WORKSHOP MANUAL
for
VOLKSWAGEN BEETLE
1200, 1300, 1500 and 1600 c.c. Engine - including Karman Ghia and Type 181
From 1968

COMPILED AND WRITTEN
BY
P. Harris

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**IDENTIFICATION NUMBERS.**

**BEETLE MODELS**

- **Type Identification Plate.** Located in the luggage compartment behind the spare wheel.
- **Chassis Number.** Located on the frame tunnel beneath the rear seat cushion.
- **Engine Number.** Located on the crankcase flange for the generator support.

**TYPE 181 MODELS**

- **Type Identification Plate.** Located in the luggage compartment on the upper part of the front bulkhead.
- **Chassis Number.** Located on the frame tunnel under the rear seat cushion.
- **Engine Number.** Located on the crankcase flange for the generator support.

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**Introduction**

Our intention in writing this Manual is to provide the reader with all the data and information required to maintain and repair the vehicle. However, it must be realised that special equipment and skills are required in some cases to carry out the work detailed in the text, and we do not recommend that such work be attempted unless the reader possesses the necessary skill and equipment. It would be better to have an AUTHORISED VW DEALER to carry out the work using the special tools and equipment available to his trained staff. He will also be in possession of the genuine spare parts which may be needed for replacement.

The information in the Manual has been checked against that provided by the vehicle manufacturer, and any peculiarities have been mentioned if they depart from usual workshop practice. Consent to publish this Manual has been obtained from Volkswagen Motors Ltd., Brighton Rd., Purley but it must be regarded as an independent publication in no way connected with Volkswagenwerk A.G. or the VW organisation.

A fault finding and trouble shooting chart has been inserted at the end of the Manual to enable the reader to pin point faults and so save time. As it is impossible to include every malfunction, only the more usual ones have been included.

A linear conversion table of millimetres to inches has been included, but we would recommend that wherever possible, for greater accuracy, the metric measurements are taken.

Brevity and simplicity have been our aim in compiling this Manual, relying on the numerous illustrations and clear text to inform and instruct the reader. At the request of the many users of our Manuals, we have slanted the book towards repair and overhaul rather than maintenance which is covered in our 'Wheel' series of handbooks.

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Although every car has been taken to ensure that the information and data are correct, WE CANNOT ACCEPT ANY LIABILITY FOR INACCURACIES OR OMISSIONS, OR FOR DAMAGE OR MALFUNCTIONS ARISING FROM THE USE OF THIS BOOK, NO MATTER HOW CAUSED.
MODELS COVERED BY THIS MANUAL:–

1200 Beetle Saloon, 1968 on.
1300 Beetle Saloon, 1968 on.
1500 Beetle Saloon, 1968 on.
1500 Beetle Convertible, 1968 on.
1600 Beetle Convertible (N. America), 1968 on.
1302 Beetle Saloon (1600 cc.), 1970 on.
1302 'S' Beetle Saloon (1600 cc.), 1970 on.
1500 Karmann-Ghia Coupe, 1968 on.
1500 Karmann-Ghia Convertible, 1968 on.
Type 181 (1500 cc.), 1968 on.
Type 181 (1600 cc.), 1970 on.

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Fig. A.1. Front sectional view of the engine assembly.

Fig. A.2. Side sectional view of the engine assembly.

**Engine**

**GENERAL**

The engine of the Beetle, essentially renewed for its long term reliability, is mounted on the back of the gearbox by four bolts. The engine is not directly attached to the frame of the car and this makes for very simple engine removal.

The black painted casing which ducts the cooling air around the engine is a snug fit in the compartment and Beetle engine tend to stay very clean. Nearly all the components involved in routine maintenance are very easy to get at, but the owner must realise that this motor car is designed and built with the facilities of the Authorized Dealer's workshop in mind. There are some jobs which can only be carried out easily with the correct tool or pieces of equipment.

**ENGINE — Removal**

1. Block the front wheels. Disconnect the negative (bare) cable at the battery (13 mm) and raise the back end of the car to the maximum height outwards.
   - Support the back end of the car on the stands or trestle so that the engine is not obstructed.
   - Make sure that the clutch plate is centred correctly.
   - Leave off the rear cover plate (over the silencer) until the engine is removed. Secure the torque converter so that it cannot move outwards.
   - Disconnect the control valve cable, the lines from the pump to the torque converter and remove and plug the oil suction pipe (Fig. A7.). Remove the four screws from the drive plate through the transmission case holes (accessible when the engine is turned). After removing the engine, secure the torque converter so that it cannot move downwards or being pressed upwards, pull the engine towards the back of the car until the clutch release ring is seen to be clear of the gearbox bell housing. It should now be possible to lower the engine to the ground, tilting it slightly so that the generator pulley clears the rear apron. You may find it necessary to loosen the distributor clamp and unclip the vacuum unit out of the way. This whole operation presents few problems unless the engine compartment has been deformed by slight collision. This often happens after the bumpers have been knocked.

2. Disconnect the cables which are attached to the generator. Crawl under the car and pull the flexible fuel hose off the heat exchangers.
   - Disconnect the oil pipes to the torque converter and remove and plug the oil suction pipe.
   - Remove the four screws from the drive plate through the transmission case holes (accessible when the engine is turned).
   - Disconnect the oil pipes to the torque converter and remove and plug the oil suction pipe.
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   - Disconnect the oil pipes to the torque converter and remove and plug the oil suction pipe.

3. Disconnect the oil pressure relief valve.
   - Disconnect the oil pressure relief valve.
   - Disconnect the oil pressure relief valve.
   - Disconnect the oil pressure relief valve.
   - Disconnect the oil pressure relief valve.

4. Disconnect the throttle cable at the carburettor and pull this through the fan housing.
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5. Under the two upper mounting bolts (Fig. A5). On the latest models, the heads of these bolts are locked and the nuts can be removed simply with a ring spanner. (You will find them down behind the fan housing).
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6. Support the engine with the jack and then remove the nuts of the two lower mounting bolts (Fig. A5).
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**DISTRIBUTOR DRIVE SHAFT — Removal & Installation**

**CYLINDER HEADS — Removal, Inspection & Installation**

**VALVE SEATS**

**ADJUSTING THE VALVE CLEARANCES**

**CYLINDERS — Removal, Inspection & Installation**

**PESTONS — Removal, Inspection & Installation**

**FLYWHEEL — Removal, Inspection & Installation**

**CRANKCASE — Disassembly, Inspection & Assembly**

**CRANKSHAFT & CONNECTING RODS — Removal, Inspection & Installation**

**CRANKSHAFT END PLAY — Measurement**

**CRANKCASE OIL SEAL — Replacement**

**CAMSHAFT — Inspection & Replacement**

**GENERAL**

**ENGINE — Removal & Installation**

**GENERAL**

1. Leave off the rear cover plate (over the silencer) until the engine is installed.
2. Make sure that the clutch plate is centred correctly.
3. Saturate high melting point grease or molybdenum disulphide powder on the surface of the main shaft which projects from the gearbox.
4. Clean out the gearbox bell housing and lightly grease the starter pinion bush.
5. The engine must be raised carefully into the engine compartment.
6. Make sure that it is not tilted when it is pushed forward to mate up with the gearbox. Check visually that the two lower mounting studs are in line with the gearbox holes before the engine is slid forward.
7. The main shaft slides in better if a gear is selected and the crankshaft is locked into the crankcase. The bolt must be undone from the inner end of the oil strainer. Make sure that the engine is not obstructed.
8. Nearly all the components involved in routine maintenance are very easy to get at, but the owner must realize that this motor car is designed and built with the facilities of the Authorized Dealer's workshop in mind. There are some jobs which can only be carried out easily with the correct tool or pieces of equipment.
9. The black painted casing which ducts the cooling air around the engine is a snug fit in the compartment and Beetle engine tend to stay very clean.
8

ENGINE — Disassembly

Once the engine has been removed from the car, it can be dismantled by following the given sequence of operations. Each of the items concerned will be dealt with further in its own section.

1. Support engine on a suitable stand (Two piles of bricks will do) and drain off the oil.
2. Unscrew the front cover plate.
3. Remove the rear cover plate (Fig. A10).
4. Take off the silencer.
5. Remove the fan housing and generator.
6. Remove the carburettor.
7. Remove the inlet manifold.
8. Remove the heat exchangers.
9. Remove the cover plates over the cylinders.
10. Pull off the crankcase pulley.
11. Remove the distributor.
12. Remove the fuel pump.
13. Remove the oil cooler.
14. Remove both rocker shafts.
15. Remove both cylinder heads.
16. Remove the cylinder.
17. Remove the pistons.
18. Remove the clutch.
19. Unbolt the flywheel.
20. Remove the oil pump.
21. Unbolt the oil strainer plate and remove strainers.
22. Open the crankcase.
23. Remove camshaft and crankshaft with connecting rods.

FAN HOUSING

The shape of the fan housing allows the fan (fitted to the end of the generator) to blow cooling air over the cylinders. Outlet on the fan housing duct off a separate supply of air for the heat exchangers. Thermostatically controlled flaps inside the housing prevent excess air reaching the cylinders until operating temperature has been reached.

On 1300 and 1600 models from August 1970, the oil cooler, which previously stood inside the fan housing, has its own separate housing behind.

Removal

1. Remove the piece of engine casing below the right hand bank of cylinders to get at the thermostat.
2. Undo the bolt which secures the thermostat to its bracket.
3. Rotate the thermostat so that it unwinds itself from the control rod.
4. Remove the screws at either side of the fan housing.
5. On 1200 and 1600 models, remove the rod which connects the two arms of heat control flaps behind the fan housing. It is held on by coil spring clips.
6. Remove the stop which holds down the generator.
7. Raise the fan housing.

Installation

1. When the fan housing is lowered, make sure that it enters the gap in the right hand casing correctly.
2. Make sure that the thermostat control rod passes down the hole in the cylinder head.
3. When the fan housing is in position, wind the thermostat on to its control rod.
4. Loosen the nut which holds the thermostat bracket to the crankcase.
5. Move the thermostat upwards so that the flap in the fan housing are fully open. Move the bracket so that the top of the thermostat is resting against the top of the bracket. Lock the bracket in position and then bolt the thermostat to it. In order to bolt the thermostat in place, it will have to be pulled downwards, thereby closing the flap in the fan housing.

SILENCER

Removal

The various nuts and bolts which secure the exhaust system are likely to be difficult to undo because of the action of heat and rust. Wire brush and soak them with release oil well before any work is carried out.

1. Remove the two wide horns flexible or pipe which can be seen inside the engine compartment. The clips at either end must be loosened.
Fig. A.5. Removing the engine upper mounting bolts - 17mm. (1300 & 1600cc. have a captive nut here).

Fig. A.6. Removing the engine lower mounting nuts - 17mm.

Fig. A.7. Union nut for oil feed pipe to automatic transmission.

Fig. A.8. Sealing oil suction pipe on automatic models.

Fig. A.9. Removing the pre-heater pipe sealing plate.

Fig. A.10. Removing the engine rear cover plate.

Fig. A.11. Correct positioning of the deflector plates.

Fig. A.12. Correct positioning of the sealing rubber on the cover plate.

Fig. A.13. Correct positioning of the spark plug sealing boot.

Fig. A.14. Removing the clips which link the main and secondary heat exchangers.

Fig. A.15. Removing the lower heating duct retaining screws.

Fig. A.16. Removing the rocker assembly to gain access to the four cylinder head nuts.

Fig. A.17. The slotted rocker shaft supports must be installed with the slots upwards and the chamfered edges outwards.

Fig. A.18. To ensure valve rotation, the tappet adjusting screw must touch the valve stem as shown.

Fig. A.19. Components of the valve operating gear.

1. Camshaft
2. Cam follower
3. Push rod
4. Rocker arm
5. Push rod tube
6. Seal ring
7. Lock nut
8. Rocker arm adjusting screw
9. Valve seal ring
10. Valve spring seat
11. Valve spring
12. Valve seat
13. Valve shaft
14. Rocker shaft
15. Rocker shaft support
16. Washer
17. Spring clip

Fig. A.20. Exploded view of the rocker assembly.

Fig. A.21. Check the manifold flange at points shown for cracks and distortion - 1200 models only.

Fig. A.22. Removing the manifold sealing ring from the cylinder head - 1200 models only.
Fig. A23. Exploded view of the crankshaft, connecting rod and piston assemblies.

Fig. A24. Push rod dimension 'a' should be: 1200-150-151.5 mm, 1300, 1500 & 1600: 190-191 mm.

Installation

1. It is well worth fitting the still pipes first as they act as handles for positioning the silencer.
2. Fix the metal rings and asbestos gaskets to the heat exchangers.
3. Lift the silencer and slide it into position.
4. Replace two of the cylinder head nuts to hold the unit in position.
5. Slide the pre-heater pipe flange gaskets into position (the one with the small hole goes on the left). Fit the four securing screws. If the metal rings and the asbestos gaskets are correctly positioned.
6. Tighten the four cylinder head nuts.
7. Fit the upper exhaust flange gaskets into position.
8. Fit the silencer backwards to free it.
9. It is usually possible to remove the tail pipes once the charge are loosened, but they may be so firmly fitted that removal will damage either them or the silencer.

Inspection

1. As the body of the oil pump is pushed in, care must be taken to ensure it is correctly positioned.
2. Oil the interior of the pump and the gears.
3. Maximum clearance between gears and cover plate face of casing is 0.1 mm (0.004") without the paper gasket.

OIL PUMP

The oil pump, driven off the back end of the crankshaft, draws oil through a gauze strainer from the sump and pumps it, via, an oil cooler to the bearings. Some oil is pumped to the camshaft bearings and some passes up to the oil control ring and upper piston ring. From August 1969 onwards, the oil passageways in the cooler and crankcase were enlarged by 2 mm and old crankcases can be matched to new ones by using a special set of tapered gaskets, part no. 111 198 029.

Removal

1. Remove the oil filter flange and gasket or oil cooler to fan housing.
2. Unscrew the oil filter flange bolts.
3. Remove the oil cooler to fan housing bolts.
4. Remove the oil cooler to manifold pre-heater pipe.
5. Loosen the clamps which secure the silencer to the heat exchanger chambers on the silencer to the main heat exchanger.
6. Remove the four bolts which attach the pre-heater pipe to the silencer (10 mm).
7. Remove the bolts which lock the silencer on to the cylinder heads (13 mm).
8. Pull the silencer backwards to free it.
9. It is usually possible to remove the tail pipes once the charge are loosened, but they may be so firmly fitted that removal will damage either them or the silencer.

The limiters are attached to the control arms on the heat exchangers by clamps which slide in 9 mm screw and a 10 mm nut. The screw must be held whilst the nut is removed or the cable will be twisted.

HEAT EXCHANGERS

Once the oil pump has been removed, the heat exchangers are easily removed by undocking the two units on each from exhaust flanges of the cylinder heads. It should be added that it is almost impossible to do this job with the engine still in the car.

Pumps air is passed through the heat exchangers to feed the car’s heating system. For this reason, it is absolutely essential that they are in good condition. Any leak could cause poisonous fumes to enter the car.

OIL COOLER

The oil cooler is a small radiator which, until August 1970, sat on a flange on top of the crankcase and projected up into the fan housing in the cooling air stream (Fig. A28). From that date, 1300 and 1600 engines have a larger aluminium oil cooler which sits in a separate housing on the back of the fan housing and this means that an intermedio exhaust has to be fitted.

From August 1969 onwards, the oil passages in the cooler and crank-case were enlarged by 2 mm and old crankcases can be matched to new ones and vice versa by means of a special set of tapered gaskets, part no. 111 198 029.
A 31.5 mm.
B 112 mm.
C 7.94 - 7.95 mm.
b 1.14 - 1.90 mm. — All Engines.
b 1.6 - 2.1 mm. — All Engines.

In August 1970, the oil system was modified by the introduction of a pressure regulating valve in addition to the relief valve (Fig A29). Both are visible under the crankcase (the large slotted screws under the right hand section of the case).

1. Oil coolers can be tested on a special high pressure testing rig, but this is a very specialised piece of equipment. They are tested to a pressure of 85 p.s.i. Normally, the performance of the oil cooler indicates whether it is faulty; if it does not leak in practice, it is obviously O.K.

2. Oil coolers which fit directly on to the crankcase flange require 2 plain cylindrical seals. They MUST be new.

3. Oil coolers that are bolted to the bottom of the crankcase (Fig. A28). On post August 1970 1300s and 1600s, it is necessary to remove part of the oil cooler casing behind the fan housing before removing the fan housing. When the fan housing has been removed, the oil cooler can be taken off the intermediate bracket after removing the 3 9mm nuts, or the complete cooler and bracket can be removed after taking off the three 13 mm nuts which secure the bracket to the crankcase.

4. Use new gaskets on either side of the strainer and new copper washers for the six retaining nuts.

5. Tighten the 6 nuts very carefully and evenly. It is all too easy to shear a stud.

**OIL PRESSURE RELIEF VALVES**

The oil pressure relief valve prevents oil flowing through the cooler until the engine has reached a reasonable temperature. The 1500 engine was fitted with a valve which had a groove around it in order to maintain lower oil temperatures.

In August 1970, the oil system was modified by the introduction of a pressure regulating valve in addition to the relief valve (Fig A29). Both are visible under the crankcase (the large slotted screws under the right hand section of the case).

**Removal**

1. Unscrew the slotted plug with a very wide bladed screwdriver.

2. Withdraw the valve and its spring. If the valve sticks in the passage way, a suitable tap can be screwed in to it to pull it out.

**Inspection**

Check that the valve moves easily in the passage and ensure that the slotted plug is replaced very tightly.

**Cleaning**

1. The valve should be clean and so show no signs of sticking. Clean it carefully.

**Installation**

Check that the valve moves easily in the passageway and that the slotted plug is replaced very tightly.

**DISTRIBUTOR DRIVE SHAFT**

The distributor drive shaft contains a gear on the crankshaft and drive both the fuel pump and the distributor. It is extremely unlikely that it would be necessary to remove it unless the engine was being stripped down and it is virtually impossible to remove it with the engine in place unless one has access to V.W. extractor 228. Details of removal during an engine strip down are given below:

**Removal**

1. Remove the screw at either side of the fan housing, undo the generator mounting strap and lift off the fan housing complete with generator. (This cannot be done with the engine in the car unless the engine compartment lid is removed first.)

2. The cooler is held in place by 3 nuts. One is close to the centre line of the crankcase and is easy to undo. The other two are located underneath the overhang of the cooler flange, just above cylinders 3 and 4. It is difficult to undo them unless the casing over cylinders 3 and 4 is removed first.

3. On post August 1970 1300s and 1600s, it is necessary to remove part of the oil cooler casing behind the fan housing before removing the fan housing. When the fan housing has been removed, the oil cooler can be taken off the intermediate bracket after removing the 3 9mm nuts, or the complete cooler and bracket can be removed after taking off the three 13 mm nuts which secure the bracket to the crankcase.

**Inspection**

Oil coolers can be tested on a special high pressure testing rig, but this is a very specialised piece of equipment. They are tested to a pressure of 85 p.s.i. Normally, the performance of the oil cooler indicates whether it is faulty; if it does not leak in practice, it is obviously O.K.

1. The mating surfaces of strainer plate, strainer and crankcase must be perfectly clean.

2. Remove the oil strainer assembly.

3. Ease the drive shaft out of its socket, turning it slightly as you do so.

4. Ease the drive shaft out of its socket, turning it slightly as you do so.

5. Remove the small coil spring which fits in to the top of the drive shaft. It will be extremelyeasy.

6. Remove the nut and washer which locates the distributor drive to the crankcase and pull out the distributor. It may be a little obstinate due to the oil sealing ring fitted half way down its shaft.

7. Remove the Seal and spring which fit to the top of the drive shaft.

8. Ease the drive shaft out of its socket, turning it slightly as you do so.

**NOTE**

There are two large washers fitted to the base of the drive shaft. They will not come out with the shaft, but will remain in position on the drive shaft. If the engine is still installed, it is absolutely vital that they do not drop into the crankcase. It is possible to remove them with a thin cylindrical magnet. If the engine is out of the car, you can tip it over to allow the washers to drop out.
Fig. A.30. Piston crowns markings.

Fig. A.31. Checking the piston ring gap.

Fig. A.32. Correct installation of the oil strainer.

Fig. A.33. Number pistons as shown before removal.

Fig. A.34. Removing the piston pin circlips using circlip pliers.

Fig. A.35. Exploded view of the oil strainer components.

**Installation**

1. Check the teeth on the drive shaft. If they are worn or damaged, it is likely that the gear on the crankshaft will be in a similar condition and so also must be inspected.
2. Check the two washers for wear. Replace them if necessary.
3. Place the two washers in position. NOTE: You cannot assemble them on the shaft because they will roll on the crankshaft gear. Cut them very finely with grease and slide them on to the shaft of a long screwdriver. Then put the screwdriver down the drive shaft passage and allow the washers to slide down it. They will lodge in position on the shaft and the grease will allow you to nudge them precisely into position without their falling in to the crankcase.
4. Set Number 1 cylinder at firing point. The timing notch on the crankshaft pulley should be in line with the split in the crankcase and both valves for number 1 cylinder should be shut. You can check this by moving the inlet valve for number 3 cylinder is just opening and the exhaust valve is just closing.
5. Insert the drive shaft so that the slot in the top of it is at right angles to the split in the crankcase (i.e. parallel to the crankshaft pulley). You may have to turn the shaft slightly as it goes in to allow the gears to mesh. The smaller segment at the top of the drive shaft should be closest to the crankcase crankshaft pulley.
6. Put the small coil spring in position in the top of the drive shaft.

**CYLINDER HEADS**

The light alloy cylinder heads are fitted to the cylinders without any gaskets. They are easily distorted and it is absolutely essential that a torque wrench is used when they are fitted.

The condition of the valves and their seatings have an important effect on the life and performance of the engine.

**Removal**

1. Step down the clip which holds the cover in position and remove the cover.
2. Remove the two nuts which secure the rocker shaft and slide it off (Fig. A16).
3. Unscrew the 8 cylinder head nuts.
4. Slacken off all the valve clearance adjusting screws on the rockers blocks face UPWARDS (Fig. A17).
5. Lightly grease the cylinder head nuts with graphited grease and loosely fit the 8 nuts and washers in position.
6. Tighten the rocker shaft securing nuts.
7. Adjust the valve clearances (see appropriate section) and refit the valve cover with a new gasket.

**VALVE SEATS**

Once the valves have been removed from the cylinder head with a valve spring compressor, the valve seats in the head can be inspected.

If the seats and the seating surfaces on the valves are in good condition, it is sufficient to grind the valves by hand, using valve grinding paste.

If the seats show signs of burning or damage, they can be re-cut, providing that the re-cutting process does not narrow the outer edge of the valve seat to below the sizes in the table. This is a most important piece of maintenance. The engine MUST be cold when it is carried out.

**Inlet Valve Seat**

<table>
<thead>
<tr>
<th>Size</th>
<th>Diameter (mm)</th>
<th>Diameter (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>1.6 mm</td>
<td>0.051 - 0.063&quot;</td>
</tr>
<tr>
<td>1.7</td>
<td>2.0 mm</td>
<td>0.067 - 0.079&quot;</td>
</tr>
</tbody>
</table>

The first cut is made with a 65 degree cutter, using the valve guide to ensure concentricity.

The lower edge of exhaust valve seat is then chamfered with a 75 degree cutter and finally both inlet and exhaust seats are chamfered with a 15 degree cutter until the seat width is within the correct limits.

**ADJUSTING VALVE CLEARANCES**

The valve clearances must be set and maintained at 0.1 mm (0.004"). This is a most important piece of maintenance. The engine MUST be cold before it is done.

1. Raise and support the back of the car and remove both rear wheels (to give greater working access to the cylinder heads).
Fig. A.36. Removing the threaded ring for the oil filler, using a special tool.

Fig. A.37. Removing the flywheel with a special fixture.

Fig. A.38. Removing the sharp edges on the oil seal counter-bore.

Fig. A.39. Installing the oil seal using a special tool.

Fig. A.40. Crankcase ventilation system components.
1. Air cleaner
2. Connecting hose
3. Oil filter tube and breather
4. Rubber drain valve

Fig. A.41. The arrow on the pistons crown must point towards the flywheel end of the engine. "a" is the piston pin offset.

