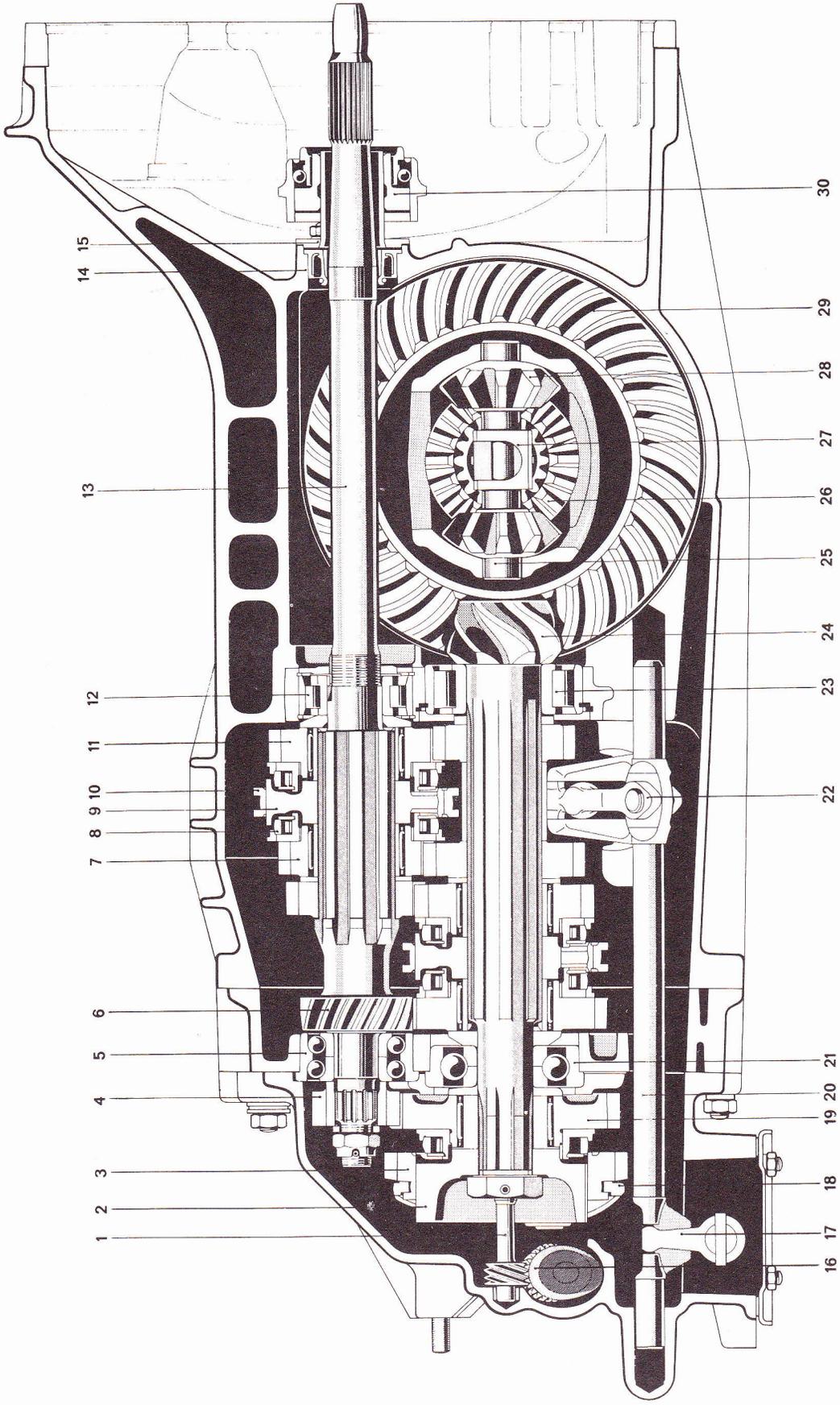
© Volkswagen

*Shift rod detent assembly*

- 1 - Intermediate plate
- 2 - Shift rod for 4th and 5th gear
- 3 - Ball
- 4 - Bushing for gear lock
- 5 - Spring (large) for gear interlock pin
- 6 - Interlock pin
- 7 - Ball
- 8 - Shift rod for 2nd and 3rd gear
- 9 - Bushing for gear lock
- 10 - Detent
- 11 - Shift rod for 1st and reverse gear
- 12 - Ball
- 13 - Bushing for gear lock
- 14 - Spring (small) for gear interlock
- 15 - Retaining bolt

Engage 5th gear and insert the intermediate plate with the gear assembly into the housing. Engage neutral and insert the inner shift rod into its bushing. Make sure that the selector lever engages correctly in the shift rod gates. Install the fork piece with a new gasket. Be sure that the inner shift lever is guided in the fork piece.

Tighten the nuts to the specified torque. Place the needle cages and the spacer sleeve on the first and reverse idler gear shaft (located in the rear transmission cover). Place a new paper gasket on the intermediate plate. Insert the bearing cages and the spacer bushing onto the reverse idler shaft. Install the reverse idler gear axial bearing and the thrust washer.



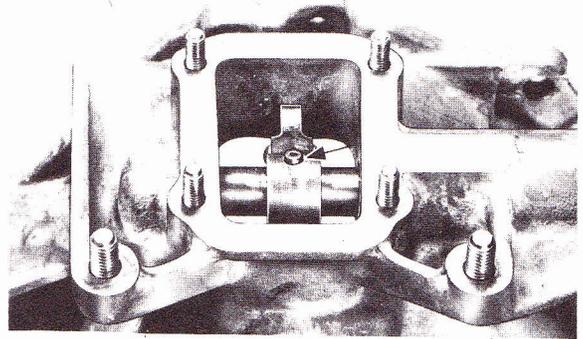
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- |                                    |                        |                                     |                           |  |
|------------------------------------|------------------------|-------------------------------------|---------------------------|--|
| 1 - Speedometer drive pinion       | 7 - 4th gear           | 13 - Drive (input) shaft            | 19 - Gear II for 1st gear | 25 - Shaft for small pinion (spider) gears |
| 2 - Guide sleeve, 1st and reverse  | 8 - Synchronizing ring | 14 - Seal                           | 20 - Shift rod            | 26 - Side gear (large pinion)              |
| 3 - Shift gear for 1st and reverse | 9 - Synchro hub        | 15 - Guide tube                     | 21 - Ball bearing         | 27 - Anchor piece                          |
| 4 - 1st gear                       | 10 - Shaft sleeve      | 16 - Speedometer drive take off     | 22 - Selector shaft       | 28 - Spider gear (small pinion)            |
| 5 - Double-row ball bearing        | 11 - 5th gear          | 17 - Shift lever                    | 23 - Roller bearing       | 29 - Ring gear                             |
| 6 - 2nd gear                       | 12 - Roller bearing    | 18 - Shaft fork for 1st and reverse | 24 - Pinion               | 30 - Throw-out bearing                     |

With the cover ready for installation, pull the thrust washer, the axial bearing and the idler gear as far to the front of the idler shaft as possible. This enables the idler gear to be guided across the first and reverse shifting gears. Make sure that the thrust washer is aligned in such a way that the outer collar of the pinion shaft ball bearing fits into the indentation of the thrust washer.

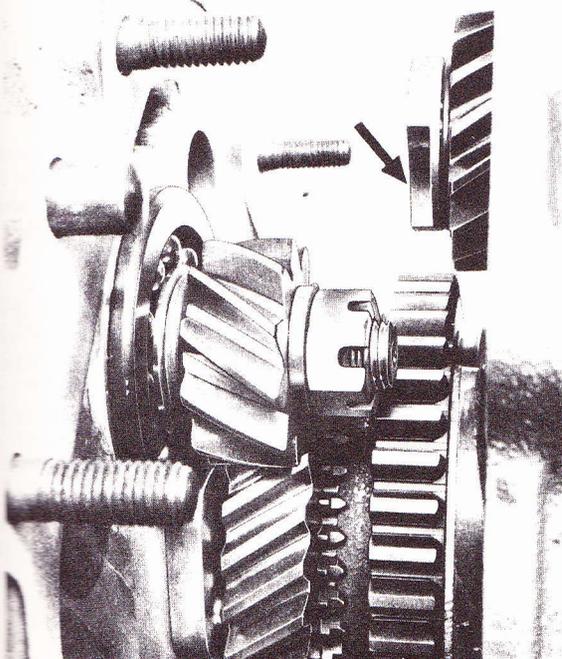
Start pushing the rear transmission on cover toward the intermediate plate. Engage the shift lever with the shift rod before positioning the rear transmission cover on the plate. Tighten the nuts for the rear transmission cover and the cover inspection plate to the specified torque. Position the contact pin for the backup light switch. The long end should point toward the shift rod. Tighten the switch to the specified torque.

from the idler shaft. Check all parts for wear and damage and replace, if necessary.



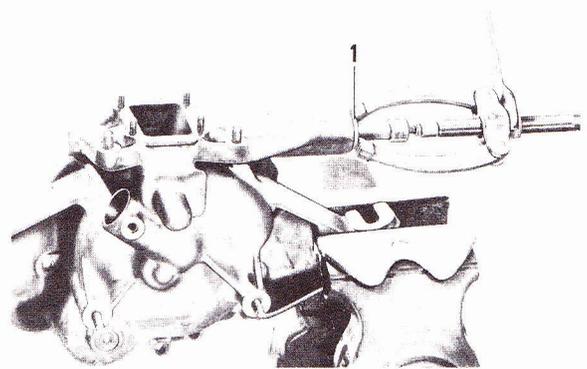
© Volkswagen

*Shaft lever pin*



© Volkswagen

*Position of thrust washer prior to final assembly*



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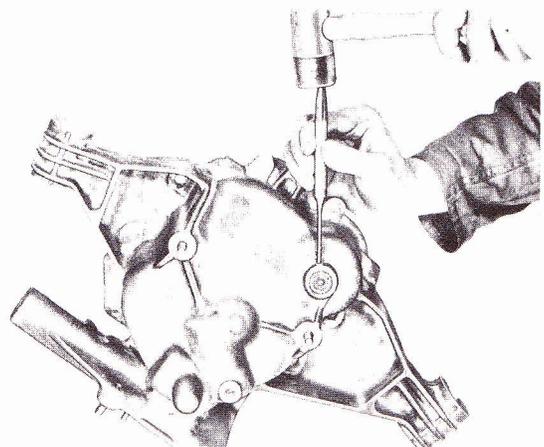
*Removing seal & bushing*

## REAR TRANSMISSION COVER

### Disassembly

Loosen the bolt for the speedometer drive and pull out the miter drive. Remove the cover plate from the bottom of the transmission cover. Knock the lock pin out of the shift lever shaft. Pull out the shaft, while removing the shift lever from the shaft. Pull out the seal and the bushing with a puller/washer combination.

Knock out the lock pin for the reverse idler shaft. Heat the transmission cover to approx. 120°C (250°F) and knock out the idler shaft in an inward direction. Then remove the thrust piece and the bushing for the speedometer drive. Remove the inner bronze thrust washers



© Volkswagen

*Reverse idler shaft lock pin*

**Assembly**

Heat the transmission cover to approx. 248°F. Install the reverse idler shaft. Make sure that the oil hole points downward at an angle. Be sure that the hole for the lock pin, in the housing and in the shaft, align. Install the lock pin. Insert the bushing for the speedometer drive pinion and the thrust piece for the speedometer drive.

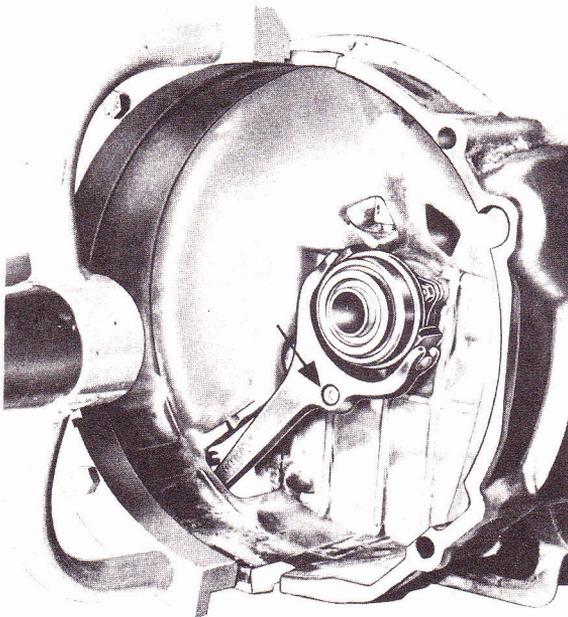
Install the bushing for the shift lever shaft and insert the seal. Insert the shift lever shaft while simultaneously sliding the shift lever onto the shaft.

The opening of the shift lever shaft and the shift lever should point upward. Heat the bronze thrust washer to approx. 248°F and slide it on the reverse idler shaft. Make sure that the thrust washer is flush against the cover, so as not to reduce the end play of the reverse idler gear. Insert the miter drive for the speedometer. Align the blind hole in the guide piece with the hole in the housing. Install the bolt with a spring washer and tighten to the specified torque.

**TRANSMISSION HOUSING**

**Disassembling**

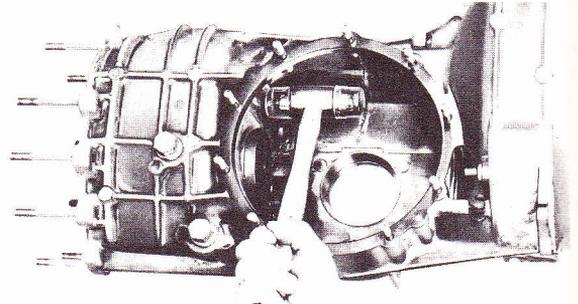
Remove the transmission cover, manual gear shift and the differential. Loosen the fillister head screw on the clutch throwout fork and remove the fork and the bearing. Do not wash the throwout bearing. Loosen the nuts on the guide tube for the throwout bearing and remove the tube.



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*Securing screw for clutch throwout fork*

drive shaft assembly installed, remove the seal with a suitable tool. Do not damage the bore or the seat.



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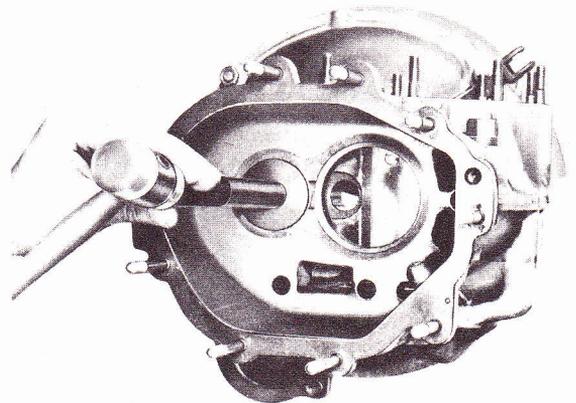
*Removing bearing races*

Loosen the ball pin for the clutch throwout fork. Remove the ball pin with the sealing washer. Next, remove the breather. Remove both snap rings from the drive shaft bearing and the rear snap ring of the drive shaft bearing in the housing, with a small screw driver.

The snap ring in front of the bearing race of the drive shaft is pressed against the housing by the bearing race. First loosen the bearing race from the snap ring with a punch. Heat the transmission housing to 248°F and remove both bearing outer races using an extractor and a plastic mallet.

**Assembling**

When cleaning the transmission housing, do not use corrosive cleaning materials as they will damage the magnesium alloy. Clean the transmission housing and



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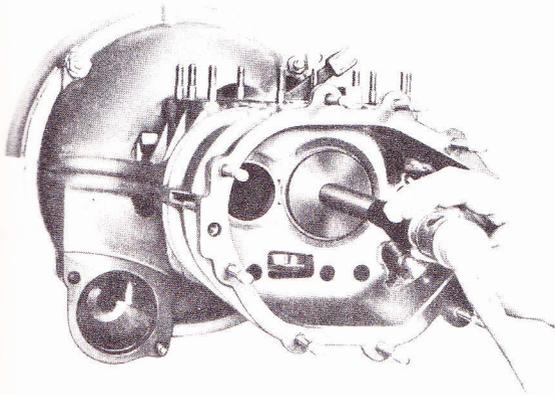
*Installing drive shaft bearing outer race*

Knock out the seal for the drive shaft from inside of the transmission with a suitable piece of tubing. With the

check for cracks, wear, and external damage. In the event of damage to the pinion shaft or the ring gear (for example fracture), check to see that the bearing bores in the center housing wall are not damaged. Replace the housing if necessary.

Install the breather and tighten it to the correct torque. Make sure the drilling in the head of the breather is at a  $45^\circ$  angle toward the front, when viewed from the top. The bore in the hexagon of the breather should be at an angle of  $45^\circ$  in a forward direction, toward the longitudinal axis of the transmission. Insert the ball pin with the sealing washer and tighten it to the correct torque.

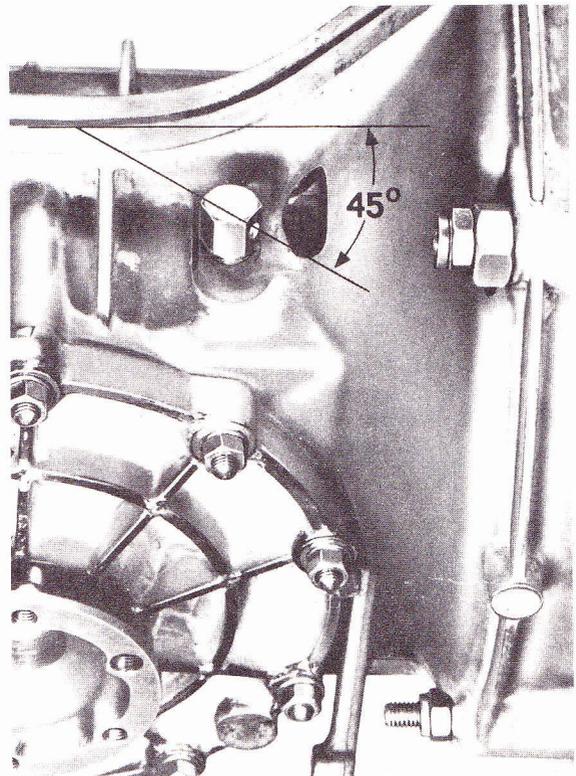
Install the intermediate plate with the gear assembly before installing the drive shaft seal. This prevents damage to the seal lip. Install the drive shaft seal making sure the seal is fully seated. Install the remaining components (refer to individual chapters). After making repairs to the transmission, apply a new protective undercoating to the entire outside of the housing.



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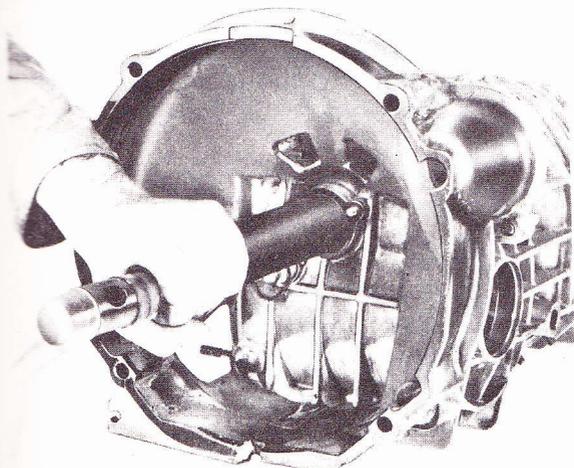
*Installing pinion shaft outer race*

Check all the other components for damage and replace as necessary. Insert the front snap ring into the groove of the drive shaft bearing outer race. Heat the transmission housing to  $248^\circ\text{F}$  and install the drive shaft bearing outer race into the bearing bore. Install the rear snap ring. Install the pinion shaft bearing outer race (with the snap ring installed) into the bearing bore. Insert the rear circlip.



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*Installing crankcase breather*



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*Installing drive shaft seal*

## SHIFT FORKS

### Adjusting

Slide a holding plate onto the shift rods. Adjust the shift fork. Put the transmission in neutral. Press the assembled reverse idler gear with the axial bearings and the thrust washer in the direction of the intermediate plate. The clearance between the shift gear and the idler shaft should be 1 mm. Eliminate any play between the shift fork and the shift gear by pushing the shift gear forward (in the drive direction) and reposition the shift fork on the shift rod.

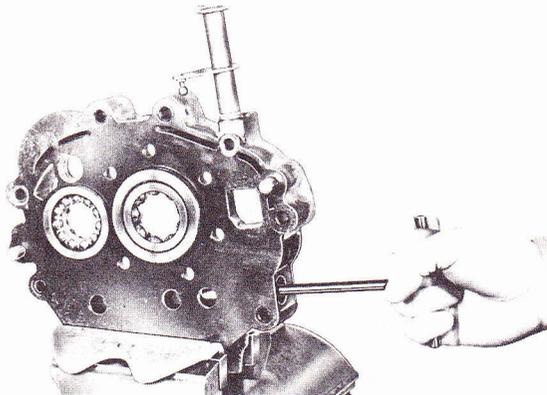
Tighten the shift fork retaining bolt to 18 ft. lbs. Make sure that the 1st and reverse shift piece has a 2 – 3 mm side play between the 2nd and 3rd gear shift piece. Adjust the 4th and 5th gear shift forks as well as the 2nd and 3rd gear shift forks. Make sure that the shift sleeve is positioned in the center, between the synchronizing rings when the transmission is in neutral.

Tighten the shift fork retaining bolts to 18 ft. lbs. Make sure that the 4th and 5th shift piece has a 2 – 3 mm side play between the 2nd and 3rd gear shift piece. Put the transmission in neutral. Make sure that the shift sleeve is centered between the synchro rings. Adjust the shift sleeve by repositioning the shift fork. Check its operation and readjust if necessary.

**INTERMEDIATE PLATE**

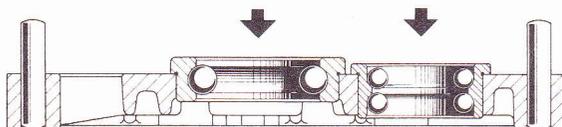
**Disassembly**

Loosen the screws for the clamping plate and remove the plate and its support. Heat the intermediate plate to 248°F. Push out the 4 point ball bearing and the double-row angular contact ball bearing with a suitable tool. Knock the lock pin out of the intermediate plate. Pull out the bushings securing the gear lock, in sequence, using a hook.



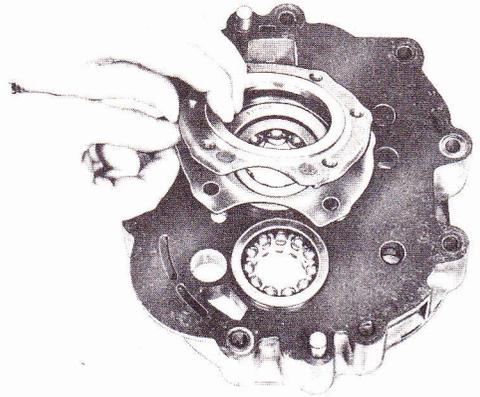
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*Removing gear lock bushing*



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*Position of bearings*



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*Assembling clamping plate & supporting plate*

**Assembly**

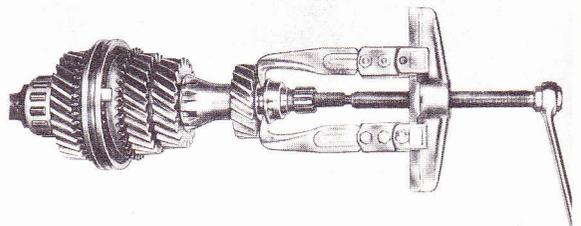
Check all parts for wear or damage and replace them if necessary. Heat the intermediate plate to 248°F. Make sure that all the balls are in the bearing sockets. Install the two bearings in the intermediate plate. Ensure that the bearing flanges are flush with the intermediate plate. Position the clamping plate together with the supporting plate.

Install the retaining bolts with washers and tighten them to the correct torque. Install the bushings for the securing gear lock with a mandrel. When installing the bushings, make sure that they do not project into the shift bores. Install the long bushing up to the stop on the mandrel. Install the short bushing up to the second mark on the mandrel. Finally, install the center bushing up to the first mark on the mandrel.

**DRIVE SHAFT**

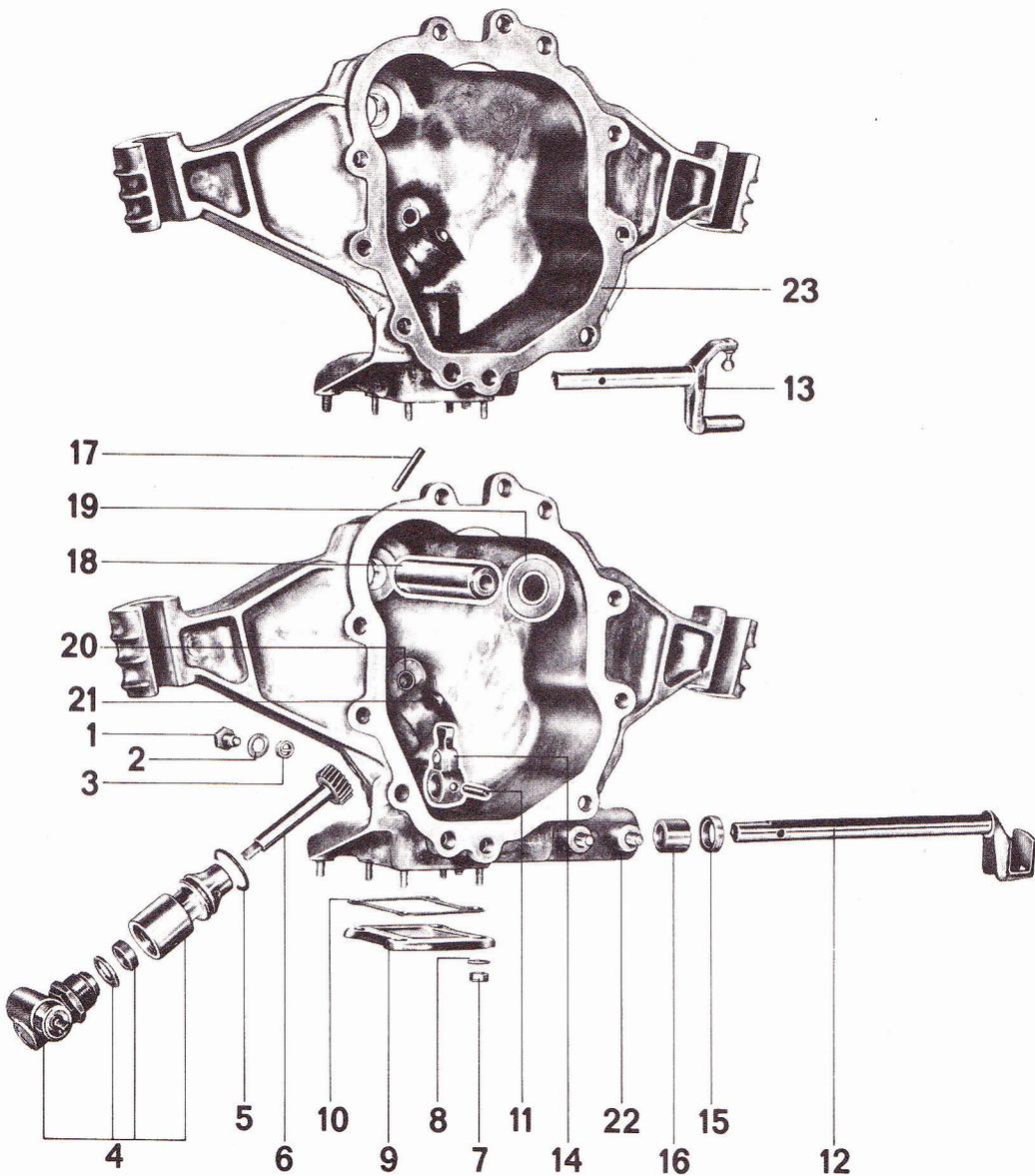
**Disassembly**

Clamp the holding plate in a vise and then secure the drive shaft. Bend back the lock plate to expose the nut, with a special tool. Press the roller bearing from the drive shaft. Pull the remaining parts from the drive shaft. Wire the needle bearings, races and the respective gears together to ensure the correct installation.



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*Removing inner bearing race*



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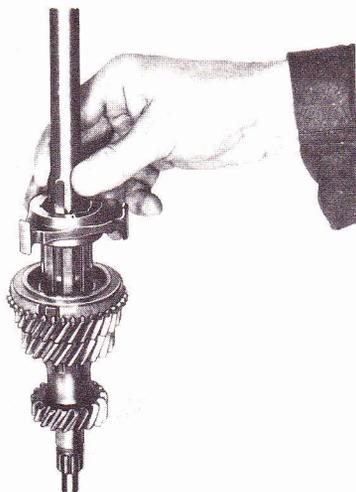
*Exploded view of cover plate*

- |                            |   |
|----------------------------|---|
| 1 - Bolt                   | 13 - Shift lever shaft 914/6              |
| 2 - Washer                 | 14 - Shift lever                          |
| 3 - Helicoil               | 15 - Seal                                 |
| 4 - Speedometer drive      | 16 - Bushing                              |
| 5 - O-ring                 | 17 - Lock pin                             |
| 6 - Drive shaft            | 18 - Idler shaft                          |
| 7 - Self-locking nut       | 19 - Thrust washer                        |
| 8 - Washer                 | 20 - Bushing for speedometer drive pinion |
| 9 - Cover plate            | 21 - Thrust piece                         |
| 10 - Seal                  | 22 - Transmission cover 914               |
| 11 - Lock pin              | 23 - Transmission cover 914/6             |
| 12 - Shift lever shaft 914 |   |

Using a brass drift, slightly separate the inner half of the ball bearing race from the contact surface (use care so as not to damage the race or seat). Remove the race with a claw puller.

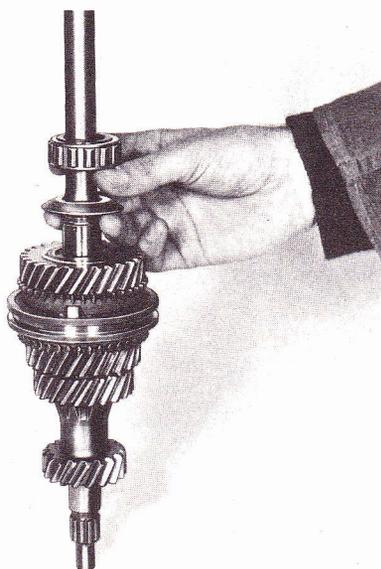
**Assembly**

Install all parts of the drive shaft dry. Make sure that oil does not enter between the contact surfaces. Slide gear 1 from 3rd gear on the drive shaft, with the narrow flange toward the splined shoulder. When installing the needle bearings and races, make sure that they are not interchanged with those of another gear.



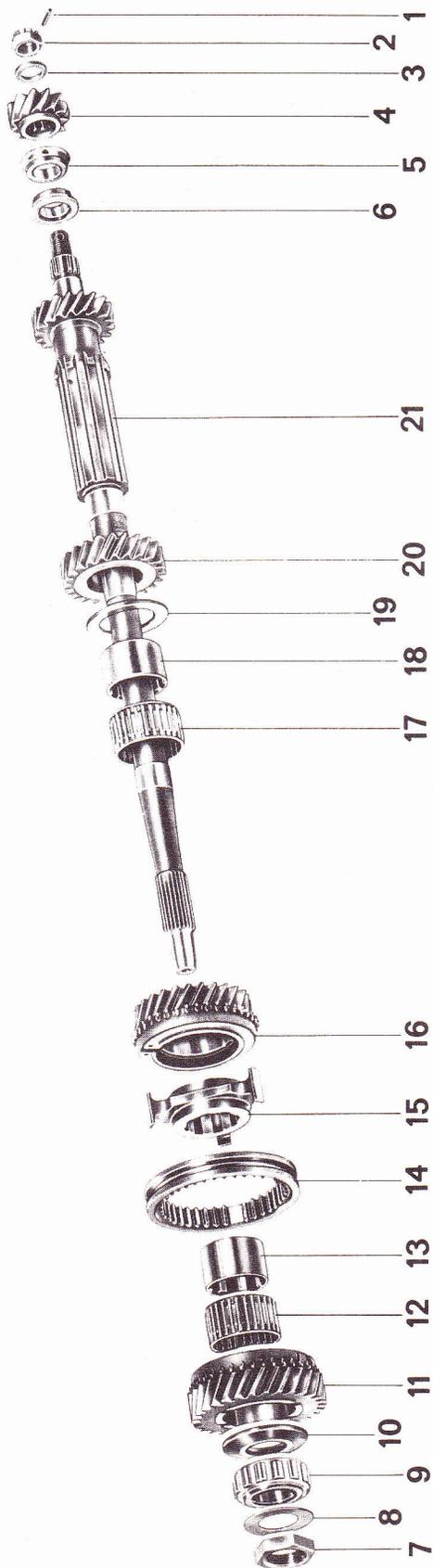
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*Installing guide sleeve*



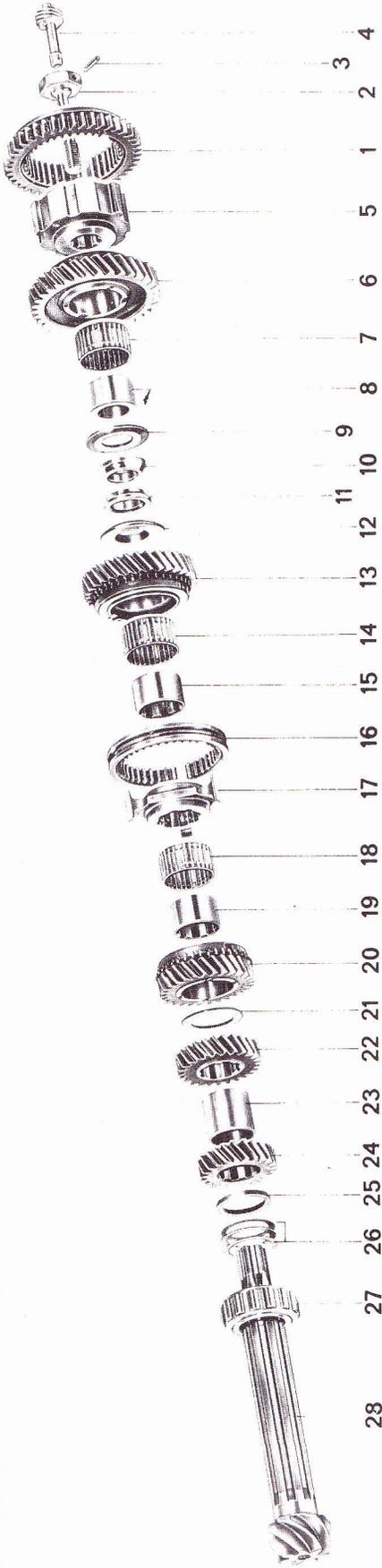
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*Installing tapered thrust washer*



© Volkswagen

*Exploded view of drive shaft*



© Volkswagen

*Exploded view of idler shaft*

- 1 - Lock pin
- 2 - Castle nut
- 3 - Washer
- 4 - 1st gear
- 5 - Bearing inner race
- 6 - Bearing inner race
- 7 - Nut
- 8 - Lock plate washer
- 9 - Roller bearing
- 10 - Thrust washer
- 11 - 5th gear

- 12 - Needle bearing
- 13 - Needle bearing race
- 14 - Shift sleeve
- 15 - Synchro hub
- 16 - 4th gear
- 17 - Needle bearing
- 18 - Needle bearing race
- 19 - Thrust washer
- 20 - 3rd gear
- 21 - Drive shaft

- 1 - Shift gear for 1st and reverse gear
- 2 - Expansion bolt
- 3 - Lock pin
- 4 - Pinion shaft for speedometer drive
- 5 - Guide sleeve
- 6 - 1st gear
- 7 - Needle bearing
- 8 - Needle bearing race
- 9 - Thrust washer
- 10 - Bearing inner race
- 11 - Bearing inner race
- 12 - Thrust washer
- 13 - 2nd gear
- 14 - Needle bearing

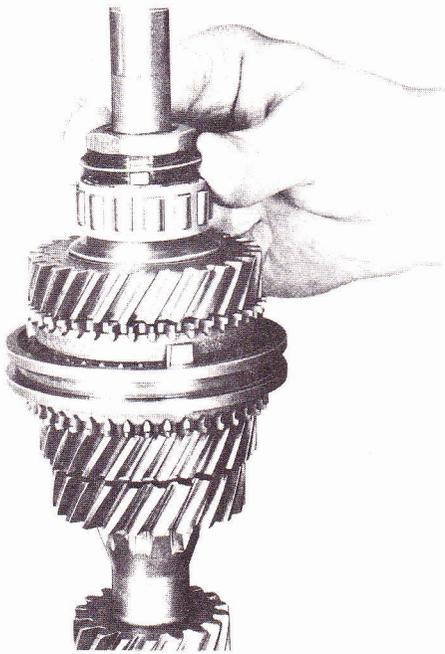
- 15 - Needle bearing race
- 16 - Shift sleeve
- 17 - Synchro hub
- 18 - Needle bearing
- 19 - Needle bearing race
- 20 - 3rd gear
- 21 - Thrust washer
- 22 - 4th gear
- 23 - Spacer bushing
- 24 - 5th gear
- 25 - Spacer washer
- 26 - Shims
- 27 - Roller bearing
- 28 - Pinion shaft

*Exploded view of idler shaft*

*Exploded view of drive shaft*

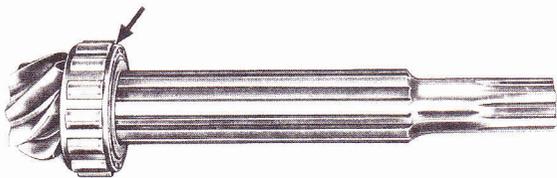
Install the thrust washer and the needle bearing race. Then install the needle bearing. Install gear 1 for 4th gear and then the guide sleeve. Position the shift sleeve, the needle bearing race, the needle bearing, and gear 1, for 5th gear.

Next, mount the tapered thrust washer (5.9 mm, 0.232 in.). Install the roller bearing with the ring of the bearing cage toward the splines of the pilot stub. Install the roller bearing with a thrust plate and a thrust piece. Install a new lock plate. Make sure that the locking tab is located in the groove on the drive shaft so that it fits under the inner race of the roller bearing.



© Volkswagen

*Installing roller plate & lock plate*



© Volkswagen

*Correct position of roller cage ring*

Lubricate the threads and the thrust surface of the nut. Install the nut with the curved face in the outward direction. Tighten the nut to the correct torque using the proper tool. Secure the nut by bending back the tab of the lock plate. Heat the inner half of the ball bearing race in oil, to approx. 212°F and press the inner half of the race on the shaft.

**SYNCHRONIZER**

**Disassembly**

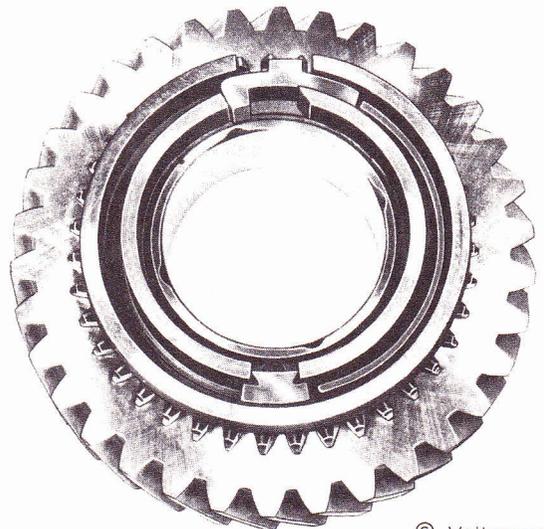
Remove the circlip and check all parts for wear and damage. Replace parts if necessary.

**Assembly**

Make sure the synchronizing ring, anchor block, thrust block and the brake band are installed properly. Position the synchronizing ring so that the rough surface faces the

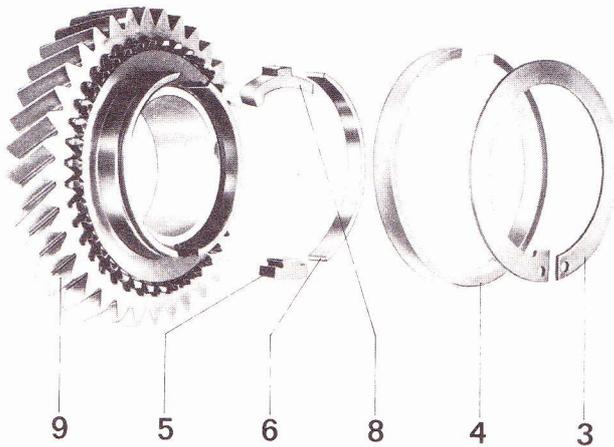
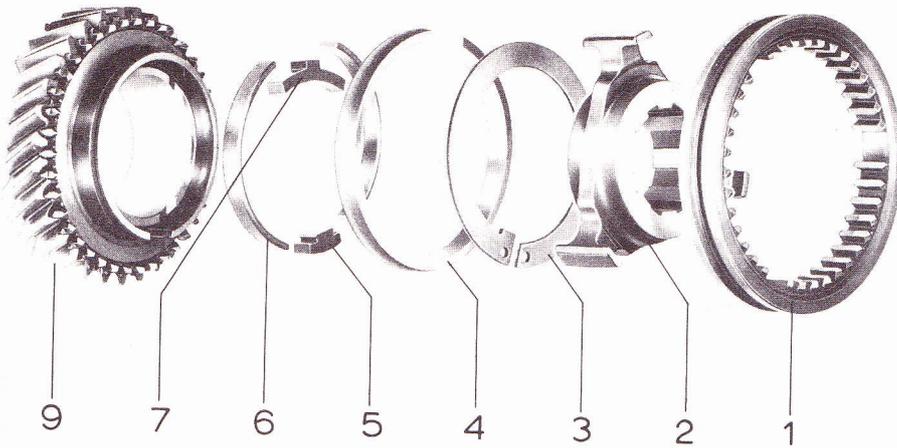


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*Synchronizing ring installation and first gear assembly*



- 1 - Shift sleeve
- 2 - Synchro hub
- 3 - Circlip
- 4 - Synchronizing ring
- 5 - Anchor block
- 6 - Brake band one only, for 1st gear
- 7 - Thrust block, 2nd to 5th
- 8 - Thrust block, 1st gear
- 9 - Gear

© Volkswagen

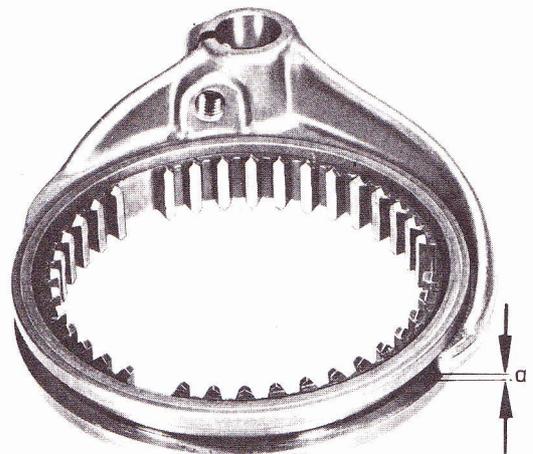
*Exploded view of synchronizers*

shift sleeve. Insert the thrust block and the anchor block together with the brake bands. When assembling the first gear synchronizer, be sure that only one brake band is inserted.

Place the tongue of the circlip into the anchor block cutout. Push the circlip into the groove, while pushing the synchronizer ring on its seat. Now, spread the circlip pliers and seat the circlip.

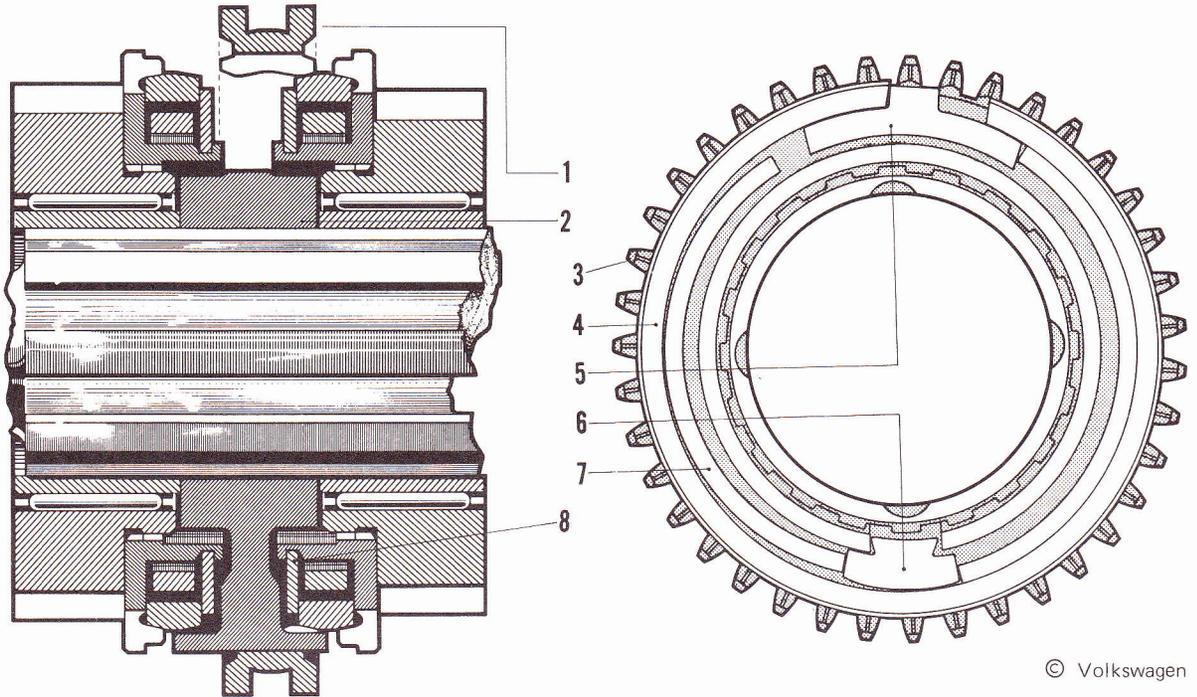
**Checking**

Check the diameter of synchronizer ring with a micrometer. Position the micrometer at the highest point of the synchronizing ring. Maximum allowable play between the shift fork and the shift sleeve, 1st to 5th gear, is 0.5 mm (0.020 in.).



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*Side clearance of shift fork in shift sleeve  
(a - 0.020 in.)*



© Volkswagen

*Typical Porsche synchronizer*

- |                        |                  |
|------------------------|------------------|
| 1 - Shift sleeve       | 5 - Thrust block |
| 2 - Synchro-hub        | 6 - Anchor block |
| 3 - Gear               | 7 - Brake band   |
| 4 - Synchronizing ring | 8 - Circlip      |

# TRANSMISSION, AUTOMATIC 8A

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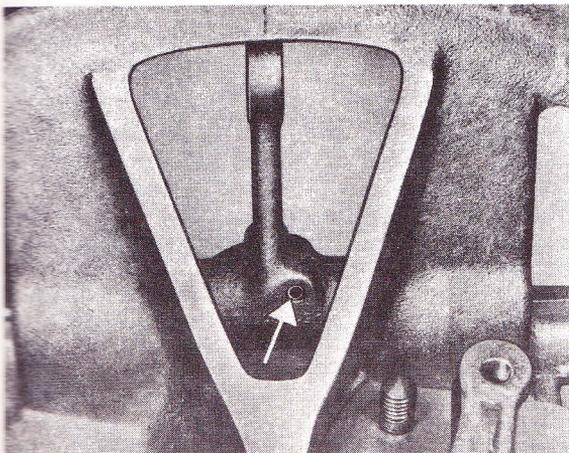
### TRANSMISSION HOUSING

#### Disassembly

Remove the torque converter and the converter housing. Next, remove the transmission cover, gearbox assembly, and the differential. Now extract the cotter pin on the bolt for the pull rod, and pull out the bolt and the fork head from the intermediate lever. Remove the cotter pin for the push rod on the intermediate lever, and disconnect the pull rod. Disconnect the push rod on the throwout lever.

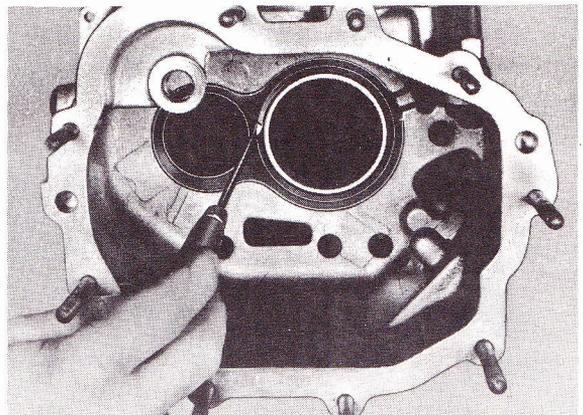
Remove both covers above the shaft of the throwout lever. Knock the clamping sleeve out of the throwout lever and force the shaft out toward one side. Force out both bushings one after the other, using the proper mandrel. Remove the intermediate lever and force the bushing out of the intermediate lever with an offset guide.

The shaft for the intermediate lever can be removed by heating the gearbox housing to 248°F and then pulling out the shaft. Unscrew the oil filter plug and the oil drain plug. Carefully force out the thrust washer for the needle



© Volkswagen

Throw out cover clamping sleeve (pin)



© Volkswagen

Removing input bearing circlip

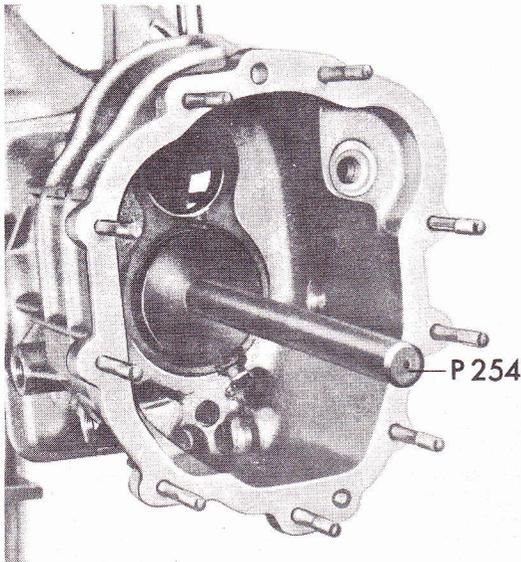
bearing by means of a mandrel. Remove both circlips of the input shaft bearing in the housing web and the front circlip of the pinion bearing with a small screw driver.

Heat the gearbox housing to approx. 248°F and pull both bearing outer races, one after the other. Force the sealing ring for the input shaft out in an inward direction.

**Assembly**

Clean the gearbox housing and check for wear, external damage, and cracks. If the pinion or ring gear are damaged, check whether the bearing holes in the central housing web are also involved. If required, replace the gearbox housing.

Insert the rear circlip for the bearing outer race of the input shaft bearing into the groove. Again, heat the gearbox housing to approx. 248°F and force the bearing outer race for the input shaft into the bearing bore by means of a thrust piece, and secure it with a front circlip. Force the bearing outer race for the pinion with assembled circlip into the bearing bore by means of a thrust piece and fit a front circlip. Insert a thrust washer for the axial needle bearing of a reversing gear, and insert the bearing bolts and a dowel pin, if required.



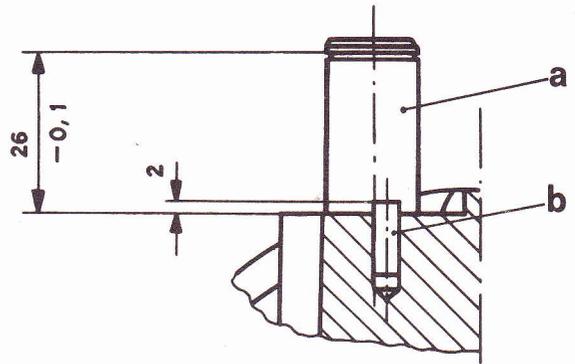
© Volkswagen

*Removing pinion bearing outer race*

Force the bearing bushing into the intermediate lever for clutch actuation, with an offset guide piece, to the extent that the bushing is flush on top. Coat the bearing bolt with lithium grease and assemble the intermediate lever in the sequence described. Insert the push rod on the throwout lever and secure it with a new cotter pin.

Force the bushings for the shaft of the throwout lever with a mandrel into the housing to the extent that the cover can later still be fitted. Coat the shaft lightly with

lithium grease and insert it together with the throwout lever and the two spacing washers. The notch in the shaft is off-center. Insert the shaft in such a manner that the notch on the shaft and the bore on the throwout lever are in alignment. The clamping sleeve must be inserted into the throwout lever and fit both closing caps.

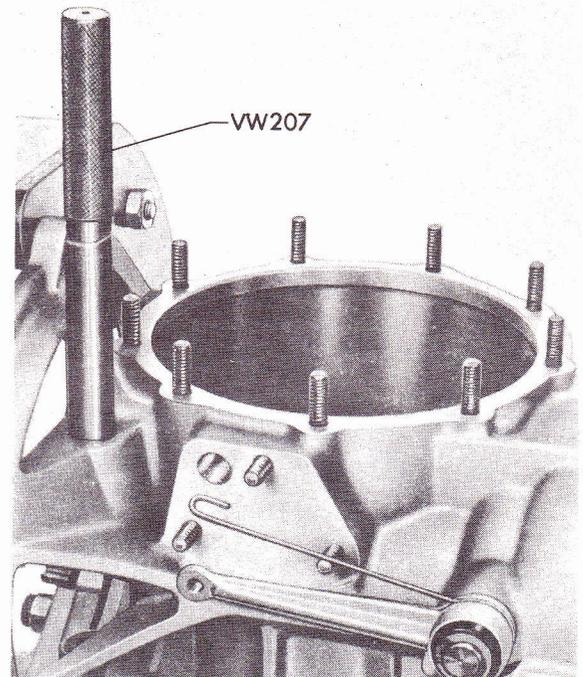


© Volkswagen

*Bearing bolts and dowel pin position*

Installation dimensions in mm.

A - Bearing bolt  
B - Spiral pin



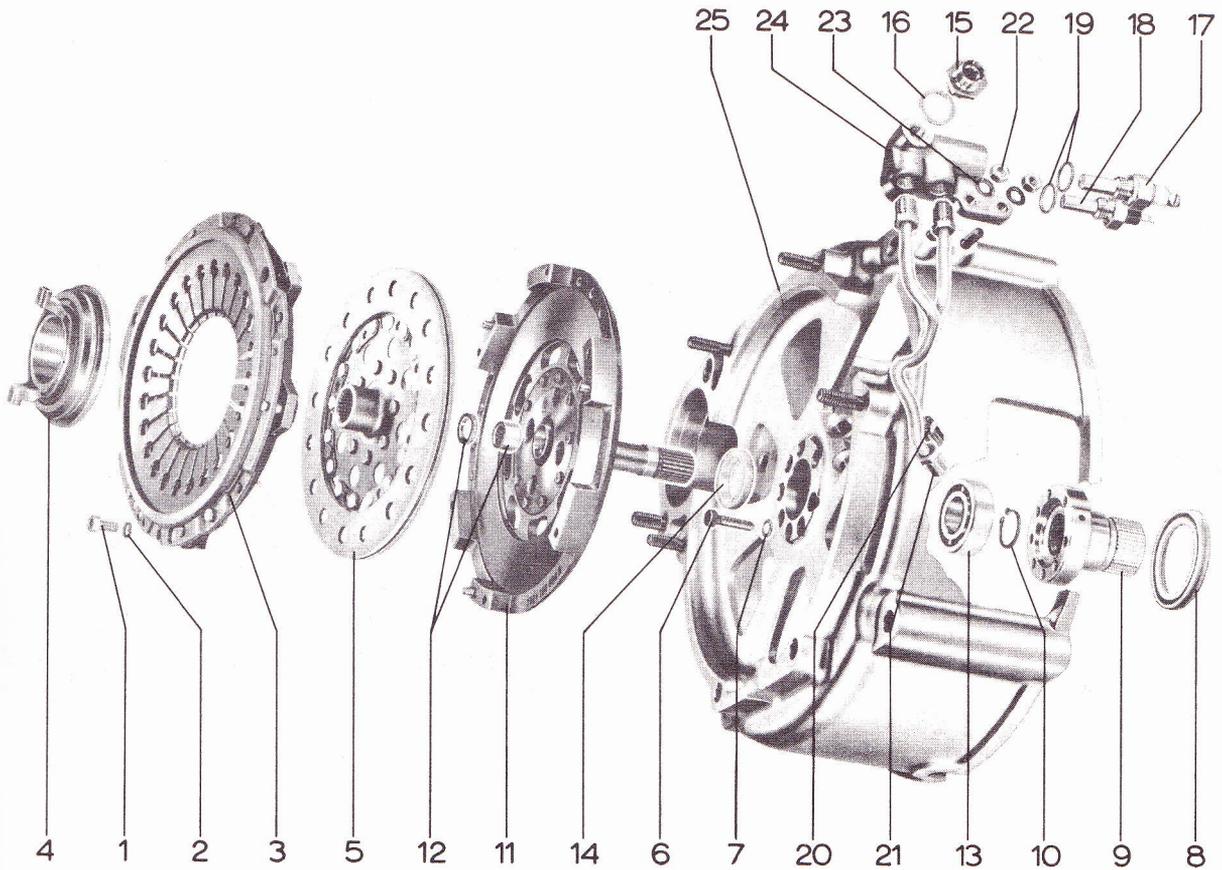
© Volkswagen

*Removing throw out lever bushings*

**CONVERTER HOUSING**

**Removal**

Place the transmission on a bench and pull the torque



© Volkswagen

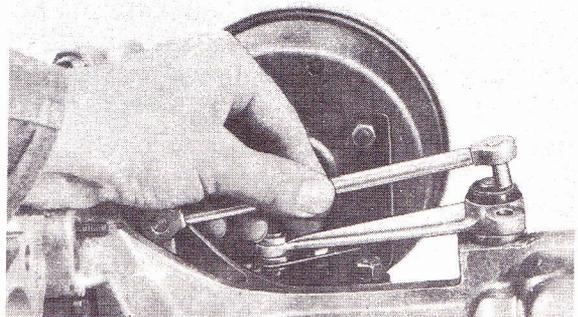
*Exploded view of converter housing*

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1 - Internal multi-tooth screw</li> <li>2 - Spring ring</li> <li>3 - Plate spring clutch with pressure plate</li> <li>4 - Throwout bearing</li> <li>5 - Clutch plate</li> <li>6 - Internal multi-tooth screw</li> <li>7 - Sealing washer</li> <li>8 - Sealing ring</li> <li>9 - Freewheeling unit</li> <li>10 - Locking ring</li> <li>11 - Carrier plate</li> <li>12 - Sealing ring and needle bearing</li> <li>13 - Grooved ball bearing</li> </ul> | <ul style="list-style-type: none"> <li>14 - Sealing ring</li> <li>15 - Double connection</li> <li>16 - Sealing ring</li> <li>17 - Tele-thermometer transmitter</li> <li>18 - Temperature switch</li> <li>19 - Sealing ring</li> <li>20 - Pressure pipe</li> <li>21 - Return flow pipe</li> <li>22 - Nut M 6</li> <li>23 - Spring plate B 6</li> <li>24 - Switch housing</li> <li>25 - Converter housing</li> </ul> |
|---|--|

converter from the freewheeling unit. Cover the hub opening, so that no foreign bodies will enter.

In the event of leaks within range of the freewheeling unit, first repair the leaks even when the converter is heavily oiled up. Exchange the converter only when the hub shows deep scoring marks on the sealing rings, or when other faults occur, for example, on the bearing bushing or on the ring gear.

Unscrew the hex. nuts for outside attachment of converter housing. Unscrew the hex. nuts inside the converter housing. Remove the cotter pin of the push rod on the intermediate lever and disconnect it. Remove the converter housing from the transmission housing while



*Removing push rod*

© Volkswagen

simultaneously removing the clutch throwout bearing from the throwout lever.

**Installation**

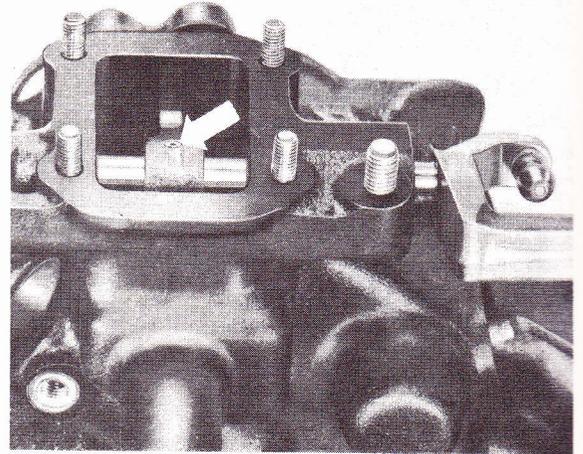
Insert the lefthand engine fastening screw into the converter housing (hex. screw can no longer be inserted because of the servo motor). Assemble the converter housing and transmission, making sure that the clutch throwout lever enters into the two lugs of the clutch throwout bearing. Tighten the hex. nuts uniformly to the specified torque. Insert the push rod on the intermediate lever and secure it with a new cotter pin. Complete the basic adjustment of the clutch. Place the torque converter on the freewheeling unit and keep turning for the insertion into the turbine shaft.

**FRONT GEARBOX COVER**

**Disassembly**

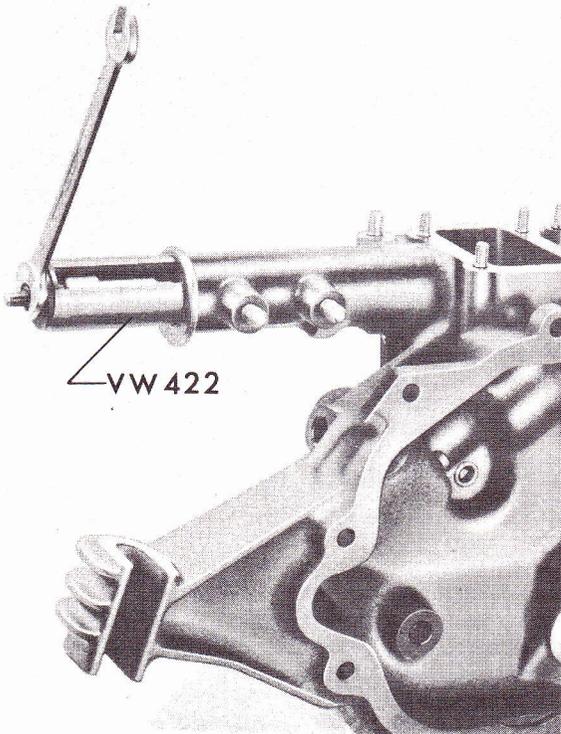
Loosen the hex. screw for the speedometer drive and pull out the angle drive. Unscrew the cover for the shift actuation. Knock the clamping sleeve out of the shifting shaft. Pull out the shifting shaft, removing the shifting fingers from the shaft. Pull out the sealing ring and bushing with the proper tools. Knock out the clamping sleeve for the shaft of the reverse gear.

piece and bearing bushing for the speedometer drive. Press the thrust washer from the shaft for the reverse gear. Check parts for wear and replace any, if required.



