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.

**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 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.

Breveness 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 'Work' series of handbooks.

SBN 901610 - 35 - 6

Although every car has been taken to ensure that the information and data are correct, WE CANNOT ACCEPT ANY LIABILITY FOR INNACCURACIES OR OMISSIONS, OR FOR DAMAGE OR MALFUNCTIONS ARISING FROM THE USE OF THIS BOOK, NO MATTER HOW CAUSED.
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CRANKSHAFT & CONNECTING RODS – Removal, Inspection & Installation
CRANKSHAFT END PLAY – Measurement
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7. Make sure that the jack supports the engine so that it is not hanging 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 unwind the vacuum unit out of the way. This whole operation presents few problems unless the engine compartment has been defaced by slight collision. This often happens after the benners have been knocked.

Semi-Automatic Cars

In addition to the above operations, disconnect the control valve cable, and the vacuum hose at the carburettor and manifold. Disconnect the oil pipe 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 (assemble when the engine is installed). After removing the engine, secure the torque converter so that it cannot move forwards.

Engine – Installation

This is a reverse of the removal procedure, but the following points must be noted:

1. Leave off the rear cover plate (over the silencer) until the engine is installed.
2. Make sure that the clutch plates are centred correctly.
3. Smear high melting point grease or molybdenum disilicide powder on the spline of the main shaft which projects from the gearbox.
4. Clean out the gearbox bell housing and lightly grease the starter pinion housing.
5. The engine must be carefully installed in the engine compartment. 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 gasket holes before the engine is slid forward.
6. The main shaft slides in better if a new seal is selected and the O-seal is locked with the fan belt. Tighten the upper mounting bolts first.

Semi Automatic models: Warning! Make sure that the converter drive plate screws are not dropped into the transmission case.
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 in 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 crankshaft 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 cylinders.
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 strainer.
22. Open the crankcase.
23. Remove camshaft and crankshaft with connecting rods.

FAN BELT

The fan belt drives both the generator and the fan. If it breaks, the red ignition warning light will come on. This condition must be investigated immediately and, if the belt is broken, the engine must not be allowed to run as it will rapidly overheat and seize.

The pulley on the generator is in two halves. When the pulley nut is removed, shafts can be taken from between the two pulley halves in order to loosen the gap between them so that the fan belt rides higher in the pulley groove. This section tightens the belt. If these shafts are taken from under the pulley nut and placed between the pulley halves, the belt will be slackened. The correct tension can be achieved in this way.

The tension is correct when a thumb placed halfway between the two pulleys can press the belt inward by about 15 mm (0.6”).

If the belt shows signs of fraying or cracking, it must be replaced.

FAN HOUSING

The shape of the fan housing allows the fan (clipped 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 1300 and 1600 models, remove the rod which connects the 2 sets of heat control flaps behind the fan housing. It is held on by self spring clips.
6. Remove the strap 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 engine 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.

Move the thermostat upwards so that the flaps in the fan housing are fully open. Move the bracket so that the top of the thermostat is mating against the top of the bracket. Lock the bracket in position. Then bolt the thermostat in place. In order to bolt the thermostat in place, it will have to be pulled downwards thereby clearing 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 will help before any work is carried out.

1. Remove the two wide bent flexible air pipes which can be seen inside the engine compartment. The clips at either end must be loosened.
2. Remove the pipe which carries pre-heated air to the air cleaner.
3. Remove the screws which retain the rear cover plate and remove it, having first removed the small sealing plates around the inlet manifold pre-heater pipe.
4. Remove the clamps which secure the silencer to the heat exchangers (10 mm).
5. Loosen the clamps which connect the small secondary 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 head (13 mm).
8. Pull the silencer backwards to free it.
9. It is usually possible to remove the tail pipe once the clamps are loosened, but they may be so firmly fitted that removal will damage either them or the silencer.

Installation
This is a reverse of the above operations, but the following points must be borne in mind:
1. It is well worth fitting the tail pipe first as they act as handles for positioning the silencer.
2. Fit the metal rings and asbestos gaskets to the heat exchangers.
3. Fit the upper exhaust flange gaskets into position.
4. Lift the silencer and slide it into position.
5. Replace two of the cylinder head nuts to hold the unit in position.
6. 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 holes do not line up at first, a small screwdriver can be used to lever them into position.
7. Fit the clamps over the silencer / heat exchanger joints, making sure that the metal rings and the asbestos gaskets are correctly positioned.
8. Tighten the four cylinder head nuts.
9. Replace the clamps between main and secondary heat exchangers.
10. Start engine and check for leaks. Tighten if necessary.
11. Replace the engine rear cover plate, ensuring that the rubber seal is correctly positioned.
12. Re-fit fresh air and pre-heater flexible hoses.

HEAT EXCHANGERS
Once the silencer has been removed, the heat exchangers are easily removed by undoing the two nuts on each front exhaust flange of the cylinder heads. It should be noted that it is almost impossible to do this job with the engine still in the car.
Fresh air is pumped 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.

The heater cables are attached to the control arm on the heat exchangers by clamps which involve a 9 mm screw and a 10 mm nut. The screw must be held whilst the nut is removed or the cable will be twisted.

The control arm on the side of the heat exchanger should be lubricated at its pivot point from time to time with oil.

OIL PUMP
The oil pump, driven off the back end of the crankshaft, draws oil through a filter screen from the sump and pumps it via a-sil oil cooler to the bearings. Some oil is pumped to the camshaft bearings and some passes up the hollow push rods to supply the valve gear. This oil drains back into the crankcase via the push rod tubes.

1. Remove the four nuts which secure the cover (10 mm on 1200, 13 mm on 1300 and 1600).
2. Remove the cover and the two gears.
3. Remove the body of the pump. It is usually a very tight fit in the crankcase. Unless you have the correct extractor, the only way to remove it is to prise it out gradually and evenly by a wide bladed screwdriver placed under the flange. Take great care not to fracture the flange.

Note: The semi-automatic model has a double pump, one section of which supplies the torque converter. One of the outer set of gaskets is beyond its drive shaft and this key must be removed before the plate behind it is pulled off.

Inspection
1. Backlash between gears must be 0 - 0.2 mm (0 - 0.008"")
2. Maximum clearance between gear and cover plate face of casing is 0.1 mm (0.004"") without the paper gasket.

Installation
Note the following points:
1. As the body of the oil pump is pushed in, care must be taken to centre it correctly.
2. Oil the interior of the pump and the gears.
3. Tighten the four cover retaining nuts evenly. DO NOT overtighten them.

OIL COOLER
The oil cooler is a small radiator which, until August 1970, sat on a flange on top of the crankcase and projected into the fan housing in the cooling air stream (Fig. A.38). 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 intermediate bracket has to be fitted.

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 coolers and vice versa by means of a special set of tapered gaskets, part no. 111 918 029.
Fig. A.25. Cylinder head nut tightening sequence. Left-hand: Stage 1, 1kgf (7 lb f). Right-hand: Stage 2, 3-6-3-5 kgf. (22-23 lb f.)

Fig. A.27. Valve seat width, dimension 'A', should be: Inlet valve: 1.3 + 1.6 mm. Exhaust valve: 1.7 + 2.0 mm.

Fig. A.26. Critical valve dimensions - Inlet & exhaust.

Fig. A.28. Exploded view of the lubrication system components

Fig. A.29. Location of the two oil pressure relief valves on later models.

Removal
1. Remove the screw at either side of the fan housing, undo the protractor mounting screw 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 10mm 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 specialized 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.

Installation

Note the following points:

1. Oil coolers which fit directly on to the crankcase flange require 2 plain cylindrical nuts. They must be new.

2. Oil coolers using an intermediate bracket use 2 stepped nuts between bracket end crankcase and two more between cooler and bracket. A3-4 must be new.

OIL STRAINER

The Beetle does not have an oil filter. Oil is merely strained through a wire gauze in the sump. The strainer is located above the sump plate which is bolted to the bottom of the crankcase (Fig. A.25).

Removal
1. Remove the 6 mm (10 mm) and washers. Allow the plate to drop downwards. It will be extremely heavy.

2. Ease off the strainer and the gaskets on either side of it. If the strainer jam on the six studs, lever it carefully so that it is not distorted.

Cleaning

The strainer can be cleaned in petrol or paraffin with a suitable brush.

Installation

Note the following points:

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

DISTRIBUTOR DRIVE SHAFT

The distributor drive shaft remains with a gear on the crankshaft and drives 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. It is virtually impossible to remove it with the engine in place unless one has access to W.V. extractor 228. Details of removal during engine strip-down are given below:

Removal
1. Remove the fuel pump.

2. Remove the nut and washer which locates the distributor clamp to the crankcase and pull out the distributor. It may be a little difficult due to the oil seal ring fitted half way down its shaft.

3. Remove the small coil spring which fits in at the top of the drive shaft.

4. 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.

A. Arrow towards flywheel
B. Piston pin bore side
C. Piston top indentation
D. Counterboring edge (blue, pink, green)
E. Part No. Identification mark
F. Details of weight grading
G. Details of piston diameter in millimetres

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

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

a = 10 +/- 1mm. (0.39 +/- 0.040 in.)
b = 6 +/- 1mm. (0.236 +/- 0.040 in.)

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.

1. Cover gasket
2. Oil strainer
3. Cover gasket
4. Bottom cover
5. Nut and washer
6. Drain plug and washer

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 too 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 fall off the crankshaft gear. Coat them very liberally with grease and slide them on to the shaft of the long screwdriver. Then put the screwdriver down the drive shaft passages and allow the washers to slide down it. They will land in position on their shaft and the gear and will allow you to judge 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 removing that 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 at 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 seating has an important effect on the life and performance of the engine.

Removal

1. Snap 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. A.16).
3. Unscrew the 8 cylinder head nuts.
4. Remove the four push-rods, receding their position.
5. Pull off the cylinder head, taking care that the cylinders are not pulled off with it. The push rod tubes will fall out.

Inspection

Inspect the cylinder head with particular attention to the following points:

1. There must be no cracks in the combustion chambers or around the exhaust ports. There should be no signs of leakage on the cylinder contact surface. If cracks or warping exist, the cylinder head must be reconditioned.
2. Examine the spark plug holes. Damaged threads can be repaired by fitting HV8 Copper inserts.

3. Valve guide wear should be minimal. One usually finds that the exhaust guide wears much more than the inlet.

If the wear is excessive, the head must be exchanged or new guides fitted. Maximum wear limit is 0.15 mm (0.006""). Sliding a clean smooth valve stem into the guide will give a good indication of the amount of wear.

The valve seats should not be burned. They can be re-cut, providing that the existing chamfer has not reached the edge of the insert.

Installation

1. Fit NEW sealing rings in the push rod tubes. Stretch the tubes a little by lengthening the conerouteria sections with the fingers (see Fig. A.25).
2. Slide the cylinder head into position so that the push rod tubes are held lightly. Check that they are neatly corrected. The welded stem on each tube should point UPWARDS.
3. Lightly grease the cylinder head nuts with graphite grease and loosely fit the 8 nuts and washers in position.
4. Tighten the B nuts in the sequence shown in Fig. A.25.
5. Slacken off all the valve clearances adjusting screws on the rockers and then refit the rocker shaft. Note that the slots in the supporting blocks face UPWARDS (Fig. A.17).
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 to the size, using valve grinding points.

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 item in the table:

Table:

<table>
<thead>
<tr>
<th>Valve</th>
<th>Exhaust valve seat diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 - 1.6 mm</td>
<td>1.7 - 1.8 mm (0.0595 - 0.0707&quot;)</td>
</tr>
</tbody>
</table>

The first cut is made with a 45 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 35 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 (0.0065"").

This is an important piece of maintenance. The engine MUST be cold when it is carried out.

1. Raise and support the back of the car and remove both rear axles (to give greater working access to the cylinder heads).
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 guard in the position in the distributor turns towards the rear on the rim of the distributor body and the notch in the crankshaft pulley lines up with the division in the crankcase (Fig. A47).

4. Loosen the lock nuts on the 2 valves of No. 1 cylinder (right hand side, towards front of car) and adjust the screws so that the gap is 0.1 mm (Fig. A46). Tighten the lock nuts without altering the setting.

5. Rotate the engine 180 degrees ANTICLOCKWISE. (Roter arm 90 degrees).

6. Adjust valves of No. 2 cylinder.

7. Rotate engine 180 degrees ANTICLOCKWISE. (Roter arm 90 degrees)

8. Adjust valves for No. 3 cylinder.

9. Both engine 180 degrees anticlockwise and reset valves of No. 4 cylinder.

10. Carefully clean around the valve cover seating face and, using NEW gaskets which have been centered into the covers with non-setting sealing compound, fit the covers.

**Cylinders**

The Beetle engine cylinders are made of cast iron and are liberally fitted. They fit into bores in the crankcase with a paper gasket between, and into bores in the cylinder heads without any gasket (Fig. A48).

**Removal**

1. Remove cylinder head and cylinder.

2. Number each piston. Try to avoid the bolt which is held by the metal is not scratched deeply. The metal willriuch gasket which way up they were fitted (Fig. A33).

3. Remove both lands on each piston and the air gap (Fig. A34).

4. Support the piston and cylinder by suitable tools.

Carefully remove the piston pins, noting which way up and in which order they were fitted. If necessary, clean any carbon deposit out of the grooves, taking care not to scratch the metal.

5. Remove carbon deposits from the crown of the pistons without scratching the metal.

Place the gasket compression rings in the bottom part of the cylinders and fit 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. A51). The gap limits are given in the following table:

<table>
<thead>
<tr>
<th>Upper compression ring</th>
<th>Oil control ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 - 0.60 mm</td>
<td>0.35 - 0.40 mm</td>
</tr>
<tr>
<td>(0.012 - 0.016&quot;)</td>
<td>(0.0014 - 0.016&quot;)</td>
</tr>
</tbody>
</table>

6. Fit the rings to position in the grooves. The top ring is plain and the lower compression ring is stepped. It should have the word "top" inscribed on its upper surface.

Check the gap between the upper surface of each ring and the groove with a feeler gauge (Fig. A44). The wear limits are given in the following table:

<table>
<thead>
<tr>
<th>Cylinder</th>
<th>Wear Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>0.05 - 0.10 mm</td>
</tr>
<tr>
<td>(0.0020 - 0.0040&quot;)</td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>0.04 - 0.07 mm</td>
</tr>
<tr>
<td>(0.0015 - 0.0027&quot;)</td>
<td></td>
</tr>
<tr>
<td>Oil Control</td>
<td>0.02 - 0.03 mm</td>
</tr>
<tr>
<td>(0.0008 - 0.0002&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

6. Support the pin on position and drift in the piston pin.

7. Fill the cranks in their grooves.
FLYWHEEL

The flywheel is located on the end of the crankshaft by four dowels and secured by a 36 mm gland nut. The gland nut is tightened to a torque of 217 ft lbs, and this figure must be adhered to or reasonably. 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 locating screws. The bar will jam against the bosses 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
Heat damage to the clutch face and starter ring teeth damage can both be dealt with by machining. A maximum of 3 mm can be taken off the clutch face of the starter ring teeth and they must be re-hardened.

The dowel holes in the flywheel must not be worn. They can be checked with a new dowel.

Installation
1. Lubricate the needle bearing in the gland nut with a very small quantity of grease.
2. If the crankcase has been split for the installation of new bearings or crankshafts, the crankshaft end play must be checked and adjusted (see relevant section).
3. Align the marks made on removal and fit the flywheel, using a new metal gasket.
4. Tighten the gland nut with a torque of 217 ft lbs. A large torque wrench should be used. If one is not available, it is possible to apply a roughly measured force by hand to the end of a bar of known length. For example, one can attach a large spring balance to the tightening bar at a distance of 4" and pull on the balance with a force of 56 lbs.