Fig. A.42. Main bearing shell locating dowels.

Fig. A.43. Theoretical valve timing diagram. The valve clearance should be 1.0 mm. (0.040 in.).

Fig. A.44. Checking the piston ring to groove clearance.

2. Clean carefully around the valve covers and then snap off the retaining clips and lift off the covers.
3. Rotate the engine with the fan belt and observe the marks in the distributor. Place the distributor towards the north on the base of the distributor body and the notch on the crankshaft pulley lines up with the division (Fig. A.47).
4. Loosen the lock nuts on the 2 valves of No. 1 cylinder (right hand side, legends front of oil) and adjust the screws so that the gap is 0.1 mm (Fig. A.46). Tighten the lock nuts without altering the setting.
5. Rotate the engine 180 degrees ANTICLOCKWISE, (Rотор arm 90 degrees).
6. Adjust valves of No. 2 cylinder.
7. Rotate engine 180 degrees ANTICLOCKWISE, (Rotor arm 90 degrees).
8. Adjust gages for No. 3 cylinder.
9. Rotate engine 180 degrees anticlockwise and adjust valves of No. 4 cylinder.
10. Carefully clean around the valve cover seating face and, using NEW gaskets which have been inserted into the covers with non-setting sealing compound, fit the covers.

CYLINDERS
The Beetle engine cylinders are made of cast iron and are liberally finned to assist cooling. The cast aluminium alloy pistons are fitted with one oil control ring and two compression rings. The piston pin is located by two circlips. This will also indicate any ovality. Scoring marks on the cylinder walls are likely to lead to heavy oil consumption. It is the oil consumption of the engine which gives a good guide to the need for replacement of cylinders and pistons.

Check that the spacer at the base of the cylinder is not damaged and that the shoulders which rest on the crankcase are absolutely clean.

Cylinders

<table>
<thead>
<tr>
<th>Ring</th>
<th>Clearance</th>
<th>Wear Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>0.06 - 0.09 mm</td>
<td>0.02 - 0.04 mm</td>
</tr>
<tr>
<td>Lower</td>
<td>0.04 - 0.07 mm</td>
<td>0.01 - 0.03 mm</td>
</tr>
<tr>
<td>Oil Control</td>
<td>0.02 - 0.03 mm</td>
<td>0.009 - 0.012 mm</td>
</tr>
</tbody>
</table>

Check that the oil seal is in place and that it is seated firmly in the groove.

6. Carefully remove the planepar edge, using a center punch and a file. Swing the other end of the groove over the center punch and file it smooth. Excessive force will damage the brittle fins. (Fig. A.45).

7. Fit the circlips in their grooves; then, lift off the cylinder head cover. Place one of the compression rings in the bottom part of the cylinder and level it up with the piston. Measure the gap in the ring with a feeler gauge, when the ring is about 3 mm inside the cylinder (Fig. A.31). The gap limits are given in the following table:

<table>
<thead>
<tr>
<th>Ring</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper compression ring</td>
<td>0.30 - 0.45 mm (0.012 - 0.018&quot;)</td>
</tr>
<tr>
<td>Lower compression ring</td>
<td>0.25 - 0.40 mm (0.010 - 0.016&quot;)</td>
</tr>
<tr>
<td>Oil control ring</td>
<td>0.25 - 0.40 mm (0.010 - 0.016&quot;)</td>
</tr>
</tbody>
</table>

Note that the gap in the oil control ring should be towards the top of the engine and the gaps in the other two should be spaced at 120 degrees from it.

1. Coat the inner wall of the cylinder with oil.
2. Fit the paper gasket in position on the base of the cylinder.
3. Use a suitable compressor to compress the piston rings (Fig. A.45).
4. Slide the cylinder into position. It is usually an easy matter here, any obstruction is likely to be caused by carbon build up in the piston ring grooves.

Pistons

The cast aluminium alloy pistons are fitted with one oil control ring and two compression rings. The piston pin is located by two circlips. This will also indicate any ovality.
Fig. A.48 Location of the paper gasket between the cylinder and cylinder head. Fix before sliding the head over the piston.

Fig. A.49. Installing the camshaft bearings.

Crankcase assembly:

Disassembly:

1. Remove cylinder heads, cylinders, pistons, flywheel, oil pump and oil strainer.
2. Undo all the nuts which clamp the two halves together.
3. Split the case by tapping carefully on the projecting lugs with a large torque.

Inspection:

4. Lift out the crankshaft with connecting rods and the camshaft.

Installation:

5. Then tighten the 6 large nuts around the cylinder bores.
6. Tighten the remainder of the nuts.

Fig. A.50 Camshaft alignment marks.

Fig. A.47. No. 1 piston is at T.D.C. on the compression stroke when the pulley points indicated.

The flywheel is located on the end of the crankshaft by four dowels and secured by a 36 mm gasket. The gasket is tightened to a torque of 217 ft.lbs, and this figure must be adhered to on reproduction. If not, there is a danger that the flywheel will loosen.

Removal:

1. Lock the flywheel by attaching a suitably drilled bar to 2 of the clutch housing screws. The bar will jam against the bench as the flywheel tries to rotate.
2. Undo the gland nut with a 36 mm socket and suitable bar.
3. Ease off the flywheel, after marking both it and the end of the crankshaft so that they can be re-aligned.

Inspection:

4. Check both inside and outside of case for cracks or other damage.
5. Carefully clean out all oil passages. If possible, blow them out with compressed air.
6. Check the bores for the cam followers. Limits are — 19.00 - 19.05 mm
7. Check that the bearing dowels are not loose.
8. Check that the bearing dowels are not loose.

Assembly:

1. After fitting crankshaft with connecting rods and the camshaft into one half of the case (see relevant section), smear non-setting sealing compound on all the mating surfaces.
2. If the crankcase has been split for the installation of new bearings or crankshaft, the camshaft end plug must be checked and adjusted (see relevant section).
3. Align the marks made on removal and fit the flywheel, using a new, longening bar at a distance of £ and pull on the balance with a force of 56 lbs.

The Beetle crankcase is in two halves, the jointing faces being machined to match. No gasket is used between them (Fig. A63).

Cylinder No. 1 Cylinder No. 2

Limits:

Table:

<table>
<thead>
<tr>
<th>Component</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main bearings</td>
<td>65.0 - 65.02 mm</td>
</tr>
<tr>
<td>Camshaft</td>
<td>50.00 - 50.03 mm</td>
</tr>
<tr>
<td>Crankcase</td>
<td>27.50 - 27.52 mm</td>
</tr>
</tbody>
</table>

Crankcase assembly:

Disassembly:

1. Remove cylinder heads, cylinders, pistons, flywheel, oil pump and oil strainer.
2. Undo all the nuts which clamp the two halves together.
3. Split the case by tapping carefully on the projecting lugs with a rubber or wooden mallet. Make sure that the crankshaft and camshaft remains in one half and do not fall out of position.
4. Lift off the crankshaft with connecting rods and the camshaft.

Inspection:

5. Tighten the gland nut with a torque of 217 ft.lbs. A large torque is a danger that the flywheel will loosen.
6. Check the bearing dowels are not loose.
7. Install the oil deflector plate which goes between the crankcase and oil strainer.
8. There should be a gasket on either side of it and one surface is machined top (the column face downwards and the longer end of the centre cut-out is closer to the top of the crankcase).

Crankcase and connecting rods:

The crankshaft runs in four main bearings, three of them being bushes and one (No. 2) being split. The rear end of the shaft carries gears for driving the camshaft and the oil pump/distributor. It is important that the crankshaft end play (the amount of movement which can be felt when the flywheel is pulled back and forth) is within the prescribed limits.

Removal:

1. Split the crankcase and lift off the shaft and connecting rods.
2. Mount the crankshaft in a stand in order to remove the rods. If a proper stand is not available, it is possible to support the crankshaft in a vice, providing that only the webs are held.
3. Unscrew the connecting rods and remove them.

Fig. A.45. Installing the cylinder, using a piston ring compressor.

Fig. A.46. Adjusting the valve clearances.

Fig. A.47. No. 1 piston is at T.D.C. on the compression stroke when the pulley marks are aligned and the rotor arm is positioned as shown.

Fig. A.49. Installing the camshaft bearings.

Fig. A.50 Camshaft alignment marks.

Fig. A.48 Location of the paper gasket between the cylinder and cylinder head. Fix before sliding the head over the piston.

Fig. A.51. Rubber drain valve fitted to the bottom of the oil breather pipe.

Fig. A.52. The crankshaft assembly must be installed with the marks indicated on the connecting rods facing upwards.

Fig. A.53. If balancing of the connecting rods is necessary, remove metal from points indicated.
rubber seal for the engine rear cover plate.

Fig. A.54. Checking the connecting rod axial play with a feeler blade.

Fig. A.55. Tightening the connecting rod bolts.

Fig. A.56. Adjustment of the air flaps is achieved by moving the thermostat bracket up or down as required.

Fig. A.57. Check the drive belt tension at a point midway between the two pulleys.

Fig. A.58. Adjustment of the drive belt is achieved by moving the spacer washers as shown.

Fig. A.59. If cooling slots (A) are present, install the generator with the slots facing downwards.

Fig. A.60. Correct installation of the rubber seal for the engine rear cover plate.

Fig. A.61. Beater cable rear connection.

Fig. A.62. Detaching the beater cable at the control lever.

Fig. A.54. Checking the connecting rod axial play with a feeler blade.

Fig. A.55. Tightening the connecting rod bolts.

Fig. A.56. Adjustment of the air flaps is achieved by moving the thermostat bracket up or down as required.

Fig. A.57. Check the drive belt tension at a point midway between the two pulleys.

Fig. A.58. Adjustment of the drive belt is achieved by moving the spacer washers as shown.

Fig. A.59. If cooling slots (A) are present, install the generator with the slots facing downwards.

Fig. A.60. Correct installation of the rubber seal for the engine rear cover plate.

Fig. A.61. Beater cable rear connection.

Fig. A.62. Detaching the beater cable at the control lever.
CRANKCASE OIL SEAL

Whenever the crankcase is split, a new oil seal must be fitted.

Removal

1. Pry out the old seal.

Installation

1. Lightly chamfer the edges of the oil seal housing with a scraper (Fig. A38).

2. Clean the housing and put a smear of sealing compound around the seal seating surface.

3. Press in the seal very evenly (Fig. A39). It MUST seat squarely.

CAMSHAFT

Each lobe of the 4 cams on the shaft operates two valves. The shaft runs in three replaceable bearings. A slot at the gear end drives the oil pump.

Inspection

1. Examine the lobes for wear. There should be no damage to the surface and the wear pattern should be even across the face of the lobe.

2. Examine the teeth of the gear for wear and check that the gear is firmly riveted to the shaft.

Replacement Camshafts

The amount of backlash between the crankshaft and camshaft gears must be within prescribed limits. Different sizes of camshaft gears are available and the back of the gear is inscribed with, for example, -1, 0, +1, +2, etc. Always replace a camshaft with another of the correct size. The backlash is correct if it is hardly noticeable and yet there is no tendency for the camshaft gear to lift the camshaft out of position when it is rotated.

Installation

1. Fit the bearing shells in position (Fig. A49).

2. Lightly lubricate the bearing surfaces and place the camshaft in one half of the crankcase, taking care that the gear tooth marked 'O' is between the two teeth on the camshaft gear which have punch marks on them (Fig. A50).
Technical Data

**General Specifications**

- **Design**
  - 4 stroke, air cooled, internal combustion engine forming one unit with gearbox and differential in rear of vehicle
- **Number of cylinders**
  - 1200 & 1300: 2
  - 1500: 2
  - 1600: 2
- **Stroke**
  - 1200: 3.37 in (85.6 mm)
  - 1300: 3.37 in (85.6 mm)
  - 1500: 3.27 in (82.5 mm)
  - 1600: 3.27 in (82.5 mm)
- **Cylinder capacity**
  - 1200: 1979 c.c. (120.0 cu.in)
  - 1300: 2048 c.c. (125.0 cu.in)
  - 1500: 2180 c.c. (134.0 cu.in)
  - 1600: 2390 c.c. (145.0 cu.in)
- **Compression ratio**
  - 1200: 7.5:1
  - 1300: 7.5:1
  - 1500: 7.5:1
  - 1600: 7.5:1

**Technical Data**

- **Connecting rods**
  - Cast iron, drilled for oil holes
  - Weight limit: 0.0012-0.0019 in (0.03-0.05 mm)

- **Pistons**
  - Light alloy with steel inserts
  - Piston ring side clearance:
    - 0.0015-0.0019 in (0.04-0.05 mm)

- **Crankcase**
  - Forged with "H" section shaft
  - Bore and stroke: 2.1654 in (55 mm), 2.52 in (64 mm)
  - Wear limit: 0.0016-0.0019 in (0.04-0.05 mm)

- **Cylinder heads**
  - Cast iron, drilled for oil holes
  - Valve seat inserts: one pair for each pair of cylinders
  - Valve seat insert: 0.0004 in (0.01 mm)
  - Valve seat width: 0.025 in (0.6 mm)
  - Valve seat thickness: 0.0012-0.0019 in (0.03-0.05 mm)
  - Compression ring: 0.0012-0.0019 in (0.03-0.05 mm)

- **Connecting rod journals**
  - Main bearing - No. 1
  - Main bearing - No. 2
  - Main bearing - No. 3
  - Main bearing - No. 4
  - Small end bush: 0.3098 in (7.90 mm)
  - Big end bush: 0.3109 in (7.90 mm)
  - Wear limit: 0.0047 in (0.12 mm)

- **Camshaft**
  - 8.9/2000 (69/2400) - DIN
  - 10.0/2800 (78/2600) - DIN
  - 10.6/3000 (81.7/3400) - DIN
  - Valve seats:
    - Valve seat width: 0.3150-0.3157 in (8.08-8.015 mm)
    - Valve seat thickness: 0.3098 in (7.90 mm)
    - Compression ring: 0.012-0.018 in (0.30-0.45 mm)

- **Lubrication**
  - Oil pressure SAE 30 Oil
  - Oil pressure contacts open: 0.928 in (23.6 mm)
  - Oil pressure contacts closed: 0.928 in (23.6 mm)
  - Oil pump:
    - 27 psi (2.0 kg/sq.cm) - Minimum
    - 50-60 psi (3.5-4.2 kg/sq.cm)

- **Max. performance** (SAE in brackets)
  - 1200: 44 H.P. at 4100 rpm. (52 at 4600 rpm)
  - 1500: 110 H.P. at 4800 rpm.

**Repair Data**

- Cylinders:
  - 1200: 6.94 in (176.5 mm)
  - 1300: 7.08 in (180.0 mm)
  - 1500: 7.28 in (185.0 mm)
  - 1600: 7.48 in (189.0 mm)

- Cylinder heads:
  - Valve seat width: 0.0047 in (0.12 mm)
  - Valve seat thickness: 0.0047 in (0.12 mm)

- Valve seat inserts:
  - One pair for each pair of cylinders
  - Valve seat insert: 0.0004 in (0.01 mm)

- Crankcase:
  - Forged high quality steel, four main bearings
  - Main bearing - No. 1: 0.0047 in (0.12 mm)
  - Main bearing - No. 2 (centre):
    - 0.0047 in (0.12 mm)
    - Oil control ring: 0.0039 in (0.10 mm)
  - Flywheel:
    - Wear limit: 0.007 in (0.18 mm)

- Crankshaft:
  - Diameter: 0.0047 in (0.12 mm)
  - Bearing clearance: 0.0047 in (0.12 mm)
  - Thrust bearing load: 0.0047 in (0.12 mm)
  - Camshaft gear backlash: 0.0047 in (0.12 mm)
  - Camshaft pulley: 0.0047 in (0.12 mm)
  - Bell housing:
    - Wear limit: 0.0047 in (0.12 mm)

- Flywheel:
  - Wear limit: 0.0047 in (0.12 mm)

**Technical Data**

- **Connecting rod journals**
  - Main bearing - No. 1
  - Main bearing - No. 2
  - Main bearing - No. 3
  - Main bearing - No. 4
  - Wear limit: 0.0047 in (0.12 mm)

- **Cylinder heads**
  - Valve seat width: 0.0047 in (0.12 mm)
  - Valve seat thickness: 0.0047 in (0.12 mm)
  - Compression ring: 0.0047 in (0.12 mm)

- **Crankcase**
  - Diameter: 0.0047 in (0.12 mm)
  - Bearing clearance: 0.0047 in (0.12 mm)
  - Thrust bearing load: 0.0047 in (0.12 mm)
  - Camshaft gear backlash: 0.0047 in (0.12 mm)
  - Camshaft pulley: 0.0047 in (0.12 mm)
  - Bell housing:
    - Wear limit: 0.0047 in (0.12 mm)

- **Flywheel**
  - Wear limit: 0.0047 in (0.12 mm)
Ignition System

GENERAL

DISTRIBUTOR — Removal & Installation

CONTACT BREAKER POINTS — Replacement and Adjustment

IGNITION TIMING — Adjustment

CONDENSER — Testing & Replacement

When the ignition is switched on, electrical current flows to the low voltage winding of the ignition coil via the contact breaker in the base of the distributor. When the engine is turning over, the contact breaker regularly interrupts this flow and so the current pulses through the coil, inducing a high voltage current in the secondary winding of the ignition coil. This high voltage current is fed to each spark plug in turn by the rotor arm in the upper part of the distributor.

As the engine speeds up, the suction created by the engine increases and this is used to advance the base plate of the distributor. This alters the time at which the contact breaker points open and so alters the time at which the spark occurs in the cylinder.

DISTRIBUTOR (Fig. B1)

The distributor does two jobs: the contact breaker interrupts the flow of current to the low voltage side of the coil (thus inducing high voltage pulses in the high voltage side) and the rotor arm distributes this high voltage current to each of the 4 spark plugs in turn.

Removal

1. Pull the vacuum hoses off the distributor vacuum unit
2. Disconnect the cable at terminal No. 1 on the ignition coil
3. Remove the distributor cap. *
4. Remove the nut and washer which lock the distributor clamp to the crankcase.
5. Pull out the distributor. If it is tight, this will probably be due to the rubber sealing ring which is fitted half-way down the shaft. DO NOT allow foreign matter to fall into the hole.

Check the following points:

1. Fit a new rubber sealing ring to the shaft.
2. As the distributor is pushed home, rotate the rotor arm slightly to ensure that the dog engages with the slot in the distributor drive shaft.

CONTACT BREAKER POINTS

It is possible to remove and re-grind the contact breaker points, but it is easier and more sensible to fit a new set when the existing ones become pitted.

Removal

1. Remove the distributor cap and rotor arm
2. Remove the screw and washer which lock the contact breaker assembly to the base plate. Take great care not to drop either of them into the distributor.
3. Lift the assembly upwards and undo the screw which holds the two sections of the contact breaker together. The cable from the condenser is also attached at this point.
4. Lift out the contact breaker points.

Installation

Check the following points:

1. Make sure that the fixed breaker point is properly seated.
2. Make sure that the movable breaker arm is properly seated on its spindle.
3. Ensure that the two contact faces line up squarely.
4. Adjust the contact breaker gap.
5. Adjust the ignition timing.

Adjustment:

The gap between the contact breaker points must be 0.4 mm (0.016") when the faces are widest apart, i.e. when the lobe of the distributor shaft is pushing the moving arm over farthest. This adjustment is quite critical and performance and economy will suffer if it is incorrectly set.

1. Remove the distributor cap.
2. Rotate the engine until the rotor arm points roughly towards the notch on the rim of the distributor body.
3. Remove the rotor arm and rotate the engine slightly until the lobe on the distributor shaft is pushing the points apart to the maximum extent.

* When the distributor is removed, the rotor arm should be held in its normal position.
IGNITION TIMING

The time at which the contact breaker points open determines the time at which the spark plug in any cylinder fires. It therefore has a major effect upon performance and economy and it is essential that the timing is correct.

As engine speed increases, it becomes necessary for the spark to occur at an earlier time and therefore the timing must be advanced. This is brought about, on the 1200, by a vacuum system which is connected to the carburettor and on the 1300 and 1600 by a combination of a vacuum system and a set of centrifugal balance weights which are situated on the distributor base-plate.

Some 1300 and 1600 engines have a double vacuum system which brings about timing reference at high speeds and timing retardation at idling speeds. This attenuation can occur without emissions.

It is possible to adjust and set the ignition timing with a simple 12 volt test lamp and this procedure should be found adequate for the 1200 engine. However, the more complex vacuum systems fitted to 1200 and 1600 engines calls for the use of a stroboscope.

Adjustment - With Test Lamp

1. Remove the distributor cap and rotor arm.
2. Check contact breaker gap.
3. Rotate the engine until the return arm points towards the notch on the rim of the distributor body and the timing mark on the crank-shaft pulley is level with the joint between the two crankcase halves.

NOTE: On the 1200 engine, there may be either 1, 2 or 3 notches on the rim of the pulley, all close together. If there is only one notch, use this. If there are 2 notches, use the left hand one (6.5 degrees before Top Dead Center). If there are 3 notches, you will be able to choose which one is the third. Use the left hand one of these two, i.e., the middle notch.

4. Connect a test lamp between terminal No. 1 on either the coil or the distributor cap and a suitable earthing point on the engine (Fig. B6). The lamp should just light as the contact breaker points open.
5. Switch on the ignition.
6. Remove the distributor body clockwise and then bring it slowly back until the lamp just lights.
7. Tighten the clamp and then check that the setting is correct by rotating the engine and observing the lamp lights when the pulley switch turns on correctly.

Adjustment - With Stroboscope Light

A stroboscope is a high voltage lamp which flashes in time with the engine. Simple versions are usually connected between the distributor and one of the plug leads in such a way that they flash each time the plug fires. Because the flashing is in time with the engine, marks on rotating parts, such as the crankshaft pulley, are "frozen".

1. Check the contact breaker gap.
2. Connect the stroboscope according to the maker's instructions and allow the engine to idle (if possible, to it around 850 rpm).
3. Direct the lamp to the centres on the crankshaft pulley (Fig. B7). The notch (see below) should line up with the crankcase joint.
4. If setting is incorrect, loosen the clamp around the base of the distributor body and rotate the distributor until the setting is correct.
5. Lock the clamp.

IGNITION SETTINGS STROBOSCOPIC LIGHT

Vehicle Type Ignition Setting

<table>
<thead>
<tr>
<th>Type</th>
<th>Ignition Setting</th>
<th>Pulley Nutch</th>
<th>Vacuum Hose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>7.5 deg. B.T.D.C.</td>
<td>left-hand one of two</td>
<td>Disconnected</td>
</tr>
<tr>
<td>1600</td>
<td>5.0 deg. A.T.D.C.</td>
<td>left-hand one of two</td>
<td>Disconnected</td>
</tr>
<tr>
<td>1300</td>
<td>7.5 deg. B.T.D.C.</td>
<td>left-hand one only</td>
<td>Connected</td>
</tr>
<tr>
<td>1600</td>
<td>5.0 deg. A.T.D.C.</td>
<td>left-hand one of three</td>
<td>Disconnected</td>
</tr>
<tr>
<td>1600</td>
<td>0.0 deg.</td>
<td>left-hand one only</td>
<td>Connected</td>
</tr>
</tbody>
</table>

CONDENSER

The condenser carries out 2 jobs: it cuts down the sparking effect at the contact breaker points and thereby increases the life of the points. It also helps to produce the high voltage which is necessary for the ignition system to work properly.

Testing Condenser (Fig. B10)

1. Remove the distributor cap and rotor arm.
2. Rotate the engine with the fan bolt until the points are fully open. When the movable portion of the contact breaker is held open by one of the cam lobes.
3. Disconnect the cable from terminal number 1 at the ignition coil (the one which is connected to the distributor).
4. Connect a 12 volt test lamp between terminal number 1 of the coil and the cable which has just been disconnected from it (Fig. B8).
5. Switch on the ignition. The lamp should not light. If it does light, the condenser is shorting and must be replaced.

Testing Condenser Performance

1. Disconnect the main high tension cable between coil and distributor at the distributor cap.
2. Hold the disconnected end of the cable about 10 mm (1/2") from
Fig. B.6. Setting the ignition timing using a test lamp.

Fig. B.7. Setting the ignition timing using a stroboscopic light.