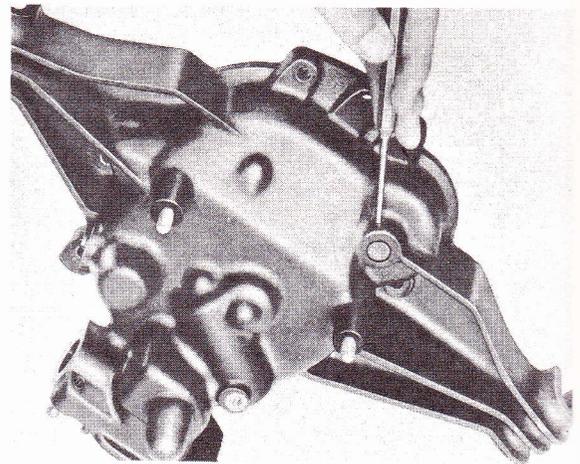
© Volkswagen

*Shifting shaft sleeve (pin)*



© Volkswagen

*Removing sealing ring & bushing*



© Volkswagen

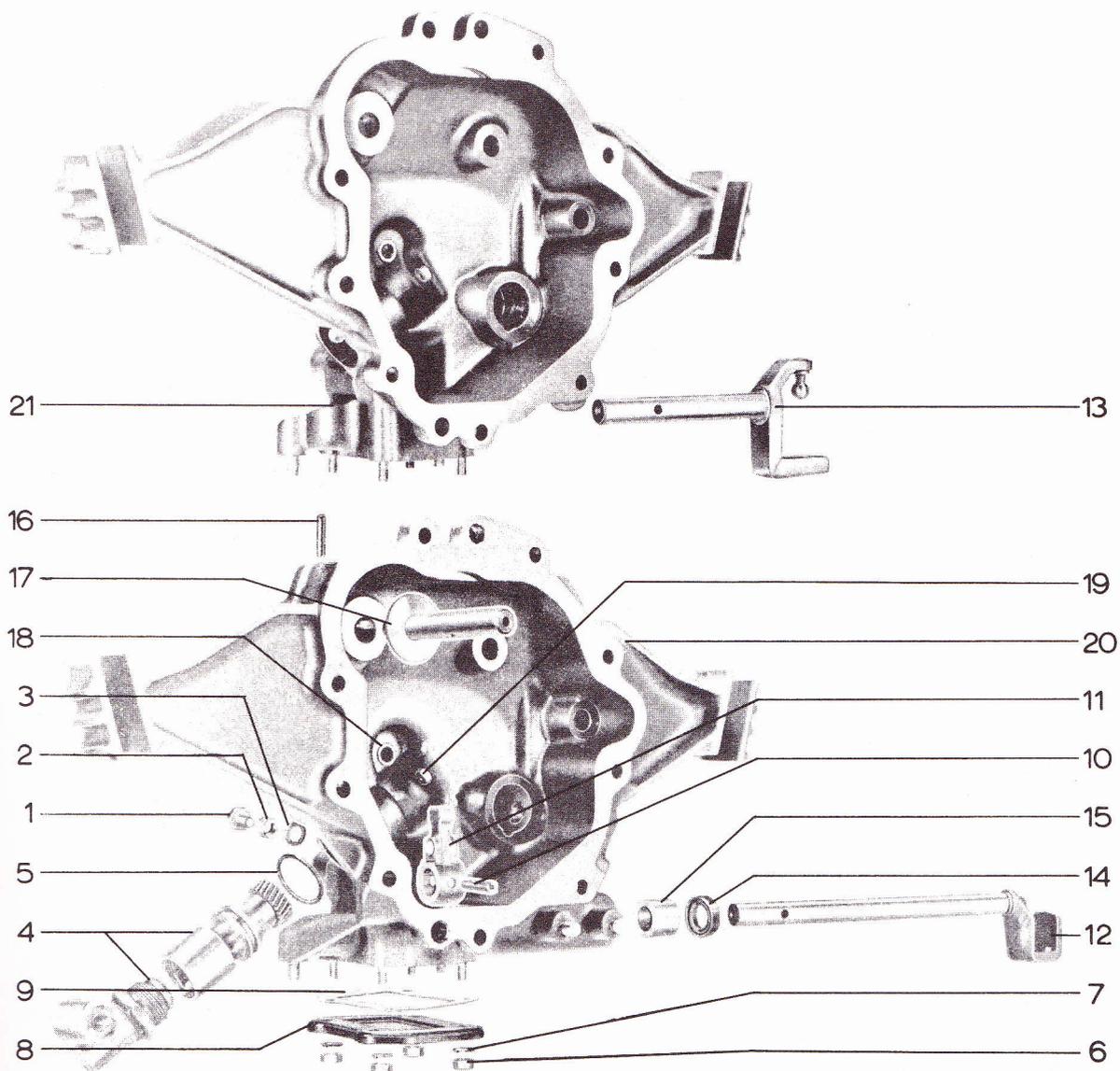
*Reverse gear shaft clamping sleeve (pin)*

Heat the gearbox cover to approx. 248°F and force out the shaft in an inward direction. Then remove the thrust

**Assembly**

Heat the gearbox cover to approx. 248°F and force in the shaft for the reverse gear. Be sure that the bore in the housing and in the shaft are in alignment, so that the clamping sleeve can be forced in later.

Insert the bushing for the pinion and thrust piece for the speedometer drive. Force in the bushing for the shifting shaft, with a mandrel, and insert a sealing ring. Insert the shifting shaft while simultaneously sliding the shifting



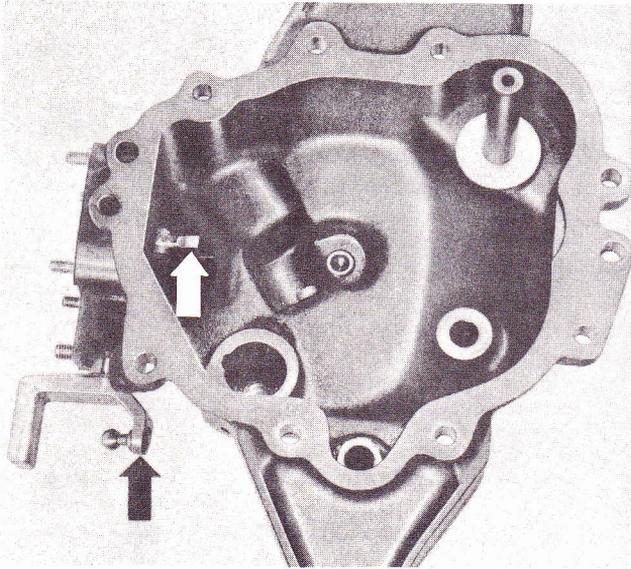
© Volkswagen

*Exploded view of front gear box cover*

- |                        |  |
|------------------------|--|
| 1 - Screw              | 11 - Shift finger                              |
| 2 - Helicoil           | 12 - Shifting shaft 914                        |
| 3 - Spring plate       | 13 - Shifting shaft 914/6                      |
| 4 - Speedometer driver | 14 - Sealing ring                              |
| 5 - O-ring             | 15 - Bushing                                   |
| 6 - Nuts               | 16 - Clamping sleeve                           |
| 7 - Spring Ring        | 17 - Shaft for reversing gear w. thrust washer |
| 8 - Cover              | 18 - Bushing for speedometer drive pinion      |
| 9 - Seal               | 19 - Thrust piece                              |
| 10 - Clamping sleeve   | 20 - Gearbox cover 914                         |
|                        | 21 - Gearbox cover 914/6                       |

fingers on the shaft. Turn the shaft slightly and force it in the clamping sleeve. Insert the clamping sleeve for the shaft of the reversing wheel.

Heat the bronze washer for the reversing shaft to approx. 248°F and slide it on to the shaft. Insert the angle drive for the speedometer. Align blind hole in guide piece with bore in housing. Screw in hex. screw with spring washer and tighten to specified torque.



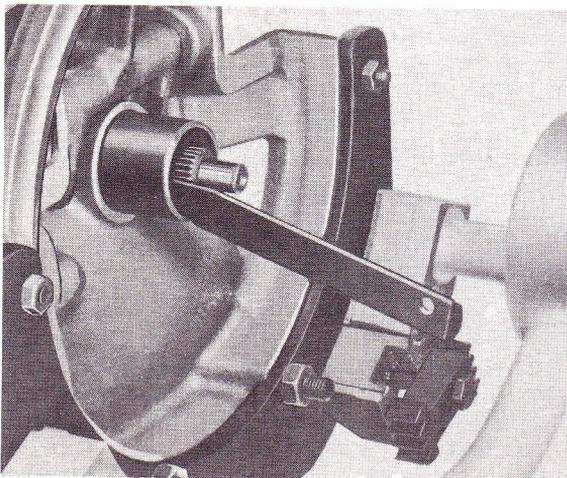
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*Shifting shaft & finger relative position*

**TRANSMISSION CLUTCH**

**Removal**

Unscrew the internal multi-tooth screw of the clutch



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*Removing sealing ring*

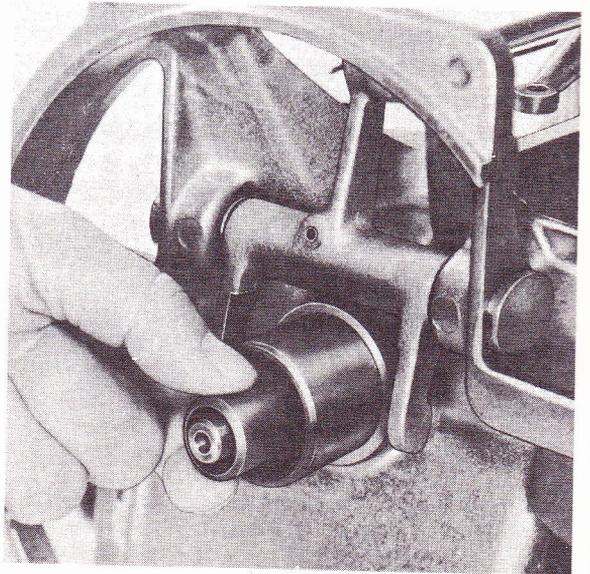
pressure plate with a socket spanner insert. Loosen the screws uniformly so that the pressure plate is not distorted. Remove the clutch pressure plate and clutch plate, being careful not to drop the throwout bearing. Slide the clutch throwout bearing out of the pressure plate at an angle toward the rear, and wipe off the bearing.

**Installation**

Check the clutch plate, pressure plate, and throwout bearing for wear or damage and replace, if required. Check the clutch carrying plate, as well as the needle bearings and sealing ring in the clutch carrier plate for wear and replace, if required.

If the clutch has been oiled up by ATF or engine oil, replace sealing ring of clutch carrier plate (seal to converter). If there is emerging oil, replace the sealing ring in the transmission housing (seal on the input shaft).

To replace the seal, pull out sealing ring with self-made hook. Fit the new sealing ring for the input shaft by sliding a sleeve on the input shaft. Then slide the sealing ring on the sleeve and force it in with thrust piece until the tool knocks against the bearing tube. Lubricate the needle bearing in the carrier plate with some lithium grease and position the driven plate on the carrier plate. This requires centering the plate with a clutch mandrel. Use grease sparingly to keep the clutch plate clean.



© Volkswagen

*Fitting new sealing ring*

Grease tongues of the diaphragm spring for the clutch pressure plate on both sides with some lithium grease and insert the clutch throwout bearing at an angle into the clutch pressure plate from inside in an outward direction. Screw down the clutch pressure plate, with internal

multi-tooth screws uniformly and then tighten. Be sure that the throwout bearing does not jam in the plate spring and that the clutch pressure plate engages with the centering pin.

Finally, grease the guides of the throwout bearing on the transmission housing neck as well as the two claws lightly with lithium grease and MOS 2 additive.

**NEW CLUTCH PLATE**

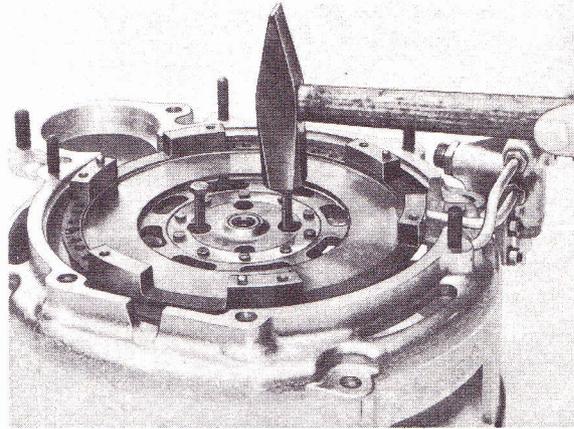
**Basic adjustment**

Remove the cotter pin on the bolt for the pull rod and intermediate lever and pull out the bolt. Pull the rod attached to the servo engine out up to the stop while simultaneously pushing the intermediate lever in the direction of the servo motor against the stop. In this position, the fork head of the pull rod should be set in such a manner that the bore of the fork head extends 10 to 12 mm beyond the bore of the intermediate lever.

**Checking clutch play**

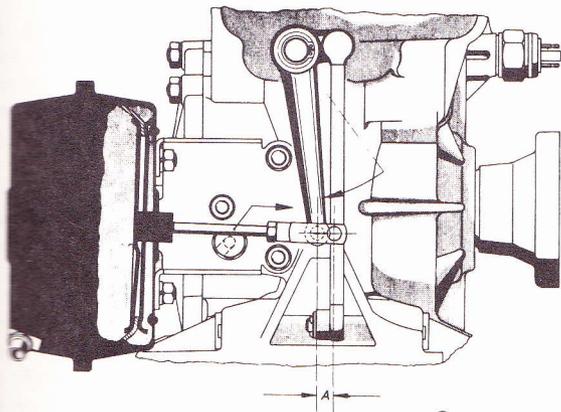
In a new clutch, the play has been properly set during the basic adjustment. The normal wear of the clutch linings will reduce this play in the course of time.

opposite position down for approx. 0.315 in. and carefully knock out the free-wheeling unit together with radial sealing ring by means of light blows against the screw.



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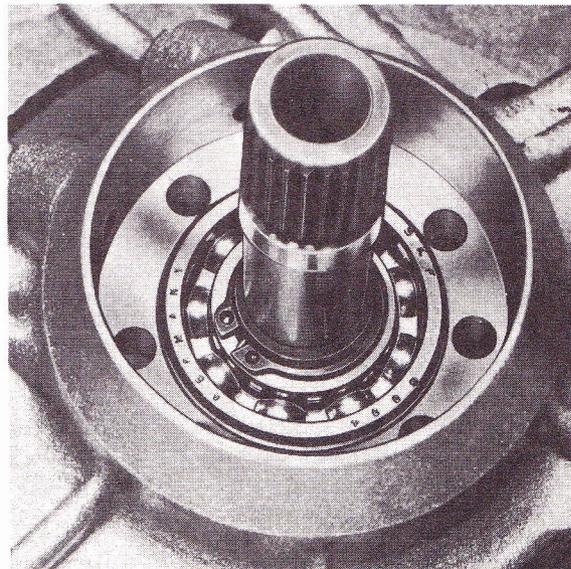
*Removing free wheeling unit*



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*Pull rod setting*

A = approx. 1/2 in.



© Volkswagen

*Removing turbine shaft lock ring*

However, there should always be a minimum play, so that the clutch can be fully engaged. If not, the clutch will slip and excessive heating and increased wear will follow. For these reasons, the clutch play must be checked at the specified internals and, if required, adjusted by pulling the vacuum hose from the servo motor and pushing the intermediate lever with your left hand away from the servo motor. The intermediate lever should move for a distance of at least 0.197 in. If it is less, the clutch play must be newly adjusted.

**CLUTCH CARRIER PLATE (CLUTCH REMOVED)**

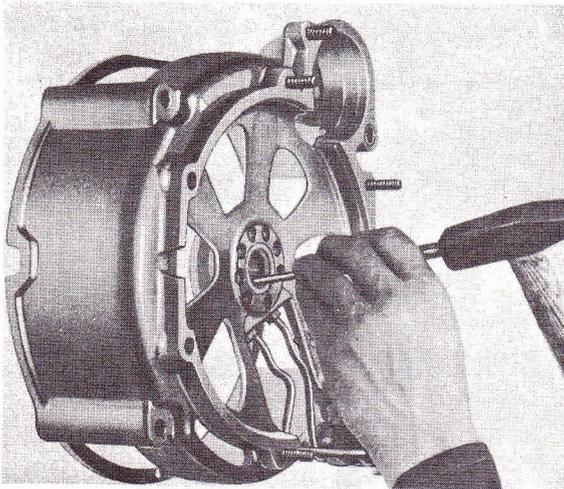
**Removal**

Unscrew the internal multi-tooth screw through the holes in the clutch carrier plate. Screw two hex. screws in

Now remove the locking ring on the turbine shaft. Knock the carrier plate out of the bearing by tapping the turbine shaft with a rubber hammer. Wash it out for good support of converter housing. Pull the sealing ring and needle bearing in the carrier plate by means of a puller. Force out the grooved ball bearing and sealing ring for the carrier plate one after the other with a punch. Replace bearings which are damaged or too noisy.

**Installation**

Lubricate the new sealing ring (silicon ring) on the seat of the converter housing well and force it in by means of a thrust piece with sealing lip pointing toward the converter. Insert the clutch carrier plate into the converter housing and position it with a thrust piece. Then force the grooved ball bearing into the converter housing against the stop by means of a thrust piece fitting sleeve. Place the locking ring on the turbine shaft.



© Volkswagen

*Removing ball bearing & sealing ring*

Insert the freewheeling unit into the converter housing. Insert the internal multi-tooth screws with new sealing rings, through the holes into the carrier plate and tighten the screws to a specified torque. Lubricate the new sealing ring for the torque converter (silicon ring) well on seat for converter housing and force it in with a thrust piece. Force in the needle bearings for the input shaft with a thrust piece.

Finally, force in the sealing ring for the input shaft with a thrust piece and grease the needle bearing for the input shaft with some lithium grease. Use grease sparingly to keep clutch plate clean.

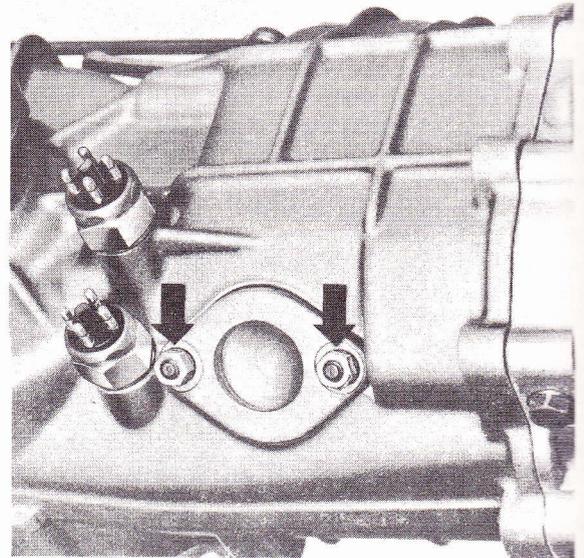
**Transmission removal & installation**

The transmission is removed complete with the engine. See engine section for details.

**TRANSMISSION**

**Disassembly**

Attach the transmission in combination with the holding plate to the holder (screw transmission down at all four points). Unscrew the closing screw for the parking lock, and remove the spring and ball. Now loosen the hex. nuts on the front gearbox cover. Remove the gearbox cover. Then remove the bolt and 7 mm (0.275 in.) ball for the parking lock from the shift lever for reverse gear. Remove the circlip from the shift rod for the reverse gear and parking lock and remove the shift fork together with the slide wheel.

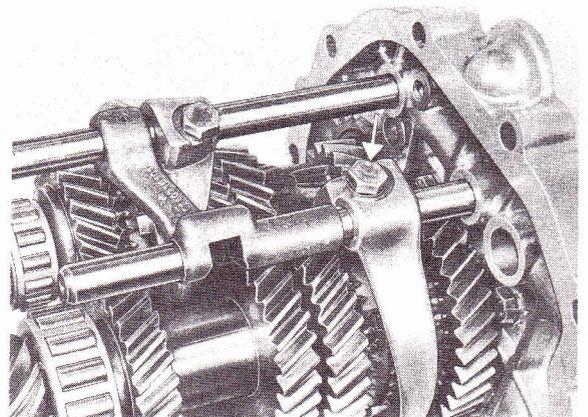


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*Nuts for internal shift lever fork piece*

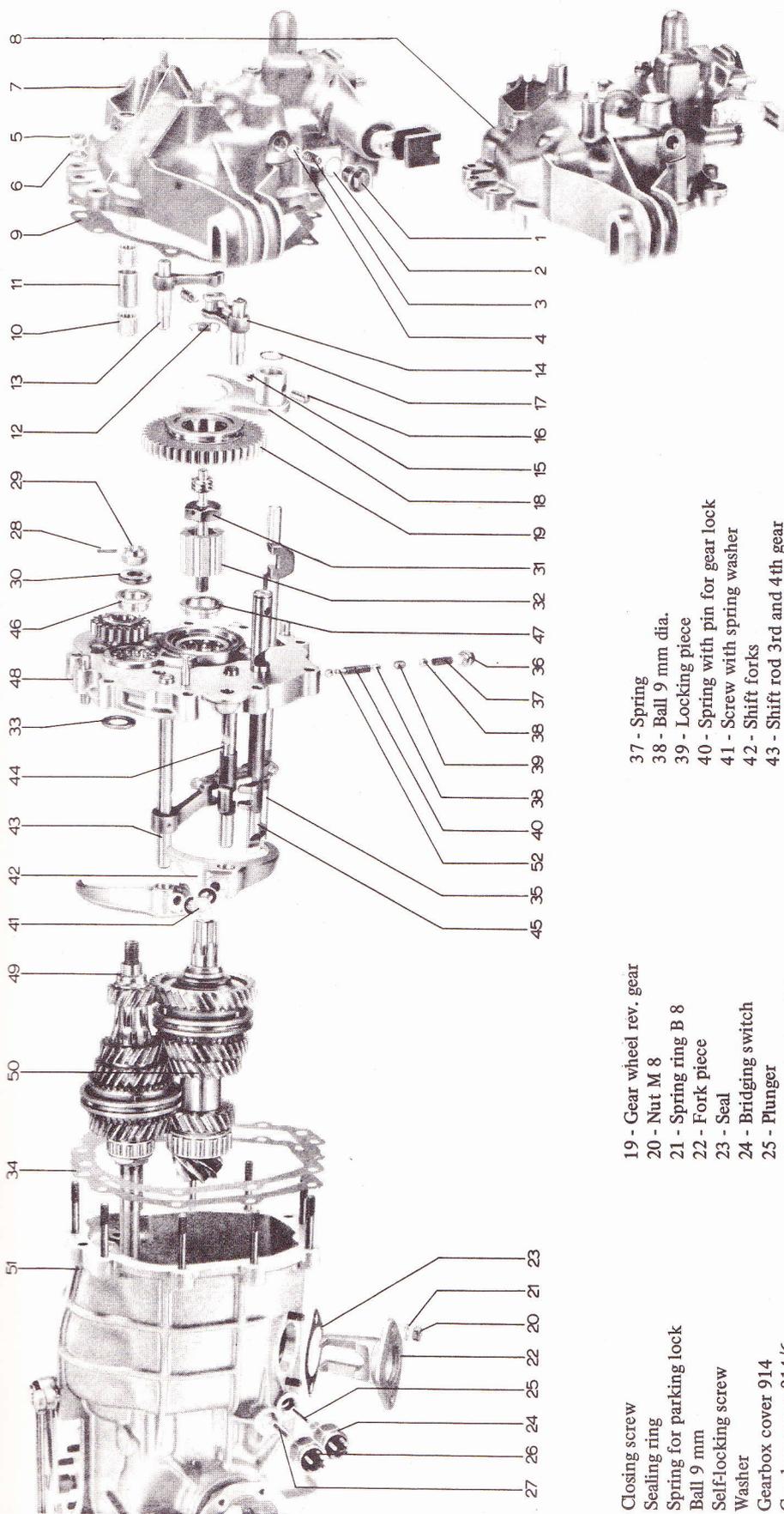
Disconnect the draw springs for the parking lock and remove the pawl as well as the lever for the parking lock. Loosen the hex. nut on the fork piece for the internal shift lever. Remove the fork piece and pull the internal shift lever out of the rear guide bore. Now, engage the 4th gear.

Block the input shaft with a supporting angle piece and loosen the expanding screw on the pinion with an insert. Pull off the spline shaft sleeve and knock out the clamping sleeve of the castle nut for the input shaft with a mandrel. Loosen the castle nut and remove the washer. Unscrew the bridging switch and switch for the backup lights and pull out the plunger for both switches. Pull the shift rod for reverse gear and parking lock up to the stop on the intermediate plate.



© Volkswagen

*1st & 2nd gear shift fork lock screw*



© Volkswagen

- 1 - Closing screw
- 2 - Sealing ring
- 3 - Spring for parking lock
- 4 - Ball 9 mm
- 5 - Self-locking screw
- 6 - Washer
- 7 - Gearbox cover 914
- 8 - Gearbox cover 914/6
- 9 - Seal
- 10 - Needle bearing
- 11 - Spacer bushing
- 12 - Draw spring
- 13 - Pawl for parking lock
- 14 - Lever for parking lock
- 15 - Ball 7 mm
- 16 - Bolt
- 17 - Locking ring
- 18 - Shift fork for reverse gear

- 19 - Gear wheel rev. gear
- 20 - Nut M 8
- 21 - Spring ring B 8
- 22 - Fork piece
- 23 - Seal
- 24 - Bridging switch
- 25 - Plunger
- 26 - Switch backup lights
- 27 - Plunger
- 28 - Clamping sleeve
- 29 - Castle nut
- 30 - Washer
- 31 - Expanding screw
- 32 - Splines shaft sleeve
- 33 - Axial needle bearing
- 34 - Seal
- 35 - Shift rod
- 36 - Closing screw

- 37 - Spring
- 38 - Ball 9 mm dia.
- 39 - Locking piece
- 40 - Spring with pin for gear lock
- 41 - Screw with spring washer
- 42 - Shift forks
- 43 - Shift rod 3rd and 4th gear
- 44 - Shift rod 1st and 2nd gear
- 45 - Shift rod for parking lock and rev. gear
- 46 - Bearing inner race
- 47 - Bearing inner race
- 48 - Intermediate plate
- 49 - Driving shaft
- 50 - Driven shaft
- 51 - Transmission housing
- 52 - Pin, gear lock

*Exploded view of transmission*

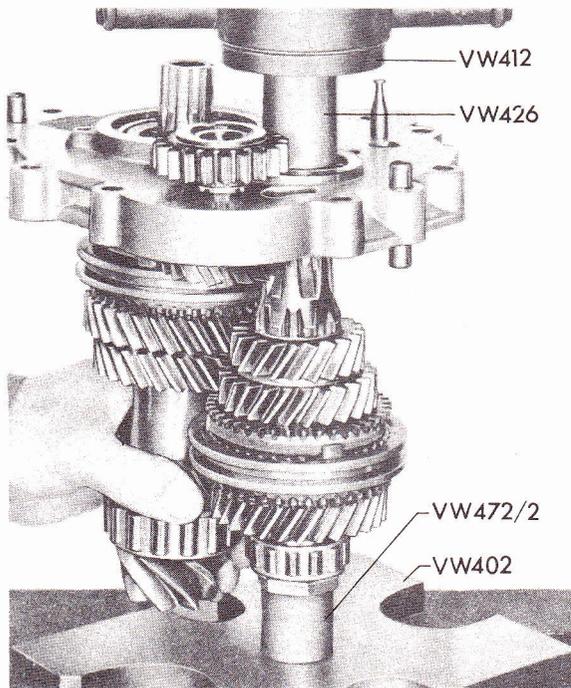
Pull the gear set with the intermediate plate, out of the transmission housing, turning intermediate plate slightly toward the left. Clamp the intermediate plate with a gear set into a soft jawed vise. Loosen the closing screw for the gear lock. Remove the compression spring and ball, and take the shift rod for reverse gear and the parking lock, as well as the parking bit, out of the intermediate plate. Loosen the hex. screw for the shift fork from first and second gear; force out the shift rod and remove it, together with the shift fork.

Mark the shift fork for 3rd and 4th gear to prevent confusion during installation. Loosen the hex. screw and remove the shift rod together with the shift fork.

Finally, press the drive pinion and driving shaft out of the intermediate plate using a thrust piece.

**Assembly**

Place the intermediate plate on the bearing inner race halves of the pinion and the driving shaft and fit the other halves of the bearing inner races. First slide a tube on to the input shaft and place it against the pressure plate. Fit the bearing inner race while holding the pinion in position. Then pull the tube from the input shaft, placing the pinion on the pressure plate and also fit the bearing inner race.



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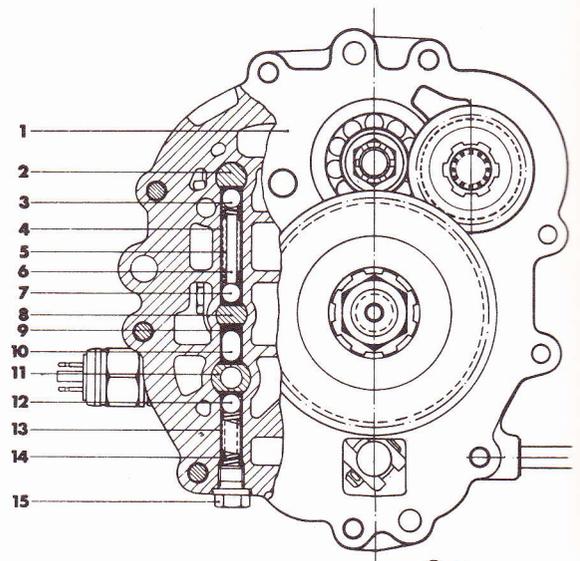
*Removing pinion shaft*

Engage the 4th gear and slide the intermediate plate with the pinion and the input shaft into the transmission housing. Attach the intermediate plate crosswise to the 4 studs of the housing with nuts (placing several washers under the nuts).

Place the washer (with chamfer outwards) to the input shaft, and screw on the castle nut to specified torque. Secure the castle nut with a clamping sleeve. Slide the splining sleeve on the pinion with the internal profile pointing outwards.

Lubricate the expanding screw for the pinion (with speedometer pinion) on the pressure surface and tighten to specified torque with an insert. Remove the intermediate plate with the pinion and input shaft again to adjust the shift forks, and clamp into a vise (use soft jaws). Assemble the shift rods and shift forks in the sequence described next.

Check the springs for the securing shift rods. Relax length of springs for 1st to 4th gear. Free length should be 1.469-1.517 in. Relax length of the spring for reverse gear and parking lock. Place the shift rod for 3rd and 4th gear on the pertinent shifting sleeve and slide the shift rod for 3rd and 4th gear through the bore of the shift fork into the intermediate plate. Tighten hex. screws with spring washer for shift fork slightly. (First attach the shift piece with clamping sleeve on the shift rod).



© Volkswagen

*Shift rod gear lock arrangement*

- 1 - Intermediate plate
- 2 - Shift rod for 3rd and 4th gear
- 3 - Ball
- 4 - Bushing for gear lock
- 5 - Spring for gear lock 1st to 4th gear
- 6 - Pin for gear lock
- 7 - Ball
- 8 - Shift rod for 1st and 2nd gear
- 9 - Bushing for gear lock
- 10 - Locking piece for gear lock
- 11 - Shift rod for reverse gear and parking lock
- 12 - Ball
- 13 - Bushing for gear lock
- 14 - Spring for gear lock (reverse gear and parking lock)
- 15 - Closing screw

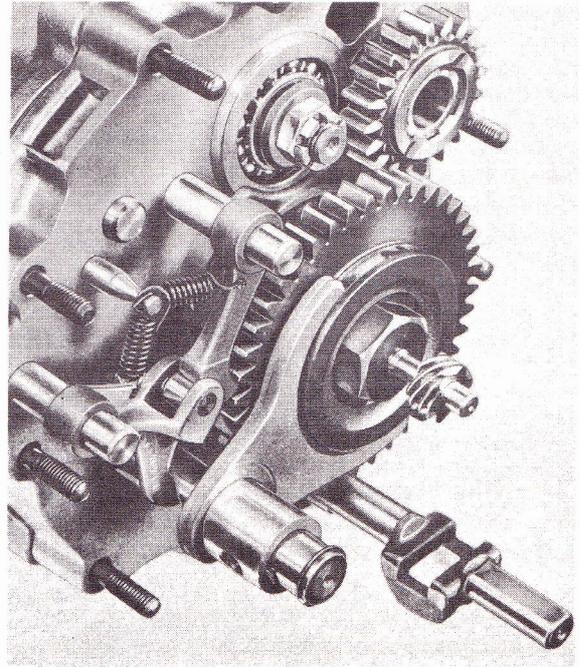
Insert one ball, pin for shift lock, long compression spring for the gear lock 1st to 4th gear and another ball into the connecting duct of the shift rod bores. It will be advantageous to insert the pin into the spring first and then assemble both parts together. Replace the shift fork for 1st and 2nd gear on the pertinent shift sleeve and slide the shift rod for 1st and 2nd gear through the bore of the shift fork into the bore of the intermediate plate. For this purpose, the shift rod of 3rd and 4th gear should be at idling and the ball for the shift rod 1st and 2nd gear must be pushed into the duct.

Tighten the hex. screw with spring washer for the shaft fork slightly. Insert the locking piece for the gear lock (set the shift rod for 1st and 2nd gear to idling). Next, insert the shift rod for reverse gear and the parking lock. Insert the ball and spring for the gear lock (reverse gear and parking lock), screw down the closing screw and tighten. Assemble the internal shift lever, noting its position. Slide the internal shift lever through the cutout in the intermediate plate.

Coat the axial needle bearings with some grease and insert them with needles pointing toward the thrust washer in the transmission. Slide seals (same number as removed) in proper size on the studs of the gearbox housing. Insert the intermediate plate with the input shaft and pinion into the housing. Slide the shift rod for reverse gear and the parking lock into the housing. Insert the internal shift lever into its bearings in the gearbox housing.

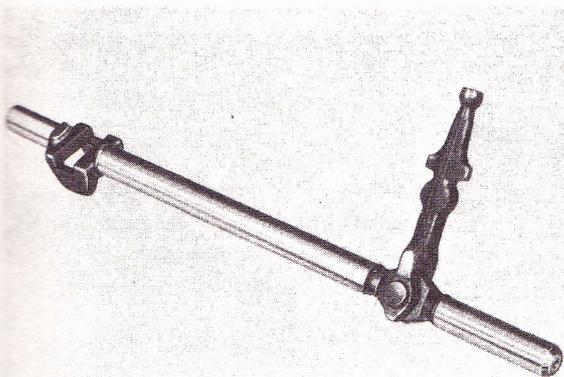
Mount the fork piece with a new seal, making sure that the internal shift lever is guided in the fork piece. Insert only when no gear is engaged. Tighten both of the hex. nuts to specified torque. Slide the shift fork and reverse gear on the shift rod or splining shaft sleeve and position the locking ring.

fork and shift rod. Place the pawl and lever for park lock on the intermediate plate and connect both draw springs. Place the needle bearing and the spacer bushing on the shaft for reverse gear. Mount the gearbox cover and tighten the nuts to specified torque.



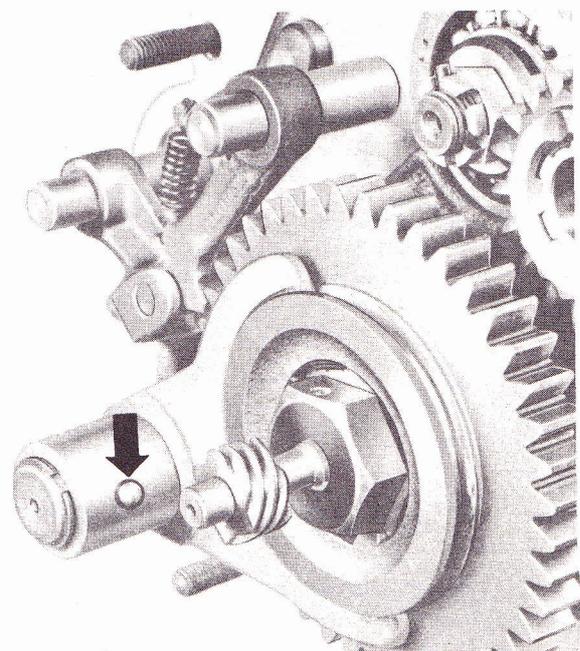
© Volkswagen

*Parking lock arrangement*



© Volkswagen

*Shift lever correct position*



© Volkswagen

*7 mm ball for parking lock*

Coat bolts and 7 mm (0.276 in.) ball for the parking lock with some grease and insert it into the bore of the shift

Insert the plunger for the backup lights and bridging switch; screw in both switches and tighten to specified torque. Install the sealing ring for the input shaft into the gearbox housing, sliding the sleeve onto the input shaft first, and then forcing in the sealing ring with its lip pointing toward the transmission well, using a thrust piece.

**SHIFT FORK**

**Adjusting**

Slide the holding plate on the shift rods and adjust the shift forks for 1st and 2nd, as well as 3rd and 4th gear. Adjust shifting sleeve via shifting fork in such a manner that it will be accurately in the center between the synchronizing rings in idling position. Compensations for any deviations must be made very accurately to guarantee perfect function of synchronization. Tighten the hex.

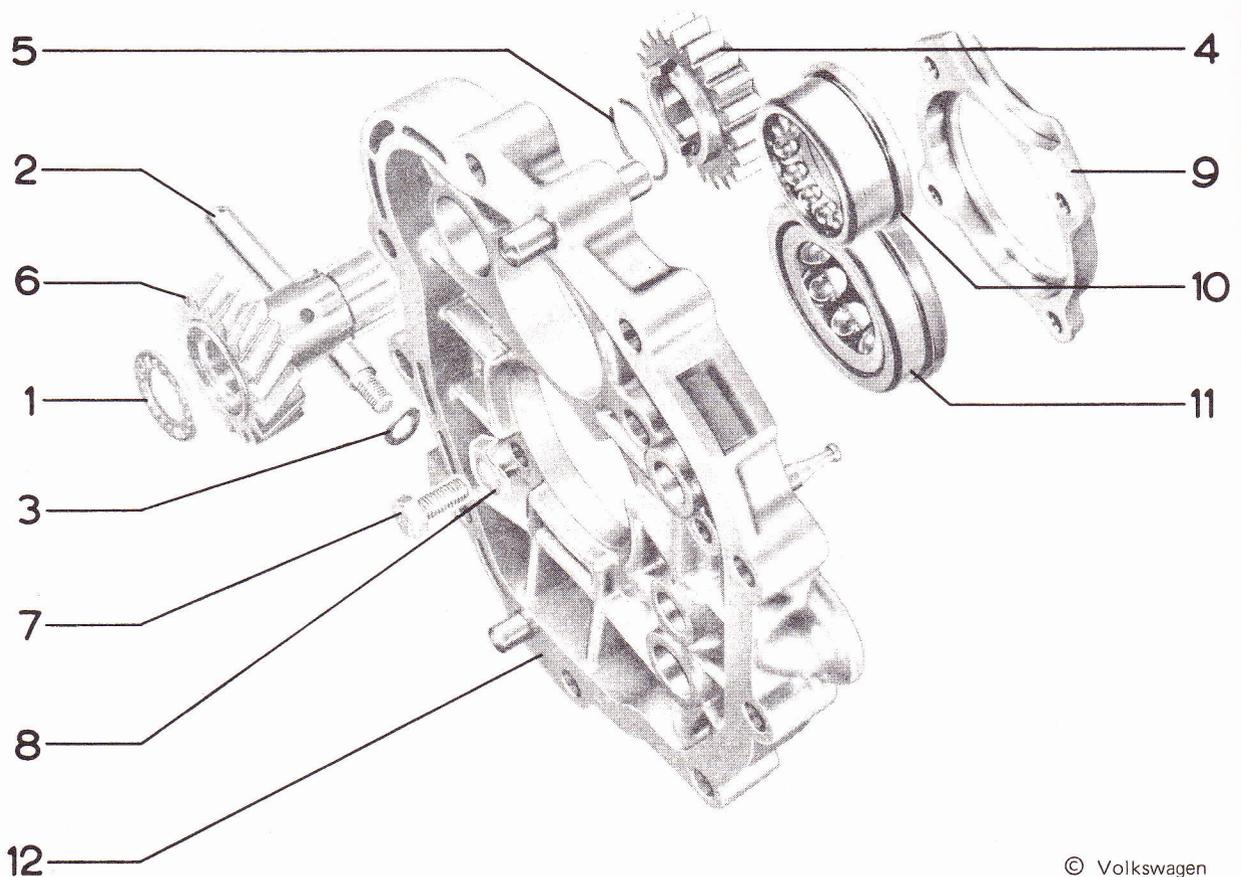
screws of the shift forks to the specified torques, making sure that the shifting piece of 3rd and 4th gear has a play of approx. 0.079 in. in relation to the shift rod of 1st and 2nd gear.

Remove the holding plate and pull the shift rod for reverse gear and the parking lock as far as possible in the outward direction toward the intermediate plate.

**INTERMEDIATE PLATE**

**Disassembly**

Pull the wheel for reverse gear with a puller and thrust piece. This will destroy the circlip. Carefully remove all the parts of the destroyed circlip so that no remnants will enter the transmission. Unbend the lock washers of the fastening screws for the clamping plate. Loosen the screws and remove the plate.



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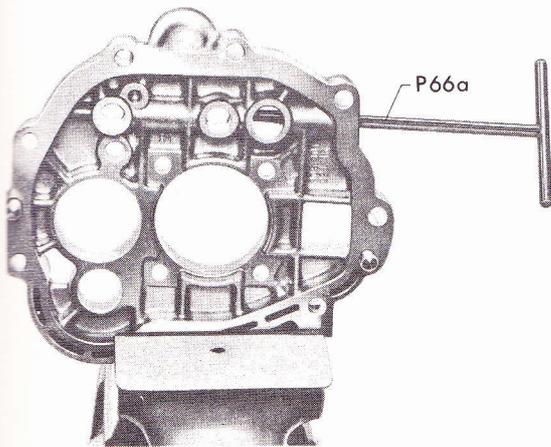
*Exploded view of intermediate plate*

- |                                       |                                  |
|---------------------------------------|----------------------------------|
| 1 - Axial needle bearing              | 7 - Screw M 8                    |
| 2 - Shaft for accelerator lever 914/6 | 8 - Lock washer                  |
| 3 - Spring washer B 8                 | 9 - Clamping plate               |
| 4 - Gear wheel/rev. gear              | 10 - Double tapered ball bearing |
| 5 - Locking ring                      | 11 - Four-point bearing          |
| 6 - Gear wheel/rev. gear              | 12 - Intermediate plate          |

Heat the intermediate plate to approx. 248°F and press out the four-point ball bearing. Then, press out the double tapered ball bearing. Knock the fitted pins out of the intermediate plate and pull out the bushings securing the gear locks by means of a pulling hook.

**Assembly**

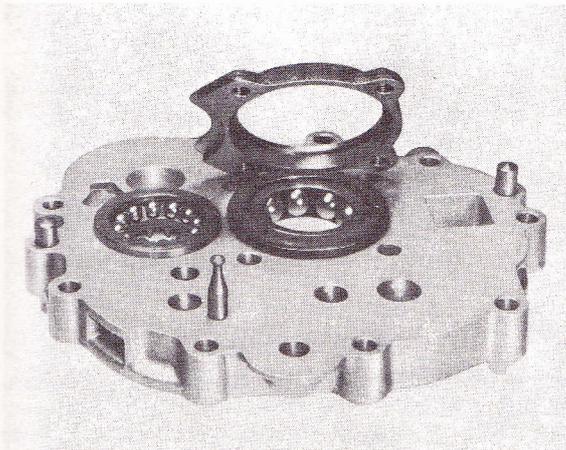
Check all parts for wear or damage and replace, if required. Heat the intermediate plate to approx. 248°F and press in the double tapered ball bearing using the proper tools. Press in the four-point ball bearing with the pressure plate, pressure pin and the pressure piece, from the same side. Insert any loose balls of double-row tapered ball bearings with grease. Now, position the clamping plate.



© Volkswagen

*Removing gear lock securing bushings*

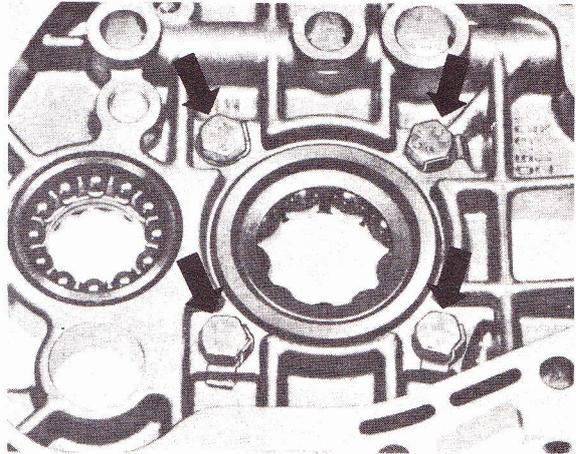
Mount the fastening screws with new lock washers and tighten the screws to the specified torque. Bend the lock



© Volkswagen

*Installing clamping plate*

washers, noting their correct position. Force in the bushings securing the gear lock with a mandrel. Force in the long bushing against the stop of the mandrel. Force in the short bushing until the guide bores of the shift rods are exposed. Now, force in the medium-long bushing up to the first mark on the mandrel. Make sure that none of the bushings extend into the guide holes of the shift rods.



© Volkswagen

*Position of lock washers*

Insert gear 2 for reversing speed from the outside, in an inward direction into the intermediate plate and fit the circlip into the groove of the gear. Slide gear 3 onto the teeth of gear 2 and compress the circlip with a pair of pliers until gear 3 engages the circlip while applying light blows with a plastic hammer.

**INPUT SHAFT**

**Disassembly**

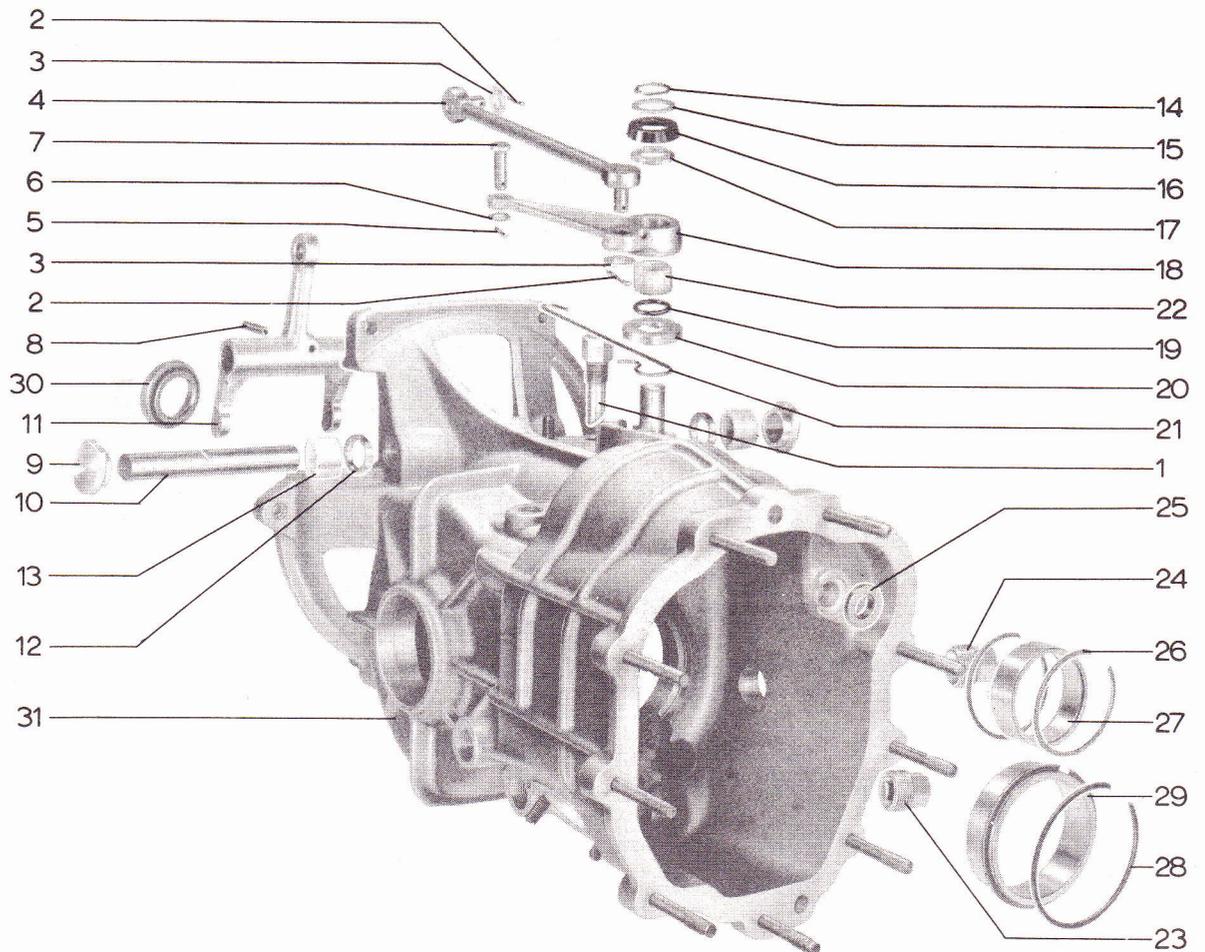
Press off the gear wheel of 1st gear with the inside race half of the tapered ball bearing by means of a pressure plate and a thrust piece. Clamp the holding plate into a vise. Mount the input shaft and knock back the lock for the hex. nut. Then loosen the hex. nut with a nut spanner. Press the cylindrical roller bearing from the input shaft with a pressure plate and a pressure pin.

Pull off the remaining parts from the input shaft. Be sure to mark the needle cages to eliminate any confusion during installation.

**Assembly**

All the parts of the input shaft must be mounted dry, so that no oil enters in between the mating surfaces. Slide second gear onto the input shaft, with the narrow flange against the stop. Fit the thrust washer and the bushing for the needle bearing. Next, mount the needle cage, the gear wheel and 3rd gear and the guide sleeve.

If needle cages are reinstalled, they must be fitted with



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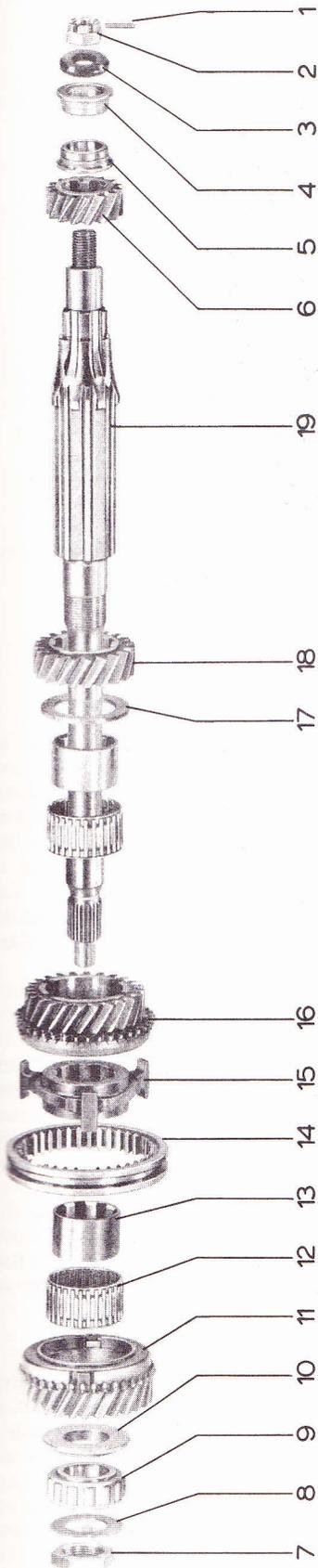
*Exploded view of gear box housing*

- |                     |                                |
|---------------------|--------------------------------|
| 1 - Breather        | 17 - Spacer sleeve             |
| 2 - Cotter pin      | 18 - Intermediate lever        |
| 3 - Washer B 6      | 19 - O- ring                   |
| 4 - Push rod        | 20 - Washer                    |
| 5 - Cotter pin      | 21 - Torsion spring            |
| 6 - Washer B 5      | 22 - Bushing f. interm. lever  |
| 7 - Bolt            | 23 - Closing screw with magnet |
| 8 - Clamping sleeve | 24 - Closing screw             |
| 9 - Closing cap     | 25 - Thrust ring               |
| 10 - Clutch shaft   | 26 - Circlip                   |
| 11 - Throwout lever | 27 - Bearing outer race        |
| 12 - Spacer ring    | 28 - Circlip                   |
| 13 - Bushing        | 29 - Bearing outer race        |
| 14 - Locking ring   | 30 - Sealing ring              |
| 15 - Washer         | 31 - Housing                   |
| 16 - Sleeve         |                                |

the same gear wheel they were removed from. Mount the shifting sleeve, the bushing for the needle bearing, the needle cage and the gear wheel for 4th gear. Position the tapered thrust washer and the cylindrical roller bearing in the correct lateral position (the mounted ring of the roller cage should face the splining of the clutch plate).

Press on the cylindrical roller bearing using a pressure plate and a pressure pin. Do not chafe or damage the threads on the driving shaft. Position the new lock washer, making sure that the tab of the washer rests in the groove on the shaft and under the inner race of the cylindrical roller bearing.

© Volkswagen



*Exploded view of input shaft*

- 1 - Clamping sleeve
- 2 - Pinion shaft for speedometer drive
- 3 - Expanding screw
- 4 - Splined shaft bushing

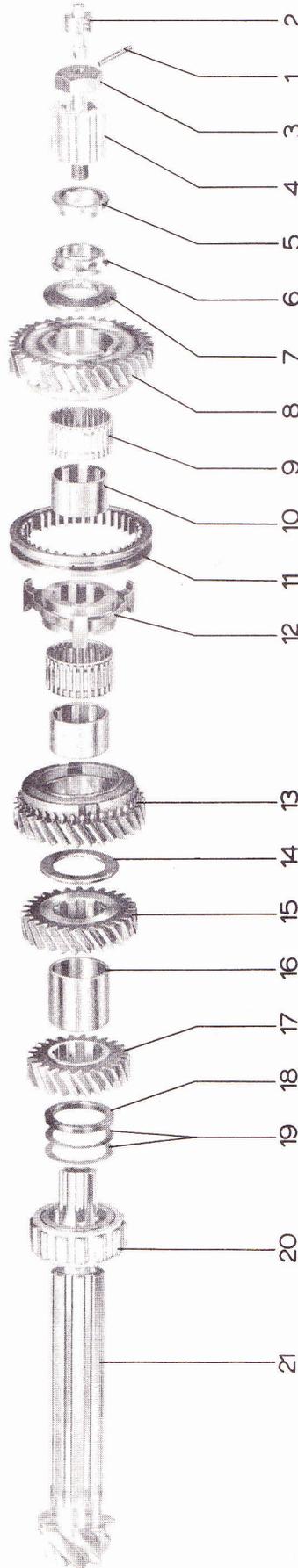
- 5 - Bearing inner race
- 6 - Bearing inner race
- 7 - Thrust washer
- 8 - Gear wheel 1st gear

- 9 - Needle bearing
- 10 - Spacer bushing
- 11 - Shifting sleeve
- 12 - Guide sleeve

- 13 - Gear wheel 2nd gear
- 14 - Thrust washer
- 15 - Gear wheel 3rd gear
- 16 - Spacer bushing

- 17 - Gear wheel 4th gear
- 18 - Spacing washer
- 19 - Adjusting washers
- 20 - Cyl. roller bearing
- 21 - Pinion shaft

© Volkswagen



*Exploded view of pinion shaft*

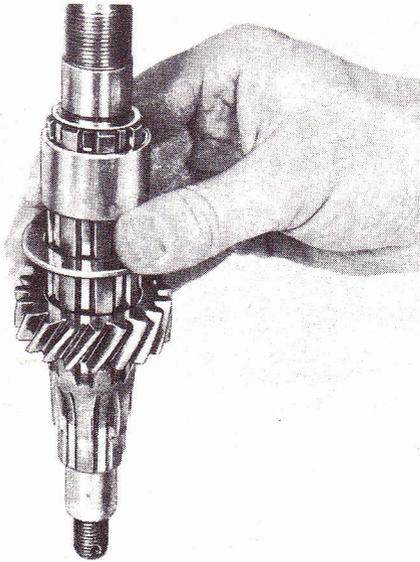
- 1 - Clamping sleeve
- 2 - Castle nut
- 3 - Washer
- 4 - Bearing inner race

- 5 - Bearing inner race
- 6 - Gear wheel 1st gear
- 7 - Nut
- 8 - Locking plate

- 9 - Cyl. roller bearing
- 10 - Spacing washer
- 11 - Gear wheel 4th gear
- 12 - Needle bearing

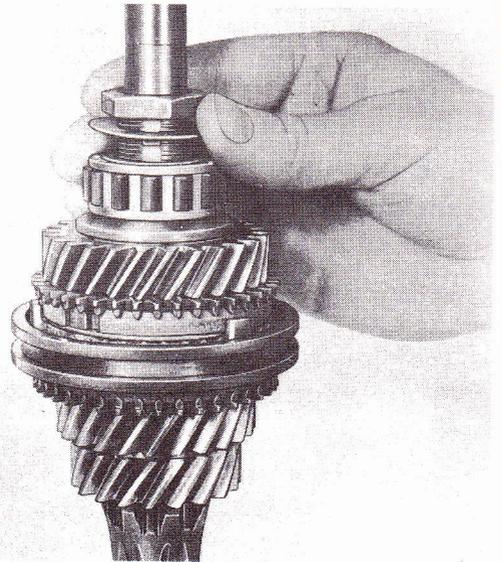
- 13 - Spacing bushing
- 14 - Shifting sleeve
- 15 - Guide sleeve
- 16 - Gear wheel 3rd gear

- 17 - Thrust washer
- 18 - Gear wheel 2nd gear
- 19 - Driving shaft



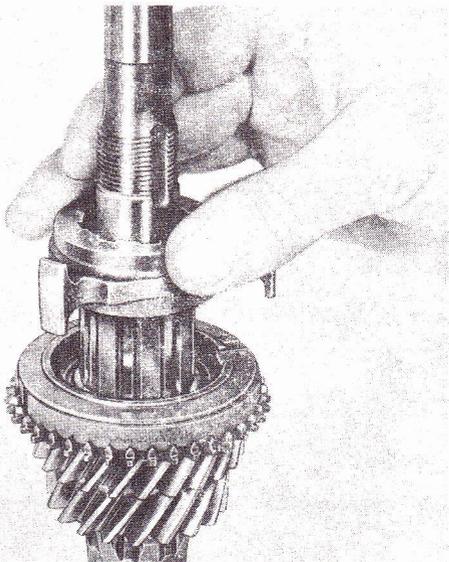
© Volkswagen

*Fitting thrust washer & bushing*



© Volkswagen

*Installing new lock washer*



© Volkswagen

*Installing guide sleeve*

Lubricate the threads and the pressure surface of the hex. nut and fit the spherical end of the nut outwards. Tighten the hex. nut to specified torque with a nut spanner and secure it with a lock washer. Fit the gear wheel for 1st gear, with the narrow flange outwards and press on the inside half of the race of the tapered ball bearing by means of a pressure pin and tube.

**Checking for out-of-true**

The shaft should always be checked for “out-of-true” in the assembled condition, since the tightening of the hex. nut may cause some wobble on the shaft. For checking purposes, press the double-row tapered ball bearing out of the intermediate plate and the outer race of the roller bearing out of the gearbox housing. The check can also be made by means of the auxiliary bearings. Place the assembled input shaft with bearings attached on V-blocks and check on trueness of the needle sleeve. Max. out-of-true 0.004 in.

**PINION SHAFT**

**Disassembly**

Remove the bearing inner race of the four-point ball bearing and the cylindrical roller bearing from pinion shaft using a pressure plate, pressure pin, tube and a thrust piece. Remove all the parts from the pinion shaft. Identify the needle cages to prevent confusion during installation.

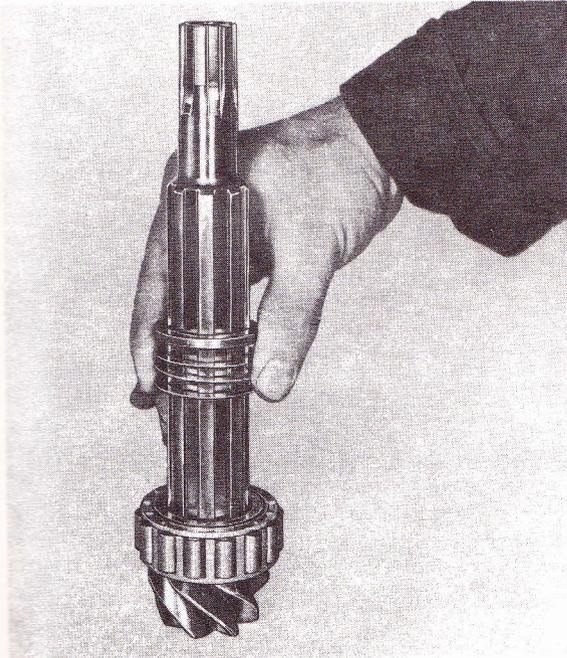
Note the number and thickness of the washers (for the pinion shaft/ring gear adjustment) between the roller bearing and the thick spacer washer, so that the adjusting washers dimensions need not be calculated during assembly.

**Assembly**

All parts of the pinion shaft must be assembled in a dry condition so that no oil enters between mating surfaces. The pinion and the ring gear must be provided with a pairing number. Be sure that these numbers match during installation.

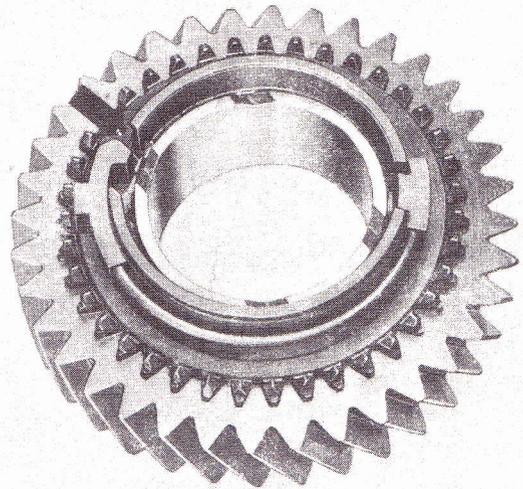
Fit the pinion shaft bearing with a pressure plate and pressure pin. Mount the bearing in such a manner that the washer on the temporary roller cage faces the gear set. Position the removed adjusting washers or the newly determined adjusting washers for the replaced pinion shaft

assembly. Then fit the thick spacer washer. Fit the gear wheel for 4th gear with a narrow collar, facing upwards. Fit the spacer bushing and the gear wheel for 3rd gear against the spacer bushing with the narrow collar facing downwards.



© Volkswagen

*Fitting adjusting washers*



© Volkswagen

*Correct position of synchronizing body & energizer*

In the event of repairs, the synchronizing ring should be turned, so that the coarse surface faces the sliding sleeve. When assembling the synchronizing components, for 1st gear, note that only one break band is inserted. The mating surfaces of the synchronizing body and the energizer are matched and should be installed accordingly.

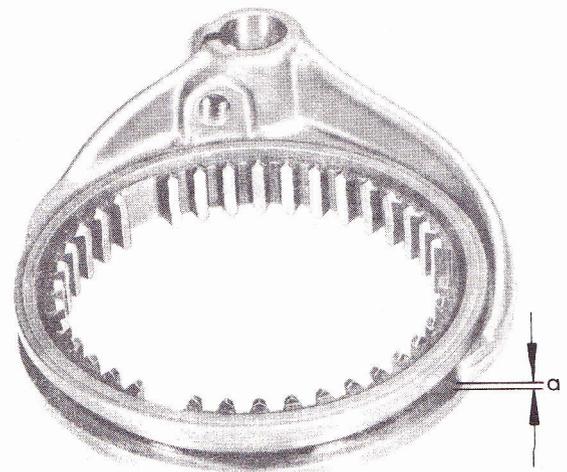
Place the nose of the retaining ring into the cutout for the energizer and push the retaining ring into the groove at this end, pushing the synchronizing ring against its seat, if required. Apply the pliers once again, to secure the ring completely. Using the retaining pliers, spread the ring

Place the thrust washer and the bushing for the needle bearings on the shaft. Fit the needle cage, the gear wheel for 2nd gear and the guide sleeve. Used needle cages must be installed with the same gear wheel as before. Now slide the bushing for the needle bearing, the needle cage and the shift sleeve on the shaft. Install the gear wheel for 1st gear and the tapered thrust washer. Finally, press the bearing inner race half on the shaft, using a pressure plate, a pressure pin, and a pipe tool.

**SYNCHROMESH ASSEMBLY**

**Disassembly**  
Remove the retaining ring for the synchronizing ring from the clutch body. For this purpose, insert the retaining pliers (outside) and spread. Simultaneously, tilt the pliers in such a manner that the noseless end of the retaining ring is raised out of the groove in an upward direction. After deep spreading the pliers and force the ring out of the groove by twisting it in a lateral direction.

**Assembly**  
Position the synchronizing ring on the clutch body, and then insert the energizer and stop, together with the braking band. The rough surface of the synchronizing ring has a gear seal ybdenum coating. During the shifting operation, the two sides of the synchronizing ring are subject to different stresses.



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*Shift rod lateral clearance.*

$a = 0.2 \text{ in.}$

## AUTOMATIC TRANSMISSION 8A-18

while simultaneously twisting the pliers laterally in such a manner that the ring can be pushed into the groove using the thumb of the other hand.

