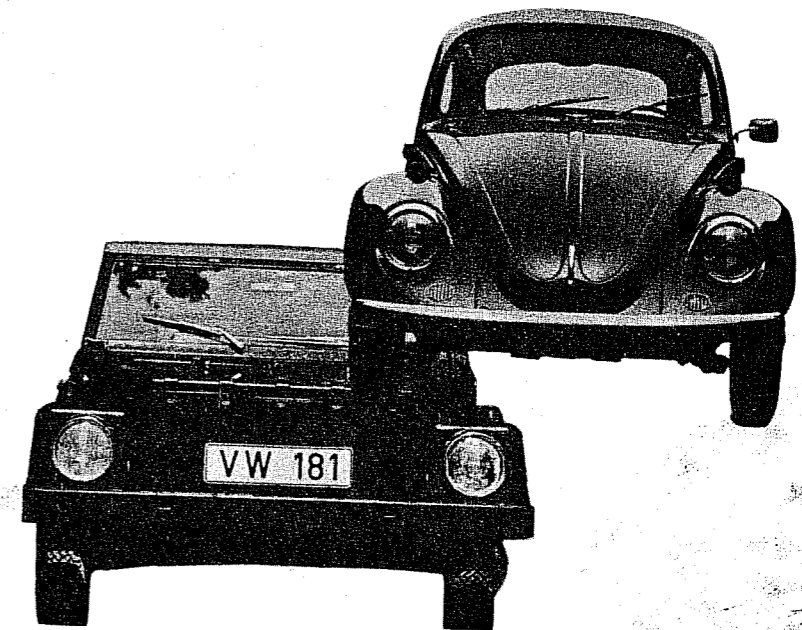


**WORKSHOP MANUAL**  
**for**  
**VOLKSWAGEN BEETLE**  
1200,1300,1500 and 1600 c.c. Engine - Including Karman Ghia and Type 181  
**From 1968**



COMPILED AND WRITTEN  
BY  
P. Harris

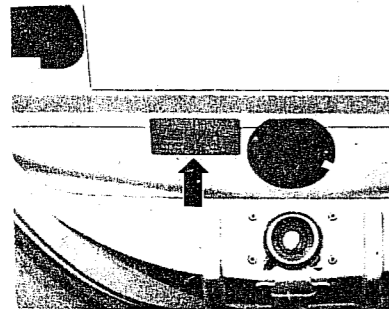
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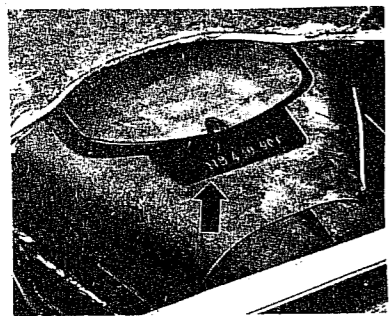
## IDENTIFICATION NUMBERS.

### BEETLE MODELS



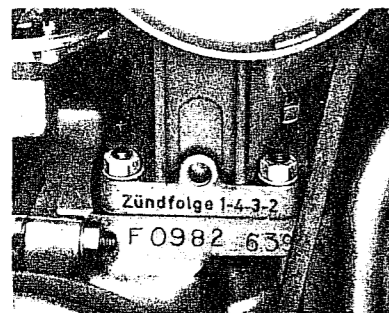
Type Identification Plate.

Located in the luggage compartment behind the spare wheel.



Chassis Number.

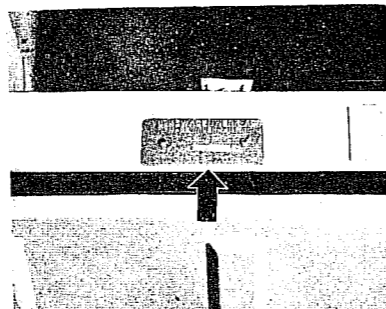
Located on the frame tunnel beneath the rear seat cushion.



Engine Number.

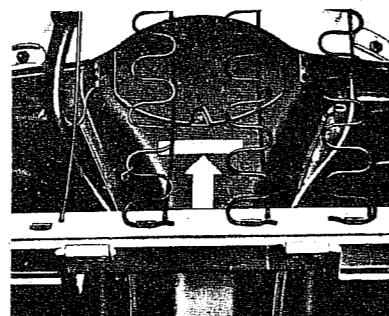
Located on the crankcase flange for the generator support.

### TYPE 181 MODELS



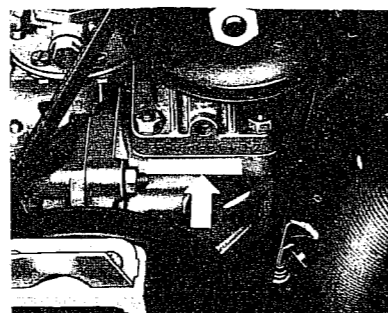
Type Identification Plate.

Located in the luggage compartment on the upper part of the front bulkhead.



Chassis Number.

Located on the frame tunnel under the rear seat cushion.



Engine Number.

Located on the crankcase flange for the generator support.

## Introduction

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

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

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

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

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

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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## MODELS COVERED BY THIS MANUAL:—

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

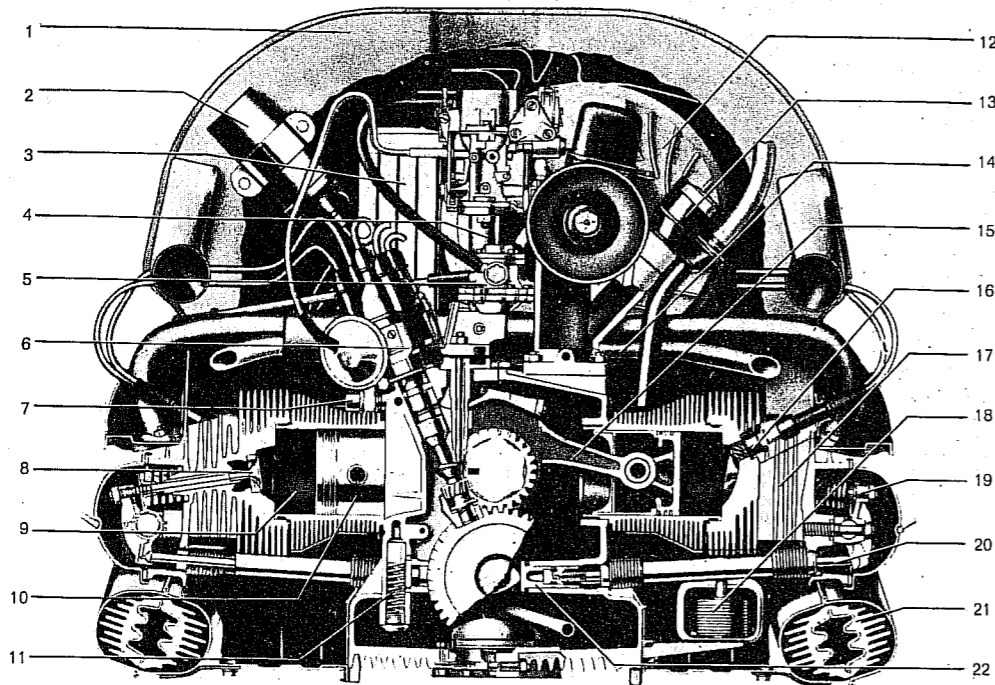


Fig. A.1. Front sectional view of the engine assembly.