Fig. B.8. Checking the condenser with a test lamp.

Fig. B.9. Checking the condenser with a voltmeter.

Fig. B.10. Condenser testing points.
1. Condenser
2. Cable entry
3. Insulation on breaker arm spring
4. Insulation on breaker arm spring

Fig. B.11. Correct alignment of the pulley mark and distributor drive slot for the installation of the distributor.

Fig. B.12. Correct position of the distributor after installation (No. 1 cylinder at T.D.C. on the compression stroke.)

the crankcase and turn the engine over by hand with the ignition switched on. A fat spark should jump between the end of the cable and the crankcase.

3. If the spark does not appear or is weak, either the coil or the condenser are faulty. The faulty item must then be found by replacing either the coil or the condenser with one which is known to be satisfactory.

Replacement
The position of the condenser varies with different types of distributor. Generally, it is either inside the housing, clamped to the base-plate, or outside, clamped to the housing itself.

Internal Condenser
1. Remove the distributor cap and rotor arm.
2. Remove the contact breaker points.
3. Disconnect the terminal at the end of the condenser lead where it is attached to the contact breaker.
4. Unscrew the condenser from the base-plate.

External Condenser
1. Unscrew the nut from terminal No. 1 on the side of the distributor housing and take off the low tension cable from the coil. The condenser lead can then be taken off.
2. Unscrew the condenser from the side of the distributor.

Installation
This is simply a reversal of the above process, but it is ESSENTIAL to re-adjust the contact breaker gap and ignition timing.
Technical Data

**Ignition Distributor**
- Firing order:
  - 1 - 4 - 3 - 2
- Contact breaker gap: 0.016 (0.4 mm)
- Dowel angle: 44 - 50°
- Wear limit: 42 - 64°

**Distributor Application**
- Prior to Aug. 1968:
  - 1500 USA
  - 1500 Auto — Prior to Aug. 1968

- Prior to Aug. 1969:
  - 1300 Auto — Prior to Aug. 1969

- Prior to July 1969:
  - 1200 - Prior to Aug. 1970
  - 1300 — Prior to Aug. 1970

- Prior to June 1971:
  - 1300 — Prior to Aug. 1970

- Prior to Aug. 1968:
  - 1600 USA

- Prior to June 1971:
  - 1600 USA

- Prior to Aug. 1969:
  - 1600 USA

**Technical Data**

<table>
<thead>
<tr>
<th>Type</th>
<th>Designation</th>
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<tbody>
<tr>
<td>Bosch</td>
<td>113 905 205 K</td>
<td>Vacuum</td>
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<td>113 905 205 V</td>
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</tr>
<tr>
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**Ignition Timing**
- Prior to Aug. 1970:
  - 1200 - As from Aug. 1970
  - 1300 — As from Aug. 1970

- Prior to July 1969:
  - 1300 — As from Aug. 1969

- Prior to Aug. 1969:
  - 1500 USA — As from Aug. 1969

**Air Cleaner**
- Remove and take the carburettor off the inlet manifold.
- Remove the five screws which secure the top of the carburettor and take it off.

**Spark Plugs**
- Type: Bosch W 145 Tl, Champion I 18, I 18n or equivalent
- Electrode gap: 0.024 - 0.028 (0.6 - 0.7 mm)
Fig. C.1. Sectional view of the Solex 28 PICT carburetor.

Fig. C.2. Exploded view of the Solex 28 PICT carburetor.

Fig. C.3. Exploded view of the Solex 28 PICT carburetor.

Fig. C.4. Exploded view of the Solex 30 PICT-1 carburetor.
Fig. C.5. Fuel pipe connection at the carburettor.

Fig. C.7. Float chamber cover screws.

Fig. C.11. Accelerator pump components.

1. Screw
2. Pump cover
3. Pump diaphragm
4. Spring
5. Washer
6. Connecting rod
7. Spring
8. Washer
9. Nut pin

Fig. C.12. Left-hand view of the carburettor body.

3. Main jet
4. Needle holder
5. Main jet carrier
6. Slow-running volume control screw
7. By-pass
8. Spring
9. Throttle lever stop screw

Fig. C.9. Right-hand view of the carburettor body.

1. Air correction (at the emission tube
2. Slow-running fuel jet

Fig. C.10. Main jet holder (1) and volume control screw (2).

Fig. C.30. Throttle valve positioner (Fig. C.23)

Some vehicles supplied to the U.S.A. have a throttle valve positioner fitted to the carburettor. This is a large cylindrical housing fitted to the fan belt side of the carburettor. It is held in place by a clamping ring fitted with 3 screws.

The job of the throttle valve positioner is to ensure that the throttle valve is opened slightly on the overrun, thereby counteracting hot exhaust emissions.

It is not possible to service the throttle positioner. If it is to be replaced, the existing one can be removed after the 3 screws have been undone and the pull rod disconnected from the carburettor.

DASHPOT (Fig. C.30)

Some vehicles supplied to the U.S.A. have a dashpot fitted to the left-hand side of the carburettor. The dashpot ensures that when the accelerator pedal is released, the throttle valve does not close immediately.

The dashpot does not require servicing, but check that the distance between the plunger and the stop on the throttle arm is correct.

Check the setting by allowing the engine to run at a high speed and then snapping the throttle shut. There should be no suggestion of the engine stalling.

IDLING ADJUSTMENT (FCT – 3 carburettors only)

On these carburettors, the screw on the throttle arm is no longer used to adjust the idling speed. It merely serves as a stop to prevent the throttle valve from jamming in the carburettor throat. Adjustment is carried out with the mixture control screw and the by-pass air screw, both of which are in recesses on the side of the carburettor (the by-pass air screw is the larger, lower screw). The mixture control screw is concealed by a plastic plug, which must be removed for adjustment and then replaced.

1. Ensure that the valve clearances are correct and that the ignition system is in order.
2. Bring the engine to correct operating temperature.
3. Carefully screw in the volume control screw as far as it will go (do NOT force it) and then back it off 2½ – 3 turns.
4. Adjust the by-pass air screw until the engine speed is at about 900 r.p.m. (an acceptable idling speed).
5. Adjust the volume control screw until the engine is running at the highest speed. Then screw it in a little so that the engine speed drops a fraction.
6. Adjust the by-pass air screw to bring the engine speed back to 900 r.p.m.

THROTTLE VALVE POSITIONER (Fig. C.23)

Some vehicles supplied to the U.S.A. have a throttle valve positioner fitted to the carburettor. This is a large cylindrical housing fitted to the fan belt side of the carburettor. It is held in place by a clamping ring fitted with 3 screws.

The job of the throttle valve positioner is to ensure that the throttle valve is opened slightly on the overrun, thereby counteracting hot exhaust emissions.

It is not possible to service the throttle positioner. If it is to be replaced, the existing one can be removed after the 3 screws have been undone and the pull rod disconnected from the carburettor.

AUTOMATIC CHOKE

Removal
1. Remove the 3 screws which hold the clamping ring to the body of the carburettor and lift off the ceramic unit.

Installation
Ensure that the hook on the end of the bi-metal spring engages with the mark alongside it on the carburettor body (Fig. C.17).

If this second adjustment has altered the idling speed too much, re-adjust the slow running screw and mixture control screw.

1. If this second adjustment has altered the idling speed too much, re-adjust the slow running screw and mixture control screw.

2. Bring the engine to correct operating temperature.

3. Carefully screw in the volume control screw as far as it will go (do NOT force it) and then back it off 2½ – 3 turns.

4. Adjust the by-pass air screw until the engine speed is at about 900 r.p.m. (an acceptable idling speed).

5. Adjust the volume control screw until the engine is running at the highest speed. Then screw it in a little so that the engine speed drops a fraction.

6. Adjust the by-pass air screw to bring the engine speed back to 900 r.p.m.
Fig. C.22. Idle adjusting screw (1) and the volume control screw (3)

Fig. C.23. Adjusting screw for the throttle positioner.

Fig. C.24. Exploded view of the Solex 30 PICT-3 carburettor.

Fuel Pump (Fig. C 34)
The fuel pump operation depends upon a flexible diaphragm which is moved up and down by a push rod.

The 1600 engine has a fuel pump with a pressed steel upper section. This is not removable. Other models have a cast upper section, secured to the lower part by screws. This permits the pump to be divided in order to inspect the diaphragms.

The 1600 engine has a separate non-return valve in the fuel line near the pump. Other models have the valve incorporated in the upper part of the pump body. Normal servicing of both types of pump is limited to cleaning the filter element.

Cleaning the Filter (not 1600)
1. Unscrew the hexagon plug on the side of the pump which faces you.
2. Take out the filter cone, clean it with petrol and blow it out.
3. Refit the plug, using a NEW sealing gasket.

Cleaning the Filter (1600)
1. Remove the dotted screw in the top of the pump.
2. Lift off the pump.
3. Fill the part containing the operating lever with grease.

Removal
1. Disconnect the fuel lines at the pump and block the input line.
2. Do not forget to replace the breather tube.
3. Remove the six screws which retain the upper parts of the pump.
4. The tank is only held in place by four bolts. These can be undone and the tank lifted out. Do not damage the gasket as you do so.

Installation
This is a reversal of the above process, but note the following points :—
1. Make sure that the gasket around the tank is in good condition and replace it if necessary.
2. Do not forget to replace the breather tube.
3. Pay very careful attention to the re-connection of the fuel line and make sure that it is not twisted.

Accelerator Cable
This is a cable which very seldom breaks, but if it does it will immobilise the car. It will have to be replaced as follows.

Removal
1. Jack up the nearside of the car, support it securely and remove the rear wheel.
2. Undo the screw in the clamp on the carburettor throttle operating arm and so release that end of the cable.
3. Remove the inspection cover on the side of the backbone opposite the pedals (where the passenger's feet go). This only applies to R.H.D. cars.

Assembly
1. Check that the upper and lower sections of the pump are properly aligned.
2. Push in the operating lever 1/4 inch (13 mm) so that the diaphragm is correctly positioned before the six screws are tightened.
3. Fill the part containing the operating lever with grease.
Fig. C.27. Check that the special lever cannot touch at points indicated by the arrows.

Fig. C.28. Checking the throttle valve closing time.

1. Carburettor cover screw
2. Spring washer
3. Carburettor cover
4. Washer (float needle)
5. Float needle valve
6. Air correction jet with emulsion tube
7. Slow-running jet and cut-off valve
8. Accelerator cable guide tube
9. Accelerator cable
10. Accelerator cable swivel pin

Fig. C.29. Exploded view of the Solex 34 PICT-3 carburettor. 30 PICT & 31 PICT carburettors with bypass air drilling are similar. (1200, 1300 & 1600 models).

Fig. C.30. North American model carburettor with dashpot.

Fig. C.31. Attaching the throttle cable to the accelerator pedal (LHD cars).

Fig. C.32. Throttle cable connection at the carburettor (Early cars.)

Fig. C.33. Reconnecting the throttle cable to the carburettor.

Fig. C.34. Sectional view of the fuel pump.

Fig. C.35. Checking the fuel pump stroke with a depth gauge.
6. The cable passes alongside the gearbox just above the path of the clutch cable. It goes into a conduit inside the backbone and there is a rubber boot over the mouth of the conduit to prevent water getting in. Remove this rubber boot.

7. Pull the cable completely out from the front end, taking care not to soil the trim.

**Installation**

1. Grease the cable thoroughly. Take care as it is installed to prevent the grease picking up dirt.

2. Pass the cable through the inspection hole at the front of the backbone and insert it into the mouth of the conduit. Make sure that it goes in neatly. Push the cable through until a few inches protrude from the other end of the conduit.

3. Slide the rubber boot over the end of the conduit and push it into its correct position.

4. Guide the cable through the fan housing.

5. Hook the front end of the cable on to the operating lever.

6. Have an assistant sit in the driver's seat and fully depress the accelerator pedal.

7. Whilst the operating arm is held in position, insert the end of the throttle cable in its clamp on the operating arm and fully tighten the screw. If you carry out the fixing in this way, you will avoid putting any strain on the mechanism when the accelerator pedal is pressed hard down.

---

**Fig. C.36. Exploded view of the push rod assembly.**

**Fig. C.37. Components of the air cleaner assemblies (inc. E.E.C. models).**
### Technical Data

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### Carburettor Settings - Solex 30 PICT-2

| Choke tube | 24 |
| Main jet | x 112.5 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | | |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 30 PICT-3

| Choke tube | 24 |
| Main jet | x 112.5 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | | |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 31 PICT-3

| Choke tube | 25.5 |
| Main jet | x 125 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.5 mm |

### Carburettor Settings - Solex 30 PICT-2 (Model 181)

| Choke tube | 24 |
| Main jet | x 120 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 30 PICT-2 (with EEC)

| Choke tube | 24.5 |
| Main jet | x 125 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.5 mm |

### Carburettor Settings - Solex 30 PICT-2 (Model 181)

| Choke tube | 24 |
| Main jet | x 120 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 30 PICT-2 (Model 181)

| Choke tube | 24 |
| Main jet | x 120 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 30 PICT-2 (with EEC)

| Choke tube | 24 |
| Main jet | x 120 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

### Carburettor Settings - Solex 30 PICT-2 (Model 181)

| Choke tube | 24 |
| Main jet | x 120 |
| Air correction jet with emission tube | 125 |
| Slow-running jet & Air distance | 65 |
| Float needle valve | 1.5 mm |
| Float weight | 8.5 grams |
| Power fuel jet | 1.0 mm |

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### Clutch

#### General

- The clutch pressure plate is bolted to the flywheel and the centre plate sits between them. The clutch springs on the pressure plate force the centre plate against the flywheel and so cause it to be driven round. The main drive shaft of the gearbox is splined into this centre plate.

When the clutch pedal is depressed, the release bearing in the bell housing presses against the release levers on the pressure plate and this takes the pressure off the centre plate so that it is no longer driven.

All Boxers have a centre plate of 180 mm diameter except for the 1500 and 1600 models which have a 200 mm clutch. The flywheel has a larger bossing to accommodate the 200 mm clutch.

The 180 mm clutches have six coil springs while the 200 mm clutches have either six coil springs or a diaphragm spring.

**Clutch Assembly - Removal**

1. Remove the engine.
2. Join the flywheel in its turning and remove the six clutch securing bolts, making sure that each one is undone a little at a time so as not to distort the pressure plate.
3. Lift off the pressure plate and centre plate (Fig. D.3).

**Installation**

Note the following points:

1. The clutch surface on the flywheel must be clean and smooth.
2. The rubbing surface of the pressure plate must be flat and smooth. If it is distorted or scored it may be turned on a lathe. If this cannot be done, a new pressure plate must be fitted.
3. Check all other parts for wear or cracks and replace them as necessary.
4. If the centre plate is worn or oily, replace it.

**Assembly**

Note the following points:

1. Place the centre plate and the pressure plate with its springs in a flywheel. If the clutch is a diaphragm type, install the three release levers first.
2. Carefully centre the clutch and fit the nuts to the pilot pin. With a diaphragm clutch, there would normally be fitted to each pilot pin, two convex ones with their convex surfaces together and then the flat one.
3. Lubricate the joints or the release levers very lightly with grease.
4. Use the new nuts on the 3 pilot pins.
5. The distance between the surface of the release ring and the surface of the flywheel should be 25.7 - 27.3 mm (1.05" - 1.07") when the pressure plate is screwed fully on to the flywheel. This dimension must be even all round and can be achieved by adjusting the nuts on the pilot pins (Fig. D.3). On late model clutches with no release ring, a spare release ring must be fitted temporarily to the release levers so that the distance can be measured and corrected.

---

**Pressure Plate Assembly**

The pressure plate fitted to the latest diaphragm clutches does not have a release ring. The clutch release bearing bears directly on the 3 release levers.

1. Bolt the clutch into a flywheel with the centre plate in position.
2. The three nuts which secure the release levers will be retained either by a spot weld or by the top of the nut having been crimped. The weld must be filed away, but a strong force on the spanner is usually enough to free the nut from the crimping.
3. Remove the three nuts. MARK all three release levers relative to the pressure plate (to ensure that balance is maintained on reassembly) and remove them.
4. The release levers on diaphragm clutches are removed by driving out their pilot pins. Once again, mark all three release levers relative to the pressure plate.

---

**General**

**Clutch Removal & Installation**

**Pressure Plate Assembly**

**Diaphragm Clutch - Replacement**

**Clutch Free Play - Adjustment**
50

The nuts on the pivot pins must be finally locked by crimping the top.

7. Check that the release levers are fitted in their original position.

RELEASE BEARING
The clutch release bearing is maintenance free. It must not be washed out in solvent as it is pre-packed with grease.

If the bearing rotates noisily, it must be replaced.

To replace the bearing, lever off the 2 retaining clips (Fig. D 8).

When inserting the new bearing, note that the clips are fitted with their hooked end engaging with the slots in the back of the operating shaft arms.

If a new bearing has been installed, the clutch free play must be checked.

CLUTCH CABLE
The right hand end of the clutch cable passes through the pedal cluster and in through the side of the backbone. This end is fitted with a hook. On the other side of the backbone is an inspection cover which conceals the conduit in which the clutch cable is attached. The clutch cable passes through a conduit in the backbone, through a bored flexible section and then runs exposed for a short distance before passing through the eye of the clutch operating lever on the left side of the car. The cable usually breaks at one or other of the two ends, but failures can occur anywhere along its length. In order to remove the broken cable, it is necessary to remove the complete pedal cluster.

Removal
1. Remove both front seats and front floor covering.
2. Remove the cover plate on the side of the tunnel.
3. Detach the linkage between the throttle pedal and the pedal cluster. (See below)
4. Remove the circlip and detach the master cylinder push rod from the brake pedal.
5. Detach the throttle cable from its operating arm.
6. Remove the pedal cluster mounting bolts.
7. Slide the whole cluster out from the side of the tunnel. The rear part of the clutch cable should be still on its hook. If it has come off, the fingers can be pushed into the hole to get hold of it.

Check free play
When the clutch pedal is depressed, there is a small amount of movement which requires comparatively little pressure. Then a greater pressure has to be exerted to cause further movement.

This initial low pressure movement is necessary to bring the clutch release bearing into contact with the release ring or operating levers on the pressure plate. If the distance is too small, there will be a possibility of clutch slip and if it is too large, the clutch will not be released properly.
Clutch for Automatic Disk Shift

Fig. D.2. Removing the clutch assembly.

Fig. D.4. Exploded view of the clutch release pressure plate assembly.

1. Release ring
2. Adjusting nut
3. Washer
4. Release lever
5. Clutch cover
6. Spring cap
7. Pressure spring
8. Pressure plate

Fig. D.3. Checking the release ring to flywheel dimension.

Fig. D.5. Insert the release levers pins so that the slots are positioned as shown.

Fig. D.6. Checking the release ring run-out with a dial gauge.

Fig. D.7. Checking the clutch disc run-out with a dial gauge.

Fig. D.8. Pulling off the release bearing retaining clips.

Fig. D.9. Installing the release bearing retaining clips.

Fig. D.10. Exploded view of the release shaft components.

Fig. D.11. Release shaft locating screw - arrowed.
The play is adjusted by turning a wing nut at the engine end of the cable and it is measured at the pedal. The correct value is:

10 - 20 mm (0.4 - 0.8")

Proceed as follows:

1. Raise and support the car and remove the left hand rear wheel.
2. Hold the cable with a Mole wrench or gas pliers and turn the wing nut until the play at the pedal is correct.
3. Lightly grease the threaded end of the cable to ensure that future adjustment is easy.

**GENERAL SPECIFICATIONS**

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<th>Type</th>
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<td>1200 &amp; 1300</td>
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<tr>
<td>1500 &amp; 1600</td>
<td>Diaphragm spring clutch</td>
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**Pedal free play**: 0.4 - 0.8 in (10 - 20 mm)

**Total lining area**:
- 1200/1300: 43 sq.in. (268 sq.cm.)
- 1500: 56 sq.in. (363 sq.cm.)
- 1600: 52 sq.in. (335 sq.cm.)

**Clutch pressure**:
- 1200/1300: 761-816 lb (345-370 kg)
- 1500: 786-863 lb (357.5-392.5 kg)
- 1600: 837-925 lb (380-420 kg)

**REPAIR DATA**

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<td>Release plate run-out</td>
<td>0.012 in (0.3 mm) max.</td>
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<td>Distance between flywheel and release ring</td>
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**Clutch springs**

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<tr>
<td>- white</td>
<td>96-109 lb (44.5-49.5 kg)</td>
</tr>
<tr>
<td>- red</td>
<td>75-81 lb (34-37 kg)</td>
</tr>
</tbody>
</table>

**Clutch pedal free-play**: 0.4-0.8 in (10-20 mm)

**Clutch driven plate run-out**: 0.03 in (0.8 mm)
**Gearbox & Final Drive**

**GENERAL**

The gearbox and final drive are housed together in a compact light alloy casing. The casing is attached at the front by a central rubber-bushed mounting and at the rear by a bracket which is bolted to the bracc on the back of the frame.

It cannot be over-emphasized that any work on the gearbox or final drive requires both experience and special tools. Unless one is both competent and well-equipped, this work is best left to the Authorised Dealers.

**TRANSMISSION UNIT**

**Removal**

The engine must be removed before the gearbox. After the engine has been removed, proceed as follows:

1. Remove the cover plate which is found under the rear seat. The gearbox and coupling can be seen through the opening. (Fig. E 3). Undo the square headed screw and move the gear lever so that the coupling comes away from the inner shaft lever.

2. Detach the clutch cable from the operating lever on the side of the gearbox, pull off its rubber boot and pull the cable and its guide tube out of the bracket on the side of the final drive cover.

3. Detach the two cables at the starter motor.

4. Disconnect the two cables from the operating lever on the side of the gearbox, pull off the rubber hood and push the cable and its guide tube out of the bracket on the side of the final drive cover.

5. If an automatic reversing lamp switch is fitted (high up at the front of the transmission), detach the two cables from it.

6. Remove the nuts from the transmission mounting at the front end.

7. Support the transmission with a trolley jack.

8. Remove the two large bolts which attach the transmission carrier to the frame (27 mm) and lower the transmission out of the car.

9. If an automatic reversing lamp switch is fitted (high up at the front of the transmission), detach the two cables from it.

10. If the vehicle is not going to be moved, you can tie the drive shafts up out of the way.

**Installation**

This is a reverse of the removal procedure, bearing the following points in mind:

**Swing-Axle Beetles**

1. Ensure that the spring plates are attached to the axle tubes correctly by aligning the marks made previously.

2. Do not attempt to tighten the large slotted nuts at the ends of the drive shaft joints and the frame. If necessary, support the transmission in the correct position whilst the mountings are tightened.

3. Bleed and adjust brakes.

4. Do not use new lock washers for the drive shaft flange screws. Fix them with the convex side towards the screw head.

5. Make sure that the drive shaft flange arms are absolutely clean. There must be no grease between the surfaces.

6. Ensure that there is adequate clearance between the inner drive shaft joints and the frame. If necessary, support the transmission in the correct position whilst the mountings are tightened.

**Double-Jointed Axle Beetles**

1. You must use new lock washers for the drive shaft flange screws. Fix them with the convex side towards the screw head.

2. Make sure that the drive shaft flanges are absolutely clean. There must be no grease between the surfaces.

3. Ensure that there is adequate clearance between the inner drive shaft joints and the frame. If necessary, support the transmission in the correct position whilst the mountings are tightened.

4. Bleed and adjust brakes.
This section gives details of the removal and installation of the final drive. This will be necessary if the rest of the transmission is to be dismantled. We have not, however, given details of dismantling or adjusting the final drive as this requires equipment and expertise which is only available to VW Dolce. The unscrewing equipment required is extremely complex and without it it is virtually impossible to separate the unit correctly.

It is recommended, therefore, that work of this nature be entrusted to a VW Agent.

Removal

1. Remove the axle tubes and drive shafts (see the section on Rear Axle).
2. Remove the nuts which hold the left final drive cover on to the gearbox (Fig. E 6). Note that each has a plain and a spring washer.
3. To remove the cover, this is not easy unless the proper extractor is used (Fig. E 7), but it can be carefully tapped off.
4. Press differential out of the housing. Make sure that all the spacer rings are in place in their position and number are correct.
5. Unbolt and remove the right hand final drive cover.
6. The bearings can now be pressed out of the covers if necessary (Fig. E 17).