### **Inspection**

To guarantee perfect synchronization, two items should

be checked. First, measure the built-in synchronizing ring (with a micrometer), to check its diameter. Position the micrometer at the highest point of the synchronizing ring. Diameter should be 2.998 – 3.014 in. Then check the clearance between the shift fork and the shifting sleeve, or the shifting gear (1st to 4th gear). Clearance should be 0.0197 in.

# DRIVE AXLE & DRIVELINE 9

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### WHEEL TRACK

#### Adjusting

Slightly loosen the hex. bolts for the control arm bearing and push the rear axle control arm outside, back or forward as required until the specified track value is attained. Tighten the hex. bolts to the specified torque and replace the lock washers if required.

### CAMBER

#### Adjusting

Mark the position of the rear axle control arm on the base plate (track setting) and unscrew the central hex. bolt. The other two hex. bolts are only slightly slackened. Mount the pertinent intermediate shims to obtain the specified camber. Intermediate shims are available in 2.3 and 4 mm thicknesses, a 1 mm shim results in approx. 0°10' change of camber. A bore at the outside permits the removal of the shims.

Tighten the hex. bolts to the specified torque and replace the lock washers, if required. Check the camber and the track values once again.

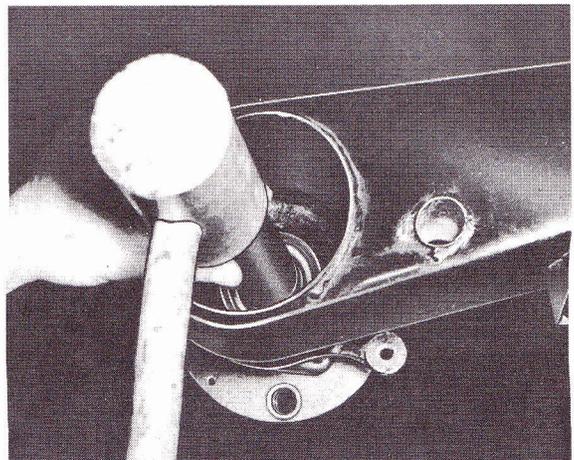
### SPRING STRUT

#### Removal

Loosen the hex. nut for the bearing bolt on the spring strut (bottom) and remove the bearing bolt. Loosen the self-locking hex. nut on the spring strut (top) and remove the spring strut in a downward direction.

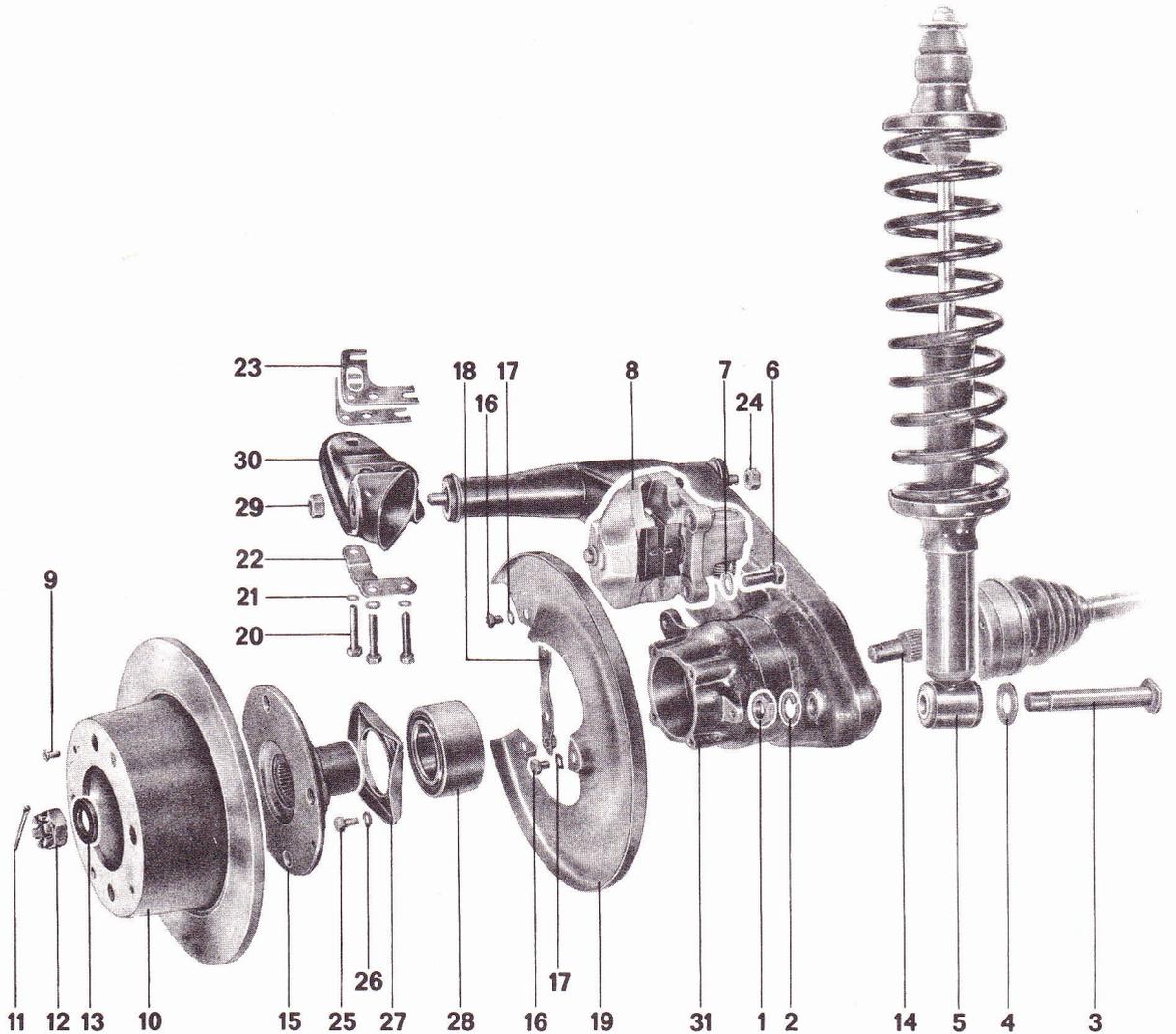
### Installation

Replace the self-locking hex. nut. Tighten the self-locking hex. nut, as well as the hex. nut for the bearing bolt, to the specified torque.



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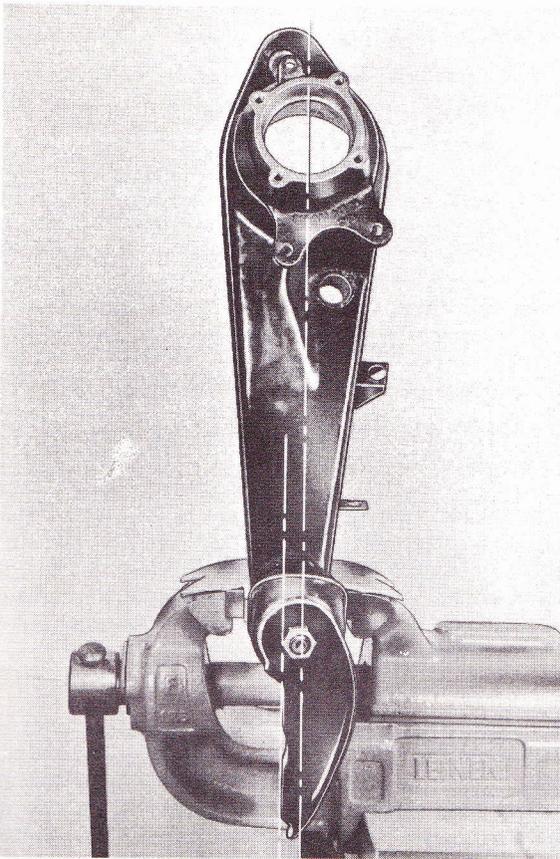
*Removing rear wheel hub*



© Volkswagen

*Exploded view of rear axle*

- |                      |                                |
|----------------------|--------------------------------|
| 1 - Hex. nut         | 17 - Spring washer             |
| 2 - Spring ring      | 18 - Holding plate             |
| 3 - Bearing bolt     | 19 - Protective cover          |
| 4 - Washer           | 20 - Hex. bolt                 |
| 5 - Spring strut     | 21 - Lock washer               |
| 6 - Hex. bolt        | 22 - Shim plate                |
| 7 - Spring washer    | 23 - Shim                      |
| 8 - Caliper          | 24 - Self-locking hex. nut     |
| 9 - Hex. bolt        | 25 - Hex. bolt                 |
| 10 - Brake disk      | 26 - Spring ring               |
| 11 - Cotter pin      | 27 - Bearing cap               |
| 12 - Castle nut      | 28 - Radial taper ball bearing |
| 13 - Washer          | 29 - Self-locking hex. nut     |
| 14 - Universal shaft | 30 - Control arm bearing       |
| 15 - Wheel hub       | 31 - Rear axle control arm     |
| 16 - Hex. bolt       |                                |



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*True relation of control arm bearing surface with control arm shafts*

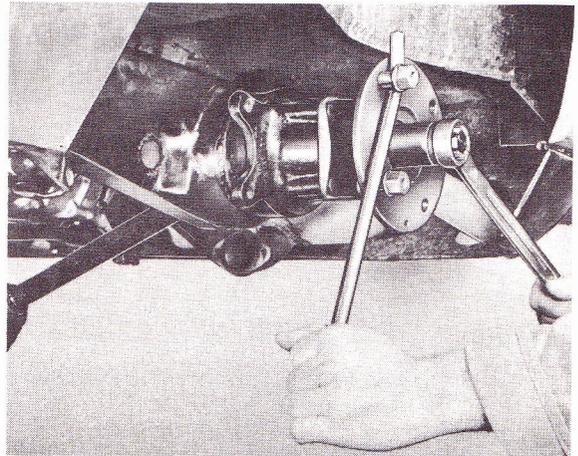
suitable thrust piece. Finally, loosen the self-locking hex. nut for the control arm bearing and remove the bearing.

#### Inspection

Check the rear axle control arm for visible damage and distortion. Replace if required. The rubber bearings of the rear axle control arm cannot be replaced. Replace the rear axle control arm, if required.

#### Installation

Attach the control arm bearing, on the rear axle control arm, in such a manner that the bearing surface of the control arm bearing is in parallel with the connecting line of the two control arm shafts. Replace the self-locking hex. nuts and tighten them to the specified torque. Install the radial taper ball bearing with a special tool.



© Volkswagen

*Installing rear wheel hub*

#### Disassembly

Clamp the coil spring with a special tool. Loosen the threaded bushing and remove the spring retainer on the top. Slacken the coil spring by alternately screwing back the clamping bolts, removing the coil spring, the supplementary spring and the stop washer from the piston rod.

Knock the cap from the shock absorber with a mandrel. Remove the bottom spring retainer in the direction of the piston rod.

#### Assembly

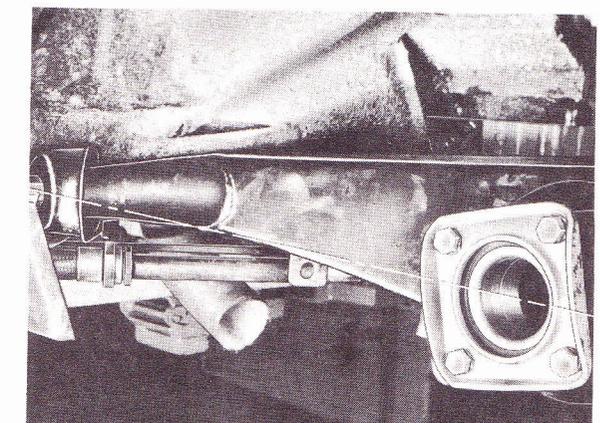
Assemble in reverse procedure of disassembly.

#### REAR AXLE CONTROL ARM

##### Removal

Loosen the brake line on the brake hose. Disconnect the hand brake cable and remove the caliper. Remove the brake disk and the universal shaft (unscrew the heat exchanger first). Remove the rear wheel hub with a special tool. Mark the position of the rear axle control arm on the shim plate and hold the shims for adjusting the camber in the position.

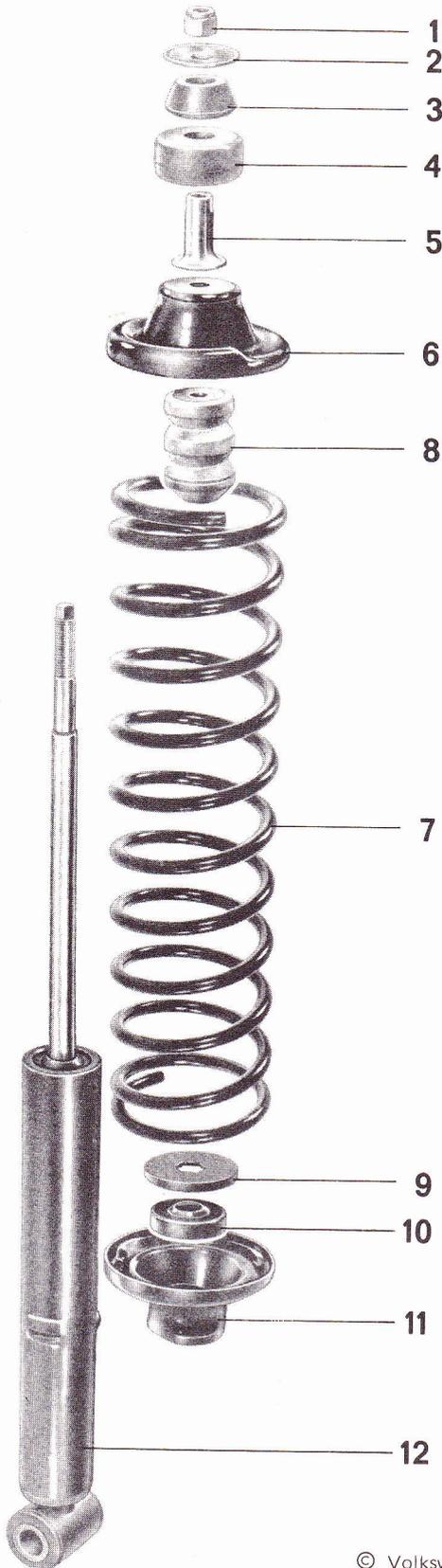
Loosen the bolts or the self-locking hex. nut on the rear axle control arm and remove the arm. Remove the bearing cover and force out the radial taper ball bearing with a



© Volkswagen

*Position of rear axle control arm*

Tighten the hex. bolts for the bearing cover to the specified torque. Tighten the rear axle control arm in a horizontal position. Install the rear wheel hub, with a special tool, in the taper ball bearing.



© Volkswagen

*Exploded view of spring and shock*

Install the universal shaft. Connect the hand brake cable and adjust the hand brake. Bleed the brake lines. Measure the rear axle optically.

**SHOCK ABSORBER**

**Checking**

The shock absorber is checked manually by pulling and pushing it, while holding the shock absorber in the installation position. It should move under a uniform load and be free of jerks along its entire stroke. Compare with a new one, if required.

The damping effect while pushing or pulling, must be clearly felt up to the end position. Dampers which have been in storage for extended periods may require some pumping action until their full effect shows up. While driving, defective shock absorbers are noticed by a rumbling noise.

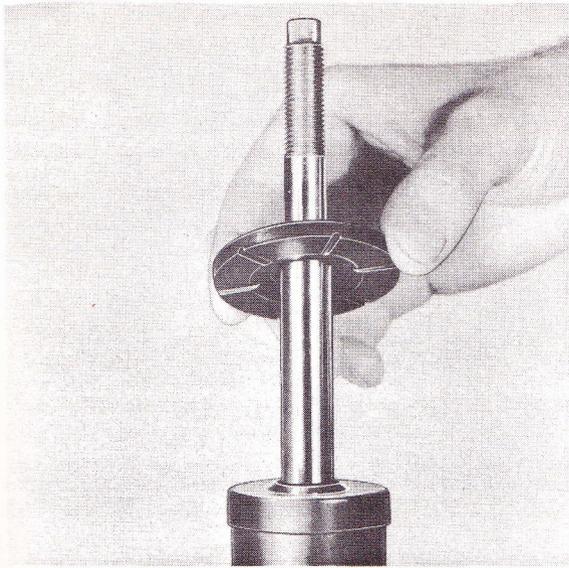
Shock absorbers require no servicing and have an adequate supply of oil to compensate for small losses. If only slight amounts of shock absorber oil are leaking out, but the shock absorber operates otherwise perfectly, no exchange is required. Shock absorber oil cannot be replenished. Defective shock absorbers must be replaced.

**Assembly**

Mount the bottom spring retainer on the shock absorber in such a manner that the water drain hole is in a lateral (inside) position with the spring strut installed. Fit on the cap. Mount the stop plate with the grooves facing the cap, so that no oil will be sucked out of the shock absorber.

Coil springs should rest correctly against the spring retainers. Tighten the threaded bushings to the specified torque.

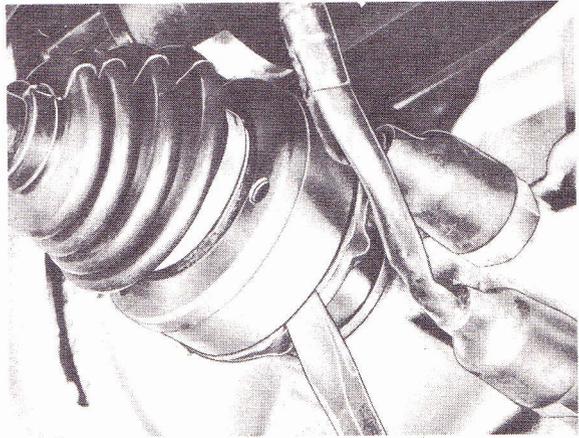
- 1 - Self-locking hex. nut
- 2 - Washer
- 3 - Ring joint
- 4 - Ring joint
- 5 - Threaded bushing
- 6 - Spring retainer, top
- 7 - Rear axle spring
- 8 - Supplementary spring
- 9 - Stop washer
- 10 - Cap
- 11 - Spring retainer, bottom
- 12 - Shock absorber



© Volkswagen

*Correct position of stop plate*

the universal shaft on the universal flange. Use a flat chisel to separate the universal shaft from the universal flange in the range of the flange seal and remove the universal shaft. Be careful not to damage the flange surfaces.



© Volkswagen

*Removing universal shaft flange*

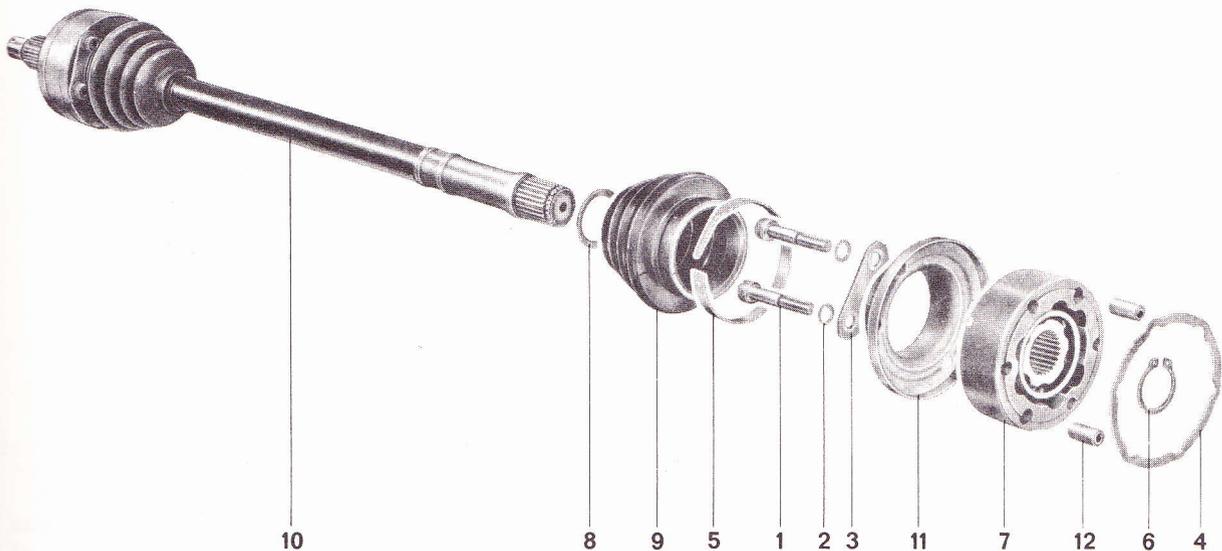
**UNIVERSAL SHAFT**

**Removal**

Unlock the castle nut of the universal shaft and loosen it. Remove the heat exchanger. Loosen the socket screws of

**Installation**

Use the new seal for the flange and make sure that the



*Exploded view of universal shafts*

© Volkswagen

- |                      |                         |
|----------------------|-------------------------|
| 1 - Cheesehead screw | 7 - Synchronizing joint |
| 2 - Lock washer      | 8 - Spring retainer     |
| 3 - Shim plate       | 9 - Sealing bellows     |
| 4 - Seal             | 10 - Universal shaft    |
| 5 - Clamping strap   | 11 - Protective cap     |
| 6 - Locking ring     | 12 - Spiral pin         |

flange surfaces are without a burr and are absolutely free of grease.

Tighten the socket screws to the specified torque, using new lock washers and making sure that the lock washers will rest with their hollow end against the shim plate. Tighten the castle nut of the universal shaft to the specified torque.

**SYNCHRONIZING JOINT**

**Removal**

Loosen the clamping strap of the sealing bellows and push the bellows back. Remove the locking ring from the ball hub. Now, press the joint from the universal shaft with the proper tool. Remove the plate spring and pull off the sealing bellows.

The protective sheet metal cap is sealed with Curil K against the joint. When the cap is removed, do not swivel the ball hub more than 20° otherwise the balls may fall out.

**Installation**

Check the universal shaft, the sealing bellows, synchronizing joint, protective cap and the plate springs for wear or damage. Replace them if required. Glue the plate spring, with the specified grease, to the joint, with the hollow end facing the joint. If the cap has been removed from the joint, seal it again with the sealing compound Curil K.

Seal the sealing bellows on the large diameter with a sealing compound. Attach the hose clips in such a manner that the clamping points are at the level of the spiral pins.

Grease the synchronizing joints. Use multi-purpose grease, such as Molykote BR 2 or Shell-Retanax AM. Fill 2/3 of the specified grease quantity through the smaller diameter of the sealing bellows. Slide the joint with the sealing bellows on the universal shaft. Be sure that the plate spring fits correctly and widen the ball hub with a special tool.

Install the locking ring and make sure that the ring is correctly located in the groove of the universal shaft. Push the remaining grease, from outside, into the joint and squeeze the sealing compound somewhat, so that the grease will enter the joint from the inside as well.

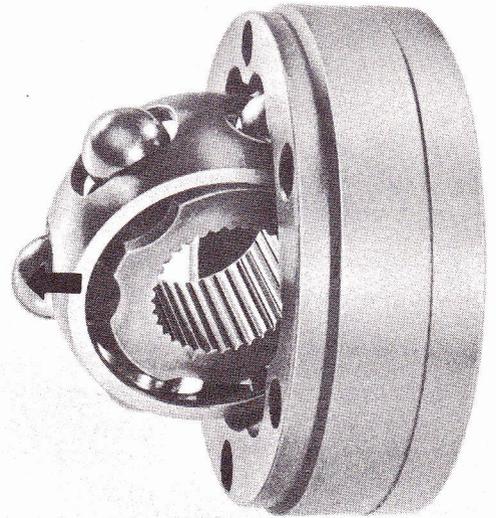
**Disassembly**

Loosen the protective cap from the joint by means of a mandrel. Swivel the ball hub with the ball cage by 90° and push it out of the joint. Push the balls out of the cage. Remove the ball hub via the ball races.

The ball hub and the joint are mated and should not be interchanged. The 6 balls for each joint are also included in one tolerance group. Exchange the ball hub, the joint, the ball cage and balls as a set. Knock the spiral pins out with a mandrel.

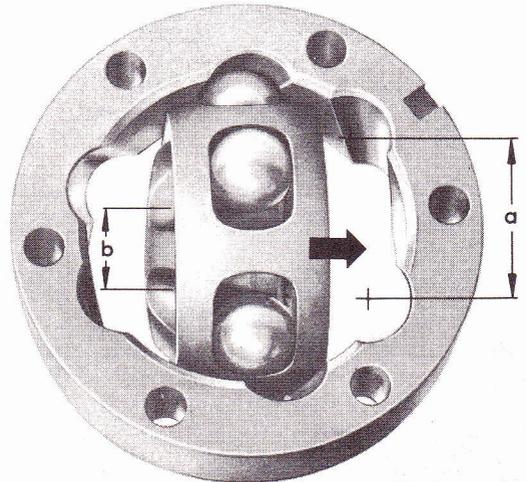
**Assembly**

Check the joint, the ball hub, ball cage and the balls for wear. Excessive radial play in the joint is noticed by knocks during load changes. In such cases, replace the pertinent joint. Press the spiral pins in, against the stop. Insert the ball hub, via both ball races, into the ball cage. The mounting position is at choice.



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*Removing ball hub and cage*



© Volkswagen

*Correct pre-assembly position*

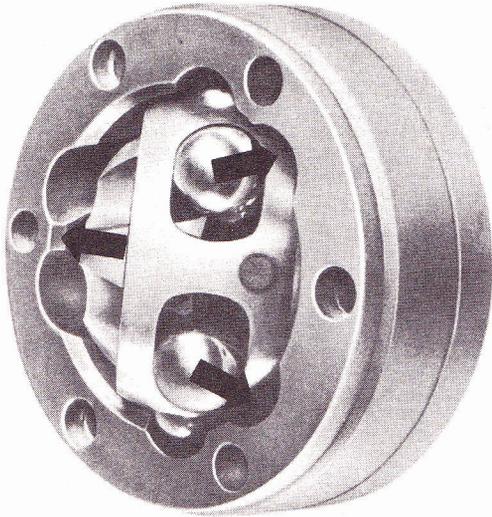
a = Large distance in outer race

b = Small distance hub

Press the balls into the cage. Insert the ball hub with the cage and balls into the joint. The bevelled end of the inside splines must point toward the bearing surface on the universal joint.

Insert the ball hub with the cage and balls, edgewise, into the joint. Be sure that a large distance "a" of the ball races at the joint, lies together on one side, with a small distance "b" of the ball hub after swivelling the ball hub into the joint. In order to swivel the ball hub with the cage and balls into the joint, the ball hub must be pushed

out of the cage (so that the balls have the distance of the ball races).



© Volkswagen

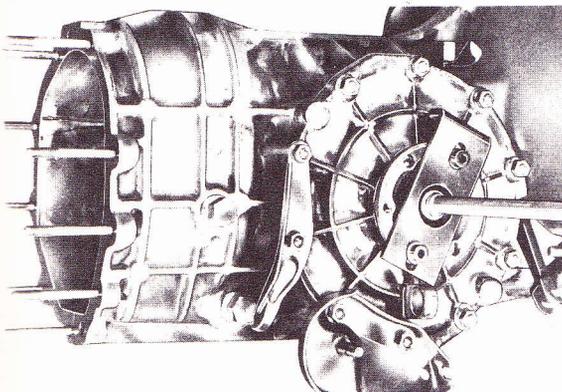
*Position of hub cage in outer race at moment of assembly*

**DIFFERENTIAL (MANUAL TRANSMISSION)**

**Removal**

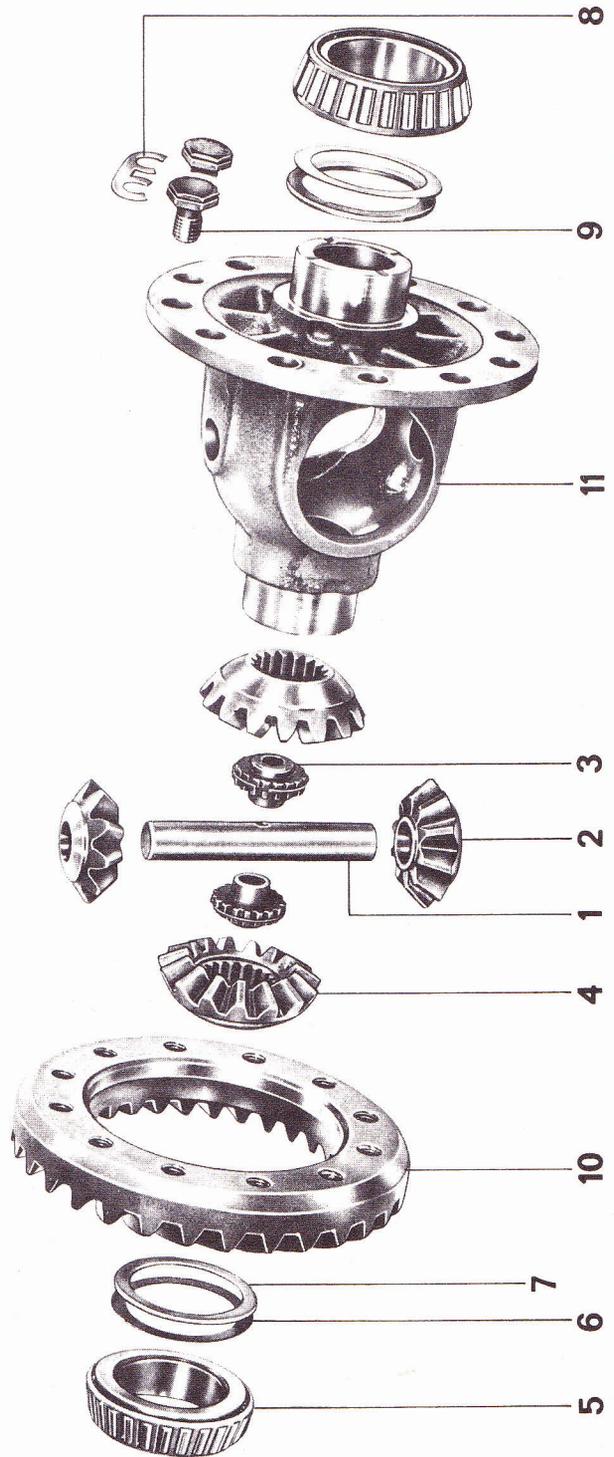
Before removing the differential, the transmission gears must be removed. Block the universal flange with a special tool and loosen the expansion bolts. Now remove the opposite universal flange. Loosen the lock nuts on the final drive cover. Remove the cover (tap the cover lightly with a plastic mallet if necessary).

Remove the differential from the housing. Knock the seal and bearing outer races from the cover and housing with a drift.



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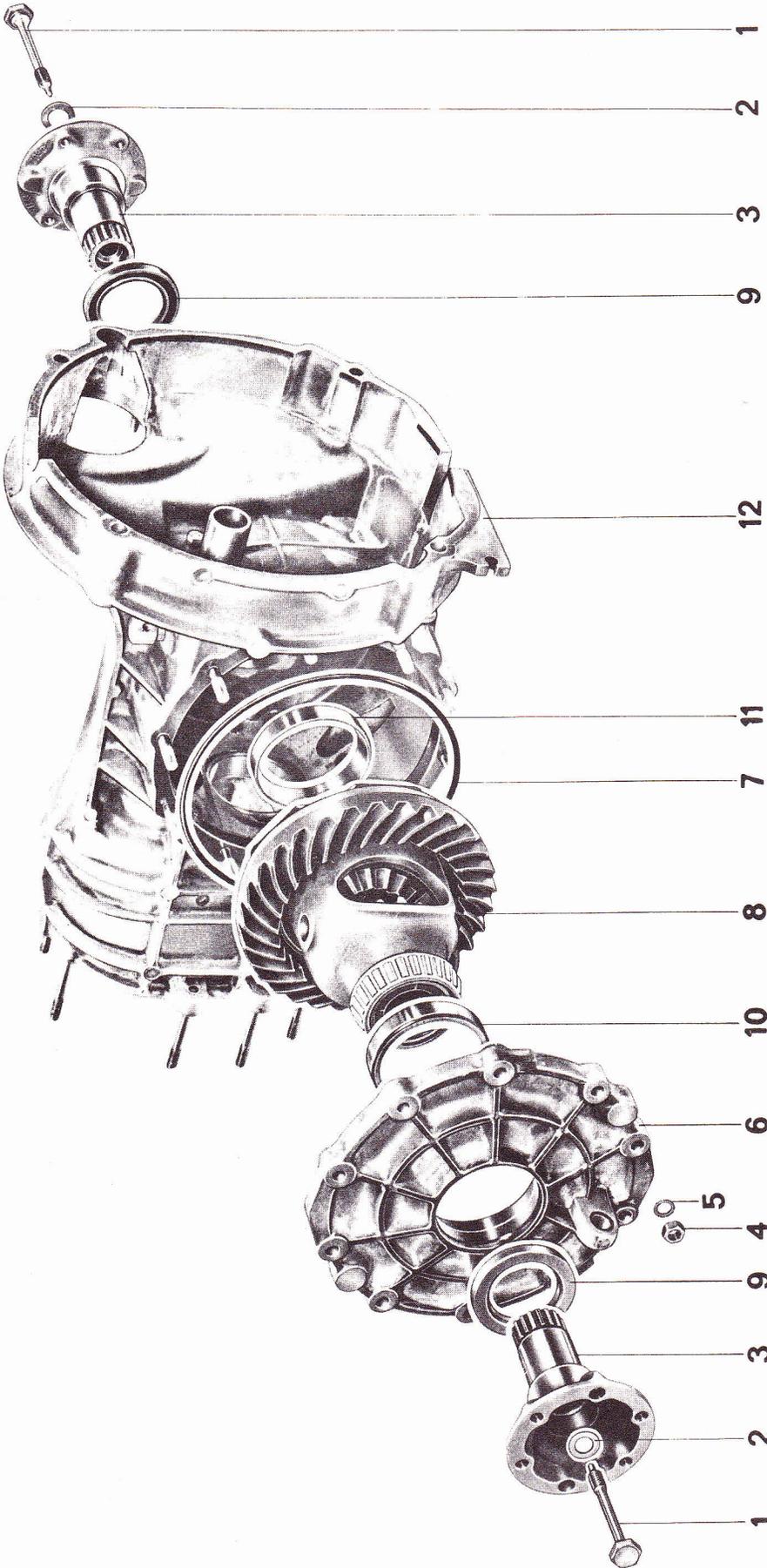
*Removing flange with puller*



© Volkswagen

*Exploded view of differential*

- |                               |                           |
|-------------------------------|---------------------------|
| 1 - Shaft                     | 7 - Spacer washer         |
| 2 - Small differential pinion | 8 - Lock plate            |
| 3 - Threaded lock piece       | 9 - Bolt                  |
| 4 - Large differential        | 10 - Ring gear            |
| 5 - Tapered roller bearing    | 11 - Differential housing |
| 6 - Shim                      |                           |



© Volkswagen

*Exploded view of differential housing*

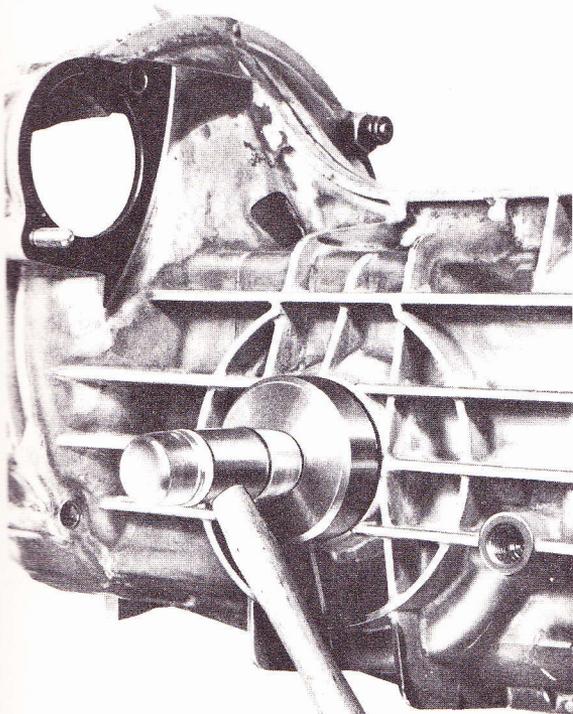
- 1 - Expansion bolt
- 2 - Washer
- 3 - Flange shaft
- 4 - Lock nut
- 5 - Washer
- 6 - Final drive cover
- 7 - O-ring
- 8 - Differential
- 9 - Seal
- 10 - Bearing outer race
- 11 - Bearing outer race
- 12 - Final drive housing

**Installation**

Check the tapered roller bearings and the differential for excessive wear or damage. Replace if necessary. When heating the transmission components, do not use an open flame. Heat the final drive cover to 248°F using either an electric hot plate or hot oil. A drop of water on the heated surface will sizzle at the correct temperature. Press, or drive, in the bearing outer race with an appropriate piece of tubing.

Install a seal in the cover using a thrust piece. Now, heat the housing to 298°F by placing the bearing side of the housing on an electric hot plate and install the bearing outer race. Use a press or drive it in with a hammer and an appropriate adaptor. Install a seal in the housing using a thrust piece. Make sure the seal is fully seated. Insert the differential. Then lightly lubricate a new O-ring for the cover and install it.

Now install the cover. Position the washers and tighten the self-locking hex. nuts to the specified torque. Insert the universal flanges, block them with a special tool, and tighten the expansion bolts to the correct torque.

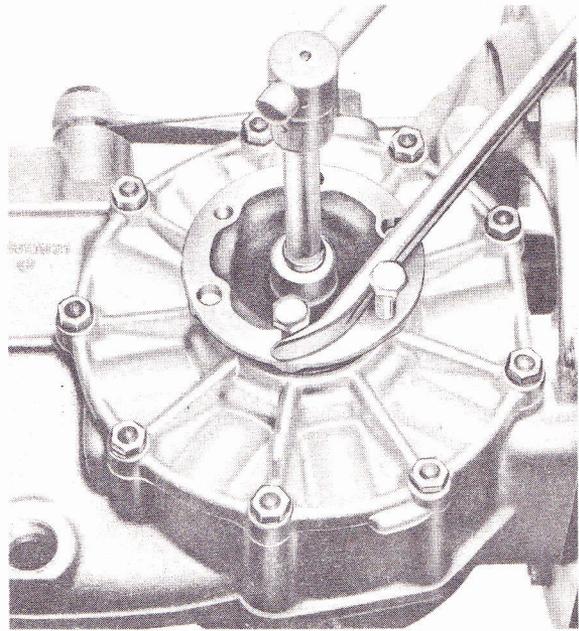


© Volkswagen

*Installing seal***DIFFERENTIAL (SPORTMATIC TRANSMISSION)****Removal**

Remove the servo motor. Unscrew the breather screw for the transmission housing. Unscrew the stretch bolt for the flange shaft and remove the flange. Remove the universal flange on the opposite end.

Loosen the hex. nuts on the lateral transmission cover and remove the cover. Now, remove the differential from the transmission housing. Knock the sealing ring and bearing outer race out of the transmission cover and the transmission housing, by means of a punch.



© Volkswagen

*Removing universal flange***Installation**

Check the tapered roller bearing and the differential. Replace if required. Heat the transmission cover to approx. 248°F and press the bearing outer ring into the cover using a pressure plate, a pressure pin, a pipe tool and a thrust piece. Press in the sealing ring with a pressure plate, a pressure pin and a thrust piece.

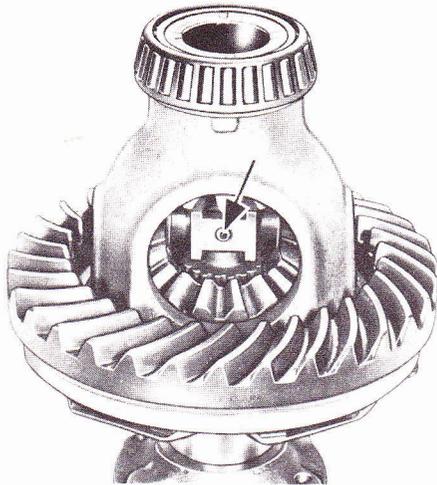
Heat the transmission housing to approx. 248°F and force the bearing outer race into the transmission housing using a thrust piece and a pipe tool. Next, force the sealing ring against the stop in the transmission housing using a thrust piece. Install the differential in the transmission housing. Insert a new paper seal for the lateral transmission cover, position the transmission cover, screw on the hex. nut with spring washers and tighten them to the specified torque.

Insert the flange shafts and tighten the stretch bolts to the specified torque. Screw the breather screw into the transmission housing. The bore in the hex. head should be at an angle of 45°, in the forward direction, in relation to the longitudinal axis of the transmission. Attach the servo motor.

**DIFFERENTIAL (with anchor piece)****Disassembly**

Drive out the pinion shaft roll pin. Knock out the

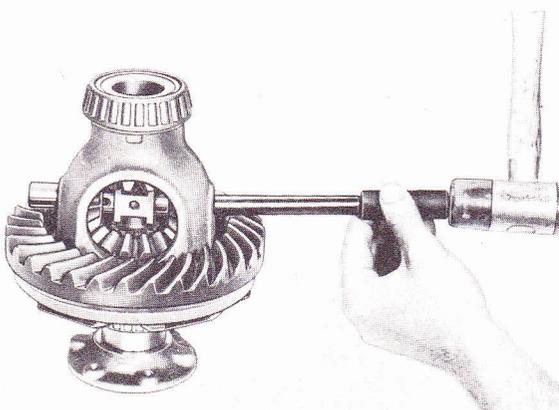
differential shaft with a mandrel and remove anchor piece. Turn the differential gears so that the small pinions can be taken out through the side openings. Take out the large pinions and threaded lock pieces.



© Volkswagen

*Pinion shaft roll clamping sleeve (roll pin)*

Remove both tapered roller bearings with a puller and thrust piece. Do not inter-change shims or spacer washers. Attach tags to prevent mixing up right side with left or vice versa. Remove the lock plates from the ring gear retaining bolts. Remove bolts and take off ring gear.

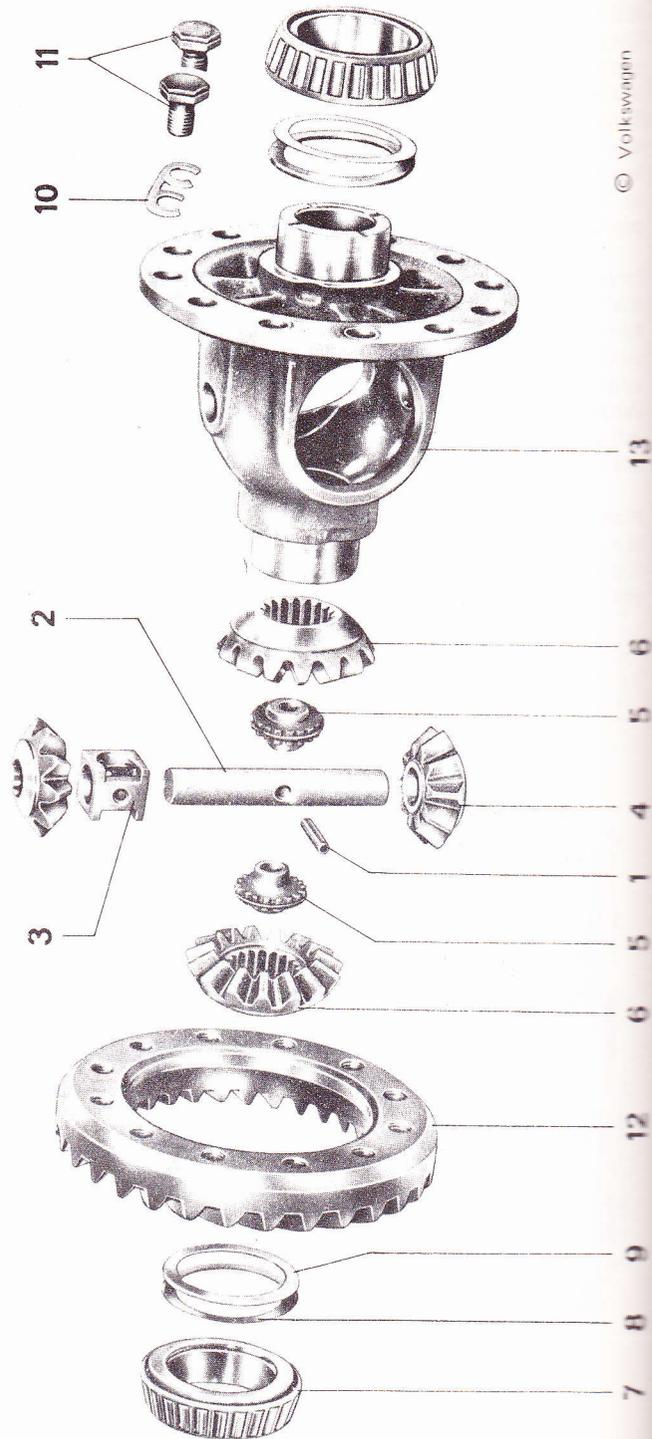


© Volkswagen

*Removing differential shaft*

**Assembly**

Check the differential housing, differential pinions, tapered roller bearings, and anchor piece for wear and damage. Replace if necessary.



© Volkswagen

*Exploded view differential with anchor piece*

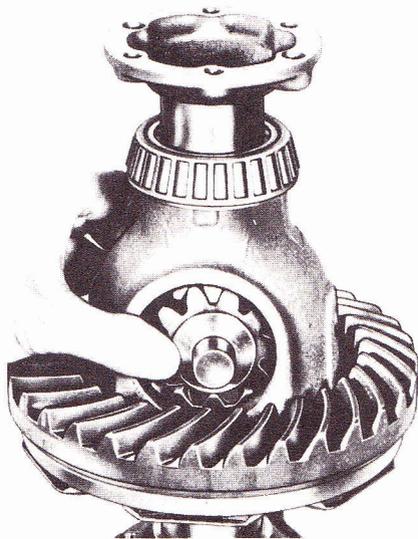
- |   |                           |
|---|---------------------------|
| 1 - Roll pin                                | 8 - Shim                  |
| 2 - Shaft                                   | 9 - Spacer washer         |
| 3 - Anchor piece                            | 10 - Lock plate           |
| 4 - Small differential pinion (spider gear) | 11 - Bolt                 |
| 5 - Threaded lock piece                     | 12 - Ring gear            |
| 6 - Large differential pinion (side gear)   | 13 - Differential housing |
| 7 - Tapered roller bearing                  |                           |

Place the ring gear on the flange of the differential housing and tighten bolts to correct torque. Slide the lock plates into grooves of bolts heads. Attach the plates to the bolt heads by closing the open ends with pliers. Secure bolts by bending the plates down on one side of the hex surface. Coat thrust surface of the differential pinions in the differential housing with Molykote or similar lubricant. Insert the large pinions (side gears) through the oval opening in the housing. Center the pinions by inserting the flange shafts.

Insert the small differential pinions (spiders) between the large differential pinions. Turn the small pinions until the bores align with those of the housing. Insert threaded lock pieces with snap rings into the large differential pinions. Slide the anchor piece between the threaded lock pieces. Position the locating hole of the differential pinion shaft so it aligns with the holes of the anchor piece.

Hold the anchor piece in place (to prevent binding) and drive in the differential pinion shaft. Make sure the bore of the shaft and anchor piece is aligned, then drive the roll pin in place.

Place marked or measured bearing shims and spacer washers on the differential housing. Install tapered roller bearing using thrust piece P 264. Re-adjust ring and pinion gears if necessary.



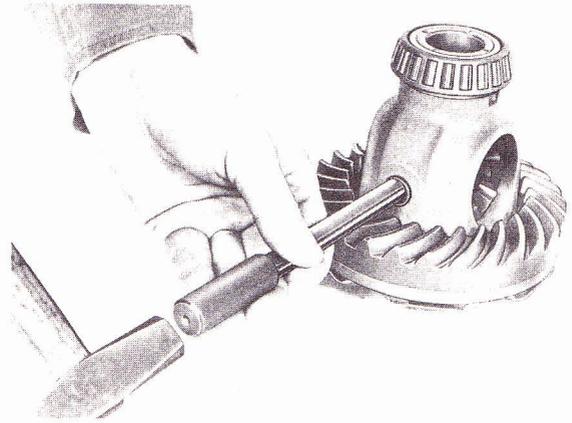
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*Installing large pinion gears*

## DIFFERENTIAL (without anchor piece)

### Disassembly

Knock out the differential shaft with a mandrel. Turn the pinions in, so that the small pinions can be removed through the openings in the differential housing. Remove the large pinions together with the threaded lock pieces. Remove both of the tapered roller bearings with a puller and a thrust piece.



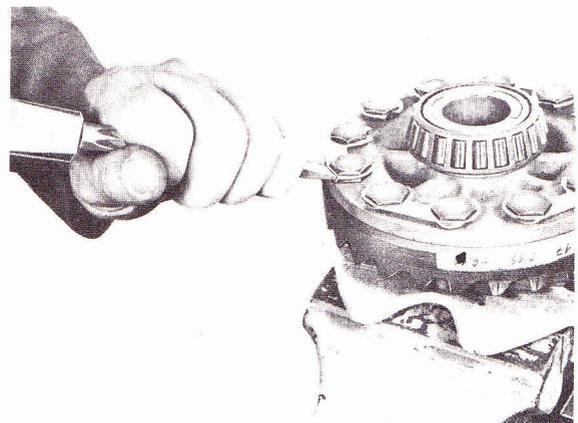
© Volkswagen

*Removing differential shaft*

Do not interchange the shims or the spacer washers. Attach tags to prevent mixing up the right side with the left or vice versa. Remove the lock washers on the bolts of the ring gear. Loosen the bolts and remove the ring gear.

### Assembly

Check the differential housing, the small and large differential pinions, and the tapered roller bearings for wear or damage. Replace them as necessary. Replace the ring gear on the flange of the differential housing and tighten the bolts to the correct torque. Slide the lock plates into the grooves of the bolt heads. Bend them together at the front with pliers. Knock down one side of the lock plate against the hex. surface

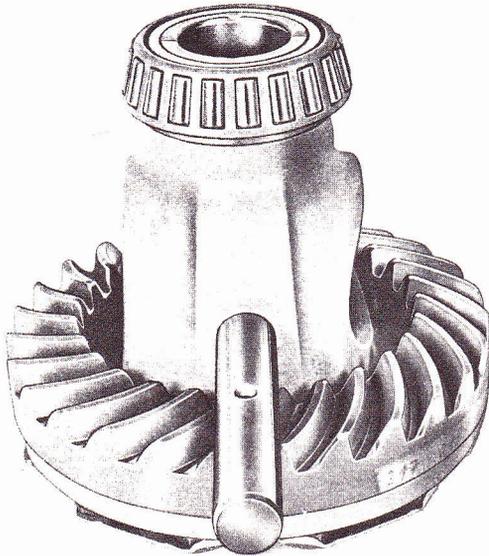


© Volkswagen

*Securing bolts*

Coat the thrust surfaces of the differential pinions in the differential housing with moly paste. Insert the differen-

tial pinions through the oval opening on the differential housing. Center the pinions by inserting flange shafts. Insert the small differential pinions between the large differential pinions and turn them until the bores of the gears are in alignment with the bores of the housing.



© Volkswagen

Correct position differential shaft locating hole

Insert the threaded lock piece, with snap rings, into the large differential pinion and install the differential shaft. The locating hole in the differential shaft must be concentric with the differential, in the axial direction. The tips of the expansion bolts extend into the locating holes and thereby retain the shaft. Place the identified, or measured shims, and the spacer washer for the tapered roller bearing on the differential housing. Now, install the tapered roller bearing using thrust piece P264.

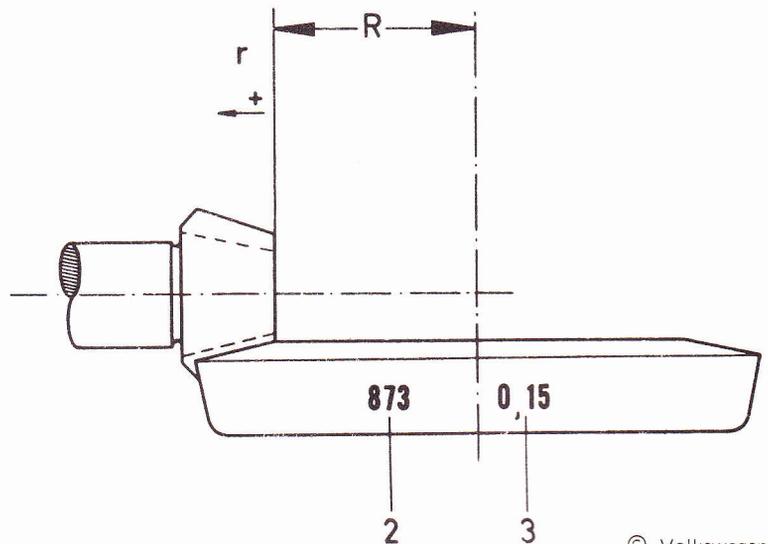
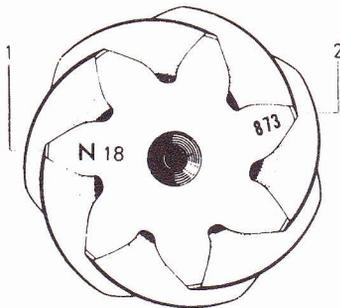
Adjust the pinion shaft and the ring gear if necessary.

**RING GEAR AND PINION**

**Adjusting**

Adjustment of the ring gear and pinion is very important for quiet operation of the rear axle assembly. For this reason the pinion shaft and ring gear are already matched as a pair during production. They are checked on testing machines for the correct contact pattern and low noise level in both directions of rotation. When the ring gear and pinion set is tested, set according to the design dimension "R". The dimension "R" is the distance from the face of the pinion to the ring gear center line. The pinion is then moved in or out of mesh until the quietest operation is determined.

The deviation from the design dimension is called "r" and is etched on the face of the pinion. While making this test, the ring gear backlash is kept within a tolerance of 0.0047-0.0070 in. The ring gear and the pinion shaft are designed in such a way that the deviation "r" must always be added to the design dimension "R".

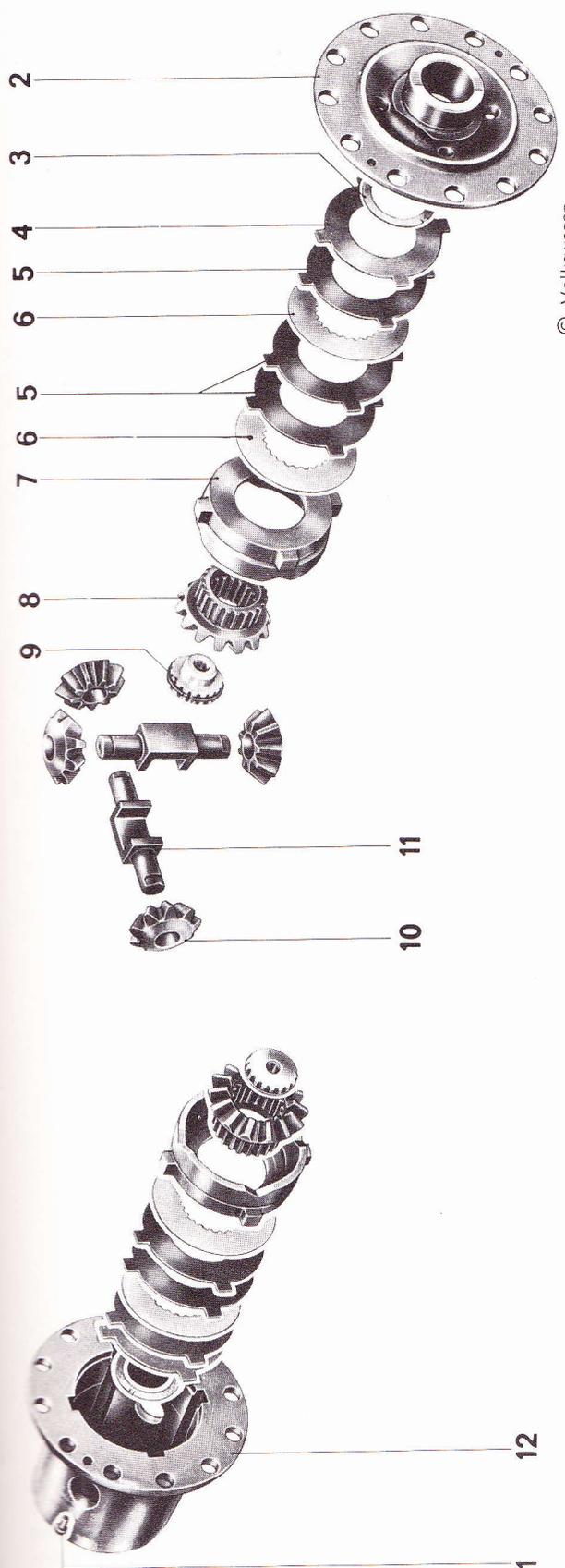


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Ring gear & pinion markings & tolerances

- 1 - Deviation r
- 2 - Mating number
- 3 - Backlash

- R - Blue print value (54.20 mm for Sportomatic transmission)
- r - Deviation from R indicated in mm (N 18)



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Earlier versions of the pinion assemblies had either a plus (+) or a minus (-) etched in front of the deviation "r", whereas on the newer pinion assemblies, the letter "N" precedes the deviation "r" on the pinion shaft.

The ring gear and pinion sets are also stamped with a matching set number and should always be replaced as a complete set.

**SHIMS FOR PINION SHAFT**

**Determining thickness**

By adding the design dimension "R" and the deviation "r" you obtain the adjusting dimension "E". The dimension "E" is the distance from the ring gear center line to the face of the pinion at which the ring and pinion set has been found to operate best.

If the pinion shaft were installed without the shims you would find a "basic distance", from the face of the pinion to the ring gear center line, of 64.70 mm. To find the shim thickness, subtract the adjusting dimension "E" from the "basic distance". The shims are available in 0.25 mm, 0.30 mm and 0.40 mm thicknesses. Therefore, the correct adjustment for this example requires the following shims: 2 each 0.40 mm, 1 each 0.30, 1 each 0.25 mm. The values are always rounded off to the next 0.05 mm.

**PINION SHAFT**

**Adjusting**

Insert the assembled intermediate plate with the gear assembly and shift rods into the housing. Do not use a gasket between the intermediate plate and the housing. Install the four spacer bushings and nuts and tighten them in a crisscross pattern. Tighten the expansion bolt of the differential pinion shaft to the correct torque before making your measurements.

Place a mandrel on the adjusting piece. Insert a dial indicator and adjust it to 1 mm preload. Determine the dimension of the mandrel and the adjusting piece. These dimensions are marked on the sides of the tools. By adding these two dimensions, the "actual adjusting dimension" is obtained.

Install the proper mandrel with the side bearings in the transaxle housing. Make sure the mandrel is under approx. 0.1 mm axial preload. The mandrel must not have any axial play when taking measurements. Axial play can be eliminated by inserting shims.

- 1 - Fillister head bolt
- 2 - Differential housing cover
- 3 - Thrust washer
- 4 - Friction plate (waved)
- 5 - Friction plate
- 6 - Friction disc (molybdenum coated)
- 7 - Thrust ring
- 8 - Side gear (large pinion)
- 9 - Threaded lock piece with snap ring
- 10 - Spider gear (small pinion)
- 11 - Differential pinion shaft
- 12 - Differential housing

Exploded view of limited slip differential

Watch the dial indicator through the hole in the mandrel. Bring the sensor of the dial indicator into contact with the end face of the pinion. A notch on the end of the mandrel shows the location of the dial indicator sensor. Turn the pinion slowly until the dial indicator shows the highest reading.

If the pointer deflects to the right, the distance is smaller than the "actual adjusting dimension" (63.53 mm). Therefore, subtract the dial indicator reading from the "actual adjusting dimension" to determine the distance from the ring gear center to the face of the pinion.

To determine the thickness of the paper gasket between the intermediate plate and the housing, subtract the distance from the face of the pinion to the ring gear center (63.27 mm) from the adjusting dimension "E" (63.38 mm - obtained by adding "R" + "r").

If the pointer deflects to the left, the distance from the ring gear center to the face of the pinion is larger than the "actual adjusting dimension" (63.53 mm). Therefore, add the dial indicator reading to the "actual adjusting dimension" to determine the distance from the face of the pinion to the ring gear center.

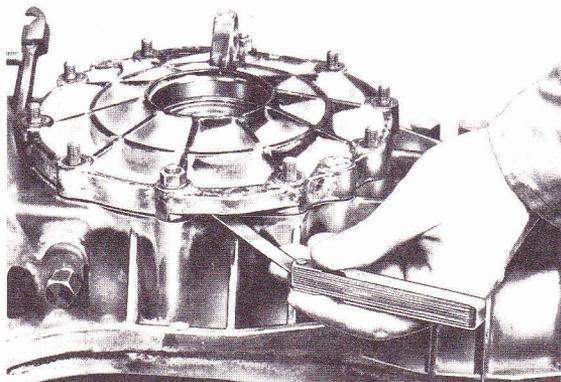
Gaskets between the housing and the intermediate plate are available in thicknesses of 0.1 mm, 0.15 mm, and 0.2 mm. The total thickness of gaskets must not exceed 0.50 mm. After inserting the gaskets, check the adjusting dimension "E" once again. The tolerance is  $\pm 0.03$  mm. No contact pattern check is required.

If the gasket thickness is not enough to obtain the correct adjusting dimension, the pinion shaft must be disassembled and the pinion shaft adjusting shims changed accordingly.

**SPACERS FOR RING GEAR ADJUSTMENT**

**Determining thickness**

Make sure that the tapered roller bearing outer races are fully seated in the housing and side cover. Install a 3.5 mm spacer S1 on the ring gear side, beneath the side bearing. Install a 3.0 mm spacer S2 on the opposite side, beneath the other side bearing.



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*Checking for required spaces*

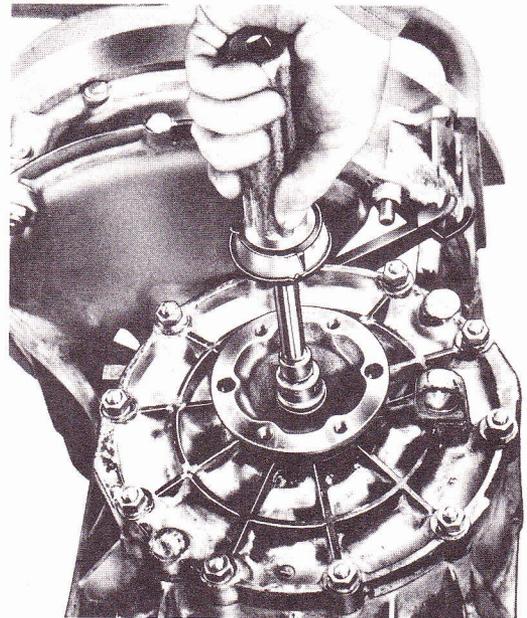
The differential can be removed or installed only when the transmission gears are removed. Insert the differential, with the tapered roller bearings, into the housing and install the gasket and the side cover (without an oil seal). Lightly tighten the side cover using two nuts that are opposite each other. This operation preloads the roller bearings. Check the gap between the cover and the gasket with a feeler gauge. The nominal value for the side bearing preload is approx. 0.15 mm.

If the nominal value of 0.15 mm is not attained, replace the S1 spacer on the ring gear side, with an appropriate spacer.

Install the rest of the nuts (with lock washers) on the side cover. Tighten the nuts to the correct torque before making any further measurements. Place the disc of the special flange tool on the axle flange and insert it. Slightly tighten the expansion bolt.

When measuring the differential drag, the pinion shaft must be disengaged and the axle flange oil seal must be removed from the side cover to prevent additional drag. Measure the drag of the assembled differential with a torque wrench. The following values must be obtained to ensure the proper side bearing preload:

- 25-35 cmkp (22-30 in. lbs.) with SKF side bearings
- 40-65 cmkp (35-57 in. lbs.) with FAG side bearings



© Volkswagen

*Measuring differential gear drag*

If the differential drag is not within the specified tolerance, replace the spacer washer. Now remove the differential. Do not interchange the spacer washers after removal. Remove both the tapered roller bearings and the spacers. Measure the thickness of the two spacers with a micrometer. Add these measurements to obtain the total thickness of the spacers for the ring gear adjustment.