1. Blower housing
2. Ignition coil
3. Oil cooler
4. Inlet manifold
5. Fuel pump
6. Ignition distributor
7. Oil pressure switch
8. Valve
9. Cylinder
10. Piston
11. Oil pressure relief valve
12. Blower
13. Oil filler
14. Pre-heating pipe
15. Connecting rod
16. Spark plug
17. Cylinder head
18. Thermostat
19. Rocker arm
20. Push rod
21. Heat exchanger
22. Cam follower
23. Carburettor
24. Dynamo
25. Flywheel
26. Crankshaft
27. Oil pump
28. Camshaft
29. Oil strainer

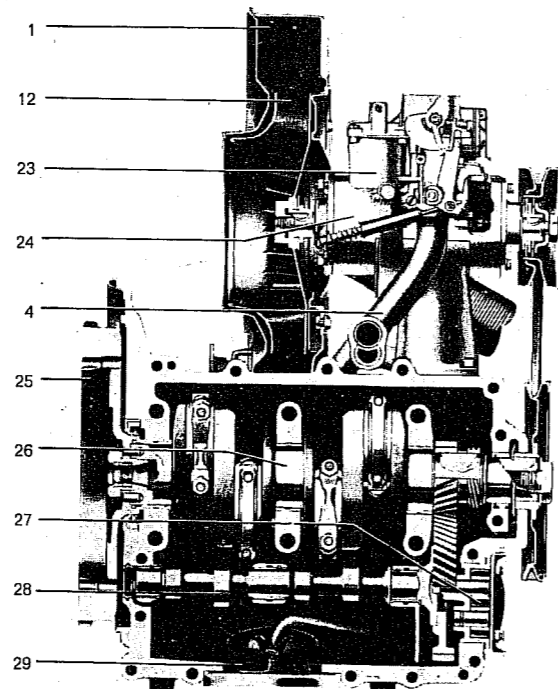


Fig. A.2. Side sectional view of the engine assembly.

## GENERAL

ENGINE – Removal & Installation

ENGINE – Disassembly

FAN BELT

FAN HOUSING – Removal and Installation

SILENCER – Removal & Installation

HEAT EXCHANGERS

OIL PUMP – Removal, Inspection & Installation

OIL COOLER – Removal, Inspection and Installation

OIL STRAINER – Removal, Cleaning & Installation

OIL PRESSURE RELIEF VALVES – Removal, Inspection & Installation

DISTRIBUTOR DRIVE SHAFT – Removal & Installation

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ADJUSTING THE VALVE CLEARANCES

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PISTONS – Removal, Inspection & Installation

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CRANKCASE – Disassembly, Inspection & Assembly

CRANKSHAFT & CONNECTING RODS – Removal, Inspection & Installation

CRANKSHAFT END PLAY – Measurement

CRANKCASE OIL SEAL – Replacement

CAMSHAFT – Inspection & Replacement

## GENERAL

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

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

## ENGINE – Removal

1. Block the front wheels, disconnect the negative (bare) cable at the battery (13 mm) and raise the back end of the car to the maximum height of the jack. Make sure that the jack is placed under the cradle which supports the transmission, not under the engine itself. Ideally, the back of the car must be at least 24" plus the height of the lowered jack clear of the ground. Support the back end of the car on the stands or trestle so that the engine is not obstructed.

2. Disconnect the cables which are attached to the generator. Crawl under the car and pull the flexible fuel hose of the rigid pipe. The hose can be blocked with a pointed piece of wood such as a short pencil. Disconnect the cables which lead to the ignition coil and the oil pressure switch.

3. Disconnect the heater cables from the heat exchangers (9 and 10 mm) and pull the big flexible heater pipes off the heat exchangers.

4. Disconnect the throttle cable at the carburettor and pull this through the fan housing.

5. Undo the two upper mounting bolts (Fig.A5). On the latest models, the heads of these bolts are locked and the nuts can be removed simply with a ring spanner. (You will find them down behind the fan housing). On older models, an assistant must prevent the bolt head from turning with a socket. On 1300 and 1600 models, the nut behind the oil cooler casing is locked into the crankcase. The bolt must be undone from underneath the car.

6. Support the engine with the jack and then remove the nuts of the two lower mounting bolts (Fig. A6).

7. Making 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 swivel the vacuum unit out of the way. This whole operation presents few problems unless the engine compartment has been deformed by slight collision. This often happens after the bumpers have been knocked.

## Semi-Automatic Cars

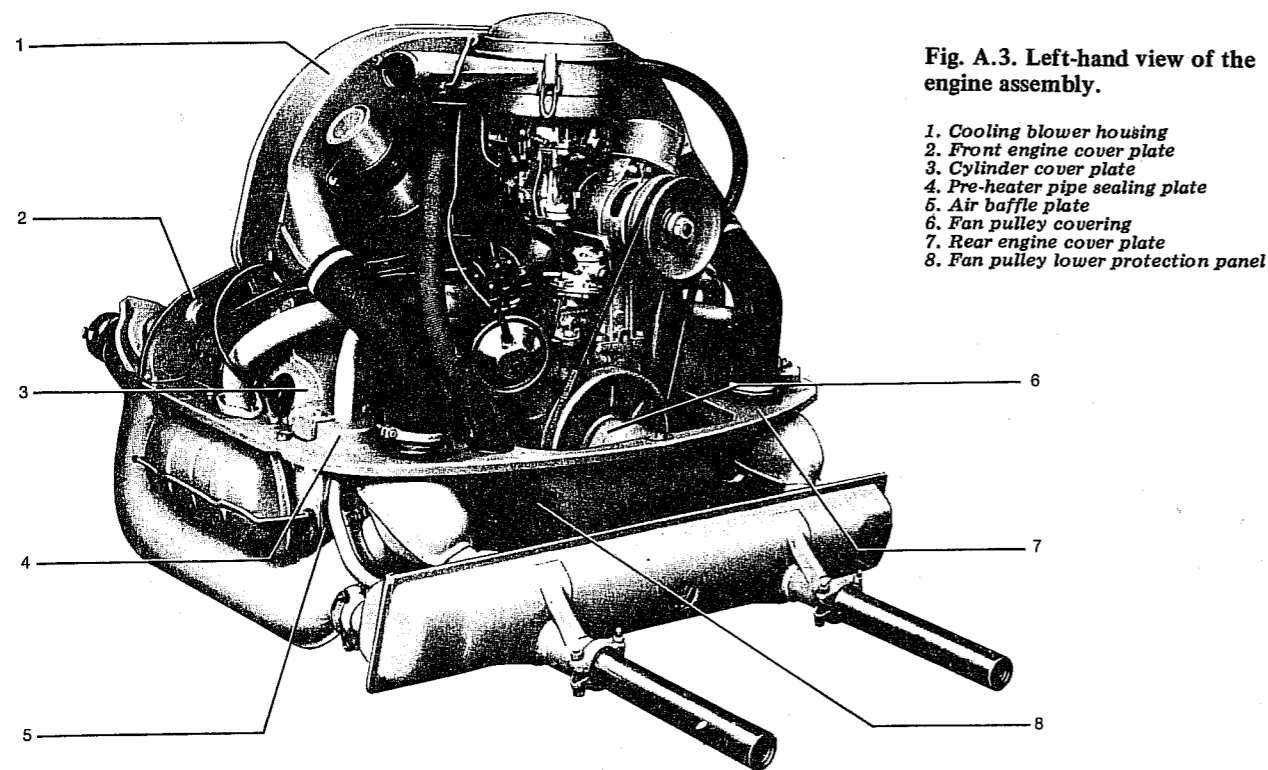
In addition to the above operations, disconnect the control valve cable, and the vacuum hose at the carburettor and manifold. Disconnect the oil pipe to the torque converter and remove and plug the oil suction pipe (Fig. A7.) Remove the four screws from the drive plate through the transmission case holes (accessible when the engine is turned). After removing the engine, secure the torque converter so that it cannot move outwards.