Swing-Axle Beetles

1. If you look into the flange to which the drive shaft was attached, you will see a plastic cap. Prise it out with a screwdriver.
2. Remove the circlip in the flange (Fig. E 8) and then lever the flange off.
3. Take out the spacer ring. (If you turn the case over, it will drop out).
4. Remove the plastic cap, circlip, flange and spacer ring on the other side.
5. Remove the nuts which hold the left hand final drive cover in place and take it off.
6. The oil seal and bearing in the final drive cover may now be pressed out if necessary. Remove the shims and note their position. They must not be mixed up with those from the other side.
7. Lift out the differential.
8. Remove the right hand final drive cover.

Installation

1. If the bearings have been removed from the final drive covers, replace them.
2. Fit the right hand final drive cover, making sure that a new O-ring is used.
3. Insert the differential into the case, making sure that the spacer rings are in the correct position.
4. Install the left hand final drive cover. Make sure that both washers are used under each nut.

Double-Jointed Axle Beetles

1. If the bearings have been removed from the final drive covers, put the shims in position and then press in the bearing outer race.
2. Coat the oil seal with oil and press them into the covers.
3. Lightly oil the O-rings and install them.
4. Install the right hand cover.
5. Slide a new circlip and reverse gear on to the rear part of the main shaft and screw both parts of the main shaft together. Back off one spline, slide on the reverse gear and install the circlip.
6. Fit the differential into the casing.
7. Fit the final drive cover on the ring gear side.
8. Insert the spiral rings and slide the flanges on. Secure them with circlips. Make sure that the spiral fits properly in its groove.

Swing-Axle Beetles

1. Remove the nuts which hold on the gear shaft housing and take off the housing together with the gasket and inner shaft lever.
2. Under the nuts which hold on the gear carrier. Note the position of the earthing strap.
3. If there are nuts on the end of the pinion and drive shaft, engage two gears at once, straighten the locking plates and remove the nuts (Fig. E 11).
4. Take the circlip for the reverse gear off the drive shaft, pull off the gear and screw the two parts of the shaft apart (Fig. E 12).
5. Take the reverse gear and the circlip off and take out the drive shaft from the rear, making sure that the oil seal is not damaged.
6. Remove the screws which secure the bearing retainer (Fig. E 13). The lock plate must be straightened first and rear must be taken out to damage the pinion.
7. Push the gear train out of the case so that it comes away in the gear carrier section (Fig. E 14).
8. Note the thickness of the shims on the pinion.
9. Remove the reverse shift fork from the relay lever.
10. Take the pinion adjusting shims off the double taper roller bearing. They must be put aside so that they can be returned to the same position.
11. Remove the locking screws from the 1/2 gear fork and the 1/2 gear fork and take off the 1/2 gear fork (Fig. E 18). It is best if the gear carrier can be supported in a stand or large vice. If the latter is used, make sure that the machined face is not damaged by the jaws.
12. Remove the shift end for the 1/2 gear out of the shift fork.
Fig. E.2. Exploded view of the gear train components.
Fig. E.3. Disconnecting the gear change coupling.

Fig. E.4. Removing the drive shaft flange screws.

Fig. E.5. Removing the gear box carrier mounting bolts.

Fig. E.6. Removing the left hand cover nut.

Fig. E.7. Removing the left hand cover and spindle.

Fig. E.8. Pressing out the differential assembly with an extractor.

Fig. E.9. Crown wheel and pinion markings and location of adjustment shims.

Fig. E.10. Exploded view of the various types of differential assemblies fitted to Beetle models.
Fig. E.11. Removing the drive pinion nut on early type gearboxes. (On late type gearboxes the shaft is retained by a circlip.)

Fig. E.12. Separating the drive shaft.

Fig. E.13. Unbolting the drive pinion bearing retainer.

Fig. E.14. Pressing out the gear train and gear carrier. (A wooden block and levers can be used instead of the tool shown.)

Fig. E.15. Removing the circlip retaining the reverse idler gear wheel.

Fig. E.16. Driving out the reverse idler shaft needle bearing.

Fig. E.17. Pressing out the differential bearing.

Fig. E.18. Removing the selector fork locking screws.

Fig. E.19. Pressing out the main drive shaft.

13. Remove the circlip from around the drive shaft at the selector end of the gear carrier. The driven washer underneath the circlip is under considerable tension and you must take great care as the circlip comes off.

14. Remove the whole gear train by pressing on the selector end of the drive shaft, taking care that the shafts are guided so that the teeth are not damaged (Fig. E 19). Take care that the 6 shaft foot does not jam.

MAIN DRIVE SHAFT (Fig. E 22)

Once the main drive shaft has been removed from the gear carrier, it can, if necessary, be dismantled in order to replace parts.

Dismantling
1. Remove the thrust washer, the 4th gear which is next to its needle bearing and its synchroniser ring.
2. Press off the inner race, the synchroniser hub and the 3rd gear (Fig. E 23).
3. Remove the 3rd gear needle bearing.
4. Take the operating sleeve, the synchroniser keys and the synchroniser key springs off the synchroniser hub.

Inspection
1. Check all parts for wear or damage.
2. Press the synchroniser rings over the cones on the gears and measure the gap (Fig. E 24) with a feeler gauge.

Wear limit = 0.6 mm
Normal dimension = 1.1 — 1.8 mm

3. NOTE: Damaged 3rd and 4th gears must only be replaced in pairs although this only applies to 1st and 2nd gears if the teeth are damaged.

Assembly
1. Heat the inner races of the double taper roller bearing and the 1st gear needle bearing to about 100 degrees C. Install them on the shaft and press them fully home when they have cooled to room temperature (Fig. E 30). This will need a force of about 3 tons.
2. Install the needle bearing for 1st gear with a NEW round nut and tighten it to 144 ft.lbs (20 kgm).
3. Knock the locking shoulder of the round nut with a carefully ground chisel at three points equally spaced around it so that it beds into the pinion spline. Do not beat or crack the shoulder.
4. Insert the shaft which limit the axial play of 1st gear.
5. Slide on the 1st gear with the synchroniser ring and synchroniser hub and check the axial play with a feeler gauge (Fig. E 32).

Limits = 0.10 — 0.25 mm (0.004 — 0.010")
(Try to keep to lower limit)

6. Slide on 2nd gear synchroniser ring, 2nd gear with its needle bearing and 3rd gear.
7. Check the axial play of 3rd gear and bring it within the prescribed limits by using a circlip of the correct thickness.

Limits = 0.10 — 0.25 mm (0.004 — 0.010")
(Try to keep to lower limit)
Circlips are available in the following sizes:

Fig. E.28}

PINION SHAFT (Figs. E 27 & 28)

Once the pinion shaft has been removed from the gear carrier, it can be dismantled to inspect the component parts and replace them if necessary.
Fig. E.20. Removing the reverse selector lever guide.

Fig. E.21. Removing the interlock springs.

Fig. E.22. Exploded view of the main drive shaft assembly.

Fig. E.23. Pressing the 3rd speed gear wheel and synchroniser off the main drive shaft.

Fig. E.24. Synchroniser to gear wheel clearance, \( a = 0.6 \) mm. max.

Fig. E.25. Synchroniser hub and sleeve alignment marks.

Fig. E.26. Installing the 3rd/4th gear synchroniser.

Fig. E.27. Exploded view of the drive pinion assembly - Early type.

Fig. E.28. Exploded view of the drive pinion assembly - Late type.
GEARBOX — Reassembly

1. Assemble the pinion and drive shaft together and press them into the gear carrier. Guide the shafts carefully to avoid damaging the teeth.

2. Check the position of the 3/4 gear shift fork.

3. Place the dished washer over the end of the drive shaft at the selector end and install a NEW circlip. Make sure that it snaps into its groove. This can be done by pressing the circlip all round with a pair of water pump pliers.

4. Install the shift forks for gears 1/2, 3/4 and reverse.

5. Adjust the shift forks. Unless you have access to VW tool 294b, this cannot be done very easily. The following points must be born in mind:
   a. The 1/2 gear shift fork (the wider one) is installed with its profile towards the gear carrier whilst the 3/4 gear shift fork is installed with its profile away from the gear carrier.
   b. The shift fork for 1/2 gear must be adjusted so that both gears will engage fully. If the 2nd gear only just engages, re-adjust the fork to provide full 2nd gear engagement at the expense of slight loss of engagement for 1st gear.
   c. Adjust the 3/4 gear shift fork so that both gears engage an equal amount.
   d. When the forks are correctly adjusted, tighten the fork locking screws to a torque of 18 Ib.ft (2.5 kg.m).

6. Put the pinion adjusting shims on the double taper roller bearing and screw 2 studs about 4" long into the bearing retainer so that it cannot turn when the gear train is inserted into the transmission case (Fig. E 37).

7. Put the reverse shift fork and the sliding gear on to the relay lever and engage reverse gear.

8. Put the gasket in position on the transmission case and push the gear carrier and its gear train into the case.

9. Put the screws into the bearing retainer (with new lock plates) and tighten them to 36 Ib.ft (5.0 kg.m).

10. Oil the lip of the oil seal and insert the rear part of the main drive shaft. Screw the two halves of the shaft together and unscrew them just enough to line up the shoulders for reverse gear. The two halves of the drive shaft must NOT be left screwed tightly together.

11. Check that the circlip for reverse gear is in good condition.
Technical Data

GENERAL SPECIFICATIONS

Gear ratios - Manual:
1st gear: 3.80:1
2nd gear: 2.06:1
3rd gear: 1.26:1
4th gear: 0.89:1
Reverse gear: 3.61:1

Gear ratios - Automatic Stickshift:
"o": 2.06:1
"i": 1.28:1
"ii": 0.89:1
Lynx: 3.67:1

Final Drive Ratios:

Prior to Aug. 1970: 1.39:1
Model 181: 3.875:1
All Auto. Trans. models (except above): 4.375:1

1600/50 BHP - Type 14, as from Aug. 1970:
1600/50 BHP - Type 15, as from Aug. 1970:
"R": 3.07:1
"2": 0.89:1
Reverse gear: 3.61:1
4th speed: 0.89:1

1600, Prior to Aug. 1970: 4.125:1
1500: 4.125:1
1300/44 BHP - Type 14, as from Aug. 1970:
1300, Prior to Aug. 1970: 4.375:1
1200: 4.375:1
"1": 1.26:1
3rd gear: 1.26:1
2nd gear: 2.06:1
1st gear: 3.80:1

REPAIR DATA

Gearbox mainshaft/needle bearing clearance (in flywheel housing): 0.0047-0.0071 in (0.12-0.19 mm)
Wear limit: 0.010 in (0.25 mm)
Front main drive shaft run-out (as measured on needle bearing seat for 3rd speed gear): 0.0006 in (0.02 mm)
Selector housing bush inner diameter: 0.9247-0.9336 in (15.05-15.85 mm)
Wear limit: 0.006 in (0.15 mm)
Inner selector lever diameter: 0.9000-0.9156 in (22.90-23.30 mm)
Wear limit: 0.015 in (0.38 mm)
Gearbox case side cover preload on differential side bearings: 0.002-0.009 in (0.05-0.23 mm)
Trencher block/case clearance (as installed in differential side gear): 0.0013-0.009 in (0.03-0.23 mm)
Axe to differential side gear clearance (measured near the rounded side of the flat ends of axle): 0.0012-0.004 in (0.03-0.10 mm)
Wear limit: 0.008 in (0.20 mm)
Axle tube retainer to gearbox side cover clearance, with plastic inserts in place: 0.010-0.014 in (0.25-0.35 mm)
Wear limit: 0.016 in (0.40 mm)
Starter motor bush to shaft clearance: 0.4941-0.4980 in (12.57-12.65 mm)
Wear limit: 0.045 in (1.1 mm)
Starter motor bush to shaft clearance: 0.0050-0.0055 in (0.12-0.14 mm)
Wear limit: 0.010 in (0.25 mm)
First speed gear end play: 0.004-0.021 in (0.10-0.53 mm)
Shifting fork to synchro sleeve clearance (inner to 4th speed): 0.004-0.012 in (0.10-0.30 mm)
Synchro ring to gear distance (measured between teeth): 0.045 in (1.1 mm)
Wear limit: 0.024 in (0.6 mm)

LUBRICATION

Transmission Capacity: 4.375 Imp.gal (5.25 US gal; 20.5 litres)
Reduction Gear capacity (181): 0.64 Imp.gal (0.5 US gal; 1.95 litres)
Recommended lubricant: Hypoid Transmission Oil SAE 80/90 (MIL-L 2105 B)

Rear Axle & Rear Suspension

GENERAL

REAR WHEEL BEARINGS (Swing Axle Vehicles) - Removal & Installation
REAR WHEEL BEARINGS (Double-Jointed Axle Vehicles) - Removal & Installation
REDUCTION GEARS (Type 181 only) - Disassembly & Assembly
REAR AXLE TUBES AND DRIVE SHAFTS (Swing Axle Vehicles) - Removal & Installation
REAR AXLE DUST SLEEVES (Swing Axle Vehicles) - Replacement
DRIVE SHAFTS (Double-Jointed Axle Vehicles)
CONSTANT VELOCITY JOINTS (Double-Jointed Axle Vehicles) - Removal, Disassembly, Assembly & Installation
SPRING PLATES (Swing Axle Vehicles)
TRAILING ARMS AND SPINDLE PLATES (Double-Jointed Axle Vehicles) - Removal & Installation
 REAR COMPENSATING SPRING (Swing Axle Vehicles Only)
SHOCK ABSORBERS

GENERAL

Vehicles with swing axles (the 1200, 1300 and the 181) have rigid drive shafts which are universally jointed at the sides of the transmission case (Fig. F 1). The drive shaft is enclosed in an outer tube which is attached to the end of the rear location bar by means of a spring plate. Some models have a rear compensating spring which is attached to brackets on the axle tube.

Vehicles with double-jointed rear axles (the 1302, 1302'S' and those with automatic transmission) have drive shafts with a constant velocity joint at either end (Fig. F 2). One end of the drive shaft is attached to the transmission whilst the outer end is attached to a short wheel shaft. In addition to the spring plate which links the rear axle to the location bar, there is a trailing arm which provides further location.

Swing axle vehicles have one bearing in the hub, whilst double-jointed axle types have two for the short wheel shaft. Telescopic shock absorbers are used in each case.

REAR WHEEL BEARINGS (Swing Axle Vehicles)
The bearing is installed in a housing which is accessible after the rear drum is removed (Fig. F 3). The components have a very long service life and seldom need to be replaced. They can only be removed with a special extractor which has jaws which fit between the balls of the bearing.

Removal

1. Remove the rear drum (see section on Brakes).
2. Remove the four screws which secure the wheel bearing cover.
3. Take off the cover, complete with O-ring, spacer and backplate.
4. Drive the wheel shaft out through the back of the housing, taking very great care not to damage the end.
5. Take out the inner spacer.
6. Lever out the inner oil seal from behind the housing (Fig. F 26).
7. Remove the circlip which secures the ball bearing in the back of the housing (Fig. F 27) and then drive the bearing out with a drift which passes through the middle of the roller bearing.
8. Take out the spacer sleeve and the inner race of the roller bearing and then drive out the inner race.

Installation

1. Press in the ball housing.
2. Install the circlip and press in the inner oil seal. If the oil seal is defective, it too must be replaced.
3. Pack the space between the bearings with 60 g of grease and grease the ball bearing oil seal lip.
4. Drive in the wheel shaft with complete with the inner spacer.

3. Replace the bearing cover, using new rubber O-rings and a new paper gasket. If the oil seal is defective, it too must be replaced.

REAR WHEEL BEARINGS (Double-Jointed Axle Vehicles)
The rear wheel shaft is supported in a housing on the end of the trailing arm by two bearings, an inner ball bearing and an outer roller bearing.

Removal

1. Remove the rear drum (see section on Brakes).
2. Remove the four screws which secure the wheel bearing cover.
3. Take off the cover, complete with O-ring, spacer and backplate.
4. Drive the wheel shaft out through the back of the housing, taking very great care not to damage the end.
5. Take out the inner spacer.
6. Lever out the inner oil seal from behind the housing (Fig. F 26).
7. Remove the circlip which secures the ball bearing in the back of the housing (Fig. F 27) and then drive the bearing out with a drift which passes through the middle of the roller bearing.
8. Take out the spacer sleeve and the inner race of the roller bearing and then drive out the inner race.

Installation

1. Press in the ball housing.
2. Install the circlip and press in the inner oil seal. If the oil seal is damaged, a new one must be used.
3. Pack the space between the bearings with 60 g of grease and grease the ball bearing oil seal lip.
4. Drive in the wheel shaft with complete with the inner spacer.
Fig. F.2. Exploded view of the double-jointed axle type rear suspension.

1. Joint cap
2. Dust sleeve for drive shaft
3. Retaining clip for dust sleeve
4. Retaining clip for dust sleeve
5. Lock washer
6. Spring plate rubber stop
7. Drive shaft
8. Screw
9. Rear wheel shaft
10. Distance tube
11. Rear wheel bearing, outer
12. Rear wheel bearing
13. Locking ring
14. Bearing cover gasket
15. Rear wheel bearing spacer
16. Rear wheel bearing spacer
17. Rear wheel bearing spacer
18. Rear wheel bearing spacer
19. Spring washer
20. Circlip for joint flange
21. Double velocity joint
22. Left-hand control arm
23. Spacer for fitted bolt
24. Rear wheel bearing spacer
25. Bearing cover bolt
26. Nut
27. Brake cable bracket
28. Rubber mounting for control arm
29. Bolt
30. Bolt
31. Washer
32. Spring washer
33. Brake hose bracket
34. Paper gasket
35. Oil deflector
36. Housing cover
37. Retaining screw

Fig. F.3. Exploded view of the rear wheel bearing assembly - Swing axle.

1. Rear axle tube
2. Steering bearing
3. Brake hose plate
4. Axle
5. Outer spacer
6. Inner spacer
7. Ball inserted
8. "O" seal
9. "O" seal
10. Outer spacer
11. Filler packet
12. Oil seal
13. Oil deflector
14. Oil deflector
15. Retaining screw
2. Remove the brake drum and brake shoe assembly.

3. Remove the four screws which secure the wheel bearing housing and its gasket.

4. Pull off the tear wheel bearing with an extractor and remove the inner spacer ring behind it.

5. Remove the shims and plastic packing which are fitted between the inner surface of the axle tube retainer and the bearing housing. Measure the clearance between the flat end of the axle shaft, differential gear should be 0.01 - 0.03 mm (0.004" - 0.012") wear or damage. Replace parts as necessary.

6. Remove the circlip which secures the differential gear can be seen through the hole in the side of the transmission case (Fig. F.8). Remove the circlip.

7. A large circlip which secures the differential gear can be seen through the side of the transmission case. Remove the circlip and the drive plate (the brake line should be disconnected from the back plate), and remove the rear brake assemblies.

8. Take out the thrust washer behind the circlip and then pull out the axle shaft (Fig. F 9).

9. Take the differential gear and the fulcrum plates out of the transmission case.

Installation

1. Carefully clean the inner surface of the axle tube retainer and the surfaces on which it seats.

2. Check the axle shaft, differential gear and the thrust washer for wear or damage. Replace parts as necessary.

NOTE: The clearance between the flat end of the axle shaft, measured across the ball shaped sides, and the inner diameter of the differential gear should be 0.01 - 0.03 mm (0.004" - 0.012") (Fig. F.10).

3. Place the fulcrum plates in the differential gear with the end of the shaft between them. Measure the clearance between the flat faces of the shaft end and the fulcrum plates (Fig. F 11). The clearance should be 0.1 - 0.3 mm (0.004" - 0.012").

4. Check the rubber boot for damage and replace if necessary. If the axle tube has breakers for the mounting of an equalizing spring, the boot must be carefully prised over the bell shaped end so it will not pass over the mounting bracket.

5. Insert differential gear, fulcrum plates and axle shaft into the side of the transmission, together with the thrust washer and circlip.

6. Slide on the axle tube, ensuring that the correct number of shims are fitted and reassemble to install the plastic packing. The number of shims should be such that the tube can just be moved in all directions without jamming at all.

REAR AXLE TUBES AND DRIVE SHAFTS (Swing Axle Vehicles)

On swing axle vehicles, the axle shaft is universally jointed to the differential. The spade-like end of the shaft fits between a pair of flanges plates on the side of the final drive unit. The other end of the shaft is splined and carries the rear brake drum and, on the 181, the reduction gears. The axle shaft is enclosed in a tube which is also universally joined to the side of the transmission case, the joint being sealed by a rubber boot.

Removal

1. Remove the rear axle nuts, raise and support the rear of the car and remove the rear brake assemblies.

2. Remove the four screws which hold the rear bearing housing to the end of the axle shaft and remove the housing and the brake back plate (the brake line should be disconnected from the back plate).

3. Mark the position of the spring plate in relation to the bearing housing with a punch of chisel (Fig. F.5). Remove the 3 bolts which attach the spring plate to the side of the final drive unit. The other end of the shaft is splined and carries the rear brake drum and, on the 181, the reduction gears. The axle shaft is enclosed in a tube which is also universally joined to the side of the transmission case, the joint being sealed by a rubber boot.

4. Remove the 6 nuts which attach the axle tube retainer to the side of the transmission case (Fig. F 7).

5. Pull off the axle tube and retainer.

6. Remove the shims and plastic packing which are fitted between the retainer and the transmission case, noting their position.

7. A large circlip which secures the differential gear can be seen through the side of the transmission case (Fig. F 6). Remove the circlip.

8. Take the thrust washer behind the circlip and then pull out the axle shaft (Fig. F 9).

9. Take the differential gear and the fulcrum plates out of the transmission case.

Diagram assembly

1. Clean the inside of the gearbox carefully and drive in the inner bearing. If they have plastic cages, they must be installed with the open side of the cage facing outwards.

2. Put the gears in place and drive on the outer bearing and fit its circlip.

3. Mark the position of the spring plate in relation to the bearing housing (Fig. F 6). Remove the 3 bolts which attach the spring plate to the side of the final drive unit.

4. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.

5. Drive on the spacer and rear wheel bearing. Install the brake back plate with a new paper gasket.

6. Slide on the axle tube, ensuring that the correct number of shims are fitted and reassemble to install the plastic packing. The number of shims should be such that the tube can just be moved in all directions without jamming at all.
Fig. F.11. Measuring the axle shaft to fulcrum plate clearance. - Swing axle.

Fig. F.12. Fitting a split dust sleeve to the axle shaft - Swing axle.

Fig. F.13. Pressing the drive shaft out of the ball hub - D/J axle.

Fig. F.14. Push out the ball hub and ball cage in the direction shown.

Fig. F.15. Position the hub and ball cage as shown when installing. "a" is the greatest ball centre on the outer ring. "b" is the smallest ball centre on the ball hub.

Fig. F.16. Rotate the hub and ball cage into position as shown.

Fig. F.17. The larger diameter of the C/V joint must face the rubber joint cap.

Fig. F.18. Unbolting the torsion bar cover - Swing axle.

Fig. F.19. Lowering the spring plate off the torsion bar - Swing axle.

1. Carefully clean the parts where the sleeve is to be attached.
2. Secure both mating faces of the new split sleeve with VW Sealing Compound D 1a. If this is not available, rubber cement of the type which is used for attaching rubber soles to shoes is just as effective. Make sure that the adhesive is spread evenly and does not run inside the sleeve.
3. Place the sleeve in position on the axle, making sure that the split edge is horizontal and points towards the back of the car.
4. Bolt up the split edge of the sleeve with the nuts, bolts and washers which are provided with the sleeve (Fig. F.12). Tighten them evenly so that the edge is not distorted. Do not overtighten; this can be easily done as there is only rubber between the nut and the head of the bolt.
5. Place the clips in position at either end of the sleeve and tighten them SLIGHTLY. If you are reusing the original clips, notice how they are assembled. You may find it easier to use replacement clips or the clean drive shaft; these are much easier to tighten up correctly, but the cost is higher. If you are using this type, you will have to install them completely so as to fit them over the axle.
6. Insert the hub and cage into the outer ring. NOTE: the chamfer on the splines of the ball hub should face towards the shoulder on the drive shaft and the larger diameter of the outer ring.