## RING GEAR BACKLASH

### Adjustment

The accurate backlash is marked on the ring gear. The backlash tolerance is 0.12 to 0.18 mm. Insert the differential with the tapered roller bearings and the correct spacers (S1 and S2) into the housing. Install the assembled transmission intermediate plate with the gears, shift rods and the predetermined gaskets. Place the spacer bushings on the four opposing studs. Tighten the intermediate plate in a crisscross pattern.

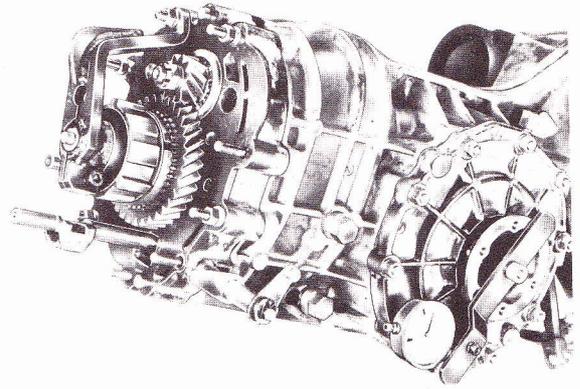
Install the side cover with an O-ring. Apply a light coat of oil to the O-ring. Tighten the differential pinion shaft expansion bolt before tightening the side cover to the correct torque. When tightening the side cover, make sure the ring and pinion does not bind. There should always be some backlash.

Tighten the side cover to the correct torque. Block the differential pinion shaft with a holding fixture at the expansion bolt. Place the disc of the special flange tool on the axle flange. Insert the axle flange. Attach a dial indicator to the bracket. Fasten the bracket to the flange surface using a M 10 x 130 bolt.

Attach a sensor to the dial indicator. Set the dial indicator so that it contacts the bracket for the clutch cable with a slight preload. Move the dial indicator bracket back and forth. Read the backlash on the dial indicator.

Turn the ring gear approximately  $90^\circ$  and measure the backlash again. The readings should not vary by more than 0.05 mm.

The spacers S1 and S2 can be exchanged by using special tools, to obtain the permissible backlash. Be sure that the total thickness of the spacers is not varied. Check the axle shaft oil seals for damage and replace them if necessary.



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*Securing differential securing shaft*

In order to check backlash correctly, the spacer S1 should be 0.1 mm thinner than one half of the sum of spacers S1 and S2. The spacer S2 should be 0.1 mm thicker than one half of the sum of spacers S1 and S2.

Spacers are available in increments of 0.10 mm from 2.5 to 3.7 mm. A shim, 0.25 mm thick, permits adjustments to the nearest 0.05 mm. The rounded off spacer thickness should not differ from the calculated spacer thickness.

Before measuring, remove any burrs that may be on the edges of the spacers. Measure the thickness of the two spacers with a micrometer at four different points; the thickness tolerance is 0.02 mm.

## BRAKES 10

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**TANDEM MASTER BRAKE CYLINDER****Removal**

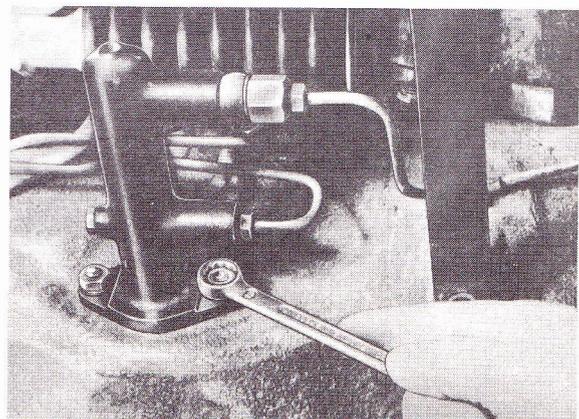
Bleed the brake fluid from both chambers of the brake fluid container. Remember that brake fluid is toxic. The fluid should not come into contact with the paintwork, because it contains acid. Remove the floor lining (front left) and pull the accelerator pedal, toward the rear, out of the push rod.

Next, loosen the hex. bolts for the floor board attachment and remove the floor board. Now, remove the underfloor protection from the front axle, and unscrew the brake lines on the tandem master brake cylinder. Loosen the hex. nuts on the flange of the tandem master brake cylinder. Pull the connecting lines from the brake fluid reservoir and remove the tandem master brake cylinder.

**Installation**

Be sure to position the piston rod correctly when installing the tandem master brake cylinder. Moisten the rubber sleeves with some brake fluid to facilitate the installation of the connecting lines from the brake fluid reservoir to the tandem master brake cylinder.

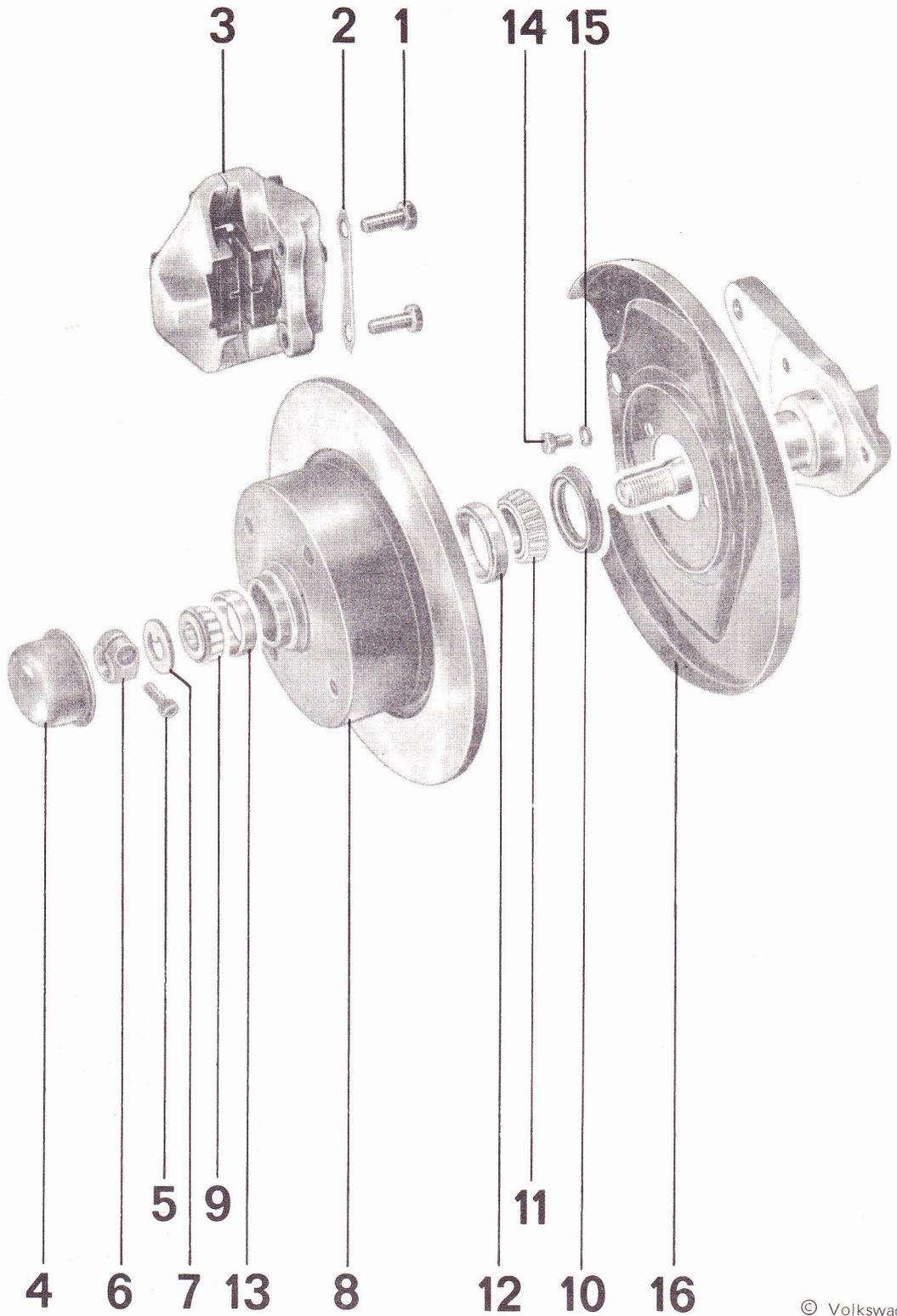
Also seal the master brake cylinder flange with a sealing gummy to prevent water from entering the interior of the



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*Removing master cylinder*

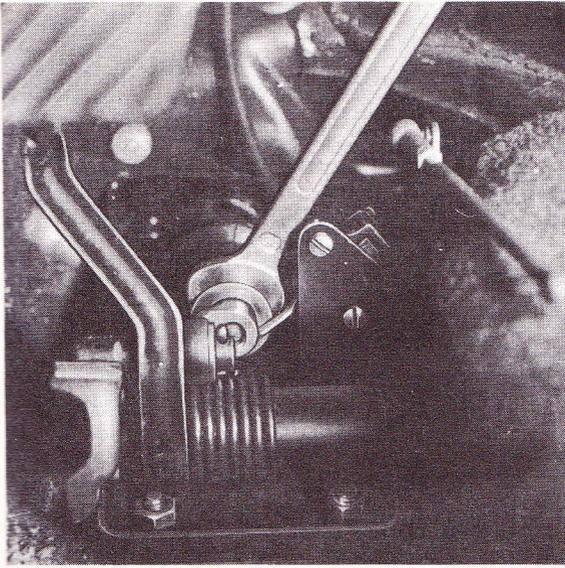
vehicle. Tighten the hex. nuts for the tandem master brake cylinder to the specified torque. Check to see that the protective cap on the piston rod is seated correctly.



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*Exploded view of front wheel assembly*

- |                              |                      |                             |                         |
|------------------------------|----------------------|-----------------------------|-------------------------|
| 1 - Hex. bolt                | 5 - Cheesehead screw | 9 - Tapered roller bearing  | 13 - Bearing outer race |
| 2 - Locking plate (only 914) | 6 - Clamping nut     | 10 - Sealing ring           | 14 - Hex. bolt          |
| 3 - Caliper                  | 7 - Nose washer      | 11 - Tapered roller bearing | 15 - Spring ring        |
| 4 - Hub cap                  | 8 - Brake disc       | 12 - Bearing outer race     | 16 - Guard plate        |



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### *Adjusting piston rod end play*

Adjust for approx. 0.039 in. clearance between the piston rod and the piston in the tandem master brake cylinder. If required, loosen the lock nut on the piston rod and turn the piston rod as required. Bleed the brake system, check the brake lights and the warning device for the dual circuit brake.

## **BRAKE FLUID RESERVOIR**

### **Removal**

Fold back the front end cover and pull the overflow hose from the brake fluid reservoir. Extract the brake fluid from the reservoir. Remove the screws for the holding strap and remove the strap from the brake fluid reservoir. Pull the intermediate hoses from the brake fluid container, making sure that the connecting lines to the tandem master brake cylinder are not pulled in an upward direction.

### **Installation**

During installation, moisten the connecting sockets of the brake fluid reservoir with some brake fluid to facilitate the attachment of the intermediate hoses.

## **BRAKE LIGHT SWITCH**

### **Removal**

Take out the floor covering (front left) and remove the accelerator pedal out of the push rod toward the rear. Loosen the hex. bolts for the floor board attachment and remove the floor board. Loosen the fastening screws for the brake light switch. Pull off the cable connections and remove the switch.

### **Installation**

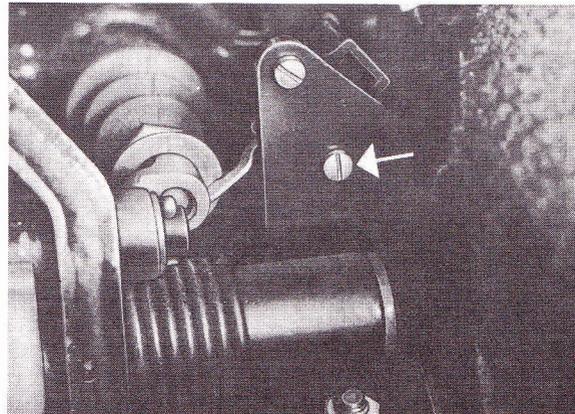
To install the brake light switch, proceed in the reverse order of removal. Adjust the switch, if necessary.

### **Adjustment**

Take out the floor cover (front left) and remove the accelerator pedal of the push rod toward the rear. Loosen

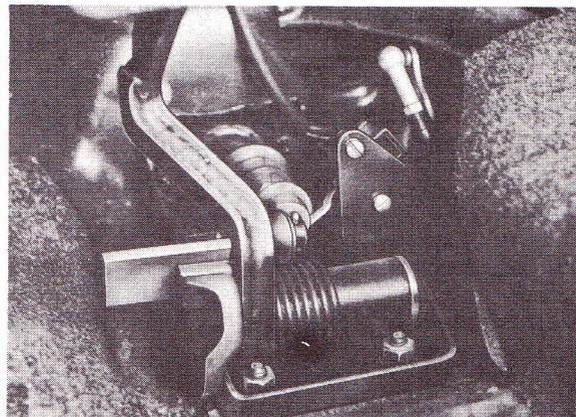
the hex. screws for the floor board attachment and remove the floor board. Clamp a piece of sheet metal, 0.158 in. thick, between the brake pedal and the stop for the brake pedal.

Loosen the lock nut for the adjusting screw on the brake light switch and turn it so that the brake light will go on. Tighten the lock nut and check the brake light switch again to insure that it is working properly.



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### *Brake light switch screw*



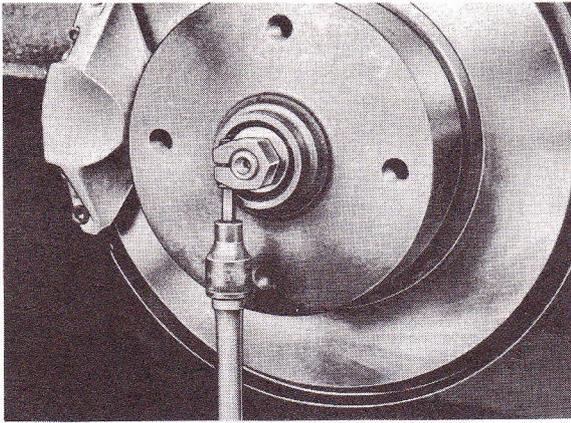
© Volkswagen

### *Adjusting brake light switch*

## **FRONT BRAKE DISC**

### **Removal**

Unscrew the brake line on the ring fitting of the caliper. Depress the brake pedal and the pedal arrester and lock it in this position. This prevents the brake fluid from flowing out of the tank. Remove the caliper at ambient temperature. Remove the cap for the front wheel hub, alternately, with the proper tool. Loosen the socket screw for the clamping nut. Unscrew the clamping nut and remove the brake disc together with the wheel bearing.



© Volkswagen

*Loosening clamping nut***Installation**

Check to see that the wheel bearing is properly adjusted. Tighten the clamping nut slightly while turning the wheel, or hub, so that the taper rollers can rest firmly against the bearing races. Loosen the clamping nut until the nose washer can barely be pushed along from the side with a screw driver and no noticeable bearing play is indicated during axial movements of the wheel hub. Do not support the screw driver against the hub.

Tighten the socket screw of the clamping nut to the specified torque. Check the adjustment once again by moving the nose washer and without turning the clamping nut. Correct it if required. The slot width of the clamping nut should be 0.098–0.112 in., so that perfect clamping is obtained even under unfavorable tolerance overlaps. Tighten the caliper bolt to the specified torque using new lock washers. Bleed the brake lines.

**LATERAL WOBBLE****Checking**

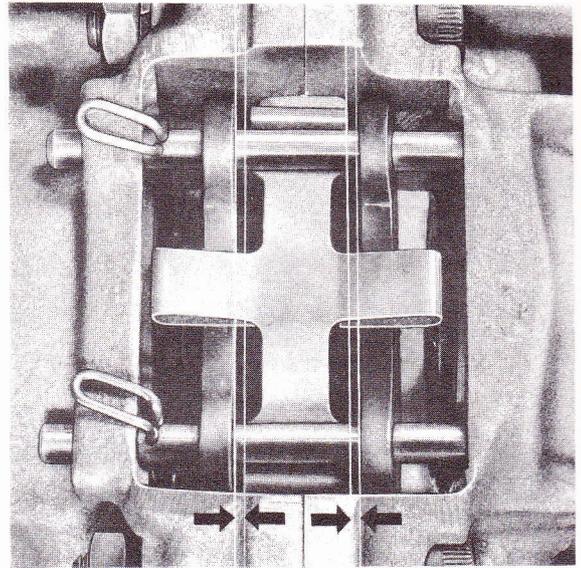
Remove the brake pads and adjust the front wheel bearing play to specifications. Fasten the measuring tool, with the holding pins. Align the tool and tighten it with a wing screw. Insert a dial gauge and tighten it with a fastening screw.

Slide a feeler pin on the dial gauge and attach it under a slight tension. The feeler tip should touch 0.394–0.591 in. inside the brake disc OD. In borderline cases, the lateral wobble must be measured on both sides of disc.

The max. permissible lateral wobble is 0.008 in. Brake discs with a higher lateral wobble must be replaced. Install the brake pads.

**BRAKE PADS****Checking**

Brake pads must be replaced when the remaining thickness is 0.078 in. Always change the four brake pads of one axle simultaneously. Replacing only one or two pads of one wheel is not recommended. In addition, replace the spreading springs of both calipers when changing the brake pads.



© Volkswagen

*Brake pads minimum thickness 0.078  
between arrowheads***VENTING CLEARANCE****Checking**

If the pedal travel is too long, though the brake is correctly adjusted and bled, the fault is often due to excessive venting clearance of the front brake linings. The venting clearance is measured with a feeler gauge, placed between the brake pad and the brake disc, and should be approx. 0.002–0.008 in. A venting play in excess of 0.008 in. is generally the result of the stationary rubber ring "glueing" to the piston. This glueing may occur after long parking periods.

**FRONT BRAKE PADS****Removal**

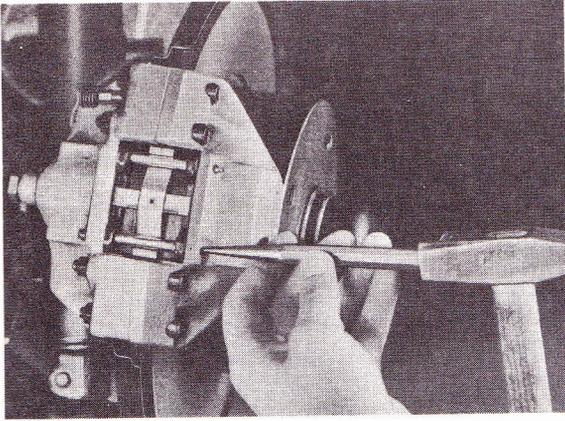
Knock out the holding pins for the brake pads with a punch. Pull the brake pads out of the caliper with a pulling hook. Do not push the holding bolt of the pulling hook on the brake pad too far inwards, since the hook might be caught on the piston anti-rotation lock and the brake lining can no longer be pulled out.

**Adjustment**

Remove one brake pad and slide a wooden board at least 0.236 in. thick, between piston and disc. Step energetically on the brake pedal in order to release the piston and make it run smoothly. Push the piston back with piston setting pliers.

Repeat the operations several times and then install the brake lining. Proceed in the same manner for the other pistons. If this method is unsuccessful, remove the caliper and recondition it. Also replace the stationary rubber ring.

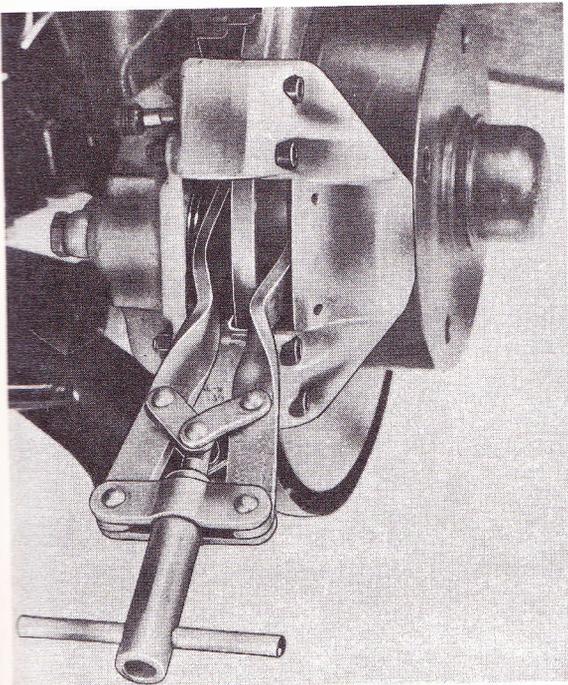
When the piston is set back, brake fluid will be forced out of the caliper into the filling tank, resulting in an overflow; for this reason, remove some brake fluid prior to starting the work and fill it up again when finished.



© Volkswagen

*Removing holding pins***Installation**

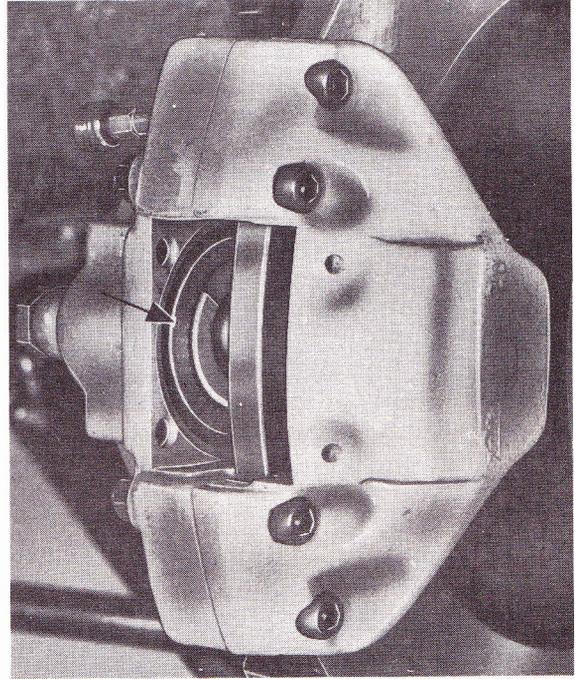
Replace pads which are oil soaked, have deep cracks or have separated from the lining plate. Push both pistons back to their basic position with a piston setting tool. Check reservoir during this operation as brake fluid behind pistons will be forced back into reservoir. This may cause it to overflow, out of reservoir. Draw some fluid out, as needed, or wrap reservoir with sponge or thick dry cloth to absorb overflow. Clean the seat and the guide surfaces of the brake linings in caliper, which requires the removal of the piston anti-rotation locks.



© Volkswagen

*Pushing back piston with special tool*

For cleaning, use only alcohol. Sharp-edged tools are not to be used. Blow out the caliper with compressed air. Check the protective cap for damage. Hardened, brittle or torn protective caps must be replaced. Correct the position of the piston with piston rotating pliers, if required.



© Volkswagen

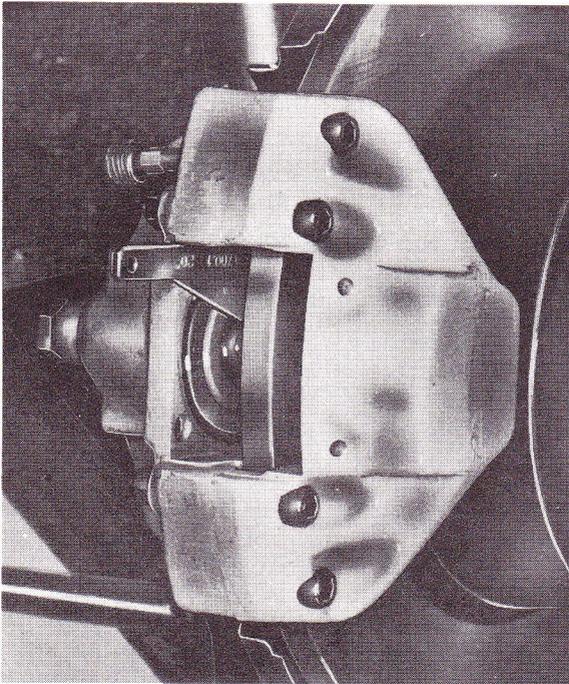
*Protective cap*

Accurately check the position of the piston with a piston gauge. The gauge should always be held against the upper guide surface in caliper, that is, opposite to the direction of rotation of the brake disc when driving forward. Install the piston anti-rotation lock in the correct position. The ring-shaped portion of the anti-rotation lock should be pushed into piston head. In addition, the anti-rotation lock should be under the piston recess.

A perfect seat of the piston anti-rotation lock also guarantees the specified 20° position of the piston. Corroded or damaged piston anti-rotation locks must be replaced. Check the brake disc for wear. Insert the brake pad into the caliper.

Install used pads in same position and side from which they were removed. Insert a new spreading spring for the brake pads in the correct position. Install holding pins for the brake pads in the caliper.

Never knock a holding pin in with a punch that is smaller in diameter than the pin, since this may cause the front collar to be cut off by the clamping sleeve. The holding pins should always be knocked in with a hammer only. Corroded or damaged holding pins must be replaced.



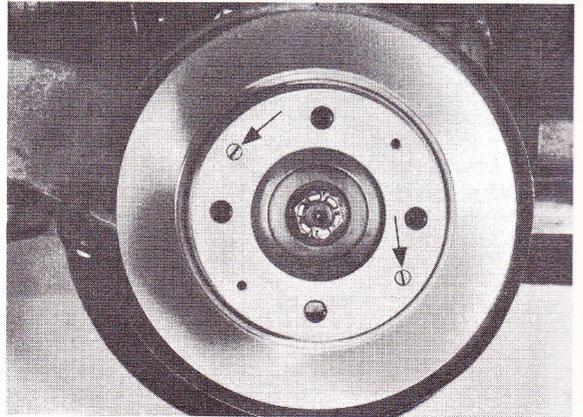
© Volkswagen

*Correct position of piston*

**REAR BRAKE DISC**

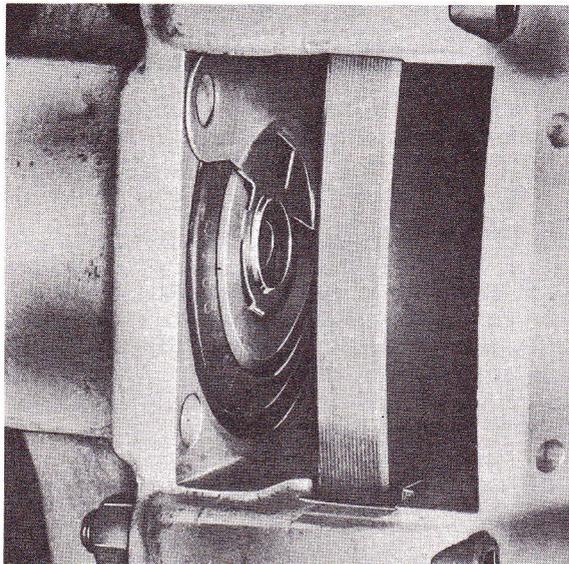
**Removal**

Depress the brake pedal (with arrester) and lock them in this position. This prevents the loss of brake fluid. Unscrew the brake line on the brake hose of the rear axle control arm. Loosen the countersunk screws on the brake disc and remove the disc.



© Volkswagen

*Rear disc attachment screws*

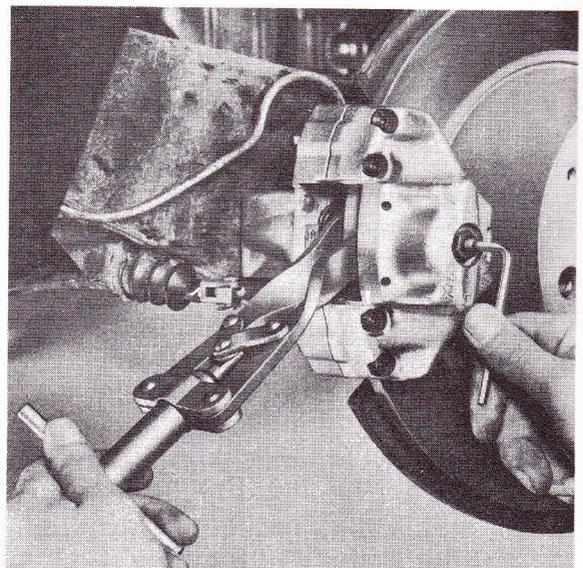


© Volkswagen

*Piston with anti-rotation lock inserted*

**Installation**

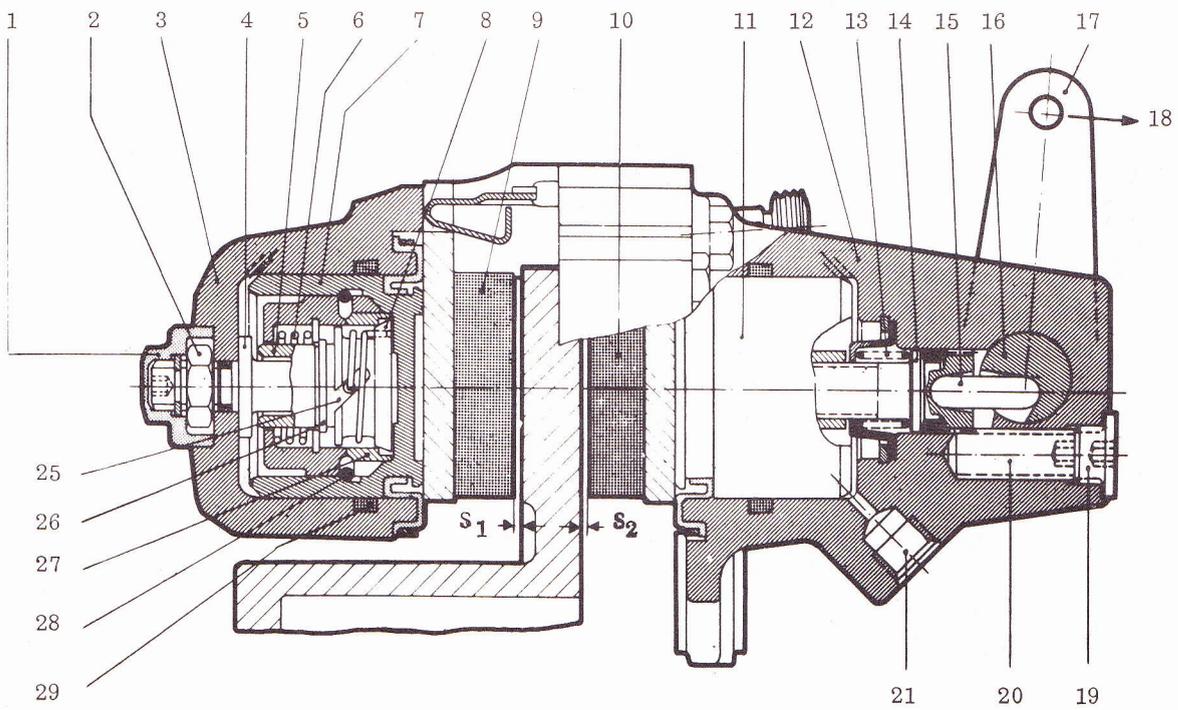
Clean all parts and replace those that are worn. Tighten the caliper to the specified torque, and bleed the brake lines.



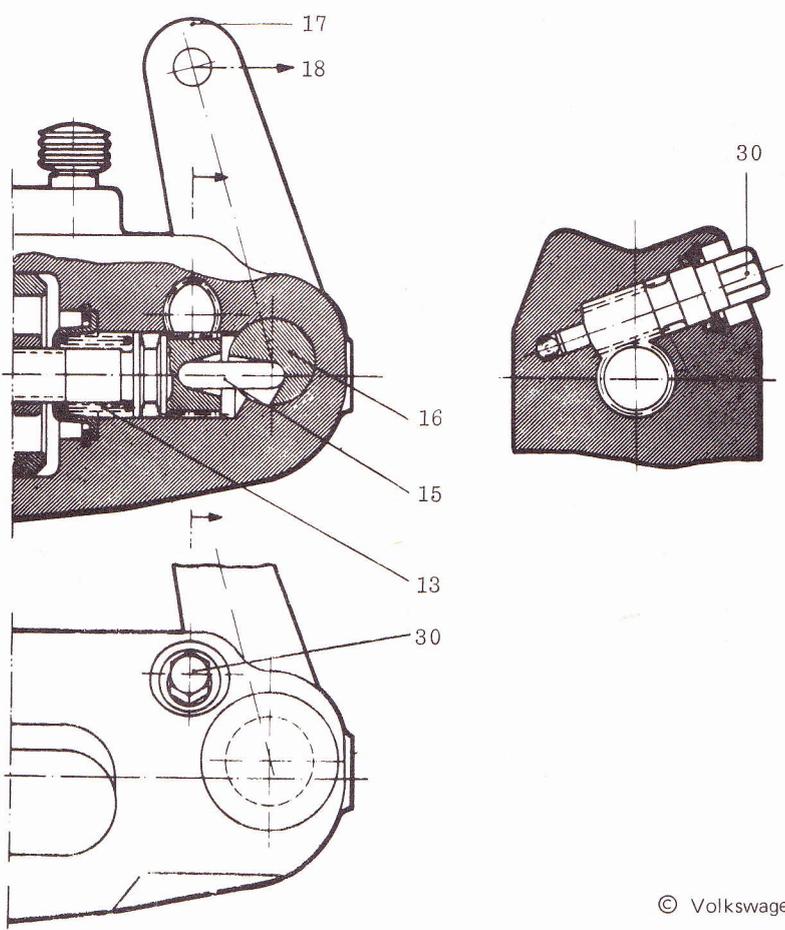
© Volkswagen

*Returning pistons to end of stroke*

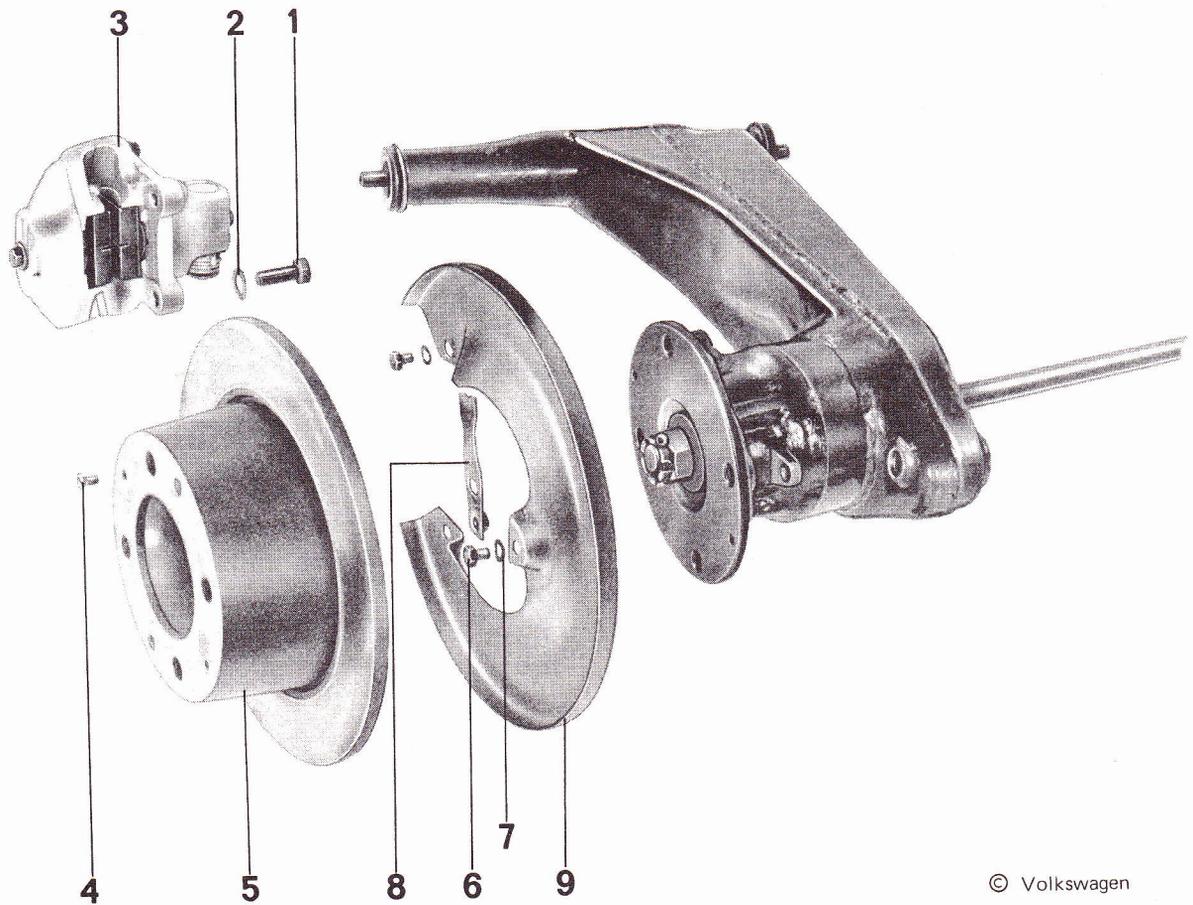
Step several times, energetically, on the brake pedal with the vehicle stopped, so that the pistons and the brake linings will take their proper position for correct operation. Then check the level of the brake fluid in the fluid container. Replenish the fluid if required.



- 1 - Closing screw - cover end
- 2 - Counter nut
- 3 - Housing - cover end
- 4 - Spindle
- 5 - Threaded sleeve
- 6 - Compression spring
- 7 - Piston
- 8 - Cone
- 9 - Friction pads
- 10 - Friction pads
- 11 - Piston
- 12 - Housing - flange end
- 13 - Spring
- 14 - Spindle
- 15 - Thrust piece
- 16 - Shaft
- 17 - Actuating lever
- 18 - Brake cable
- 19 - Closing screw - flange end
- 20 - Resetting shaft
- 21 - Connection
- 25 - Inclined slot
- 26 - Carrier
- 27 - Housing
- 28 - Spring ring (safety connection)
- 29 - Sealing ring
- 30 - Hexagon



Rear brake assembly



© Volkswagen

*Exploded view of rear wheel assembly*

- |                       |                   |
|-----------------------|-------------------|
| 1 - Hex. bolt         | 6 - Hex. bolt     |
| 2 - Spring washer     | 7 - Spring washer |
| 3 - Caliper           | 8 - Holding plate |
| 4 - Countersunk screw | 9 - Cover plate   |
| 5 - Brake disc        |                   |

**LATERAL WOBBLE****Inspection**

Attach a measuring device, as described under "Inspection of Front Axle Brake Disc Lateral Wobble". Pull the brake disc toward the hub by means of wheel studs. To eliminate distortion of the disc, place flat steel washers under the wheel studs.

Tighten the wheel studs to the specified torque. The max. permissible lateral wobble is 0.008 in. Replace discs, if the lateral wobble is above this level.

**REAR BRAKE LININGS****Removal**

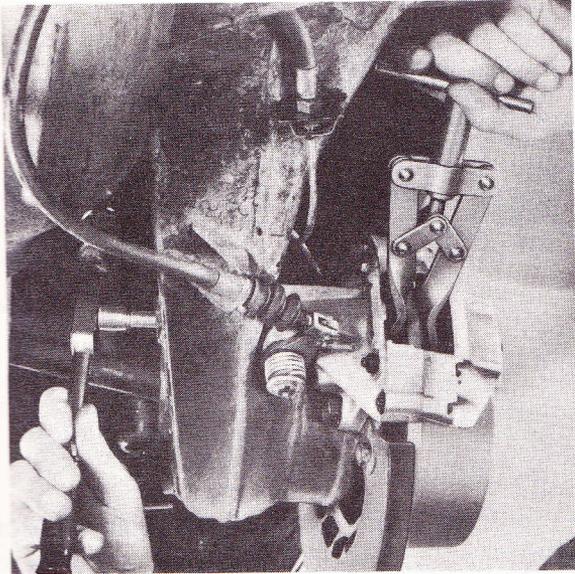
Pull out the locking eyes and knock out the holding pins of the brake pads with a punch (in the direction of the vehicle center). Pull the pads with a pulling hook out of the caliper.

**Installation**

Replace pads having large cracks, are oil soaked, as well as pads which have separated from the plate. Always place new pads against new plates. Place the piston resetting tool between the pistons and apply a light load. Remove the closing screw on the cover housing of the caliper.

Loosen the counter nut and set the piston back by turning the spindle clockwise, by means of a hex. pin spanner while maintaining the tension of the setting pliers. Remove the closing screw on the flange end of the caliper.

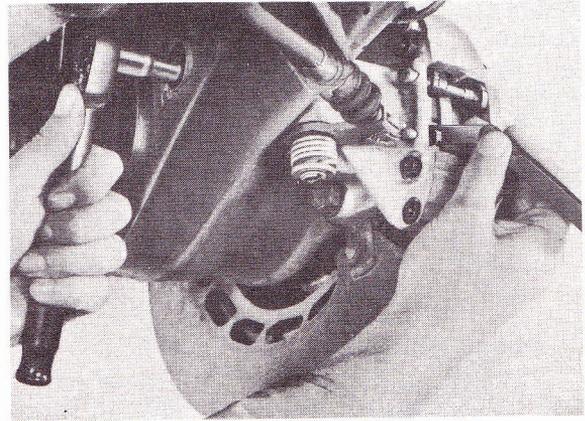
This requires a 3/8" extension with a 4 mm (5/32 in.) socket, which is introduced through the bore of the rear axle control arm. Set the piston back while maintaining the tension of the resetting pliers by rotating the setting shaft counterclockwise.



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*Removing closing screw*

cover housing of the caliper. Loosen the lock nut and adjust the venting play between the brake disc and the brake pad by means of a 0.008 in. feeler gauge by rotating the spindle with a wrench.



© Volkswagen

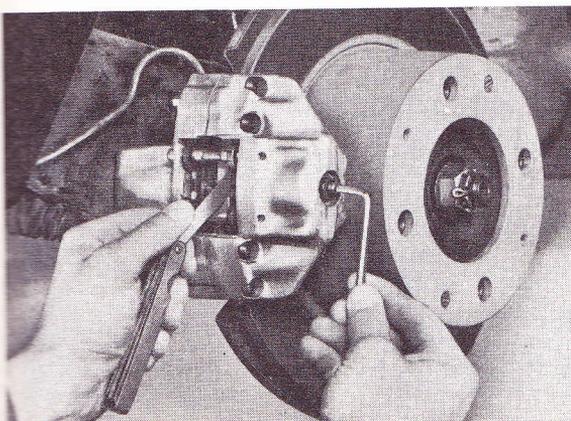
*Adjusting inside venting clearance*

Insert the brake linings into the caliper. Always install used linings in accordance with their markings on the housing half. Locate the brake linings with holding pins, without the spreading spring, and adjust the 0.008 in. venting clearance on both ends of the brake disc. Remove the holding pins and insert the disc again together with the spreading spring and secure.

**VENTING CLEARANCE**

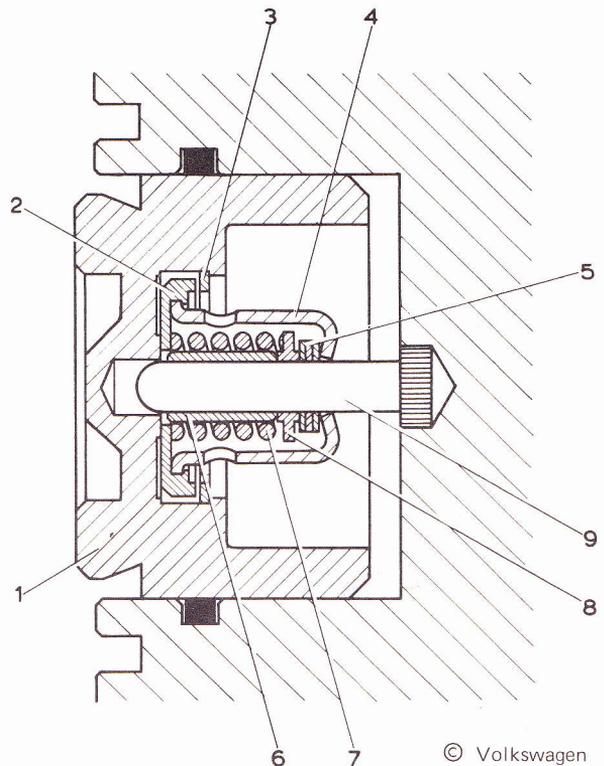
**Adjustment**

For a better adjustment of the venting clearance, remove the spreading spring and locate the brake pads with holding pins. In addition, the brake disc wobble should not exceed 0.008 in. Remove the closing screw on the



© Volkswagen

*Adjusting venting clearance*



© Volkswagen

*Adjuster and brake disc deflection compensator*

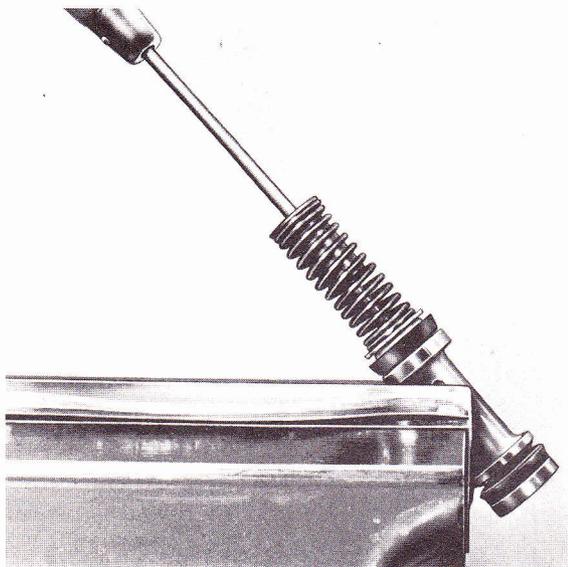
- 1 - Piston
- 2 - Stop washer
- 3 - Lock washer
- 4 - Spring housing
- 5 - Friction disc
- 6 - Spacing sleeve
- 7 - Compression spring
- 8 - Spacing washer
- 9 - Friction pin

Tighten the lock nut. Actuate the hand brake once and check the venting clearance. Adjust clearance, if required. Now, mount the closing screw. When new calipers are installed, the venting clearance also requires adjustment, since the calipers are supplied with a larger adjusting dimension due to the permitted adjusting limits. Do not actuate the caliper until the venting clearance has been set.

**TANDEM BRAKE MASTER CYLINDER**

**Disassembly**

Loosen the stop screw for the intermediate piston and blow the intermediate piston out of the housing with compressed air. Clamp the pressure piston lightly in a vise and loosen the pressure piston stop screw. Compress the pressure spring slightly so that the threads for the stop screw in the pressure piston are not damaged.



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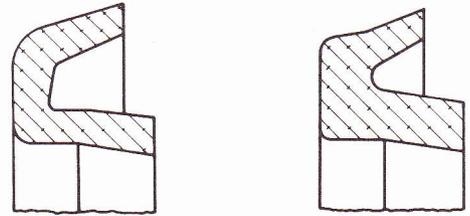
*Loosening pressure piston stop screw*

Loosen the brake warning light switch. Loosen the closing screw and remove the piston together with the compression spring by blowing them out of the housing with compressed air.

**Assembly**

Clean all parts with alcohol, and blow out particles with compressed air. Push the intermediate piston, with a non-metallic object, into the housing until the hole for the hex. stop screw is freed. Screw in the stop screw together with a new sealing ring.

Check the stop screw positioning. The stop screw should be in front of the intermediate piston and the intermediate piston should move up to the housing bottom. When changing the sleeves, position them correctly.



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*Section through sleeves*

Primary

Separating

**DUAL CIRCUIT BRAKE SYSTEM WARNING DEVICE Checking**

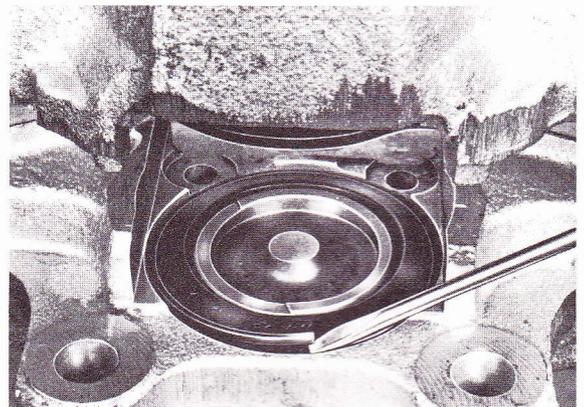
Check the warning device whenever the hydraulic brake system is being repaired. Turn on the ignition. The hand brake warning light should go on. Now, start the engine. Depress the brake pedal to the pressure point. A second mechanic can simulate the loss of one brake circuit by opening a bleeder on one of the wheel cylinders. The warning light should go on.

Close the bleeder and release the brake pedal. The light should go out. Repeat this operation on the second brake circuit. If no lamps are lighting up during one of the tests, check the warning system in the tandem brake master cylinder.

**BRAKE CALIPER**

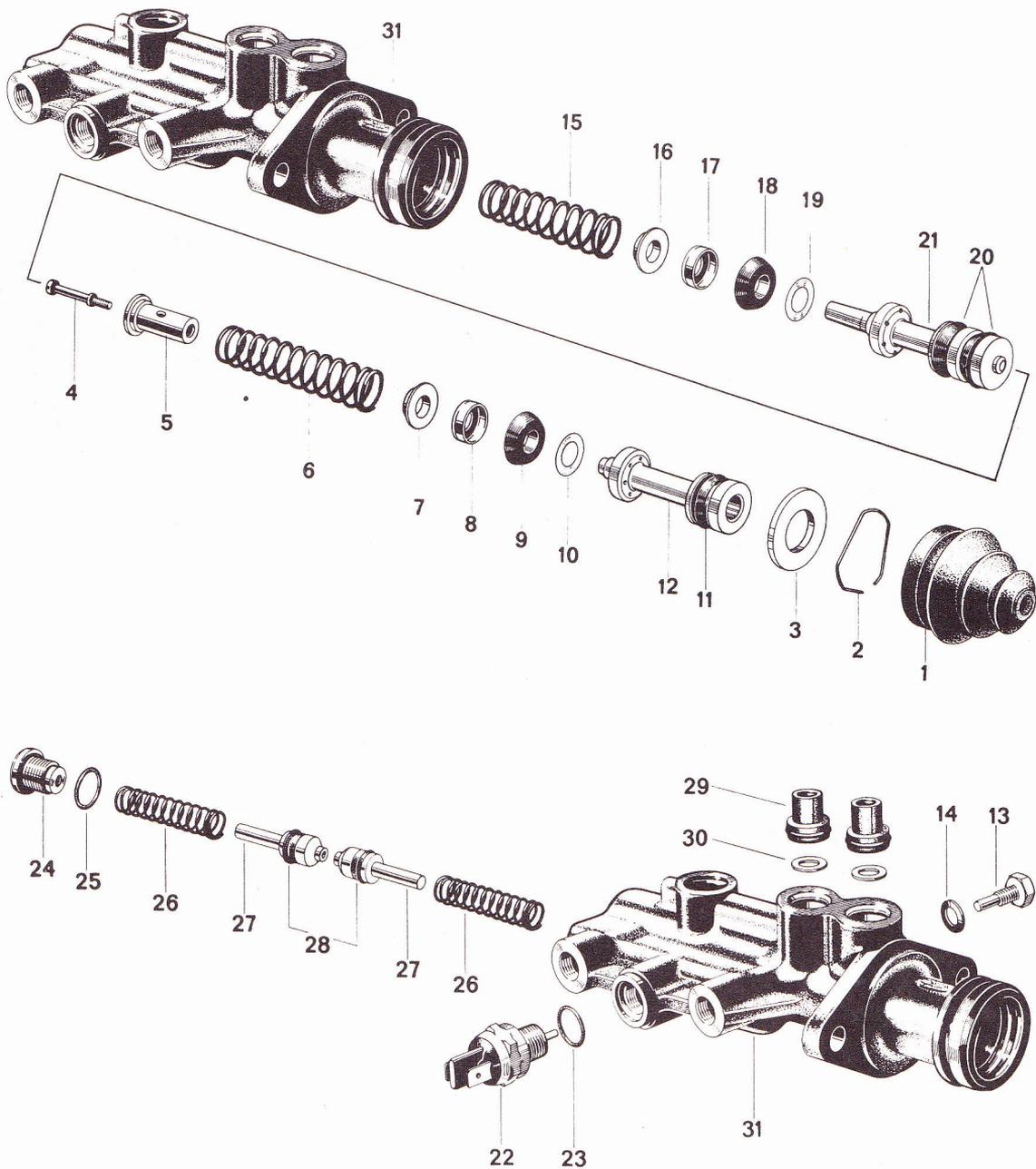
**Disassembly**

Remove the caliper from the vehicle. Loosen the bleeder valve and blow any brake fluid carefully out of caliper. Clamp the caliper with the flange into a vise. Use soft vise jaws. Remove the piston retaining plate, clamping ring and the protective cap.



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*Removing piston retaining plate*



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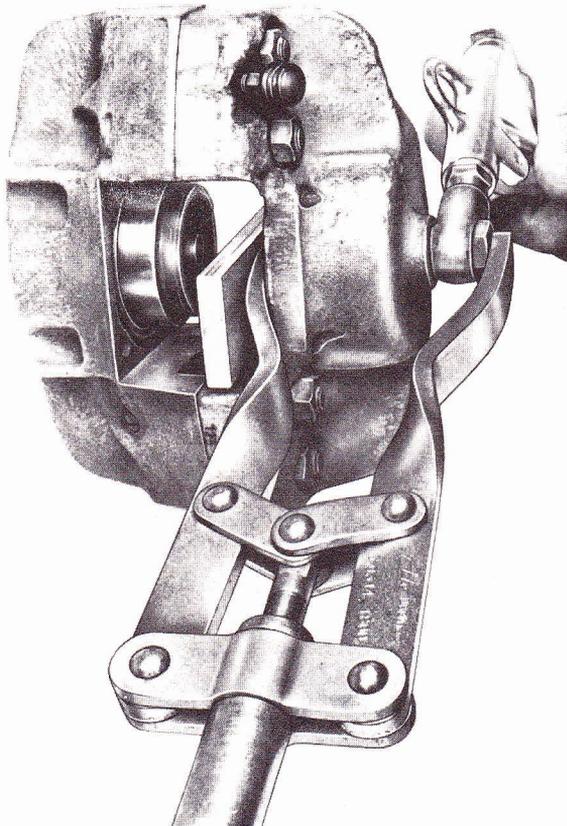
*Exploded view of master cylinder*

- 1 - Friction pad retaining pin
- 2 - Spreader spring
- 3 - Brake friction pad
- 4 - Piston retaining plate
- 5 - Clamp ring
- 6 - Seal
- 7 - Piston
- 8 - Rubber seal
- 9 - Dust cap
- 10 - Bleeder valve
- 11 - Hexagon nut

- 12 - Fillister head bolt
- 13 - Cover housing
- 14 - Seal
- 15 - Flange housing
- 16 - Brake disc
- 17 - Rubber seal
- 18 - Dust cap
- 19 - Filling disc
- 20 - Separating sleeve
- 21 - Intermediate piston

- 22 - Brake warning switch
- 23 - Round cord ring
- 24 - Screw
- 25 - Round cord ring
- 26 - Compression spring
- 27 - Piston
- 28 - Sleeve
- 29 - Tank plug
- 30 - Washer
- 31 - Tandem brake master cylinder housing

Push one piston out of the caliper with compressed air. Start with approximately 28 psi and increase, if necessary. Hold the piston in position with a piston setting fixture. In addition, a hardwood or rubber block about 0.197–0.394 in (3/16–3/8") thick must be inserted into the housing grooves so that the piston is not damaged.



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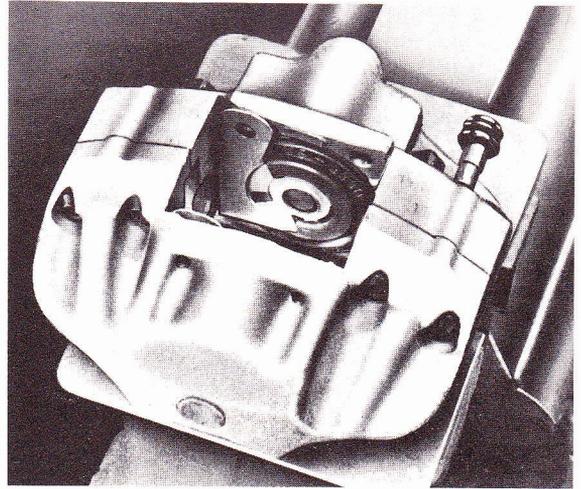
*Removing piston*

The cylinders can only be repaired one at a time, since no pressure can be built up in the caliper when one piston has been removed. Remove the rubber seal using a plastic or hard rubber rod so that the seal ring groove is not damaged.

#### Assembly

Clean all parts with alcohol or brake fluid. Check the parts for wear and replace as necessary. If a cylinder is damaged, the entire caliper must be replaced. Replace the seals when repairing the caliper. Coat the piston and new rubber seal with a thin coat of brake cylinder paste.

Install a new rubber seal in the cylinder groove. Insert a piston into the correct position using a piston gauge and push it into the cylinder with a piston setting fixture. Do not cant the piston, always use a piston retaining tool. Install a new seal and clamp ring.



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*Piston with retaining plate in correct position*

Check the 20° position of the piston with a piston gauge. Correct this value with piston rotating pliers if necessary. Insert the piston retaining plate in the correct position. Push the second piston out of the caliper and repeat the respective steps in sequence.

### BRAKE CALIPER HOUSING

#### Reconditioning

The brake caliper may be disassembled only if the joint between the two housings becomes leaky and the fluid channel O-rings have to be replaced.

#### Disassembly

Remove the four fillister head caliper housing bolts. Remove the cover housing.

#### Assembly

Install two new fluid channel O-rings. Use new nuts and bolts. Observe the different bolt lengths. The shorter bolts are on the outside. Align the housing halves with each other. Tighten the bolts in the specified sequence to 7 ft.-lb. Check the relative position of the housing halves once again. Tighten the bolts in the same sequence to the specified torque.

### BRAKE PRESSURE REGULATOR

#### Removing

Depress the brake pedal slightly with the pedal retainer and lock them, so that the brake fluid will not run out when the brake lines are disconnected. Remove the brake lines at the brake pressure regulator. Remove the bolts on the flange of the regulator and remove the regulator.

#### Installing

Bleed the brake system and check the operation of the brake pressure regulator.

#### Checking and adjusting

To determine whether or not the brake pressure regulator is operating, one mechanic must step down hard on the brake pedal while another mechanic places his hand on

the valve to feel if the piston in the regulator is moving. (When the brake pedal is released, a slight knock should be felt on the regulator).

Check the following items in the sequence shown: Remove the bleeder valve on the left front caliper and install a connector. Install a similar connection on the left rear caliper. Remove the caps from the hose connections and connect both hoses. Bleed both hoses and pressure gauges via the bleeder valves of the pressure gauges. Apply the brake pedal several times with force so that a pressure of at least 1422 psi is attained in the front brake circuit.

Then apply a load to the brake pedal until the pressure gauge of the front brake circuit shows a pressure of 924 psi. At this pressure the second pressure gauge in the rear brake circuit should indicate  $793.5 \text{ psi} \pm 28 \text{ psi}$ . The same measurements must be made at a pressure of 1422 psi in the front brake circuit. Here the pressure in the rear brake circuit should be  $1023.8 \text{ psi} \pm 43 \text{ psi}$ .

If the specified pressures in the rear brake circuit are not attained or are exceeded, the preload of the spring should be changed by turning the adjusting screw until the required pressure is attained. By turning in, the pressure increases in rear axle circuit; by turning out, the pressure decreases.

If the specified test pressure is not attained even after making adjustments, the brake pressure regulator must be replaced. Seal the adjusting screw and nut with sealing compound after tightening the lock nut. Bleed the brake

system, if necessary.

## REAR BRAKE FRICTION

### Removing

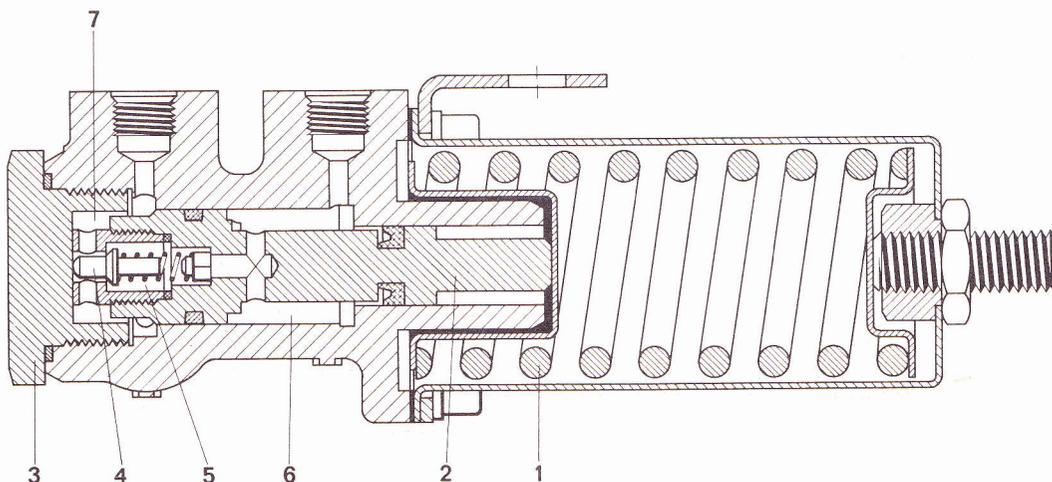
Pull out the clips and drive out the friction pad retaining pins (toward vehicle center) using a punch. Pull the friction pads out of the caliper with an extractor. If the friction pads are to be reused, they must be marked to match their respective housing halves. Friction pads must *not* be interchanged as this can cause uneven braking.

### Installing

Oily or cracked friction pads or pads which separated from the metal plate must be replaced. Here too, all four rear linings must be replaced. Place the piston retaining tool in between the pistons and lightly preload the pistons. Remove the closing screw on the cover housing of the caliper. Loosen the lock nut and set the piston back by turning the spindle clockwise with a hex. pin spanner (4 mm) maintaining the preload on the setting pliers.

Insert the brake friction pads into the caliper. Install used friction pads into the housing halves according to their markings from removal. Position the friction pads with retaining pins without the expanding spring and set for a 0.2 mm clearance on both sides of the brake disc.

Remove the retaining pins again and install the pads with the expanding spring and secure. Do not disassemble the rear caliper, since disassembly of the piston may damage the automatic adjusting fixture.



© Volkswagen

*Brake pressure regulator*

- |                 |                      |
|-----------------|----------------------|
| 1 - Spring      | 5 - Spring           |
| 2 - Piston      | 6 - Pressure chamber |
| 3 - Plug        | 7 - Chamber          |
| 4 - Check valve |                      |

# FRONT SUSPENSION 11

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## FRONT AXLE

### Measuring

The height adjustment of the front axle as well as the position of the wheels is an important factor in determining the road holding and cornering characteristics of a vehicle. Excessive deviations from the specified values for the height adjustment, track, camber, caster and the track differential angle may considerably influence otherwise good driving characteristics and result in abnormal tire wear.

Measuring of the vehicle requires an optical axle measuring device of the type offered by dealers in various makes. For this reason, the actual measuring of the vehicle is not described in detail and only instructions for adjusting and making corrections are given.

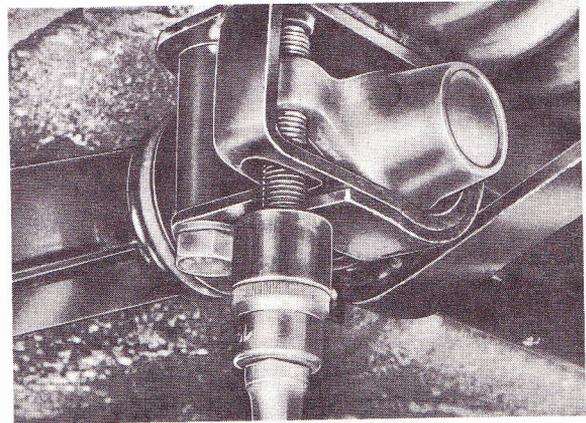
### Height adjustment

The accurate height adjustment of the front axle is the basis for measuring the vehicle. Prior to making adjustments, see that the vehicle has the proper dead weight with the fuel tank filled and a spare wheel.

Next, check the tire pressure. Drive the vehicle on to a measuring platform or level ground.