## ENGINE – Installation

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

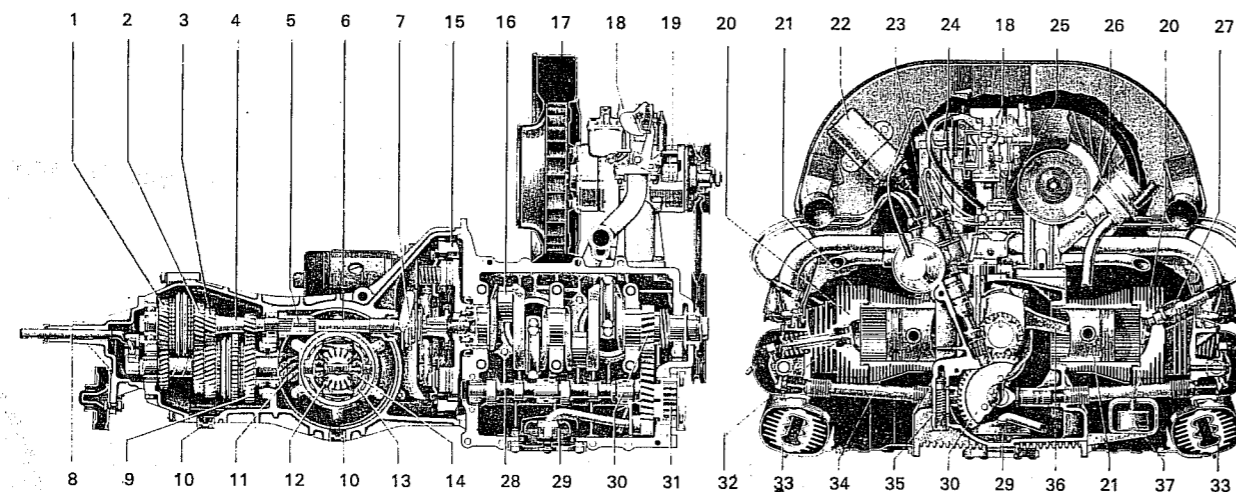
1. Leave off the rear cover plate (over the silencer) until the engine is installed.
2. Make sure that the clutch plate is centred correctly.
3. Smear high melting point grease or molybdenum disulphide powder on the splines of the main shaft which projects from the gearbox.
4. Clean out the gearbox bell housing and lightly grease the starter pinion bush.
5. The engine must be raised carefully into the engine compartment. Make sure that it is not tilted when it is pushed forward to mate up with the gearbox. Check visually that the two lower mounting studs are in line with the gearbox holes before the engine is slid forward.
6. The main shaft slides in better if a gear is selected and the crankshaft is rocked 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.



**Fig. A.3. Left-hand view of the engine assembly.**

1. Cooling blower housing
2. Front engine cover plate
3. Cylinder cover plate
4. Pre-heater pipe sealing plate
5. Air baffle plate
6. Fan pulley covering
7. Rear engine cover plate
8. Fan pulley lower protection panel



**Fig. A.4. Front and side sectional views of the engine and transmission.**

- |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. 4th speed gearwheels</li> <li>2. 3rd speed gearwheels</li> <li>3. 2nd speed gearwheels</li> <li>4. Main drive shaft</li> <li>5. Reverse gear</li> <li>6. Clutch shaft</li> <li>7. Clutch release bearing</li> <li>8. Selector rod</li> <li>9. 1st speed gearwheels</li> <li>10. Oil drain plug</li> <li>11. Drive pinion</li> <li>12. Differential side gear</li> </ol> | <ol style="list-style-type: none"> <li>13. Differential housing</li> <li>14. Differential pinion</li> <li>15. Flywheel</li> <li>16. Crankshaft</li> <li>17. Cooling fan</li> <li>18. Carburettor</li> <li>19. Dynamo</li> <li>20. Cylinder head</li> <li>21. Piston</li> <li>22. Ignition coil</li> <li>23. Ignition distributor</li> <li>24. Oil cooler</li> </ol> | <ol style="list-style-type: none"> <li>25. Fuel pump</li> <li>26. Oil filler tube</li> <li>27. Spark plug</li> <li>28. Camshaft</li> <li>29. Oil strainer</li> <li>30. Camshaft timing gear</li> <li>31. Oil pump</li> <li>32. Valve</li> <li>33. Heat exchanger</li> <li>34. Cylinder</li> <li>35. Oil pressure relief valve</li> <li>36. Connecting rod</li> </ol> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**ENGINE — Disassembly**

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

1. Support engine on a suitable stand (Two piles of bricks will do) and drain off the oil.
2. Unscrew the front cover plate.
3. Remove the rear cover plate (Fig. A10).
4. Take off the silencer.
5. Remove the fan housing and generator.
6. Remove the carburettor.
7. Remove the inlet manifold.
8. Remove the heat exchangers.
9. Remove the cover plates over the cylinders.
10. Pull off the 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, shims can be taken from between the two pulley halves in order to lessen the gap between them and so make the fan belt ride higher in the pulley groove. This section tightens the belt. If spare shims are taken from underneath 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 inwards by about 15 mm (0.6").

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

When loosening or tightening the generator pulley nut, a large screwdriver can be inserted into one of the wide notches in the rear half of the pulley in order to brace it against a screw on the generator and so prevent it from turning.

**FAN HOUSING**

The shape of the fan housing allows the fan (fitted to the end of the generator) to blow cooling air over the cylinders. Outlets 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 coil 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 resting against the top of the bracket. Lock the bracket in position and then bolt the thermostat to it. In order to bolt the thermostat in place, it will have to be pulled downwards, thereby closing the flaps in the fan housing.

**SILENCER**

**Removal**

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

1. Remove the two wide bore flexible air pipes which can be seen inside the engine compartment. The clips at either end must be loosened.

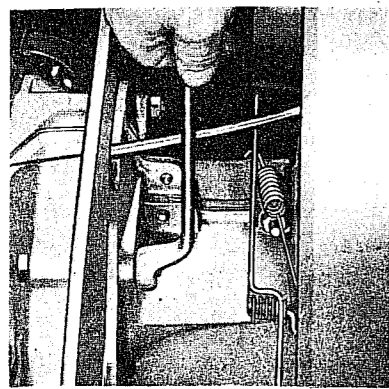


Fig. A.5. Removing the engine upper mounting bolts - 17mm. (1300 & 1600cc. have a captive nut here).

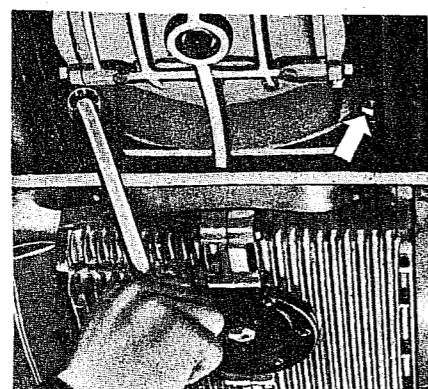


Fig. A.6. Removing the engine lower mounting nuts - 17mm.

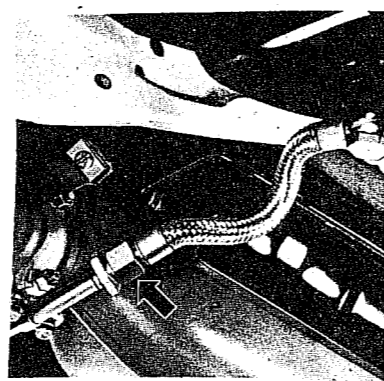


Fig. A.7. Union nut for oil feed pipe to automatic transmission.

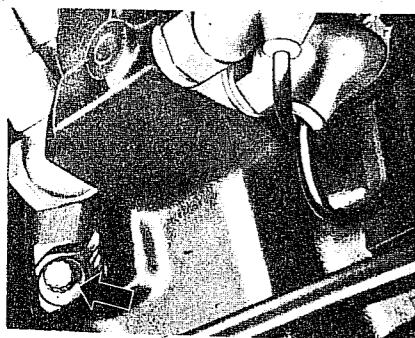


Fig. A.8. Sealing oil suction pipe on automatic models.