CRANKCASE

The Bentine crankcase is in two halves, the jointing faces being machined to match, No gasket is used between them (Fig. A.63).

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 cushion made. Make sure that the crankshaft and camshaft remain in one half and do not fall out of position.
4. Lift out the crankshaft with connecting rods and the camshaft.

Inspection
1. Check both inside and outside of case for cracks or other damage.
2. Carefully clean out all oil passages. If possible, blow them out with compressed air.
3. Check the bores for the cam followers. Limits are approximately 19.00 - 19.05 mm
4. Examine the faces of the cam followers for damage.
5. Remove all traces of sealing compound from the mating surfaces.
6. Check the bearing bores with an internal micrometer. (Case must be held up to the correct torque). Limits are given in the table below:

| Component | Bore | Limit
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankcase</td>
<td>Bore 1</td>
<td>65.0 - 65.02 mm</td>
</tr>
<tr>
<td></td>
<td>Bore 2</td>
<td>50.00 - 50.03 mm</td>
</tr>
<tr>
<td></td>
<td>Bore 3</td>
<td>27.80 - 27.83 mm</td>
</tr>
</tbody>
</table>

7. Pay particular attention to the mating surfaces for No. 1 main bearing. Use the new bearing to check that the mating surfaces for the flanges are not worn.
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), make sure non-setting sealing compound is applied to all mating surfaces.
2. Fit the camshaft end plug into position with a smear of sealing compound all round it.
3. Slide the two halves of the case together, making sure that the cam followers do not fall out of their bores.
4. IMPORTANT: First tighten the 13 mm nut which is close to No. 1 main bearing.
5. Then tighten the 6 large nuts around the cylinder bores.
6. Tighten the remaining of the nuts.
7. Install the oil deflector plate which goes between the crankcase and the oil filler bowls. There should be a gasket on either side of it and one surface is machined top (the valve ports face downwards and the longer end of the centre cut-out is closer to the end of the crankcase).

CRANKSHAFT AND CONNECTING RODS

The crankshaft runs in four main bearings, three of them being bushed and one (No. 2) being split. The rear end of the shaft carries gears for driving the camshaft and the fuel 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 out the shaft and connecting rods.
2. Mount the crankshaft on 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 one webs are total.
3. Unbolt the connecting rods and remove them.
Figure A.54. Checking the connecting rod axial play with a feeler blade.

Figure A.55. Tightening the connecting rod bolts.

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

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

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

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

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

Figure A.61. Heater cable rear connection.

Figure A.62. Detaching the heater cable at the control lever.

Inspection

1. Inspect the condition of the crankshaft journals. If necessary, the shaft must be reground.
2. Check the camshaft and distributor drive gears.
3. Check the connecting rod bolts for damage. If there is any damage at all, they must be replaced.
4. Check the fit of the piston pin in the small end bush of the rod. It should be a push fit with no slip.

Removal of the Crankshaft Geants and No. 3 Main Bearing

In order to replace No. 3 main bearing, the two gears must be pulled off.

1. Fit the crankshaft pulley retaining bolt in the end of the crankshaft to avoid damaging the threaded.
2. Remove the circlip which retains the gears.
3. Use an extractor to pull off the gears.

Replacement of Crankshaft Geants and No. 3 Main Bearing

1. Slide the new bearing into position, making sure that the dowel emerges is away from the gear.
2. Wrap the crankshaft and place it in a deep freeze or refrigerator.
3. Heat both the gears in an oil bath to a temperature of about 80 degrees C.
4. Slide on the crankshaft gear (chamfered edge first), the spacer and then the distributor gear.
5. Refit the circlip, taking care not to damage No. 4 main bearing journal.

Assembly of Connecting Rods on Crankshaft

1. Clean the big end journals and clean out the oil passages. Lubricate the journals with oil.
2. Clean the big end bearing surfaces on the connecting rods and fit the bearing shells in position. (Note the position of the locating lug).
3. Assemble the rod loosely on the shaft, making sure that the stamped numbers on both rod and big end cap are on the same side (Fig. A.57).
4. Gradually tighten the bolts to the required torque, tapping the joint regularly to avoid pre-stress (Fig. A.57). When the bolts are fully tightened, the rod should still move smoothly under its own weight.
5. Measure the gap between the rod from and the adjacent web with a feeler gauge (Fig. A.56). The limits are:
   - New: 0.1 to 0.4 mm
   - Worn: 0.7 mm
6. Lock the big end bolts with a small pressing chisel. Hammer it into the slot as that metal is forced against the bolt.

Assembly of Crankshaft in Crankcase

1. Place the 2 halves of No. 2 main bearing shell in position in the case.
2. Lubricate the cam followers and place them in their bores.
3. Place the crankshaft and camshaft in the right hand half of the crankcase.

NOTE: A small circle is engraved against one of the teeth of the crankshaft and there are two punch marks against a pair of teeth on the crankshaft gear. The tooth on the camshaft gear must be between the two teeth on the crankshaft gear (Fig. A.50).

4. Check that the dowels are correctly seated in the recesses of the main bearings (Fig. A.57). It makes the job easier if each bearing is marked with a pencil opposite the dowel hole. This allows one to move them to the correct position and the dowels can then be ‘fit’ in. It is extremely important to ensure that the dowels are located correctly.

5. Lower the other half of the case into position, making sure that the cam followers do not fall out.
6. Tighten in crankcase nuts in the order indicated in the relevant section. Keep turning the crankshaft to check that it is not binding. If any binding is felt, re-seat the case to check that the dowels are correctly fitted.

CRANKSHAFT END PLAY

There are two ways of measuring this:

Measurement with Crankshaft installed:

1. Bolt on the flywheel.
2. Set up a dial gauge so that its pointer rests against the flywheel.
3. Rock the flywheel back and forth and record the distance.
4. Deduct from this distance the mean permissible end play (0.1 mm).
5. Select three shims which, in total, give the correct thickness. Various thicknesses of shims are available, (see below) and 3 must be selected which provide the correct clearance. Although the thicknesses are revised on each one, it is advisable to measure this with a micrometer.

NOTE: 3 shims must always be used.

6. Install the 3 shims and refit the flywheel with a new metal gasket. Tighten it fully and re-check the end play.

Measurement with Crankshaft out of Crankcase:

1. Bolt the flywheel to the shaft with a new metal gasket, and with No. 1 main bearing shell in position on its journal. Use feeler gauges to measure the distance between the flywheel spindle and the outer flange of the bearing.
2. Select shims which will provide the correct end play.
3. When the crankshaft is assembled in this case, check the end play.

Shims Available:

- 0.04 mm
- 0.13 mm
- 0.22 mm
- 0.34 mm
- 0.36 mm
- 0.38 mm

NOTE: 3 shims must always be used.

23
CRANECASE OIL SEAL

Whenever the cranecase 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. A 39). It MUST seat squarely.

CAMSHAFT

Each lobe of the 4-cass 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 tooth 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 marked 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 crankshaft gear to lift the camshaft out of position when it is rotated.

Installation
1. Fit the bearing shells in position (Fig. A 49).
2. Lightly lubricate the bearing surfaces and place the camshaft in one half of the cranecase, taking care that the gear tooth marked 'V' is between the two teeth on the crankshaft gear which have punch marks on them (Fig. A 50).
## 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
- 1500
- 1600
**Stroke**
- 2.52 in (64 mm)
- 2.72 in (69 mm)
**Cylinder capacity**
- 1250 cc
- 1300 cc
- 1500 cc
- 1600 cc
**Compression ratio**
- 7.1:1
**Max. performance (SAE brackets)**
- BS HP at 4000 rpm (41.5 at 3900 rpm)
- 40.0 HP at 4500 rpm (50 at 4200 rpm)
- 44.0 HP at 4500 rpm (50 at 4200 rpm)
- 50.0 HP at 4500 rpm (53 at 4200 rpm)
- 50.0 HP at 4500 rpm (57 at 4400 rpm)
- 50.0 HP at 4500 rpm (57 at 4400 rpm)
- 44.0 HP at 4500 rpm (53 at 4200 rpm)
- 44.0 HP at 4500 rpm (53 at 4200 rpm)
**Max. torque (Kgm/rpm & lbs-ft/rpm)**
- 48.2/2000 (65/2400)-DIN
- 82/2000 (69/2400)-DIN
- 95/3000 (80/3000)-DIN
- 103/2000 (87/3600)-DIN
- 103/2000 (87/3600)-DIN
- 103/2000 (87/3600)-DIN
- 103/2000 (87/3600)-DIN
**Cylinders**
- Single cylinders of special cast iron, fitted
**Crankcase**
- Magnesium cast alloy, built in two halves
**Cylinder heads**
- One piece for each pair of cylinders, cylinder head bolts
**Valve seat inserts**
- Valve guide: non ferrous, special brass
**Pistons**
- Forged with "H" section shaft
- Barrel and fingers: cast iron
- Pins: Tin-plated
**Connecting rods**
- Light alloy with steel inserts
**Pistons**
- Solid type
**Pistons rings**
- 2 compression, 1 oil control ring
**Valve operating gear**
- Single cam shaft located in crankcase below crankshaft, valves operated via push rods and rocker arm
**Camshafts**
- Grey cast iron, three bearings
**Camshaft bearing**
- Holes are drilled with chrome metal
**Camshaft drive**
- Helical gears: from crankshaft
**Valves**
- 1 inlet, 1 exhaust per cylinder
**Valve arrangement**
- Overhead
**Valve clearance (cm) (**
- 0.05 (10 mm)
**Valve springs**
- 1 per valve
**Valve timing with valve clearance of 0.04 (1.0 mm)**
- Inlet open: 89° B.T.D.C. (120)
- Inlet close: 23° A.T.D.C. (90)
- Exhaust open: 42° B.T.D.C. (120)
- Exhaust close: 49° A.T.D.C. (90)
**Cooling system**
- Air cooled by fan and generator shaft
**Fan drive**
- Belt driven from crankshaft
**Cooling air intake**
- Thermosyphon controlled
**Air intake amount**
- 350 cc (21.5 in3)
- 550 cc (33.7 in3)
- 575 cc (35.0 in3)
**Lubrication**
- Oil pressure: 1.5 bar (22 psi)
- Oil capacity: 3.2 liters (0.88 gallons)
**Oil control**
- By relief valve
**Fuel control**
- 4.4 Imp. pt (3.5 US pt. 2.5 l)

### REPAIR DATA

**Cylinder coating depth in cylinder head:**
- 0.038-0.543 in (13.1-13.8 mm)
- 0.540-0.544 in (13.7-13.75 mm)
**Cylinder head: Cylinder coating depth:**
- 0.015-0.019 in (0.40-0.50 mm)
**Piston ring clearance:**
- 0.008 in (0.20 mm)
- 0.008 in (0.20 mm)
- 0.008 in (0.20 mm)
- 0.009 in (0.23 mm)
**Lubrication:**
- Oil pressure: 1.5 bar (22 psi)
**Fuel control:**
- 4.4 Imp. pt (3.5 US pt. 2.5 l)

### Cylinder Data

<table>
<thead>
<tr>
<th>Cylinder coating depth in cylinder head</th>
<th>0.038-0.543 in (13.1-13.8 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder coating depth in cylinder head</td>
<td>0.540-0.544 in (13.7-13.75 mm)</td>
</tr>
<tr>
<td>Piston ring clearance</td>
<td>0.015-0.019 in (0.40-0.50 mm)</td>
</tr>
<tr>
<td>Piston ring clearance</td>
<td>0.008 in (0.20 mm)</td>
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<tr>
<td>Piston ring clearance</td>
<td>0.009 in (0.23 mm)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>Oil pressure: 1.5 bar (22 psi)</td>
</tr>
<tr>
<td>Fuel control</td>
<td>4.4 Imp. pt (3.5 US pt. 2.5 l)</td>
</tr>
</tbody>
</table>
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 vacuum 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 cylinders.

DISTRIBUTOR (Fig. B1)
The distributor does two jobs: it controls the contact breaker interrupts the flow of current to each spark plug when 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 hose off the distributor vacuum unit.
2. Disconnect the cable at terminal No. 1 on the ignition coil.
3. Remove the distributor cap.

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 square.
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.

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 locks 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 square.
4. Adjust the contact breaker gap.
5. Adjust the ignition timing.
4. Use a CLEAN feeler gauge to check the gap (Fig. B3). (Even a minute amount of grease or dirt can seriously affect the life and performance of the points.)

5. If the gap is incorrect, loosen the screw which holds the points down to the base plate just enough to allow the fixed point to move. Lower with a screwdriver until the gap is correct.

6. Re-tighten the locking screw. Re-check the gap.

**IGNITION TIMING**

The time at which the contact breaker points open determines the time at which the spark plug in each cylinder fires. It therefore has a major effect upon performance and economy and 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 1300, 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 advance weights which are situated on the distributor base plate.

Some 1300 and 1600 engines have a double vacuum system which brings about timing advance at high speeds and timing retardation at idling speeds. This retardation eats down exhaust emissions.

It is possible to adjust and set the ignition timing with a single 12 volt test lamp and this procedure should be found adequate for the 1200 engine. However, the more complex vacuum systems fitted to 1300 and 1600 engines call for the use of a stroboscopic light.

**Adjustment – With Test Lamp**

1. Remove the distributor cap and rotor arm.

2. Check contact breaker gap.

3. Rotate the engine until the rotor arm points towards the notch on the rim of the distributor body and the timing mark on the crankshaft pulley is level with the point 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 (7.5 degrees before Top Dead Centre). If there are 3 notches, two will be seen to be close together, the third 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 and a suitable earth point on the engine (Fig. B6).

5. Switch on the ignition.

The lamp should just light as the notch comes level with the crankcase joint. If it does not, line up the pulley correctly and loosen the clamp around the base of the distributor.

6. Rotate 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 ensuring the lamp lights when the pulley mark lines up correctly.

**Adjustment – With Stroboscopic Light**

A stroboscopic 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 so 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, set it to around 850 rpm).

3. Direct the lamp on to the notches 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**

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Ignition Setting</th>
<th>Pulley Notch</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>Disconnect</td>
</tr>
<tr>
<td>1300</td>
<td>(stickshift) 7.5 deg. B.T.D.C.</td>
<td>left-hand one of two</td>
<td>Disconnect</td>
</tr>
<tr>
<td>1300</td>
<td>5.0 deg. A.T.D.C.</td>
<td>one only</td>
<td>Connect</td>
</tr>
<tr>
<td>1300</td>
<td>(stickshift) 5.0 deg. A.T.D.C.</td>
<td>one only</td>
<td>Connect</td>
</tr>
<tr>
<td>1600 (with emission control)</td>
<td>0.0 deg.</td>
<td>left-hand one of three</td>
<td>Disconnect</td>
</tr>
<tr>
<td>1600</td>
<td>5.0 deg. A.T.D.C.</td>
<td>one only</td>
<td>Connect</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 their life and it 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 belt 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 (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
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

**Fuel System**

**GENERAL**

Fuel, which is stored in the tank under the front luggage compartment, is drawn by the mechanical fuel pump along the fuel line and into the carburetor. There are flexible hoses between the tank and the rigid line inside the bonnet and between the bonnet line and the line in the engine compartment. The hoses can be disconnected if they are plugged or clamped.

In the carburetor, the fuel is mixed with air which is pre-heated, if necessary, by the thermostatically controlled air cleaner.

**AIR CLEANER**

The air is cleaned by drawing it across the surface of a layer of oil inside the air cleaner. This oil should be replaced at regular intervals.