### Adjustment

Mark the center on the front wheel hub caps. Push the vehicle down several times near the front shock absorber and permit it to rise due to its own strength. Measure the vertical distance from a level surface or measuring platform to the center of the front wheel (dimension "a"). Dimension "a" less 90 mm is dimension "b". This dimension "b", may be set on a height gauge for the favorable measuring of the adjusting lever for the torsion bar on the closing cover.

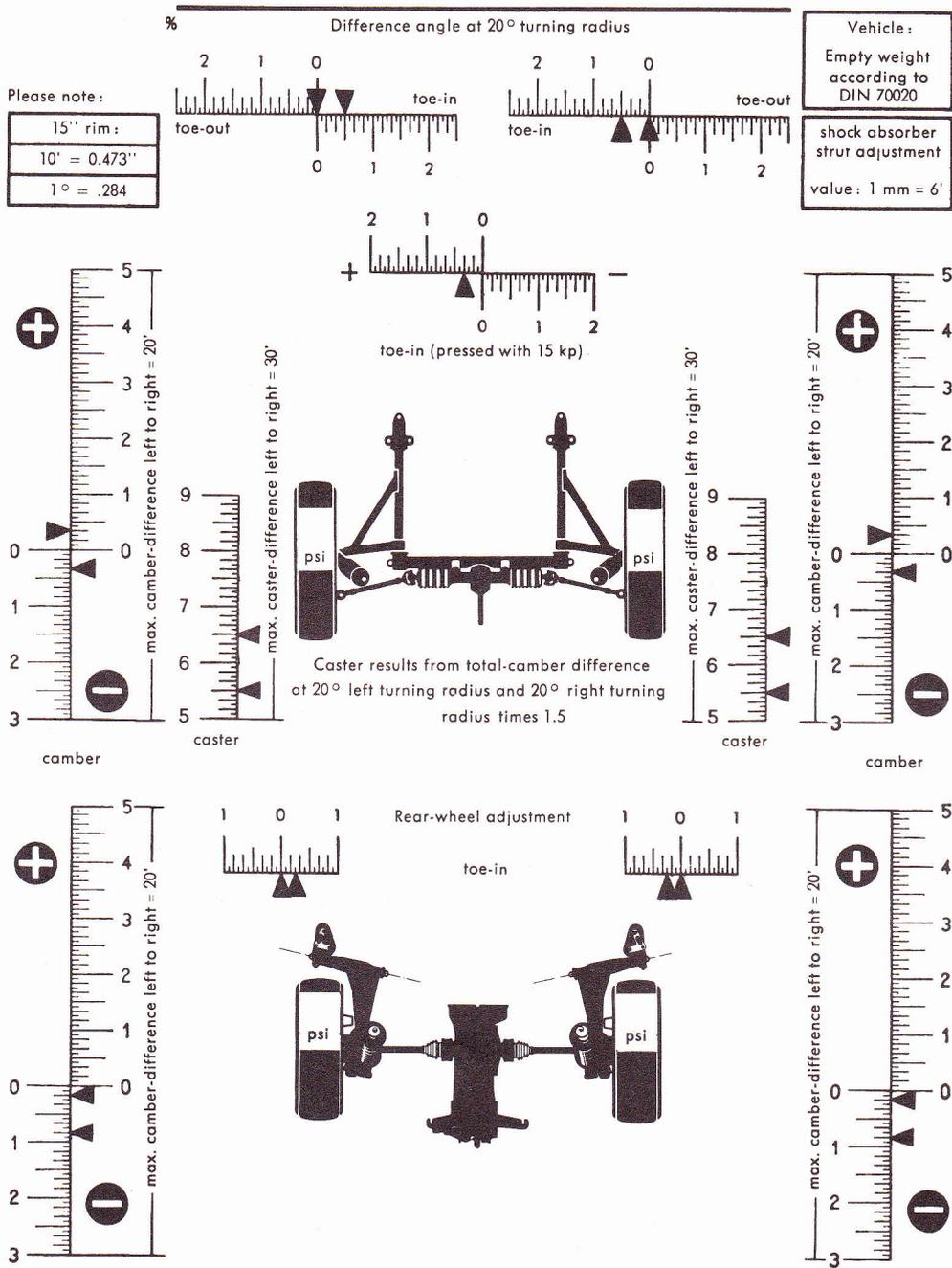


© Volkswagen

*Height adjustment screw*

Clean the closing cover on the adjusting lever of the torsion bar so that the marking for the center of the closing cover is easily seen. Loosen or tighten the adjusting screw of the torsion bar until the dimension "b" on the marking for the center of the closing cover is obtained. Depress the front of the vehicle again and permit it to rise under its own strength.

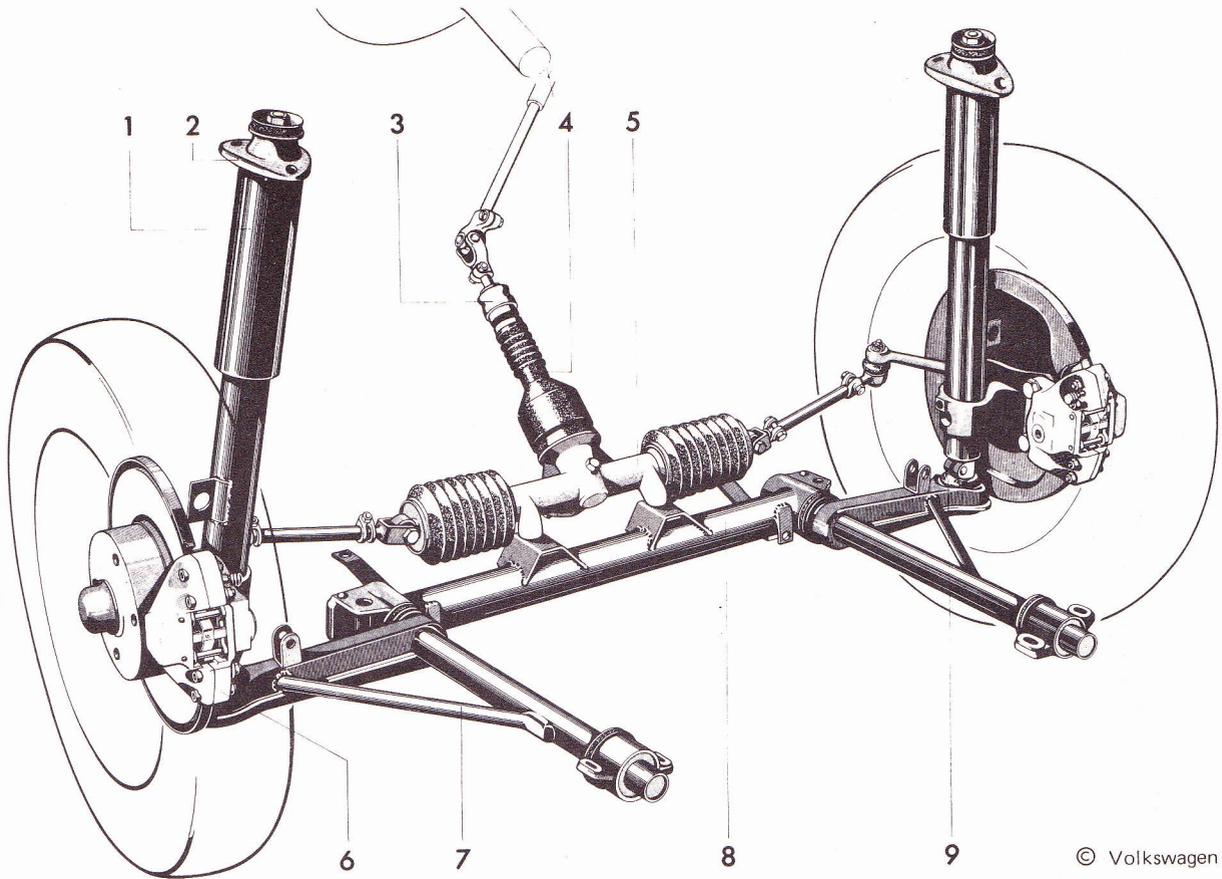
Check dimension "b" again, on both sides, and correct it if required. Though the tolerance of  $\pm 5$  mm for dimension "b" may be exploited, the difference between the lefthand and righthand end may not exceed the max. of 5 mm.



© Volkswagen

Measuring chart

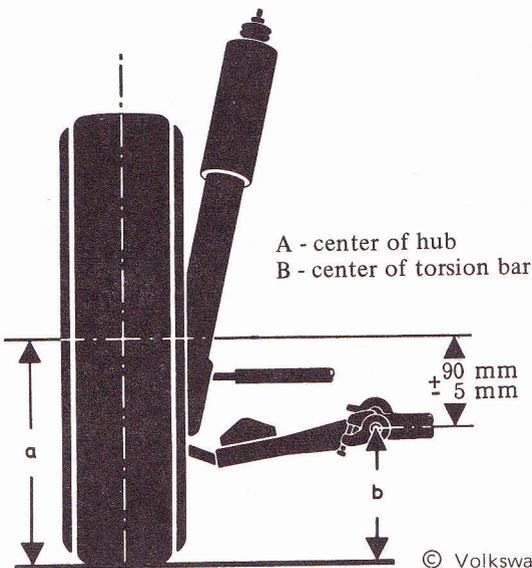
Small triangles in the measuring card are marking the permissible adjusting values for a quick checkup and evaluation of the measuring results.



© Volkswagen

Front axle assembly

- |   |  |  |
|---|--|--|
| <ul style="list-style-type: none"> <li>1 - Suspension strut</li> <li>2 - Strut support bracket with grommet</li> <li>3 - Steering shaft support bearing with grommet</li> </ul> | <ul style="list-style-type: none"> <li>4 - Dust boot</li> <li>5 - Rack &amp; pinion steering</li> <li>6 - Brake caliper, complete</li> </ul> | <ul style="list-style-type: none"> <li>7 - Transverse control arm with rubber mounts</li> <li>8 - Auxiliary support</li> <li>9 - Ball joint</li> </ul> |
|---|--|--|



© Volkswagen

Height of front axle

**TOE-IN Adjustment**

The toe-in must be set with the steering gear in the center position, otherwise the total wheel lock left and right will vary, which in turn, will result in a varying turning circle. Turn the steering wheel to full lock on one side. Hold the steering wheel in this position and estimate the position of the bottom steering wheel spokes in relation to the horizontal.

Turn the steering wheel toward the other end up to the full lock position and estimate the location of the bottom steering wheel spokes. If the position of the bottom steering wheel spokes is different at the lefthand and righthand lock, the steering wheel must be loosened and adjusted.

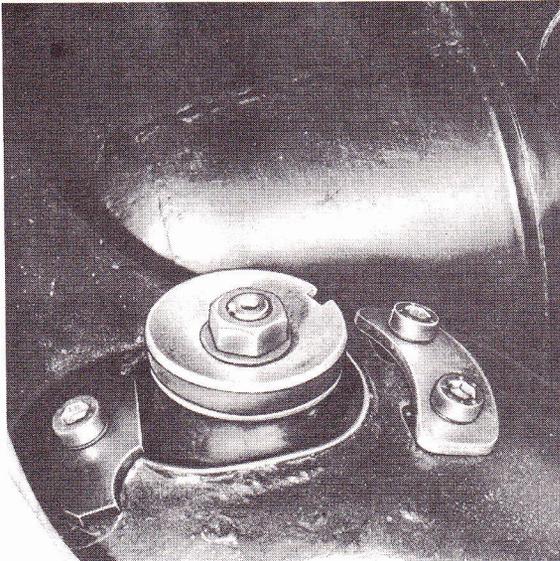
Turn the steering wheel to the center position (straight ahead) and adjust the lefthand and righthand track rod, by means of an optical axle measuring device, in such a manner that each wheel has the specified toe-in. (Wheels should be loaded with 33 lb.). The vehicle weight should correspond to the dead weight specifications.

**Track differential angle**

A faulty track differential angle cannot be compensated for by adjusting the track rods. If the differential angle deviations are higher, the steering arm, the track rod or the king pin on the shock absorber strut are distorted.

**CAMBER AND CASTER****Adjustment of camber**

Fold back the front end covering. Completely remove the sealing compound on the pressure plates and the supporting bearing. Mark the position of the single-hole and the double-hole pressure plates and loosen the cheesehead screws.



© Volkswagen

*Camber and caster adjusting screws*

Shift the supporting bearing with the shock absorber strut in accordance with the desired adjusting values for the camber, crosswise to the vehicle length. A 0.039 in. movement on the supporting bearing, corresponds to a 0° 6' angle change on the shock absorber strut.

Shifting the supporting bearing with the shock absorber struts in a lengthwise direction will change the caster adjustment. Tighten the socket screws. Seal the plates, as well as the supporting bearing with a permanently elastic sealing compound.

**Adjusting the caster**

Complete the pertinent steps as described under "Adjusting the Camber". Shift the supporting bearing with the shock absorber strut in an axial direction. Any shift in the transverse direction will change the camber adjustment.

On certain optical measuring instruments the caster cannot be directly read. The caster can be determined from the total camber difference at 20° lefthand lock and 20° righthand lock x 1.5.

Example: Camber at 20° lefthand lock = + 3°. Camber at righthand lock = - 2° (20° lock set on righthand wheel). Total camber difference = 5°. Total camber difference 5° x 1.5 = 7.5° caster.

**FRONT WHEEL BEARINGS****Removal**

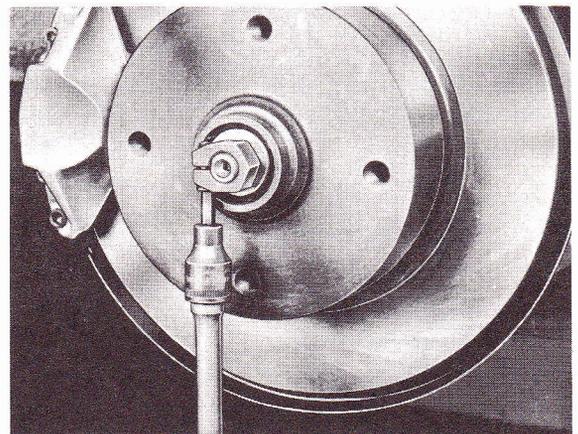
Depress the brake pedal, and the pedal support so that the brake fluid will not run out of the refill tank. Loosen the hollow screw of the brake line on the caliper. Loosen the fastening bolts for the caliper and remove it. Pry off the cap of the front wheel hub with the proper tool.

Loosen the cheesehead screw of the clamping nut for the wheel bearing. Unscrew the clamping nut and remove the tab washer. Remove the front wheel hub along with the brake disc and bearing. Extract the front wheel bearing using a shop press. The brake disc may have to be removed, depending on the type of shop press.

Mark the brake disc and hub. Loosen the screws on the brake disc and remove the hub. Heat the hub to 120-150°C. Press out the internal tapered roller bearing with the sealing ring. Press out the outer race of the outer tapered roller bearing.

**Adjustment**

Push off the cap for the front wheel hub with the proper tool. Loosen the screw of the clamping nut. Tighten the clamping nut slightly while turning the wheel or hub, so that the taper rollers will be positioned correctly against the bearing races.



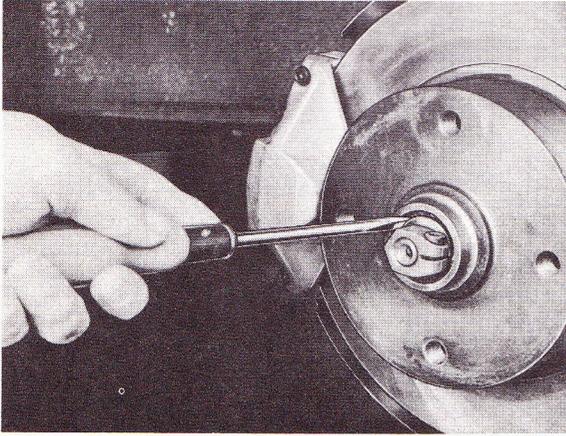
© Volkswagen

*Loosening clamping nut*

Loosen the clamping nut until the tab washer can be pushed easily and laterally by means of a screwdriver, so that no perceptible bearing play is felt when the wheel hub is moving axially.

Do not support the screwdriver against the hub but hold it freely in hand. Tighten the socket screw of the clamping

nut to the specified torque without turning the clamping nut and check the adjustment once again by moving the tab washer. Correct, if required.



© Volkswagen

*Checking tab washer play*

The slot width of the clamping nut should be 0.098–0.118 in., so that perfect clamping is obtained even under unfavorable tolerance overlaps. Coat the clamping nut and the tab washer lightly with lithium grease and fit the cap without grease by means of a plastic hammer or the like.

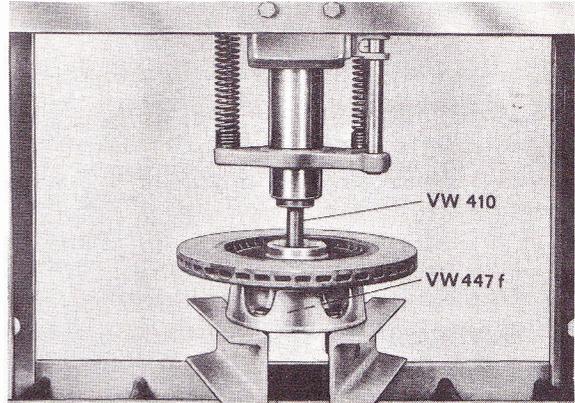
#### Installation

Tapered roller bearings of various makes (SKF, FAG and Timken) are installed as standard equipment. New bearing parts (bearing outer race and the bearing inner race with taper rollers) can be interchanged for parts of the same make; be sure that a complete bearing consists of parts made by the same manufacturer.

Clean both tapered roller bearings carefully and check for wear and damage; replace, if required. Heat the hub to 120–150°C. Press in the outer race of the inner tapered roller bearing. Insert the inner race of the inner tapered roller bearing and press in the sealing ring, until the sealing ring is flush with the hub.

Press in the outer race of outer tapered roller bearing. Position the brake disc on the hub in such a manner that the marks are in alignment.

Tighten the hex. bolts of the hub brake disc to the specified torque. Be sure that the bolts are mounted from the inside, so that the screw head comes to rest against the brake disc. Place new spring washers under the nuts. Fill the hub with approx. 65 cc of lithium grease (multi-purpose grease), coating the bearings well. The space between the sealing lips of the sealing ring should also be filled with grease, so that the outer sealing lip will not run dry.



© Volkswagen

*Removing outer race of outer tapered bearing*

Adjust the front wheel bearings. Tighten the hex. bolts for the caliper, together with the spring washers, to the specified torque. Tighten the hollow screw of the brake line on the caliper to the specified torque.

#### SHOCK ABSORBER STRUT

##### Removal

Loosen the brake line on the holder of the spring strut (first push the brake pedal with the pedal support slightly downwards, so that the brake fluid cannot run out of the refilling tank). Loosen the fastening bolts for the caliper and remove the complete caliper. Push off the front wheel hub cap with the proper tool.



© Volkswagen

*Removing brake line*

Loosen the socket screw of the wheel bearing clamping nut; screw out the clamping nut and remove the tap washer. Now, remove the brake disk and the bearing. Next, loosen the hex. bolt for the guard plate and remove the guard plate.

Unlock the castle nut of the track rod joint and pull off the ball joint with a puller. Unscrew the adjusting screw of the torsion bar and remove the adjusting lever. Loosen the hex. screw for the ball joint of the shock absorber strut. Push the transverse control arm downwards and pull the ball joint out of the shock absorber strut.

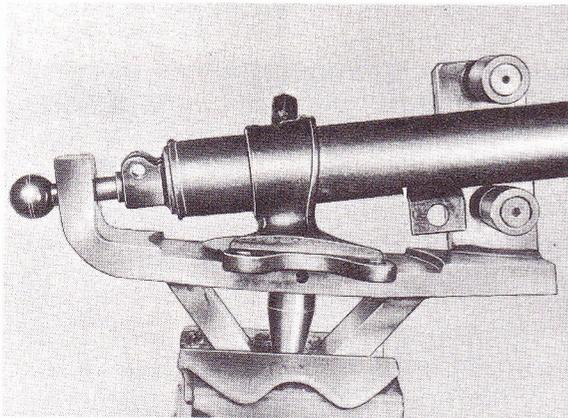
Unlock the hex. nut on the shock absorber strut. Loosen and remove the lock washer, tab washer and the shock absorber strut. Loosen the socket screw for the guard clip on the front transverse control arm bearing and remove the guard clip

**Inspection of components**

Check the shock absorber strut, with the steering knuckle using a special tool. Clamp the special tool in a vise and slide the bearing pins of the shock absorber strut into the test holes of the tool.

If the bearing pin cannot be pushed in up to the stop against the flange section, the bearing pin is bent and the shock absorber strut must be replaced. Check the seats of the front wheel bearings for seizing marks.

Rotate the shock absorber strut between the measuring pin and locate it with the holding pin. If the shock absorber strut cannot be rotated between the two measuring pins, replace the shock absorber strut. In addition, a maximum distance of only 0.087 in. is permissible between the shock absorber strut outer tube and the face-end measuring surface of the measuring pin. If this dimension is exceeded, the shock absorber strut should also be replaced.

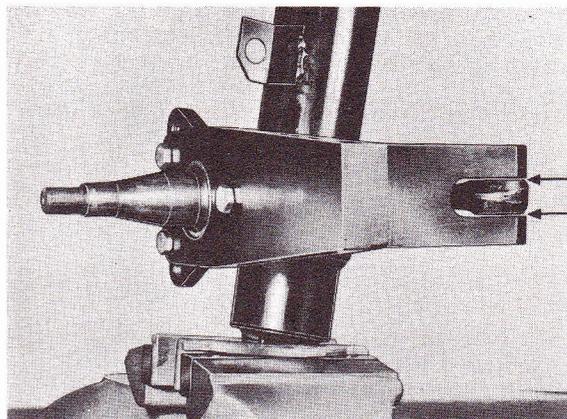


© Volkswagen  
*Checking straightness of shock absorber*

Check the shock absorber strut for hydraulic defects and leaks. If the entire shock absorber tube is covered with oil, replace the entire shock absorber strut. Clamp the shock absorber strut vertically into a vise, with the piston rod up.

Push the shock absorber down several times, so that the

oil moves in between its cylinder and determine the idle travel of the shock absorbers by a short counter movement. If the idle travel is too high, replace the shock absorber strut. Check the steering arm using a special tool.

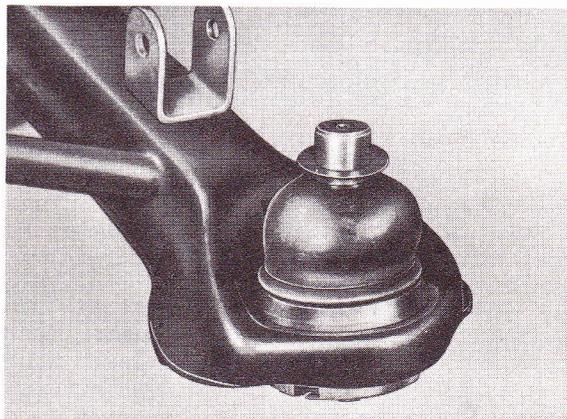


© Volkswagen  
*Checking steering arm*

The attaching of the special tool to the steering knuckle by means of 3 screws should be readily effected in such a manner, that the steering arm is between the inspection holes. The large bore dia. for the track rod joint in the steering arm should not be outside the inspection hole of the special tool. (Sight test). Replace the shock absorber strut if the deviation exceed the permissible dimensions.

**Installation**

Install the hollow rubber spring without any lubricant. Tighten the hex. nut on the shock absorber strut to the specified torque. Use a new lock washer and be sure that the tab of the lock washer points upwards when fitted. Tighten the hex. bolt for the ball joint to the specified torque. Be sure to fit a steel washer between the sealing bellows of the ball joint and the shock absorber strut.



© Volkswagen  
*Placement of steel washer*

Mount the adjusting lever to the torsion bar as described. Push the transverse control arm, with the shock absorber strut connected, down against the stop on the shock absorber strut using a mounting lever. Slide the adjusting lever as closely as possible against the stop of the auxiliary carrier for the adjusting screw on the torsion bar. The adjusting lever must be provided with a closing cover.

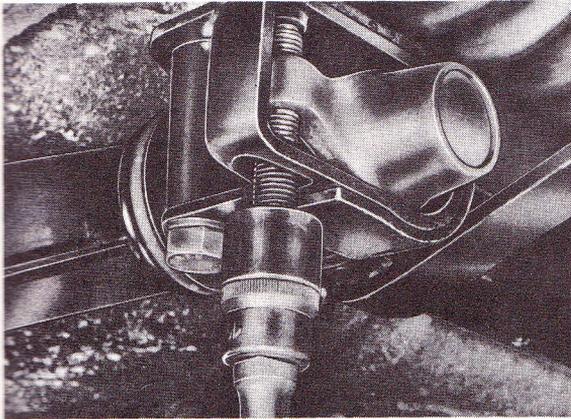
Grease the threads of the adjusting screw with lithium grease and tighten the adjusting screw slightly. Check to see that the closing cover in the transverse control arm is properly seated since inadequate assembly of the adjusting lever may force the torsion bar out of the teeth of the transverse control arm (at the front). Screw down the protective member for the transverse control arm.

Tighten the castle nut of the track rod joint to the specified torque. Tighten the hex. bolts for the guard plate to the specified torque. Install the front wheel bearing and adjust it. Tighten the hex. bolts for the caliper to the specified torque. Bleed the brake system and test it for leaks. Measure the vehicle optically.

## TRANSVERSE CROSS ARM

### Removal

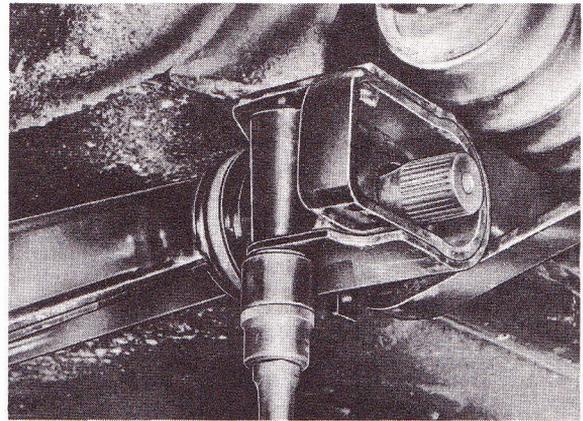
Unscrew the adjusting screw on the torsion bar. Pull the adjusting lever from the torsion bar and remove the seal. Loosen the hex. bolt for the ball joints of the shock absorber strut. Push the transverse control arm downwards and pull the ball joints out of the shock absorber strut. Loosen the hex. bolt for the transverse control arm and the auxiliary carrier.



© Volkswagen

*Removing torsion bar adjusting screw*

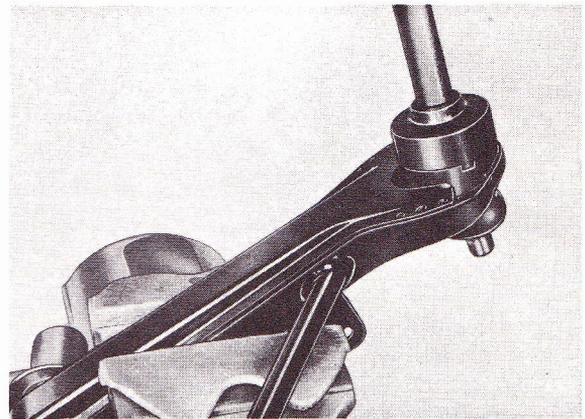
Loosen the socket screw for the protective member on the front transverse control arm bearing and remove the protective member. Next, unscrew the hex. bolts on the front transverse cross arm bearing. Push the transverse control arm, together with the torsion bar, out of the auxiliary carrier and remove it.



© Volkswagen

*Removing control arm carrier bolt*

If both transverse control arms must be removed, remove one at a time. Clamp the transverse control arm into a vise (use soft jaws); unlock the grooved nut of the ball joint and loosen it by using a special tool.



© Volkswagen

*Removing grooved nut of ball joint*

### Checking the individual parts

Check the transverse control arm with a special tool. Force the closing cover for the torsion bar tooting (with a suitable pipe tool) out of the transverse control arm. Hold the transverse control arm in a special tool.

The transverse control arm should turn easily when mounted with its ball joint supporting hole on the test pin of the special tool and with the ball joint seat resting against the test pin flange. Replace distorted or damaged transverse cross arms.

Mount the closing cover on the transverse control arm

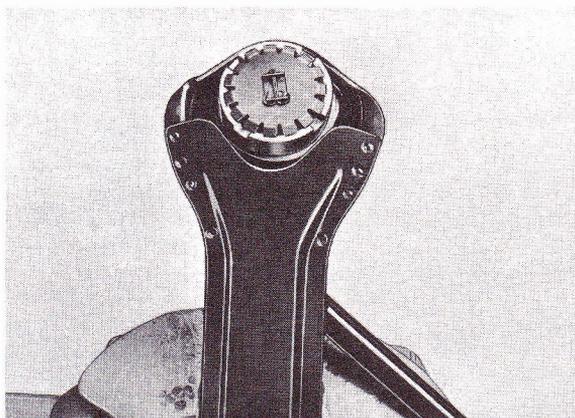
with its spherical end facing outwards. Knock the closing cover in with a mandrel. Check the rubber bearing of the transverse control arm for visible wear. Replace the transverse control arm, if the rubber bearings are defective.

Now check the ball joint. Some friction torque should be felt when moving the ball pin. If the ball pin can be moved without resistance and if end play is shown, replace the ball joint. In the event of a damaged sealing bellows, replace the bellows as follows.

Loosen the damaged sealing bellows from the ball joint with a flat chisel. Fit a new sealing bellows alternately with a mandrel. Do not damage the bellows. Grease the ball joint with multi-purpose grease if required. Check the torsion bar for any damage of serrations and paintwork, particularly for evidence of rust. Replace, if required.

**Installation**

Tighten the grooved nut for the ball joints to the specified torque and secure it by bending a pertinent tab on the lock washer. Coat the torsion bar lightly with lithium grease. Grease the serrations well and insert the torsion bar into the transverse control arm. Do not push the closing cover out of the transverse control arm. Insert the transverse control arm with the torsion bar into the auxiliary carrier.

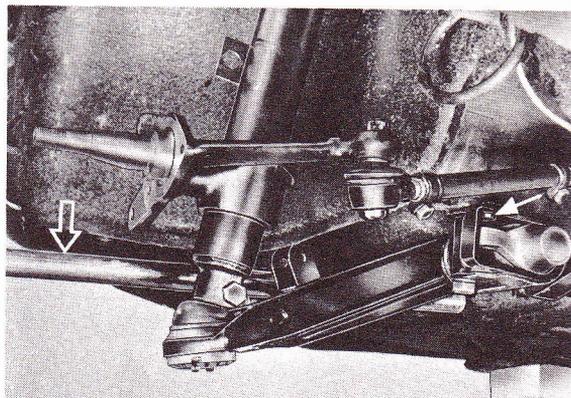


© Volkswagen  
*Ball joint lock washer in place*

The torsion bars are pretensioned during production. Never interchange the righthand and lefthand torsion bar. Lefthand torsion bars are identified by an "L", and righthand torsion bars by a "R" on the face of the bar. Tighten the hex. bolts for the transverse control arm (front) to the specified torque. Tighten the hex. bolts for the transverse control arm and the auxiliary carrier to the specified torque.

Tighten the hex. bolt for the ball joint to the specified torque. Slide the seal across the torsion bar and mount the adjusting lever for the torsion bar on the bar as described. Push the transverse control arm, with the shock absorber strut connected, down against the stop in the shock

absorber strut, using a mounting lever. Slide the adjusting lever, as close as possible, against the stop of the auxiliary carrier for the adjusting screw on the torsion bar. The adjusting lever must be provided with a closing cover.



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*Sliding adjusting lever against auxiliary carrier stop*

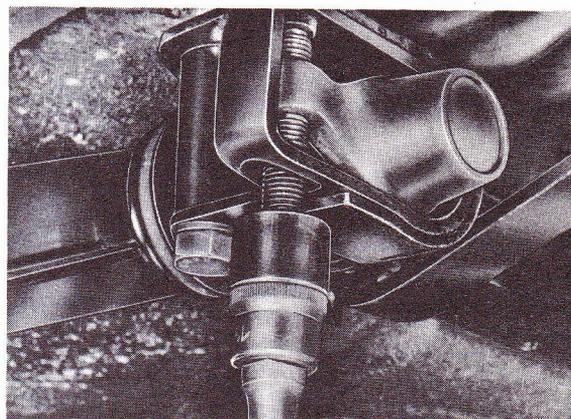
Grease the threads of the adjusting screw with multi-purpose grease and tighten the adjusting screw slightly. Check to see that the closing cover in the transverse control arm is seated correctly since bad assembly of the adjusting lever may force the torsion bar out of the serrations of the transverse control arm (at the front).

Screw down the protective member for the transverse control arm. Now, complete the height adjustment of the front axle and measure the vehicle optically.

**TORSION BAR**

**Removal**

Unscrew the adjusting screw of the torsion bar. Pull the



© Volkswagen

*Removing torsion bar adjusting screw*

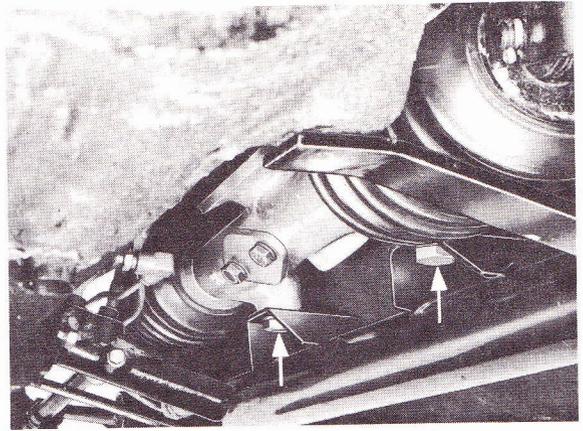
adjusting lever from the torsion bar and remove the seal. Pull the torsion bar out toward the rear. Loosen the cheesehead screw for the protective member and remove it.

### Checking

Check the torsion bar for damage of the serrations, and paintwork, and for evidence of rust. Replace the bar if required.

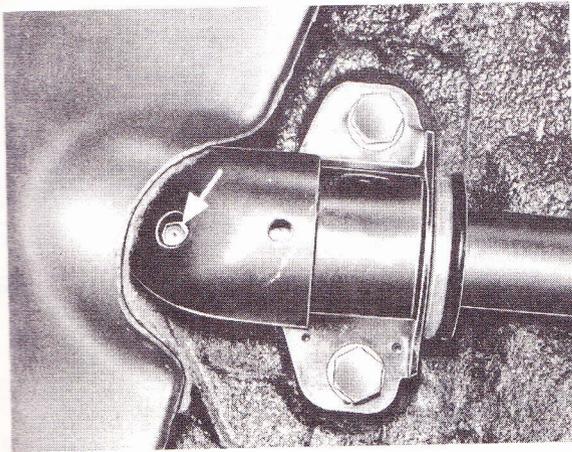
### Installation

Coat the torsion bar lightly with lithium grease. Grease the serrations particularly well and slide the torsion bar into the transverse control arm. Do not knock out the closing cover in the transverse control arm. Slide the seal on the torsion bar. Slide the adjusting lever for the torsion bar on the bar by doing the following.



© Volkswagen

*Steering gear bolts*



© Volkswagen

*Screw for guard clip*

Push the transverse control arm, with the connected shock absorber strut, against the stop in shock absorber strut using a mounting lever. Push the adjusting lever as close as possible against the stop of the auxiliary carrier for the adjusting screw on the torsion bar. The adjusting lever must be provided with a closing cap.

Grease the threads of the adjusting screw with multi-purpose grease and tighten the adjusting screw slightly. Check to see that the closing cover in the transverse control arm is correctly seated since inadequate assembly of the adjusting lever may force the torsion bar out of the serrations of transverse control arm (at the front).

Screw on the protective member for the transverse control arm. Complete the height adjustment of the front axle and measure the vehicle optically.

### AUXILIARY CARRIER

#### Removal

Remove the underfloor protection on the front axle. Loosen the hex. bolts for the steering gear on the

auxiliary carrier. Unscrew the adjusting screws on the torsion bars. Pull the adjusting levers from the torsion bars and remove the seals. Unscrew the hex. bolts for the auxiliary carrier and the transverse control arm and remove the auxiliary carrier. Loosen the socket screw for the protective member and remove it.

### Checking

Place the auxiliary carrier on a level surface and check it for distortion. In the event of distortions or unpermissible dimensional deviations, replace the auxiliary carrier. Check the auxiliary carrier for cracks or visible damage and replace it if required.

### Installation

Be sure that the auxiliary carrier is correctly located in the fitted bolts on the body. Tighten the hex. bolts for the auxiliary carrier and the transverse control arm, to the specified torque. Tighten the hex. bolts for the steering gear to the specified torque, using new spring rings.

Slide the seal on the torsion bar. Slide the adjusting lever for the torsion bar on the bar as described following. Push the transverse control arm, with shock absorber strut connected, down against the stop on the shock absorber strut by means of a mounting lever. Sliding the adjusting lever as closely as possible, against the stop of the auxiliary carrier for the adjusting screw on the torsion bar. The adjusting lever must be provided with a closing cap.

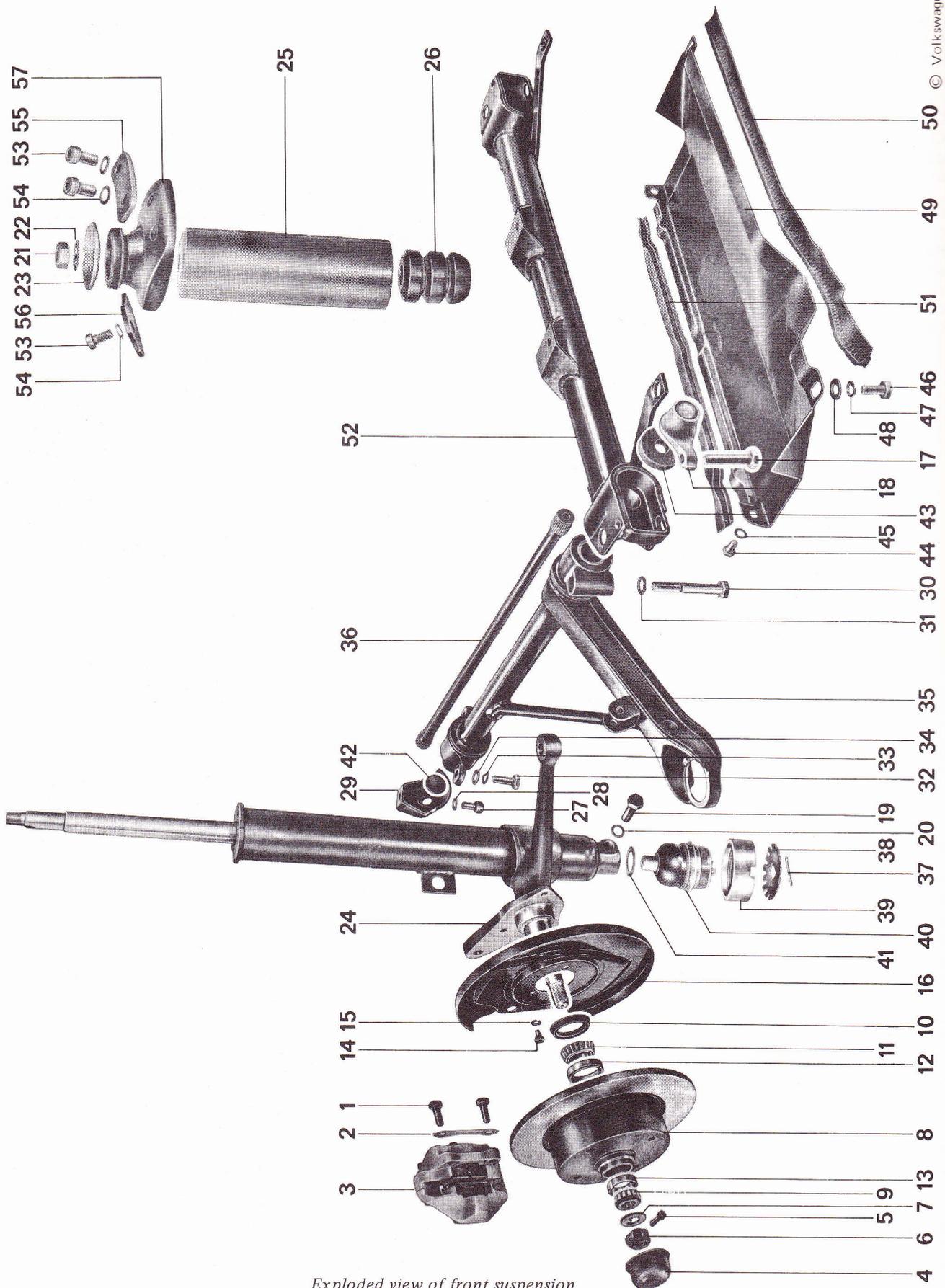
Grease the threads of the adjusting screw with multi-purpose grease and tighten adjusting screw slightly. Check to see that the closing cover in the transverse control arm is properly seated, since inadequate assembly of the adjusting lever may push the torsion bar out of the serrations of the transverse control arm (at the front).

Screw on the protective member for the transverse control arm. Complete the height adjustment of the front axle and measure the vehicle optically.

### SUPPORTING BEARING AND BEARING RUBBER

#### Replacement

Fold back the front end covering. Unlock the hex. nut on



Exploded view of front suspension

the shock absorber strut (top). Loosen and remove the lock washer as well as the tab washer. Push the transverse control arm, with the spring strut, down and extend the piston rod out of the bearing rubber.

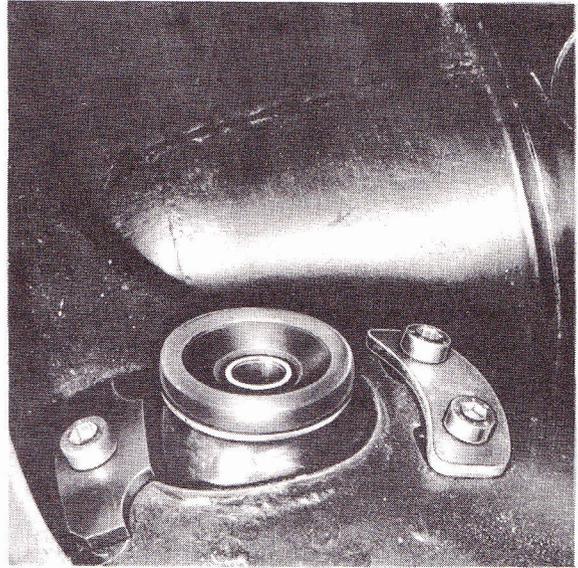
Remove the sealing compound on the pressure plate. Mark the position of the single hole and the double hole

- 44 - Hex. bolt
- 45 - Spring ring
- 46 - Hex. bolt
- 47 - Spring ring
- 48 - Washer
- 49 - Underfloor protection
- 50 - Profiled rubber
- 51 - Profiled rubber
- 52 - Auxiliary support
- 53 - Cheesehead screw
- 54 - Lock washer
- 55 - Two-hole pressure plate
- 56 - Single-hole pressure plate
- 57 - Supporting bearing

- 30 - Hex. bolt
- 31 - Spring ring
- 32 - Hex. bolt
- 33 - Spring ring
- 34 - Washer
- 35 - Transverse control arm
- 36 - Torsion bar
- 37 - Cotter pin
- 38 - Lock washer
- 39 - Grooved nut
- 40 - Ball joint
- 41 - Washer
- 42 - Cover
- 43 - Sealing ring

- 16 - Guard plate
- 17 - Adjusting screw
- 18 - Adjusting lever
- 19 - Hex. bolt
- 20 - Lock washer
- 21 - Hex. nut
- 22 - Locking plate
- 23 - Tab washer
- 24 - Shock absorber strut
- 25 - Protective tube
- 26 - Hollow rubber spring
- 27 - Cheesehead screw
- 28 - Spring ring
- 29 - Guard clip

- 1 - Hex. bolt
- 2 - Locking plate (914 only)
- 3 - Caliper
- 4 - Hub cap
- 5 - Cheesehead screw
- 6 - Clamping nut
- 7 - Nose washer
- 8 - Brake disc
- 9 - Tapered roller bearing
- 10 - Sealing ring
- 11 - Tapered roller bearing
- 12 - Bearing outer race
- 13 - Bearing outer race
- 14 - Hex. bolt
- 15 - Spring ring

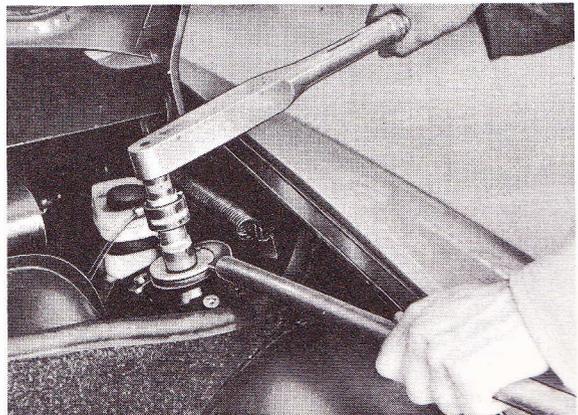


Support bearing

© Volkswagen

pressure plate. Loosen the socket screws and remove the supporting bearing with the bearing rubber. Install new supporting bearing, with a bearing rubber, and tighten the screws to the specified torque.

Tighten the hex. nut on the shock absorber strut to the specified torque and lock it. Use a new lock washer and make sure that the tab of the lock washer is fitted facing upwards. Measure the vehicle optically. Use a permanently elastic sealing compound for the pressure plates as well as the supporting bearing.



Tightening shock absorber strut nut

© Volkswagen

# STEERING 12

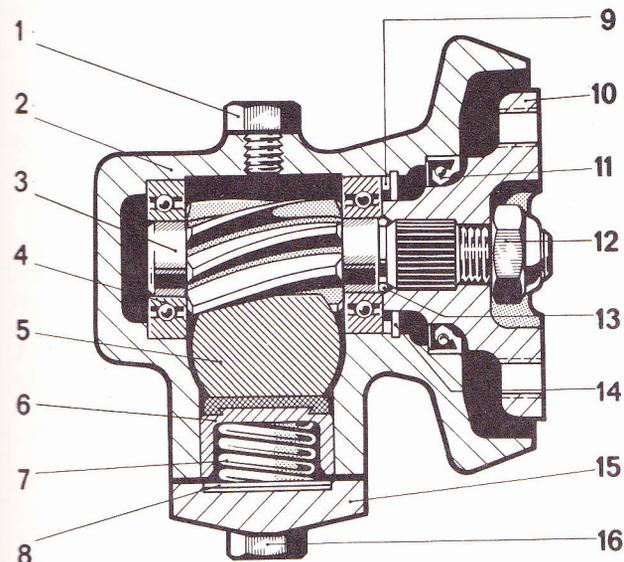
## INDEX

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### DESCRIPTION

The steering rack is mounted in two replaceable bushings, one at each outer end of the housing. The pinion is mounted on two ball bearings in the steering housing. A pressure block spring, and adjusting shims, press the steering rack against the pinion, thereby ensuring continuous contact between rack and pinion. The correct drag can be obtained by inserting and/or removing adjusting shims.

The rack and pinion steering assembly is lubricated during manufacture and requires no additional lubrication.



Cross section

© Volkswagen

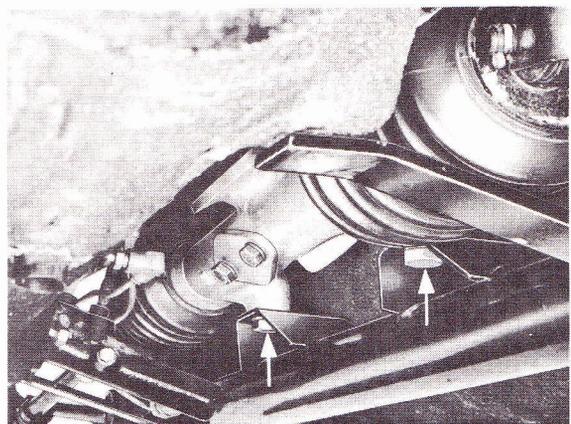
- |                       |                             |
|-----------------------|-----------------------------|
| 1 - Filler plug M 8x8 | 9 - Spacer                  |
| 2 - Housing           | 10 - Connecting flange      |
| 3 - Steering pinion   | 11 - Oil seal               |
| 4 - Ball bearing      | 12 - Self-locking nut, M 10 |
| 5 - Steering rack     | 13 - O-ring                 |
| 6 - Pressure block    | 14 - Snap ring              |
| 7 - Spring            | 15 - Housing cover          |
| 8 - Adjusting shim    | 16 - Hex. bolt M 8x18       |

### STEERING GEAR

#### Removal

Loosen the self-locking hex. nut from the bottom hex. bolt on the bottom of the universal joint and remove the bolt. Unlock the slotted nuts of the track rod joints and pull off the ball joints with a track rod puller. Remove the underfloor protection from the front axle.

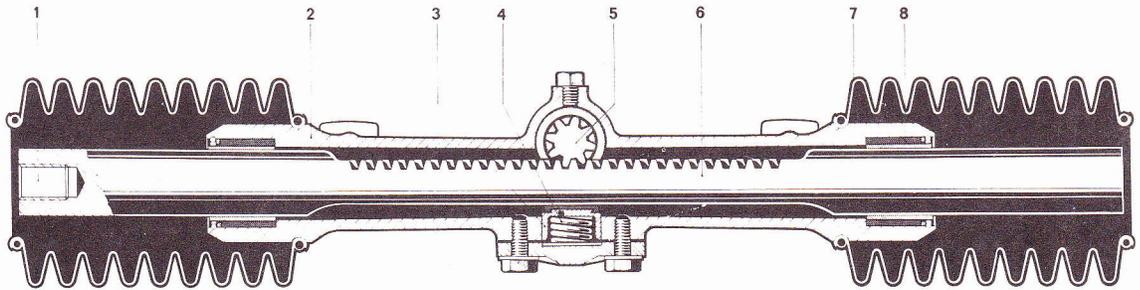
Loosen the hex. bolts for the steering gear on the auxiliary carrier. Unscrew the adjusting screws of the torsion bars. Pull the adjusting lever from the torsion bars and remove the seals. Unscrew the hex. bolts for the transverse control arm and the auxiliary carrier.



© Volkswagen

Steering gear bolts

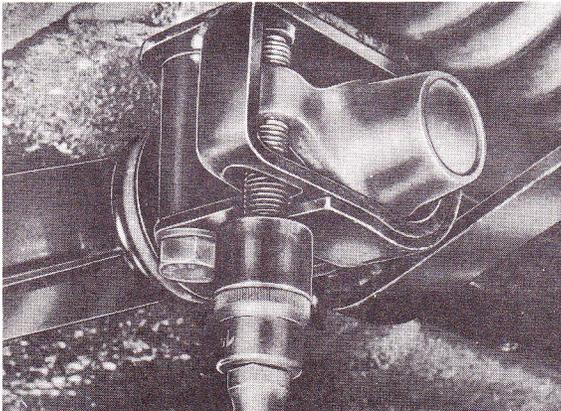
Remove the auxiliary carrier. Next, remove the steering gear with the track rods. Unlock the bolt on the fork-type joint for the track rods; loosen and remove them. If the steering shaft bearing must be replaced, remove the fuel tank first.



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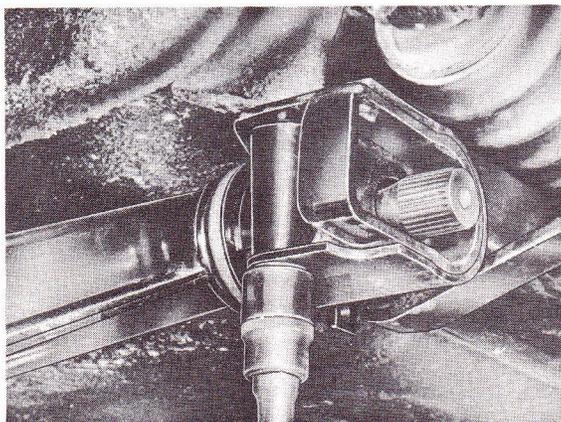
*Side section*

- |                              |                     |
|------------------------------|---------------------|
| 1 - Thread for tie rod joint | 5 - Steering pinion |
| 2 - Housing                  | 6 - Steering rack   |
| 3 - Pressure block           | 7 - Dust boot       |
| 4 - Spring                   | 8 - Bushing         |



© Volkswagen

*Removing torsion bar adjusting screws*



© Volkswagen

*Removing carrier screw*

**Installation**

Check the track arms for damage. Also, check the track rod ball joints. Moving the ball pin should produce a small friction torque. If the ball pin moves without resistance and end play is showing up, replace the ball joint.

Install the joint bolts with multi-purpose grease and tighten to the specified torque and lock them. Slide the sealing bellows upwards on the bearing rubber. Make sure that the bellows are seated correctly. Grease the running surface of the needle bearing on the steering shaft with some multi-purpose grease and insert the steering gear upwards in such a manner that the steering shaft is resting in the needle bearing.

When the steering gear is installed, the bottom universal joint in the passenger compartment must be mounted on the splines of the steering shaft in such a manner that the hex. screw can be fitted. The universal joint cannot be fitted when the steering gear is installed.

Install the auxiliary carrier, making sure that the auxiliary carrier is properly located on the fitted pins of the body. Use new spring rings for the hex. bolts of the steering gear and tighten them to the specified torque. Push the transverse control arm down against the stop in the shock absorber strut by means of a mounting lever, pushing the adjusting lever as closely as possible against the stop of the auxiliary carrier for the adjusting screw on the torsion bar.

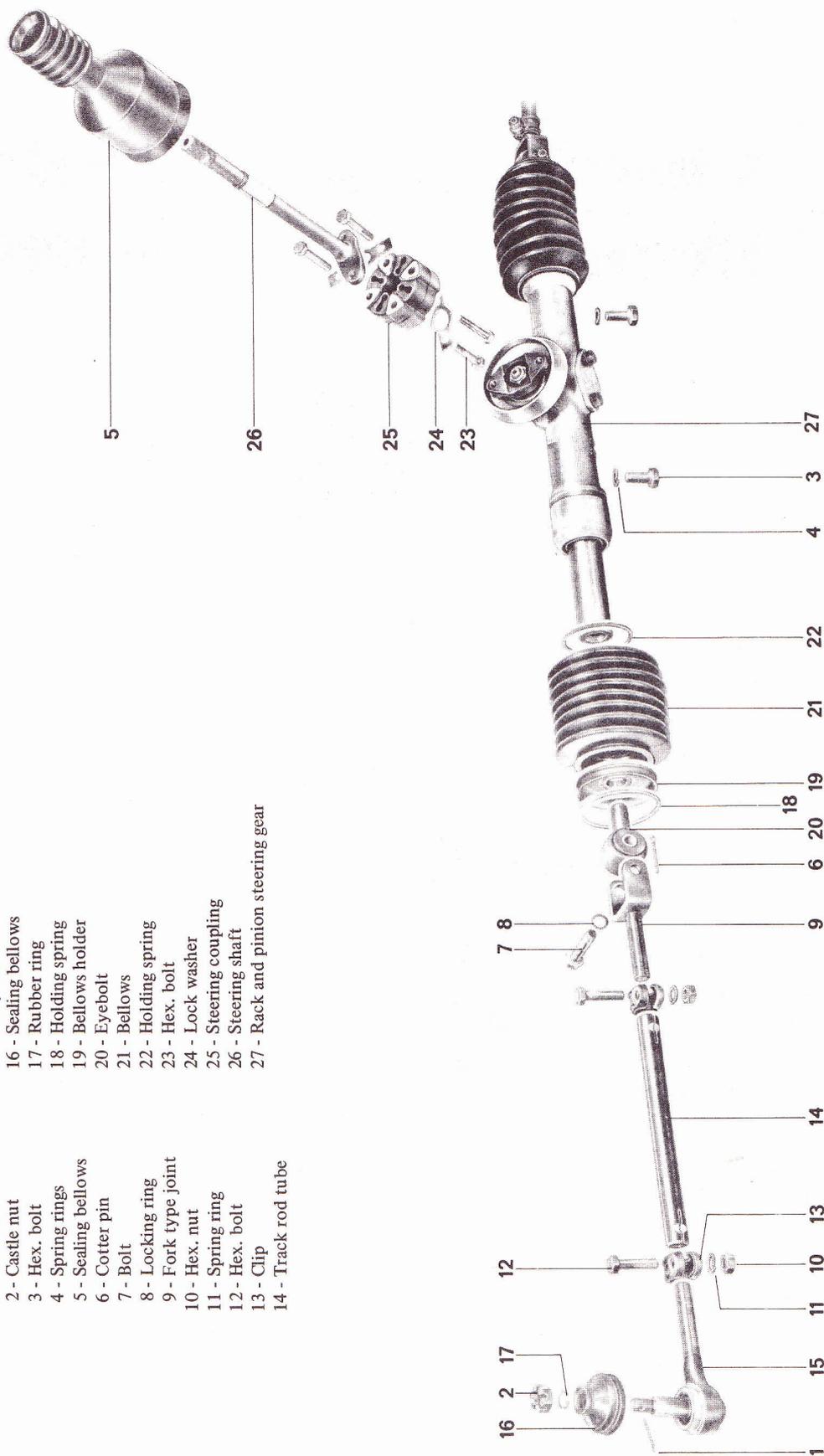
Screw the bottom universal joint, in the passenger compartment, down and make sure that the universal joints are not distorted. Use a new self-locking hex. nut. Tighten the hex. nut to the specified torque. Unscrew the protective member on the front transverse control arm bearing and check to see that the closing cover in the transverse control arm is correctly seated. Tighten the cheesehead screws for the protective member to the specified torque. Complete the height adjustment of the front axle and measure the vehicle optically.

**EYEBOLTS**

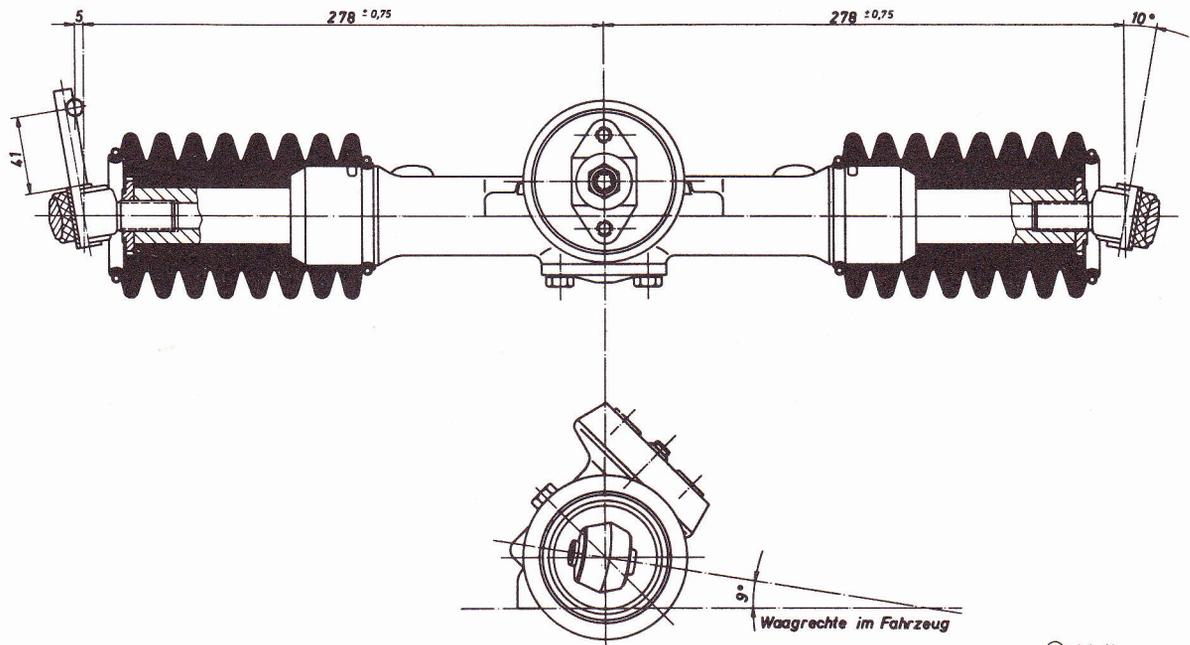
The eyebolts must be installed in a precise position to ensure free movement of the steering components and the exact guiding of the track rod.

- 1 - Cotter pin
- 2 - Castle nut
- 3 - Hex. bolt
- 4 - Spring rings
- 5 - Sealing bellows
- 6 - Cotter pin
- 7 - Bolt
- 8 - Locking ring
- 9 - Fork type joint
- 10 - Hex. nut
- 11 - Spring ring
- 12 - Hex. bolt
- 13 - Clip
- 14 - Track rod tube

- 15 - Ball joint
- 16 - Sealing bellows
- 17 - Rubber ring
- 18 - Holding spring
- 19 - Bellows holder
- 20 - Eyebolt
- 21 - Bellows
- 22 - Holding spring
- 23 - Hex. bolt
- 24 - Lock washer
- 25 - Steering coupling
- 26 - Steering shaft
- 27 - Rack and pinion steering gear

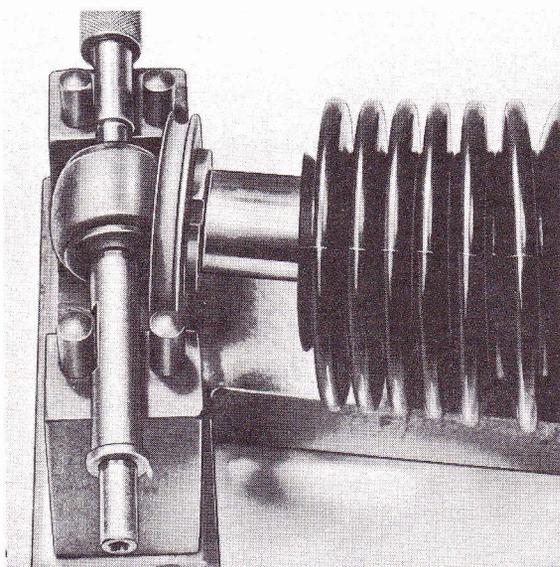


*Exploded view of steering gear assembly*



© Volkswagen

Eye bolts location



© Volkswagen

Checking eye bolt with tool P 285b

**Removal**

Clamp the steering gear into a special tool without the 3 mm (0.118 in.) washers. Remove the holding spring on the outside of the bellows, and pull the bellows from the bellows holder. Loosen the bellows holder with a hook spanner and unscrew the eyebolt together with a bellows holder.

**Checking parts**

Check the eyebolt for any visible wear and replace it if required. Check the bellows for cracks and leaks and replace them if required. Replace defective holding springs.

**Installation**

Mount both bellows on the housing. Screw the bellows holder on the eyebolts. Coat the threads of the eyebolts with sealing compound and install the eyebolts. Attach the steering gear without the 3 mm washers on the special tool. The locating pins should enter easily into the eyebolts, with the flattened end of the locating pins resting, with a slight play, against the outer fitted pin.

Tighten the bellows holder to the correct torque. Attach the bellows, with the holding spring, to the bellows holder.

**RACK AND PINION STEERING GEAR**

**Disassembly**

Clamp the steering gear in a vise (use soft jaws), loosen the hex. bolts for the housing cover and remove the cover. The adjusting washers, if any, will fall out. Remove the locking ring and take off the compensating washers.