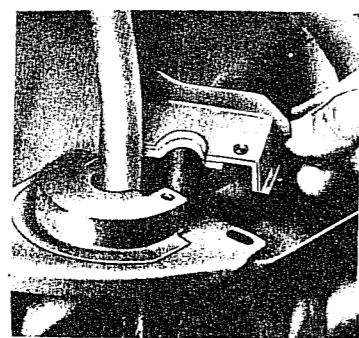


Fig. A.9. Removing the pre-heater pipe sealing plate.

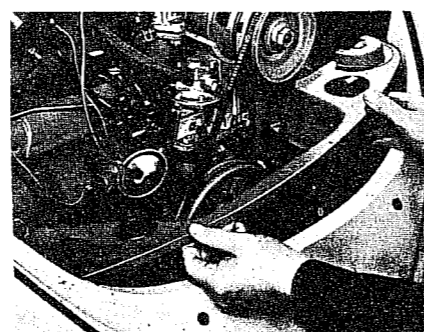


Fig. A.10. Removing the engine rear cover plate.

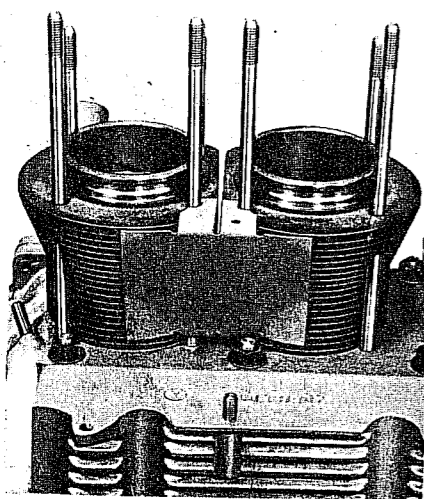


Fig. A.11. Correct positioning of the deflector plates.

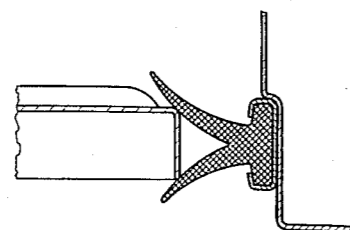


Fig. A.12. Correct positioning of the sealing rubber on the cover plate.

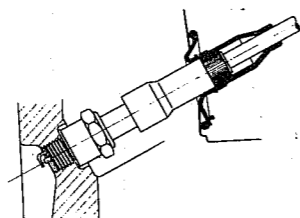


Fig. A.13. Correct positioning of the spark plug sealing boot.

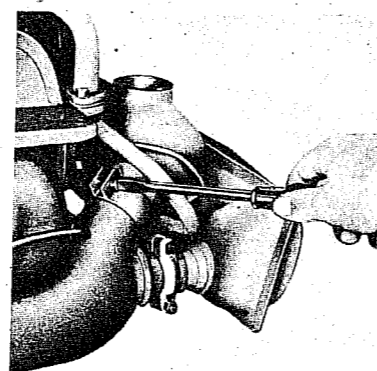


Fig. A.14. Removing the clips which link the main and secondary heat exchangers.

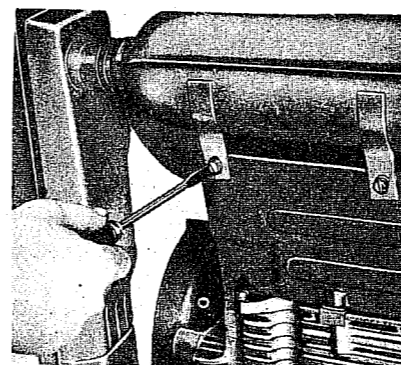


Fig. A.15. Removing the lower heating duct retaining screws.

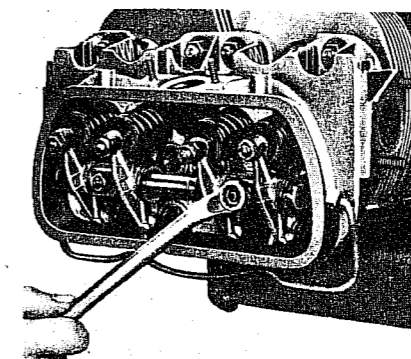


Fig. A.16. Removing the rocker assembly to gain access to the four cylinder head nuts.

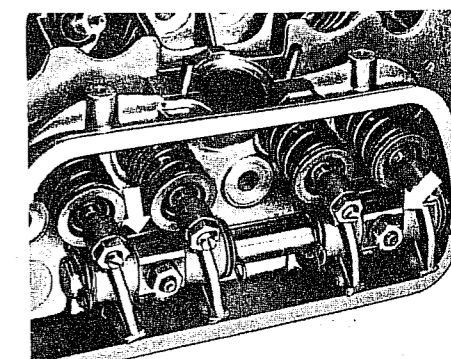


Fig. A.17. The slotted rocker shaft supports must be installed with the slots upwards and the chamfered edges outwards.

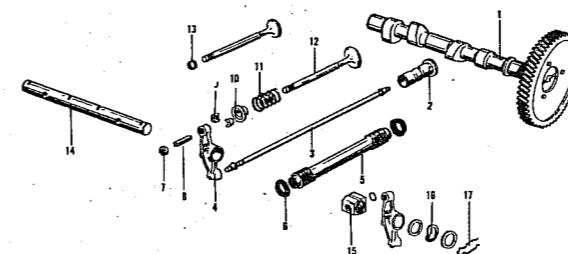


Fig. A.19. Components of the valve operating gear.

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

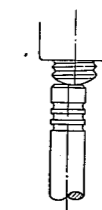


Fig. A.18. To ensure valve rotation, the tappet adjusting screw must touch the valve stem as shown.

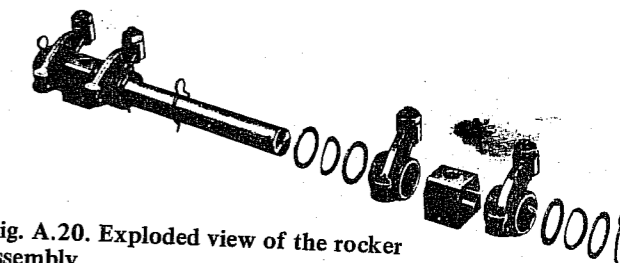


Fig. A.20. Exploded view of the rocker assembly.

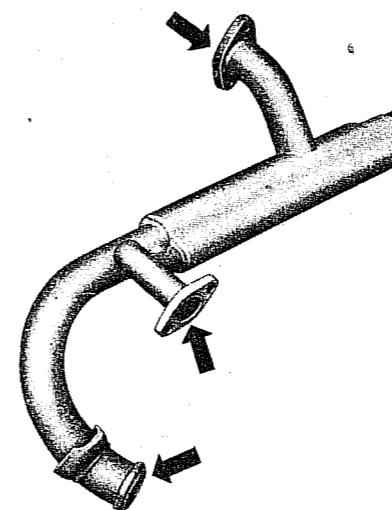


Fig. A.21. Check the manifold flange at points shown for cracks and distortion - 1200 models only.

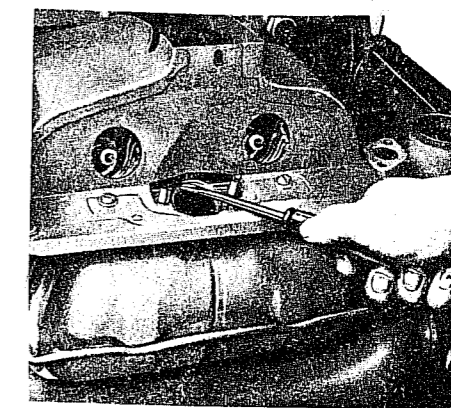


Fig. A.22. Removing the manifold sealing ring from the cylinder head - 1200 models only.