REAR AXLE DUST SLEEVES (Swing Axle Vehicles)

The 1200 and 1300 Beetles (not 1302) have each half of the rear axle universally jointed to the side of the transmission case. It is essential that dust should not enter this joint and it is covered by a flexible rubber sleeve. One end is clamped on to the axle tube and the other end is clamped to the flange on the side of the transmission case.

These sleeves may eventually split, the result being that dust is no longer excluded and there will be a loss of transmission oil through the split. It is the latter fact which usually indicates the failure; the sleeve is normally wrinkled to some extent and a split is difficult to see. The original sleeves are slid over the axle as the transmission is assembled and if this type were to be used as a replacement, the rear axle would have to be dismantled in order to fit it. Fortunately, a split type of sleeve is available and this can be fitted without any disassembly.

Removal
1. Jack up the appropriate side of the car, support and remove the rear wheel.
2. Remove the two clips which attach the sleeve to axle and transmission case. This can be done by pulling the pins out from the straps.
3. Use a sharp knife or razor blade to slit the damaged sleeve so that it can be taken off.

Installation
1. Carefully clean the parts where the sleeve is to be attached.
2. Secure both mating faces of the new split sleeve with VW Sealing Compound D 1a. If this is not available, rubber cement of the type which is used for attaching rubber soles to shoes is just as effective. Make sure that the adhesive is spread evenly and does not run inside the sleeve.
3. Place the sleeve in position on the axle, making sure that the split edge is horizontal and points towards the back of the car.
4. Bolt up the split edge of the sleeve with the nuts, bolts and washers which are provided with the sleeve (Fig. F.12). Tighten them evenly so that the edge is not distorted. Do not overtighten; this can be easily done as there is only rubber between the nut and the head of the bolt.
5. Place the clips in position at either end of the sleeve and tighten them SLIGHTLY. If you are reusing the original clips, notice how they are assembled. You may find it easier to use replacement clips or the clean drive shaft; these are much easier to tighten up correctly, but the cost is higher. If you are using this type, you will have to install them completely so as to fit them over the axle.
6. Insert the hub and cage into the outer ring. NOTE: the chamfer on the splines of the ball hub should face towards the shoulder on the drive shaft and the larger diameter of the outer ring.

DRIVE SHAFTS (Double-jointed Axle Vehicles)

Vehicles with double-jointed rear axles have drive shafts with constant velocity joints at either end. These drive shafts can be removed by unscrewing the socket headed screws which anchor them to the side of the transmission and to the wheel shaft. Installation is simply a reverse of this process.

CONSTANT VELOCITY JOINTS (Double-jointed Axle Vehicles)

Removal
1. Remove the drive shaft.
2. Loosen the clips which secure the rubber boots and slide back the boots.
3. Remove the circlip from the hub of the joint.
4. Drive the cap off the joint with a drift.

NOTE: do NOT tilt the ball hub in the outer ring of the joint as the balls can now fall out.
5. Pull out the drive shaft from the ball hub and remove the dished washer (Fig. F.13).

Disassembly
1. Press the hub and cage out of the outer ring of the joint as shown in Fig. F.14.
2. Press the ball hub in and wet axle and outer ring are machined and they should not be mixed with parts from other joints.
3. Align the grooves and slide the ball hub out of the cage.

Assembly
1. Check all parts for wear or damage. Excessive wear will result in noise and the joint should be replaced.
2. Slide the ball hub along the grooves of the ball cage.
3. Press the ball into the cage.
4. Insert the hub and cage into the outer ring. NOTE: the seal height on the splines of the ball hub should face towards the shoulder on the drive shaft and the larger diameter of the outer ring.
The hub and ball cage should be pushed in at right angles to the outer ring as shown in Fig. F 15 and then swung round so that the ball fits into place in the outer ring (Fig. F 16). When the hub and cage are in position, it should be possible to move the hub in and out whilst it is tilted to any position.

**Installation**

1. Put new clips for the boot on the drive shaft.
2. Slide the boot on to the drive shaft, making sure that it is not damaged on the splines.
3. Place the joint cap in position and then press on the constant velocity joint, making sure that its larger diameter is towards the drive shaft (Fig. F 17). Fit the dished washer and fit a new circlip.
4. Pack the joint with molybdenum disulphide grease. The amount per velocity joint, making sure that its larger diameter is towards the drive shaft (Fig. F 17). Fit the dished washer and fit a new circlip.
5. Slide the hub clips on to the rubber boot and tighten them. NOTE: the hole in the hub must be aligned so that they do not block the screw holes in the joint.
6. Secure the boot to force some grease into the boot from behind.

**SPRING PLATES (Swing Axle Vehicles only)**

The axle tubes are connected to the torsion bars by long flat arms called spring plates. They are attached to the axle tubes by three bolts. When the axle end of the spring plate has been unbolted, it is removed from the torsion bar in the same way as the double jointed rear axle spring plate (see next section).

The hub and ball cage should be pushed in at right angles to the outer ring as shown in Fig. F 15 and then swung round so that the ball fits into place in the outer ring (Fig. F 16). When the hub and cage are in position, it should be possible to move the hub in and out whilst it is tilted to any position.

**Installation**

1. Put new clips for the boot on the drive shaft.
2. Slide the boot on to the drive shaft, making sure that it is not damaged on the splines.
3. Place the joint cap in position and then press on the constant velocity joint, making sure that its larger diameter is towards the drive shaft (Fig. F 17). Fit the dished washer and fit a new circlip.
4. Pack the joint with molybdenum disulphide grease. The amount per velocity joint, making sure that its larger diameter is towards the drive shaft (Fig. F 17). Fit the dished washer and fit a new circlip.
5. Slide the hub clips on to the rubber boot and tighten them. NOTE: the hole in the hub must be aligned so that they do not block the screw holes in the joint.
6. Secure the boot to force some grease into the boot from behind.

**SPRING PLATES (Swing Axle Vehicles only)**

The axle tubes are connected to the torsion bars by long flat arms called spring plates. They are attached to the axle tubes by three bolts. When the axle end of the spring plate has been unbolted, it is removed from the torsion bar in the same way as the double jointed rear axle spring plate (see next section).

1. Check the large rubber bushes on the spring plate for wear. Replace them if necessary. Coat them liberally with lanolin powder before installing them.
2. Note that the rubber bushes as are marked "oben" at the top and that the inner and outer ones are different (Fig. F 25).
3. When attaching the spring plates to the trailing arm, push something between the tines of the spring plates to force them apart so as to make fitting easier. Secure the torsion arm end of the spring plate first. It may be difficult to make the cover close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 25). The standard screws can be inserted, two at a time, once the spring plate has been lifted to line up with its mounting on the trailing arm. A jet can be used to lift it into this position (Fig. F 25).
4. Secure the torsion arm end of the spring plate last. It may be difficult to make the cover close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 25). The standard screws can be inserted, two at a time, once the spring plate has been lifted to line up with its mounting on the trailing arm. A jet can be used to lift it into this position (Fig. F 25).
5. Fit the trailing arm into its bracket and insert the screw and washers, taking care that these are installed in the correct order. Look the screw in place by peening the metal shoulder which it bears against.
6. Attach the trailing arm to the spring plate, taking care that the alignment marks line up (Fig. F 27).

**TRAILING ARMS & SPRING PLATES (Double-jointed Axle Vehicles)**

Beetles with automatic transmission and the Types 1302 and 1302'S' have double-jointed rear axles.

**Removal**

1. Lock the rear wheels and loosen the rear axle nuts.
2. Raise and support the rear of the car.
3. Remove the screws which secure the drive shaft to the wheel end. Cover the exposed joint so that dirt cannot enter.
4. Remove the lower shock absorber mounting bolt.
5. Fully slacken off the rear brake shoes and slide off the drum. The brake line and hand-brake cable can be disconnected from the back plate if necessary and the back plate can be removed.
6. Mark the spring plate relative to its mounting on the trailing arm, using a chisel or centre-punch (Fig. F 21).
7. Remove the bolts which attach the spring plate to the trailing arm.
8. Remove the socket screw which secures the trailing arm to its mounting bracket (Fig. F 25). IMPORTANT : the position of the washers must be noted as they affect the rear wheel alignment.
9. Remove the 4 screws which hold the cover on the torsion bar end of the spring plate and take off the cover.
10. Lever the spring plate off the end of the torsion bar.

**Installation**

1. Check the large rubber bushes on the spring plate for wear. Replace them if necessary. Coat them liberally with lanolin powder before installing them.
2. Note that the rubber bushes as are marked "oben" at the top and that the inner and outer ones are different (Fig. F 25).
3. When attaching the spring plates to the trailing arm, push something between the tines of the spring plates to force them apart so as to make fitting easier. Secure the torsion arm end of the spring plate first. It may be difficult to make the cover close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 25). The standard screws can be inserted, two at a time, once the spring plate has been lifted to line up with its mounting on the trailing arm. A jet can be used to lift it into this position (Fig. F 25).
4. Secure the torsion arm end of the spring plate last. It may be difficult to make the cover close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 25). The standard screws can be inserted, two at a time, once the spring plate has been lifted to line up with its mounting on the trailing arm. A jet can be used to lift it into this position (Fig. F 25).
5. Fit the trailing arm into its bracket and insert the screw and washers, taking care that these are installed in the correct order. Look the screw in place by peening the metal shoulder which it bears against.
6. Attach the trailing arm to the spring plate, taking care that the alignment marks line up (Fig. F 21).
REAR SHOCK ABSORBERS

1. If the paint on the torsion bar is damaged, corrosion will occur and may provoke fatigue fractures. Any damage to the paintwork must be touched up.

2. Do not mix up the two bars. The end face of each is marked either "L" or "R".

3. When the torsion bar is in place, fit the spring plate on to the end of it so that it hangs freely.

4. Check that the car is level, fore and aft, and transversely.

5. Place a spirit level protractor on the edge of the spring plate and measure its angle to the horizontal. The position of the torsion bar must be adjusted until the angle is correct. (See table).

REAR COMPENSATING SPRING
(Swing Axle Vehicles only)

Some swing axle vehicles are fitted with a rear compensating spring which has a beneficial effect upon the handling.

The spring is mounted in bushes which are beneath the floor of the rear luggage compartment. Levers are attached to either end of the spring and these have operating rods which pull on brackets on the axle tubes (Fig. F.28). These operating levers are so adjusted that they only bring the spring into operation when the suspension is under load.

The spring may be removed after the nuts have been removed from the ends of the operating rods so that they can be withdrawn from the brackets (Fig. F.29). The levers are attached to the spring by clamping screws.

REAR SHOCK ABSORBERS

The rear shock absorbers are secured by nuts and bolts between the frame of the car (at the top) and a mounting on the end of the axle tube (swing axle types) or on the trailing arm (double-jointed rear axle types).

They are removed by taking out the bolts. The performance of the rear shock absorbers has a marked effect upon the handling and comfort of the car and heavy duty versions are available for vehicles used on rough roads or for fast driving.

Technical Data

Type — 1200, 1300 & 181 models

— All models other than above

— Swing axle with flexible trailing arms. Transverse torsion bars provide the suspension medium. An equalising spring inter-connects the suspension on either side. Telescopic double acting dampers.

— Rigid trailing arms with transverse torsion bars as the suspension medium. Double-jointed axle shaft. Telescopic double acting dampers.

Rear Suspension Spring Plate Settings

<table>
<thead>
<tr>
<th>Swing Axle Models</th>
<th>1200 and 1300</th>
<th>1500</th>
<th>20° ± 50'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-jointed Axle Models</td>
<td></td>
<td></td>
<td>20° ± 50'</td>
</tr>
</tbody>
</table>

Models without Equaliser Springs:

- All Beetle Models from the following chassis Nos:
  - 1-0929 746
  - 2232 161
  - 2528 668
  - Model 113
  - Model 115
  - Model 116
  - Model 181

- 13° ±30'
- 10° ±30'
- 10° ±30'
- 10° ±30'
- 17° ±50'
- 18° ±50' (wide track)

Models with Equaliser Springs:

- 20° ± 50'
Front Axle & Front Suspension

GENERAL

WHEEL BEARINGS — Adjustment
SHOCK ABSORBERS (Models other than 1302 & 1302'S') — Removal & Installation
STEERING KNUCKLES (Models other than 1302 & 1302'S') — Removal & Installation
STEERING KNUCKLES (1302 & 1302'S' Models) — Removal & Installation
TORSION ARM BALL JOINTS (Models other than 1302 & 1302'S') — Cleaning, Regreasing & Replacement
TRACK CONTROL ARM BALL JOINTS (1302 & 1302'S' Models) — Removal & Installation
TORSION ARMS (Models other than 1302 & 1302'S') — Removal & Installation
TORSION ARMS (Models other than 1302 & 1302'S') — Removal & Installation
TORSION ARM BEARINGS AND BUSHES (Models other than 1302 & 1302'S') — Removal & Installation
SUSPENSION STRUTS (1302 & 1302'S' Models) — Removal, Disassembly, Assembly & Installation
TRACK CONTROL ARMS (1302 & 1302'S' Models) — Removal & Installation
STABILISER BAR (Models other than 1302 & 1302'S') — Removal & Installation
STABILISER BAR (1302 & 1302'S' Models) — Removal & Installation
WHEEL ALIGNMENT

WHEEL BEARINGS

The front wheels of the Beetle (other than the 1302 and 1302'S' models) are each suspended on two arms (front arm) which are connected on the ends of the torsion bars. These torsion bars are located in the front axle beam (see Fig. H1). The steering knuckle and brake assembly are mounted on the torsion bars by means of ball bearings. The steering knuckle has a steering arm for the attachment of the track rods.

A stabilizer or anti-roll bar links the lower torsion arms on each side and this has a marked effect upon the car's handling.

The 1302 and 1302'S' models have a coil spring/shock absorber suspension which fits between the steering knuckle and the body of the car. The rear wheel is further located by a single track control arm which serves near the centre line of the car and a massive front stabilizer.

SHOCK ABSORBERS (Models other than 1302 & 1302'S')

These are attached at their upper end by a pin which passes through the axle side plate. This pin carries a rubber buffer. At the bottom end is an eye; a pin which projects from the lower torsion arm passes through this eye.

It is not possible to test shock absorbers properly without a special rig. The performance in use indicates when replacement is required.

The performance in use indicates when replacement is required.

General

1. Slacken off the brake adjusters so that the linings do not rub and the wheel spins freely (drum-braked vehicles only).
2. Raise the rear of the vehicle on a jack and support it on jackstands.
3. Remove the wheel and brake drum. If necessary, slide down the rubber buffer and the protective tube so that you can grip the pin. If the nut still cannot be removed, hold the pin tightly and use a spanner on the flats of the shock absorber shaft to unwind the shaft from the pin (Fig. H6).
4. Remove the upper mounting nuts.
5. Remove the shock absorber and spring assembly from the car. If necessary, remove the brake pipes from the wheel. Be careful not to damage the brake pipes when removing or replacing the spring assembly.
6. Remove the shock absorber from the car and inspect it for wear.
7. Replace the shock absorber if it is worn or damaged.
8. Install the new shock absorber and spring assembly in the reverse order of removal.
9. Check that all parts are properly secured and tighten the mounting nuts to the specified torque.
10. Adjust the wheel bearings if necessary.
11. Replace the wheel and brake drum and lower the vehicle.
12. Check the operation of the suspension by gently pushing the suspension up and down several times.
13. Check the brake operation and adjust the brake lining if necessary.
14. Check the suspension for proper alignment.
15. Check the steering and brake systems for proper operation.

Removal

1. Raise and support front of car and remove front wheels.
2. Loosen the small nut at the upper attachment to the axle side plate. If necessary, slide down the rubber buffer and the protective tube so that you can grip the pin. If the nut still cannot be removed, hold the pin tightly and use a spanner on the flats of the shock absorber shaft to unwind the shaft from the pin (Fig. H6).
3. Remove the small nut at the upper attachment to the axle side plate. If necessary, slide down the rubber buffer and the protective tube so that you can grip the pin. If the nut still cannot be removed, hold the pin tightly and use a spanner on the flats of the shock absorber shaft to unwind the shaft from the pin (Fig. H6).
4. Unscrew the nut at the lower mounting point and take out the shock absorber. The rubber bush has a steel insert and this may be seized.
STEERING KNUCKLE

Removal

1. Detach the stabilizer on that side.
2. Press the tie rod end out of the steering arm.
3. Disconnect the brake hose at the bracket on the suspension strut and remove the brake caliper from the steering knuckle. (On 1302, remove brake drum and brake plate).
4. Remove the screws which link suspension struts to steering knuckle and pull the strut away.

Installation

1. Fit the suspension strut to the steering knuckle and tighten the securing screws.
2. Install brake assembly, re-connect brake pipe and adjust wheel bearings.
3. Install stabilizer.

TORSION ARM BALL JOINTS

Models other than 1302 & 1302’S"

The torsion arms are attached to the steering knuckle by ball joints. Maintenance of these joints is possible if it is thought that dirt has entered.

Cleaning and Regreasing

1. Remove the rubber seal and thoroughly clean the joint with solvent.
2. Remove the plastic plug in the top of the joint and screw in a grease nipple.
3. Force suitable grease through the nipple.
4. Fit a new seal to the joint with a new retaining ring or wire. If the seal was previously clipped with a retaining ring, this must not be replaced with wire. Check that the ends of the ring are at 90 degrees from the operating angle of the ball joint.
5. Force in more grease, allowing it to escape through the other end of the seal. If necessary, lift the seal away from the pin with something which will not tear it.
6. Move the pin around to allow excess grease to escape and then slide a new plastic retaining ring on to that end of the seal.
7. Replace the grease nipple with a new plastic plug. This should be screwed in, not pushed.

Replacement

Existing ball joints can be pressed out of the torsion arms. Note that oversize versions are available to fit torsion arms with oversize holes.

TRACK CONTROL ARM BALL JOINT

(1302 & 1302’S Models)

There is one ball joint at each side between the steering knuckle and the track control arm.
Fig. H.8. Removing the brake calliper on disc-braked models.

Fig. H.9. Wheel bearing seat dimensions on the steering knuckle.
A = 26.97 - 26.98 mm. (1.0618-1.0622 in.)
B = 17.45 - 17.46 mm. (0.6870-0.6874 in.)

Fig. H.10 Checking the stub axle alignment.

Fig. H.11. The slot in the eccentric bush must face forwards.

Fig. H.12. Tightening the upper ball joint stud nut.

Fig. H.13. Bend up the tabs on the stabiliser clips as shown.

Fig. H.14. Installing the stabiliser clip locking plates.

Fig. H.15. Measuring the ball joint wear with Special Tool VW 282 d.

Removal
1. Raise and support the front of the car and remove the front wheel.
2. Detach the stabiliser on that side.
3. Remove the nut below the ball joint and pull the track control arm off the ball joint with a puller. (Protect the end of the stud with the nut).
4. Remove the screws which hold the ball joint to the steering knuckle. (Support the steering knuckle by tying it up).

Installation
1. Attach the ball joint to the steering knuckle and tighten the screws.
2. Check that the pin of the ball joint is free from grease and position it in the track control arm.
3. Tighten the ball joint securing nut. If necessary, the ball joint pin can be held with a spanner on the flats on the thread. Use a NEW self-locking nut.
4. Refit the stabiliser.

TORSION ARMS
(Model other than 1302 & 1302'S')
The torsion arms connect the steering knuckle assembly to the torsion bars which are located in the front axle tubes.

Removal
1. Raise and support front of car and remove wheel.
2. Remove the steering knuckle complete with brake assembly.
3. Remove the stabiliser.
4. Loosen the lock nuts on the torsion arm securing set screws and remove the set screws.
5. Pull off the torsion arms.

Installation
1. Check the condition of the rubber sealing rings and replace them if necessary.
2. Fit the torsion arms on to the end of the torsion bars, tighten the set screws and then tighten the lock nuts.
3. Install stabiliser and steering knuckle complete with brake assembly.

TORSION BARS
(Model other than 1302 & 1302'S')
The front springs of Beetles (other than the 1302 and 1302'S') are torsion bars which are located inside the front axle tubes. Their outer ends are connected to the torsion arms and they are located centrally by set screws.

Removal
1. Raise and support front of car, remove wheel, steering knuckles, torsion arms and torsion bars.
2. Pull out the needle bearing.
3. Pull out the metal bush. Note that it is inserted into a plastic seat and this remains in position in the tube.

Installation
1. Note the following points:
   1. The metal bush must be properly located in its plastic seating. It is easy to damage this seating and it cannot be replaced.
   2. The mark on the shoulder of the needle bearing should point outwards.
   3. Lubricate the bush and bearing before inserting torsion bar and arm.

   4. It is important that the bearing and bush are driven into the tube to the correct depth. In order to ensure this, they must be inserted to the following depths from the extreme end of the axle tube:
      - Metal bush:
        - upper: 122 - 124 mm
        - lower: 132 - 134 mm
      - Needle bearing:
        - upper: 3.5 - 4.0 mm
        - lower: 3.5 - 4.0 mm

   5. The front springs of Beetles (other than the 1302 and 1302'S') are torsion bars which are located inside the front axle tubes. Their outer ends are connected to the torsion arms and they are located centrally by set screws.

Removal
1. Remove the steering knuckle and brake assemblies complete and remove the torsion arms on one side.
2. Loosen the lock nuts of the set screws and remove the set screws (Fig. H.17).
3. Use the remaining torsion arms to pull out the torsion bars (Fig. H.18).

TORQUE ARM BEARINGS & BUSHES
(Model other than 1302 & 1302'S')
Each torsion arm is mounted in the axle beam by a needle bearing (at the end of the tube) and a metal bush (further into the tube).

These bearings are not usually subject to very much wear and seldom need replacement; removal is difficult as one has to remove the parts from inside the axle tube and a special extractor should be used.

Removal
1. Raise and support front of car, remove wheel, steering knuckle, torsion arms and torsion bars.
2. Pull out the needle bearing.
3. Pull out the metal bush. Note that it is inserted into a plastic seat and this remains in position in the tube.

Installation
1. Note the following points:
   1. The metal bush must be properly located in its plastic seating. It is easy to damage this seating and it cannot be replaced.
   2. The mark on the shoulder of the needle bearing should point outwards.
   3. Lubricate the bush and bearing before inserting torsion bar and arm.

   4. It is important that the bearing and bush are driven into the tube to the correct depth. In order to ensure this, they must be inserted to the following depths from the extreme end of the axle tube:
      - Metal bush:
        - upper: 122 - 124 mm
        - lower: 132 - 134 mm
      - Needle bearing:
        - upper: 3.5 - 4.0 mm
        - lower: 3.5 - 4.0 mm

   5. The front springs of Beetles (other than the 1302 and 1302'S') are torsion bars which are located inside the front axle tubes. Their outer ends are connected to the torsion arms and they are located centrally by set screws.

Removal
1. Remove the steering knuckle and brake assemblies complete and remove the torsion arms on one side.
2. Loosen the lock nuts of the set screws and remove the set screws (Fig. H.17).
3. Use the remaining torsion arms to pull out the torsion bars (Fig. H.18).

Removal
1. Raise and support front of car, remove wheel, steering knuckle, torsion arms and torsion bars.
2. Pull out the needle bearing.
3. Pull out the metal bush. Note that it is inserted into a plastic seat and this remains in position in the tube.

Installation
1. Note the following points:
   1. The metal bush must be properly located in its plastic seating. It is easy to damage this seating and it cannot be replaced.
   2. The mark on the shoulder of the needle bearing should point outwards.
   3. Lubricate the bush and bearing before inserting torsion bar and arm.

   4. It is important that the bearing and bush are driven into the tube to the correct depth. In order to ensure this, they must be inserted to the following depths from the extreme end of the axle tube:
      - Metal bush:
        - upper: 122 - 124 mm
        - lower: 132 - 134 mm
      - Needle bearing:
        - upper: 3.5 - 4.0 mm
        - lower: 3.5 - 4.0 mm

   5. The front springs of Beetles (other than the 1302 and 1302'S') are torsion bars which are located inside the front axle tubes. Their outer ends are connected to the torsion arms and they are located centrally by set screws.

Removal
1. Remove the steering knuckle and brake assemblies complete and remove the torsion arms on one side.
2. Loosen the lock nuts of the set screws and remove the set screws (Fig. H.17).
3. Use the remaining torsion arms to pull out the torsion bars (Fig. H.18).