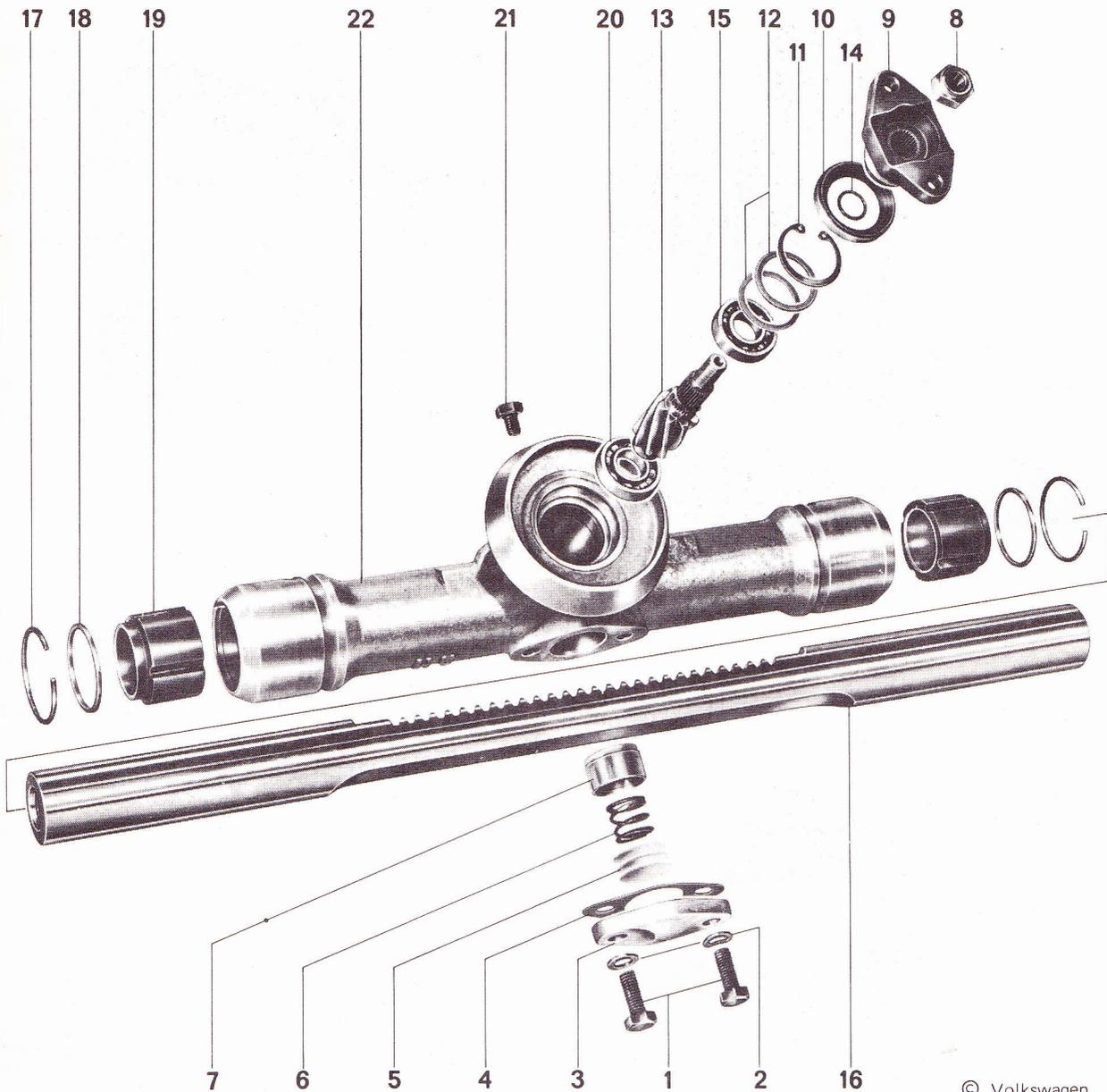
Screw the hex. nut on the drive pinion and push the pinion out of the housing by means of two heavy screw drivers. Now, pull the bearing bushing. Pull the grooved ball bearing out of the steering gear housing and remove it from the housing (laterally).

**Assembly**

During assembly, coat all parts with a multi-purpose grease LM-KFZ 3 or LM-47 L. During assembly, provide

the steering gear with a one-time supply of 25 grams of multi-purpose grease. Adjust the play of the thrust piece. Measure the distance of the thrust piece up to the supporting surface on the housing (Distance A).

Measure the recess in the housing cover. The dimension of the recess in the housing cover, with the seal, must be 0.008 in. larger than the distance A. Compensate any difference by means of adjusting washers. The thrust piece

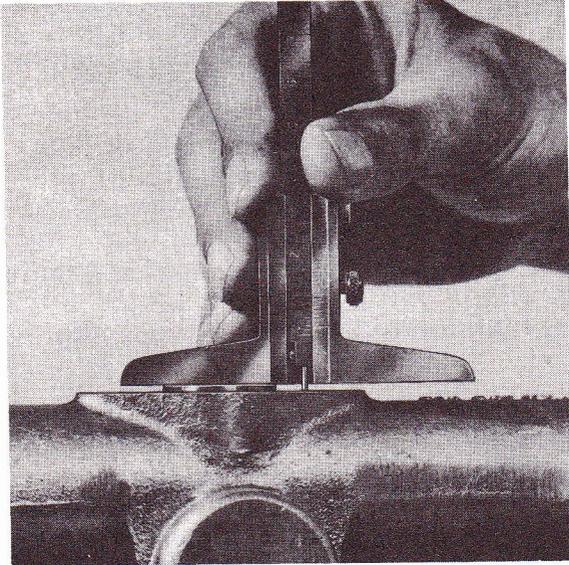


© Volkswagen

Exploded view of rack and pinion unit

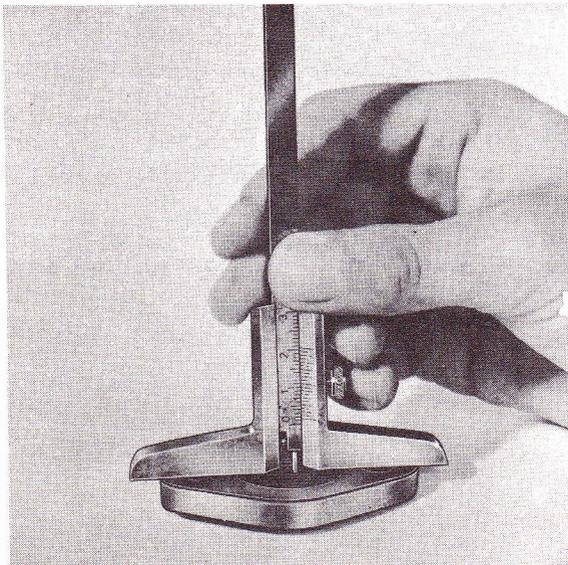
- |                                 |                           |                                     |
|---------------------------------|---------------------------|-------------------------------------|
| 1 - Hex. bolt M 8x18            | 9 - Coupling flange       | 16 - Rack                           |
| 2 - Spring washer               | 10 - Radial sealing ring  | 17 - Circlip                        |
| 3 - Housing cover               | 11 - Locking ring         | 18 - Supporting ring                |
| 4 - Seal                        | 12 - Compensating washer  | 19 - Bearing bushing                |
| 5 - Adjusting washer            | 13 - Drive pinion         | 20 - Grooved ball bearing           |
| 6 - Compression spring          | 14 - Round cord ring      | 21 - Hex. bolt (filler screw M 8x8) |
| 7 - Thrust piece                | 15 - Grooved ball bearing | 22 - Steering gear housing          |
| 8 - Self-locking hex. bolt M 10 |                           |                                     |

should have a 0.008 in. play with the housing cover attached. Check the torque of the steering gear along the entire turning range of the steering system. A torque of 5-7 in. lb. should be obtained.



© Volkswagen

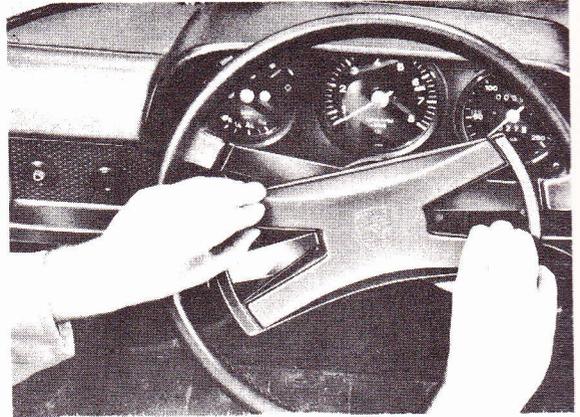
*Measuring height of thrust piece*



© Volkswagen

*Measuring recess in housing cover*

and remove it. Now pull out the contact finger. Loosen the steering wheel retaining nut. Mark the position of the steering wheel in relation to the steering column. Remove the steering wheel watching out for the supporting ring and the compression spring of the steering spindle bearing.



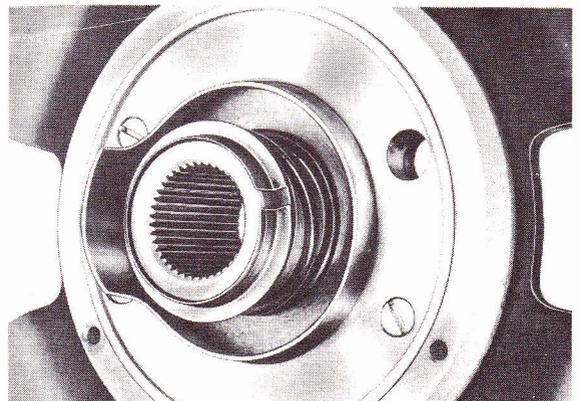
© Volkswagen

*Removing horn ring*

**Installation**

Position the compression spring and the supporting ring on the steering wheel hub. Lightly grease the contact ring for the signal horn. Use electrical contact grease. Position the steering wheel according to the disassembly markings. Place the wave washer under the steering wheel retaining nut. Tighten the nut.

Check the operation of the release ring (canceller). Insert the contact finger. Turn the horn ring slightly to the left so that it aligns with the recesses in the steering wheel. Then press down and turn the horn ring to the right until it locks.



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*Compression spring and supporting ring installed*

**STEERING WHEEL**

**Removal**

Disconnect the battery. Turn the horn ring toward the left

## ELECTRICAL 13

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**ALTERNATOR TESTER**

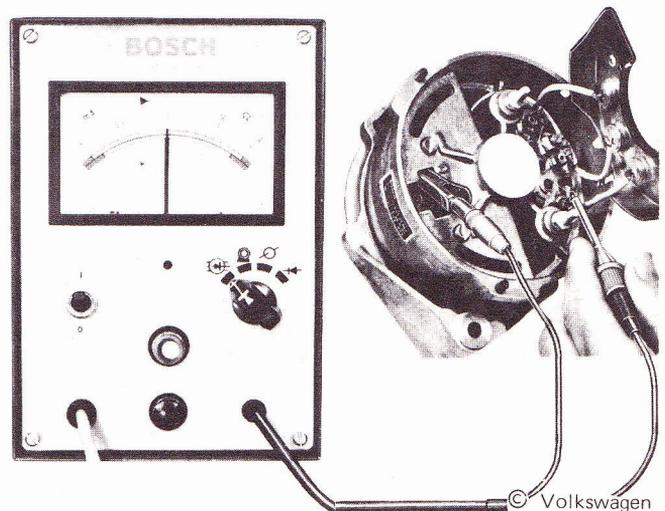
The alternator tester serves for testing installed and connected exciting and power diodes, as well as individual diodes, and for testing stator and rotor windings. During the test, place the test points of the instrument securely but only momentarily against the measuring points. Be sure that with the alternator partially disassembled the tilted positive diode carrier is not becoming connected to the housing.

**Testing the exciting diodes**

Set the test type switch to the extreme left position. Hold the test points one after the other against the collecting points. The connection of the test points is arbitrary. The needle will deflect to the left or to the right. The diodes are in order, when the needle deflects during all three measurements up into the green range at the right or left at the end of the scale.

**Testing the power diodes**

The test type switch is maintained in the extreme left position.



*Testing exciting diodes*

If the needle deflections are showing deviation, the following faults apply:

Needle deflections

2x in green range  
1x in red range

2x in red range  
1x no deflection

1x red range  
2x no deflection

Faults

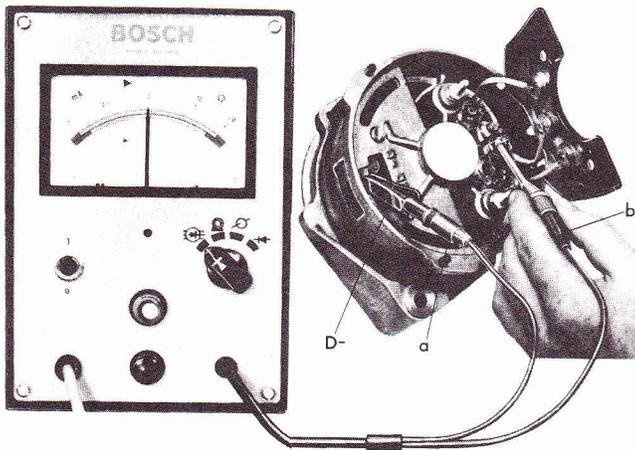
Interruption of diode located in red range

Short circuit of diode at which no deflection occurs.  
Note: The diodes in the red range may be in order and should be checked after unsoldering the defective diode.

Short circuit of diodes, at which no deflection occurs (check the third one)

To test the negative diodes place one lead in the fixed position and the other lead after the other against the collecting points. Negative diodes are the diodes which are in connection with the fixed connection. Needle deflections and faults are similar to exciting diodes.

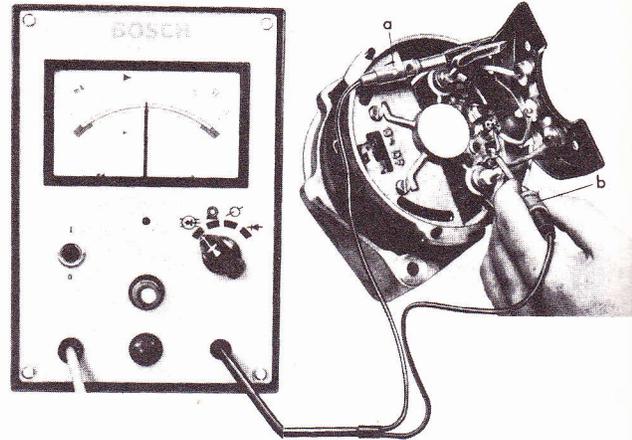
mA at housing temperature. If the needle remains at 0 during both measurements, the diode is interrupted. If the needle deflects entirely to the left during both measurements, the diode is shorted.



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Testing negative diodes

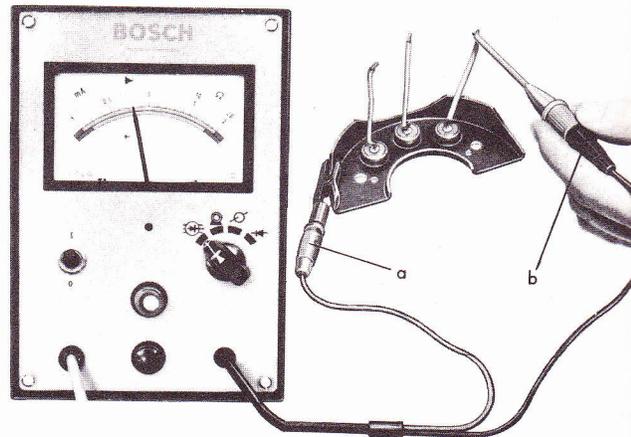
a = red plug      b = black plug



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Testing positive diodes

a = red plug      b = black plug



© Volkswagen

Testing individual diodes

a = red plug      b = black plug

To test the positive diodes, place one lead in the fixed position and the other lead, one after the other against the collecting points. Positive diodes are the diodes which are in connection with the fixed position. Needle deflections and faults are similar to exciting diodes.

Testing of individual diodes

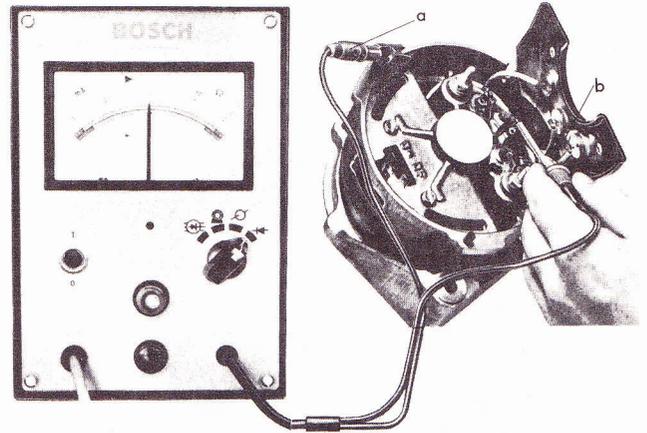
Set test type switch to the extreme left position. The diodes are tested individually in unsoldered condition in both directions. When the needle deflects completely toward the left, it is an indication that the diode has been connected in the forward direction. When the needle deflection is less, the diode has been connected in the inverse direction. The inverse current may be a max. 0.8

The same switch position can be used to determine the polarity of an intact diode. A direct voltage between the test points amounts to approx. 40 Volt. The red point is the positive connection, the black point the negative connection. Example for determining the polarity: Place the red point against the connecting wire of the diode, the black point against the diode housing. If a high current

flows (approx. 1 mA) the diode has been connected in forward direction, that is, the negative pole of the diode is on the housing (negative diode). If with the same connection there is no or only a low current, the diode has been connected in the reverse direction, that is, the positive pole of the diode is on the housing (positive diode).

#### Testing the stator windings

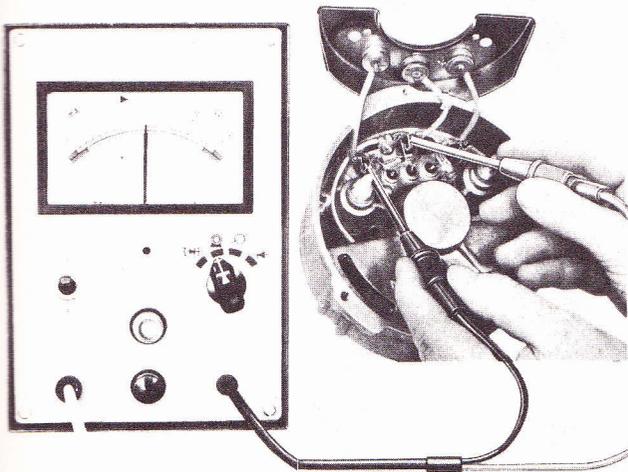
Set the test type switch to the second position from the left. Place the test points against two collecting points. Make a total of three measurements. During the measurements, the resistances should be of uniform size. If there are differences in the resistance ratings between the individual measurements, the stator winding has a winding short. When in doubt, unsolder the stator assembly and measure the stator winding with a measuring bridge.



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#### Testing for shorts

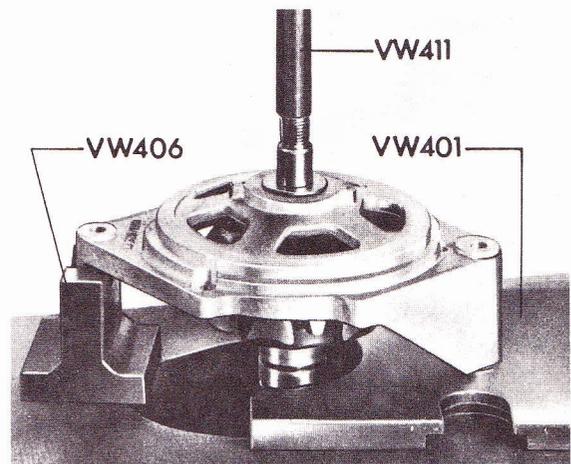
a = black plug      b = red plug



© Volkswagen

#### Testing stator windings

Prior to disassembling the alternator, pull back both carbons with a wire hook. The carbons can be held down with the aid of the pressure spring by pulling them wide enough out of the brush holder. Press the claw pole rotor with a repair press and suitable support out of the drive bearing, holding the rotor in position.



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#### Pressing out rotor bearing

#### Testing the alternator for body contact

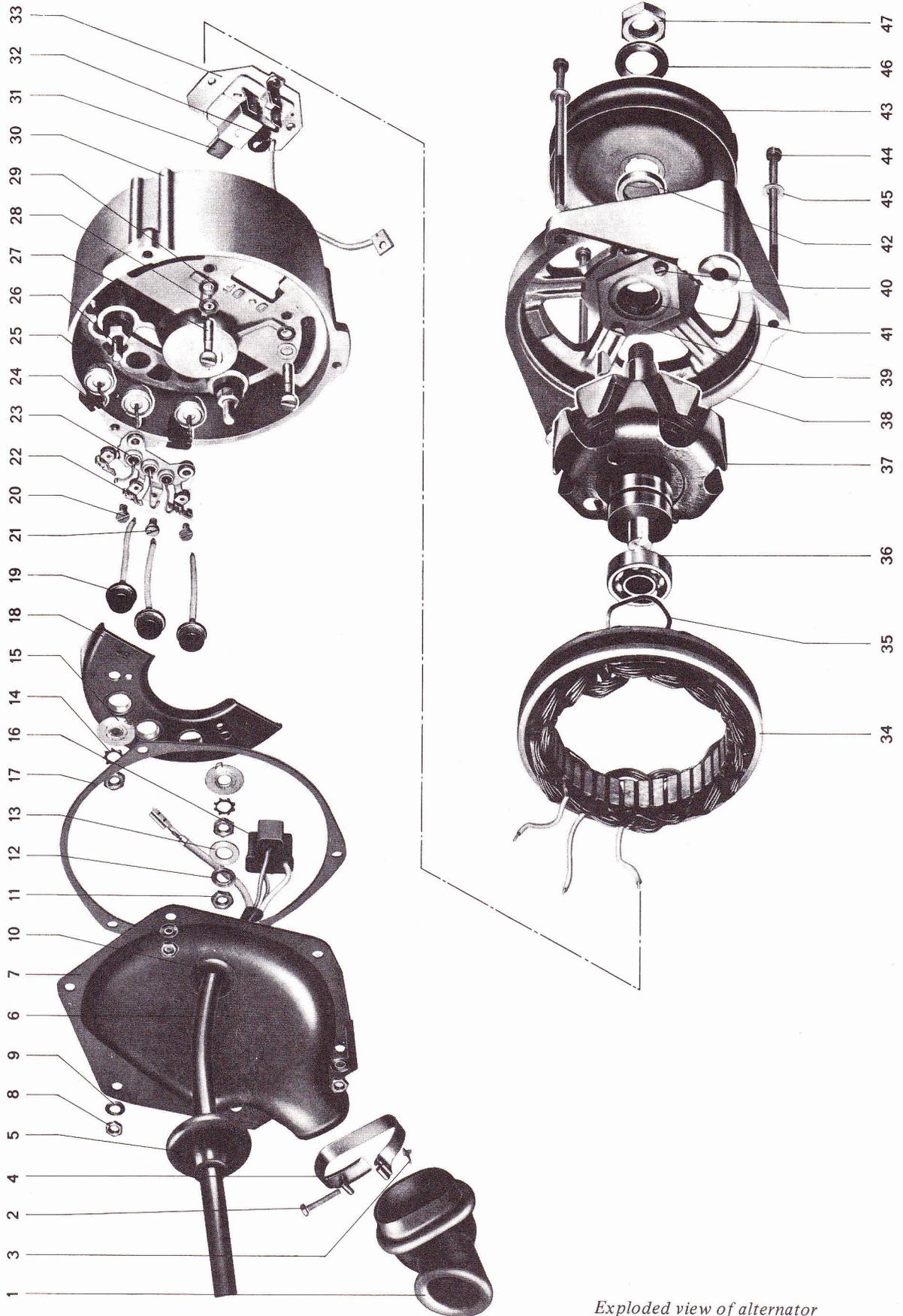
A test for a ground short circuit can be completed only when the negative diodes are in order. Defective negative diodes may simulate body contact. Set test type switch to the extreme right position. Place the black test point against the housing, and the red test point in sequence against the collecting points on the soldering strip. The alternator has body contact if, during all the three measurements the needle deflects against the stop toward the left.

#### Disassembly

Test the alternator with the alternator tester EFAW 192 (Bosch) or an Ohmmeter in accordance with test instructions given under inspection procedure. Hold a pulley in recesses provided and loosen the fastening nuts. Remove the pulley (use three-legged puller, if required). Mark the position of the swivel arm in relation to the housing.

Press off the ball bearing at the slip ring end on a repair press using a suitable fixture. The ball bearing can also be pulled off with a claw-type puller against the inner race. When the ball bearing is pulled off at the outer race, a new ball bearing must be installed.

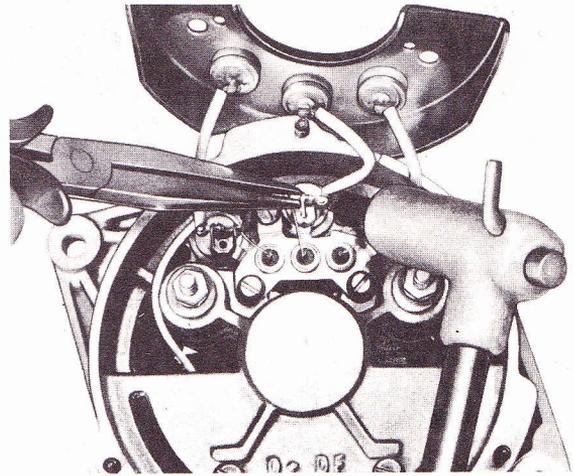
Prior to disassembling the slip ring bearing further, test the diodes with diode tester EFAW 192 (Bosch) or with an ohmmeter. The diode carrier should not rest against housing, since this will falsify the measurements.



Exploded view of alternator

- |  |   |                                 |
|--|---|---------------------------------|
| 1 - Elbow connector                                  | 18 - Positive diode carrier                     | 33 - Brush holder plate         |
| 2 - Screw for hose clip                              | 19 - Positive diodes                            | 34 - Stator                     |
| 3 - Thread connection for hose clip                  | 20 - Cheeshead screw                            | 35 - Spring washer              |
| 4 - Hose clip  | 21 - Connecting screw for stator winding        | 36 - Ball bearing, slip ring    |
| 5 - Rubber sleeve for line layout to engine sheeting | 22 - Exciting diode carrier                     | 37 - Claw pole rotor            |
| 6 - Wiring alternator                                | 23 - Exciting diodes                            | 38 - Bearing plate              |
| 7 - Suction cover for alternator                     | 24 - Seal                                       | 39 - Ball bearing bearing plate |
| 8 - Hex. nut   | 25 - Negative diodes                            | 40 - Cheeshead screw            |
| 9 - Spring washer                                    | 26 - Fastening bolts for positive diode carrier | 41 - Ball bearing, drive end    |
| 10 - Rubber sleeve for suction cover                 | 27 - Fastening screws for brush holder          | 42 - Intermediate ring          |
| 11 - Hex. nut for B+ connection                      | 28 - Washer                                     | 43 - Pulley                     |
| 12 - Washer  | 29 - Spring ring                                | 44 - Housing screw              |
| 13 - Washer  | 30 - Alternator housing                         | 45 - Washer                     |
| 14 - Serrated washer                                 | 31 - Carbon brush                               | 46 - Washer                     |
| 15 - Contact washer                                  | 32 - Pressure spring for carbon brush           | 47 - Nut M 14x1.5               |
| 16 - Plug housing, 3-pole                            |   |                                 |
| 17 - Seal for suction cover                          |   |                                 |

Loosen the connecting line to the exciting diodes on the exciting diode carrier. Unscrew the fastening screws for the brush holder. The brush holder can then be removed. Unsolder the connections of positive diodes, negative diodes and stator winding from the soldering strip of the exciting diode carrier, using pointed pliers. The individual parts of the alternator may be washed with gasoline or trichlorethylene for short periods only.



© Volkswagen

*Using pliers as heat sink*

### Inspecting and repairing

Test the stator with an ohmmeter for ground short circuit. Test the resistance of the stator windings between phase outlets. Resistance rating:  $0.2 + 0.02$  ohms.

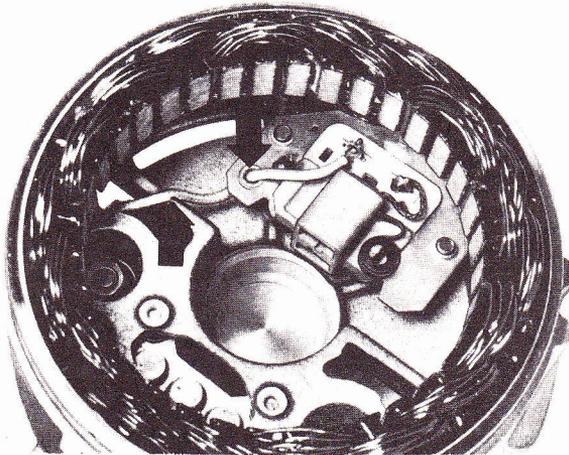
Test the claw pole rotor for body contact (with ohmmeter). Measure the exciting winding (field rotor) with the resistance measuring switch. Resistance rating:  $4.0 + 0.4$  ohms. Note that the slip rings should be machined in a special shop only. The minimum dia. is 31.5 mm, the max. permissible runout 0.03 mm and the max. permissible runout for field spider 0.05 mm.

### Installing the diodes

Coat the diode seat with silicon oil prior to installation. Use a pressing-in punch for installation. Following the installation of the diodes, measure all the diodes with tester EFAW 192 or with an ohmmeter. Prior to installing the exciting diode carriers, solder the three connecting lines of the positive diodes from below to the exciting diode carrier. Use rosin-core solder only. Upon installation of the exciting diode carrier, solder the line outlets of stator winding negative diodes as well as exciting diodes to soldering strip. Solder carefully so that the negative diodes are not overheated.

### Installing the brush holder

Pull up the carbons prior to installation and hold. Screw the connecting line to the exciting diode carrier, watching out for correct layout of the line.



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Installing brush holder

**Starter testing while installed**

A faulty starter should first be tested at terminal 50 of the magnetic switch for the required voltage of at least 7 Volts for pulling. If the voltage is under that rating, the electric system, and in particular the lines of the starter circuit must be checked.

Testing the starter for pull at full battery voltage can be done by lifting the car and crossing terminals 30 and 50 on the starter. If the starter meshes perfectly, the fault is in the line to the starter. If the starter does not mesh, remove and check.

**Testing when removed**

Function and output of the starter can be checked on a starter test stand. At least a 135 ampere hour battery should be used. The indicated test sequence should be maintained to prevent any faulty measurements by heating of the starter or battery discharge.

**Idling test**

Place the starter on a test stand and adjust the pinion for correct distance to ring gear of braking fixture. The meshed pinion should enter the flywheel teeth with its entire tooth width. Connect starter, terminal 30, to battery + and test stand control line to terminal 50 of the magnetic switch. During the idling test, the starter is operated in such a manner that the pinion is in full mesh with the flywheel teeth and the flywheel is not braked. These measurements determine the speed, the power input and the battery voltage. During idling operation, the starter speed should be high and the power input low. This will indicate that there is no winding or ground short circuit and that the armature rotates easily in its bearings.

**Load test**

For the load test, the starter is braked from idling to a given speed (approx. 1,000 rpm) by means of the braking fixture of the test stand. During this test the power input and voltage are measured. The load test should not take longer than 10 seconds. Insufficient battery voltage or an

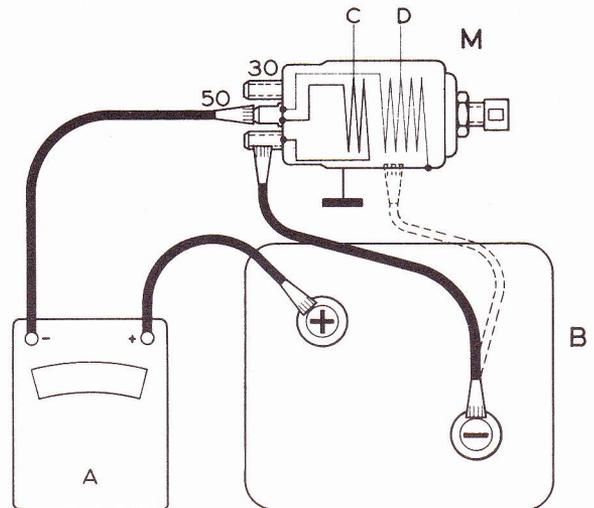
excessively heated starter will result in a lower speed. This test also permits inspecting the pinion for proper meshing in and out. Under light braking, the pinion should mesh in and out accurately when the starter is switched on or off.

**Short circuit test**

During the short circuit test the starter-driven flywheel is braked momentarily to a stop. The test should not take longer than 5 seconds. The short circuit power input is a power rating for the break-away torque created by the starter. The torque depends on the power input. Release the brake immediately after reading the measured values. Switch off starter only then.

**Testing the magnetic switch**

For judging the two coils of the magnetic switch only the power input need be measured. For this purpose, an ammeter and a battery are connected to the switch. The test values are 35 A for a draw-in coil and 11 A for holding coil. Magnetic switches with defective pulling or holding coil cannot be repaired.



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Testing magnetic switch

- A - Ammeter
- B - Battery
- C - Draw-in winding
- D - Holding winding
- M - Magnetic switch

**RETRACTABLE HEADLAMP MOTOR**

**Removal**

Run the retractable headlamp completely up by means of the hand wheel. Pull the crank from the retractable headlamp motor, use a Kuko puller, if required. Unscrew the three fastening screws for the headlamp motor and remove the headlamp. Loosen the ground connection screw. Connection of headlamp cables: red to red, blue to grey, black to green.

The headlamp motor cannot be repaired.

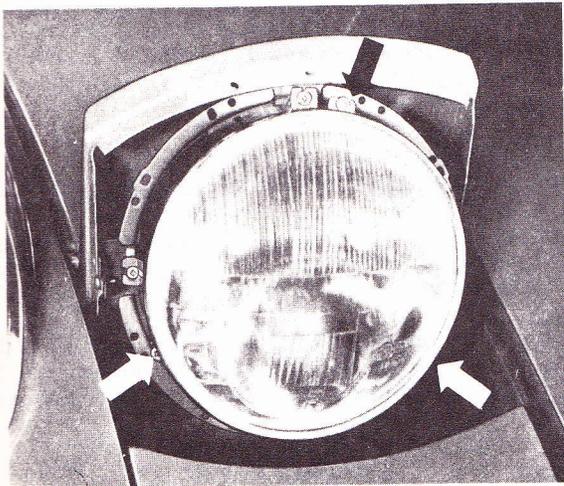
### Installation

Put the motor into "up" position of headlamps prior to installation. Connect negative to the brown line (cable shoe), and to the red and blue lines. The motor will run into its end position and remain there automatically. If the motor does not start, see if it is in its end position already. This is done by connecting plus to both the black and the red line, which will cause the motor to run into the position "down". Then let the engine run again into position "up". For this purpose, the standard relay, spare part No. 901 615 109 01, must be inserted into the relay holding bracket.

### RETRACTABLE HEADLAMPS

#### Removal

Actuate the headlamp switch. Disconnect the battery ground connection cable. Loosen the three screws of the front panelling and remove the panelling. Loosen two screws of the rear panelling and remove. Remove the rubber cover on bulb socket and pull lines from contacts. Loosen three screws of headlamp, not the two adjusting screws, and then remove the headlamp.



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*Headlamp securing screws*

### Installation

To install reverse the removal procedures.

#### Aiming with headlamp adjuster

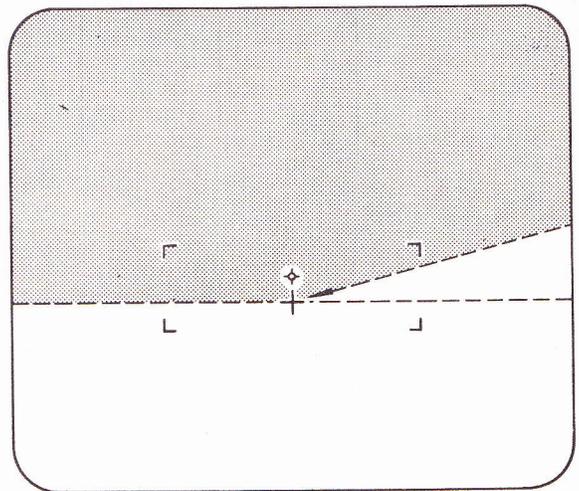
When using headlamp adjusters of other makes, the operating instructions of the manufacturer must be observed. Headlamp adjustments obtained with such equipment must meet legal regulations.

Position the vehicle as vertically as possible in relation to the adjuster. Check the specified tire pressure and correct it, if required. Load the vehicle with one person or 154 lb. on the driver's seat. Push the vehicle back and forth several feet so that the suspension conforms to load conditions. Move the adjuster in front of the headlamps

and set the distance between the focusing lens in the optics carrier and the headlamp to approximately 10 inches. Move the adjuster in front of the vehicle center and switch on the light beam projector.

Direct the light beam left and right to one prominent point of vehicle each (for example upper edges of retractable headlamps). The aiming is done by loosening the pedal lever on the column guide. Move the adjuster in front of headlamp and align to the headlamp center. The deviation of the optical axis (headlamp - optical carrier) may amount to a maximum 1.18 inch vertically or laterally. Set the inclination of headlamp on scale of knurled disk to 10. Adjust the headlamps with the dimmer switched on. Remove the front plastic cover on the headlamp.

Adjust the headlamps vertically in such a manner that the border line between the light and dark runs at the left of the adjusting cross horizontally on the adjusting line. Adjust the headlamps laterally in such a manner that the border line between light and dark runs along the sloping line (15°) and the break in the border between bright and dark is in the center of the focusing cross. With the border line between bright and dark of the dimmer accurately positioned, the center of the high beam should be on the focusing cross. The permissible deviation is 0.4 inch to the right and left, 0.3 inch toward the top and 0.2 inch to the bottom.



© Volkswagen

*Headlight pattern*

#### Aiming without adjuster

The headlamps can be aimed by using an adjustable, vertical surface. The test surface should be light in color and must be provided with markings for the centers of the headlamps and a marking for the border line between light and dark.

Position the vehicle 16.5 ft. from test surface on level

ground. The test surface should be vertical in relation to the direction of driving and the separating line should be parallel to the base of the vehicle. The tires should be inflated to the specified pressure. Move the vehicle several feet back and forth to settle the suspension. Check the headlamps individually. Always cover the other. Aim the headlamps vertically and laterally with the dimmer switched on, with the vehicle loaded with one person or 155 lb. on driver's seat.

Aim the headlamps vertically in such a manner that the border line between light and dark to the left of the focusing cross proceeds horizontally along adjusting line. Aim the headlamps laterally in such a manner that the border line between light and dark proceeds along-side the sloping line ( $15^{\circ}$ ) and the break of the border line between light and dark is accurately in the center of the focusing cross.

### HALOGEN HIGH BEAM HEADLAMPS

#### Removal

Unscrew the front deflector plate and trim. Unscrew the fastening screw of the headlamp and remove. Loosen the fastening screw of the reflector. Remove the reflector from the housing and pull off the lines.

#### Installation

Reverse the instructions for removal. Then aim the headlamps as per instructions given under Aiming Headlamps.

#### Aiming

The high beam is adjusted with the retractable headlamps covered. Align the adjuster to the high beam center. Set the inclination scale to 10. The center line of the high beam should be against the upper focusing cross, that is, when the luxmeter indicates maximum light intensity. The high beam radiates parallel to the lane. Halogen headlamps can be adjusted vertically only.

### FAULTS IN HEADLAMP SYSTEM

#### Excessive voltage drop

If in spite of accurate aiming of the headlights, the illumination is insufficient, check the voltage on the headlamp connections. The reason for weak headlamps is often an excessive voltage drop caused by loose line connections, defective switch contacts or bad ground connection. The fusebox can also be the cause of excessive voltage drop as a result of corroding transition points between the fuse and the holder. At a voltage drop of only 10% the light intensity will drop by approximately 30%. The voltage drop in the headlamp lines should generally not exceed 0.6 Volt.

#### Bulb not in order

Another cause of unsatisfactory light may be the position of the filament in the bulb. The bulb or the socket can also be badly inserted.

#### Aiming without an adjuster

The high beam is adjusted with the retractable headlamps covered. In addition, the general instructions given for the retractable headlamps apply. The center of the light beam should be at the same height as the bulb center. The high beam headlamps are adjustable only in height, but not laterally. Loosen the fastening screw of headlamps for making adjustments.

### FRONT BLINKER AND SIDE MARKER LAMP

#### Description

The front blinker and side marker lamps are installed in the front fenders. The rear blinker lamps are in the brake-blinker-tail lamps. The blinker switch is installed in the steering column switch. The two indicating lamps for the blinker system are installed in the time clock. They indicate which directional blinker is switched on. With the warning lamp system switched on, one indicator lamp in the pull knob of the warning lamp switch indicates the function of the warning lamp system. When the warning lamp system is actuated with the ignition switched on, the indicator lamp for the blinker system in the speedometer will light up.

#### Removal and installation

Loosen the two window screws and remove. Loosen screw nut (SW 10) inside the fender. Pull off the spring ring and washer. Remove the fastening clamp. Pull out the blinker and side marker lamp in the forward direction. Pull the rubber sleeve and line from the socket.

Proceed vice versa for installation. Spray contact lugs with contact spray, if required. The lamp sockets are not exchangeable.

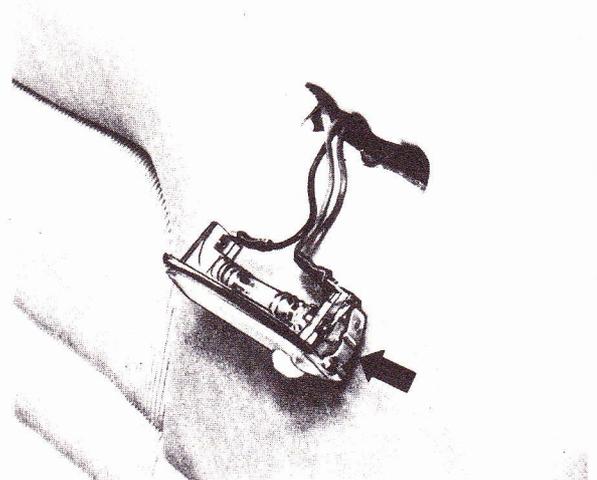
### INTERIOR LAMP

The interior lamp in the backrest between the two seats can be switched on and off by means of the installed switch, as well as by the switch position "top" above the door contact switch.

#### Removal and installation of bulb

Disconnect the negative battery cable. Apply a screw driver to push back the clamping spring behind the headlamp housing and pull the interior lamp out of the backrest cutout. Replace the bulb, making sure to have a good seat and good contact of bulb.

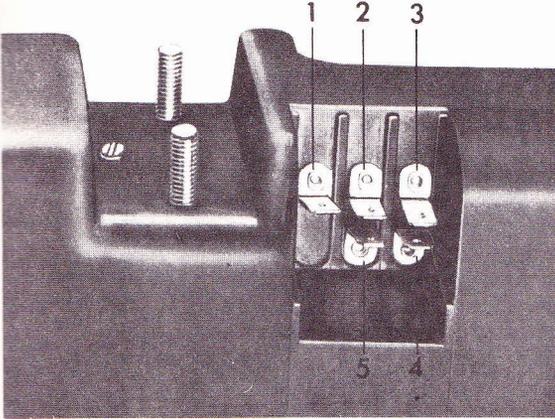
Proceed vice versa for installation. Be sure that the interior lamp is installed into backrest cutout with the clamping spring end first (watch out for the ground line).



Interior light remover

**BRAKE, BLINKER AND TAIL LAMPS WITH BACKUP LAMPS****Replacing bulbs**

The two triple chamber tail lamps with built-in backup lamps are installed in the rear side members and the rear end panel. Loosen the three plastic nuts from the trunk end and pull out the window toward the rear.



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*Tail light connections***Installation of bulb bracket**

Use original VW profiled rubber glue for glueing the rubber seal. Spray the contacts at their centers with contact spray, if required.

**TRUNK LAMP**

The trunk lamp has no switch of its own. It is connected in parallel with the two license plate lights and lights up together with the parking lamp.

**BULB BRACKET FOR TRUNK LAMP****Removal and installation**

Loosen the felt cover and the two fastening screws. Remove the bulb bracket. Pull off the window. Disconnect the cable.

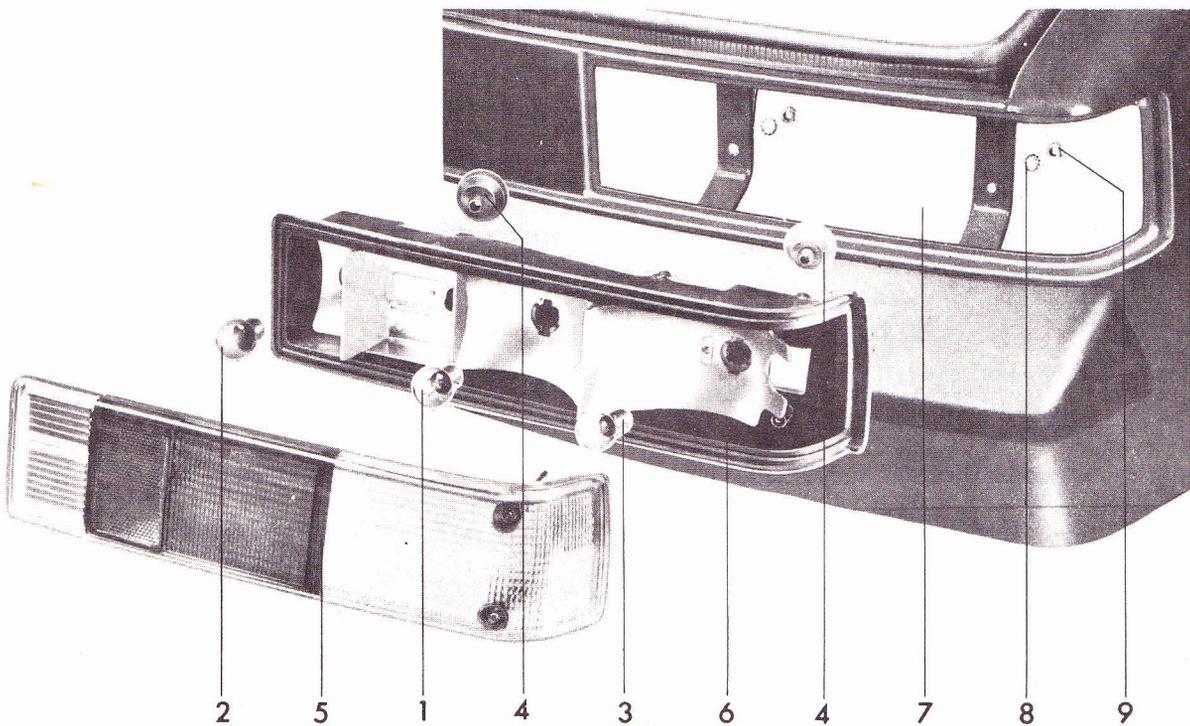
Proceed vice versa for installation.

**BRAKE LIGHT SWITCH****Removal**

Pull the accelerator pedal out of the trust rod in the rearward direction. Loosen the two hex. nuts for the floor board attachment and remove the floor board. Loosen the fastening screws for the brake light switch, remove the switch and pull off the cable connections.

**Installation**

Proceed vice versa for installation. The brake light switch must be adjusted.

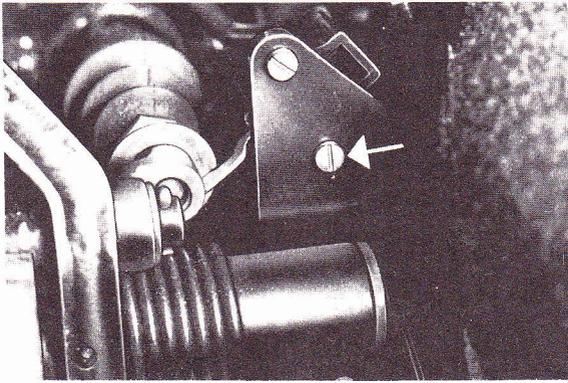
*Rear light assembly*

© Volkswagen

- 1 - Bulb for brake and parking lamp  
SL 12 V/21/5 W
- 2 - Bulb for backup lamp RL 12 V/21 W
- 3 - Bulb for blinker lamp (yellow)  
E 12 V/25 W

- 4 - Plastic nuts for window attachment
- 5 - Window for SBBR lamps
- 6 - Bulb bracket

- 7 - Recess for bulb bracket
- 8 - Notched washers
- 9 - Fastening nuts for bulb bracket

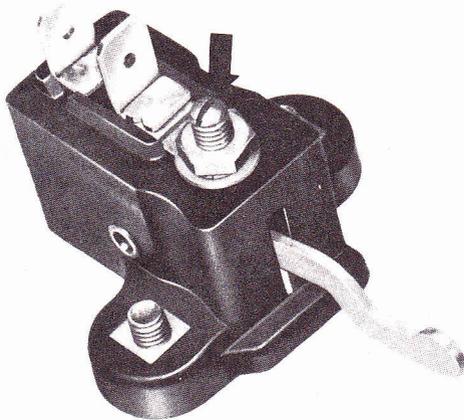


© Volkswagen

*Brake light switch screws*

**Adjusting**

The brake light switch is adjusted while installed. Loosen the counter nut and adjusting screw. Clamp a sheet metal strip 1/6 inch thick between the brake pedal lever and the brake pedal stop. Turn the adjusting screw until the brake lamp lights up. The cut-in point can also be checked with an ohmmeter. Remove the brake light switch and lock the adjusting screw. Reinstall the brake light switch, connect the cable and check the switch for proper function.



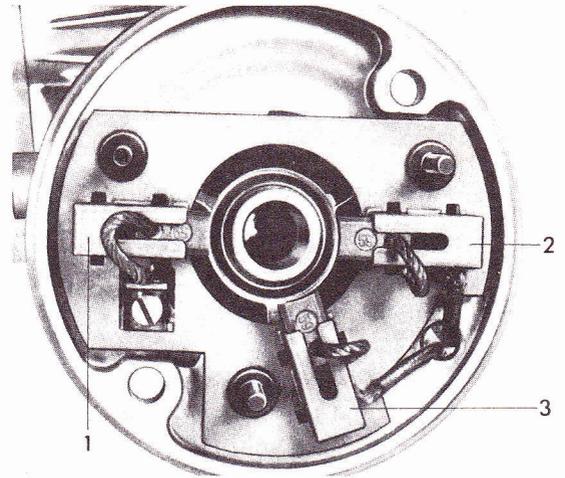
© Volkswagen

*Brake light switch adjustment screw*

**WINDSHIELD WIPER SYSTEM**

The windshield wiper motor, both wiper shafts and the wiper rod are mounted on a common frame. The wiper arms are attached to the serrated windshield wiper shaft with cap nuts. When the windshield wiper switch is turned to its first stop, the motor and contact plate on the worm gear are energized via terminal 53 of the switch. The system runs at its slowest speed. The brush holder plate is

provided with three carbon brushes, with one brush installed offset to the earth brush. In combination with the switch (terminal 53b) this brush serves for switching directly to full speed.



© Volkswagen

*Windshield wiper motor brushes*

- 1 - Earth brush
- 2 - Brush for slow speed
- 3 - Brush for high speed

**Inspecting while installed**

Measuring the current (by connecting an ammeter to the line toward switch, terminal 30) permits checking the operating condition of the system. The power input is 3.5 amps under fast operation and 2.5 amps under slow operation. These values are attained when with the system switch on the wiper arms and their blades are folded away from the windshield. Measuring with the wiper blades resting against the windshield will result in wrong values, since the friction pressure varies considerably as a result of the condition of blades and windshields.

If the input is considerably above the specified values and if the windshield wiper operates more slowly in combination with squeaking noises, the fault is mainly caused by non-lubricated bearings. Increased input without loud running noises indicates a short in the armature winding.

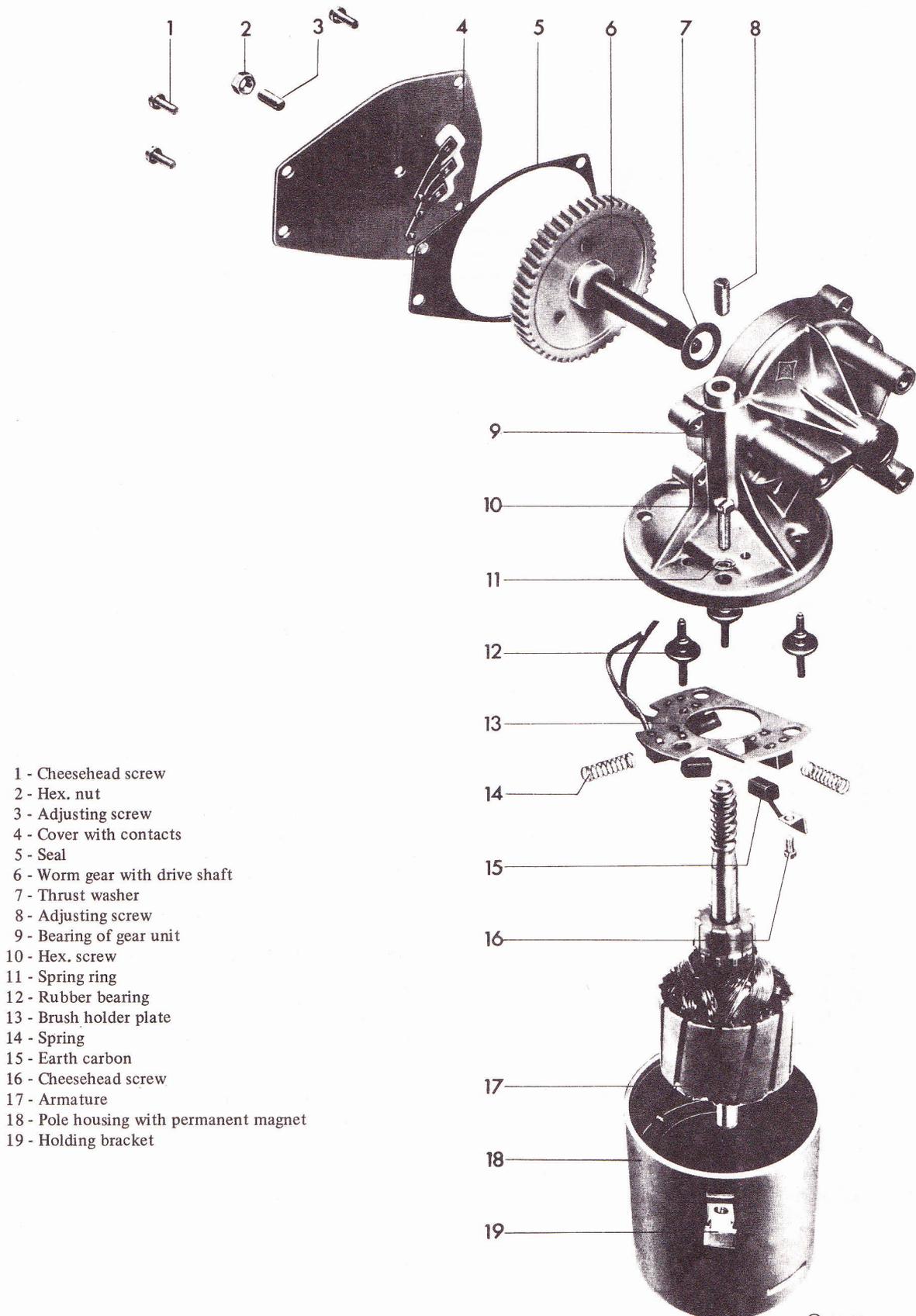
**WINDSHIELD WIPER MOTOR**

**Removal**

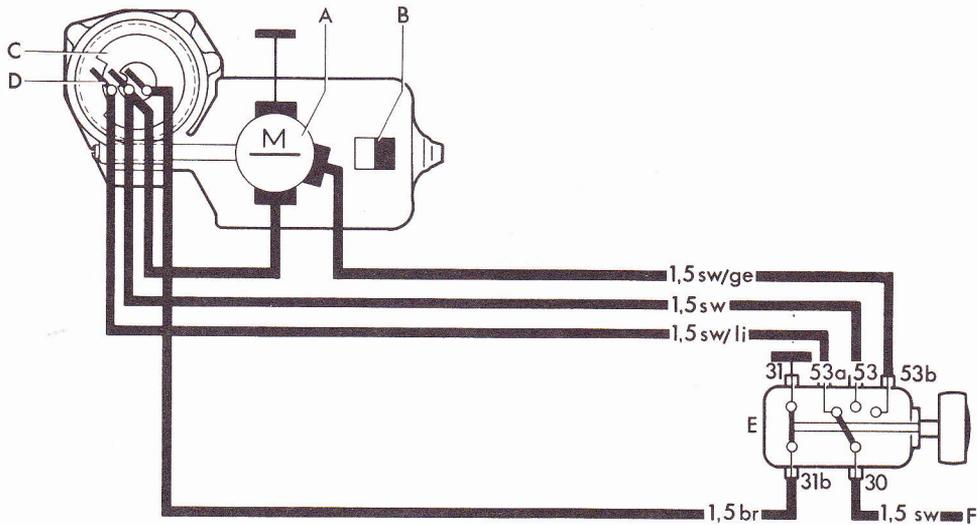
Remove the wiper frame complete with motor per instructions given under windshield wiper frame with motor-removal. Remove hex. nut and washer from the windshield wiper motor shaft. Pull the linkage drive crank from the shaft of the windshield wiper motor with puller. Loosen the three hex. bolts and remove the motor.

**Installation**

When installing the windshield wiper motor into the windshield wiper frame, move the windshield wiper motor



Windshield wiper motor assembly



© Volkswagen

Windshield wiper motor schematic

- A - Armature
- B - Permanent magnet
- C - Contact plate
- D - Sliding contacts
- E - Switch
- F - to fusebox (terminal 15)

into parking position prior to attaching the drive crank. Connect the ground wire from the engine to the ground of the battery. Connect the line from terminal 53 and 53a to the positive pole and run the motor for a few minutes. When the line is then disconnected from terminal 53, the motor will stop in its parking position. Then place the drive crank in parallel with the drive rod on the drive shaft of the worm gear and attach by means of a lock washer and a hex. nut. The parking position of the crank may vary by  $\pm 5^\circ$ .

**Inspecting disassembly**

If the collector is oily or contaminated, wipe with a clean cloth moistened in gasoline. If the collector shows traces of wear or burnt spots, reconditioning is required. Machining of the collector is permitted to a maximum 0.8 in. only. The insulation between the laminations is then refinished with a collector saw. Make sure that no metal chips collect between the laminations, so that no short circuit between the armature windings will result. The permissible radial wobble of the armature is 0.0012 in. Damages on the armature are often not seen from the outside. The electrical checkup also includes a test for interruptions, as well as for winding and grounding shorts. These tests are conducted in a manner similar to measurements on the armature of the alternator.

**WINDSHIELD WIPER FRAME WITH MOTOR**

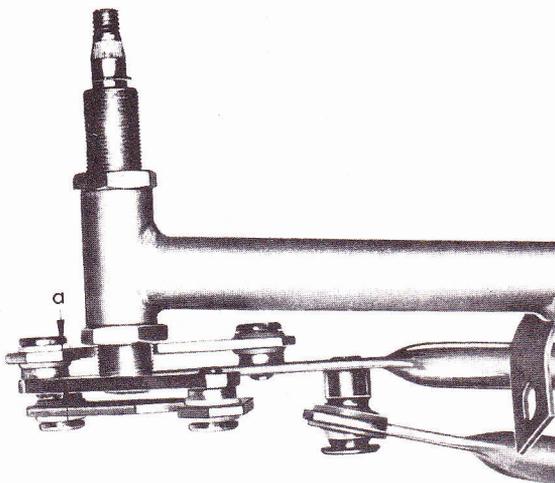
**Removal**

Disconnect the battery ground. Unscrew the cap nut on the clamp piece of the two wiper arms and remove the arms. Remove the bearing cap, unscrew the hex. nut, and remove the hollow washer and rubber seal. Remove the container. Remove fresh air blower housing, referring to the chapter body.

Loosen the hex. nut of rubber/metal anti-vibration bearing from the interior of the vehicle (under the instrument panel), making sure that the anti-vibration bearing is not twisted. Pull out the windshield wiper frame with motor in a downward direction. Disconnect the lines.

**Installation**

Connect the lines according to a wiring diagram. Insert the windshield wiper frame with motor. Make sure that the anti-vibration bearing is in the bore provided. Screw the hex. nut to the anti-vibration bearing, holding the bearing



© Volkswagen

Setting position of crank

a = 0.33 in.

in position to prevent distortions. Position the windshield wiper arms, observing the parking position of arms. Connect the battery and check the windshield wiper system for function. Install the fresh air blower housing and fuel tank. When installing a new or repaired windshield wiper motor, be sure that the motor is in the parking position.

### WINDSHIELD WIPER SHAFT

#### Removal

For removing the wiper shaft, remove the complete wiper frame together with motor. Remove the motor from the windshield wiper frame. To pull the two wiper shafts from the wiper bearings, remove the circlips from the wiper shafts by means of pointed pliers and a rubber hammer. Apply only light blows against the pointed pliers with a rubber hammer.

#### Installation

Rub the shafts prior to installation with molybdenum disulphide ( $\text{MoS}_2$ ) grease. Watch out for correct and tight seat of circlips. The distance between the bottom hex. nut and the crank should be 0.33 in.

### WORM GEAR

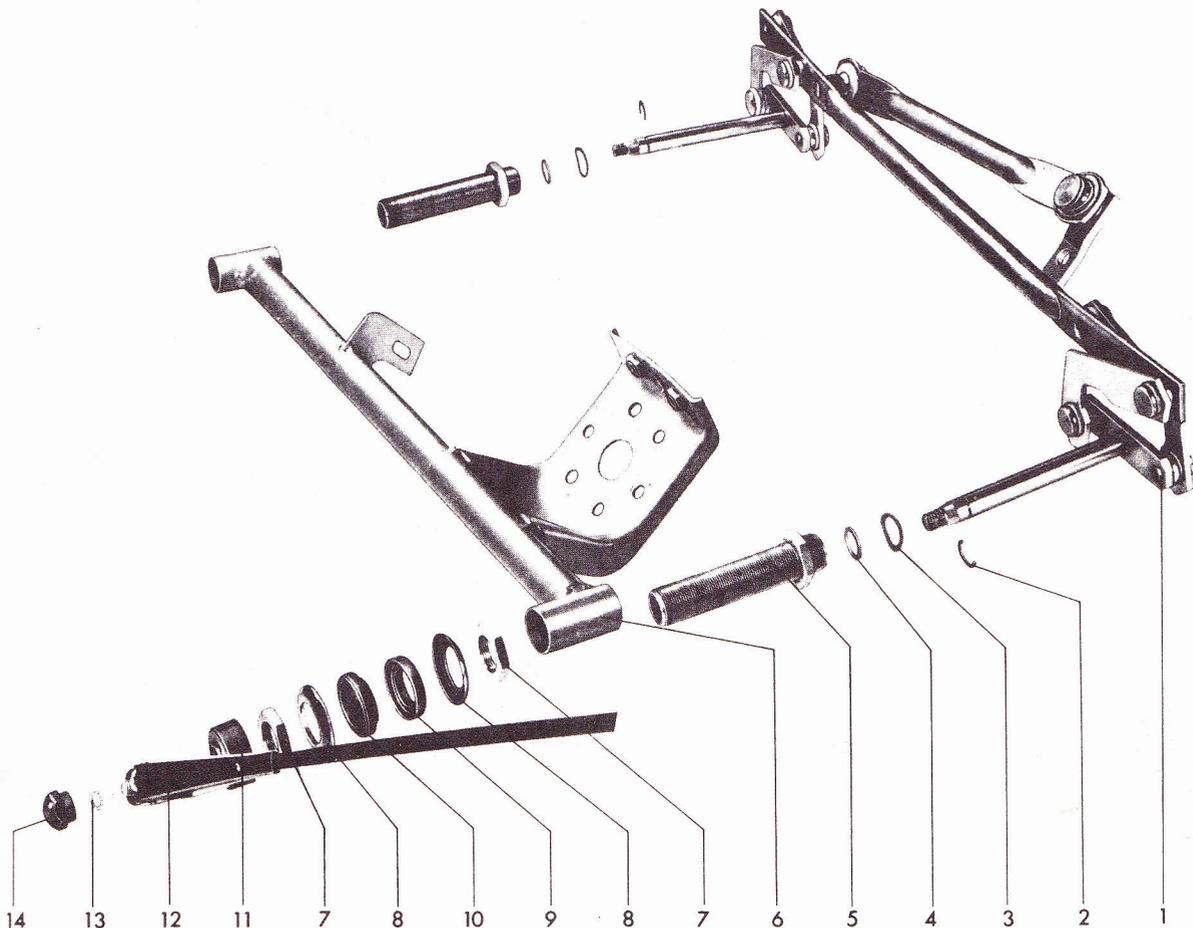
#### Adjusting end play

The end play should be approximately .008 inch. To adjust loosen the counter nut. Screw the adjusting screw carefully up to stop and then screw back by 1/4 turn. Counterlock the adjusting screw.