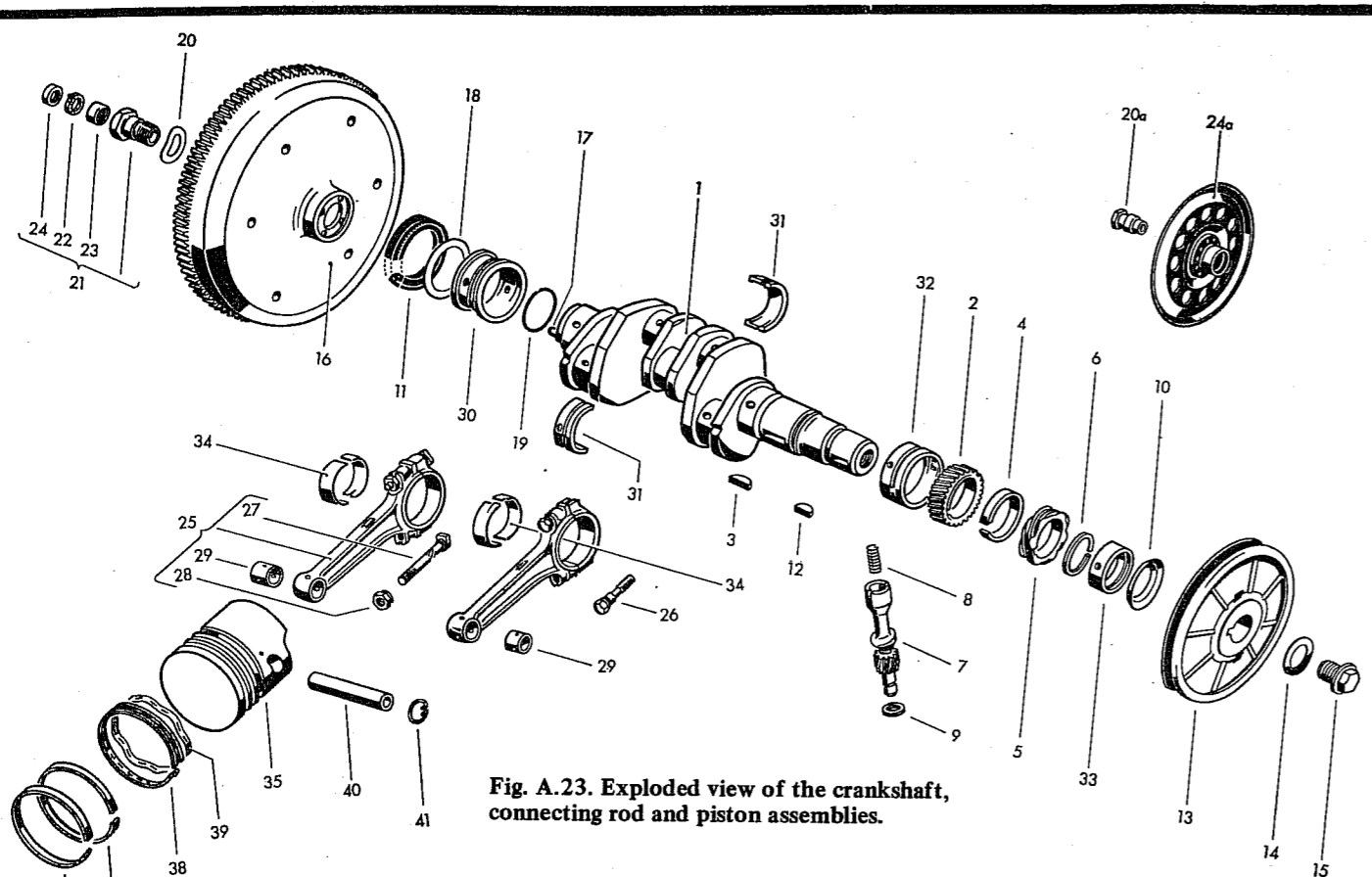


Fig. A.23. Exploded view of the crankshaft, connecting rod and piston assemblies.

1. Crankshaft
2. Crankshaft timing gear
3. Woodruff key for timing gear
4. Spacer for crankshaft timing gear
5. Distributor drive gear
6. Lockring for drive gear
7. Distributor drive pinion
8. Coil spring
9. Washer
10. Oil thrower
11. Crankshaft oil seal
12. Woodruff key for crankshaft pulley
13. Crankshaft pulley
14. Spring washer
15. Crankshaft pulley bolt
16. Flywheel
17. Dowel pin
18. Spacer
19. Sealing ring
20. Lock washer for flywheel
21. Gland nut (hollow bolt)
22. Needle bearing gasket
23. Needle bearing
24. Sealing ring
25. Connecting rod
26. Connecting rod bolt
27. Connecting rod bolt
28. Connecting rod bolt nut
29. Small end bush
30. Crankshaft No. 1 bearing
31. Crankshaft No. 2 bearing
32. Crankshaft No. 3 bearing
33. Crankshaft No. 4 bearing
34. Connecting rod bearing shell
35. Piston
36. Upper piston ring
37. Lower piston ring
38. Oil control ring
39. Ring expander
40. Gudgeon pin
41. Securing circlip

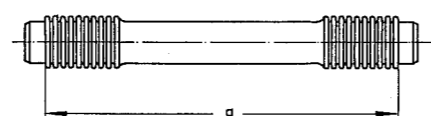


Fig. A.24. Push rod dimension 'a' should be - 1200 : 180 - 181.5 mm.  
1300, 1500 & 1600 : 190 - 191 mm.

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 exchangers.
6. Remove the four bolts which attach the pre-heater pipe to the silencer (10 mm).
7. Remove the bolts which lock the silencer on to the cylinder heads (13 mm).
8. Pull the silencer backwards to free it.
9. It is usually possible to remove the tail pipes once the 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 pipes 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. Retighten 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 passed through the heat exchangers to feed the car's heating system. For this reason, it is absolutely essential that they are in good condition. Any leak could cause poisonous fumes to enter the car.

The heater cables are attached to the control arms 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 camshaft, draws oil through a gauze strainer from the sump and pumps it, via an oil cooler to the bearings. Some oil is pumped to the camshaft bearings and some passes up the hollow push rods to supply the valve gear. This oil drains back into the crankcase via the push rod tubes.

**Removal**

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 gears is keyed on to 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 gears 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 up into the fan housing in the cooling air stream (Fig. A28). From that date, 1300 and 1600 engines have a larger aluminium oil cooler which sits in a separate housing on the back of the fan housing and this means that an 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. 111 198 029.

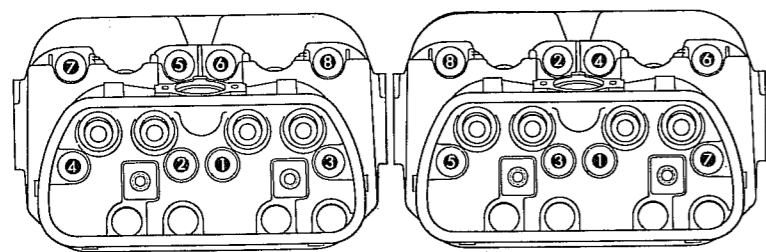


Fig. A.25. Cylinder head nut tightening sequence. Left-hand: Stage 1, 1kgm. (7 lb.ft.) Right-hand: Stage 2, 3.0-3.2 kgm. (22-23 lb.ft.)