Removal
1. Raise and support front of car, remove wheel, steering knuckle, torsion arms and torsion bars.
2. Pull out the needle bearing.
3. Pull out the metal bush. Note that it is inserted into a plastic seat and this remains in position in the tube.

Installation
1. Note the following points:
   1. The metal bush must be properly located in its plastic seating. It is easy to damage this seating and it cannot be replaced.
   2. The mark on the shoulder of the needle bearing should point outwards.
   3. Lubricate the bush and bearing before inserting torsion bar and arm.

   4. It is important that the bearing and bush are driven into the tube to the correct depth. In order to ensure this, they must be inserted to the following depths from the extreme end of the axle tube:
      - Metal bush:
        - upper: 122 - 124 mm
        - lower: 132 - 134 mm
      - Needle bearing:
        - upper: 3.5 - 4.0 mm
        - lower: 3.5 - 4.0 mm

   5. The front springs of Beetles (other than the 1302 and 1302'S') are torsion bars which are located inside the front axle tubes. Their outer ends are connected to the torsion arms and they are located centrally by set screws.

Removal
1. Remove the steering knuckle and brake assemblies complete and remove the torsion arms on one side.
2. Loosen the lock nuts of the set screws and remove the set screws (Fig. H.17).
3. Use the remaining torsion arms to pull out the torsion bars (Fig. H.18).
SUSPENSION STRUTS (1302 & 1302'S Models)

These vehicles have suspension struts which are combination shock absorbers and coil springs. The upper ends are bolted to a reinforced part of the body whilst the lower ends are bolted to the steering knuckles.

Removal
1. Detach stabiliser at that side.
2. Press the tie rod end out of the steering arm.
3. Disconnect the brake pipe at the bracket on the strut.
4. Remove the ball joint nut and pull the track control arm off the ball joint, but leave it in place for the time being.
5. Unscrew the 3 self locking nuts at the top of the strut. Do NOT loosen the one in the centre.
6. Press the track control arm downwards and take out the strut.

Shock Absorber Removal
1. Compress the coil spring with a suitable compressor.
2. Unscrew the central lock nut at the top of the strut. The stud has flats on it so that it can be held.
3. Carefully release the compressor and take the shock absorber out of the strut.

Shock Absorber Installation
1. Assemble the shock absorber into the strut, using the compressor.

Installation
1. Attach ball joint and steering knuckle to strut and tighten the screws.
2. Attach the upper end of the strut to the body in the correct position and tighten the self-locking nut.
3. Insert the ball joint stud into the track control arm and tighten the nut.
4. Attach stabiliser and re-assemble brake assembly and pipe

TRACK CONTROL ARMS (1302 & 1302'S Models)
The track control arm is the main lower suspension member on these cars.

Removal
1. Remove the nut from the ball joint stud and pull the track control arm off it.
2. Remove the split pin from the nut on the end of the stabiliser and remove the nut.
3. Remove the self-locking nut which holds the track control arm to the frame and then pull the arm away from the frame and stabiliser.

Installation
1. Push the stabiliser through its bush on the control arm and install the nut, but do not tighten it yet.
2. Fit the control arm on to the ball joint stud. Check that there is no oil or grease on the stud.
3. Place the arm into position on the frame end, install the eccentric bolt and its washer and then tighten the NEW self locking nut.
4. Fully tighten the nut on the stabiliser and lock it with a new split pin.
5. Tighten the nut on the ball joint stud (use a NEW nut).
6. Have the front wheel camber checked and adjusted, if necessary.

STABILISER BAR (Models other than 1302 & 1302'S)
The stabiliser has an important effect upon the handling of the car. It is attached to the lower torsion arms by two clips on each side.

Removal
1. Remove the nut from the ball joint stud and pull the track control arm off it.
2. Slightly squeeze up the front of each clip in turn. This allows the locking clips to be tapped off with a chisel (Fig. H 13).

Installation
1. Check the condition of rubber bushings, clamps and locking plates. Replace parts as necessary.
2. Slide on the rubber bushings and ensure that they are correctly positioned relative to the lower torsion arms.
3. Fit the clamps around each torsion arm and squeeze up the front of each one in turn so that the locking plates can be slid on. A mole wrench is ideal for this.
4. Bend over the tabs on the locking plates (Fig. H 14).

STABILISER BALL (1302 & 1302'S Models)
On these models, the stabiliser helps to locate the front wheels.

Removal
1. Remove the split pin and nut which lock the stabiliser to the track control arm.
2. Slide off the rubber bushes and ensure that they are correctly positioned relative to the lower torsion arms.
3. Fit the clamps around each torsion arm and squeeze up the front of each one in turn so that the locking plates can be slid on. A mole wrench is ideal for this.
4. Bend over the tabs on the locking plates (Fig. H 14).

Installation
1. Check the rubber mountings and replace them if necessary.
2. Put the end of the stabiliser into the track control arm.
3. Bolt the front mounting clip to the frame.
4. Tighten the nut on the end of the stabiliser and fit a new spUt pin.

**WHEEL ALIGNMENT**

It is essential that the various geometrical factors of the front suspension, i.e., toe-in, caster angle and camber angle, are correctly adjusted and maintained. Failure to do this will lead to premature tyre wear and poor handling characteristics.

The checking of these factors requires specialized knowledge and equipment and it is recommended that this is carried out by an Authorized Dealer.

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**Technical Data**

**Type** - all except 1302 & 1902S

- Upper and lower trailing arms with torsion bar on the suspension arm between the suspension arm and the coil spring. These bars are parallel and each consist of 8 leaves. A stabiliser bar interconnects the suspension on either side.

- Transverse torsion bars as the suspension on either side.

- A stabiliser bar interconnects the suspension on either side.

- Metal bushes for torsion arm - axle beam upper needle bearing seat diameter . 1.9673-1.9681 in

- Oversize seat diameter. 1.9752-1.9760 in

- Corresponding oversize needle bearing diameter 1.9764 in (50.2 mm)

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**WHEELS & TYRES**

<table>
<thead>
<tr>
<th>Tyres</th>
<th>Wheels size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.15R15</td>
<td>4Jxl5 Saloon.</td>
</tr>
<tr>
<td>5.60-15 (crossply)</td>
<td>All models (except 181).</td>
</tr>
<tr>
<td>5.60-15 (radial)</td>
<td>1—2 persons — front.</td>
</tr>
<tr>
<td>5.60-15 (radial)</td>
<td>— rear.</td>
</tr>
</tbody>
</table>

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**STEERING**

**GENERAL**

All steering columns now incorporate a collapsible section beneath the fuel tank. There is a flexible joint between the column and the steering box.

**STEERING WHEEL - Removal & Installation**

1. Disconnect the battery.
2. Remove the steering wheel.
3. Disconnect the earth lead to the horn ring and then take out the 3 plastic washers. 1200s have a horn button instead of a ring, but the method of removal is the same.
4. Disconnect the earth lead to the horn ring and then take out the 3 plastic washers. 1200s have a horn button instead of a ring, but the method of removal is the same.
5. Refit the clamp at the bottom of the column.

---

**STEERING COLUMN - Removal & Installation**

1. Check that the upper column mounting is tightly fastened.
2. Slide the column out through the rubber bush in the bulkhead.
3. Slide the column into the tube and then attach the tube to the upper mounting. Do not forget the clamp at the bottom of the column.
4. Install the switch assembly, but do not fully tighten the screws.
5. Centre the steering and refit the steering wheel.
6. Refit the clamp at the bottom of the column using a NEW locking plate.

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**STEERING DAMPER - Removal, Inspection & Installation**

**STEERING ADJUSTMENT (Not 1302 & 1302S' Models)**

**STEERING ADJUSTMENT (1302 & 1302S' Models)**

**STEERING BOX - Removal & Installation**
9. Move the switch assembly until there is a gap of 2 - 3 mm between switch and steering wheel hub and then tighten the screws.

STEERING DAMPER

The steering damper is a shock absorber fitted between the track rods and the frame. It prevents undue vibrations reaching the steering wheel. Severe vibration which is not due to wheel imbalance or wear in the suspension is usually due to a worn damper.

Removal

1. Raise and support the front of the car and remove the front wheels.
2. Bend up the tab on the locating plate and remove the screw which holds the damper to the frame bracket.
3. Remove the nut at the track rod end of the damper and pull the damper off.

Inspection

The damper should show no signs of leakage and its action should be the same in both directions. If possible, compare its behaviour to a new one. Note that the rubber bushes may be worn. They can be removed with a press and new ones fitted.

Installation

1. Fit the damper to the track rod with a NEW self locking nut and tighten it.
2. Using a new lock plate, fit the other end to the frame bracket and tighten the screw.

TRACK RODS

The track rods transmit the movement of the Pitman arm on the steering box to the steering knuckles. One is much longer than the other and both are adjustable for length so that toe-in may be adjusted.

Removal

1. Remove the split pins from the tie rod nuts with pliers and undo the nuts.

Installation

1. Install the rods so that the left hand thread is on the left when one looks towards the front of the car.
2. Fit new split pins at the track rod ends.
3. Ensure that the two ends of each rod are properly aligned with each other.
4. CHECK and, if necessary, adjust toe-in.

STEERING ADJUSTMENT

(The front of the car must be off the ground in order to check the steering.

Play may occur for the following reasons (Fig. J 3):

1. axial play of worm spline (a)
2. play between roller and worm (b)
3. axial play of roller (c).

Axial Play of Worm Splines

This can be checked by turning the spindle to end of the slot in the flexible coupling (Fig. J 4). Play can be eliminated as follows:

1. Turn the steering wheel fully in one direction.
2. Loosen the large lock nut on the front end of the steering box.
3. Whilst the spindle is slowly rocked to and fro, tighten the socket adjusting screw on the front of the steering box.
4. Re-tighten the lock nut without moving the position of the adjuster.
5. Turn the steering to check that there is no tightness; if there is, the adjusting screw has been tightened too far.

Roller / Worm Play

After adjusting the worm spline axial play, any further play should be taken up by adjusting the screw on the top of the steering box (Fig. J 5).

1. Remove the inspection cover behind the spare wheel.
2. Turn the steering wheel 90 degrees from the straight ahead position.
3. Loosen the lock nut and turn in the adjusting screw until the roller can just be felt to contact the worm.
4. Re-tighten the lock nut without altering the adjusting screw position.
5. Lower the front wheels and check that, in the straight ahead position, there is no free play at the steering wheel rim. If there is, the adjustment is too tight.

Axial Play Axial Play

This can be checked by turning the spindle to end of the slot in the flexible coupling (Fig. J 4). Play can be eliminated as follows:

1. Turn the steering wheel fully in one direction.
2. Loosen the large lock nut on the front end of the steering box.
3. Whilst the spindle is slowly rocked to and fro, tighten the socket adjusting screw on the front of the steering box.
4. Re-tighten the lock nut without moving the position of the adjuster.
5. Turn the steering to check that there is no tightness; if there is, the adjusting screw has been tightened too far.
STEERING ADJUSTMENT (1302 & 1302’S Models)

The steering on these models is checked with the wheels of the vehicle on the ground. When the front wheels are in the straight ahead position, there should not be more than 15 mm free play, measured at the steering wheel rim. If the play is in excess of this figure, the following factors may be responsible:

1. play between roller and worm
2. play in the universal joints
3. axial play at the worm spindle.

Roller/Worm Play
1. Raise and support front of car.
2. Turn steering wheel through 90 degrees from straight ahead position.
3. Remove cover in floor of front luggage compartment to gain access to adjusting screw.
4. Loosen lock nut on adjusting screw.
5. Loosen the adjusting screw and then tighten it until it can be felt to just make contact between roller and worm.
6. Re-tighten lock nut without altering position of adjusting screw.
7. Lower vehicle and re-check play.

Universal Joint Play
If the joints show excessive wear, they must be replaced.

Axial Play at Worm Spindle
This can only be dealt with when the steering box is dismantled, and the box should be exchanged or overhauled by a V.W. Dealer.

STEERING BOX
The steering gearbox transfers movement of the steering wheel and column to the track rods.

Adjustment of the steering box is given in the following sections. It is not recommended that the steering box should be dismantled except by V.W. Dealers who have the specialised equipment which is necessary to set the box up properly.

If the normal adjustments do not bring about the desired result and the steering box is at fault, it should be exchanged or overhauled by a V.W. Dealer.

Removal (out 1302 & 1302’S)
1. Raise and support the front of the car and remove the front wheels.
2. Disconnect the steering damper from the drop area.
3. Prise the track rod end out of the drop arm. Keep the nut on the end of the rod whilst this is done to prevent thread damage.
4. Remove the bolt which holds the lower universal joint to the worm spindle of the steering box.
5. Remove the 3 screws which attach the steering box to the body.
6. Pull the steering box spindle out of the lower universal joint and take off the box.

Installation
1. Push the spindle of the steering box into the lower universal joint, making sure that it is correctly aligned (so that the clamping bolt will go through its groove). Insert the clamping bolt.
2. Attach the steering box to the body.
3. Attach the steering damper to the drop arm.
4. Attach the track rod to the drop arm. Tighten the nut to the correct torque and then tighten it further to align the split pin holes.
5. Put a new self locking nut on the lower universal joint clamping bolt and then tighten it to the correct torque.
Fig. J.2. Sectioned view of the steering gear.

1. Drop arm shaft adjusting screw
2. Locknut
3. Upper worm bearing
4. Locknut
5. Oil seal
6. Lower worm bearing
7. Steel bushing
8. Coupling flange
9. Coupling disc
10. Locknut
11. Worm adjusting screw
12. Lower worm bearing
13. Worm adjusting screw
14. Coupling clamp
15. Steering drop arm
16. Earth cable terminal
17. Steering roller
18. Roller support pin
19. Roller needle bearing
20. Roller support pin

Fig. J.3. Critical play areas in the steering gear.
a. Worm spindle axial play
b. Worm and roller play
c. Roller axial play

d. Eartc cable terminal

Fig. J.4. Check the play in the steering gear as shown.

e. Roller needle bearing
f. Roller support pin

Fig. J.5. Adjusting the play between the roller and worm.

Fig. J.6. Disconnecting the track rod ball joint from the steering arm.

Fig. J.7. Drop arm clamp bolt.

Fig. J.8. Steering damper attachment point on the track rod.

Fig. J.15. Steering damper attachment point on the track rod.

Fig. J.16. Removing the steering wheel nut.

Fig. J.17. Correct clearance between steering wheel hub and indicator switch.
  a. = 1.0 - 2.0 mm (0.04 - 0.08 in.)

Fig. J.18. Assembly sequence for the components at the upper end of the steering shaft.

Fig. J.19. Details of the safety steering column.
  A. Earth connection.
  B. Column clamp.
  C. Column support clamp.

Fig. J.20. Safety steering column upper attachment points.

Fig. J.21. The upper mounting bracket must be fitted with the slotted side facing the direction shown.
### Technical Data

**Type:** Warm & roller with divided track ends & steering damper

**Steering Geometry:**
- Toe-in (wheel not pressed)........................................ 0° 30' ± 15'
- Toe-in (wheel pressed)........................................... 0° 3' ± 15'

**Turning Circle (kerb):**
- Wheel base ......................................................... 10.5 m
- Wheel base ......................................................... 11.0 m
- Turning Circle (walls)............................................ 9.5 m
- Turning Circle (walls)............................................ 9.0 m

**Steering roll radius:**
- 1302 & 1302'S' .................................................. 10.5 m
- 1302 & 1302'S' .................................................. 10.5 m
- 1302 & 1302'S' .................................................. 10.5 m
- 1302 & 1302'S' .................................................. 10.5 m

**Wheel lock angle (unladen):**
- Inner ............................................................... 28° ± 1°
- Inner ............................................................... 34° ± 2°

**Toe-out angle at 20° steering lock:**
- LHD models on right lock ........................................ 2° 10' ± 30'
- RHD models on right lock ........................................ 1° 35' ± 30'
- LHD models on left lock ......................................... 1° 20' ± 30'
- RHD models on left lock ......................................... 2° 15' ± 30'

**Technical Data**

**Steering Damper**

The greatest emphasis must be put on the inspection and maintenance of the steering damper. The steering damper will require removal of the drum, and adjustment will not overcome any defects. It is very important to ensure that each shoe is the same distance from the drum. If they have been unbalanced before, a few test crash stops may be necessary to bed them down evenly, and the thickness of brake pads and linings must be checked at regular intervals.

**FOOT-BRAKE ADJUSTMENT**

As the brake linings wear down, it becomes necessary to move the shoes nearer to the drums if braking is to be carried out efficiently. If this were not done, the brake pads would have to be pressed a considerable distance before any braking occurred. This adjustment is carried out readily by rotating the threaded adjuster at the fixed end of each brake shoe. (Disc brakes only — discs do not require adjustment).

1. Remove all the hub caps and wedge the wheels.
2. Release hand-brake.
3. Press the brake pedal several times. This will centralise the shoes in the drums.
4. Jack up one side of the car.
5. Rotate one wheel until one of the adjusters can be seen through the inspection hole. These are in the back plate, covered by plastic plugs.
6. If it may not be easy at first to see the adjuster through the inspection hole. It may not be easy at first to see the adjuster through the inspection hole. They are in the back plate, covered by plastic plugs.
7. Back off the adjuster until drag is no longer felt.
8. Move to the other adjuster in the same drum and repeat the procedure.

**FOOT-BRAKE ADJUSTMENT**

The hand-brake should seldom need adjustment, providing that the rear brakes are kept properly adjusted. It should only be necessary to carry it out in order to take up stretch in the cables.

1. Wedge the wheels on one side of the car and raise the other.
2. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.
3. Release the hand-brake and press the brake pedal a few times to centralise the shoes.
4. Whilst you are doing this job, keep your eyes open for signs of trouble such as fluid or oil leaks at the drums. Faults of this nature will require removal of the drums, and adjustment will not overcome the trouble.

**GENERAL**

With the exception of 1200 models prior to Oct. 1969, all V.W.s now have a dual circuit braking system. When the driver presses the foot-brake pedal, he moves a pair of pistons in the tandem master cylinder. One piston forces hydraulic fluid along the brake lines to the rear brakes, whilst the other piston forces fluid to the front brakes.

1. Remove aU the hub caps and wedge the wheels. If you have carried out the job carefully, the brakes should be free of fluid in the double reservoir and the thickness of brake pads and linings must be checked at regular intervals.

2. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.
3. Release the hand-brake and press the brake pedal a few times to centralise the shoes.
4. Whilst you are doing this job, keep your eyes open for signs of trouble such as fluid or oil leaks at the drums. Faults of this nature will require removal of the drums, and adjustment will not overcome the trouble.

**ADJUSTMENT OF HAND-BRAKE**

The hand-brake should seldom need adjustment, providing that the rear brakes are kept properly adjusted. It should only be necessary to carry it out in order to take up stretch in the cables.

1. Wedge the wheels on one side of the car and raise the other.
2. Release the hand-brake and press the brake pedal a few times to centralise the shoes.
3. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.

**WHEEL CYLINDERS - Removal, Overhaul & Installation**

**DISC BRAKE PADS - Removal & Installation**

**DISC BRAKE CALLIPERS - Removal, Overhaul & Installation**

**BRAKE DRUMS - Removal & Installation**

**BRAKE DISCS - Removal & Installation**

**BRAKE PIPES**

**BLEEDING THE HYDRAULIC SYSTEM**

**HAND-BRAKE CABLES - Replacement**

**GENERAL**

With the exception of 1200 models prior to Oct. 1969, all V.W.s now have a dual circuit braking system. When the driver presses the foot-brake pedal, he moves a pair of pistons in the tandem master cylinder. One piston forces hydraulic fluid along the brake lines to the rear brakes, whilst the other piston forces fluid to the front brakes.

1. Remove aU the hub caps and wedge the wheels. If you have carried out the job carefully, the brakes should be free of fluid in the double reservoir and the thickness of brake pads and linings must be checked at regular intervals.

2. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.
3. Release the hand-brake and press the brake pedal a few times to centralise the shoes.
4. Whilst you are doing this job, keep your eyes open for signs of trouble such as fluid or oil leaks at the drums. Faults of this nature will require removal of the drums, and adjustment will not overcome the trouble.

**ADJUSTMENT OF HAND-BRAKE**

The hand-brake should seldom need adjustment, providing that the rear brakes are kept properly adjusted. It should only be necessary to carry it out in order to take up stretch in the cables.

1. Wedge the wheels on one side of the car and raise the other.
2. Release the hand-brake and press the brake pedal a few times to centralise the shoes.
3. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.
Fig. K.1. General layout of the braking system (Single-line system).

Fig. K.2. Adjusting the drum brakes.

Fig. K.3. Handbrake lever mechanism.

Fig. K.4. Adjusting the handbrake cable.

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3. The threaded end of the cable has two 10 mm nuts on it (Fig K.3). You must loosen the upper nut which acts as a lock nut and then adjust the lower. You can hold the cable by putting a screwdriver in the slot at the end (Fig. K.3), but it is much better to use two 10 mm spanners, one on each nut, to loosen the lock nut.

4. Turn the lower, adjusting nut until the rear wheel locks on the fourth click of the brake shoes. Check this by trying to turn the wheel by hand. If there is not enough play, slacken the drum slightly and then try again. If there is too much play, tighten the drum handwheel.

5. When you have the adjustment right, tighten the lock nut with a 10 mm spanner and then slacken it off by one turn.

6. Repeat the whole process for the other side of the car.

7. Replace the rubber boot.

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FRONT BRAKE DRUMS

Each drum is fitted with two bearings and these fit on to a tapered stub axle. If the bracket shoxes are not retracted sufficiently, the drum will slide off quite easily. If it is an oil car, you can bolt the wheel back on to it and use this to pull it off.

---

Removal

1. Remove the split pin from the castellated nut with strong pliers. If it is worn or deformed that it cannot be pulled out, remove the end with a hack saw and drive it out with a drift.

2. Remove the steel pipe and brake pipe from the inner bore.

3. Lock the wheel firmly and remove the nut.

4. Jack up the car and remove the wheel.

5. Slacken off the brake adjusters so that the shoes are completely released.

6. Pull off the drum. This may be easy or it may stick on the splines. If an extractor is not available, the drum can usually be driven off by bolting the wheel back on to it and using this as a means of pulling it. You can drum the tyre with a stout piece of wood if necessary. If an extractor is available, the drum can usually be driven off by bolting the wheel back on to it and using this as a means of pulling it. You can drum the tyre with a stout piece of wood if necessary.

7. Remove the split pin from the castellated nut with strong pliers. If it is worn or deformed that it cannot be pulled out, use a replacement available. The nut is tightened during assembly with a torque wrench capable of this figure should be used, but a good substitute is to carefully mark the components before removal. With a suitable edged file, strike a line across the end of the axle shaft and a matching one in the face of the nut; this will give the final degree of tightening. It will be fairly easy to decide by feel how tight the nut should be until the last part of a turn, it may help to count and note the number of exposed threads on the end of the axle shaft.

---

Installation

1. Thoroughly clean the inside of the drum and the splines of the axle. After the spines have been cleaned, lubricate them thoroughly with oil or liquid grease.

2. Fit the oil deflector in place in the drum with its tube in its hole and the securing tab through the aperture in the face.

3. Make sure that the brake shoes are centralised.

4. Slide drum into place.

5. Re-fit the axle nut, making sure that it is tightened correctly. If you have a torque wrench the value is 215 lb-ft, but if you have not one available, you must ensure that the lines scribed on the nut and axle line up correctly.

6. Fit a new split pin.
The brake linings are mounted on brake shoes and these are pressed against the rubbing surface of the brake drums by the action of the wheel cylinders. The linings are either riveted or bonded into place; retouched linings can be replaced, but when they are bonded, the shoes must be exchanged.

**Removal**

1. Remove the brake drum.
2. Remove the small coil spring and cap which retain each shoe. (Fig. K.7). A pin with spade end passes through the back plate and then through the spring plate. If the plate is gripped with pliers, it can be pressed in and rotated to free the pin.
3. Lower the brake shoes out of the wheel cylinder and adjuster notches. Make a note of the position of the return springs so that they can be replaced correctly.
4. At the rear, the handbrake cable must be lifted off the operating lever which pivot on one of the shoes (Fig. K.8).