Warm air can be drawn into the air cleaner to speed up the rate at which correct operating temperature is reached and, on the latest models, to mix with cold air so as to provide intake air within the correct temperature range, thereby reducing exhaust emissions.

On earlier models, the flap which controls the entry of hot air is connected to the engine temperature by a cable. On later models, the flap is controlled by a thermostat inside the air cleaner itself.

**CARBURATOR**

The carburetor mixes fuel and air in the correct ratio. When the accelerator pedal is depressed, the throttle valve in the throat of the carburetor opens and allows more air to be drawn into the engine. This increased air flow draws a greater amount of fuel from the float chamber.

When the engine is cold, a richer fuel/air mixture is needed. For the upper part of the carburetor throttle is the choke valve. With a cold engine, this is found in its closed position by a cam plate which is burned in the ceramic case on the side of the carburetor. Because this valve is closed, there is considerable suction beneath it and this draws a very rich mixture into the engine. The choke valve is also connected to a piston in a vacuum cylinder. This is controlled by a diaphragm to a point below the throttle valve. As the engine speed increases, the suction causes the piston in the vacuum cylinder to move and open the choke valve.

In the same ceramic case as the bi-metal spring is a hastening element connected to the ignition system. As soon as the ignition is switched on, this begins to heat up and as it reaches the bi-metal spring, the choke valve begins to move. In this way, the choke valve can be adjusted in a different way to its predecessor, the PICT-2.

The 1970-1972 Beetle and all 1971 models are fitted with a modified carburetor, the PICT-3, which is adjusted in a different way to its predecessor, the PICT-2.

**THROTTLE VALVE POSITIONS**

**DASHPOD**

**FUEL PUMP** - Cleaning the Filter, Removal, Disassembling & Assembly

**FUEL TANK** - Removal & Installation

**ACCELERATOR CABLE** - Removal & Installation

---

**Removal**

1. Detach the hot air intake pipe to the air cleaner, the oil breather tube and the float control cable (if fitted).
2. Loosen the clamping screw around the neck of the air cleaner and lift it off. Set it down carefully so that it cannot tip over and the oil will spill.
3. Disconnect the fuel line and the vacuum lines from the rear side of the carburetor.
4. Detach the cable for the automatic choke.
5. Disconnect the carburetor at the throttle cable. The rubber end of the cable passes through a clamp in the throttle operating arm.
6. Unbolt the carburetor from the inlet manifold (1 3/8). Unscrew the carburetor clamp through holes in the inlet manifold flange. There are nuts and lock washers on them. The one at the front is easy to undo, but there is very little room to reach the one at the back. It can only be undone a little at a time. Do not worry if the stud unwraps from the carburetor as it can easily be replaced.

---

**Installation**

This is a reversal of the above processes, but the following points should be noted:

1. Always use a new gasket between carburetor and inlet manifold - on air leaks at this point would cause poor performance and economy.
2. When you reconnect the carburetor to the operating arm, check that the throttle is fully open when the pedal is fully depressed.
   You will need an assistant to operate the pedal.
3. Take care when tightening the carburetor on to the manifold. Tighten the two nuts equally and ensure that they are both done up firmly, but do not overtighten.
4. It will be necessary to adjust the idling adjustment when the engine has been thoroughly warmed up.

---

**Dismountable**

1. Remove the air cleaner and take the carburetor off the inlet manifold.
2. Remove the five screws which secure the top of the carburetor and take it off.

---

**Spark Plugs**

**Type**

- Bosch W 145 T1, Champion L 18 E, L 85, or equivalent
- 0.024 - 0.028 in (0.6 - 0.7 mm)

**Electrode gap**

- 0.04 - 0.05 in (0.06 - 0.13 mm)
Fig. C.5. Fuel pipe connection at the carburettor.

Fig. C.6. Carburettor mounting nuts arrowed.

Fig. C.7. Float chamber cover screws.

Fig. C.8. Vacuum diaphragm assembly.
1. Diaphragm rubber
2. Diaphragm spring
3. Diaphragm cover

Fig. C.9. Right-hand view of the carburettor body.
1. Air correction jet with emulsion tube
2. Slow-running fuel jet

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

Fig. C.11. Accelerator pump components.
1. Screw
2. Pump cover
3. Pump diaphragm
4. Pump spring
5. Washer
6. Connecting rod
7. Spring
8. Washer
9. Split pin

Fig. C.12. Left-hand view of the carburettor body.
3. Main jet
4. Seating washer
5. Main jet carrier
6. Slow-running volume control screw
7. Spring
8. Spring
9. Throttle lever stop screw

Fig. C.13. Checking the fuel valve seat.

Float: If it is suspected that it is leaking, immerse it in hot water and look for bubbles.

Electro-Magneto Shut off Jet: Connect it to a 12 volt supply and check that the solenoid pulls the jet in. If necessary, the jet may be removed for cleaning.

Main Jet: Remove the hexagon plug and then unscrew the jet to clean it.

Accelerator pump: Remove the four securing screws and check the pump diaphragm.

Mixture Control Screw: Remove it and check the tapered part for wear or damage.

The remaining jets may be unscrewed and cleaned. This should only be done by blowing through them; they must never be cleaned with wire, etc.

Any deposit in the carburettor can be removed with acetone or tetrachloroethylene.

Assembly:
Always use a new gasket between the upper and lower parts of the carburettor. Tighten the five cover screws evenly and do not overtighten. Lubricate the make-up nuts lightly with oil. Ensure that the accelerator cable is adjusted correctly.

AUTOMATIC CHOKE

Removal
1. Remove the 3 screws which hold the clamping ring to the body of the carburettor and slide off the collar nut.

Inspection
Check that the heat-ring 3 is not damaged and that there is good contact between its end and the terminal. Any deposits inside the casing can be removed with acetone or tetrachloroethylene.

Installation
Ensure that the hook on the end of the metal spring engages with the lug on the choke valve operating arm. Tighten the 3 screws evenly, ensuring that the mark on the edge of the ceramic casing lines up with the mark alongside it on the carburettor body (Fig. C.17).

IDLING ADJUSTMENT (PCT – 2 carburettors only)

1. Ensure that the valve clearances are correct and that the ignition system is correctly adjusted.

2. Bring the engine to correct operating temperature. Warning it up only slightly is not sufficient.

3. Adjust the slow running control screw until the engine is running at about 800 – 900 r.p.m. (an acceptable idling speed).

4. Slowly screw in the mixture control screw until the engine speed starts to drop and then unscrew it about 1/16 – 1/32 turn, when the engine should run smoothly.

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

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

THROTTLE VALVE POSITIONER (Fig. C.25)

Some vehicles supplied to the U.S.A. have a throttle valve positioner fitted to the carburettor. This is a large cylindrical housing fixed 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 slow-run, thereby cutting down exhaust emissions.

It is impossible to reuse 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.

DASHPOD (Fig. C.30)

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

The dashpod does not require servicing, but check that the distance between the plunger and the tab on the throttle arm which pushes against it is 1 mm when the plunger is pushed fully in. The position of the dashpod can be adjusted by means of the screws on its mounting stud.

38
Fig. C.14. Right-hand side of the carburettor body.
1. Air correction jet with extension tube
2. Electromagnetic pilot jet

Fig. C.15. Removing the pilot jet.

Fig. C.16. Altitude corrector (not generally fitted).
1. Main jet
2. Needle
3. Pressure chamber
4. Pressure capillary
5. Air correction jet
6. Adjusting nut

Fig. C.17. Alignment of the choke ceramic cover.

Fig. C.18. Adjusting the volume control screw.

Fig. C.19. Adjusting the slow running adjusting screw.

Fig. C.20. Sectional view of the Solex 30 PICT-2 carburettor.

Fig. C.21. Exploded view of the Solex 30 PICT-2 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 lowest part by screws. This permits the pump to be divided in order to inspect the diaphragm.

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 of the top of the pump, remove the filter and clean it with petrol and blow it out.
3. Refit the top of the pump using a NEW sealing gasket. Take care not to overtighten the securing screw.

Removal
1. Disconnect the fuel lines at the pump and block the inlet line.
2. Remove the two screws which secure the pump to the crankcase.
3. Lift off the pump.
4. The push-rod can be removed if required. It is unlikely that the plastic intermediate flange will come out very easily and it can easily crack if force is applied. It should be left in place if possible.

Disassembling
Note that the pump with a pressed steel upper section cannot be disassembled. The following remarks only apply to pumps with a screwed down upper section.
1. Remove the six screws which retain the upper part of the pump.
2. Lift off the upper part and remove the diaphragm.
3. If necessary, remove the circlip from the operating lever pin and then remove both pin and lever.

Assembly
Note the following points:
1. Check that the upper and lower sections of the pump are properly aligned.
2. Push 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.

FUEL TANK
Removal
1. Remove spare wheel, jack and the flooring of the luggage compartment.
2. Pull the flexible fuel hose away from the bottom of the tank. Have a mildly shaped piece of wooden ready to push into the end of the tube and make sure that you disconnect it from the main fuel line and NOT from the tank itself.
3. Pull away the breather pipe from the neck of the fuel tank (if a breather pipe is fitted).
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 immobilize the car. It will have to be replaced as follows.

Removal
1. Jack up the rear axle 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 remove that end of the cable.
3. Remove the inspection cover on the side of the backbone opposite the pedal (where the passenger's feet go). This only applies to R.H.D. cars.
4. Unhook the end of the cable from the arm which can be seen through the inspection hole.
5. Pull the cable so that it passes out of the back of the fan housing.
Fig. C.25. Exploded view of the throttle valve positioning.

Fig. C.27. Check that the special lever cannot touch at points indicated by the arrows.

Fig. C.26. Checking the fast idle speed.

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

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

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

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

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

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

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

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 great 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 cleanly. 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. Move the throttle operating arm on the side of the carburettor downwards until it is almost touching its stop on the side of the carburettor. You should attempt to hold it about 1 mm from the stop and this can be done quite easily by trapping a piece of card of suitable thickness between the two parts.

8. 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.
Technical Data

Carburetor Application:

<table>
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<tr>
<th>Model 181 - 1100</th>
<th>Soles 25 PICT-2</th>
<th>1500 - 1500</th>
<th>Soles 30 PICT-3</th>
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1500 / Automatic

- x 120
- x 116
- 125 x
- 140
- 1.5 mm
- 8.5 grams
- Main jet: 1500 from Feb. 1968 = x 116

Carburetor Settings – Soles 30 PICT-3

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<tr>
<td>Air correction jet with emission tube</td>
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Carburetor Settings – Soles 31 PICT-3

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<td>Float needle valve</td>
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Carburetor Settings – Soles 30 PICT-2 (Model 181)

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<td>Float weight</td>
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<tr>
<td>Power fuel jet</td>
<td>0.5 mm</td>
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<tr>
<td>Idle air jet</td>
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Clutch

Clutch – Removal & Installation

Pressure Plate Assembly – Disassembly, Inspection & Assembly

Release Bearing

Clutch Cable – Adjustment

Clutch Free Play – Adjustment

Note the following points:

1. If the clutch has been subject to overloading, the springs should be replaced.
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 pressure plate is worn or oily, replace it.

Assembly

1. Place the centre plate and the pressure plate with its rings in a flywheel. If the clutch is a diaphragm type, install the three release lever pins first.
2. Carefully compress the clutch and fit the nuts to the pivot pins. With a diaphragm clutch, there washers must be fitted to each pivot pin, two convex cones with their convex surfaces together and then the flat one.
3. Lubricate the joints or the release lever very lightly with grease.
4. Use new nuts on the pivot pins.
5. The distance between the surface of the release ring and the surface of the flywheel must be 26.7 – 27.3 mm (1.0525 – 1.087”) when the pressure plate is screwed fully on the flywheel. This dimension must be even all round and can be achieved by adjusting the nuts on the pivot pins (Fig D.3). On late model clutches with no release ring, a spare release ring must be fitted temporarily to the release lever so that the distance can be measured and corrected.
6. 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 or in any way be treated with grease.

If the bearing rotates freely, it must be replaced.

To replace the bearing, first remove the 2 retaining clips (Fig. D 8).
When inserting the bearing, note that the clips are fitted with their hooked end engaging with the slot in the back of the operating shaft arm.

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

CLUTCH CABLE
The spindle of the clutch pedal passes through the pedal cluster and in through the side of the backbox. This spindle is fitted with a hook. On the other side of the backbox is an inspection cover which conceals the rearward spindle mounting and the arm to which the throttle cable is attached. The clutch cable passes through a conduit in the backbox, through a bellow flexible section and then runs exposed for a short distance before passing through the eye of the clutch operating lever on the side of the gearbox. 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 spindle.
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 end of the clutch cable should still be on its hook. If it has come off, the fingers can be pushed into the hole to get hold of it.

The front portion of the broken cable can easily be pulled out. If the break has occurred right at the back, the cable does sometimes get jammed in the boxed portion of the conduit on the rear. If this does occur, the flexible portion of the conduit can be detached at the rear by pulling it out of its mounting socket.

The rear portion can easily be removed after the wing nut has been removed. Do not use the sealant greemant which fits over the rear end of the conduit.

Installation
The new cable should be very thoroughly greased, but care should be taken that it does not pick up dirt after this has been done. Lay out the cable to have an assistant hold it. Take care not to let it rub against the trim of the car. It is inserted as follows:
1. Take hold of the threaded end of the cable. This is to be inserted through the hole where the pedal cluster was attached and then into the mouth of its conduit. Unfortunately, the mouth of the conduit is an inch or two behind the rear edge of the hole and cannot be seen. The cable can be fed in by pushing the fingers of one hand into the hole until they reach the mouth of the conduit. If you then cut these fingers slightly, they will form a guide along which the cable can be pushed into the conduit. Whatever you do, don't push the cable down the backbox if you miss the conduit as it may get jammed against other parts.
2. Feed the cable down the conduit until a foot or so is left.
3. The end of the cable will now be projecting from the end of the conduit. Place the sealing greemant over it and then feed it through the eye of the clutch operating lever. Thread on the wing nut a short way so that the cable cannot be pulled out.

Place the eye of the cable on the hook of the pedal cluster. The cluster must now be put back into position and the cable adjusted without it becoming detached from this hook. This is where assistance is helpful. He should hold the pedal in a vertical position whilst it is being secured in position.

Adjust the free play of the brake pedal by moving the pedal stop. This consists of a shaped piece of plate which fits under the pedal cluster and is secured by bolts in the floor. The push rod which is attached to the brake pedal should have a clearance of 1 mm. (0.04") in the piston of the master cylinder.

After the brake and throttle pedals have been reattached, replace the inspection cover on the outside of the backbox.

The clutch pedal free play must now be adjusted at the rear of the car (see below).

As the brake pedal has been disconnected, it is wise to check brake operation before using the car.

CLUTCH CABLE CONDUIT ADJUSTMENT
The flexible section at the rear of the conduit was long and the extent to which it does this is critical for proper operation of the clutch (Fig. D 1). The gap is achieved by pre-loading the conduit by placing washers between the floor and its mounting. The gap should amount to 20 - 30 mm. (0.8 - 1.2") at its midpoint. It is unlikely that this condition will have been altered while replacing the cable, but it is worth checking.

CLUTCH FREE PLAY
When the clutch pedal is depressed, there is a small amount of movement which is usually accompanied by a 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.
Fig. D.2. Removing the clutch assembly.