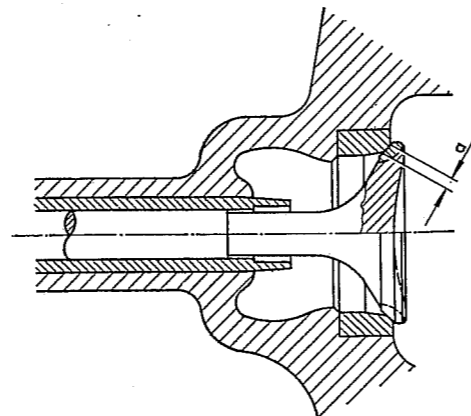


Fig. A.27. Valve seat width, dimension "A", should be: - Inlet valve: 1.3-1.6mm. Exhaust valve: 1.7-2.0mm.

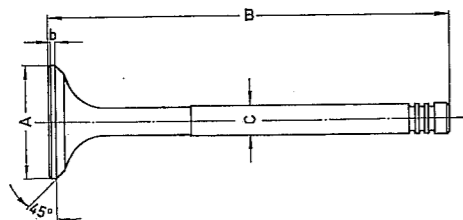


Fig. A.26. Critical valve dimensions - Inlet & exhaust.

	VW 1200	VW 1300	VW 1300, 1500/1600 from 1971
A	31.5 mm.	33.0 mm.	35.5 mm. - Inlet valve
B	112 mm.	112 mm.	112 mm.
C	7.94 - 7.95 mm. - All Engines.		
b	1.14 - 1.90 mm. - All Engines.		
A	30.0 mm.	30.0 mm.	32.0 mm. - Exhaust valve
B	112 mm.	112 mm.	112 mm.
C	7.91 - 7.92 mm. - All Engines		
b	1.6 - 2.1 mm. - All Engines.		

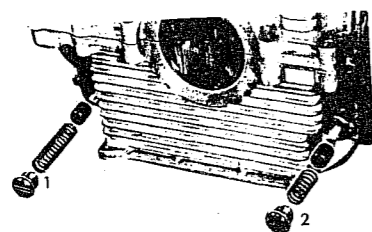


Fig. A.29. Location of the two oil pressure relief valves on later models.

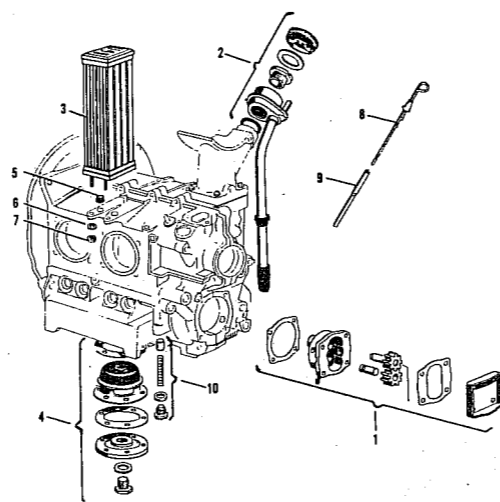


Fig. A.28 Exploded view of the lubrication system components

- |                          |                               |
|--------------------------|-------------------------------|
| 1. Oil pump assembly     | 6 Spring washer               |
| 2. Oil filler assembly   | 7. Nut                        |
| 3. Oil cooler            | 8. Dipstick                   |
| 4. Oil strainer assembly | 9. Guide tube                 |
| 5. Sealing ring          | 10. Oil pressure relief valve |

Removal

1. Remove the screw at either side of the fan housing, undo the generator mounting strap and lift off the fan housing complete with generator. (This cannot be done with the engine in the car unless the engine compartment lid is removed first.)
2. The cooler is held in place by 3 nuts. One is close to the centre line of the crankcase and is easy to undo. The other two are located underneath the overhang of the cooler flange, just above cylinders 3 and 4. It is difficult to undo them unless the casing over cylinders 3 and 4 is removed first.
3. On post August 1970 1300s and 1600s, it is necessary to remove part of the oil cooler casing behind the fan housing before removing the fan housing. When the fan housing has been removed, the oil cooler can be taken off the intermediate bracket after removing the 3 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 specialised piece of equipment. They are tested to a pressure of 85 p.s.i. Normally, the performance of the oil cooler indicates whether it is faulty; if it does not leak in practice, it is obviously O.K.

Installation

Note the following points:

1. Oil coolers which fit directly on to the crankcase flange require 2 plain cylindrical seals. They MUST be new.
2. Oil coolers using an intermediate bracket use 2 stepped seals between bracket and crankcase and two more between cooler and bracket. All 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 circular plate which is bolted to the bottom of the crankcase (Fig. A35).

Removal

1. Remove the 6 nuts (10 mm) and washers. Allow the plate to drop downwards. It will be extremely messy.
2. Ease off the strainer and the gaskets on either side of it. If the strainer jams 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.

B

2. Use new gaskets on either side of the strainer and new copper washers for the six retaining nuts.
3. Tighten the 6 nuts very carefully and evenly. It is all too easy to shear a stud.

OIL PRESSURE RELIEF VALVES

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

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

Removal

1. Unscrew the slotted plug with a very wide bladed screwdriver. The plug will be very tight.
2. Withdraw the valve and its spring. If the valve sticks in the passage way, a suitable tap can be screwed in to it to pull it out.

Inspection

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

Installation

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

DISTRIBUTOR DRIVE SHAFT

The distributor drive shaft meshes 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 and it is virtually impossible to remove it with the engine in place unless one has access to V.W. extractor 228. Details of removal during an engine strip down are given below:

Removal

1. Remove the fuel pump.
2. Remove the nut and washer which lock the distributor clamp to the crankcase and pull out the distributor. It may be a little obstinate due to the oil sealing ring fitted half way down its shaft.
3. Remove the small coil spring which fits in to 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 their ledge. 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.



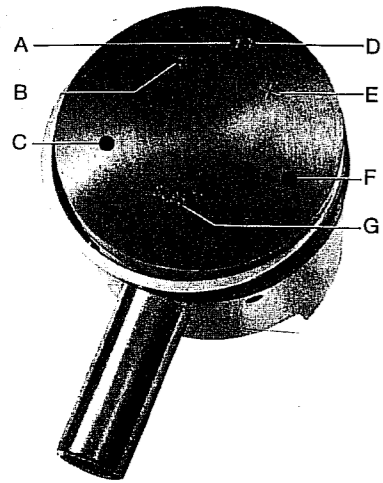


Fig. A.30. Piston crown markings.

- A. Arrow towards flywheel
- B. Piston pin bore size
- C. Paint spot indicating matching size (blue, pink, green)
- D. Part No. identification mark
- E. Details of weight grading
- F. Paint spot for weight grading (brown — minus weight, grey — plus weight)
- G. Details of piston diameter in millimetres

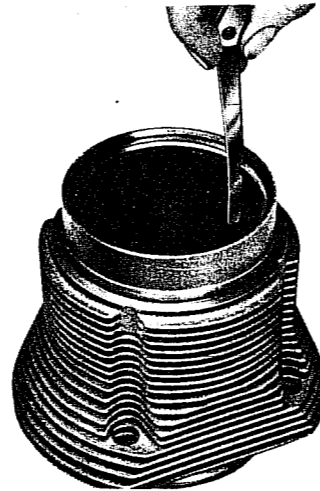


Fig. A.31. Checking the piston ring gap.

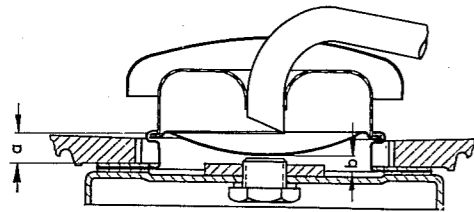


Fig. A.32. Correct installation of the oil strainer.  
 a = 10 +/- 1mm. (0.39 +/- 0.040 in.)  
 b = 6 +/- 1mm. (0.236 +/- 0.040 in.)