### ARMATURE

#### Adjusting end play

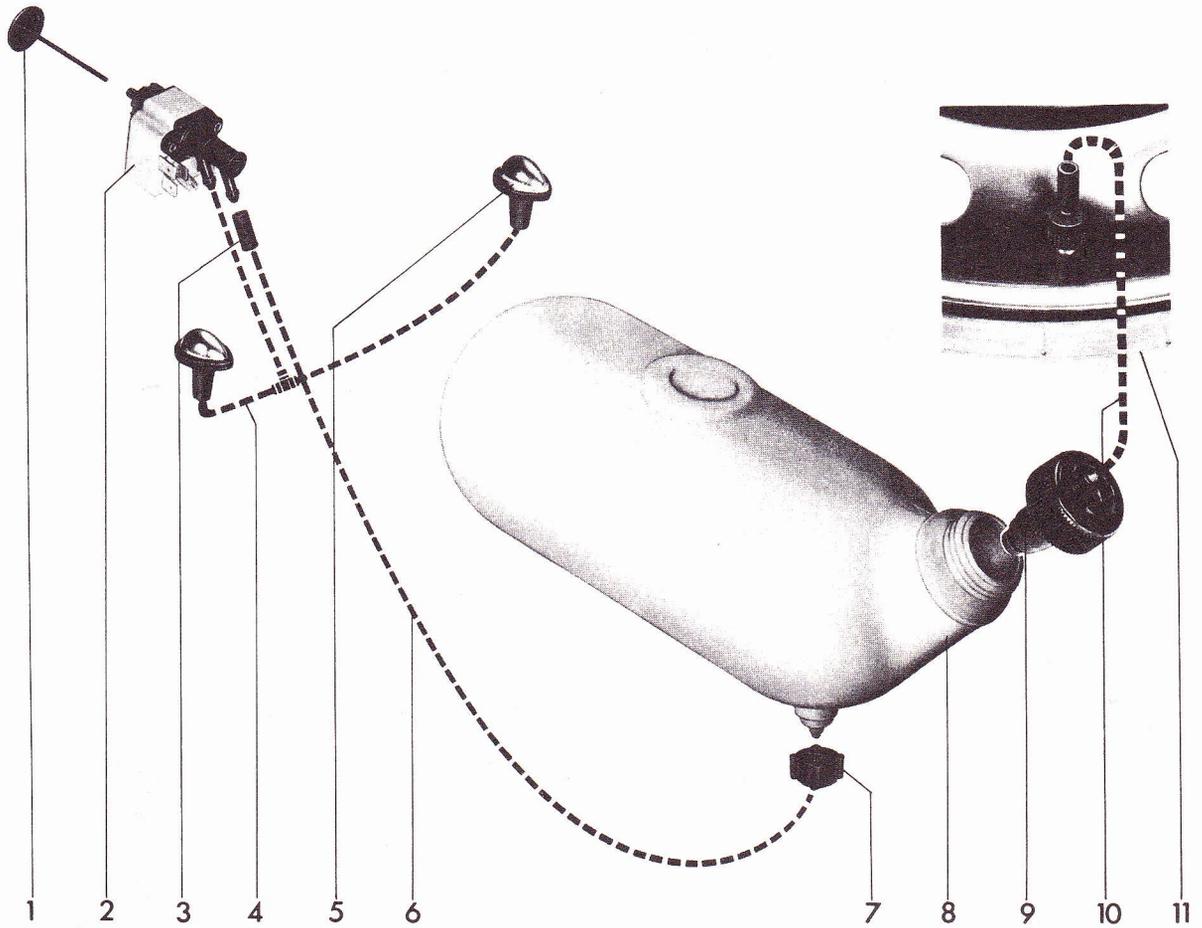
The play should be approximately .008 inch. Adjustments are made similar to the end play adjustment of worm gear.



Windshield wiper linkage

- |                            |                           |
|----------------------------|---------------------------|
| 1 - Wiper linkage          | 8 - Hollow washer         |
| 2 - Circlip                | 9 - Bottom rubber seal    |
| 3 - Spring washer          | 10 - Top rubber seal      |
| 4 - Washer                 | 11 - Bearing cap (rubber) |
| 5 - Shaft bearing          | 12 - Wiper arm            |
| 6 - Frame for wiper system | 13 - Washer               |
| 7 - Hex. nut               | 14 - Cap nut              |

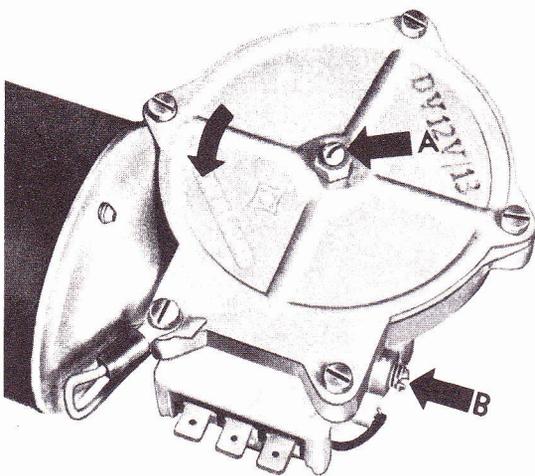
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Windshield washer assembly

© Volkswagen

- |   |   |                                  |
|---|---|----------------------------------|
| 1 - Releasing Button                            | 5 - Double spray nozzle                     | 9 - Rotary closing cap           |
| 2 - Switch with valve insert                    | 6 - Hose between fluid container and nozzle | 10 - Compressed air tapping hose |
| 3 - Rubber sleeve                               | 7 - Coupling nut                            | 11 - Spare wheel                 |
| 4 - Hose with T-piece between switch and nozzle | 8 - Fluid container                         |                                  |



Wiper motor adjustment

© Volkswagen

A - Gear end play

B - Worm gear end play

**WINDSHIELD WASHER SYSTEM**

The windshield washer cleans the windshield by using the windshield wipers. The fluid container is pressurized to a maximum 43 psi for a capacity of 1.5 lits. and is mounted at the right between the front trunk and the instrument panel. The excess air in the spare wheel puts the contents of the fluid tank under pressure via a plastic connecting line and a pressure tapping hose. A shutoff valve installed in the closing cap of the container disconnects the compressed air when the air pressure in the spare wheel is down to 28 psi, so that the minimum pressure in the spare wheel will be maintained. The excess pressure in the fluid tank will force the washing fluid to the two spray nozzles under the windshield.

To protect the washing fluid against freezing during the winter, add a window cleaning agent of pertinent concentration to the water. Fuel alcohol can also be used as an anti-freeze. In such a case, a mixture of one part fuel alcohol and three parts water will provide anti-freeze protection up to approximately + 10°F.

**Removal**

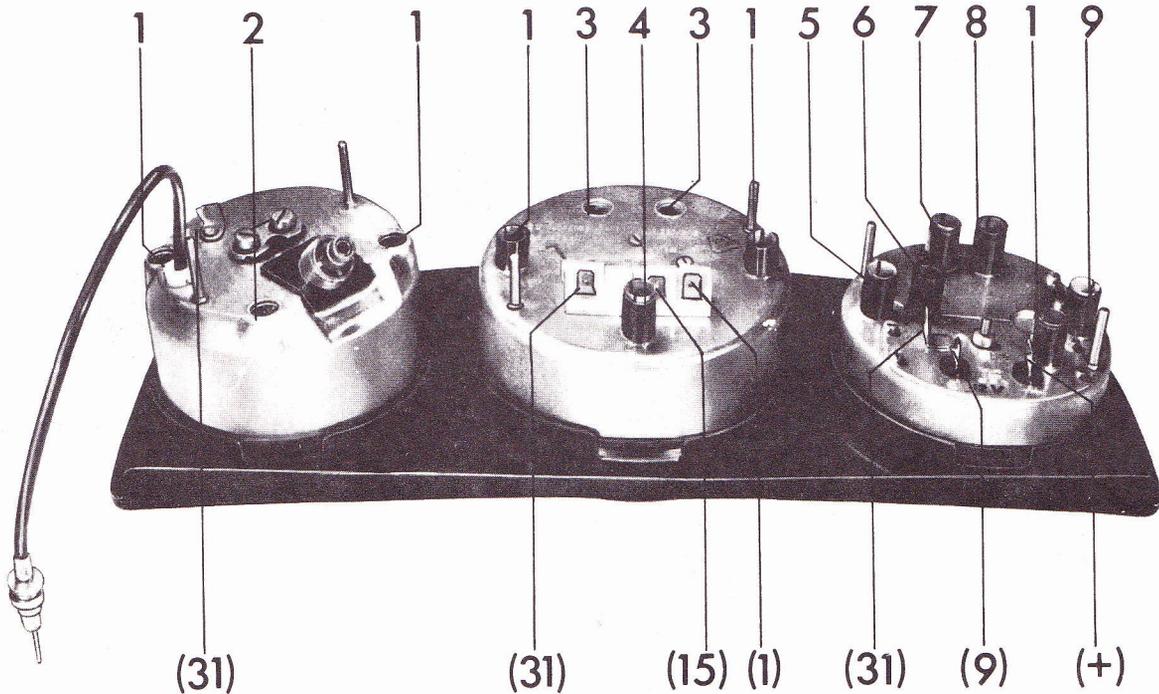
Disconnect the battery ground. Remove the steering wheel by removing the turn signal spoke by means of a short lefthand turn and unscrewing the hex. nut. Loosen the four screws of the instrument panel insert. Unscrew the speedometer shaft and Bowden wire of the tachometer.

Pull the complete instrument panel insert out in the

forward direction. Pull the lines and indicating lights, which will release the instrument panel insert. Push the individual instruments out in the forward direction, making sure that the pertinent rubber clamping ring is not damaged. Remove the clamping ring, if required.

**Installation**

Proceed vice versa for installation. Connect lines to individual indicating points according to a wiring diagram.

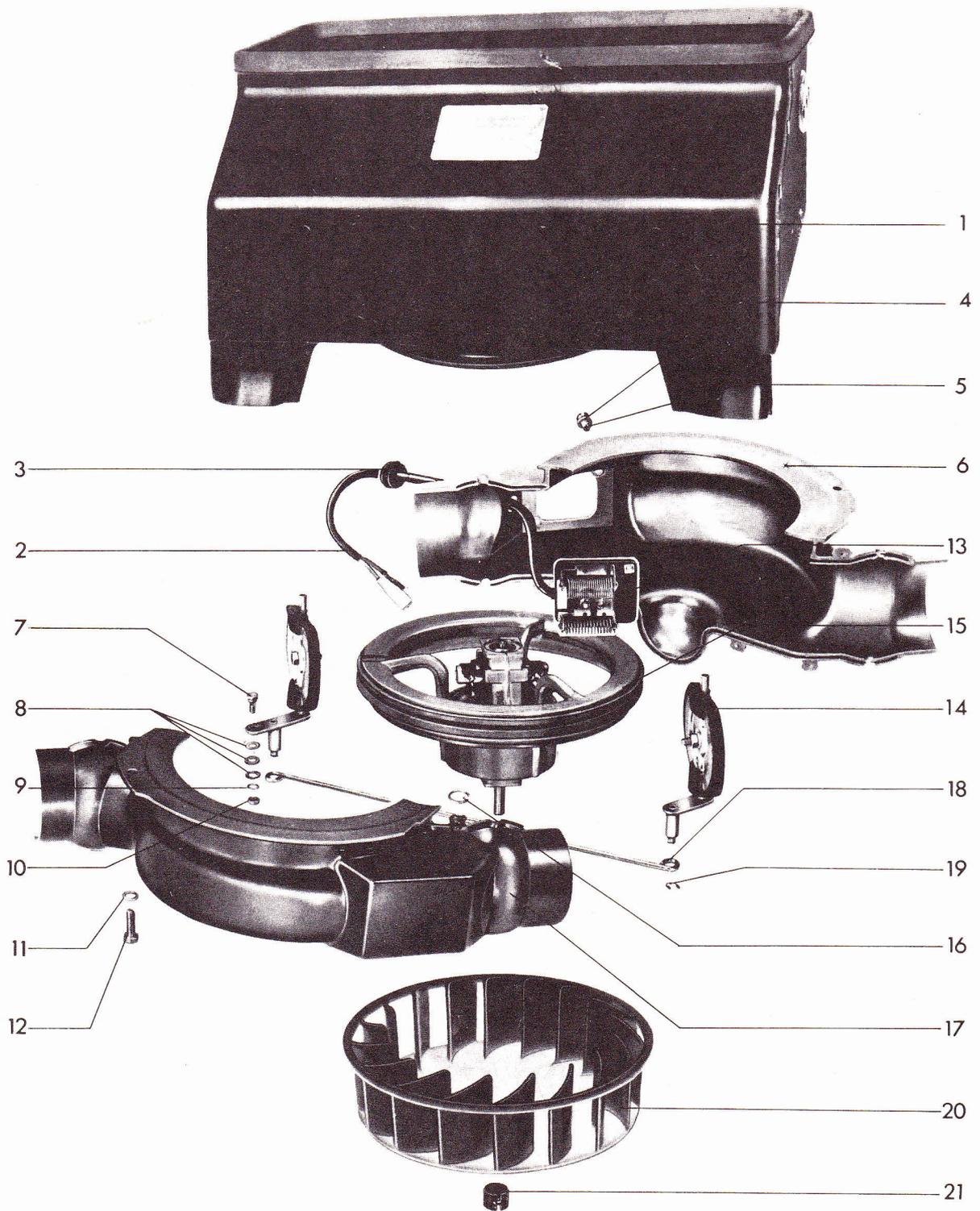


*Instrument lights and wiring connections*

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The numbers in parantheses are the terminal designations.

- 1 - Instrument lights
- 2 - Side marker indicating light - green
- 3 - Blinker indicating light - green
- 4 - High beam indicating light - blue
- 5 - Charging control light - red
- 6 - Warning light fuel reserve - red
- 7 - Oil temperature warning light - red, only on 914/6
- 8 - Hand brake warning light - red
- 9 - Oil pressure indicating light - green



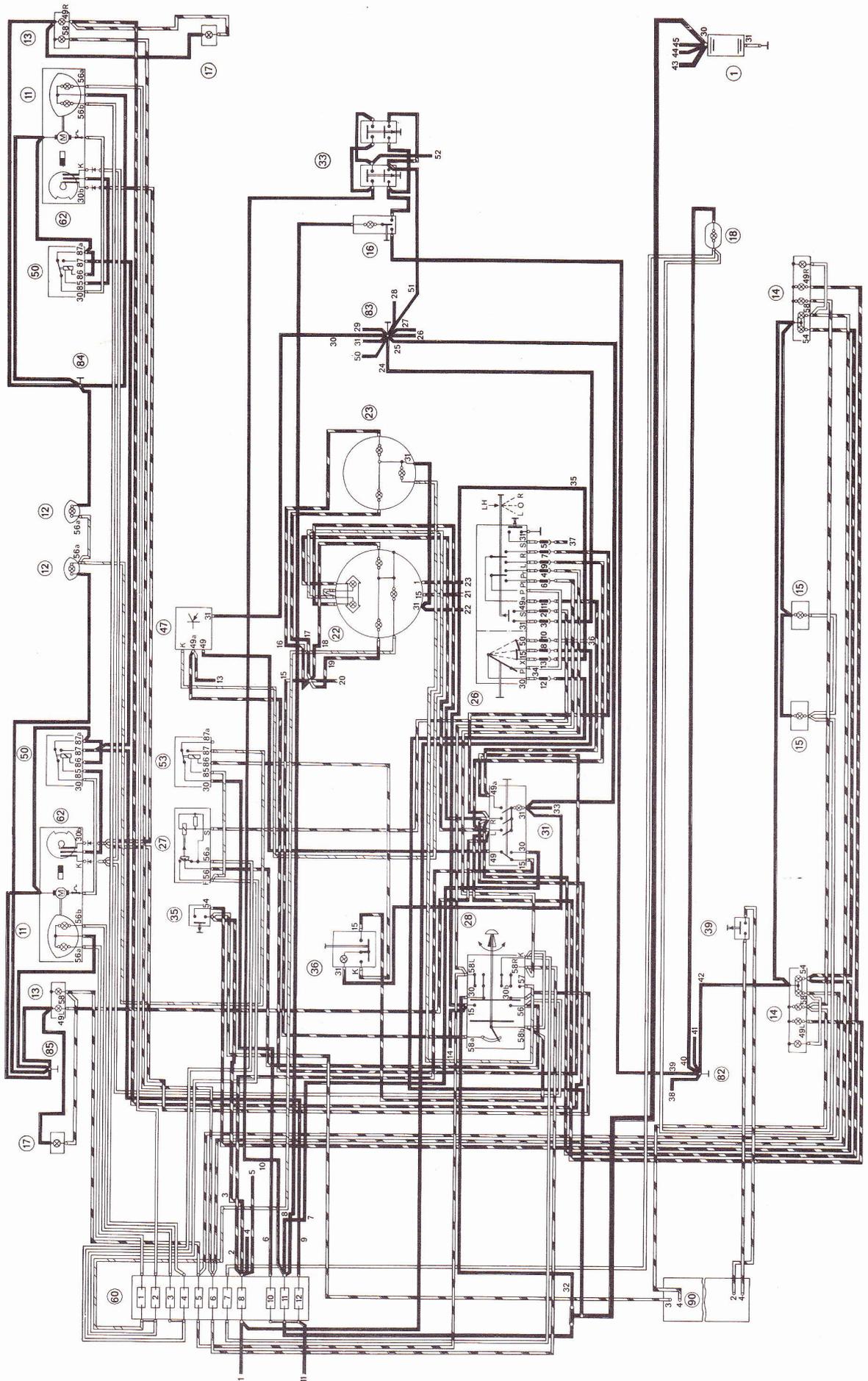
© Volkswagen

*Fresh air blower assembly*

- |  |  |                                |
|--|--|--------------------------------|
| 1 - Fresh air blower                   | 8 - Washer                             | 15 - Motor housing with motor  |
| 2 - Line                               | 9 - Lock washer                        | 16 - Clamping ring             |
| 3 - Cable sleeve                       | 10 - Hex. nut                          | 17 - Blower housing half front |
| 4 - Cheesehead screw                   | 11 - Lock washer                       | 18 - Connecting rod            |
| 5 - Washer                             | 12 - Hex. screw                        | 19 - Circlip                   |
| 6 - Blower housing half rear           | 13 - Bimetallic switch with resistance | 20 - Impeller                  |
| 7 - Screw for cable control attachment | 14 - Flap with seal                    | 21 - Spring clip               |



Elect. I - Electric wiring diagram (Part I)



*Elect. I – Electrical wiring diagram (Part I)*

**CAUTION!**

Disconnection of battery with the engine running will result in immediate destruction of alternator.

**FUSES:**

- |  |   |   |
|--|---|---|
| 1 Battery  | 31 Warning light switch                       | 1 High beam left  |
| 11 Headlamps   | 33 Door contact switch with buzzer contact    | 2 High beam right   |
| 12 Fog lamps (optional)  | 35 Brake light switch                         | 3 Dimmer left   |
| 13 Blinker-, clearance lamps   | 36 Switch for fog lamps (optional)            | 4 Dimmer right  |
| 14 Tail-, brake-, blinker-, backup- and side marker lamps                                | 39 Backup light switch                        | 5 Clearance light left  |
| 15 License plate lamp  | 47 Direction warning blinker indicator        | 6 Clearance light right   |
| 16 Interior lamp   | 50 Relay for retractable headlights           | 7 License plate light   |
| 17 Side marker lamps   | 53 Relay for fog lamps (optional)             | 8 Brake-, blinker-, backup light, windshield wiper, cigarette lighter |
| 18 Trunk light rear  | 60 Fuse box                                   | 10 (Fog lamps)  |
| 22 Transistor revolution counter   | 62 Motor for actuating retractable headlights | 11 Interior light, warning light, buzzer                              |
| 23 Speedometer   | 82 Ground connection point A                  | 12 Motor for actuating retractable headlights                         |
| 26 Steering ignition starter switch, dimming switch with signal button in steering wheel | 83 Ground connection point B                  |   |
| 27 Combination relay   | 84 Ground connection point C                  |   |
| 28 Light switch  | 85 Ground connection point D                  |   |
|  | 90 Regulator plate                            |   |

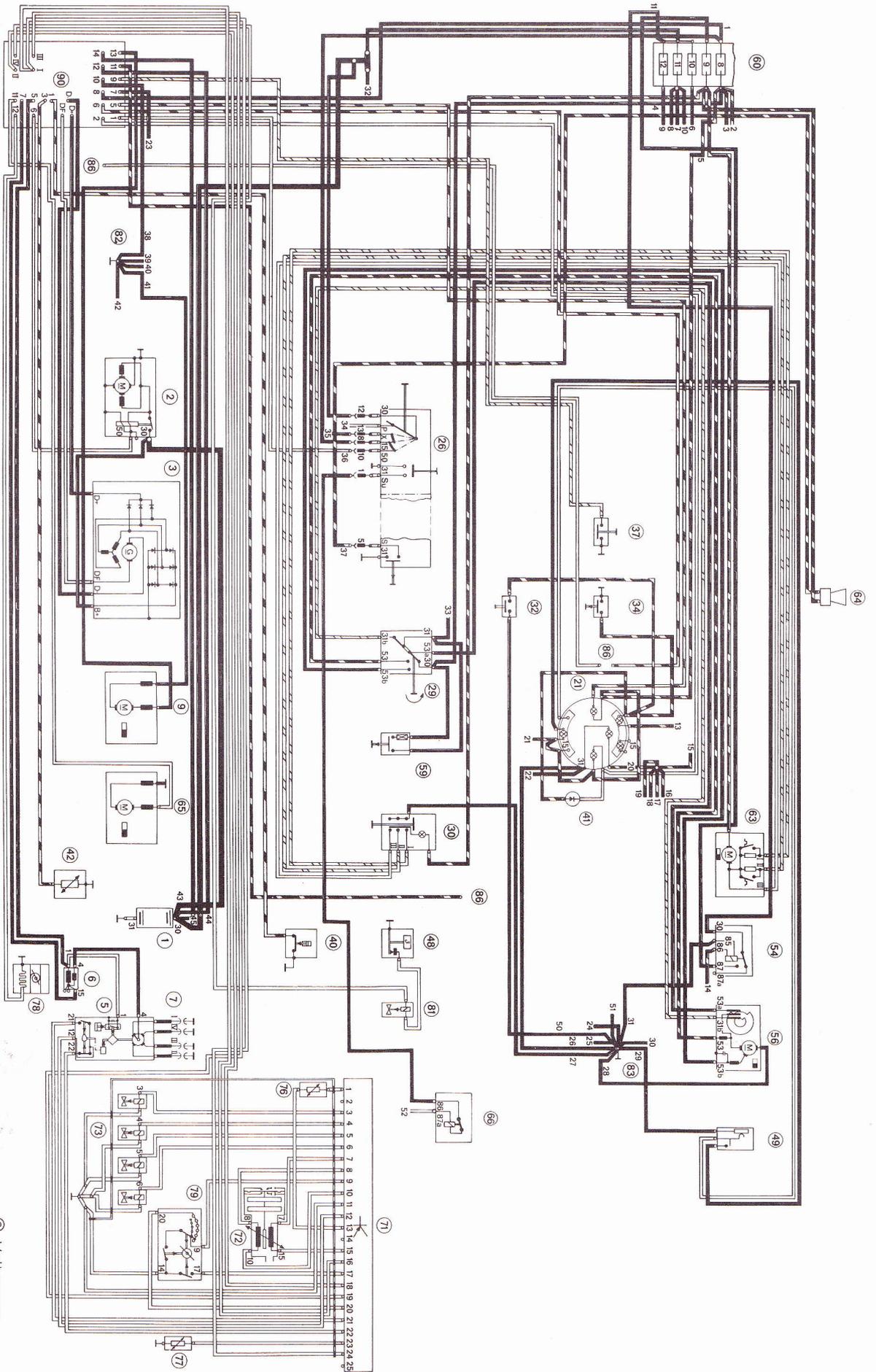
*Elect. II – Electrical wiring diagram (Part II)*

**CAUTION!**

Disconnection of battery with the engine running will result in immediate destruction of alternator.

**FUSES:**

- |  |   |   |
|--|---|---|
| 1 Battery  | 34 Hand brake contact                   | 66 Buzzer   |
| 2 Starter  | 37 Switch for heater blower             | 71 Electronic control unit for fuel injection                         |
| 3 Alternator   | 40 Oil pressure switch                  | 72 Pressure sensor  |
| 5 Ignition distributor   | 41 Diode                                | 73 Electric injection valve   |
| 6 Ignition coil  | 42 Oil temperature indicator (optional) | 76 Temperature sensor I   |
| 7 Spark plugs  | 48 Thermostat                           | 77 Temperature sensor II  |
| 9 Gasoline pump  | 49 Indicator for fuel gauge             | 78 Supplementary air valve  |
| 21 Combination instrument  | 54 Relay for fresh air blower           | 79 Throttle valve switch  |
| 26 Steering ignition starter switch, dimming switch with signal button in steering wheel | 56 Wiper motor                          | 81 Cold start valve   |
| 29 Wiper-washer switch   | 59 Cigarette lighter                    | 82 Ground connection point A  |
| 30 Fan and separate heater switch  | 60 Fuse box                             | 83 Ground connection point B  |
| 32 Brake warning switch  | 63 Fresh air blower                     | 86 Sportomatic (optional)   |
|  | 64 Horn                                 | 90 Regulator plate  |
|  | 65 Heater blower                        |   |
|  |   | 8 Brake-, blinker-, backup light, windshield wiper, cigarette lighter |
|  |   | 9 Fresh air blower, horn  |
|  |   | 10 (Fog lamps)  |
|  |   | 11 Interior light, warning light, buzzer                              |
|  |   | 12 Motor for actuating retractable headlights                         |



Elect. II - Electrical wiring diagram (Part II)

# BODY 14

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**DESCRIPTION**

The two-door unitized body of Type 914 is provided with an integrated roll bar and a detachable roof panel made of glassfiber-reinforced vinyl.

The body is subdivided by bulk heads into the front luggage compartment, the compartment for the fuel tank, passenger compartment, engine compartment and rear luggage compartment.

The body consisting of side and cross beams, bulk heads and door pillows, front and rear side members (fenders) and the roll bar is welded to the frame to form a unitized body.

The front and rear panels as well as side member panelling and the bumpers are made of steel sheet and bolted on.

The rear luggage compartment and the engine compartment have individual lids, the front luggage compartment and the compartment for the fuel tank have a common lid.

**Heating system**

The vehicle is equipped with a fresh air heater. The fresh air is heated by heat exchangers. The heat flow is generated by the engine fan or the electric fan. During city traffic with low engine speed, the electric fan supplies fresh air for the heater, at higher speed only the engine fan supplies the air.

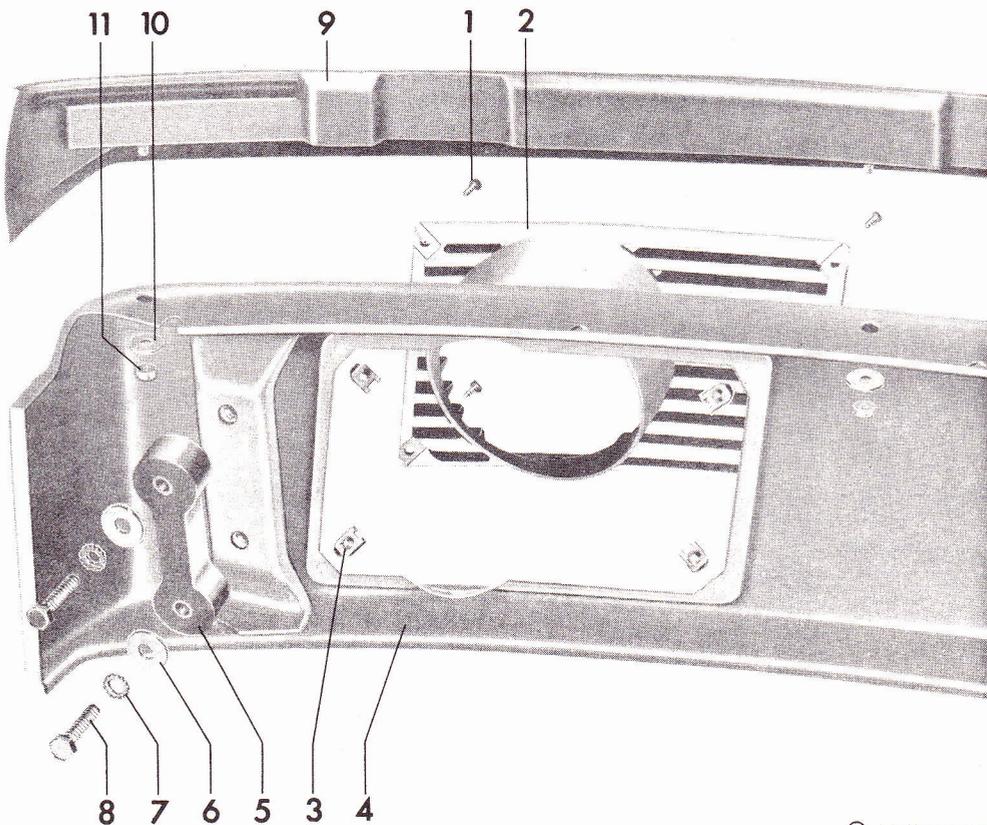
To operate the heater pull the lever with the red handle between the front seats up. In fully raised position an electric contact starts the electric fan.

The red lever in the center of the dashboard controls warm air supply by an air distributor to the defroster outlets as well as to the outlet for the footwell.

**FRONT BUMPER**

**Removal and Installation**

Unscrew the two hex. screws from the direction of the mudguard and remove the bumpers. During installation, a uniform spacing between the bumpers and the front overriders, as well as parallel alignment from bumper to



© Volkswagen

*Disassembly of front bumper*

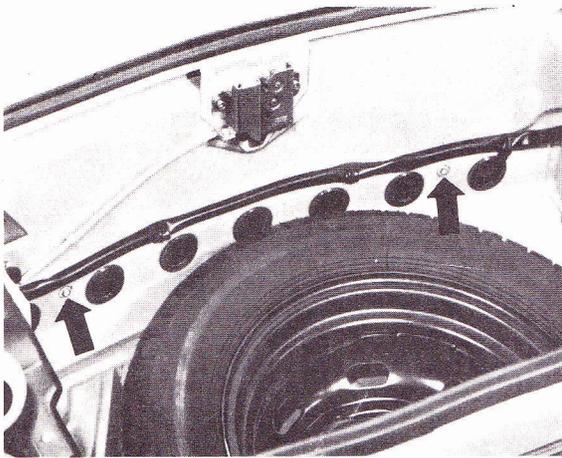
- |                            |                   |
|----------------------------|-------------------|
| 1 - Sheet metal screw      | 6 - Washer        |
| 2 - Sound-absorbing grille | 7 - Serrated disc |
| 3 - Sheet metal nut        | 8 - Hex. screw    |
| 4 - Bumper                 | 9 - Bead strip    |
| 5 - Shim                   | 10 - Washer       |
| End plate front            | 11 - Hex. nut     |

front lid should be attained before tightening the hex. nuts. Do not forget the washers and serrated discs.

**FRONT PANEL**

**Removal**

Remove the self tapping bolt from wheel housing side. Remove sheet metal screws from inside of the front trunk and remove the front panel.



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*Inside sheet metal screws*

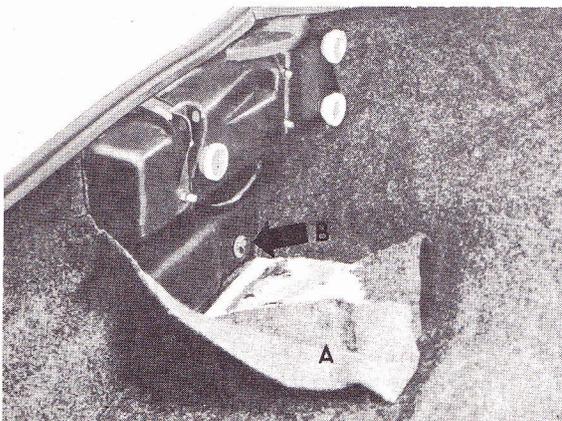
**Installation**

Loosely attach the front panel with the two sheet metal screws. Loosely attach the two sheet metal screws in the wheel housing. Align the front panel and tighten.

**REAR BUMPER**

**Removal and Installation**

Unscrew the license plate lights prior to removal. Unscrew one hex. screw each from under the mudguard. Pull the paneling and unscrew the hex. screw on each side from direction of the trunk. Remove the bumper.



© Volkswagen

*Luggage compartment screw*

During installation, make sure that a uniform distance between the bumper and the overriding rear, and that a parallel alignment in relation to the styling bead in the rear end plate, is maintained. Tighten the hex. screws. Do not forget washers and serrated discs.

**HOOD**

**Removal**

The work should be done with extreme care to eliminate any possibility of damaging the windshield vents. In addition, the vents should be covered. When the hood is used again, mark the position of the hinges on the inside hood plate with a tracing needle.

**Installation**

Make sure there is perfect seating and that the condition of hood sealing strips is good prior to installation. Prior to glueing new rubber sealing strips down, remove remainders of old glue with gasoline from the sealing ways, coat with original VW universal glue D 12 and let set. Then insert the new seal. When the same hood is put back again, align according to the hinge marks on the hood and screw it down well. No fitting of the hood is required.

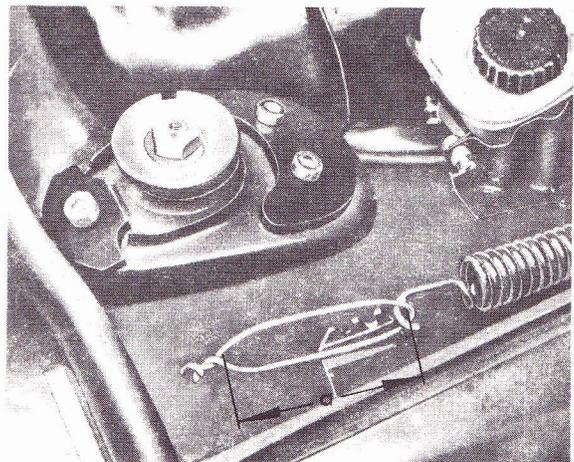
A new hood should be fitted prior to applying paint finish to prevent scratching. Screw the hood loosely to the hinges and shift in the oblong holes until a perfect seating and sealing is attained along its entire circumference. Then tighten the screws well. Align the lid at the level of the blinker lights by screwing the adjustable rubber buffer in or out. Check the operation of the hood lock by repeated opening and closing. Adjust the hood lock top in the oblong holes — or engaging depth of tap lock in oblong holes of cover lock bottom.

**HOOD SPRING AND HINGE**

The hood hinge can be installed only with the hood removed.

**Removal**

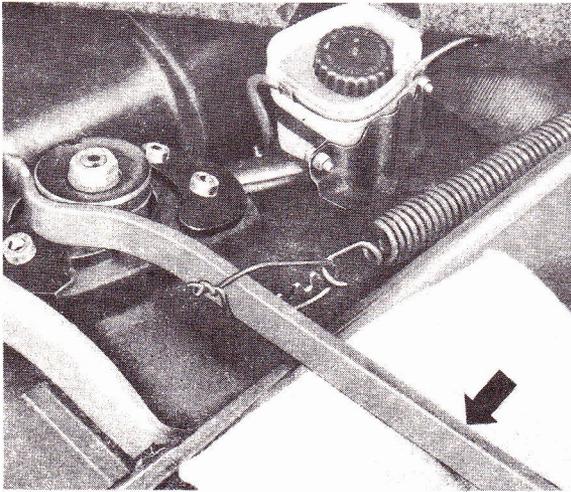
Bend the lug from the welding wire and attach it to the



© Volkswagen

*Spring installing (a - 4 in.)*

upper eye of the hood spring. Use a long mounting lever to remove the hood spring carefully from its mountings. The head of the spring strut is used as a counter support. The lateral section must be covered for this job. Unscrew the hinge from reinforcement wheel arch. Disconnect the hood spring from the hole on the hinge section of the cover. Loosen the hood hinge section by unscrewing the bearing pin from the wheel arch hinge section, if required.

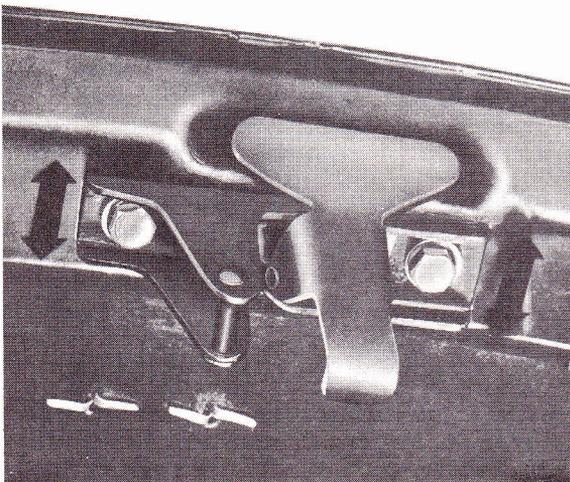


© Volkswagen

*Stretching the spring*

**Installation**

Screw the hood hinge section to the wheel arch hinge section. Attach the hood spring to the hinge section. Screw the preassembled hinge to the reinforcement of the wheel arch. Mount the hood and fit. Align the hinge in the



© Volkswagen

*Adjusting depth engagement*

oblong holes of the wheel arch hinge section for height, if required. Attach the hood spring carefully to the spring mount. The spring mount has three holding slots for the spring. If the preload of the spring is too low, attach it to another slot.

**HOOD LOCK TOP**

**Installation**

Replace the hood lock top, if required, but first try greasing with lock grease. Check for a perfect seat of the top by opening and closing the hood several times. If required, correct the seat of the top by shifting the assembly in the oblong holes. Check the operation of the safety hook. If required, unbend the bent tab on the hood lock bottom up to the engagement point of the safety hook. The engagement depth of the tap lock can be adjusted at the lid lock bottom by shifting the assembly in the oblong holes.

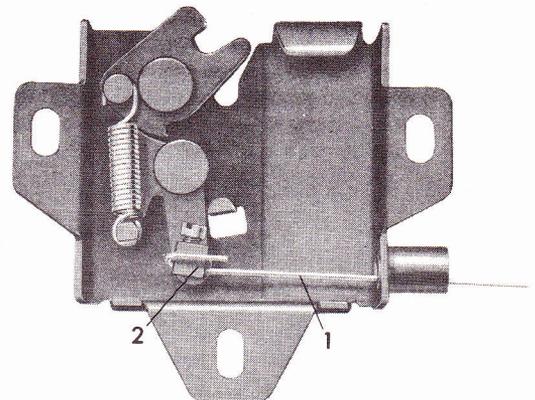
**HOOD LOCK BOTTOM**

**Removal**

Loosen the clamping screw for the lock cable controls. Unscrew the 3 hex. screws. Pull the bottom of the hood lock laterally from the hood lock cable controls.

**Installation**

When new cable controls are used, grease lightly when inserting them into the guide tube as a protection against corrosion. Slide the cable controls through the guide of the base and screw provisionally to the clamping piece. Screw the base to the front of the lock cross wall. Loosen the clamping screw, pull the cable controls tight and screw down. Then bend the cable controls behind the clamping piece.



© Volkswagen

*Lid lock*

1 - Cable controls

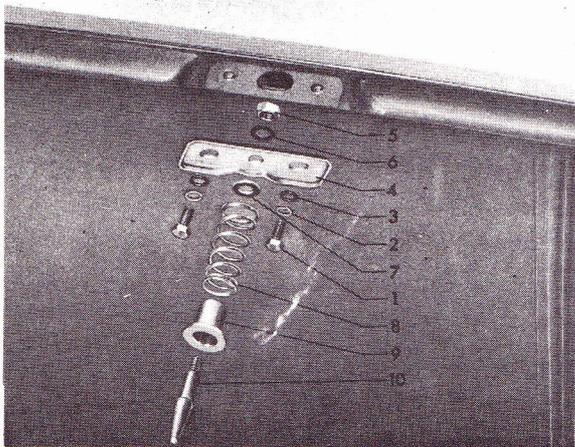
2 - Clamping piece

To check the lock cable controls for perfect operation, permit the latch to engage and disengage several times with the hood opened. Check for a perfect seat of lock bottom by opening and closing the hood several times. If required, shift the assembly in the oblong holes to correct the seat of the base.

**TRUNK LOCK TOP**

**Removal and installation**

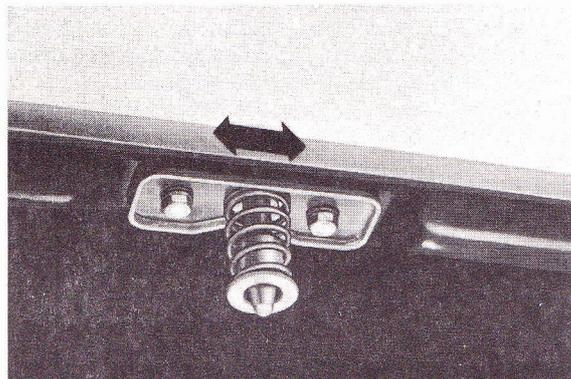
The lid lock top with lock tap can be adjusted lengthwise and crosswise in the rectangular cutouts for the fastening screws. Screw the lid loosely to its hinges and shift in the oblong holes until a uniform seating and sealing is obtained along the entire circumference. Then tighten the screws. Align the lid in relation to the lateral member by screwing the adjustable rubber buffers in and out. Check the operation of the lid lock by repeatedly opening and closing the lid. If required, adjust the lock top in the rectangular cutout or change the depth of engagement of the lock tap by adding or removing spacer washers between the molding and the lock top.



© Volkswagen

*Rear lid lock*

- |                  |                      |
|------------------|----------------------|
| 1 - Hex. screw   | 6 - Undulated washer |
| 2 - Locking ring | 7 - Spacer washer    |
| 3 - Washer       | 8 - Spring           |
| 4 - Molding      | 9 - Bushing          |
| 5 - Hex. nut     | 10 - Lock tap        |



© Volkswagen

*Rear lid lock adjustment*

**LID LOCK BOTTOM**

**Installation**

Check the locking cylinder and replace, if required, but first try greasing or using graphite. Insert the locking cylinder from the outside through the hole in the end plate. Watch the installation position of the locking cylinder in relation to the end plate. The snap lock is installed correctly when the closing tap points in, between the two upper grooves of the end cross wall when in the opened position.

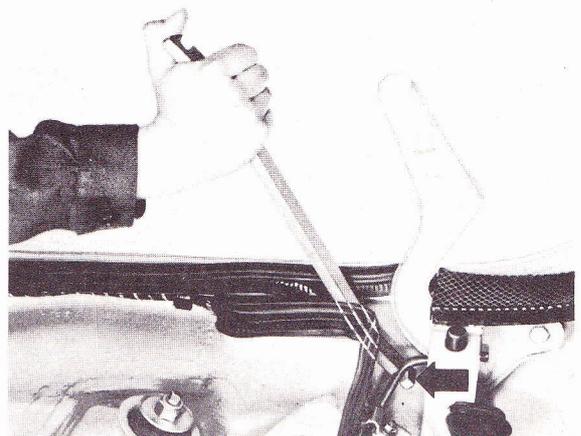
Fit the spacer bushing to the snap lock with the flat surface toward the end plate. Screw the hex. nut to the snap lock and tighten. Check the lid lock top and replace, if required, but first try lubricating. Then screw the lock to the lid supports.

**TRUNK HINGES AND TORSION ROD**

**Disassembly**

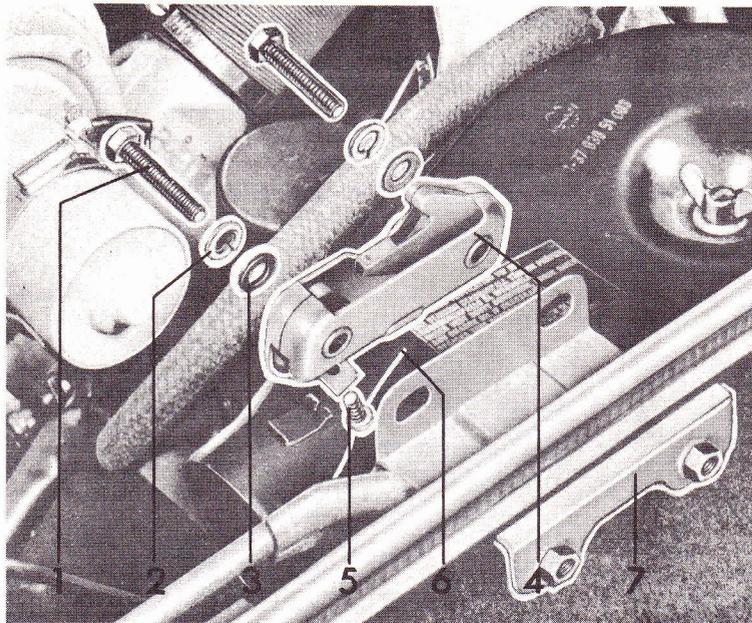
The two torsion rod springs assist in opening the trunk lid and hold it in the open position. Use caution when removing the trunk lid as the torsion rod springs are under tension.

Remove the trunk lid as described under trunk lid removal. Place assembly tool P 304 (local manufacture) behind the upper bend of the torsion rod spring. Always position the assembly tool in such a manner that the opening of the slot faces the center of the vehicle. Remove the torsion rod from the guide roller by pushing the guide roller sideways with a screw driver until the torsion rod clears the roller. Allow the torsion bar to press the assembly tool against the body. Hold the torsion bar with a box wrench and remove the assembly tool. Slacken the spring completely. Continue to release the tension using the box wrench. Remove the two clamps then pull the torsion rod to the right out of the welded-on retaining eye. Remove shoulder bolt: the hinge can be removed.



© Volkswagen

*Removing torsion rod spring*



- 1 - Hex. screw
- 2 - Locking washer
- 3 - Washer
- 4 - Lid lock base
- 5 - Clamping screw for lock cable controls
- 6 - Lid lock cable controls
- Lid support
- 7 - Holding plate

© Volkswagen

*Engine compartment lid lock*

**Assembly**

Install the hinge and position the guide roller. Install the torsion rod and align it with the guide roller. Tighten the securing clamps. Preload the torsion bar spring with a box wrench until the assembly tool (P 304) can be positioned behind the upper bend. Remove the box wrench and set the spring on the guide rollers using a screw driver.

**ENGINE COMPARTMENT LID**

**Removal**

Using the two mechanics, unscrew one hex. screw each. Carefully remove the lid.

**Installations**

Prior to installation, watch out for a perfect seat and condition of the seals between the engine compartment lid and the rear window. Use a new seal, if required. A new lid must be fitted prior to painting to eliminate subsequent scratching. Screw the lid loosely to the hinges and align to provide a uniform distance laterally and at the rear, so that a reliable seal will be provided between the lid and the rear window. Then tighten the screws well. Align the lid in relation to the lateral engine compartment molding by screwing the adjustable rubber buffer in or out. Check the operation of the lid lock by opening and closing it several times. Change the depth of engagement of the lock hook by screwing it in or out.

**TORSION BAR SPRING**

**Removal**

Remove the tightening piece after unscrewing one cross-slotted screw. Disconnect one spring bar each at the left and right, and pull out. Water pump pliers may be used.

**Installation**

For installation, insert the spring, first into the guide holes, then attach and screw to the tightening piece.

**ENGINE COMPARTMENT LOCK**

**Removal**

Loosen the clamping screw for the lock cable controls. Unscrew the two hex. screws and remove the lid lock base.

**Installation**

Check the lid lock base, and replace, if required, but first try to lubricate it. New lid lock cable controls must be slightly greased when inserting into the guide tube.

Screw the lock cable controls provisionally to the clamping piece. Screw the base to the lock support. Loosen the clamping screw, pull the cable controls tight and screw down. Then bend the clamping piece.

Check the lock cable controls for perfect function. Engage and disengage the latch several times with the lid opened. Check for a perfect seat of the lid lock base by repeatedly opening and closing the lid: if required, shift the base in the oblong hole or change the engagement depth of the lock hook on the engine compartment lid by screwing it in or out.

**ENGINE LID GRILL**

**Installation**

Position the drip pan on the compartment lid pins and press on the clamping discs. Install the rubber stop with reinforcing elbow on the left side of the lid and tighten the screw. Connect the right side of the pan to the lid. Insert a spacer bushing and tighten the screw.

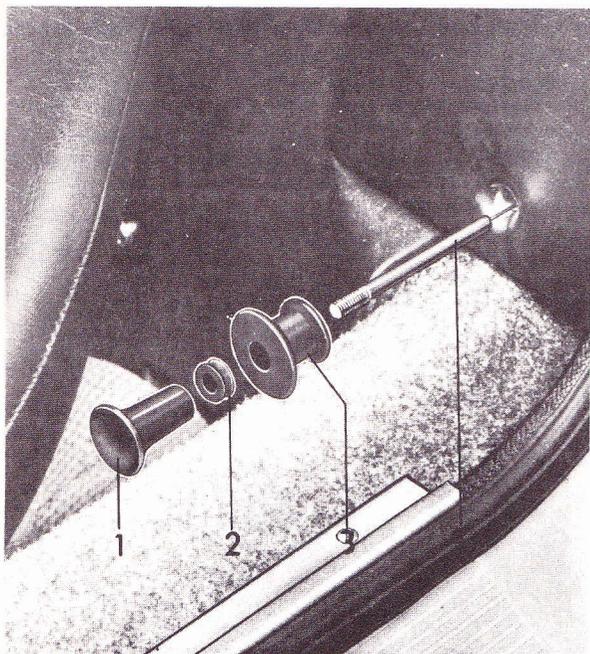
**ENGINE LID RELEASE CABLE**

**Removal**

To remove the grill, the engine compartment lid should first be removed.

**Assembly**

Install grill before painting to prevent any scratching later on. Place the seven plastic washers on the grill pins, then install the grill in the engine compartment lid. The plastic washers must be placed between the grill and the lid to prevent rattling. Press on the center and side edge molding.



© Volkswagen

*Engine compartment lid release*

- 1 - Lid release knob
- 2 - Rubber washer
- 3 - Retainer bushing
- 4 - Cable

**DOOR Removal**

Extract the pin for the door safety lock, after pulling out the cotter pin. If the same door is to be reinstalled, mark the position of the hinges on the hinge pillar with a tracing point. Unscrew the 6 hex. screws and remove the door. Spray rusted screws with a solvent or loosen by means of an impact screw driver.

**Installation**

Check the door seals and replace, if required. Glue in new seals using VW profile glue D 21. In the upper range of the door, the seal is glued under the outer window channel seal and clamped to the door inside panel with a spreader pin. If the same door is reinstalled, simply align in accordance with the markings on the hinge pillar. Fitting the door into the body cutout is not required.

When a new door is installed, proceed as follows: Screw on the door and fit into the body cutout in such a manner that a uniform all-around of the rubber seal is assured and

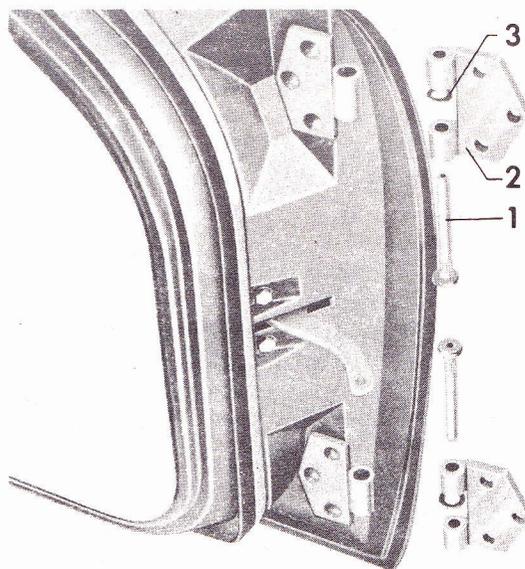
that the door can be opened and closed without jamming. This requires removal of the locking plate. The door hinges are screwed to movable, threaded, plates located in the hinge pillar. This permits reliable adjustment and fitting of the door to the external contours of the vehicle. Screw the locking plate back again and adjust in such a manner that the depression for the handle in the door is in alignment with the depression in the lateral member at the rear. Simultaneously, see that the door does not extend too far outwards or inwards. Lubricate the door hinges, coat the mating surfaces of the door catch housing on the locking plate and on the latch, lightly, with vaseline.

**HINGE PIN**

**Removal**

Pull the cotter pin out of the bearing bolt and extract the bolt for the door safety lock.

Remove the hinge bolt with special tool P 290, which can be used both, for the upper and the lower hinge pin by only changing the bottom section of the tool.



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*Door hinges*

- 1 - Hinge pin
- 2 - Hinge half
- 3 - Spring washer

**Installation**

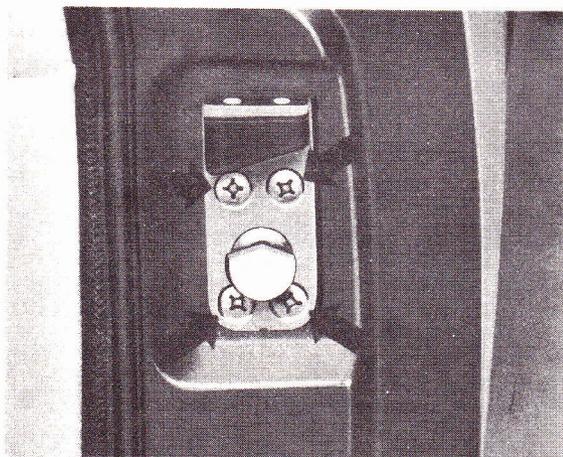
Insert the hinge half and spring washer into the hinge half on the pillar end. Force the hinge pins into the hinge from the door center. The pin is far enough in the hinge when it rests against the small lug. 1/4 inch will remain between the hinge and the collar to receive the extractor.

**DOOR LOCKING PLATE**

**Adjustment**

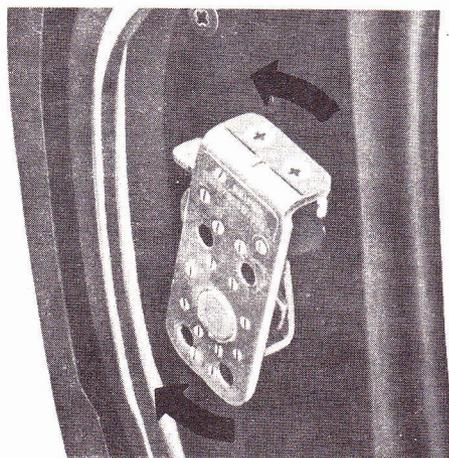
To eliminate any back-and-forth movements of the catch while driving, the locking plate is provided with a resilient

rubber-metal latch. This latch cannot be adjusted. Occasionally, door chatter cannot be completely avoided merely by adjusting the locking plate. In such a case, the locking plate need not be replaced. Simply place a sheet metal shim approximately 1/25 inch thick between the latch and the locking plate.



© Volkswagen

*Locking plate adjusting screws*



© Volkswagen

*Checking locking plate and catch*

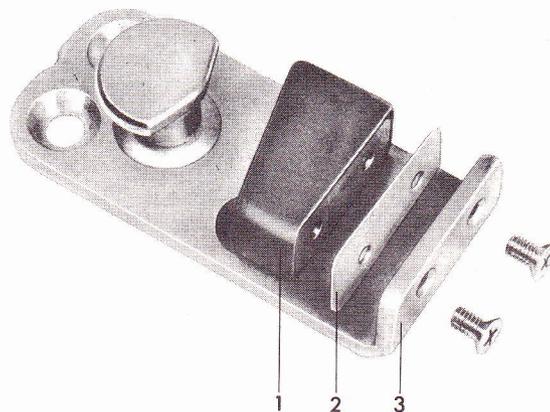
To check whether the latch is resting well against the latch of the locking plate, proceed as follows: Remove the locking plate. Insert the locking plate first at the bottom into the lock catch and then push down completely to the closed position. Then swing the locking plate around in an upward direction. If swinging the locking plate up and down in this position shows play, the latch must be

replaced or a shim must be added. For this purpose, unscrew two counter-sunk screws out of the angle portion of the locking plate. Insert the shim and reassemble.

Upon removal of the locking plate, the seating of the door in the door cutout is checked as follows: Tight seat of hex. screws for fastening the door hinges. Alignment of the door and front lateral member. Uniform distance between door and door cutout. Alignment of the door and rear side member. Alignment of the door handle depression with the depression inside the member rear.

If the above does not apply, proceed as follows: Loosen the hinges and displace the door as required inwards, outwards or upwards. Tighten the hex. screws well.

Install the locking plate and adjust. The plate is adjusted correctly if: the door is in alignment with the rear side member, the depression of the door handle is in alignment with the depression in side member rear, no play is felt between the lock and the latch when pulling or pushing door, the door can be opened from outside and inside without excessive energy.



© Volkswagen

*Locking plate assembly*

- 1 - Latch
- 2 - Shim
- 3 - Locking plate

A poorly adjusted locking plate can be adjusted as follows: If the door closes too tightly, the handle will be hard to move. The reason is, that the locking plate tilts too far inwards in the upper range. Correct the locking plate by rotating it to the short end of the latch.

If the door does not engage in its end position when it is slammed, but jumps back into the safety position, the locking plate is screwed down with too much outward tilt at the top. The door can be easily opened with handle. Correct the locking plate by rotating it toward the long end of the latch.

When the locking plate is set too high, the door is hard to

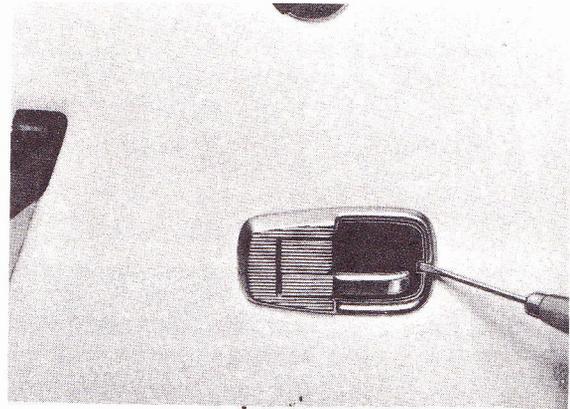
open by means of the handle. When the door is opened, it will not move out of the door cutout in parallel alignment, but will sag. Displace the locking plate in a downward direction.

When the locking plate is set too low, the door will merely engage in the safety position when slammed. But it will jump out of the end position. Displace the locking plate in an upward direction.

**DOOR PANELING**

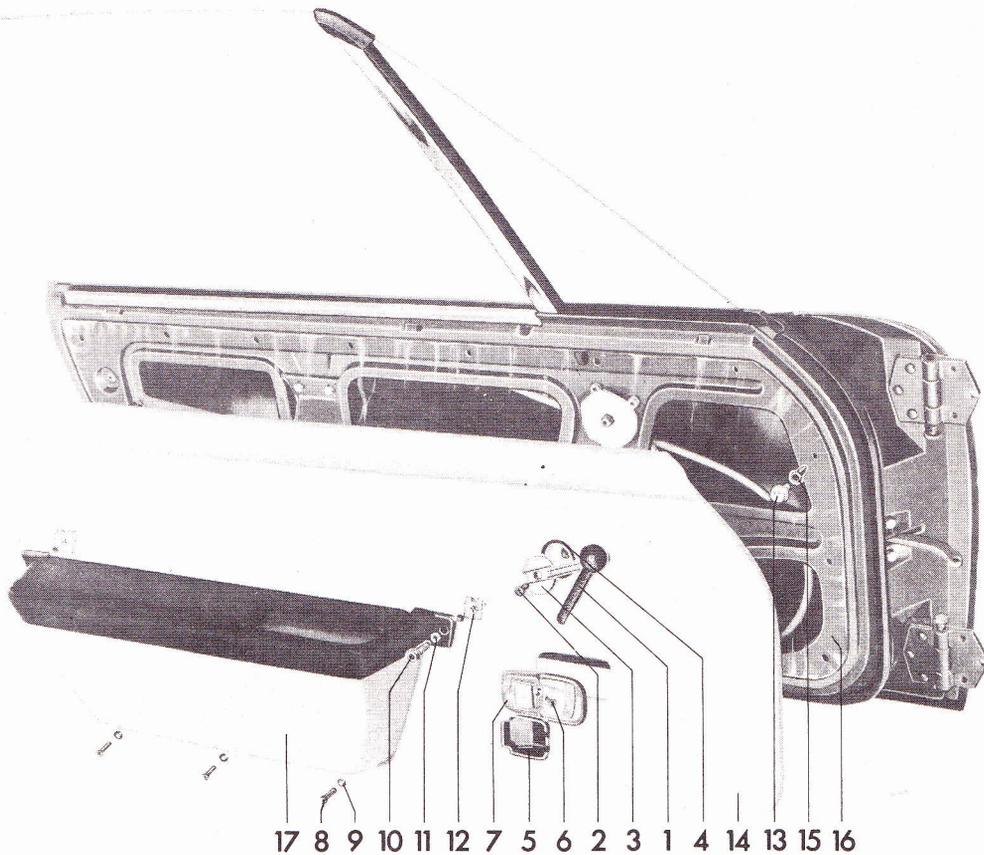
**Removal**

Press off the inside handle shell by using a screw driver as a lever, unscrew one cross-slotted screw of the cover plate and remove the plate. Unscrew the window crank after pressing off the cap. Unscrew the 3 sheet metal screws in the lower range of door. Unscrew the 2 hex. socket screws out of the door pocket on driver's side.



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*Removing inner handle shell*

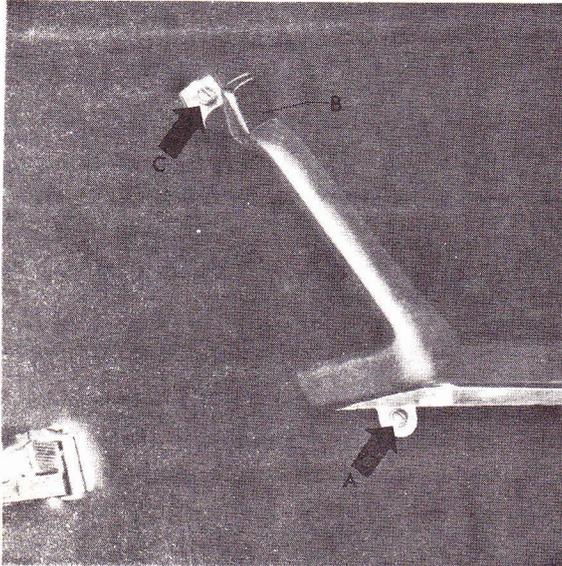


*Door paneling*

© Volkswagen

- |  |                        |
|--|------------------------|
| 1 - Cover for window crank                 | 10 - Hex. socket screw |
| 2 - Cross-slotted screw                    | 11 - Washer            |
| 3 - Window crank                           | 12 - Cage nut          |
| 4 - Shim                                   | 13 - Clip              |
| 5 - Handle shell for inside actuation      | 14 - Door panelling    |
| 6 - Cross-slotted screw                    | 15 - Seal for clip     |
| 7 - Cover plate for inside actuation assy. | 16 - PVC foil          |
| 8 - Cross-slotted sheet metal screw        | 17 - Door pocket       |
| 9 - Washer                                 |                        |

The door pocket can be removed, if required, by unscrewing 6 sheet metal screws from the arm rest. When removing the door paneling on the front passenger side, observe the following: Unscrew the three sheet metal screws from the arm rest bottom, and remove by sliding it towards its fat end parallel to the screws.

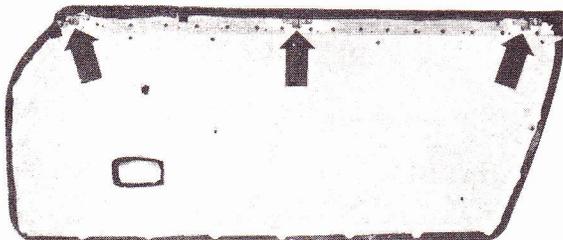


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Inside door pull screws

**Unscrew the oval head screw**

Remove the door paneling from the inside door sheeting. Proceed carefully to prevent any damage to the door paneling and paint. The door paneling is attached to three slots in the inside door sheeting by means of three welded-on sheet metal clips. For this reason, the door paneling must first be pulled off slightly and then removed in the upward direction. For the front passenger door, after unscrewing the 2 screw bolts from the door paneling, the arm rest can also be replaced. Pull the glued on foil from the inner door sheeting and push out the clip seals.