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

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

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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<tr>
<th>Type</th>
<th>Clutch pressure</th>
<th>Total lining area:</th>
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<tbody>
<tr>
<td>1200 &amp; 1300</td>
<td>761–816 lb (345–370 kg)</td>
<td>1200/1300: 43 sq. in. (26.8 sq.cm.)</td>
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<tr>
<td>1500</td>
<td>786–863 lb (357–392.5 kg)</td>
<td>1500: 55 sq. in. (363 sq.cm.)</td>
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<td>1600</td>
<td>817–921 lb (380–420 kg)</td>
<td>1600: 52 sq. in. (335 sq.cm.)</td>
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**REPAIR DATA**

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<tr>
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<tr>
<td>Pressure plate run-out</td>
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<tr>
<td>Release plate run-out</td>
<td>0.012 in (0.3 mm) max.</td>
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<td>Distance between flywheel/ \ release ring</td>
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<tr>
<td>Clutch spring</td>
<td>1.1495 in (29.2 mm)</td>
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<tr>
<td>Fitted load</td>
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<td>– light blue</td>
<td>136–145 lb (62–66 kg)</td>
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<td>– white</td>
<td>96–109 lb (44.5–49.5 kg)</td>
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<td>– std</td>
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<td>Clutch pedal free-play</td>
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<td>Clutch driven plate run-out</td>
<td>0.03 in (0.8 mm)</td>
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**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 frame at the back of the frame.

It cannot be over-stressed 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 fixed under the rear seat. The gear selector and coupling can be seen through the opening (Fig. E.1). Undo the square headed screw and move the gear lever so that the coupling teases away from the inner shaft lever.

**Swing Axle Bevels**

1. Disconnect the rear brake hoses at the joint between the flexible hose and the rigid pipe (11 mm).

2. Remove the nuts from the cable ends at the hand-brake lever and move the lever so that you can pull the two cables out of their guide tubes.

3. Detach the rubber boots from the axle shaft tubes.

4. Undo the lower shock absorber mounting and withdraw the bolts.

5. Remove the lower nuts from the push rods for the equaliser spring (not on 1200s) and pull the rods out of their places.

6. Mark the position of the spring plates relative to the housing on the axle tube which they are bolted to. This can best be done by marking both with a sharp chisel.

7. Remove the three bolts on each side which attach the spring plate to the axle tube. They are likely to be very tight.

**Double-Jointed Axle Bevels**

1. Remove the socket headed screws from the drive shaft flanges (Fig. E.6). Undo the transmission end first and then the wheel end. Take out the shafts. (You do not have to undo the wheel end of the drive shafts if the vehicle is not going to be moved. You can tie the shafts up out of the way).

2. From this point onwards, the procedure for both types is the same:

3. 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.

4. Disconnect the two cables at the starter motor.

5. If an automatic reversing lamp switch is fitted (high up at the front end 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.

**Installation**

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

**Swing-Axle Bevels**

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 socketed nuts at the ends of the axle shafts until the car is resting on the ground.

3. Blend and adjust brakes.

4. **Double-Jointed Axle Bevels**

   1. You must use new lock washers for the drive shaft flange screws. Fit 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. Blend and adjust brakes.
## FINAL DRIVE

This section gives details of the removal and installation of the final drive. This will be necessary if the rear of the transmission to be dismantled is not available or if its removal and installation is problematic.

### Removal

**Swing-Axle Beetles**

1. Remove the axle tubes and drive shafts (see the section on Rear Axle).  
2. Remove the nuts that hold the left final drive cover to the gearbox (Fig. E.8). Note that each has a plain and a spring washer.  
3. 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 the differential out of the housing. Make sure that all the spacer rings stay in place in their position and number are critical.  
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).

**Double-Jointed Axle Beetles**

1. If you look into the flange to which the drive shaft was attached, you will see a plastic cap. Pry 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 that 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 flange 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

**Swing-Axle Beetles**

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.

**Double-Jointed Axle Beetles**

1. Install the left hand final drive cover. Make sure that both washers are used under each nut.  
2. Coat the oil seals 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 right end 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 spacer rings and slide the flanges on. Secure them with circlip. Make sure that the circlip fits properly in its groove.  
9. Door in new plastic caps.

### GEARBOX — Disassembly

Before the gearbox can be dismantled, the differential must be removed (see relevant section).

1. Remove the nuts which hold on the gearbox housing and take off the housing together with the gearbox and inner drive.  
2. Undo the nuts which hold on the gear carrier. Note the position of the thrusting strip.  
3. If there are nuts on the end of the propeller 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 plates must be straightened first and must be taken out not 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 back so that they can be returned to the same position.  
11. Remove the locking screws from the 6.5 gear fork and the 6.5 gear fork and take off the 6.5 gear fork (Fig. E.18). It is best if the gear carrier is 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 rod for the 6.5 gear out of the shift fork.

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Fig. E.2. Exploded view of the gear train components.

FINAL DRIVE

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 experience which is only available to VW dealers. The measuring equipment required is extremely complex and without it it is actually impossible to adjust the unit correctly. It is recommended, therefore, that work of this nature be entrusted to a VW garage.

Removal

Swing-Axle Beetles
1. Remove the axles and drive shafts (see the section on Rear Axle).
2. Remove the nuts which hold the left hand final drive cover to the gearbox (Fig. E.6). Note that each has a plain and a spring washer. Insert the required number of washers.
3. 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 the differential out of the housing. Make sure that all the grease caps stay in place as their positions and pressures are critical.
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).

Double-Jointed 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.18) and then lever out 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 of necessity. Remove the seals and note their position. They must not be mixed up with those from the other side.
7. Lift off the differential.
8. Remove the right hand final drive cover.

Installation

Swing-Axle Beetles
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 in use.
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 seals 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 end of the main shaft and screw both parts of the main shaft together. Back off until flat, drive in 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 spacer rings and slide the flanges on. Secure them with new circlips. Make sure that the circlip fits properly in its groove.

GEARBOX – Disassembly

Before the gearbox can be dismantled, the differential must be removed (see relevant section).
1. Remove the nuts which hold on the gearbox housing and take off the housing together with the gasket and inner shift lever.
2. Undo the nuts which hold on the gear carrier. Note the position of the earthing step.
3. If there are nuts on the end of the pinion and drive shaft, engage two gears at once, straighten the locking plate and remove the pin (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 case, making sure that the oil seal and is not damaged.
6. Remove the screws which secure the bearing retainer (Fig. E.13). The lock plates must be straightened first and care must be taken not 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 n gear fork and the % gear fork and take off the % gear fork (Fig. E.18). It is best if the gear carrier can be supported in a stand or on laps. If the latter is used, make sure that the machined face is not damaged by the jaws.
12. Remove the shift rod for the % gear out of the shift fork.

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Fig. E.3. Disconnecting the gear change coupling.

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

Fig. E.5. Removing the gearbox 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.

A1. Limited slip differential
A2. Differential housing
A3. Differential housing cover
A4. Crown wheel and pinion
A5. Crown wheel securing bolt
A6. Differential side gear
A7. Differential pinion
A8. Differential pinion shaft
A9. Differential gear shaft
A10. Differential shaft lock pin
A11. Thrust washer
A12. Differential hypoid bearing
A13. Spacer plate
A14. Joint flange circlip
A15. Joint flange spacer ring
A16. Joint flange
A17. Joint flange cap
A18. Thrust bearing
A19. Screw
A20. Differential housing cover
A21. Set of shims
A22. Differential pinion
A23. Differential side gear
A24. Pressure ring
A25. Differential pinion shaft
13. Remove the circlip from around the drive shaft at the selector end of the gear carrier. The dished 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 lock 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 the shaft, needle bearings, inner race and gears for damage or wear.
2. Press the synchroniser rings over the cones on the gears and measure the gap (a, Fig. E.24) with a feeler gauge.

<table>
<thead>
<tr>
<th>Normal dimension</th>
<th>Wear limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 - 1.6 mm</td>
<td>0.6 mm</td>
</tr>
</tbody>
</table>

**Asmembly**

1. Assemble the synchroniser hubs for 3rd and 4th gears. There are a pair of matching marks in each case (Fig. E.25)/The 1 mm deep groove should be at the top and the chamfer on the hub should be at the bottom. Note that the operating sleeves and the synchroniser hubs are in matched pairs and must not be mixed up.
2. Install the synchroniser key springs with their ends offset 120 degrees. The ends of the springs must be right over the ends of the synchroniser keys.
3. Press the synchroniser hub onto the shaft as far as it will go (Fig. E.16). The chamfer on the operating sleeve must be towards the 3rd gear.
4. Heat the inner race for the needle bearing to about 100 degrees C and install it. When it has cooled to room temperature, press it into place.
5. Install the needle bearing, synchroniser ring, gear and thrust washer for 4th gear.

**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.
8. Install the spacer sleeve and then install the inner race for the needle bearing after heating it to about 100 degrees C., together with 4th gear (Fig. E.33).

9. Fit a new circlip and check that it seats properly.

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 thrust washer over the end of the drive shaft at the selector end and install a NEW circlip. Make sure that it engages 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 2944, this cannot be done very easily. The following points must be borne 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 lb.ft (2.5 kg.m).

   NOTE: when any one gear is engaged, it must be impossible to engage any other gear.

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 trains into the case.

9. Put the screws into the bearing retainer (with new lock plates) and tighten them to 38 lb.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 splines 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.

12. Tighten the nuts which secure the gear carrier in a diagonal order to 14 lb.ft (2.0 kg.m).

13. Replace the gearshift housing with the inner shift lever, making sure that a NEW gasket is used. Tighten the nuts in a diagonal order to 11 lb.ft (1.5 kg.m).
Technical Data

GENERAL SPECIFICATIONS

| Gear ratio 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 ratio Automatic Stickshift | "P" | 0.70:1 |
|                                | "R" | 0.89:1 |
|                                | "N" | 3.07:1 |

Final Drive Ratios

| 1200 | 4.375:1 |
| 1300, Prior to Aug, 1970 | 4.375:1 |
| 1300/94 RBP - Type 11, as from Aug, 1970 | 4.375:1 |
| 1300/94 RBP - Type 14, as from Aug, 1970 | 4.125:1 |
| 1500 | 4.125:1 |
| 1600, Prior to Aug, 1970 | 4.125:1 |
| 1600/90 RBP - Type 15, as from Aug, 1970 | 4.125:1 |
| 1600/90 RBP - Type 14, as from Aug, 1970 | 3.875:1 |
| Auto Trans | 4.125:1 |
| All Auto Trans models (except 1500) | 4.375:1 |
| Model 181 | 3.875:1 |

Reduction Gear Ratios (Model 181)

| Prior to Aug, 1970 | 1.29:1 |
| As from Aug, 1970 | 1.26:1 |

LUBRICATION

| Transmission Capacity | 4.375 imp. gal (5.25 US gal; 23.5 liters) |
| Reduction Gear capacity (181) | 0.64 imp. gal (0.5 US gal; 2.3 liters) |
| Recommended lubricant | Hypere Transmiss. Oi SAS 80/90 (MIL-L 2105 B) |

REPAIR DATA

| Gearbox mount/shaft needle bearing clearance | 0.00470-0.0077 in (0.12-0.19 mm) |
| Wear limit | 0.010 in (0.25 mm) |
| Front output shaft run-out (measured on needle bearing seat for 3rd speed gear) | 0.0008 in (0.02 mm) |
| Selector housing bush inner diameter | 0.5934-0.5956 in (15.05-15.63 mm) |
| Wear limit | 0.0014 in (0.35 mm) |
| Selector lever diameter | 0.5900-0.5916 in (15.00-14.99 mm) |
| Wear limit | 0.0007 in (0.18 mm) |
| Gearbox case side cover preload on differential side bearings | 0.055 in (1.4 mm) |
| Torsion block axle clearance (as installed in differential side gear) | 0.0020-0.009 in (0.04-0.24 mm) |
| Axle to differential side gear clearance (measured across the rounded sides 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 shaft bush inner diameter | 0.4941-0.4949 in (12.57-12.57 mm) |
| Wear limit | 0.4900 in (12.55 mm) |
| Starter motor brush-to-shaft clearance | 0.0035-0.0055 in (0.09-0.14 mm) |
| Wear limit | 0.015 in (0.22 mm) |
| First speed gear end play | 0.004-0.01 in (0.10-0.25 mm) |
| Shifting fork-to-synchronization sleeve clearance (1st 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) |

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 SPRING PLATES (Double-Jointed Axle Vehicles) - Removal & Installation
TORSION BARS (Double-Jointed Axle Vehicles) - Removal & Installation
REAR COMPENSATING SPRING (Swing Axle Vehicles Only)
SHOCK ABSORBERS

VEHICLES

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

Vehicles with double-jointed rear axles (the 1302, 1302/86 and those with automatic transmission) have drive shafts with a constant velocity joint at either end (Fig. 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 transaxle housing, 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 bearings are fitted in a housing which is removable after the rear drum is removed (Fig. 3). These 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 baths of the bearing.

Removal

1. Remove the rear drum (see section on Brakes).
2. Remove the four screws which secure the wheel bearing cover. Take off the cover.
3. Pull off the bearing with an extractor.

Installation

1. Press on the inner spacer (if it has been removed).
2. Press in the bearing.

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 great care not to damage the end.
5. Take out the inner spacer.
6. Loosen the inner oil seal from behind the housing (Fig. 26).
7. Remove the circlip which secures the ball bearing in the back of the housing (Fig. 27) and then drive the bearing out with a shaft 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 outer race.

Installation

1. Press in the ball bearing.
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 and oil seal lip.
4. Drive in the wheel shaft complete with the inner spacer.
REAR AXLE TUBES AND DRIVE SHAFTS
(Swing Axle Vehicles)

On swing axle vehicles, the axle shaft is universally jointed to the differential. The splined end of the shaft fits between a pair of flaxen 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 gear. The axle shaft is located in a tube which is also universally jointed 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 bearing housing (Fig. F 6).
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 hole in the side of the transmission case (Fig. F 8). Remove the circlip.
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 flaxen plates out of the transmission case.