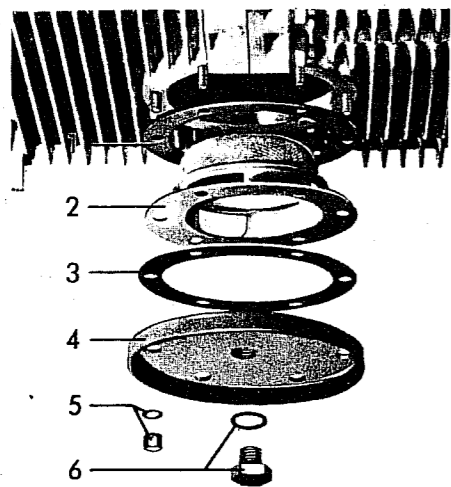


Fig. A.35. Exploded view of the oil strainer components.

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

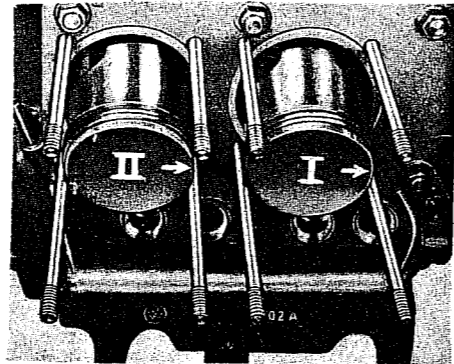


Fig. A.33. Number pistons as shown before removal.

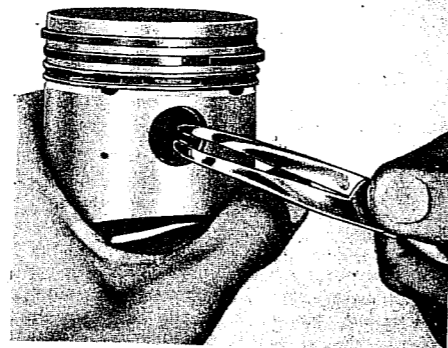


Fig. A.34. Removing the piston pin circlips using circlip pliers.

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 it 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 foul the crankshaft gear. Coat them very liberally with grease and slide them on to the shaft of a long screwdriver. Then put the screwdriver down the drive shaft passageway and allow the washers to slide down it. They will lodge in position on their shelf and the grease will allow you to nudge them precisely into position without their falling in to the crankcase.
4. Set Number 1 cylinder at firing point. The timing notch on the crankshaft pulley should be in line with the split in the crankcase and both valves for number 1 cylinder should be shut. You can check this by ensuring that the inlet valve for number 3 cylinder is just opening and the exhaust valve is just closing.
5. Insert the drive shaft so that the slot in the top of it is at right angles to the split in the crankcase (i.e. parallel to the crankshaft pulley). You may have to turn the shaft slightly as it goes in to allow the gears to mesh. The smaller segment at the top of the drive shaft should be closest to the crankcase crankshaft pulley.
6. Put the small coil spring in position in the top of the drive shaft.

CYLINDER HEADS

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

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

Removal

1. 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. A16).
3. Unscrew the 8 cylinder head nuts.
4. Remove the four push-rods, recording their position.
5. Pull off the cylinder head, taking care that the cylinders are not pulled off with it. The push rods 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 sign of leakage on the cylinder contact surface. If cracks or warping exist, the cylinder head must be exchanged.
2. Examine the spark plugs holes. Damaged threads can be repaired by fitting Heli Coil 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 unworn valve stem into the guide will give a good indication of the amount of wear.
4. 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 to the push rod tubes. Stretch the tubes a little by lengthening the concertina section with the fingers (see Fig. A24).
2. Slide the cylinder head into position so that the push rod tubes are held lightly. Check that they are seated correctly. The welded seam on each tube should point UPWARDS.
3. Lightly grease the cylinder head nuts with graphited grease and loosely fit the 8 nuts and washers in position.
4. Tighten the 8 nuts in the sequence shown in Fig. A25.
5. Slacken off all the valve clearance adjusting screws on the rockers and then refit the rocker shaft. Note that the slots in the supporting blocks face UPWARDS (Fig. A17).
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 conditions, it is sufficient to grind the valves in by hand, using valve grinding paste.

If the seats show signs of burning or damage, they can be re-cut, providing that the re-cutting process does not narrow the outer edge of the valve seat to below the sizes in the table :

Inlet valve seat	Exhaust valve seat
1.3 - 1.6 mm (0.051 - 0.063")	1.7 - 2.0 mm (0.067 - 0.079")

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 15 degree cutter until the seat width is within the correct limits.

ADJUSTING VALVE CLEARANCES

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

1. Raise and support the back of the car and remove both rear wheels (to give greater working access to the cylinder heads).

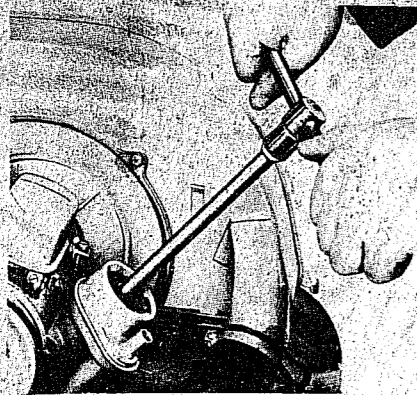


Fig. A.36. Removing the threaded ring for the oil filler, using a special socket.

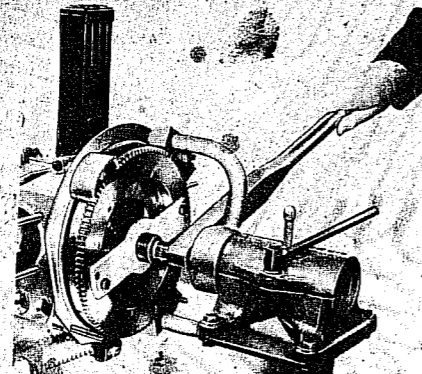


Fig. A.37. Removing the flywheel with a special fixture.

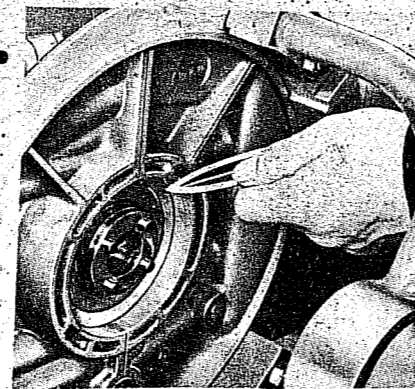


Fig. A.38. Removing the sharp edges on the oil seal counter-bore.

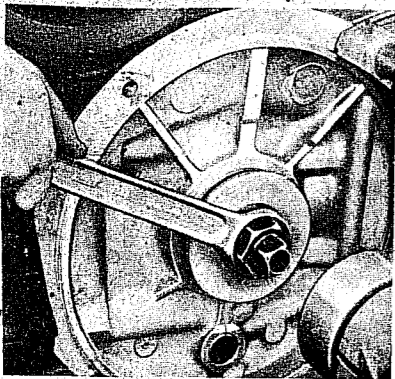


Fig. A.39. Installing the oil seal using a special tool.