© Volkswagen

Three door paneling slots

**Installation**

Check that the water drain holes are free. Check the foam covers and be sure to replace it if damaged, to keep out drafts. Coat the inside door sheeting lightly with universal glue D 12 and glue on the foil free of wrinkles. Perforate the foil with a pin where the seals for the clips must be pushed in. When fitting the door paneling, first attach the plate clips to the opening of the inside door sheeting.

**DOOR SAFETY LOCK**

**Removal**

Extract the cotter pin from the bearing bolt of the door plate and push out the bolt. Remove the door paneling and pull the foil from the inside door sheeting. Unscrew the two hex. screws holding the door safety lock from the inside door sheeting. Remove the safety lock from between the inside and outside door sheeting. Unscrew the two hex. screws holding the door safety lock from the inside door sheeting. Remove the safety lock from between the inside and outside door sheeting.

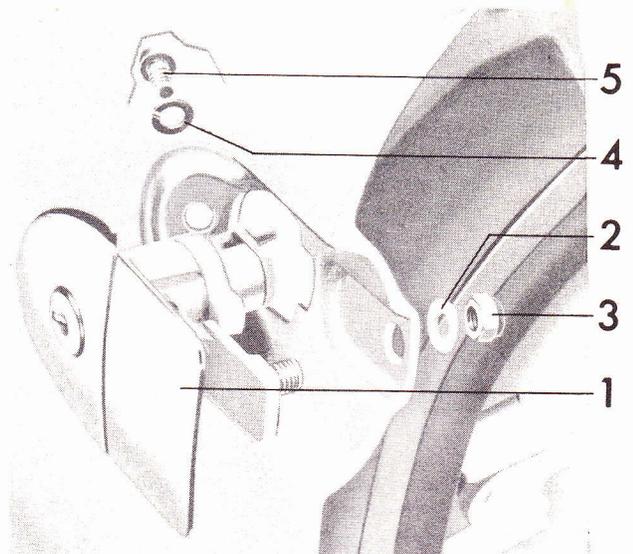
**Installation**

Prior to installation, lubricate the bearing points of the rollers in the door safety lock with HD oil, SAE 30. Insert and screw the safety lock in between the inside and outside sheeting. Reinsert the bearing bolt, seal it with a cotter pin. Slightly lubricate the safety lock joint. Glue in the foil, and assemble the door completely.

**DOOR HANDLE**

**Removal**

Prior to removal, move the door window pane in the topmost position and then remove the door paneling. Unscrew the hex. nut. Unscrew the hex. socket screw between the door inside and outside sheeting. Remove the door handle. Use only new, self-locking nuts for installation.



© Volkswagen

Door handle

- 1 - Door handle
- Door outside sheeting
- 2 - Wahser

- 3 - Hex. nut self-locking
- 4 - Spring ring
- 5 - Hex. socket screw

**LOCK CYLINDER**

**Removal**

Remove the flat head screw and cone washer and pull the eccentric from the lock cylinder. Remove the lock cylinder return spring. Insert a key and push the lock cylinder with seal in the forward direction out of the door handle. The inserted key prevents the loss of the tumblers and springs which are only loosely assembled in the guide ducts of the lock cylinder.

**Disassembly**

Remove the lock cylinder and push the tumblers and springs out. The tumblers and springs are loose in the lock cylinder and are not peened.

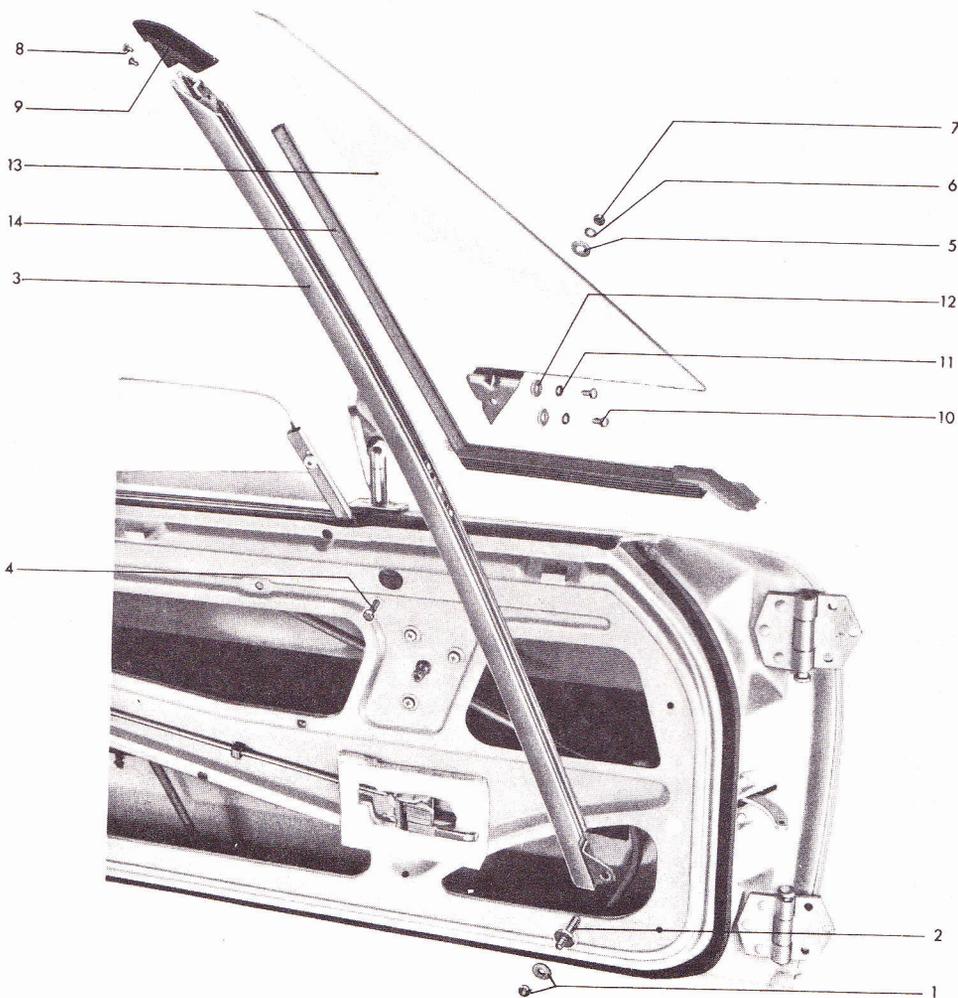
**Installation**

Insert the lock cylinder with the inserted key and attached seal into door handle. Install the spring on the lock cylinder end, keeping the spring under tension between the eccentric and housing. Push the eccentric on the square end of the lock cylinder and install the flat head screw with the cone lock washer. Install the door handle and packing.

**WINDOW REAR GUIDE CHANNEL**

**Removal**

Remove the door panel and pull off the PVC sheeting. Then crank the window completely down. Pull the window weatherstrip back until the window guide piece



*Front channel guide*

© Volkswagen

- |                                |                       |
|--------------------------------|-----------------------|
| 1 - Nut, washer                | 8 - Countersunk screw |
| 2 - Adjusting screw            | 9 - Protective cap    |
| 3 - Window front guide channel | 10 - Bolt             |
| 4 - Bolt, M 6x12               | 11 - Lock washer      |
| 5 - Flat washer                | 12 - Flat washer      |
| 6 - Lock washer                | 13 - Quarter window   |
| 7 - Hex. nut                   | 14 - Sealing frame    |

moves freely. Remove the Philips head screw from the guide piece. Pull the guide piece out in an upward direction. Remove the screw at the bottom of the rear guide channel of the door. Remove the guide channel through the opening in the inner door panel.

**Installation**

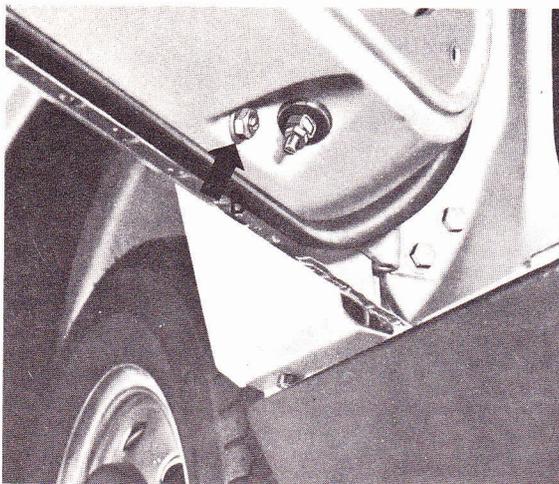
Clean the guide channel and, if necessary, coat it lightly with grease at the inner edges. Crank the window completely down. Install the speed nut, replacing it, if necessary. Insert the guide channel through the lower panel opening. Push the window guide piece on the window guide channel and window duct.

Align the rear guide channel with the window and tighten the screw from outside of the panel. Check the window operation. Readjust the bottom fastening screw if necessary. Install the PVC sheeting and door panel.

**WINDOW FRONT GUIDE CHANNEL AND FRONT QUARTER WINDOW**

**Removal**

Remove the door panel first. The door glass and lifter assembly need not be removed. Remove the hex. nut from the adjusting screw located at the bottom of the door. Turn the adjusting screw into the door until the window front guide channel is loose. Remove the anchor bolt from the door, using an open end wrench to hold the nut. Pull the guide rail with quarter window approximately four inches out of the door duct. Remove the front guide adjusting screw and pull the guide rail out completely.



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*Channel adjusting screw*

**Installation**

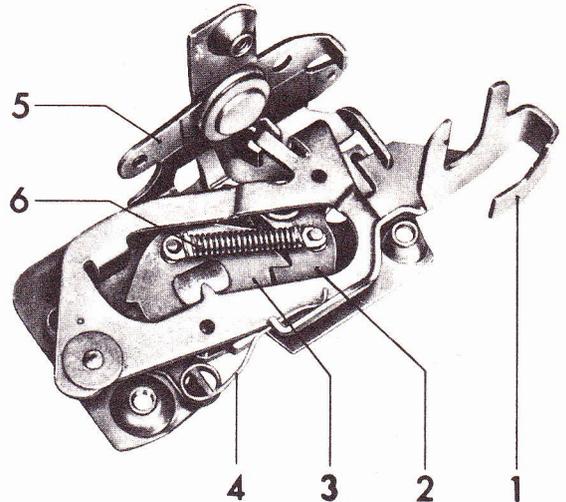
Slide the front guide channel with the front quarter window into the window duct. Align the quarter window with the front guide channel to the windshield frame. Close the door and check the fit of the door glass in relation to the seals on the roof and roll bar. Seal the

quarter window and sealing frame with D 10 cement. Install the door panel. Glue the front of the sealing frame to the door seal with SICOMET 85 or similar adhesive.

**DOOR LOCK**

**Removal**

First remove the door panel and the window rear guide channel. Pull off the PVC sheeting from inside the door panel.



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*Door lock*

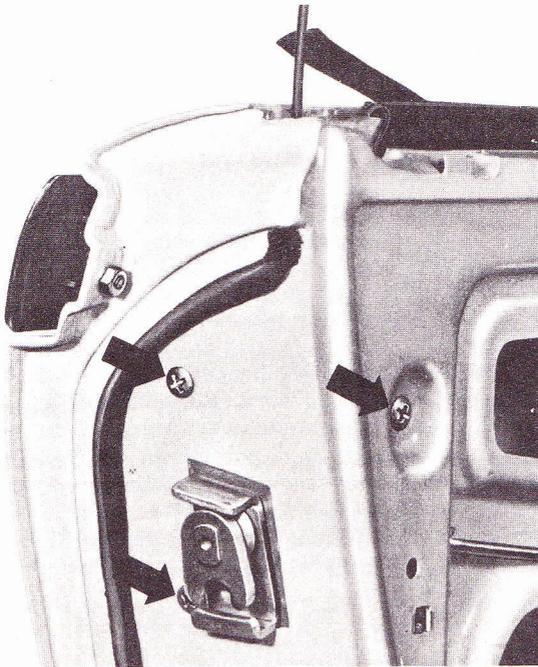
- 1 - Actuating lever
- 2 - Pawl
- 3 - Ratchet wheel
- 4 - Spring
- 5 - Remote control lever
- 6 - Draw spring

Wind the window up completely. Remove the retaining spring clip for the pull rod and disconnect rod. Move the lock latch to the vertical position, remove the three Philips head screws and pull the lock downward out of the door.

**Installation**

Move the lock latch to the vertical position and insert the lock into the door from below. Fasten with three Philips head screws. Attach the pull rod to the remote control lever on the lock. Slide the retaining spring clip at the end of the pull rod toward the opposite end of the hook. Connect the pull rod to the lock and turn the retaining clip on the rod until it snaps in place. Before further assembly check the operation of the door lock release lever and safety catch. To make adjustments to the length of the pull rod use a bending tool or pliers as required.

The correct length of the pull rod is attained if the opening lever on the inside door handle is aligned with the safety lever. To prevent any rattling of the pull rod, be sure that the pull rod holder is properly inserted in the inside door panel. Install the window rear guide channel and door panel. Glue on the PVC sheeting.



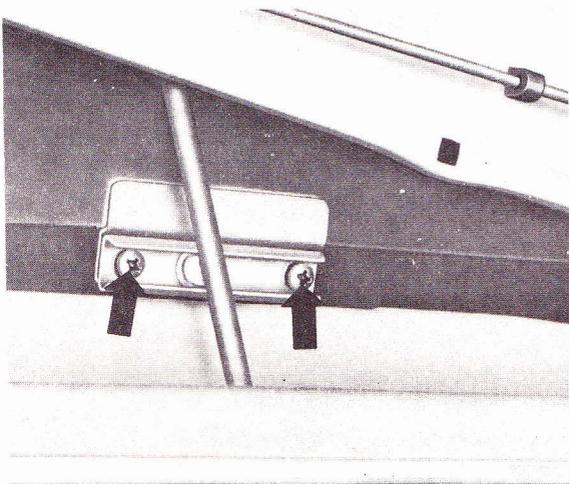
© Volkswagen

*Lock retaining screws*

**DOOR WINDOW**

**Removal**

Remove the door panel first, Pull off the inside door duct weatherstrip. Remove the guide piece from the window rear guide channel. Remove the two Philips head screws to loosen the window lifter channel. Remove the two Philips head screws and pull off the protective cap on the front quarter window. Lift the door glass out of the window duct.

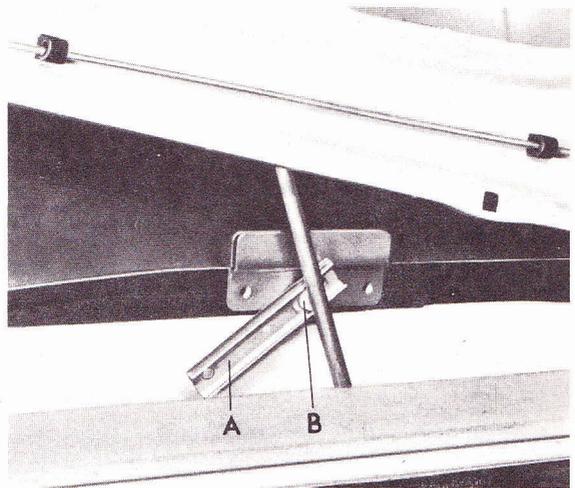


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*Window lifter channel screws*

**Installation**

Insert the door glass with guide rollers into the window channel. Clean guide rail, if necessary, and coat it slightly with grease at the inner edges. Then slide on the guide roller and fasten it to the window lifter channel with two Philips head screws. Insert the window rear channel guide piece and fasten it with Philips head sheet metal screw. Press on the door duct weatherstrip on the flange of the inside door panel. Open and close the window several times to check for free operation. Close the door and check the glass alignment with seals on the roof and roll bar.



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*Installing guide roller in channel*

A - Guide rail

B - Guide roller

**Adjusting**

If the window cannot be cranked high enough: Loosen the lock nut on the adjusting screw and release the screw several turns. Move the window to the top position and check adjustment. Make the required correction and tighten lock nut again.

If the window can be cranked up too high: Crank the window down approximately one turn. Loosen the lock nut on the adjusting screw and tighten the screw several turns. Move the window to the top position and check the adjustment. Make the required correction and tighten the lock nut again.

If the glass tilts too far inward: Loosen the lock nut on the adjusting screw and release the screw several turns. The pane will tilt outward. Check the adjustment. Make the required correction and tighten the lock nut again.

If the pane tilts too far outward: Loosen the lock nut on the adjusting screw and turn the screw several turns to the left and check the adjustment. Make the required correction and tighten the lock nut again. Glue on PVC sheeting and install the door panel.

**WINDOW LIFTER**

**Removal**

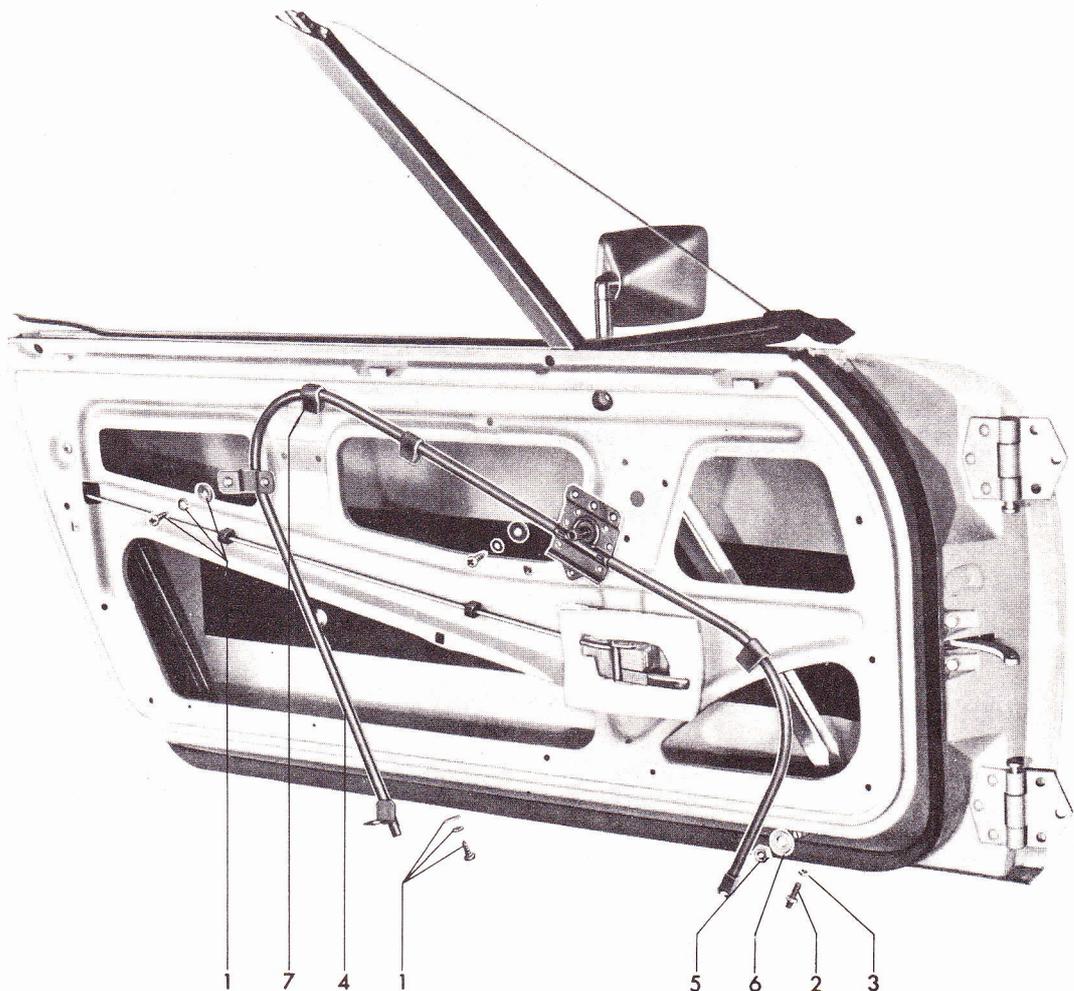
Remove the door paneling and door glass first. Unscrew the lock nut from the adjusting screw and remove the adjusting screw. Push the window lifter out of the rubber sleeve. Loosen the lock nut from the adjusting screw and turn the adjusting screw down until the front window guide rails are loose. Remove the hex. head bolt (hold the nut with an open end wrench.) Pull the window front guide channel toward the rear. Push the window lifter drive from inside the door panel and remove the window lifter from the door duct.

**Installation**

Check the operation before installing the lifter. If necessary straighten the slotted tube and oil drive coil. If tight

spots cannot be eliminated, replace the window lifter. If the coil in the slotted tube of the window raiser rattles, carefully squeeze the tube at the location where the rattling occurs.

Insert the window lifter in the door duct. Insert the window lifter with stop into the rubber sleeve of the inside door panel. Turn in the adjusting screw with nut and lock. Insert the adjusting screw for the window tilt into the inside door panel together with the window front guide channel. Loosely attach the lock nut. Loosely attach the window front guide channel with anchor bolt. Insert the window duct weatherstrip near the front quarter window. If the window duct weatherstrip at the quarter window end should become loose during assembly, glue it to the door seal with SICOMET 85 cement or similar adhesive.



*Window lifter*

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- 1 - Phillips head screw, lock washer, flat washer  
Inside door panel
- 2 - Adjusting screw (winding height)
- 3 - Hex. nut

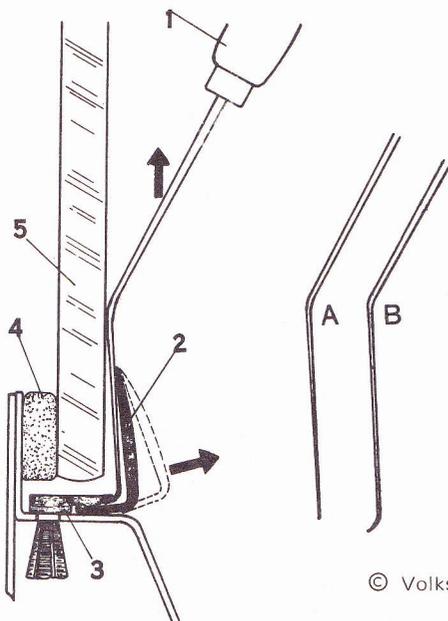
- 4 - Window lifter
- 5 - Hex. nut (to lock lateral tilt adjusting screw)
- 6 - Flat washer
- 7 - Foam strip

Attach the window lifter with six Philips head screws. Install the door glass. Crank up and check fit with the door closed, then make corrections, if necessary. Fasten the lock nut on the window tilt adjusting screw. Fasten the anchor bolt for the window front guide channel. Glue PVC sheeting to the inside door panel and install the door panel.

**WINDSHIELD**

**Removal**

Loosen the windshield trimstrip. Use 2 spatulas or flat steel blades 1 inch wide. Tool A serves for locating clips. Tool B serves to lift clips so that trimstrip is released. Unscrew the upholstery parts from the windshield frame laterally and at top. Pull the edge protection from the lower window flange. To prevent any damage to the instrument panel when subsequently "cutting out" the pane, cover the instrument panel adjacent to the pane with adhesive tape. Punch a steel wire of approximately .02 inch diameter through the sealing layer and "cut out" the pane. Carefully remove the remaining sealing material from the window flange with a sharp knife.



© Volkswagen

*Removing windshield*

- 1 - Spatula or flat steel blade
- 2 - Trimstrip
- 3 - Plastic clips
- 4 - "Solbit"
- 5 - Windshield

**Installation**

Install the pane with Solbit TWS 8 mm diameter made by the Bostik GmbH. If required, insert a spreader pin for the trim strip attachment in the windshield frame. Clean the windshield frame with nitro solution. Apply Solbit Primer 5014 10 mm wide on the circumferential glueing surface

of pane with a brush. Connect Solbit sealing strip to a power source for 10 to 15 secs. For this purpose, a quick charger can be set to 24 Volt for an 11 Amp. current to two 12 Volt batteries can be connected in series (positive pole of first battery to negative pole of second battery). Press the sealing strip on the edge of the pane. Bend the strip ends at a right angle. The ends should meet at the lateral portion of the pane. Press the ends projecting from the pane edge and twist.

Insert the pane. Place two wooden strips .16 inch thick between the pane and frame in the lower range. Watch for a uniform, lateral spacing of the pane in relation to the frame. The sealing strip in the lower range should rest against the outermost edge of the pane. If not, the edge protection can be fitted badly or not at all. Insert two wooden spacer blocks, each, at the top and bottom.

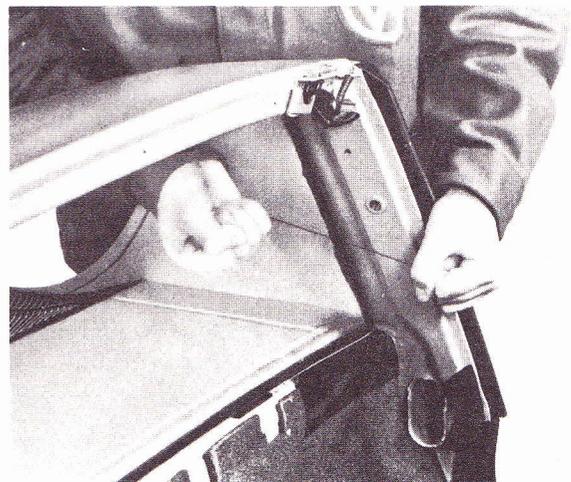
Mask the body below the connecting point. Connect the ceiling strip to the power source. After heating for approximately three minutes squeeze it for a distance of 1/6 inch. Push uniformly with one hand against the pane for 5 seconds. Heat the pane for 1 hour. After heating, cut off any projecting ends of the ceiling strip close to the edge of the pane and smooth out with a flat knife.

Pull out the assembly block and wooden strips. Screw the upholstery components to the windshield frame. Fit the windshield trim strip and edge protection.

**REAR WINDOW**

**Removal**

The rear window safety glass is bound with its weatherstrip to the frame. Remove both seats and remaining backrest, the engine compartment lid release, the interior light, the rear wall panel and roll bar padding. Remove the rear window flange seal. Push a thin baling wire through the rubber seal and pass along the glass to break the bonding. Clean the glass of any remaining seal.



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*Removing rear window*

**Installation**

Install the window with "Solbit TWS 8 mm" manufactured by Bostik or similar. Clean the window seal contact surfaces with lacquer thinner. Apply a primer to the bonding surface with a brush. Cut the Solbit strip to a length of 10 ft. 6 in. Connect the ends to a power source for approximately 1 minute. The recommended power source is indicated under Windshield Pane-Installation.

Press the Solbit strip against the edge of the window glass. The ends should meet at the center of the lower edge. Twist the ends. Install the window from inside the passenger compartment. Position the 2 spaces (Part No. 914 541 907 10) between the frame and the bottom edge of the glass. Protect the engine compartment lid from profile wires by masking the area with tape.

Reconnect the Solbit strip to the power source. When the strip is pliable, press it evenly against the window by hand for 5 secs. to assure proper sealing. Heat the window for about one hour. When finished heating, cut off the projecting ends of the Solbit strip at the edge of the glass. Smooth out using a flat blade.

Install the seal to the flange between the engine compartment lid and rear window by pressing it on. Apply 3/4 inch electrical tape all around the inside window edge. Apply additional tape, approximately 8 inches wide on the lower corners. Reinstall the roll bar padding, rear paneling, engine compartment lid release and interior light.

**DRIVERS SEAT**

**Removal**

The seat cushion is held to the drivers seat at the front by means of a sheet metal clip. Raise the cushion at the rear end and unhook it at the front. Pull up the longitudinal adjustment lever and slide the seat out in the forward direction until the stop is reached. Raise the spring underneath the left running rail and slide the seat out. If required, remove the running rails after unscrewing the eight hex. socket screws.

**Installation**

If required, screw the running rails to the seat with eight hex. socket screws. Clean the guide rails and coat them thinly with universal grease. Insert the running rails into the guide rails. Slide the seat toward the rear and let it engage.

**HEIGHT ADJUSTMENT WITH GUIDE RAILS**

**Removal**

Remove the drivers seat. Unscrew the four hex. socket screws and remove the height adjustment. Remove the retaining plate after unscrewing the two hex. bolts.

**Installation**

Unscrew the retaining plate. Install the height adjustment. Slide the drivers seat into position.

**FRONT PASSENGER SEAT, CENTER SEAT AND REAR WALL PANELING**

**Removal**

Remove the interior light and pull knob for the engine compartment lid. Remove the drivers seat and take out the center seat cushion. Remove the center seat bracket after unscrewing the four cross-slotted screws. Remove

the seat cushion for the front passenger seat. Remove the support for the front passenger seat cushion after unscrewing four hex. nuts and two hex. screws. Unscrew the two sheet metal screws in the lower range of the rear wall. Unhook the rear wall lining in the downward direction. It is attached to the rear wall with four clips. The rear wall lining can be disassembled in three parts: Front passenger seat backrest, after unscrewing two continuous screws. At the top, the backrest is hooked to the lining with two wire gears. Drivers seat lining, after unscrewing six sheet metal screws.

**FRESH AIR AND BLOWER BOX**

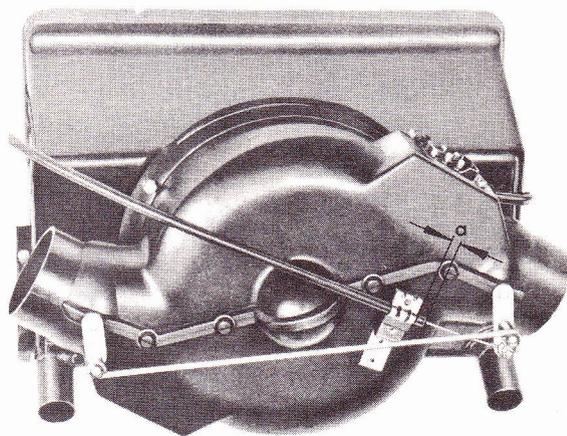
**Removal**

First remove the fuel tank. Unscrew one hex. screw on each box end, as well as one hose clip, after unscrewing a cheese head screw and pull off the hoses. Pull off the two water drain hoses in a downward direction. Remove the wire cable underneath the blower by loosening the clamping nut and pushing off the holding clip. Do not bend or distort the cable, since only a straight cable will function properly.

Pull off the multiple plug for the electrical connection. Remove the fresh air box.

**Installation**

Position the box without screwing it on and provisionally attach the cable. Attach the cable envelope with holding clip. The envelope is properly attached if it ends approximately 1/4 inch in front of the holding clip. Screw the box to the holding bracket.



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*Adjusting cable length*

$a = 7/32 \text{ in.}$

Adjust the cable: Adjust in such a manner that in position III on the actuating lever for fresh air, both opening flaps on the fresh air box are open. Check the function several times. Position the air hoses and screw the hose clips tight. Attach the water drain hoses. Attach the multiple plug for the electrical connection. Install the fuel tank.

**CONTROL BOX LEFT/RIGHT AND DEFROSTER NOZZLES**

**Removal**

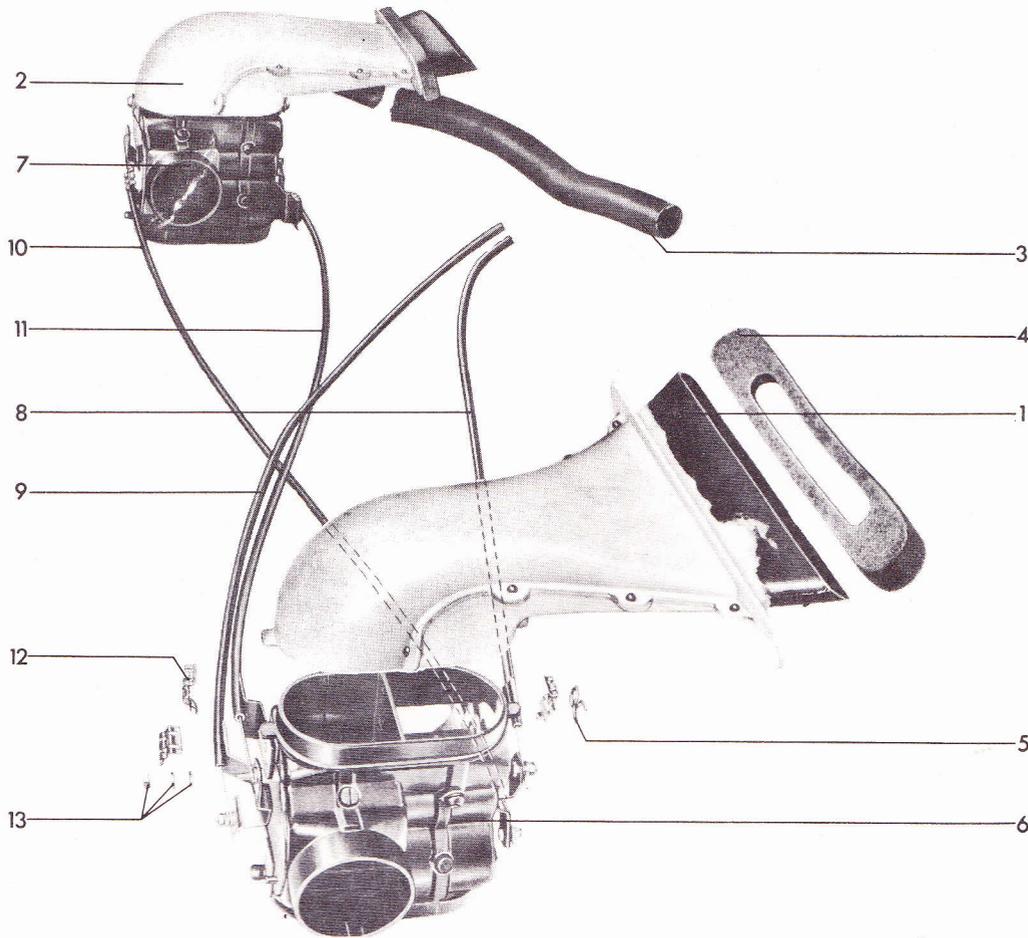
First remove the fuel tank and fresh air blower box. Loosen the hose clips from the control boxes by unscrewing the cheesehead screws. Pull off the hoses. Loosen the control box from the passenger side by unscrewing two hex. nuts. Unscrew the supports for the venting section from below and swing it up. Remove the cable controls for fresh and warm air from the control box by loosening the two clamping nuts and pushing off the two holding clips.

**Installation**

Assemble the connecting cable controls – No. 10 and 11 – with control boxes – No. 6 and 7 – while removed. Connect the cable controls to the actuating levers of the control box. Attach the cable controls with the holding clips. Insert the cable controls crosswise into the clamping screws on the control box. Tighten the clamping screws lightly. Clamp the cable controls with holding clips.

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*Relative positive of control knob and flap*



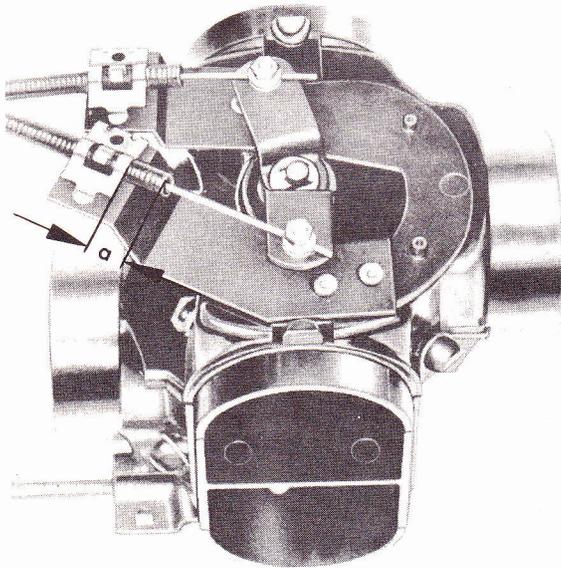
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*Defrosters*

- |                            |                              |   |
|----------------------------|------------------------------|---|
| 1 - Defroster nozzle left  | 6 - Control box left         | 10 - Connection controls fresh air            |
| 2 - Defroster nozzle right | 7 - Control box right        | 11 - Connection controls warm air             |
| 3 - Air hose               | 8 - Cable controls fresh air | 12 - Holding clip                             |
| 4 - Seal                   | 9 - Cable controls warm air  | 13 - Clamping nut with spring ring and washer |
| 5 - Clip                   |                              |   |

Move the opening flaps of each control box into the upper end position and then tighten the clamping nuts well. Check the function several times. Place the defroster nozzles on the control boxes and clamp down. Insert the preassembled control boxes with defroster nozzles into the car. Insert the fresh and warm air cable controls into the clamping screws on the control box. Tighten the clamping nuts lightly. Clamp the cable controls down with the holding clips.

Move the opening flaps into the end position on the instrument panel then tighten the clamping nuts well. Check the function several times. Screw on the supports for the venting section. Screw on the control boxes on the passenger side. Position the air hoses and attach them with clips. Install the fresh air and blower box. Install the fuel tank.



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*Adjusting fresh air control cable*  
a = 7/32 in.

**INSTRUMENT PANEL**

**Removal**

Remove the knee protection strip, heater and blower, fresh air actuator, fuel tank and container for windshield washer. Unscrew the four hex. nuts below the venting

section. Unscrew the two sheet metal screws from the instrument panel. Carefully remove the instrument panel, beginning on the instrument cutouts, by means of a wooden or a plastic wedge.

**LOCK FOR INSTRUMENT PANEL BOX**

**Removal and installation**

Remove the instrument panel box before removing the lock.

For installation of the lock, observe the following: Set the lock into the opened closing position. Insert the lock with lugs into the grooves in the supporting plate.

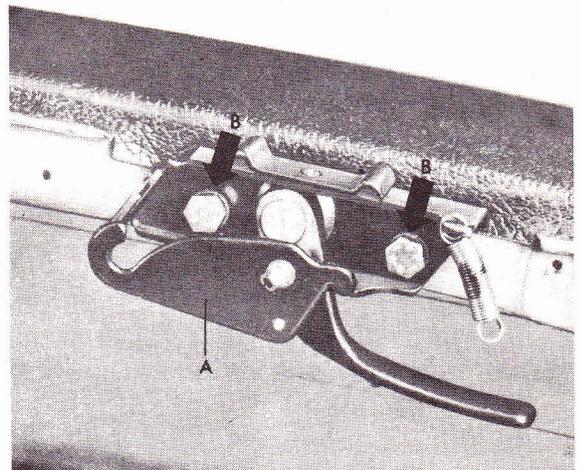
**ROOF LOCK**

**Removal**

Remove the supporting plate padding strip. Disconnect the spring. Move the closing hook to the downward position. Remove the roof lock after unscrewing two hex. screws.

**Installation**

Replace the roof lock, if required, or grease. Screw on the roof lock. Connect the spring. Screw on the supporting plate padding strip. Check the function of the roof lock several times.



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*Roof lock adjusting screws*

A - Closing hook

B - Screws

# SPECIFICATIONS 15

## GENERAL DATA

Wheel base .....	2,450 mm (96.5")
Track width front (at dead weight acc. to DIN) .....	1,337 mm (52.7")
Track circle dia. ....	approx. 10.35 m (33.9 ft.)
Smallest turning circle dia. ....	11.0 m (36 ft.)
Center of tire contact .....	40.5 mm (1.594")
Front axle load at perm. total load .....	650 kp (1,433 lbs.)
Torsion bar: .....	Length 611.5 mm (24.075")
	Dia. 17.9 mm (0.705")
	Number of teeth 29
Total reduction of steering gear .....	17.78
Steering wheel turns from lock to lock .....	Approx. 3.1

## GENERAL SPECIFICATIONS

Rims .....	4½J x 15, optional 5½J x 15
Tires .....	155 SR 15; optional 165 SR 15 on either 4½J or 5½J x 15 rims (if subsequently installed, speedometer must be replaced)
Wheelbase .....	96.5 in. (2450 mm)
Track (DIN curb weight) .....	Front 52.40 in (1331 mm); with 5½J x 15 rims 52.87 in. (1343 mm)
	Rear 53.98 in. (1371 mm); with 5½J x 15 rims 54.45 in. (1383 mm)
Overall length .....	156.8 in. (3985 mm)
Overall width .....	65.0 in. (1650 mm)
Overall height (car empty) .....	48.4 in. (120 mm)
Ground Clearance (car loaded) .....	4.7 in. (120 mm)
Turning circle .....	Approx. 36 feet (11 m)

## CAPACITIES

Engine .....	Approx 3.7 US qts. without oil filter, 3.2 US qts. premium quality HD oil, acc. to API specification SD or SE SAE 30 = 32°F (0°C) SAE 20 W 20 = from + 5° to 32°F (-15° to 0°C) SAE 10 W = below + 5°F (-15°C)
Transmission and differential .....	Approx. 2.6 US qts, SAE 90
Torque convertor .....	6.3 US qts. HD oil SAE 20 W 20
Fuel tank .....	16.4 US gals. including approx. 1.6 US gals. reserve Required octane rating: 98 octane
Brake fluid .....	Approx. 12 fl. oz. J 1703

## ENGINE

Type .....	aircooled 4-stroke gasoline injection engine
Number of cylinders .....	4
Cylinder arrangement .....	2 cylinders each opposed, flat flour
Bore .....	90 mm (3.543") dia.
Stroke .....	66 mm (2.598")
Total piston displacement .....	1,679 cc (102.5 cu. in.)
Compression ratio .....	8.2
Max. performance (SAE) .....	85 HP at 5,000 rpm
Max. torque (SAE) .....	99.45 ft. lb. at 3,500 rpm
Mean piston speed .....	10.8 m/s (35.4 ft/sec) at 4,900 rpm
Octane number .....	98 (Research Method)

<b>IGNITION</b> .....	battery ignition
Ignition coil .....	Bosch 022 905 115
Ignition distributor .....	Bosch 022 905 205 Sportomatic: 022 905 205B
Firing point .....	27° BTDC at 3,500 rpm (vacuum hoses removed)
Firing order .....	1-4-3-2
Ignition timing .....	by centrifugal governor and intake vacuum
Timing angle .....	44 - 50°
Spark plugs .....	14 mm (0.55") plug threads (long), thermal value 175
Spark gap .....	0.7 mm (0.0276")
<b>COOLING</b> .....	aircooled by radial blower on crankshaft
Delivery volume .....	approx. 800 lits/sec (211 US gal.) at n (engine) = 4,600 rpm
<b>LUBRICATION</b> .....	forced feed by gear pump
Oil cooling .....	oil cooler in blower air stream
Oil filter .....	in main stream
Oil pressure indic .....	by pilot lamp
Oil capacity .....	3.5 lits (0.92 US gal) with oil filter change 3.0 lits (0.79 US gal) without oil filter change
Oil consumption .....	0.5-1.0 lits/1,000 km (0.13-0.26 US gal/6,214 miles)
<b>CYLINDER HEAD</b> .....	one each for 2 cylinders with cast-on cooling ribs, aluminum alloy
Valve seat rings .....	shrunk-in, sintered steel
Valve guides .....	shrunk-in, special brass
Spark plug threads .....	cut into cylinder head
<b>VALVES</b> .....	1 inlet and 1 exhaust valve per cylinder
Exhaust valve .....	with hard-faced seat
Arrangement .....	overhead
Clearance .....	0.10 mm (0.0039") with cold engine
	0.10 mm (0.0039") with cold engine
	Inlet
	Exhaust
<b>VALVE TIMING WITH .04" valve clearance:</b>	
Intake opens .....	12° BTDC
Intake closes .....	42° ABDC
Exhaust opens .....	43° BTDC
Exhaust closes .....	4° ATDC
<b>CYLINDERS</b> .....	individual cylinders, special grey iron casting with cooling ribs
Center distance .....	4.90"
<b>PISTON</b> .....	light metal alloy with steel insert
Piston pin .....	floating, secured by circlips
Piston rings .....	2 compression rings 1 oil scraper ring
<b>CRANKCASE</b> .....	split, with vertical center division by crankshaft and camshaft bearings, aluminum alloy
<b>CAMSHAFT</b> .....	grey casting, 3 plane bearings
Camshaft bearings .....	thin-walled steel half shells with babbitt metal running surface
Camshaft drive .....	spur gears, helical
<b>CRANKSHAFT</b> .....	forged, fine steel, 4 plane bearings
Main bearings 1, 3 and 4 .....	aluminum sleeves with lead-coated running surface
Main bearing 2 (center bearing) .....	half shells, three-component bearing
Main bearings 1-3 .....	60 mm dia. (2.36")
Main bearing 4 .....	40 mm dia. (1.87")
Conrod bearing .....	55 mm dia. (2.17")
Flywheel .....	forged, with starter ring gear, one-piece

<b>CONNECTING RODS</b> .....	forged, with I-shaped shank cross section
Conrod bearings .....	thin-walled half shells, three-component bearings
Piston pin bearings .....	pressed-in steel bushing with lead-bronze running surface
<b>CLUTCH</b> .....	Diaphragm spring clutch
Type .....	single-plate dry clutch
Total facing area .....	47.3 sq. in.
<b>BRAKES</b>	
Tandem main brake cylinder	
Bore .....	17.46 mm dia. (.6874")
Stroke .....	18/13 mm (.7/.5")
Play: actuating rod/Piston .....	1 mm (.04")
Front wheel brake	
Brake disc (dia.) .....	281 mm (11.063")
Min. thickness after refinishing .....	10.5 mm (.391")
(The brake disc may be refinished only symmetrically, this is, uniformly from both sides.)	
Thickness tolerance .....	max. 0.02 mm (.0008")
Lateral wobble .....	0.2 mm (.008")
Caliper piston dia. ....	42 mm (1.7")
Thickness of lining .....	10 mm (.4")
Release clearance .....	.0020-.0079"
Lining surface of four linings .....	16.4 sq. in.
Rear wheel brake	
Brake disc (OD) .....	282 mm (11.102")
Thickness, new .....	9.5 mm (.374")
Lateral wobble .....	0.2 mm (.008")
Caliper piston dia. ....	33 mm (1.3")
Thickness of lining .....	10 mm (.4")
Release clearance .....	.008"
Lining surface of four linings .....	12.4 sq. in.
<b>SUSPENSION</b>	
Total track of front wheels under pressure	+20' ± 10'
Size of force for front wheel pressure .....	15 kp (33 lbs.)
Camber of front wheels .....	0 ± 20'
Max. permissible difference in camber between both sides .....	20'
Track difference angle at 20° lock .....	
to the left	0 + 30'
to the right	0 + 30'
Caster of front wheels .....	6° ± 30'
Height adjustment of front axle .....	90 mm ± 5 mm
(wheel center above torsion bar center— rear) .....	(3.5 ± .2")
Height difference left to right .....	max. 5 mm (.2")
Total Frictional torque (steering assembled) .....	6 - 8 cmkp
Frame .....	Welded pressed steel box section frame, welded to body
Front suspension .....	Independent, suspension struts and track control arm
Front springs .....	Round section longitudinal torsion bar for each wheel
Rear suspension .....	Independent, semi-trailing arms
Rear springs .....	Coil spring, double acting telescopic shock absorber and progressive rate hollow rubber spring for each wheel
<b>ELECTRICAL SYSTEM</b>	
Operating voltage .....	12 volts
Battery capacity .....	45 Ah
Alternator output .....	50 amps at 14 volts AC, 700 watts capacity

**5-SPEED TRANSMISSION**

Transmission .....	Porsche, servo-lock synchronization
Number gears .....	5 forward, 1 reverse
Gearshift location .....	Floor-mounted, central
Final-drive .....	Spiral bevel pinion and differential – 4.43:1
Drive ratio .....	7:31 (4.429)
Rear axle drive .....	Over double joint half axles
Gear ratios .....	1st – 3.09:1 2nd – 1.88:1 3rd – 1.26:1 4th – 0.93:1 5th – 0.71:1 Reverse – 3.13:1

**MAINTENANCE**

Complete the following maintenance and lubrication jobs in accordance with valid service instructions:

Air filter .....	Check, clean base and fill in fresh oil.
Fuel filter .....	Replace.
Ignition distributor .....	Lubricate, check contact points and replace, if required. Adjust timing angle and firing point.
Spark plugs .....	Clean, check spark gap and adjust, check compression pressure.
Exhaust system .....	Check for damage.
V-belts .....	Check and tighten, if required, or replace.
Engine .....	Check oil level and replenish, if required or change oil.
Full-flow oil filter .....	Replace
Valves .....	Adjust valve clearance and replace seals for cylinder head cover.
Engine .....	Sight test for leaks.
Clutch .....	Adjust clutch play.

**TORQUE SETTINGS**

<b>ENGINE</b>	<b>ft. lb.</b>
Screws for universal shaft .....	32.5
Nuts for transmission support .....	14.5
Nuts for engine support (body) .....	21.7
Screws for torque converter .....	21.7
Nuts for engine attachment to transmission .....	21.7
Spark plugs .....	25.3
Nut for small pulley .....	43.4
Screws for blower impeller .....	14.5
Nuts for oil pump .....	14.5
Oil drain plug .....	15.9
Closing nut for oil strainer cover .....	9.4
Nuts for rocker arm shaft .....	10.1
Cylinder head nuts .....	23.1
Screws for engine support (crankcase) .....	21.7
Screw for blower wheel hub .....	23.1
Screws for flywheel .....	79.6
Screws for carrier plate .....	61.5
Screws and nuts for crankcase halves .....	14.5
Nuts for crankcase halves .....	23.9
Conrod nuts .....	23.9
Screws for clutch .....	14.5

**MANUAL TRANSMISSION**

	ft.lb.
Side and rear cover on transmission housing (studs) nut . . . . .	16-18
Fork piece on housing nut . . . . .	15-17
Guide tube for throwout bearing on housing nut . . . . .	7
Transmission housing plug (oil filler hole) . . . . .	15-18
Transmission housing plug (oil drain hole) . . . . .	15-18
Transmission housing ball pin (bearing throwout fork) . . . . .	15-17
Transmission housing breather (breathing) . . . . .	15-22
Backup light switch on housing . . . . .	25-29
Holding plate on throwout fork screw . . . . .	6-7
Starter on transmission housing nut . . . . .	33-35
Clamping plate on intermediate plate screw . . . . .	15-17
Bolt for guide lever on intermediate plate . . . . .	15-17
Lock on intermediate plate screw (gear shift lock) . . . . .	16-18
Speedometer drive on rear housing cover bolt . . . . .	12-13
Miter drive in guide bushing screw . . . . .	16-18
Drive shaft nut . . . . .	72-86
Drive shaft nut . . . . .	65-80
Pinion shaft expansion bolt . . . . .	80-87
Shift forks on shift rods hex. screws (m 8 x 25) . . . . .	18-19
Ring gear on differential housing bolt . . . . .	72-86
Constant velocity flange on differential expansion bolt . . . . .	25-29
Shift rod bearings on rear nut transmission cover (914 only) . . . . .	15-17
Cover plate on rear transmission cover nut . . . . .	6-7

**TRANSMISSION – SPORTOMATIC**

Hex. nuts on transmission housing M8 . . . . .	18.0
Hex. screw with trunnion (angle drive) M8 . . . . .	10.8
Closing screw on intermediate plate M12 . . . . .	21.7
Closing screw oil inlet M24 . . . . .	18.0
Magnetic plug oil drain M24 . . . . .	18.0
Hex. screws for intermediate plate clamping plate . . . . .	18.0
Hex. nut on input shaft M24 . . . . .	80
Crown nut on input shaft M14 . . . . .	72
Expanding screw of pinion shaft M12 . . . . .	87
Hex. screws of shift forks M8 . . . . .	18.0
Hex. screws for ring gear attachment M 12 . . . . .	72
Expanding screws for universal flange of differential M10 . . . . .	25.3-18.9
Hex. nuts on converter housing and servo motor M 8 . . . . .	18.0
Hex. nuts on converter housing and starter M 10 . . . . .	32.5
Closing screw on front gearbox cover for parking lock M 12 x1.5 . . . . .	34.0
Double hex. socket screws for clutch pressure plate M 6 . . . . .	10.8
Double hex. socket screws for freewheel support M 6 . . . . .	10.8
Double hex. screw for converter-drive plate M 8 . . . . .	17.4-18.8
Bridging switch M 18 x 1.5 . . . . .	25.3-28.9
Backup light switch M 18 x 1.5 . . . . .	25.3-28.9
Hollow screw of angle drive in guide bushing M 24 x 1.5 . . . . .	15.9-17.4

**FRONT AXLE AND STEERING**

	ft. lbs.
Fillister head bolt for clamp nut . . . . .	11
Hollow bolt on caliper . . . . .	14
Caliper on steering knuckle bolt . . . . .	50
Wheel hub on brake disc nut . . . . .	(17)
Guard plate on steering knuckle bolt . . . . .	18
Shock absorber leg bottom on ball joint bolt . . . . .	47
Shock absorber leg on supporting bearing nut . . . . .	58
Supporting bearing on body socket . . . . .	34.0
Protective clamp on body socket . . . . .	32
Front wishbone bearing on body bolt . . . . .	34
Ball joint on wishbone nut . . . . .	108
Floor pan on body bolt . . . . .	34
Floor pan on auxiliary support bolt . . . . .	10.8
Auxiliary support on body bolt . . . . .	65.1
Hub stud bolt, 25 mm . . . . .	108

Hub stud bolt, 39 mm .....	94
Hub nut .....	(94)
Steering gear housing cover bolt .....	11
Steering gear housing filler bolt .....	11
Drive pinion coupling flange nut .....	34
Dust boot retainer for universal bushing nut .....	50
Fork on joint bushing bolt .....	34
Steering shaft on steering coupling bolt .....	18
Steering gear on auxiliary support bolt .....	34
Ball joint at tie rod end nut .....	32
Bottom universal joint on steering shaft lock nuts .....	18
Tie rod clamp nut .....	11
Steering wheel retaining nut .....	(54)
Steering and control switch components on body screw .....	7.2
Control switch components/steering post extension screw .....	7.2

**REAR AXLE**

Spring strut bottom nut on control arm .....	72-87
Spring strut top on body nut .....	36-43
Threaded bushing on piston rod .....	11-14
Castle nut on universal shaft .....	217-253
Synchronizing joint on universal flange screw .....	31
Control arm bearing on body bolt .....	50
Control arm bearing on control arm nut .....	108
Bearing cover on control arm bolt .....	18
Wheel bolt 914 bolt .....	108
Wheel nut 914/6 nut .....	94

**BRAKES**

Tandem brake master cylinder on bulkhead nut .....	18
Brake line to tandem master brake cylinder .....	11-14
Bolt for clamp nut screw .....	11
Hollow bolt on brake caliper .....	14
Caliper on steering knuckle bolt .....	50
Guard plate on steering knuckle bolt .....	18
Bleed valve in caliper .....	1.5-2.5
Wheel hub on brake disc nut .....	(16.6)
Housing bolt for front caliper .....	16
	(24.4-3.6)
Caliper on rear axle steering arm bolt .....	50
Brake disc on wheel hub bolt .....	3.6
Guard plate on rear axle steering arm bolt .....	18
Bleed valve in caliper .....	1.5-2.5
Wheel on wheel hub bolt (25 mm), nut .....	108.5 (94)
Wheel on wheel hub bolt (39 mm) .....	94

**TOLERANCES AND WEAR LIMITS**

**COOLING**

Thermostat . . . . .	Opening temp.	Upon installation (new)	
			65-70°C (149-158°F)
Impeller/V-belt pulley . . . . .	Unbalance		max. 5 cmg

Wear limit

**OIL CIRCUIT**

Oil pressure (for SAE 30 grades only) at 70°C (158°F) oil temp.: . . . . .	Pressure	approx.	
at 2,500 rpm . . . . .		3 kg/cm <sup>2</sup> (43 psi)	2 kg/cm <sup>2</sup> (28 psi)
Spring f. oil pressure relief valve Length under load: 23.4 mm (.921") . . . . .	Load	11.1 kg (24.5 lbs)	
Spring f. oil pressure contr. valve Length under load: 16.8 mm (.661") . . . . .	Load	4.35 kg (9.59 lbs)	
Oil pressure switch opens at . . . . .	Pressure	0.15-0.45 kg/cm <sup>2</sup> (2.13-6.40 psi)	

**CYLINDER HEAD WITH VALVES**

Depth of cylinder seat in cylinder head . . . . .		5.4-6.5 mm (.213-.256")	
Combustion chamber capacity . . . . .		51.1-52.6 cc (3.12-3.21 cu.in.)	
a) Rocker arm . . . . .	ID	20.0-20.02 mm (.7874-.7882") dia.	20.04 mm (.7890") dia.
b) Rocker arm shaft . . . . .	Dia	19.95-19.97 mm (.7854-.7862") dia.	19.93 mm (.7846") dia.
Valve spring Length under load 30.0 mm (1.18") . . . . .	Load	72.5-83.5 kg (159.8-184.1 lbs)	
Valve seat a) Inlet . . . . .	Width	1.8-2.2 mm (.0708-.0866")	
b) Exhaust . . . . .	Width	2.0-2.5 mm (.0787-.0984")	
c) Inlet . . . . .	Seat angle	30°	
d) Exhaust . . . . .	Seat angle	45°	
e) External correction angle . . . . .		15°	
f) Internal correction angle . . . . .		75°	
Valve guides Inlet . . . . .	ID	8.00-8.02 mm dia. (.3150-.3158")	8.06 mm dia. (.3173")
Exhaust . . . . .	ID	9.00-9.02 mm dia. (.3543-.3551")	9.06 mm dia. (.3567")
Valve stem Intake . . . . .	Dia.	7.94-7.95 mm dia. (.3126-.3130")	7.90 mm dia. (.3110")
Exhaust . . . . .	Dia.	8.91-8.92 mm dia. (.3508-.3512")	8.87 mm dia. (.3492")
	out-of-round	max. 0.01 mm (.00039")	
Valve guide - valve stem . . . . .	Rocker play	max. 0.45 mm (.0177")	0.9 mm (.0354")
Inlet and exhaust . . . . .			
Valve disc Inlet . . . . .	Dia.	39.0 mm dia. (1.54")	
Exhaust . . . . .	Dia	33.00 mm dia. (1.30")	
Valve clearance (cold) Inlet . . . . .	Adjustment	0.10 mm (.0039")	
Exhaust . . . . .	Adjustment	0.10mm (.0039")	
Compression pressure (with throttle valve open and engine at operating temp., all plugs unscrewed, with practically no-loss pressure gauge in plug seat, cranking with starter) . . . . .	Pressure	9.0-11.0 kp/cm <sup>2</sup> (128-156 psi)	7.0 kp/cm <sup>2</sup> (100 psi)
Pressure difference between individual cylinders . . . . .		max. 1.5 kg/cm <sup>2</sup> (21.3 psi)	

**CYLINDERS AND PISTONS**

2 Excess sizes, each with 0.5 mm (.0197") higher dia.

Cylinder .....	out-of-round	max. 0.01 mm (.0004)	
Cylinder/Piston .....	Clearance	0.04-0.06 mm (.0016-.0024")	0.20 mm (.0079")
a) Upper piston ring .....	Side clearance	0.06-0.09 mm (.0024-.0035")	0.12 mm (.0048")
b) Lower piston ring .....	Side clearance	0.04-0.07 mm (.0016-.0028")	0.10 mm (.0039")
Oil scraper ring .....	Side clearance	0.02-0.05 mm (.0008-.0020")	0.10 mm (.0039")
a) Upper piston ring .....	Gap width	0.35-.055 mm (.0138-.0216")	0.90 mm (.0354")
b) Lower piston ring .....	Gap width	0.30-0.35 mm (.0118-.0138")	0.90 mm (.0354")
Oil scraper ring .....	Gap width	0.25-0.40 mm (.0098-.0157")	0.95 mm (.0374")
<b>Piston weight</b>			
- Weight (brown) .....		472-480 grams	
+ Weight (grey) .....		480-488 grams	
Weight difference of pistons of one engine .....		max. 4 grams	max. 10 grams*
*)In the event of repairs			

**CRANKCASE**

Bore for crankshaft bearings		70.00-70.02 mm dia.	70.03 mm dia.
a) Bearings 1-3 .....	Dia.	(2.7559-2.7567")	(2.7571")
b) Bearing 4 .....	Dia.	50.00-50.04 mm dia.	50.04 mm dia.
		(1.9685-1.9701")	(1.9701")
Bore for sealing ring/ flywheel end .....	Dia.	95.00-95.05 mm dia.	
		(3.7402-3.7422")	
Bore for sealing ring/ blower gear end .....	Dia.	62.00-62.05 mm dia.	
		(2.4409-2.4429")	
Bore for camshaft bearing .....	Dia.	27.50-27.52 mm dia.	
		(1.0827-1.0835")	
Bore for oil pump housing .....	Dia.	70.00-70.03 mm dia.	
		(2.7559-2.7571")	
Bore for tappet .....	Dia.	24.00-24.02 mm dia.	24.05 mm dia.
		(.9449-.9457")	(.9469")

**CAMSHAFT**

Bearings 1-3 .....	Dia.	24.99-25.00 mm dia.	
		(.9839-.9843")	
Measured on center bearing (1st and 3rd bearing point on V-blocks) .....	Out-of-true	max. 0.02 mm (.008")	0.04 mm (.0016")
Camshaft/camshaft bearings (including bearing pressure through housing) .....	Radial play	0.02-0.05 mm (.0008-.0020")	0.12 mm (.0048")
Guide bearing .....	Axial play	0.04-0.13 mm (.0016-.0051")	0.16 mm (.0063")
Camshaft gear .....	Backlash	0.00-0.05 mm (.00-.0020")	
Tappet .....	Dia.	23.96-23.98 mm dia.	23.93 mm dia.
		(.9433-.9441")	(.9421")

Housing bore/tappet	Radial play	0.02-0.06 mm (.0008-.0024")	0.12 mm (.0047")
Push rod	out-of-true	max. 0.3 mm (.0118")	

**CRANKSHAFT WITH CONNECTING RODS**

3 Undersizes, with dia. reduced in  
0.25 mm (.0098") steps

a) Bearings 1-3	Dia.	59.97-59.99 mm dia. (2.3610-2.3618")	
b) Bearing 4	Dia.	39.98-40.00 mm dia. (1.5740-1.5748")	
c) Connecting rod bearing	Dia.	54.98-55.00 mm dia. (2.1646-2.1654")	

Crankshaft on 2nd and 4th bearing point (1st and 3rd bearing point on V-blocks	Out-of-true		0.02 mm (.008")
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	Unbalance	max. 12 cmg	
Main bearing pin	Out-of-true		0.03 mm (.0012")
Conrod bearing pin	Out-of-true		0.03 mm (.0012")

Crankshaft/main bearing

(including bearing pressure through housing)			
a) Bearings 1 and 3	Radial play	0.05-0.10 mm (.0020-.0039")	0.18 mm (.0071")
b) Bearing 2	Radial play	0.03-0.09 mm (.0012-.0035")	0.17 mm (.0067")
c) Bearing 4	Radial play	0.05-0.10 mm (.0020-.0039")	0.19 mm (.0075")

Crankshaft/main bearing 1	Axial play	0.07-0.13 mm (.0028-.0051")	0.15 mm (.0059")
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Crank pin/conrod	Radial play	0.02-0.07 mm (.0008-.0029")	0.15 mm (.0059")
	Axial play	0.10-0.40 mm (.0039-.0157")	0.70 mm (.0276")

Conrod weight

-Weight (white)	746-752 grams
+ Weight (black)	769-775 grams

Weight difference of conrods of one engine

	max. 6 grams
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Piston pins	Dia.	23.996-24.000 mm dia. (.94472-.94488")
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Small end bushing	Dia.	24.015-24.024 mm dia. (.94547-.94582")
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Piston pin/small end bushing	Radial play	0.02-0.03 mm (.0008-.0012")	0.04 mm (.0016")
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Fly wheel (measured in center of clutch area)	Lt. wobble	max. 0.4 mm (.0157")	
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Shoulder for sealing ring	Out-of-balance	max. 20 cmg	
	OD	74.9-75.1 mm dia. (2.949-2.957")	74.4 mm dia. (2.929")

Refinishing of tooth width			max. 2 mm (.08")
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Driven plate	Unbalance	max. 5 cmg	
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**CLUTCH**

Total clutch pressure	Pressure	420-480 kg (926-1,058 lbs)	
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Total clutch unbalance		max. 15 cmg	
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Clutch pressure plate	Out-of-true		0.10 mm (.0039")
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Clutch disc (measured at 210 mm dia. = 463")	Lat. wobble	max. 0.5 mm (.0197")	
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