Assembly
1. Clean the inside of the gearbox carefully and drive in the inner bearings. If they have plastic cages, they must be installed with the open side of the cage facing outward.
2. Put the gears in place and drive in the outer bearing and fit its circlip.
3. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.
4. Drive on the spur and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
5. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
6. Install the spacer sleeve, grease the outer race of the roller bearing and press it in.
7. Bore in the inner race of the roller bearing.
8. Install the bearing cover complete with spacer and back plate. A NEW O-ring must be used and if the oil seal is damaged, it must be replaced.
9. The rear axle shaft and tube of the 181 is shorter than on Bottles in order to accommodate a reduction gear next to the hub (Fig. F 4). The reduction gearbox can be dismantled without removing the axle from the vehicle.
10. Use a NEW gasket to install the gearbox cover and tighten the screws to the correct torque.
11. Install the bearing cover complete with spacer and back plate. A NEW O-ring must be used and if the oil seal is damaged, it must be replaced.
12. Clean the inside of the gearbox carefully and drive in the inner bearings. If they have plastic cages, they must be installed with the open side of the cage facing outward.
13. Put the gears in place and drive in the outer bearing and fit its circlip.
14. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.
15. Drive on the spur and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
16. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
17. Remove the outer bearing and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
18. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
19. The rear axle shaft and tube of the 181 is shorter than on Bottles in order to accommodate a reduction gear next to the hub (Fig. F 4). The reduction gearbox can be dismantled without removing the axle from the vehicle.
20. Use a NEW gasket to install the gearbox cover and tighten the screws to the correct torque.
21. Install the bearing cover complete with spacer and back plate. A NEW O-ring must be used and if the oil seal is damaged, it must be replaced.
22. Clean the inside of the gearbox carefully and drive in the inner bearings. If they have plastic cages, they must be installed with the open side of the cage facing outward.
23. Put the gears in place and drive in the outer bearing and fit its circlip.
24. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.
25. Drive on the spur and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
26. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
27. The rear axle shaft and tube of the 181 is shorter than on Bottles in order to accommodate a reduction gear next to the hub (Fig. F 4). The reduction gearbox can be dismantled without removing the axle from the vehicle.
28. Use a NEW gasket to install the gearbox cover and tighten the screws to the correct torque.
29. Install the bearing cover complete with spacer and back plate. A NEW O-ring must be used and if the oil seal is damaged, it must be replaced.
30. Clean the inside of the gearbox carefully and drive in the inner bearings. If they have plastic cages, they must be installed with the open side of the cage facing outward.
31. Put the gears in place and drive in the outer bearing and fit its circlip.
32. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.
33. Drive on the spur and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
34. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
35. The rear axle shaft and tube of the 181 is shorter than on Bottles in order to accommodate a reduction gear next to the hub (Fig. F 4). The reduction gearbox can be dismantled without removing the axle from the vehicle.
36. Use a NEW gasket to install the gearbox cover and tighten the screws to the correct torque.
37. Install the bearing cover complete with spacer and back plate. A NEW O-ring must be used and if the oil seal is damaged, it must be replaced.
38. Clean the inside of the gearbox carefully and drive in the inner bearings. If they have plastic cages, they must be installed with the open side of the cage facing outward.
39. Put the gears in place and drive in the outer bearing and fit its circlip.
40. Using a NEW gasket, install the gearbox cover and tighten the screws to the correct torque.
41. Drive on the spur and rear wheel bearing. Install the brake back plate with a new paper gasket. Make sure that the oil drain hole of the housing is in the bottom.
42. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
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74. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.
75. The rear axle shaft and tube of the 181 is shorter than on Bottles in order to accommodate a reduction gear next to the hub (Fig. F 4). The reduction gearbox can be dismantled without removing the axle from the vehicle.
7. Position the rubber O-ring on the inside of the retainer and smear both the retainer inside surface and its seating with Molykote gum paste.

8. Bolt the retainer into position.

9. Check that the seating surfaces for the rubber boot are free from grease or oil and clip it in position.

**IMPORTANT**: do not tighten the clips for the rubber boot until the axle has been fully installed or it will be damaged by twisting.

**REAR AXLE DUST SLEEVES (Swing Axle Vehicles)**

The 1200 and 1300 Berlin (not 1302) have each half of the rear axle universally joined 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 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 weighed 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 dismantling.

**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 joint out from the sleeves.

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. Squeeze both seating faces of the new split sleeves with VW Sealing Compound D 1a. If this is not available, rubber cement of the type which is used for attaching rubber seals to doors 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 over-tighten; 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 much easier to use replacement clips or use new drive pins; these are much easier to tighten up accurately, but the cost is higher. If you are using this type, you will have to ream them completely in order to fit them over the axle.

6. Lower the car before fully tightening the clips. This is most important. The clips must not be tightened until the axle is under load or the sleeve will become distorted.

7. Check to see that the clips are properly positioned and that the sleeve is not distorted. If you have to replace one sleeve because of splitting, it would be well worth while replacing the other one at the same time — it will probably fail at about the same mileage.

**DRIVE SHAFTS (Double-joined Axle Vehicles)**

Vehicles with double-joined 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 axle of the transmission and in the wheel shaft. Installation is simply a reverse of this process.

**CONSTANT VELOCITY JOINTS (Double-joined 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. Press out the drive shaft from the ball hub and remove the driven washer (Fig. F 15).

6. Remove the circlip from the ball hub and cage (Fig. F 14).

**Disassembly**

1. Press the ball hub and cage out of the outer ring of the joint as shown in Fig. F 14.

2. Press the balls out of the cage. Note that the balls, hub and outer cage are matched and they must 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 balls into the cage.

4. Insert the hub and cage into the outer ring. **NOTE**: the chamfer on the outside 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 balls fit 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 washers and fit a new circlip.
4. Pack the joint with molybdenum disulphide grease. The screw on the joint is 60 kg and two-thirds of this should be packed between joint, cap and boot and the other third is pressed into the open joint from the front.
5. Slide the boot clips onto the rubber boot and tighten them. NOTE: the boot clip clamps must be aligned so that they do not block the screw holes in the joint.
6. Squeeze 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-armed called spring plates. They are attached to the axle tubes by three bolts. Before these are removed, the position of the spring plate relative to the axle must be marked by matching both with a chisel cut (Fig. F 5).

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 joined rear axle spring plate (see next section).

TRAILING ARMS & SPRING PLATES (Double-joined Axle Vehicles)

Beetles with automatic transmissions and the Types 1303 and 1302S have double-joined rear axles.

Torsion bars are still used as the suspension medium and spring plates are used to attach the rear axle to these torsion bars. In addition, the axle is located by a trailing arm (Fig. F 2).

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 at 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 brake 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 22).

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

Note the following points:

1. Check the large rubber bushing on the spring plate for wear. Replace them if necessary. Coat them liberally with talcum powder before installing them.
2. Note that the rubber bushings are marked "obren" at the top and that the inner and outer cores are different (Fig. F 23).
3. When attaching the spring plate to the trailing arm, push something between the leaves of the spring plate to force them apart so as to make fitting easier.

4. Secure the torsion arm end of the spring plate first. It may be difficult to make the covers close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 24). The standard screws can then be inserted and tightened, two at a time, once the spring plate has been lifted to line up with its mounting on the trailing arm. A jack 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 they are installed in the correct order. Lock the screw in place by peening the medial shoulder which it bears against.

6. Attach the trailing arm to the spring plate, taking care that the alignment marks line up (Fig. F 25).

TORISON BARS (Double-joined Axle Vehicles)

The rear torsion bars are half the width of the vehicles and fit into a splined socket at the centre of their mounting tube. The outer end is also splined and the spring plate fits on to this. The inner end of each bar has 48 splines and the outer end bar 44 splines. Because of this, it is possible to adjust the position of the spring plate relative to the car and this controls the camber of the rear wheels. It is vital that the spring plate inclination on each side is equal and if a torsion bar is removed, it must be re-installed in the correct position.

Removal

1. Remove the five screws which attach the front part of the rear wing to the body. Remove the bolt between rear wing and mounting board. Pull the wing away and prop it up with a suitable piece of wood. Kamura Gllin have a circular access hole which is removed instead.

2. Remove the spring plate (see previous section).

3. Withdraw the torsion bar.

Installation

Note the following points:

1. Check the rubber bushing on the spring plate for wear. Replace them if necessary. Coat them liberally with talcum powder before installing them.
2. Note that the rubber bushings are marked "obren" at the top and that the inner and outer cores are different (Fig. F 23).
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6. Attach the trailing arm to the spring plate, taking care that the alignment marks line up (Fig. F 25).
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 type) or on the trailing arm (double-jointed rear axle type).

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.

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 brackets 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.26). 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.27). The levers are attached to the spring by clamping screws.

Fig. F.28. Exploded view of the rear compensating spring. - Swing axle.

1. Outer bracket
2. Rubber bush
3. Inward bracket
4. Bearing (inner)
5. Stepped bearing (outer)
6. Right-hand inner
7. Compensating spring rod
8. Damper ring
9. Protective cap
10. Left-hand lever
11. Right-hand lever
12. Left-hand guide
13. Right-hand guide
14. Left-hand operating rod
15. Right-hand operating rod
16. Washer
17. Nut
18. Clamp bolt

Fig. F.29. Disconnecting the spring operating rod from its mounting bracket.

Fig. F.30. Compensating spring pivot bracket assembly. - Swing axle.

Fig. F.31. Disconnecting the shock absorber lower mounting. - Swing axle.

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**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.

**Rear Suspension Spring Plate Settings**

<table>
<thead>
<tr>
<th>Swing Axle Models</th>
<th>1200 and 1300</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>17° 30' ± 50'</td>
<td>20° ± 50'</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Double-jointed Axle Models</th>
<th>20° 30' ± 50'</th>
</tr>
</thead>
</table>

Models with Equaliser Springs:

- Models with Equaliser Springs:

  - Models without Equaliser Springs:
    - All Beetle Models from the following chassis Nos:
      - L-0379 023
      - L-0929 746
      - 2521 161
      - 2528 668
      - Model 11, 112, 115, 116
      - Model 18
      - 279° 30' ± 50' (wide track)

- Models with Equaliser Springs:
  - 20° ± 50'
Front Axle & Front Suspension

GENERAL

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

WHEEL ALIGNMENT

GENERAL

The front wheels of the Beetle (other than the 1302 and 1302S models) are each suspended on two arms (torison arm) which are connected to the ends of torsion bars. These torsion bars are located in the front axle beam (see Fig. H.1). Telescopically shock absorbers are mounted between the lower torsion arm and the axle beam side plates.

The steering knuckle and brake assembly are mounted on the torsion arms by means of two ball joints. The steering knuckle has a steering arm for the attachment of the track rod.

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

WHEEL BEARINGS

The front wheel is carried on two tapered roller bearings. The adjustment of these bearings is quite critical if long life is to be ensured.

Adjustment

1. Slacken off the brake adjusting so that the linings do not rub and the wheel spins freely (drum-braked vehicles only).
2. Remove the wheel bearing caps (on the left hand wheel, the small clip which retains the end of the speedometer cable must be removed).
3. Loosen the socket nut in the clamp nut.
4. Turn the wheel as you do so, tighten the clamp nut until you can feel the bearing tightening up. Note that the left hand nut has a left hand thread (Fig. H.3).
5. Mount a dial gauge on one of the wheel nut holes so that its pointer rests against the clamp nut.
6. Loosen the nut until the axial play is between 0.03 in (0.12 mm (0.001" - 0.005") (this is the distance shown on the gauge when the wheel is pushed in and out) (Fig. H.2).
7. Tighten the clamp nut socket screw without removing the clamp nut. The gap should be 2.5 - 3.0 mm (0.10 - 0.12") (Fig. H.4).
8. Check the play.
9. Refit the wheel bearing caps — they should be free of grease.

SHOCK ABSORBERS (Models other than 1302 & 1302S)

These are attacked 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 with a special rig. The performance in use indicates when replacement is required.

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 cannot be removed, hold the pin lightly and use a taper on the flats of the shock absorber shaft to unwind the shaft from the pin (Fig. H.5).
3. Remove the upper mounting nut.
4. Unscrew the nut at the lower mounting point and take of the shock absorber. The rubber bush has a steel lami and this may be seized.
on to the pin. If this occurs, it is usually possible to pull the rubber bush away from the steel liner, leaving the latter still on the pin. It can then be removed after heating and lubricating with release fluid.

**Installation**

1. Check the lower bush and replace if necessary (this will probably require a press). Replace the buffer pan if necessary.
2. Grease the lower mounting pin and fit the shock absorber to it.
3. Place one damper ring with its shoulder upwards on the buffer pin, pass the pin through the mounting hole and then fit the other one with its shoulder downwards (Fig. H.7).
4. Fit the damper ring plate and tighten the nut to 14 lbf-ft (2.0 kg m)

**STEERING KNUCKLE**

*(Models other than 1302 & 1302S)*

The steering knuckle carries the stub axle and brake assembly. It is attached to the torsion arm by ball joints.

**Removal**

1. Raise and support the front of the car and remove the front wheel.
2. Drum brakes: Disconnect the flexible brake pipe from the rigid section at the bracket and plug it (the bleed valve cap will do).
3. Disc brakes: Undo the two bolts which secure the brake caliper so that it can be pulled off. Take the weight off the flexible pipe by tying it up (Fig. H.8).
4. Remove the brake drum and brake plate or the disc and its splash guard (see section on Brakes).
5. Press the tie rod end out of the steering arm on the knuckle. An extractor should be used. If it becomes necessary to tap the tie rod end, screw a nut on to the end of it to prevent the splines from being damaged.
6. Remove the nut on the upper ball joint and loosen the eccentric bush.
7. Lift the upper ball joint out of the steering knuckle. A jack can be used for this.

**Installation**

1. Install the steering knuckle. The upper torsion arm can be raised with a jack if necessary. Tighten the nuts at upper and lower ball joints. *(ALWAYS use new self locking nuts)* (Fig. H.12).
2. Ensure that the slot in the eccentric bush faces forwards (Fig. H.11). This bush permits camber adjustment. It will be necessary to have the camber checked after the work is completed.
3. Install the shock end, tighten the nut and fit a new split pin.
4. Install the brake assembly, ensuring that the brake pipes are installed without any twist.
5. Adjust the wheel bearings.

**STEERING KNUCKLE (1302 & 1302S Models)**

**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 plates)*.
4. Remove the screws which link suspension strut 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.

**TOURENS ARM BALL JOINTS**

*(Models other than 1302 & 1302S)*

The torsion arm 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 Re-greasing**

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 end to the joint with a new retaining ring or wire. If the seal was previously slipped 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 seep 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 screwed to allow extra grease to seep in 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 arm. Note that over-tightening is available to fit torsion arms with over-run holes.

**TRACK CONTROL ARM BALL JOINT**

*(1302 & 1302S Models)*

There is one ball joint at each side between the steering knuckle and the track control arm.
Removal
1. Raise and support the front of the car and remove the front wheel.
2. Detach the stabilizer 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 stabilizer.

TORSION ARMS
(models other than 1302 & 1302S)
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, remove wheels, 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
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 bush 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:

<table>
<thead>
<tr>
<th>Component</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal bush</td>
<td>122 - 134 mm</td>
<td>132 - 134 mm</td>
</tr>
<tr>
<td>Needle bearing</td>
<td>3.5 - 4.0 mm</td>
<td>3.5 - 4.0 mm</td>
</tr>
</tbody>
</table>
**SUSPENSION STRUTS**
(1302 & 1302S 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 screw.
2. Attach the upper end of the strut to the body in the correct position and tighten the self-locking nuts.
3. Insert the ball joint stud into the track control arm and tighten the nut.
4. Attach stabiliser and re-assembly brake assembly and pipe

**TRACK CONTROL ARMS**
(1302 & 1302S 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.

**STABILISER BAR**
(More than 1302 & 1302S)

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. Raise and support the front of the car and remove both front wheels.
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 bushes, clamps and locking plates. Replace parts as necessary.
2. Slide on 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 malleable iron is ideal for this.
4. Tilt over the tabs on the locking plates (Fig. H 14).

**STABILISER BALL**
(1302 & 1302S 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. Remove the bolt which holds the front supporting clip to the frame and remove the clip.
3. Pull the stabiliser out of the track control arm.

**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 stabilizer and fit a new split pin.

WHEEL ALIGNMENT
It is essential that the various geometrical factors of the front suspension, such as toe-in, caster angle and camber angle, are correctly adjusted and maintained. Failure to do so 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.

Technical Data

Type: all except 1302 & 1302S

- Upper and lower trailing arms with transverse torsion bars at the suspension mount. These bars are parallel and each consist of 8 leaves. A stabilizer bar interconnected the suspension on either side.
- Telescopic damper.
- MacPherson strut type, the strut on each side comprising a double-hollow telescopic damper integral with the strut tube. Coil springs are concentric with the wheels. Slight locational by track control arm and radius rod.