**Installation**

1. Hook the hand-brake cable into position.
2. Assemble the return springs on the shoes and then prise the shoes into position in their notches (Figs. K.11 & K.12).
3. Fit each shoe retaining spring into position.
4. Adjust the position of each shoe so that the drum slides on easily.

Note the following points:

1. The hand-brake operating lever must be removed from the shoe on which it pivot before this shoe can be relined (Fig. K.10).
2. V.W. permits linings cause complete with shoes. Use only these parts.
3. The linings must be inserted down evenly, working from the middle of the shoe.
4. The ends of the linings must be chamfered after fitting. (See Fig. K.13).

**BRAKE BACK PLATES**

The shoes and wheel cylinders are mounted on a back plate. The shoes and wheel cylinders must first be removed before the plate can be taken off. The front back plates are secured by screws to the steering knuckle. When installing the back plate, the following points should be noted:

1. The screws must be tightened to the correct torque.
2. Use new rubber sealing rings for the rear wheel bearing cover.
3. After the brake assembly has been installed, the system must be bled.

**WHEEL CYLINDERS**

Pressure which is built up in the master cylinder by the action of the brake pedal is transmitted via the brake fluid in the brake lines to the wheel cylinders. The fluid also passes into the stop lamp switches and closes the contacts.

The condition of the parts inside the cylinder is of vital importance as failure here will affect the whole braking system.

1. Jack up the car, support it securely and remove the front wheel.
2. Pull the lines which lead to the reservoir out of the master cylinder. They enter at the top of the cylinder, through sinter plugs. Simply pull the plastic blocks out of the plugs.
3. As you disconnect these lines, the fluid will be free to run out. Hold a clean container beneath the end until it has all run out. NOTE: Brake fluid strips paint!
4. Disconnect the cables from the stop lamp switches.
5. Unthread the brake lines from the master cylinder. These unions may be very difficult to untighten. Make sure that you do not twist the brake lines as you undo them as this will seriously weaken them. Seal the end of the lines with dust caps.
6. Disconnect the push rod from the brake pedal.
7. Lift out the push rod from the driver's side of the bulkhead.
8. Undo the two bolts on the bulkhead which hold the cylinder in position — now the spaces inside the bulkhead!
9. Lift out the cylinder from the front of the bulkhead.

**Installation**

This is a reversal of this process; but note the following points:

1. There must be a certain amount of play (1 mm) between the push rod and which is attached to the pedal and the plate inside the cylinder. This is adjusted by loosening the pedal stop plate and adjusting the position of the pedal accordingly. The stop plate is located by the bolt which goes down into the floor just behind the brake pedal. When the pedal is moved to such a position that there is just 1 mm of play before the push rod presses against the plates, tighten the stop plate securely.
2. Do not forget to put the shoes in position around the mounting bolts.
3. When all the brake lines and cables are attached, the reservoir must be filled with fresh fluid and the whole system bled.
Fig. K.13. New linings must be chamfered at the ends as shown.

Fig. K.14. Brake fluid reservoir - Beetle models.

Fig. K.15. Brake fluid reservoir - Karmann-Ghia models.

Fig. K.16. Sectioned view of the single-line master cylinder.

Fig. K.17. Exploded view of the single-line master cylinder.

Fig. K.18. Disconnecting the brake lines from the master cylinder (single-line system).

Fig. K.19. Removing the master cylinder.

Fig. K.20. Refitting the distance tube. (Do not drop into bulkhead.)

Fig. K.21. Push rod to master cylinder clearance. \( s = 1.0 \text{mm} \) (0.04 in.).

Fig. K.22. Free-play at the brake pedal "X" should be 5-7 mm (0.2-0.28 in.).

Fig. K.23. Adjusting the push rod clearance by moving the pedal stop plate.

Fig. K.24. Sectioned view of the dual-circuit master cylinder.

Fig. K.25. Exploded view of the dual-circuit master cylinder.
OVERHAUL

The wheel cylinder is normally overhauled if the brake becomes defective owing to fluid leaking past the rubber cup and entering the drum or if any slight leak is apparent when the shoes are retracted.

In order to remove the cylinder from the brake plate and work on it conveniently, it is necessary to detach the flexible hose from it (at the front only). The hose will be strained if it is twisted to any extent, and as it must either be detached at the support where it meets the metal hose or the cylinder must first be unbolted and then rotated off the flexible hose. This last method is most convenient, as it involves least work.

The wheel cylinder is detached from the brake plate by undoing the screws which pass through from the back of the plate and into the wheel cylinder casting (Figs. K 27 & K 28). The flexible hose, must be plugged to prevent undue loss of fluid.

The rubber boots and push buttons are easily removed. The other parts can be removed by pushing them all through from one side with the finger. It is important not to scratch the bore of the cylinder. The bleed valve should be removed with a 7 mm wrench.

Inspect the inside of the bore. It should be absolutely smooth and free from pitting. If there is any considerable degree of wear, the whole cylinder should be replaced. The pistons tend to pick up a deposit on their rubbing surface. This must be removed, taking care not to scratch the soft piston.

If the wheel cylinder is dismantled, the rubber cups must be replaced, even if these do not appear worn. Wear is usually shown as lines along the edge of the cup.

Before reassembling the cylinder, blow through the bleed valve and fluid entry ports. Make sure that the bleed valve itself is free from dirt.

When the cylinder parts are re-assembled, they should all, including the bore, be lubricated with V.W. brake cylinder paste or brake fluid. The upstream end must be taken to prevent any dust or grit of any kind adhering to the metal surfaces.

DISC BRAKE PADS

The disc brake pads must be replaced when they are worn down to a thickness of 2 mm or when they become oily or cracked. The thickness can be checked by looking in at the back of the caliper (Fig. K 30). All 4 pads must always be changed at the same time.

Removal

1. Check that the brakes are thoroughly cooled down.
2. Raise and support the front of the vehicle and remove the front wheels.
3. Use a suitable punch to drive out the 2 pins which locate the pads (Fig. K 31).
4. Pull the pads out of the back of the caliper (Fig. K 32). The pins holes will provide a grip.

Installation

1. Force both pistons in the caliper back into the housing so that there is room for the pads to be inserted (Fig. K 33).

NOTE: There is a likelihood that the brake fluid reservoir will overflow when this is done, due to fluid being forced back into it. To avoid this happening, syphon off some of the fluid from the reservoir using a plastic bottle with a thin spout.
2. Remove the piston retaining plates and clean out the pad apertures and other parts. Use methylated spirit and a small stiff brush. Other solvents must NOT be used.
3. Reassemble the piston retaining plates. They are shaped so that they engage with the piston. If they do not do so, the position of the piston should be corrected by rotating it (Fig. K 34).
4. Insert the pads and then drive in the 2 locating pins (Fig. K 36). These pins should not be driven in too far, as they drive with the faces of a hammer; do not use a punch which might damage them too far.
5. Depress the brake pedal several times so that the pads and other parts take up their proper operating positions. Check the level in the brake fluid reservoir and top-up if necessary.

DISC BRAKE CALIPERS

The brake pads are held on either side of the disc in a housing called the caliper. This caliper is attached to the steering knuckle by two bolts.

Removal

1. Raise and support the front of the car and remove the front wheels.
2. Check that the brake calipers have cooled down properly.
3. Lever up the locking tabs and unscrew the two hexagon screws which attach the caliper to the steering knuckle (see Fig. H 8).
4. Slide off the caliper. Support it on a piece of wire so that the brake hose is not stretched (Fig. K 37).

Overshauling (Fig. K 38)

1. Remove the brake pads and the piston retaining plates.
2. Hold the caliper in a vice with soft jaws and lever out the seal spring ring (Fig. K 39).
3. Lower out the seal with something like a plastic rod (Fig. K 40). A metal instrument must NOT be used.
4. Push out one piston. To do this, the other piston must be clamped in position and compressed air must be pumped in the brake hose hole to force the free piston out. The pistons can only be dealt with one at a time like this as the fluid passages are continuous.
5. Remove the rubber seal with a soft instrument.
6. Clean all the parts, using only methylated spirit or brake fluid.
7. Check the cylinders for damage. If any is apparent, the whole caliper must be replaced.
8. Coat the piston and the rubber seal with brake assembly paste or brake fluid and insert them, taking great care that the piston does not tilt. It should be driven in slowly with a clamp.
1. Raise and support front of car and remove the front wheels.
2. Remove the brake calliper as described above.
3. Remove the speedometer cable circlip on the left hand side and unscrew the nut (note the left hand thread on the left side).
4. Loosen the socket screw in the wheel bearing clamp nut and unscrew the nut (note the left hand thread on the left side).
5. Remove disc complete with wheel bearings.
6. Support the calliper as shown to prevent strain on the hose.

Installation
1. Install the disc and bearings and then adjust the bearing (see section on Front Suspension).
2. Check the run-out of the disc with a dial gauge (Fig. K 41). The play should be checked as severe wear around the circumference and should not exceed 0.2 mm (0.008 in). If the run-out exceeds this figure, the disc must be replaced.
3. Install the brake calliper at described previously.

BRAKE DISCS
It is essential that the brake discs run true and that their surface is in good condition. It is essential to replace the brake pads at the correct time in order to prevent the discs becoming scored. Cracked discs must be replaced. Scored discs can be re-machined, providing that the overall thickness does not come below 8.5 mm after machining.

Removal
1. Lift the matting on the bulkhead behind the pedals and wedge it up out of the way.
2. Lift up the sound-proofing felt around the battery area.
3. Operate the brake pedal several times to allow the parts to take up their correct operating positions.

Installation
1. Place the caliper in position and tighten the mounting bolts to the correct torque. NOTE: new bolts and locating plate MUST be used.
2. Insert the brake pads.
3. Operate the brake pedal several times to allow the parts to take up their correct operating positions.

BRAKE PIPES
The brake lines carry the hydraulic fluid from the master cylinder to the floor wheel cylinders. These come off the front end of the master cylinder; two pass to the front wheels and the other passes down inside the car to the rear wheels. On vehicles with dual circuit brakes, two pipes leave the front of the master cylinder, one for the front brakes and one for the rear. Because the wheels can move relative to the rest of the car, completely solid lines would snap. Short lengths of flexible rubber hose connect the ends of the lines to the wheel cylinders.

Removal
1. Remove front and rear seats and all material from the interior of the car.
2. Lift the matting on the bulkhead behind the pedals and wedge it up out of the way.
3. Lift up the sound-proofing felt around the battery area.
4. Jack up the offside of the car, secure it on supports and remove both offside wheels.
5. Undo the union at either end of the line (11 mm).
**BLEEDING THE HYDRAULIC SYSTEM**

When any part of the hydraulic braking system is disconnected, air gets into the system. This will make the brakes less effective and reduce their efficiency. To overcome the trouble, the system must be bled, i.e. the air bubbles must be eliminated.

It is usually essential to have two people to do this job; one of them has little to do except sit in the driver’s seat and pump the brake pedal so a high degree of mechanical ability is not called for in the assistant.

You will require a 7 mm open ended spanner, a length of plastic or rubber tube (clear plastic is best) about \(49^\prime\) (1 1/2 inch) in diameter and a small glass jar.

In addition to this a sufficient supply of new hydraulic fluid will be required. You will need much more than you expect. Although the system only holds a given amount, you cannot keep on filling the reservoir from the jar or this fluid which has been pumped out of the system will be dirty and, more important, full of air bubbles which you are trying to eliminate. Make sure then that you have a good supply of new fluid (make sure that it is the recommended good quality fluid) and keep the reservoir topped up during the whole operation. If the reservoir level falls too low, more air will be sucked in. The method shown in Fig. K.44 is ideal.

1. Fill reservoir with new fluid if it is not already full.
2. Remove the rubber dust cap from one of the bleeder valves on the back of the brake drum. Clean around the valve.
3. Pour a little or so of clean fluid into the jar. Press the plastic tube tightly on to the valve and let the outer end dip below the surface of the fluid in the jar. Try to hold the jar so that the fluid level is higher than the valve.
4. Using the 7 mm spanner, undo the valve about one turn. If the assistant now presses the pedal, fluid should shoot along the tube and into the jar. If not, the valve has not been unscrewed sufficiently.
5. When the valve has been undone so that fluid can be ejected, have the assistant press the pedal fully into the floor and let it return to its normal position under its own power. This should be repeated until it is quite obvious that the fluid which is being ejected contains no air whatsoever.
6. When the correct stage has been reached, ask the assistant to hold the pedal down and then fully tighten the valve. This process can then be repeated for each of the other three wheels. Follow the order shown in Fig. K.45. Vehicles with dual circuit systems follow order: right rear, left rear, right front, left front.

**IMPORTANT :** Never let the fluid level in the reservoir fall too low. Don’t keep the old fluid. There are those who attempt to strain and reduce it after the air has been bubbled off. This is a false economy. Remember, the braking system is the most important part of the car, and, apart from anything else, old fluid tends to have absorbed water and this will boil under heavy braking and also cause corrosion.

**HAND-BRAKE CABLES**

The two hand-brake cables serve as a link between the lever in the car and the operating levers in the two rear drums. The drum end has an eye which hooks on to the operating lever, whilst the front end has a threaded portion. Most of the cable is bare and passes through a conduit in the backbone; the last couple of feet have an outer sleeve.

The cable is liable to stretch; this can be taken up by adjusting the nut and lock nut on the threaded end of the cable at the hand-brake lever.

If one cable snaps, the other should be quite sufficient to hold the car under most conditions, but replacement should be fairly rapid or the car will be unbalanced. Most of the cable is bare and passes through a conduit in the backbone; the last couple of feet have an outer sleeve.

The cable is liable to stretch; this can be taken up by adjusting the nut and lock nut on the threaded end of the cable at the hand-brake lever.

If one cable snaps, the other should be quite sufficient to hold the car under most conditions, but replacement should be fairly rapid or the remaining cable will be strained.

**Removal**

1. Wedge the rear wheel of the opposite side. Release hand-brake level. Undo the two nuts on the threaded end of the cable.
2. Remove rear brake drum, making sure that the shoes have been fully released from their normal position by the adjuster ratchets.

**NOTE :** From this point, the rubbing surface of the drum and the shoes is exposed. Contamination by oil or grease must be avoided.

3. Allow the shoes to hang away from the brake-plate. Wrap a piece of wire around the wheel cylinder to prevent the pistons expending. 
The cable nuts and brake drum can now be replaced.

3. Prise off the circlips which locate the pivot rod.

4. Slide the rubber boot up the lever, out of the way.

6. Rhoroughly grease the cable. From now on, it will be difficult to ensure that the greasy cable does not pick up dirt and so it should remain in place; if they slip out, they are easily replaced.

3. Pass the cable into the conduit. In order to attach the forward end of the cable, it may be necessary to dismantle the hand-brake lever.

4. Dismantle the part which locates the end of the cable sleeve in the back-plate. Unhitch cable from operating lever and pull out from the conduit.

Installation

Effect of Cold Weather

The simplest way of testing a battery is to use a hydrometer. This is simply a spring which can suck up some of the electrolyte of each cell and measure its specific gravity (relative density) with a scale. Suction from the thermally simply indicates discharged, partially charged or fully charged whilst others are marked in millimetres. One point: remember that the hydrometer has been dipped in acid. Don't put it down anywhere. An old jar to stand it in is best.

Damage by Acid

Whilst the sulphuric acid in a battery is dilute, it can still be very dangerous. If it is splashed on the body, and gets into the eyes, wash it off immediately with copious quantities of water. If any on the clothes, remove them immediately, after washing and rinsing them in water. In the case of the eyes, wash them with plenty of water. If any on the clothes, remove them immediately, after washing and rinsing them in water. If any of the fluid is swallowed, give copious quantities of water immediately. Do not attempt to induce vomiting. Do not attempt to relieve thirst by drinking vinegar, lemon juice or any other acid solution. Do not attempt to replace a cell with water if it is not quite suitable.

Lack of Use

If the battery is left in a discharged state for very long (a few weeks), a process called sulphation occurs. This means that lead sulphate is deposited on the plates. Once this has occurred, the battery is useless. If you have a battery which you know will not be charged for some time, it must be kept topped up and charged at intervals.

Calculation can occur even if the car is used regularly. If the supply of current from the generator is too low, the battery may suffer because fully charged and sulphation can slowly occur. This will not occur if the generator output is correct, the regulator set properly and the battery's efficiency. This is because a chemical action is going on inside it and the rate of the action varies as the temperature drops. For example, the battery efficiency at 70 degrees Fahrenheit (20° C) is twice that at 5 degrees Fahrenheit (-15° C). This makes it very necessary to keep the battery in a good state of charge during the winter months.

Electrical Equipment

HEADLAMPS — Removal & Installation

BRAKE LIGHTS

HORN

STEERING COLUMN SWITCH ASSEMBLY

FLASHER RELAY

SPEEDOMETER AND FUEL GAUGE

SPEEDOMETER CABLE — Replacement

Testing

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1. Generator with voltage regulator
   - Bosch
2. Generator with voltage regulator
   - VW
3. Generator without voltage regulator
   - Bosch
4. Generator pulley
5. Spacer washer for pulley
6. Fan belt
7. Mounting strap
8. Nut
9. Bolt
10. Pulley mounting nut
11. Special washer
12. Armature
13. Armature
14. Armature
15. Woodruff key
16. Ball bearing
17. Locking ring
18. Oilslinger
19. Oilslinger
20. Spring washer
21. Spacer washer
22. Distance ring
23. Field coil
24. Field coil (later models)
25. Field coil
26. Field coil
27. Field coil
28. Field coil
29. Screw
30. Armature cable
31. End plate for brushes
32. End plate for brushes
33. End plate for brushes
34. Carbon brush
35. Carbon brush
36. Carbon brush
37. Slip ring
38. Slip ring
39. Screw
40.lock washer
41. Screw
42. Brush spring
43. End bracket
44. End bracket
45. End bracket
46. Oil slinger
47. Throat ring
48. Thrust washer
49. Thrust washer
50. Cup washer
51. Bolt
52. Bolt
53. Bolt
54. Bolt
55. Oilslinger
56. Felt gasket
57. Retaining ring
58. Voltage regulator
59. Voltage regulator
60. Voltage regulator
61. Lock washer
62. Screw
63. Spring washer
64. Tapping screw

Fig. L.1. Exploded view of the various types of generators fitted.

Fig. L.2. Location of the screws securing the generator and fan assembly to the fan housing.

Fig. L.3. If cooling slots (A) are present, install the generator with the slots facing downwards.

Fig. L.4. Charging system test circuit.

Fig. L.5. Generator no-load test circuit.

Fig. L.6. Testing the generator field coils with an ohmmeter.

Fig. L.7. Testing the insulation of the field coils.

Fig. L.8. Testing the armature on a 'growler'.

Fig. L.9. Connections for polarizing the generator.

Fig. L.10. Regulator location on Karman-Ghin models.
1. Remove the armature, and the fan belt.
2. Remove the large diameter flexible pipe which connects the fan housing to the heat exchangers.
3. Remove the screw at either side of the fan housing.
4. On 1100 and 1600s, remove the rod which connects the two sets of air control flaps behind the fan housing.
5. Lift the fan housing and remove the four screws which attach the fan assembly to it (Fig. L 1).
6. Remove the generator mounting strap and take off the generator.

Installation
This is a reversal of the above procedure, but bear the following points in mind:
1. Check that the generator and crankshaft pulleys are in line.
2. Check fan belt tension.
3. Check that the generator and crankshaft pulleys are in line.

Replacement of the Brushes
This can be done with the generator installed in the car, but it is then difficult to reach the lower brushes. If necessary, remove the generator first.
1. Remove the slotted screw which secures the connecting tag on the brush. Take care not to drop the screw and washer into the generator.
2. Use fine pliers to pull back the brush spring and then remove the brush.
3. Remove the remaining half of the pulley from the spindle. Take care not to lose the keys for fan and pulley.
4. Do not forget to insert the keys for fan and pulley.

Polarizing
If the armature or field coils have been replaced, it is necessary to ensure that the generator has the correct polarity by connecting it to a battery and testing it for a few seconds as a motor.

To do this, the negative terminal of the battery must be connected to both terminal DF on the connector block and to D+ (the screw on the casing), and the positive terminal of the battery must be connected to DV on the connector block.

REGULATOR
The regulator cannot be repaired except with very specialised equipment. If it fails, it must be replaced with an exchange unit.

Position
Karmann Ghia and 181 — on bolted in engine compartment (Fig. L 10).
Beetle — under rear seat.

Before disconnecting the regulator, the negative cable to the battery MUST be disconnected and the motor must not be running.

Installation
Note the following connections:

Generator

<table>
<thead>
<tr>
<th>D-</th>
<th>to</th>
<th>D+</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-</td>
<td>to</td>
<td>D+</td>
</tr>
</tbody>
</table>

In addition, terminal B+/51 on the regulator is connected to the positive terminal of the battery and terminal 61 on the regulator is connected to the generator warning lamp in the speedometer.

STARTER MOTOR (Fig. L 13)
The starter motor is mounted alongside the gearbox and is secured by the right hand upper engine mounting bolt and a stud which projects from the bell housing.

Brush replacement can only be accomplished when the motor is removed.

Removal
1. Raise the side of the car and remove the rear wheel.
2. Disconnect the negative cable at the battery.
3. Push back the flexible heater pipe near the starter motor.
4. Pull off the thicker cable from the terminal on the motor solenoid.

Assembly
Check the condition of the bearings. They should spin freely and without noise. Check out the inside of the casing with a small brush.

Note the following points:

1. Lift out the brushes so that the commutator end of the armature can be inserted into the end plate.
2. The end plates have grooves which engage with projections on the casing.
3. Check that the armature spins very freely.
4. Do not forget to insert the keys for fan and pulley.
Fig. L.11. Removing the regulator (where fitted to generator).

Fig. L.12. Regulator connections.

Fig. L.14. Removing the brush holder plate from the starter motor.

Fig. L.15. Removing/installing the starter motor end cap.

Fig. L.16. Removing the solenoid connecting link.

Fig. L.17. Removing the solenoid retaining screws.

Fig. L.18. Check dimension "a" before fitting the solenoid.

a = 19 +/- 0.1 mm. (0.748 +/- 0.004 in.).

Fig. L.19. Engaging the solenoid pull-rod in the actuating lever.

Fig. L.20. Seal the starter motor at the points indicated during assembly.

Fig. L.21. Removing the starter motor drive pinion stop ring.

Fig. L.22. Wiper arm clamp screw (Late models have a splined spindle.)

Fig. L.23. Removing the wiper motor and mounting bracket.

Fig. L.24. Wiper arm connecting rod detached on Type 181 models.

Fig. L.25. Location of the wiper motor cable clip.

Fig. L.26. Wiper motor and mounting bracket.

Fig. L.27. Removing the headlamp retaining screw.

Fig. L.28. Detaching the connector block on sealed-beam units.
a. Distance between headlamp centres
Type 1 — 31.1 in. (790 mm.)
Type 2 — 31.1 in. (790 mm.)

b. Headlamp centre from ground level
Type 1 — 18 in. (460 mm.)
Type 2 — 18 in. (460 mm.)

c. Distance between headlamp centres
(as for asymmetrical low beam lamps)

Fig. L.30. Exploded view of the asymmetrical type headlight unit.

Fig. L.31. Headlight alignment diagram for asymmetrical type headlight units.

Fig. L.32. Headlight alignment diagram for sealed-beam type headlight units.

5. Unscrew the nut on the other terminal and take off the cable.
6. Remove the nut from the lower mounting stud.
7. Remove the nut from the upper engine mounting bolt on that side (as in the engine compartment). The motor is heavy and it must be supported carefully as it is lifted down.

Installation

Installation Note the following points:

1. Lubricate the bush in the bell housing with grease.
2. Put some sealing compound around the joint between starter and bell housing.
3. Check that the connections are both clean and tight.

STARTER SOLENOID

This cannot be serviced and if it becomes defective, it must be replaced.

Removal

1. Pull the starter motor spindle as far out of the motor as it will go.
2. The solenoid can now be pulled away from the bracket on the motor and its pull rod can be unhooked from the operating lever. (Fig. L.17).