WHEEL ALIGNMENT

- Type 3P 20° ± 40°
- Type 2P 30° ± 20°
- King pin inclination: 1°
- Max. caster difference between sides: 2°
- Toes in (wheels not pressed): 0° ± 2°
- Toes in (wheels pressed): 0° ± 1°

REPAIR DATA

- Torsion bar twist: 0.008 in (0.2 mm) max.
- Torsion bar twist in fibre bush clearance: 0.008 in (0.2 mm)
- Wear limit: 0.0128 in (3.25 mm)
- Lower ball joints: 0.020 in (0.5 mm)
- Wear limit: 0.008 in (0.2 mm)
- Metal bushes for torsion arm: 1.4911 in (37.36 mm)
- Wear limit: 1.417 in (36 mm)
- Axle beam upper needle bearing seat diameter: 1.8098 in (46.45 mm)
- Corresponding needle bearing diameter: 1.8100 in (46.46 mm)
- Overrun nut diameter: 1.8177 in (46.46 mm)

WHEELS & TYRES

- Wheels size:
  - Saloon: 41 x 15
  - Karmann Ghia: 41 x 15
  - 181, prior to Feb. 1971: 41 x 15
  - 181, from Feb. 1971: 52 x 14

STEERING WHEEL

The steering wheel is splined to the top of the steering column and is supported by a hexagon nut.

STEERING COLUMN

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

GENERAL STEERING WHEEL - Removal & Installation

1. Disconnect the battery.
2. Remove the fuel tank.
3. Detach the earth cable from the lower end of the column.
4. Remove the screw from the clamp which is just above the flexible coupling and remove the column support clips at the bulkhead.
5. Remove the steering wheel and take off the circlip at the top of the column.
6. Turn the ignition key to the "Drive" position and remove the 3 socket screws which clamp the switch assembly to the column. Lift off the switch assembly and support it so that the cable are not strained.
7. Remove the 2 socket screws which attach the column outer tube at the upper mounting and take out the column and tube.

STEERING COLUMN

Removal

1. Check that the upper column mounting is tightly fastened.
2. Slide the column outer tube 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.

Installation

1. Ensure that the steering wheel is correctly aligned.
2. Tighten each of the horn ring retaining screws a little at a time to ensure that it seats properly.
3. Install the wheel with the indicator arm in the central position.

STEERING DAMPER - Removal, Inspection & Installation

Remove, inspection, and install.

STEERING ADJUSTMENT (Not 1302 & 1302S Models)

1. Disconnect the battery.
2. Remove the fuel tank.
3. Detach the earth cable from the lower end of the column.
4. Remove the screw from the clamp which is just above the flexible coupling, and remove the column support clip at the bulkhead.
5. Remove the steering wheel and take off the circlip at the top of the column.
6. Turn the ignition key to the "Drive" position and remove the 3 socket screws which clamp the switch assembly to the column. Lift off the switch assembly and support it so that the cable are not strained.
7. Remove the 2 socket screws which attach the column outer tube at the upper mounting and take out the column and tube.

STEERING BOX - Removal & Installation

1. Disconnect the battery.
2. Remove the fuel tank.
3. Detach the earth cable from the lower end of the column.
4. Remove the screw from the clamp which is just above the flexible coupling, and remove the column support clip at the bulkhead.
5. Remove the steering wheel and take off the circlip at the top of the column.
6. Turn the ignition key to the "Drive" position and remove the 3 socket screws which clamp the switch assembly to the column. Lift off the switch assembly and support it so that the cable are not strained.
7. Remove the 2 socket screws which attach the column outer tube at the upper mounting and take out the column and tube.

STEERING COLUMN

1. Check that the upper column mounting is tightly fastened.
2. Slide the column outer tube 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. Install the contact ring in the switch assembly bell bearing from below and then install the circlip.
6. Refit the clamp at the bottom of the column, using a new locking plate.
7. Insert the support ring for the column on the front of the bulkhead and secure it by bending down the tabs.
8. Centre the steering and refit the steering wheel.
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 locking 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 bush 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 larger 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.
2. Press the tie rod ends out of the steering arm on the steering knuckles. You should use an extractor for this. (Fig. 15). Leave the nut on the end of the stud so that the thread is not damaged. Make sure that the rubber bush around the nuts is not damaged.
3. Remove the steering damper.
4. Press the inner ends of the track rods out of the Pitman arm.

**Inspection**

Check the track rod ends for wear and ensure that the long rod is not bent. The joints should not be immovable and yet there should be no excessive play. The track rod ends may be replaced if necessary.

**STEERING ADJUSTMENT**

This can be checked by turning the spindle to end f) at the flexible coupling (Fig. 4). Play may 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 locked and end f) tightens the socket adjusting screw on the front of the steering box.
4. Re-tightens the lock nut without moving the position of the adjuster.
5. Turn the steering wheel to check that there is no looseness; if there is, the adjuster screw has been tightened too far.

**Roller/Worm Play**

After adjusting the worm spindle axial play, any further play should be taken up by adjusting the screw on the top of the steering box (Fig. 15).

1. Remove the inspection cover behind the spare wheel.
2. Turn the steering wheel 90 degrees from the straight ahead position, note.
3. Loosen the lock nut and turn the adjusting screw until the roller can just be felt to contact the worm.
4. Re-tightens the lock nut without altering the adjusting screw position.
5. Lower the front wheels and check that, in the straight ahead position, the free play at the steering wheel rim does not exceed 25 mm (1”). When in motion, the steering should self-centre freely. If not, the adjustment is too tight.

**Axial Play of Worm Spindle**

This can only be adjusted when the steering box is dismantled, and in this case the steering box should be exchanged or overhauled by a V.W. Dealer.
STEERING ADJUSTMENT (1302 & 1302S 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 joint.
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. Retighten 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 reconditioned or overhauled by a V.W. Dealer.

STEERING BOX

The steering gearboxes 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 specialized 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 (not 1302 & 1302S)

1. Raise and support the front of the car and remove the front wheels.
2. Prise up the locking tabs on the bolts on the drop arm, remove the bolt and pull the drop arm off its shaft (Fig. J 7).
3. Disconnect the steering damper from the drop arm.
4. Remove the nut and bolt from the steering column clamp just above the flexible coupling. The operation is helped considerably if the foot is removed (see Fuel Section).
5. Bend up the locking tabs on the bolts which clamp the steering box to the axle beam and then remove the bolts.
6. Lift off the steering box.

Installation

The correct positioning of the steering box is ensured by two welded stops on the axle beam which match up with two notches in the steering box clamp. The number 13 or 14 and two arrows are marked on the clamp. On 1200s, 1300 and 1500s, the number 13 should be on the left with its arrow facing forwards. On the 1500 Kammn Ghia, the number 14 should be on the left with its arrow facing forwards.

1. Install the steering box and clamp in the correct position.
2. Fit new locking plates to the clamp bolts and tighten them.
3. Put the drop arm on its shaft and tighten the clamp bolt, using a NEW locking plate.
4. Attach column to steering box, making sure that it is correctly positioned.
5. Have the toe-in checked if necessary.

Removal (1302 & 1302S Models)

1. Raise and support the front of the car and remove the front wheels.
2. Disconnect the steering damper from the drop arm.
3. Prise the track rod end out of the drop arm. Keep the nut on the end of the rod while 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. Adjusting shim
5. Oil seal
6. Drop arm
7. Coupling plug
8. Coupling flange
9. Steering column
10. Locknut
11. Worm adjusting screw
12. Worm sleeve, bearing
13. Seat screw
14. Mounting clamp
15. Steering drop arm
16. Earth cable terminal
17. Steering roller
18. Spring washer
19. Roller support pin

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

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

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

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

Fig. J.7. Drop arm clamp bolt.

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.
1. Steering column
2. Support ring
3. Thrust spring
4. Circlip
5. Spring washer
6. Steering wheel nut

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 (wheels not permitted) 0° 30' ± 15'
- Toe-in (wheels permitted) 0° 5' ± 15'

**Toe-out angle at 20° steering lock:**
- RHD models on full lock 29° 15' ± 30'
- RHD models on tight lock 19° 35' ± 30'
- LHD models on tight lock 19° 20' ± 30'
- LHD models on tight lock 19° 10' ± 30'

**Wheel lock angle (valance):**
- Inner 34° ± 2°
- Outer 28° ± 1°

**Turning Circle (kerb):**
- All models except 1302 & 1302S 10.5 m
- 1302 & 1302S 9.0 m

**Turning Circle (wall):**
- All models except 1302 & 1302S 11.0 m
- 1302 & 1302S 9.5 m

**Steering roll radius:**
- Drum braked models 37 mm
- Disc braked models 40 mm

**Braking System**

**GENERAL**

**FOOT-BRAKE ADJUSTMENT**

**ADJUSTMENT OF THE HAND-BRAKE**

**FRONT BRAKE DRUMS** — Removal & Installation

**REAR BRAKE DRUMS** — Removal & Installation

**BRAKE SHOES** — Removal, Installation & Refinishing

**BRAKE BACK PLATES** — Removal & Installation

**MASTER CYLINDER** — Removal & Installation

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

**DISC BRAKE PADS** — Removal & Installation

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

**BRAKE DISCS** — Removal & Installation

**BRAKE PIPES** — Replacement

**BLEEDING THE HYDRAULIC SYSTEM**

**HAND-BRAKE CABLES** — Replacement

6. Put a large, wide-bladed screwdriver through the hole and press it against the teeth, bracing the shank against the side of the inspection hole. This will allow you to vary the adjuster. (Fig. K.3 shows the direction in which it should be extended, but you cannot make a mistake as turning in the tightening direction will almost certainly cause it to jam tight after a few turns. If this occurs whilst you are trying to loosen it, simply reverse the direction of rotation.)

7. Back off the adjuster in this way until you can spin the wheel freely with no hint of drag.

8. Move to the other adjuster in the same drum and repeat the procedure. Note that you have to turn the adjuster in the opposite direction.

9. If you have carried out the job carefully, the brakes should be carefully perfectly balanced and straight braking will result. If they have been unbalanced before, a few test brake stops may be necessary to bed them down evenly.

10. 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 renewal of the drums, and adjustment will not cure 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. Release the hand-brake and press the brake pedal a few times to centre the wheel in its bearings.

2. Pull the threaded ends of the hand-brake cables through the slots in the rubber boot around the base of the lever.
3. The threaded end of the cable has two 10 mm nuts on it. (Fig K3). You must loosen the upper one which acts as a lock nut and then adjust the lower. You can hold the cable by putting a screw-driver in the slot at the end (Fig K4), but it is much better to see two 10 mm spanners, one on each nut, to loosen the lock nut.

4. Turn the lever, adjusting nut until the rear wheel looks on the fourth click of the knee-stick. Check this by trying to turn the wheel by hand. It should just turn on the third click and be immovable on the fourth.

5. When you have got the adjustment right, tighten the lock nut without moving the adjusting nut.

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

7. Replace the rubber boot.

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**REAR BRAKE DRUMS**

The rear brake drum fits on to the splined end of the axle shaft. It is held in place by a 36 mm slotted nut, secured by a split pin. This pin will almost certainly be damaged during removal and it is necessary to have a replacement available. The nut is tightened during assembly with a torque of 215 ft. Ib – a considerable force. It is essential that it be tightened to the same extent after the drum is replaced. If it is not, the oil seal at the end of the axle will leak oil into the drum and ruin the linings. A torque wrench capable of this figure should be used, but a good substitute is to carefully mark the companion flange before removal. With a sharp edged file, scribe a line across the end of the axle shaft and a matching one in line with it on the nut; this will give the final degree of tightness. 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.

The force which has to be applied to undo this nut is so large that it is difficult to hold the nut in position. The car should be in gear, the handbrake on and wedges jammed between tyre and ground.

**Removal**

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

2. Mark the end of the axle shaft and the nut with a file to ensure correct tightening on assembly.

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 clear of the drum.

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 shifted by bolting the wheel back on to it and using this as a means of pulling it. You can drill the tyre with a stout piece of wood if necessary. Don’t forget that the most likely cause of the drum sticking is that the brake shoes have not been released sufficiently; the drum will pull against them and damage them.

**Installation**

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

3. Make sure that the brake shoes are centred.

4. Slide drum on to the shaft.

5. Refit the axle nut, making sure that it is tightened correctly. This cannot be over-emphasised. If you have a torque wrench the value is 215 ft. Ib, 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.

7. The brakes must be adjusted after carrying out this procedure.
**BRAKE SHOES**

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; worn 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 spokes and a washer 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. Lever 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 pivots on out of the shoes (Fig. K.8).

**Installation**

1. Hook the handbrake cable into position.
2. Assemble the return springs on the shoes and then place the shoes into position in their notches (Figs. K.11 & K.13).
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 handbrake operating lever must be removed from the shoe on which it pivots before this shoe can be retained (Fig. K.10).
2. V.W. genuine linings come complete with clamps. Use only these clamps.
3. The linings must be set 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 brake plate. The shoes and wheel cylinders must first be removed before the plate can be taken off. The front brake plates are secured by screws to the steering knuckle. The rear brake plates are secured by the four screws which retain the wheel bearing cover.

When installing the back plates, 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 housing.
3. After the brake assembly has been installed, the system must be bled.

**MASTER CYLINDER**

The master cylinder is located on the back of the brakehead behind the foot pedal. Access is obtained by jacking up the car and removing the wheel. The piston in the cylinder is connected to the brake pedal by a push rod.

When the brake pedal is pushed down, the piston moves along inside the cylinder and pushes fluid along the brake lines to the wheel cylinders. The fluid also presses into the stop lamp switches and closes the contacts.

The condition of the parts inside the cylinder is 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 rubber plugs. Simply pull the plastic elbows 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 strip paint !
4. Disconnect the cables from the stop lamp switches.
5. Unsecure the brake lines from the master cylinder. These unions may be very difficult to unsecure. Make sure that you do not twist the brake lines as you undo them as this will seriously weaken them. Seal the ends 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 brakehead.
8. Undo the two bolts on the brakehead which hold the cylinder in position - note the spacer inside the brakehead !
9. Lift out the cylinder from the front of the brakehead.

**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 which is attached to the pedal and the piston 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 piston, tighten the stop plate securely.
2. Do not forget to put the screws 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.

**WHEEL CYLINDERS (Fig. K.26)**

These are built up in the master cylinder by the action of the brake pedal. The stroke is transmitted by the brake fluid to the wheel cylinders. The wheel cylinder consists of a casting with a large bore in which slide the pistons which apply the pressure to the brake shoes. The fluid is pumped into the central portion of the bore and this causes the two pistons to move outwards. The pistons are separated from the fluid by
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.

1. Cap seal
2. Cap
3. Brake fluid reservoir
4. Brake fluid level
5. Brake fluid tube
6. Check valve
7. Pinion return spring
8. Braided boot
9. Sealing washer
10. Pinion sleeve
11. Main piston cup
12. Pinion washer
13. Intake port
14. Pinion
15. Pinion secondary cup
16. Pinion stop washer
17. Pinion retaining nut
18. Pinion push rod
19. Brake boot

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

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

1. Push rod
2. Rubber boot
3. Snap ring
4. Snap washer
5. Piston cup
6. Piston
7. Piston washer
8. Cylinder seals cup
9. Piston return spring
10. Spring seat
11. Sealing washer
12. Plug
13. Cylinder body
14. Brake light switch
15. Compensation port
16. Cup
17. Pinion spring
18. Stop screw and seal
19. Seal
20. Secondary cup
21. Pinion
22. Cylinder seal
23. Brake light switch
24. Spring plate
25. Support ring
26. Cap washer
27. Stop screw
28. Stroke limiting screw
29. Pinion

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

Fig. K.19. Removing the master cylinder.

(Do not drop into bulkhead.)

Fig. K.20. Refitting the distance tube.

Fig. K.21. Push rod to master cylinder clearance. S = 1.0mm (0.04 in.).

Fig. K.22. Free-play at the brake pedal "X" should be 5-7mm (0.20-0.28 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.
accurate rubber cups which form a tight seal and prevent loss of fluid past the piston.

Between the piston and the brake shoe is a dotted push button which allows for the slight upwards and downwards movement of the shoe. Each end of the cylinder is covered by a rubber boot to prevent the ingress of dust. This part does not act as a fluid seal.

**Overhaul**

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

In order to remove the cylinder from the brake plate and work on it conveniently, it is necessary to detach the flexible brake hose from it (at the front only). The hose will be stained if it is twisted to any extent, and so 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 unscrewing 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 blend 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 blend 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 upper end must be taken to prevent any dust or dirt of any kind adhering to the moist 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 pin 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 assembled (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 spirits and a small stiff brush. Other solvents must NOT be used.

3. Re-insert the pistons 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.35). These pins should not be driven in too far, as drive them with the face of a hammer; do not use a punch which might dent 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 the brake calipers have cooled down properly.
3. Lower up the locking tabs and remove the two hexagon screws which attach the caliper to the steering knuckle (see Fig. K.36).
4. Slide off the caliper. Support it on a piece of wire so that the brake hose is not stretched (Fig. K.37).

**Overhauling** (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. There are two different size of pistons, smaller than the other.
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.
9. Install a new seal and spring ring. (New seals and rings will be in the caliper overruns kit).

10. Ensure that the piston is correctly protruded so that the retaining plate fits properly against it. Rotate it if necessary.

Installation

1. Place the caliper in position and tighten the mounting bolts to the correct torque.
   NOTE: new bolts and locking plates MUST be used.

2. Insert the brake pad.

3. Operate the brake pedal several times to allow the parts to take up their correct operating positions.

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. Scored discs must be replaced. Scored discs can be re-machined, provided that the overall thickness does not come below 8.5 mm after machining.

Removal

1. Raise and support front of car and remove the front wheels.

2. Remove the brake caliper as described above.

3. Remove the bendorometer cable circlip on the left hand side and lever off the wheel bearing cup.

4. Leverage the socket screw in the wheel bearing clamp out and unscrew the nut (using the left hand thread on the left side).

5. Remove disc complete with wheel bearings.

Installation

1. Installs 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 run should be checked at several points around the circumference and should not exceed 0.2 mm (0.008”). If the run-out exceeds this figure, the disc must be replaced.

3. Install the brake caliper at described previously.

Brake Pipes

The brake lines carry the hydraulic fluid from the master cylinder to the four wheel cylinders. There comes off the front end of the master cylinder; two pass to the front wheels and the other passes down inside the car to a junction at the rear end. Another short pair of tubes link this with the rear wheels. On vehicles with dual circuit brakes, two pipes leave 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.

Keep an eye on the condition of both lines and hoses. If the metal lines become rusty, they must be replaced. The rubber hoses will be seriously damaged if oil or grease gets on to them (this often happens when the front suspension is lubricated) and this should be removed immediately. Even if properly looked after, there will come a time when they will need to be replaced. Examine the surface very carefully at frequent intervals - there should be no evidence of the rubber perishing or of any bulges.

Replacement of the Flexible Pipes

You cannot simply unscrew the hose; they will twist up.

1. The inner end of the hose passes through a bracket attached to the frame and is then connected to the metal brake pipe by a union. Undo this union, and pull the metal pipe away from the hose end. (Do not bend the line more than you need.)

2. The metal end of the flexible hose is locked in place in the bracket by a U-shaped plate on the inner side. Push this plate off with a suitably sized piece of steel or a large screwdriver or cold chisel. When it is off, the hose can be pulled out of the bracket.

3. Unscrew the other end of the hose from the wheel cylinder.

Installation

Installation is a reversal of the above, but the following points should be noted:

1. The hoses must be installed so that the tube bends towards the front of the car (Fig. K 43). Achieve this bending by twisting the hose about 90 degrees before you finally lock it in position.

2. Make sure that the locating plates snug into place properly.

3. Bleed the system.

Replacement of the Metal Pipes

Removal

Three lines leave the front of the master cylinder (two on the dual circuit cars); two pass towards the front wheels whilst the other is the long line which carries fluid to the rear wheels. It bends backwards and passes through the bulkhead into the passenger compartment, behind the pedals. Note that this bulkhead is double sided and the line can become damaged inside without it being apparent. It passes beneath the pedal cluster and then travels in the angle between backbone and floor until leaving the compartment through the bulkhead behind the battery. The line meets a "T" piece which is fixed to the frame. Shorter lines travel from this "T" piece to each rear wheel.

There is an 11 mm union on the end of each of the metal lines. It is therefore quite easy to detach each end providing that corrosion has not caused the thread to stiffen up. This can be overcome by vigorous wire brushing and coating with one part in nine parts water. The short lines will present no problem, so use only details for the long pipe system.

1. Remove front and rear seats and all bulkheads in the interior of the car.

2. Lift the mounting 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 unions at either end of the line (11 mm).
6. The line is fitted with three grommets where it passes through the rear bulkhead and where it passes through the double-walled front bulkhead. These grommets will probably have stiffened with age and can be cut away if they are too stiff to pull out of the brake.

7. The line is held in the angle between bulkhead and floor by simple clamps which can be plugged up with a screwdriver. It is coated with heavy rubbery compound which prevents vibration and corrosion. This should not be dug away as it will provide a shaped bed for the new line. It will be quite easy to pull the old line away from it.

8. If it has not been snapped, the line must be pulled out from the front. If it is being replaced, break it up as to remove it easily. Don’t forget that it is full of hydraulic fluid and that this is a point stripper!

**Installation**

1. Blow through the line to make sure that no foreign matter is clogging it.

2. The line must be carefully fed in from the front wheel arch. It must pass through both front bulkhead holes, under the pedal chassis and into the car. Pass the end through the hole in the rear bulkhead, but make no effort to secure the end in this stage.

3. Carefully adjust the position of the line so that it settles in the groove left by the old cable and passes exactly under the pedal cluster and through all the three holes. Tighten the securing clamps along its length, but take care not to spread the soft walls of the tube.

4. The two ends of the line can now be screwed into place. This is a rather slow process because the end of the line must match up with the socket very precisely if the union is not to be cross-threaded.

5. Fit new grommets to the three bulkhead holes. They must be split in order to fit them on to the line.

6. Part of the line which passes along the floor must be coated in a similar manner to the original. Thicker underlining compound or marvin should be used. This should also be applied around the grommet holes if there is any doubt about their sealing properties.

**IMPORTANT**: The whole brake system must now be bled to eliminate the minute air lock which has been introduced. Most of this will be eliminated from the rear blend valves, but the front part of the system must be bled in case air has passed into it.

**BLEEDING THE HYDRAULIC SYSTEM**

Wherever any part of the hydraulic braking system is disconnected, air gets into the system. This gives a spongy feel and reduces 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 apart from sitting in the driver’s seat and pressing 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 1” - 1½” long and 5” 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 as 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, 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 bleeding valves, on the back of the brake drum. Clean around the valve.

3. Pour an inch or so of clean fluid into the jar. Press the plastic tube tightly on to the valve and let the other 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 loosened sufficiently.

5. When the valve has been undone so that fluid can be ejected, have the assistant press the pedal to 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. The process can then be repeated for each of the other three valves. Follow the order shown in Fig. K 45. Vehicles with dual circuit systems follow order - right front, right rear, left front, left rear.

**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 reuse it after the air has 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 cable serves 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, while the front end has a threaded portion. Most of the cable is bent and passes through a conduit in the bulkhead; the last couple of feet have an outer sleeve.

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

If any 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 wrat of the opposite side. Release hand-brake lever. Undo the nuts on the threaded end of the cables.

2. Remove rear brake drum, making sure that the shoes have been fully released from their normal position by the adjuster nuts.

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

3. Allow the drums to hang away from the back-plate. Wrap a piece of wire around the wheel cylinder to prevent the pistons expelling.
4. Diamondize the part which forms the end of the cable above the back plate. Unbend cable from operating lever and pull out from the conduit.

Installation

1. Thoroughly grease the cable. From now on, it will be difficult to ensure that the creamy cable does not pick up dirt and so it should be handled with care.
2. Hook the eye of the cable over the operating lever and reassemble the locating pins. Replace the shoes and all springs.
3. Put the cable into the conduit. In order to attach the forward end of the cable, it may be necessary to diamondize the hand-brake lever.
4. Slide the rubber boot over the lever, out of the way.
5. Remove the nuts from the remaining cable.
6. Trim off the cinctures which locate the pivot rod.
7. Pull out the pivot rod and lift out the lever. The pawl and ratchet ought to remain in place; if they slip out, they are easily replaced.

The threaded end of the new cable should now be projecting from the front end of the conduit. Pull it to take up any slack and wind it around the groove at the base of the lever and through the eye. Taking care that the cable does not slip out of the groove, replace the hand-brake lever and reassemble it.

The cable nuts and brake drum can now be replaced.

The brakes (NOT HAND-BRAKE) should now be adjusted, and then the hand-brake can be adjusted by tightening the nuts at the lever (Fig. 4A).

### Technical Data

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front-brake operates hydraulically on all four wheels. Drum front brakes on 1200, 1300, 1002 &amp; 161 models. Disc front brakes on all others. Drum rear brakes on all models. Drum brakes are of the one-leading, one-trailing shoe &amp; type. Hand-brake operates mechanically on the rear wheels only.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake Master Cylinder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-line system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake</td>
<td>0.487 in (17.46 mm)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>1.199 in (35 mm)</td>
<td></td>
</tr>
<tr>
<td>Dual-circuit system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake</td>
<td>0.750 in (19.05 mm)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>0.610 in (15.5 mm)</td>
<td></td>
</tr>
<tr>
<td>disc brake models</td>
<td>0.550 in (14.0 mm)</td>
<td></td>
</tr>
<tr>
<td>Rear circuit strake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>drum brake models</td>
<td>0.490 in (12.5 mm)</td>
<td></td>
</tr>
<tr>
<td>disc brake models</td>
<td>0.550 in (14.0 mm)</td>
<td></td>
</tr>
<tr>
<td>Pad wear length</td>
<td>Adjustable</td>
<td></td>
</tr>
<tr>
<td>Pedal travel</td>
<td>0.75 in (190 mm)</td>
<td></td>
</tr>
<tr>
<td>Clearance pad rod to piston</td>
<td>0.04 in (1.0 mm)</td>
<td></td>
</tr>
<tr>
<td>Brake pedal free travel</td>
<td>0.40 in (10.2 mm)</td>
<td></td>
</tr>
</tbody>
</table>

| Front Wheel Brakes | | |
| Brake drum diameter | 9.095 + 0.008 in (231.0 + 0.2 mm) |
| Wear limit | 9.114 in (231.5 mm) |
| Permissible skidded diameter | 9.102 + 0.008 in (231.2 + 0.2 mm) |
| Wear limit | 9.114 in (231.5 mm) |
| Min. permissible braking | 0.004 in (0.1 mm) |
| Max. permissible braking | 0.006 in (0.1 mm) |
| Wheel cylinder diameter | 0.875 in (22.2 mm) |
| Brake lining thicknesses | | |
| New | 0.16 - 0.18 in (4.0 - 4.5 mm) |
| Overdue | 0.18 - 0.19 in (4.5 - 4.3 mm) |
| Brake lining width | 1.17 in (40 mm) |
| Total lining area | 55.5 sq. in (358 sq. cm) |
| Brake disc diameter | | |
| Thickened (new) | 0.037 - 0.045 in (0.9 - 0.1 mm) |
| Min. permissible thickening (per side) | 0.003 in (0.5 mm) |
| Min. permissible disc thickness | 0.335 in (8.5 mm) |
| Thicken tolerance | 0.0008 in (0.02 mm) max. |
| Lateral run-out | 0.008 in (0.2 mm) max. |
| Caliper piston diameter | 0.10 in (10 mm) |
| Front pad thickness | 0.394 in (10 mm) |
| Running clearance | 0.002 - 0.006 in (0.05 - 0.15 mm) |
| Pinion pad area (4) | 0.0032 in (0.072 sq. mm) |

### Electrical Equipment

#### General

All Beetle types except 1200 models in certain countries, are fitted with a 12 volt electrical system.

Current is produced when the engine is running by a generator and is stored in the battery.

A main supply cable goes from the regulator (usually under the rear seat) to the switches and fuse box behind the facia. Removal of the front luggage compartment trim reveals the back of all the switches, instruments, etc.

Note all the connections in the electrical system are of the "push-on" type. It is essential that all these connections are very firm fit on their terminal.

### Testing

The simplest way of testing a battery is to use a hydrometer. This is simply a spring gauge which can hook up some of the electrolyte of each cell and measure its specific gravity (relative density) with a finest. Sometimes the wires simply indicate discharged, partly charged or fully charged which others are marked in units. One point, remember, is that the hydrometer has been dipped in acid. Don't put it down anywhere. An old jar or a tumbler to see its best.

### Effect of Cold Weather

It is not often realised that, as the temperature drops, so does the battery's efficiency. This is because a chemical action is going on inside it and the rate of the action slows down 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.

### Damage by Acid

Whilst the sulphuric acid in a battery is dilute, it can still be very dangerous. If it is splashed or drunk, the water slowly evaporates from it and causes the acid to become more concentrated. Because of this it is essential to treat any spillage with water, however small. Any spills can be neutralised with a liberal application of baking powder dissolved in water. If no water is available, use plenty of water.

### Generator (Fig. 1A)

When the engine is running, the generator is driven by the fan belt and produces electricity which, if not used, is stored in the battery. On the end of the generator is a cooling fan, set into a housing.

In order to remove the generator, it is necessary to either lift or remove the fan housing, it is sometimes possible to carry out the complete piece of maintenance, replacing the brushes, without removing the generator.

### Removal

1. Remove the lower cooling duct cover beneath the right hand bank of cylinders.
2. Remove the screw which holds the thermostat to its bracket and unscrew the thermostat from its seat.
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.9. Connections for polarising the generator.

Fig. L.10. Regulator location on Karmann-Ghia models.

Fig. L.8. Testing the armature on a "growler".
3. Remove the carburetor, and the fan belt.
4. Remove the large diameter flexible pipes which connect the fan housing to the heat exchangers.
5. Remove the screw at either side of the fan housing.
6. On 1100 and 1600s, remove the rod which connects the two sets of air control flaps behind the fan housing.
7. Lift the fan housing and remove the four screws which attach the fan assembly to it (Fig. L.13).
8. 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.

**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.

The brushes should always project well above the level of their holders. If this is not so, they will not be held firmly enough against the commutator by the springs.

**Disassembly**

1. Remove the remaining half of the pulley from the spindle. Take care not to lose the key.
2. Hold this end of the spindle as a vise, using SOFT jaws and undo the large nut which holds the fan on to the spindle.
3. Remove the fan (note the key) and note the position of the various washers and spacers.
4. Unscrew the two long screws which hold the ends of the generator together.
5. Lift off the ends and remove the armature.
6. If necessary, press off the bearings.

**Inspection**

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

**Assembly**

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 freely.
4. Do not forget to insert the keys for fan and pulley.

**Polishing**

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 letting it run for a few seconds as a motor.

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

**REGULATOR**

The regulator cannot be serviced except with very specialized equipment. If it fails, it must be replaced with an exchange unit.

**Position**

Karmann Ghia and 181 — on bulkhead in engine compartment (Fig. L.10), Beetles — under rear seat.

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

**Installation**

Note the following connections:

- Generator to Regulator

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

In addition, terminal B+ (5) on the regulator is connected to the positive terminal of the battery and to terminal 30 of the car's electrical system and terminal 64 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 thinner cable from the terminal on the motor solenoid.