Installation

Check the following points:

1. Check the condition of the rubber gasket between motor bracket and solenoid. It must be properly seated.
2. Put sealing compound around the joint (Fig. L.20).
3. Pull the spindle right out of the motor to allow the solenoid pull rod to be hooked on (Fig. L.19).

HEADLAMPS

European Beetle Headlamps are of the pre-focus type employing a bulb unit (Fig. L 27).

The headlamp bulb can be removed once the securing flange and spring have been rotated.

The headlight bulb can be removed after taking off the steering wheel (see section on steering). The wires should be pulled off the various terminals behind the instrument panel after first disconnecting the battery and noting their position.

THE HEADLAMP UNIT IS HELD IN PLACE BY A SERIES OF SPRING CLIPS WHICH MUST HAVE BEEN ROTATED SLIGHTLY AND THEN PULLED OUT.

Faulty units should be exchanged.

FLASHER RELAY

The flasher relay is installed on the shelf of relay sockets which can be seen behind the fuse box, once the cover over the rear of the instrument panel has been removed.

The relay cannot be serviced and if it proves defective it must be replaced.

It should be pointed out that these components are very reliable and faults in the flashing system are much more likely to be due to poor connections or earthings at the lamps themselves.

SPEEDOMETER AND FUEL GAUGE

The combined speedometer / fuel gauge is attached to the instrument panel by two screws. Once these have been loosened, the unit can be rotated slightly and then pulled out through the luggage compartment.

Faulty units should be exchanged.
**SPEEDOMETER CABLE**

The speedometer is driven by a cable from the left hand front wheel.

**Removal**
1. Remove the hub cap and snap off the circlip which locates the end of the cable.
2. Unscrew the upper end of the cable from the speedometer and pull the cable out from this end.

**Installation**
1. Check that the cable does not foul the track rod.
2. Ensure that the tachometer cable is correctly fitted into the speedometer.

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**Technical Data**

**Electrical System**
- **Voltage**: 6 volts
- **Battery Capacity**: 6 volt type 66 Amp./hr; 12 volt type 36 Amp./hr

**Charging System**
- **Generator/Regulator**
  - **1200 (6V)**: 111 903 021 H (Bosch), 111 903 021 F (VW)
  - **1300, 1500, 1600 from Aug. 1967**: 311 903 023 A (Bosch), 311 903 023 B (VW)
  - **from March 1970**: 311 903 023 C (Bosch)

**Starter Motor**
- **Type**: Nominal Output
  - **1200 (6V)**: 111 911 021 E (Bosch) 0.5 BHP, 111 911 021 F (VW) 0.5 BHP
  - **1300, 1500, 1600 from Aug. 1967**: 311 911 023 A (Bosch), 311 911 023 B (VW)
  - **from Aug. 1969**: 311 911 023 C (Bosch)
  - **from March 1970**: 311 911 023 D (Bosch)

**Automatic Trans. Models**: 003 911 023 A (Bosch) 0.8 BHP

**Bulb Application Chart**
- **Front**:
  - Headlights: 40-45 watts
  - Parking lights: 4 watts
  - Direction indicator lights: 21/5 watts
- **Rear**:
  - Stop/tail lights: 21/5 watts
  - Brake/steer/tail lights (type 141): 2 watts
  - Direction indicator lights: 21 watts
  - License plate light (diesel): 10 watts
  - License plate light (Type 141): 5 watts
  - License plate light (Karmann-Ghia): 5 watts
  - Reversing lights: 25 watts
  - Rear fog light (Type 141): 16 watts
- **Interior**:
  - Warning lights: 1.2 watts
  - Panel lights: 1.2 watts

---

**WIRING DIAGRAM FOR SALOON MODELS WITH 6 VOLT SYSTEM**

(Sealed-beam Headlamps)

- **A** Battery
- **B** Starter
- **C** Generator
- **D** Ignition-starter switch
- **E** Windshield wiper switch
- **F** Light switch
- **G** Turn signal switch
- **H** Horn and emergency light switch
- **I** Door contact switch, left
- **J** Door contact switch, right
- **K** Windshield wiper motor
- **L** Stop, turn signal and taillight, left
- **M** Stop, turn signal and taillight, right
- **N** License plate light
- **O** License plate light
- **P** License plate light
- **Q** License plate light
- **R** Ignition distributor
- **S** Oil pressure sending unit
- **T** Automatic transmission

---

**BULB APPLICATION CHART**

Front:
- Headlights: 40-45 watts
- Parking lights: 4 watts
- Direction indicator lights: 21/5 watts

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- Rear fog light (Type 141): 16 watts

Interior:
- Warning lights: 1.2 watts
- Panel lights: 1.2 watts.
## Trouble Shooting

### Engine

#### Symptoms

<table>
<thead>
<tr>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE WILL NOT CRANK</td>
</tr>
<tr>
<td>ENGINE CRANKS SLOWLY</td>
</tr>
<tr>
<td>ENGINE CRANKS BUT DOES NOT START</td>
</tr>
<tr>
<td>ENGINE STOPS BUT RUNS FOR SHORT PERIODS ONLY</td>
</tr>
<tr>
<td>ENGINE MISFires AT LOW SPEED</td>
</tr>
<tr>
<td>ENGINE MISFires AT HIGH SPEED</td>
</tr>
<tr>
<td>ENGINE MISFires AT ALL SPEEDS</td>
</tr>
<tr>
<td>ENGINE MISFires ON ACCELERATION AND FAILS TO REV.</td>
</tr>
<tr>
<td>ROUGH IDLE</td>
</tr>
<tr>
<td>RUNS ROUGH AT HIGH SPEED</td>
</tr>
<tr>
<td>LACK OF POWER</td>
</tr>
<tr>
<td>POOR ACCELERATION</td>
</tr>
<tr>
<td>LACK OF TOP SPEED</td>
</tr>
<tr>
<td>EXCESSIVE FUEL CONSUMPTION</td>
</tr>
<tr>
<td>EXCESSIVE OIL CONSUMPTION</td>
</tr>
<tr>
<td>PINKING</td>
</tr>
<tr>
<td>COMPRESSION LEAK</td>
</tr>
</tbody>
</table>

#### Probable Cause

- Fault in the starting system - Refer to the ELECTRICAL EQUIPMENT section for diagnosis.
- Engine oil too thick.
- Stiff engine.
- Mechanical seizure.
- Fault in the ignition system - Refer to the IGNITION SYSTEM section for diagnosis.
- Fault in the fuel system - Refer to the FUEL SYSTEM section for diagnosis.
- Incorrect valve timing.
- Compression leak.
- Leak or restriction in the exhaust system.
- Poor valve seating.
- Sticking valves.
- Leaking cylinder head gasket.
- Worn camshaft lobes.
- Incorrectly installed spark plug.
- Cracked cylinder.
- Broken or weak valve springs.
- Worn or damaged cylinder bores, pistons and/or piston rings.
- Worn valve guides.
- Damaged valve stem seals.
- Leaking oil seal or gasket.
- Faulty oil pressure gauge, switch or wiring.
- Oil pickup pipe restrictor blocked.
- Oil filter over-flow valve defective.
- Worn oil pump.
- Leaking or worn main and/or big-end bearings.
- Incorrect grade of engine oil.
- Oil level too high.
- Oil leak or the pressurised side of the lubrication system.
- Incorrectly installed spark plug.
- Replace plug with correct one.
- Cracked cylinder.
- Broken or weak valve springs.

#### Remedies

- Drain oil and replace with correct oil.
- Add small quantity of oil to the fuel and run engine gently.
- Strip engine and renew parts as necessary.
- Retime engine.
- Trace and seal.
- Trace and seal.
- Remove restriction.
- Remove restriction.
- Replace seals.
- Replace valve guides.
- Replace spark plugs.
- Replace spark plugs.
- Renew cylinder block.
- Replace spark plugs.
- Replace oil with correct grade.
- Top up oil.
- Drain off surplus oil.
- Trace and remedy.

### Lubrication System

#### Symptoms

<table>
<thead>
<tr>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCESSIVE OIL CONSUMPTION</td>
</tr>
<tr>
<td>LOW OIL PRESSURE</td>
</tr>
</tbody>
</table>

#### Probable Cause

- Worn or damaged cylinder bores, pistons and/or piston rings.
- Worn valve guides.
- Damaged valve stem seals.
- Leaking oil seal or gasket.
- Faulty oil pressure gauge, switch or wiring.
- Oil pickup pipe restrictor blocked.
- Oil filter over-flow valve defective.
- Worn oil pump.
- Leaking or worn main and/or big-end bearings.
- Incorrect grade of engine oil.
- Oil level too high.
- Oil leak or the pressurised side of the lubrication system.

#### Remedies

- Regrind cylinder bores and fit new oversize pistons and rings.
- Replace valve guides.
- Replace oil seals.
- Replace seals.
- Seal leak or replace gasket.
- Trace and rectify.
- Check and rectify if necessary.
- Replace oil pump.
- Check and rectify if necessary.
- Replace oil pump or parts.
- Replace oil with correct grade.
- Top up oil.
- Drain off surplus oil.
- Trace and remedy.

### Cooling System

#### Symptoms

<table>
<thead>
<tr>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE</td>
</tr>
</tbody>
</table>

#### Probable Cause

- Insufficient coolant.
- Drive belt slipping or broken.
- Radiator fins clogged.
- Cooling fan defective.
- Water pump defective.
- Thermostat jammed shut.
- Thermostat jammed open.
- Ignition timing too far retarded.
- Excessive vehicle load or dragging brakes.
- Internal passage in the engine and/or radiator blocked.
- Hoses blocked.
- Cooling system not pressurised.
- Drain all coolant.
- Insufficient engine oil or use of inferior grade of oil.
- Excessive radiator area.

#### Remedies

- Top up radiator.
- Tighten belt or renew.
- Replace water pump.
- Replace water pump.
- Replace thermostat.
- Replace thermostat.
- Replace thermostat.
- Replace thermostat.
- Unload car, check brakes.
- Trace and clear.
- Trace and clear.
- Top up radiator.
- Insufficient coolant.
- Top up with correct grade.
- Drain if necessary.
- Partially blank off in winter only.
Trouble Shooting

Ignition System

**SYMPTOMS**

<table>
<thead>
<tr>
<th>abcdefghijklmnopr</th>
<th>abcdefghijklmnopr</th>
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<tbody>
<tr>
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<tr>
<td>ENGINE STARTS BUT RUNS FOR SHORT PERIODS ONLY</td>
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<td>EXCESSIVE FUEL CONSUMPTION</td>
</tr>
<tr>
<td>PINNING</td>
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</tr>
</tbody>
</table>

**PROBABLE CAUSE**

- Battery discharged or defective.
- Contact breaker plate not dusting or warping.
- Loose or broken sparking plug leads.
- Spark plugs not cleaning or renewing.
- Incorrect spark plug gaps.
- Contact breaker points need cleaning or renewing.
- Con|act breaker spring weak.
- Contact breaker points not adjusting correctly.
- Incorrect ignition timing.  
- Carburettor needle valve jammed.
- Erratic fuel flow due to blockage.
- Air leak at intake manifold.
- Insufficient air supply.
- Air filter clogged.
- Incorrect ignition timing.
- Carburettor piston sticking.
- Wrong carburettor jets fitted.
- Carburettor icing.
- Backfire

**REMEDIES**

- Replace as necessary.
- Clean or renew.
- Retime ignition.
- Fit correct plugs.
- Adjust gaps.
- Adjust contact breaker set.
- Clean or renew plugs.
- Renew contact breaker set.
- Fit correct points.
- Clean with dry lint free rag.
- Connect correctly.
- Adjust correctly.
- Check and rectify.
- Replace defective parts.
- Change to correct grade of fuel.

**Fuel System**

**SYMPTOMS**

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<tr>
<th>abcdefghijklmnopqrstuvwxyz</th>
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</tbody>
</table>

**PROBABLE CAUSE**

- Fuel tank empty.
- Fuel line blocked.
- Fuel pump defective.
- Blockage in carburettor.
- Air leak in fuel line.
- Fuel filter blocked.
- Carburettor needle valve jammed.
- Water in carburettor.
- Erratic fuel flow due to blockage.
- Idling speed too low.
- Incorrect setting of choke control.
- Incorrect carburettor fuel/air level.
- Carburettor icing.
- Air leak at intake manifold.
- Incorrect grade of fuel.
- Carburettor accelerator pump defective.
- Throttle linkage mal-adjusted.
- Incorrect adjustment of idling mixture.
- Air filter clogged.
- Incorrect ignition timing.
- Carburettor piston sticking.
- Wrong carburettor jets fitted.

**REMEDIES**

- Fuel tank.
- Blow out obstruction with compressed air.
- Replace pump.
- Remove blockage.
- Change to correct grade of fuel.
- Clean or renew.
- Adjust correctly.
- Check and rectify.
- Replace defective parts.
- Fit correct points.
- Clean or renew.
- Adjust correctly.
- Check and rectify.
- Replace defective parts.
- Change to correct grade of fuel.
- Examine and oil sparingly.
- Adjust throttle stop screw.
- Adjust or renew.
- Retime ignition.
- Replace defective parts.
- Examine and oil sparingly.
- Adjust or renew.
- Adjust or renew.
- Adjust or renew.
- Adjust throttle stop screw.
- Adjust correctly.
- Change to correct grade of fuel.
- Check and rectify.
- Replace defective parts.
- Fit correct points.
- Clean or renew.
## Trouble Shooting

### Steering

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLUTCH SLIPPING (WILL NOT ENGAGE PROPERLY)</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH DRAG (WILL NOT DEENGAGE PROPERLY)</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH JUDDER</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH GRAB (ON ENGAGEMENT)</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH NOISE - SQUEAL WHEN DEPRESSING THE PEDAL</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH NOISE - RATTLE WHEN IDLING</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>CLUTCH NOISE - CRATCH ON ENGAGEMENT</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
</tbody>
</table>

#### PROBABLE CAUSE

| a. | Insufficient free-play in release linkage. |
| b. | Clutch disc facing worn or hardened. |
| c. | Corrosion or oil on clutch disc facing. |
| d. | Weak or broken pressure plate coil springs or diaphragm spring. |
| e. | Air in hydraulic system. |
| f. | Incorrect adjustment of clutch pedal. |
| g. | Excessive freeplay in release linkage. |
| h. | Misalignment of clutch housing. |
| i. | Clutch disc bush binding on retainer gear box input shaft. |
| j. | Clutch disc faci ng loose or broken. |
| k. | Pressure plate making surface warped. |
| l. | Clutch plates damaged. |
| m. | Losses in transmission or suspension. |
| n. | Clutch disc distorted. |
| o. | Pressure plate making surface warped. |
| p. | Insufficient free-play in release linkage. |

#### REMEDIES

| a. | Adjust linkage. |
| b. | Replace clutch disc. |
| c. | Clean and adjust release mechanism. |
| d. | Renew springs. |
| e. | Bleed system. |
| f. | Adjust travel. |
| g. | Adjust or renew worn parts. |
| h. | Adjust release mechanism. |
| i. | Remove cause of binding. |
| j. | Replace clutch disc. |
| k. | Fit new parts. |
| l. | Replace cover. |
| m. | Take up play. |
| n. | Renew clutch disc. |
| o. | Renew bearing. |
| p. | Renew release mechanism. |
| q. | Top up hydraulic fluid. |

### Clutch

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>CLUTCH JUDDER</td>
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</tr>
<tr>
<td>CLUTCH GRAB (ON ENGAGEMENT)</td>
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</tr>
<tr>
<td>CLUTCH NOISE - SQUEAL WHEN DEPRESSING THE PEDAL</td>
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</tr>
<tr>
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</tr>
<tr>
<td>CLUTCH NOISE - CRATCH ON ENGAGEMENT</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
</tbody>
</table>

#### PROBABLE CAUSE

| a. | Adjust linkage. |
| b. | Replace clutch disc. |
| c. | Clean and adjust release mechanism. |
| d. | Renew springs. |
| e. | Bleed system. |
| f. | Adjust travel. |
| g. | Adjust or renew worn parts. |
| h. | Adjust release mechanism. |
| i. | Remove cause of binding. |
| j. | Replace clutch disc. |
| k. | Fit new parts. |
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| n. | Renew clutch disc. |
| o. | Renew bearing. |
| p. | Renew release mechanism. |

#### REMEDIES

| a. | Adjust linkage. |
| b. | Replace clutch disc. |
| c. | Clean and adjust release mechanism. |
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| f. | Adjust travel. |
| g. | Adjust or renew worn parts. |
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| m. | Take up play. |
| n. | Renew clutch disc. |
| o. | Renew bearing. |
| p. | Renew release mechanism. |

### Braking System

<table>
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<tr>
<th>SYMPTOMS</th>
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</thead>
<tbody>
<tr>
<td>BRAKE FAILURE</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>BRAKES INEFFECTIVE</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>BRAKES GRAB OR PULL TO ONE SIDE</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>BRAKES BIND</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>PEDAL SpongY</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>PEDAL TRAVEL EXCESSIVE</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>EXCESSIVE PEDAL PRESSURE REQUIRED</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
<tr>
<td>BRAKE SQUEAL DEVELOPS</td>
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</tr>
<tr>
<td>BRAKE SHUDDER DEVELOPS</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
</tr>
</tbody>
</table>

#### PROBABLE CAUSE

| a. | Brake fluid leak or brake fluid. |
| b. | Incorrect brake fluid. |
| c. | Air in the hydraulic system. |
| d. | Fluid leak in the hydraulic system. |
| e. | Flu0d line blocked. |
| f. | Incorrect brake fluid. |
| g. | Brake drums or discs scored. |
| h. | Insufficient brake fluid. |
| i. | Incorrect brake fluid. |
| j. | Inoperative brake fluid. |
| k. | Fluid line blocked. |
| l. | Incorrect brake fluid. |
| m. | Brake pads contaminated. |

#### REMEDIES

| a. | Replace master cylinder and seals. |
| b. | Renew or correct type. |
| c. | Adjust adjustment. |
| d. | Renew or install correctly. |
| e. | Bleed brake system. |
| f. | Check and replace hoses. |
| g. | Replace new. |
| h. | Replace master cylinder or caliper seal. |
| i. | Replace brake pedal. |
| j. | Replace brake pedal. |
| k. | Replace new parts. |
| l. | Replace master cylinder and seals. |
| m. | Replace locknut. |

### EXCESSIVE PEDAL PRESSURE REQUIRED

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
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<tbody>
<tr>
<td>BRAKE SQUEAL DEVELOPS</td>
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#### PROBABLE CAUSE

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| e. | Fluid line blocked. |
| f. | Incorrect brake fluid. |
| g. | Brake drums or discs scored. |
| h. | Insufficient brake fluid. |
| i. | Incorrect brake fluid. |
| j. | Inoperative brake fluid. |

#### REMEDIES

| a. | Replace master cylinder and seals. |
| b. | Renew or correct type. |
| c. | Adjust adjustment. |
| d. | Renew or install correctly. |
| e. | Bleed brake system. |
| f. | Check and replace hoses. |
| g. | Replace new. |
| h. | Replace master cylinder or caliper seal. |
| i. | Replace brake pedal. |
| j. | Replace brake pedal. |
| k. | Replace new parts. |
| l. | Replace locknut. |

### Excessive Pedal Pressure

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>abcdefghijklmnopqrstuvwxyz</th>
</tr>
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<tbody>
<tr>
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#### PROBABLE CAUSE

| a. | Brake fluid leak or brake fluid. |
| b. | Incorrect brake fluid. |
| c. | Air in the hydraulic system. |
| d. | Fluid leak in the hydraulic system. |
| e. | Fluid line blocked. |
| f. | Incorrect brake fluid. |
| g. | Brake drums or discs scored. |
| h. | Insufficient brake fluid. |
| i. | Incorrect brake fluid. |
| j. | Inoperative brake fluid. |

#### REMEDIES

| a. | Replace master cylinder and seals. |
| b. | Renew or correct type. |
| c. | Adjust adjustment. |
| d. | Renew or install correctly. |
| e. | Bleed brake system. |
| f. | Check and replace hoses. |
| g. | Replace new. |
| h. | Replace master cylinder or caliper seal. |
| i. | Replace brake pedal. |
| j. | Replace brake pedal. |
| k. | Replace new parts. |
| l. | Replace locknut. |

### Misalignment of the Brake Pedal

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<tbody>
<tr>
<td>BRAKE SQUEAL DEVELOPS</td>
<td>abcdefghijklmnopqrstuvwxyz</td>
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<tr>
<td>BRAKE SHUDDER DEVELOPS</td>
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#### PROBABLE CAUSE

| a. | Brake fluid leak or brake fluid. |
| b. | Incorrect brake fluid. |
| c. | Air in the hydraulic system. |
| d. | Fluid leak in the hydraulic system. |
| e. | Fluid line blocked. |
| f. | Incorrect brake fluid. |
| g. | Brake drums or discs scored. |
| h. | Insufficient brake fluid. |
| i. | Incorrect brake fluid. |
| j. | Inoperative brake fluid. |

#### REMEDIES

| a. | Replace master cylinder and seals. |
| b. | Renew or correct type. |
| c. | Adjust adjustment. |
| d. | Renew or install correctly. |
| e. | Bleed brake system. |
| f. | Check and replace hoses. |
| g. | Replace new. |
| h. | Replace master cylinder or caliper seal. |
| i. | Replace brake pedal. |
| j. | Replace brake pedal. |
| k. | Replace new parts. |
| l. | Replace locknut. |
Trouble Shooting

Electrical Equipment

SYMPTOMS

<table>
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<tr>
<th>a</th>
<th>b</th>
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<th>d</th>
<th>e</th>
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<th>g</th>
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<th>j</th>
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</thead>
<tbody>
<tr>
<td>Broken or loose drive belt.</td>
<td>Starter operates but does not crank engine.</td>
<td>Starter cranks engine slowly.</td>
<td>Starter not in operation.</td>
<td>Ignition warning light remains illuminated with engine at speed.</td>
<td>Ignition warning light fails to illuminate when ignition is switched on.</td>
<td>Ignition warning light stays on when run is switched on.</td>
<td>Lights dim or will not illuminate.</td>
<td>Bulbs blow frequently and battery requires frequent topping-up.</td>
<td>Diode. Indicators not functioning properly.</td>
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REMEDIES

<table>
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<th>a</th>
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<tr>
<td>a. Add a small quantity of oil to the fuel and run the engine.</td>
<td>b. Recharge or replace battery.</td>
<td>c. Trace and rectify.</td>
<td>d. Release pinion.</td>
<td>e. Replace defective parts.</td>
<td>f. Correct deflection.</td>
<td>g. Replace defective parts.</td>
<td>h. Adjust or replace.</td>
<td>i. Adjust or replace.</td>
<td>j. Replace unit.</td>
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### ENGINE TUNING DATA CHART

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<th>VOLKSWAGEN</th>
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#### ENGINE CHECK
- Compression Ratio
- Compression Pressure
- Valve Clearance - Inlet
- Valve Clearance - Outlet
- Oil Pressure
- Valves - Cylinder
- Output
- Road Horsepower
- Top Speed at 1000 rpm.
- Acceleration
- Carburettor

#### ELECTRICAL CHECK
- Battery Type/Polarity
- Ignition Coil
- Ballast Resistor
- Voltage at Terminal 15
- Coil with steady Current
- Primary Resistance at 20°C/68°F
- Distributor
- Dwell Angle
- Contact Breaker Gap
- Condenser Capacity
- Firing Order/Cylinder 1
- Timing mark location
- Ignition Timing - Static
- Stroboscopic Timing
- Stroboscopic at Idl. Speed
- Central Advance

#### SPARKPLUGS
- Make
- Type
- Degrees/%
- min. mm/in.

#### GENERATOR CHECK
- Starting Voltage
- Lockdraw
- Open Circuit
- Voltage Regulator
- Closed Circuit
- Current Regulator
- Cut-in Voltage
- Drop-off Voltage
- Reverse Current
- Idling Speed
- Fuel Pump Pressure
- Fuel Consumption
- Combustion Efficiency

---

**Note:** The content of the image appears to be a technical specification chart for Volkswagen Type 1 engines, detailed with various mechanical and electrical specifications including compression ratios, oil pressures, valve clearances, and electrical test parameters. The chart is comprehensive and technical, aimed at mechanics or enthusiasts familiar with automotive engineering.
### CONVERSION TABLE

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