**Fig. L.13. Exploded view of the various types of starter motor fitted.**
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 gear mounting bolt on that side (in the engine compartment). The motor is heavy and it must be supported carefully as it is lifted down.

**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 unhinged 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 which can for the USA are fitted with sealed beam units.

**Removal**

Remove the screw at the base of the headlamp rim and lift out the whole unit (Fig. L.27).

Pull the three pin connector block off the back of the bulb / sealed beam unit (Fig. L.28).

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

The sealed beam unit is held in place by a series of spring clips which must be snapped off.

**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 three components are very reliable and fault in the flashing system are much more likely to be due to poor connections or earthing 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.
**Technical Data**

**Electrical system**
- **Voltage**
  - 1200: 6 volts
  - 1300, 1500, 1600, 181: 12 volts

**Polarity**
- Negative ground

**Battery capacity**
- 6 volt type: 66 Amp / Hr
- 12 volt type: 36 Amp / Hr

**Charging system**
- 1200 (4/9): 111 903 023 H: 111 903 802 F
- Basic versions (M 610): 131 903 021 J: 131 903 802 G
- US versions (M611): 211 903 031: 211 903 803 D
- Police versions (M613): 133 903 033 F: 133 903 803 E
- 1300 & 1500: 211 903 031 A: 211 903 803 B
- 1600: 113 903 033 G: 113 903 803 E
- 181: 211 903 031 E: 113 903 803 C
- (Fully equipped versions): 111 903 023 K: 111 903 803 D

**Starter Motor**
- TYPE: 111 911 021E (Bosch)
- NOMINAL OUTPUT: 0.5 BHP

**BULB APPLICATION CHART**

**Front**
- Headlights: 40/45 watts
- Parking lights: 4 watts
- Direction indicator lights: 21/0 watts

**Rear**
- Stop / tail lights: 21/0 watts
- Break / tail lights (type 181): 21/0 watts
- Direction indicator lights: 21 watts
- License plate light (type 181): 5 watts
- License plate light (Karmann-Ghia): 5 watts
- Reversing lights: 25 watts
- Rear fog light (type 181): 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)

**VW 1200 and VW 1300 SALOON AND CONVERTIBLE MODELS**
Trouble Shooting

Engine

SYMPTOMS

** **

ENGINE WILL NOT CRANK

** **

ENGINE CRANKS SLOWLY

** **

ENGINE CRANKS BUT DOES NOT START

** **

ENGINE STARTS BUT RUNS FOR SHORT PERIODS ONLY

** **

ENGINE MISFIRE AT LOW SPEED

** **

ENGINE MISFIRE AT HIGH SPEED

** **

ENGINE MISFIRE AT ALL SPEEDS

** **

ENGINE MISFIRE ON ACCELERATION AND FAILS TO REV

** **

ROUGH IDLE

** **

RUNS ROUGH AT HIGH SPEED

** **

LACK OF POWER

** **

POOR ACCELERATION

** **

LACK OF TOP SPEED

** **

EXCESSIVE FUEL CONSUMPTION

** **

EXCESSIVE OIL CONSUMPTION

** **

PINGING

** **

COMPRESSION LEAK

** **

** **

PROBABLE CAUSE

a. Fault in the starting system - Refer to the ELECTRICAL EQUIPMENT section for diagnosis.
b. Engine oil too thick.
c. Stiff engine.
d. Mechanical seizure.
e. Fault in the ignition system - Refer to the IGNITION SYSTEM section for diagnosis.
f. Fault in the fuel system - Refer to the FUEL SYSTEM section for diagnosis.
g. Incorrect valve timing.
h. Compression leak.
i. Air leak at inlet manifold.
j. Restrictions in exhaust system.
k. Poor valve seating.
l. Slack valves.
m. Leaking cylinder head gasket.

** **

REMEDIES

b. Drain oil and replace with correct oil.
c. Add small quantity of oil to the fuel and run engine gently.
d. Stop engine and renew parts as necessary.

g. Renew engine.
h. Trace and seal.
i. Trace and seal.
j. Remove restriction.
k. Regulate seats.
l. Free and trace cause.
m. Renew gasket.
n. Fit new camshaft.
o. Adjust tappets.
q. Replace valve guides.
r. Replace seals.
s. Replace gasket.
t. Replace plug with correct one.
u. Renew cylinder block.
w. Replace springs.

Trouble Shooting

Lubrication System

SYMPTOMS

** **

EXCESSIVE OIL CONSUMPTION

** **

LOW OIL PRESSURE

** **

PROBABLE CAUSE

a. Worn or damaged cylinder bore, pistons and/or piston rings.
b. Worn valve guides.
c. Damaged valve stem seals.
d. Leaking oil seal or gasket.
e. Faulty oil pressure gauge, switch or wiring.
f. Oil pickup pipe strainer blocked.
g. Oil filter one-way valve defective.
h. Worn oil pump.
i. Damaged or worn main and/or big-end bearings.
j. Incorrect grade of engine oil.
k. Oil level too high.
l. Oil leak or the pierced side of the lubrication system.

** **

REMEDIES

a. Reground cylinder bores and fit new oversized pistons and rings.
b. Replace valve guides.
c. Replace seals.
d. Seal leak or replace gasket.
e. Trace and rectify.
f. Check and replace if necessary.
g. Replace oil pump.
h. Replace oil pump if necessary.
i. Replace pump or parts.
j. Renew bearings.
k. Replace oil with correct grade.
l. Top up oil.
m. Drain off surplus oil.
n. Trace and rectify.

Trouble Shooting

Cooling System

SYMPTOMS

** **

OVERHEATING

** **

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

** **

PROBABLE CAUSE

a. Insufficient coolant.
b. Drive belt slipping or broken.
c. Radiator fins clogged.
d. Cooling fan defective.
e. Water pump defective.
f. Thermostat stuck closed.
g. Thermostat jammed open.
h. Ignition timing too far ahead.
i. Excessive vehicle load or dragging brakes.
j. Internal passage in the engine and/or radiator blocked.
k. Hoses blocked.
l. Water in mixture.
m. Excessive carbon deposit in the cylinder.

** **

REMEDIES

a. Top up radiator.
b. Tightly bolt or renew.
c. Clean fins.
d. Trace belt, rectify or renew.
e. Fit and renew water pump.
f. Replace thermostat.
g. Replace thermostat.
h. Adjust timing.
i. Seal leak or check brakes.
j. Stop engine.
k. Trace and rectify.
m. Drain engine.
n. Top up with corrected grade. Drain if necessary.
o. Partially drain off in winter only.
## Trouble Shooting

### Ignition System

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<tr>
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<tr>
<td>PINKING</td>
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</table>

### PROBABLE CAUSE
- Battery discharged or defective.
- Contact breaker points need cleaning or renewing.
- Spark plugs need cleaning or renewing.
- Spark plugs not firing correctly.
- Ignition timing incorrect.
- Ignition advance not functioning correctly.
- Vacuum advance not functioning correctly.
- Using wrong grade of fuel.

### REMEDIES
- Replace or replace battery.
- Clean or renew.
- Clean or renew.
- Adjust spark plugs.
- Repair or renew.
- Replace or renew.
- Check and rectify.
- Replace defective parts.
- Change to correct grade of fuel.

## Trouble Shooting

### Fuel System

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<tr>
<td>BACKFIRE</td>
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### PROBABLE CAUSE
- Fuel tank empty.
- Fuel line blocked.
- Fuel pump defective.
- Blockage in carburettor.
- Air leak in fuel line.
- Fuel filter blocked.
- Carburettor idle valve jammed.
- Water in carburettor.
- Eratic fuel flow due to blockage.
- Idling speed too low.
- Incorrect setting of choke control.
- Incorrect carburettor fuel/air level.
- Carburettor leaking.
- Air leak at inlet 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 jet fitted.

### REMEDIES
- Fill tank.
- Blow out obstruction with compressed air.
- Replace pump.
- Replace.
- Remove blockage.
- Trace and bled out.
- Clean filter.
- Clean fuel.
- Drain out water, dry out.
- Remove blockage.
- Adjust throttle stop screw.
- Rejet control.
- Adjust level.
- Wait for it to cool. If persistent, trace cause.
- Trace leak and seal.
- Dilute fuel with highest octave rating obtainable.
- Clean or renew.
- Adjust correctly.
- Adjust mixture control.
- Clean filter.
- Replace with correct jet.
Trouble Shooting

Clutch

SYMPTOMS

CLUTCH SLIPPING (WILL NOT ENGAGE PROPERLY) 

CLUTCH DRAG (WILL NOT DISENGAGE PROPERLY) 

CLUTCH Judder 

CLUTCH GRAB (ON ENGAGEMENT) 

CLUTCH NOISE - SQUEAL WHEN DEPRESSING THE PEDAL 

CLUTCH NOISE - RATTLE WHEN IDLING 

CLUTCH NOISE - CRATTER ON ENGAGEMENT

PROBABLE CAUSE

- Insufficient free-play in release linkage.
- Clutch disc facing worn or hardened.
- Cotter or split on clutch disc facing.
- Weak or broken pressure plate coil springs or diaphragm spring.
- Air in hydraulic system.
- Air in or around clutch pedal.
- Excessive freeplay in release linkage.
- Misalignment of clutch input shaft.
- Clutch disc hub binding on splines of gearbox input shaft.
- Clutch disc facing loose or broken.
- Pressure plate marring release surface.
- Clutch cover distorted.
- Looseness in transmission or suspension.
- Clutch disc distorted.
- Pressure plate buckled.
- Release bearing defective.
- Release bearing seized.
- Low hydraulic fluid level.

REMEDIES

- Adjust linkage.
- Replace clutch disc.
- Clean and properly cause.
- Renew springs.
- Bleed system.
- Adjust travel.
- Adjust or renew worn parts.
- Replace input shaft.
- Remove source of binding.
- Replace clutch disc.
- Fit new parts.
- Replace cover.
- Take up play.
- Renew disc.
- Replace hub.
- Renew bearing.
- Release bearing.
- Top up hydraulic fluid.

Steering

SYMPTOMS

STEERING STEEPNESS

STEERING SLACK

STEERING WANDER

WHEEL SLIPPED TO ONE SIDE

POOR RECOVERY OF STEERING WHEEL TO CENTRE

EXCESSIVE OR ABNORMAL TYRE WEAR

PROBABLE CAUSE

- Tyre pressures incorrect or uneven.
- Lack of lubrication in steering gear.
- Lack of lubrication at steering linkage ball joints.
- Incorrect wheel alignment.
- Incorrectly adjusted steering gear.
- Steering linkage worn or damaged.
- Front wheel bearings worn or incorrectly adjusted.
- Block wheels on both sides.
- Sway bars or stabilizers loose.
- Sway bars or stabilizers defective.
- Sway bars or stabilizers or tires unevenly worn.
- Suspension springs weak or broken.
- Broken steering link.
- Chassis frame or suspension misaligned.
- Improper steering.

REMEDIES

- Inflate and balance tyres.
- Inspect lubricant.
- Lubricate.
- Check steering geometry.
- Adjust correctly.
- Adjust or renew defective parts.
- Tighten or replace joints.
- Tighten to correct torque.
- Tighten to correct torque.
- Tighten to correct torque.
- Replace worn parts.
- Replace with new.
- Balance wheels.
- Renew spigots.
- Balance brakes.
- Realign.
- Adjust tuition on fitting.

Trouble Shooting

Braking System

SYMPTOMS

BRAKE FAILURE

BRAKES INEFFECTIVE

BRAKES CARG OR PULL TO ONE SIDE

BRAKES BIND

PEDAL SPOONGY

PEDAL TRAVEL EXCESSIVE

EXCESSIVE PEDAL PRESSURE REQUIRED

HYDRAULIC SYSTEM WILL NOT MAINTAIN PRESSURE

BRAKE SQUEAL DEVELOPS

BRAKE SHUDDER DEVELOPS

HANDRAKE INEFFECTIVE OR REQUIRES EXCESSIVE MOVEMENT

PROBABLE CAUSE

- Brake shoe linings or friction pads excessively worn.
- Incorrect brake shoe linings or friction pads.
- Brake shoe linings or friction pads contaminated.
- Brake drums or shoes scored.
- Insufficient brake fluid.
- Air in the hydraulic system.
- Fluid leak in the hydraulic system.
- Fluid line blocked.
- Mal-function in the brake pedal linkage.
- Unequal pressure.
- Brake disc or drum distorted or cracked.
- Brake back plate or collar mounting bolts loose or broken.
- Taints as necessary to correct torque.

REMEDIES

- Replace linings or pads.
- Bleed with correct fittings or pads.
- Clean thoroughly.
- Renew or install correctly.
- Bleed out fluid and replace with correct type.
- Top up reservoir.
- Bleed brake system.
- Trice and seal.
- Trice and seal.
- Adjust as necessary.
- Adjust and balance tyre pressures.
- Renew disc or drum.
- Adjust as necessary to correct torque.
- Adjust wheel bearings.
- Renew or install correctly.
- Trice cause and remedy.
- Adjust correctly.
- Fine and clear.
- Renew.
- Replace master cylinder and seals.
- Lower fluid level.
- Adjust as necessary.
- Check and replace hoses.
- Renew service unit if defective.
- Replace as necessary.
Trouble Shooting

Electrical Equipment

SYMPTOMS

STARTER FAILS TO OPERATE *******

STARTER OPERATES BUT DOES NOT CRANK ENGINE *******

STARTER CRANKS ENGINE SLOWLY *******

STARTER NOisy IN OPERATION *******

IGNITION WARNING LIGHT REMAINS ILLUMINATED WITH ENGINE AT SPEED *******

IGNITION WARNING LIGHT FAILS TO ILLUMINATE WHEN IGN. IS SWITCHED ON *******

IGNITION WARNING LIGHT STAYS ON WHEN IGN. IS SWITCHED OFF *******

LIGHTS DEM OR WILL NOT ILLUMINATE *******

BULBS BLOW FREQUENTLY AND BATTERY REQUIRES FREQUENT TOPPING-UP *******

DETECTION INDICATORS NOT FUNCTIONING PROPERLY *******

PROBABLE CAUSE

a. Stiff engine.
b. Battery discharged or defective.
c. Broken or loose connection in circuit.
d. Starter pinion jammed in need with flywheel ring gear.
e. Starter motor defective.
f. Starter pinion does not engage with flywheel ring gear due to worn or broken pinion gear.
g. Starter drive pinion defective or flywheel ring gear worn.
h. Startersystems defective.
i. Ignition/master switch defective.
j. Broken or loose drive belt.
k. Regulator defective.
l. Generator/alternator defective.
m. Bulb burned out.
n. Mouting bolts loose.
o. Fuse blown.
p. Light switch defective.
q. Flasher unit defective.

REMEDIES

a. Add a small quantity of oil to the fuel and run the engine carefully.
b. Recharge or replace battery.
c. Trace and rectify.
d. Release pinion.
e. Rectify fault or replace starter motor.
f. Clean and spray with penetrating oil.
g. Replace defective parts.
h. Take fault, renew if necessary.
i. Replace switch.
j. Adjust or replace.
k. Adjust or replace.
l. Renew bulb.
m. Tighten bulbs to correct torque.

ENGINE TUNING DATA CHART

ENGINE TUNING DATA CHART

**NOTE**

CL 1600: 1500 **CL 1600: 1600** **CL 1600: 1600** **CL 1600: 1600**


**NOTE**

CL 2.0: 2.0 **CL 2.0: 2.0** **CL 2.0: 2.0** **CL 2.0: 2.0**

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**NOTE**

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**NOTE**

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