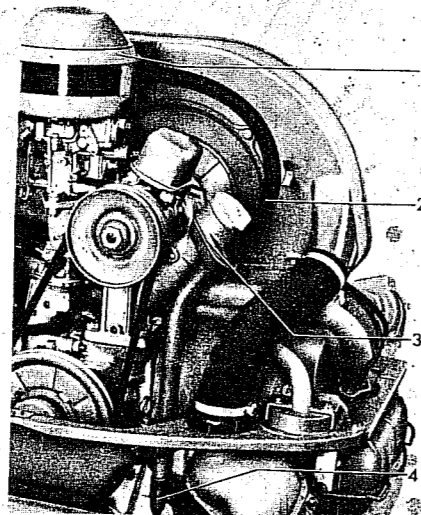


Fig. A.40. Crankcase ventilation system components.  
 1. Air cleaner  
 2. Connecting hose  
 3. Oil filler tube and breather  
 4. Rubber drain valve

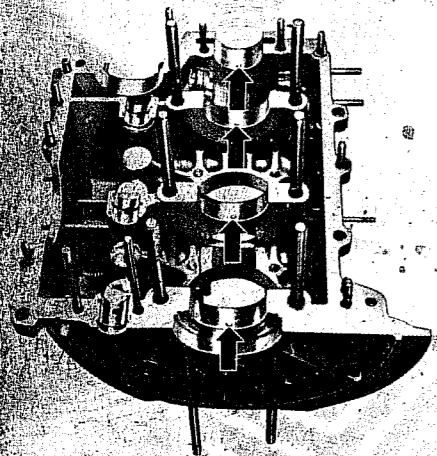


Fig. A.42. Main bearing shell locating dowels.

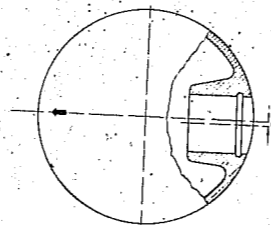


Fig. A.41 The arrow on the piston crown must point towards the flywheel end of the engine. "a" is the piston pin offset.

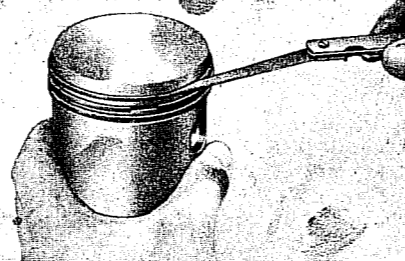


Fig. A.44. Checking the piston ring to groove clearance.

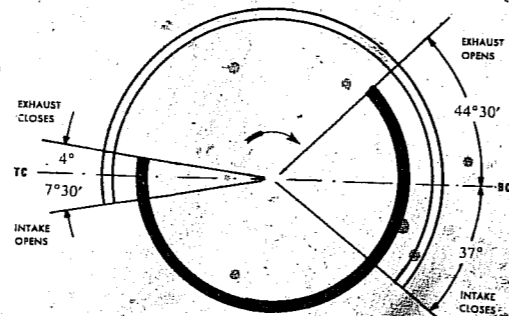


Fig. A.43. Theoretical valve timing diagram. The valve clearance should be 1.0mm. (0.040 in.).

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 until the rotor arm in the distributor points towards the notch on the rim of the distributor body and the notch on 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. (Rotor arm 90 degrees).
6. Adjust valves of No. 2 cylinder.
7. Rotate engine 180 degrees ANTICLOCKWISE. (Rotor arm 90 degrees)
8. Adjust valves for No. 3 cylinder.
9. Rotate engine 180 degrees anticlockwise and adjust valves of No. 4 cylinder.
10. Carefully clean around the valve cover seating face and, using NEW gaskets which have been cemented into the covers with non-setting sealing compound, re-fit the covers.

**CYLINDERS**

The Beetle engine cylinders are made of cast iron and are liberally finned. 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 the cylinder heads.
2. Number each cylinder. This is best done by paint marks or by filing small notches on the top fin.
3. Slide off each cylinder. It is unlikely that one will jam, but, if it does so, tap it very lightly all round with a rubber hammer. Excessive force will damage the brittle fins.

**Inspection**

General wear can be estimated by the size of the lip at the top of the cylinder. It can be measured precisely with an internal micrometer, and this will also indicate any ovality. Scoring marks on the cylinder walls are likely to lead to heavy oil consumption. It is the oil consumption of the engine which gives a good guide to the need for replacement of cylinders and pistons.

Check that the spigot at the base of the cylinder is not damaged and that the shoulder which rests on the crankcase is absolutely clean.

**Installation**

1. Coat the inner wall of the cylinder with oil.
2. Fit the paper gasket in position on the base of the cylinder.
3. Use a suitable compressor to compress the piston rings (Fig. A45).

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

4. Slide the cylinder into position. There is usually no difficulty here; any obstinacy is likely to be caused by carbon build up in the piston ring grooves.

**PISTONS**

The cast aluminium alloy pistons are fitted with one oil control ring and two compression rings. The piston pin is located by two circlips.

**Removal**

1. Remove cylinder heads and cylinders.
2. Number each piston. Try to do this in such a way that the metal is not scratched deeply. The marking should indicate which way up they were fitted (Fig. A33).
3. Remove both circlips on each piston with fine-nosed pliers (Fig. A34).
4. Support the piston and drive out the piston pin with a suitable drift.

**Inspection**

1. Carefully remove the piston rings, 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.

2. Remove carbon deposit from the crown of the piston without scratching the metal.

3. Place one of the compression rings in the bottom part of the cylinder and level it up with the piston. Measure the gap in the ring with a feeler gauge when the ring is about 5 mm inside the cylinder (Fig. A31). The gap limits are given in the following table:

Upper compression ring	0.30 - 0.45 mm	(0.012 - 0.018")
Lower " "	0.30 - 0.45 mm	(0.012 - 0.018")
Oil control ring	0.25 - 0.40 mm	(0.010 - 0.016")

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

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

	Clearance	Wear Limit
Upper Ring	0.06 - 0.09 mm (0.002 - 0.003")	max. 0.12 mm (0.005")
Lower Ring	0.04 - 0.07 mm (0.0015 - 0.0027")	max. 0.10 mm (0.004")
Oil Control Ring	0.02 - 0.05 mm (0.0008 - 0.002")	max. 0.10 mm (0.004")

6. Support the piston in position and drift in the piston pin.
7. Fit the circlips in their grooves.

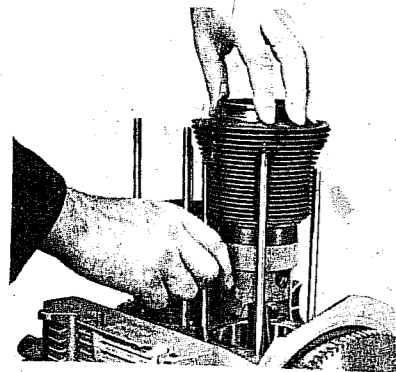


Fig. A.45. Installing the cylinder, using a piston ring compressor.

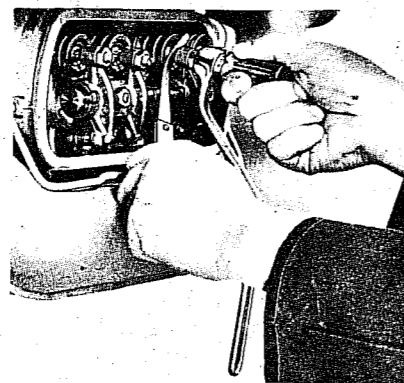


Fig. A.46. Adjusting the valve clearances

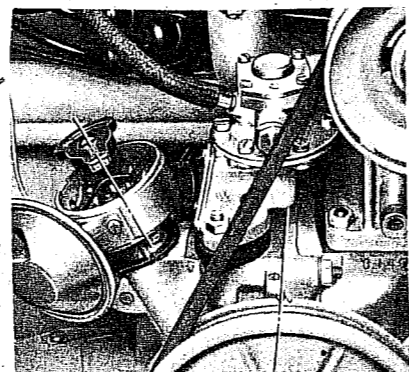


Fig. A.47. No. 1 piston is at T.D.C. on the compression stroke when the pulley marks are aligned and the rotor arm is positioned as shown.

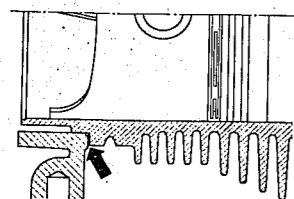


Fig. A.48 Location of the paper gasket between the cylinder and cylinder head. Fit before sliding the head over the piston.

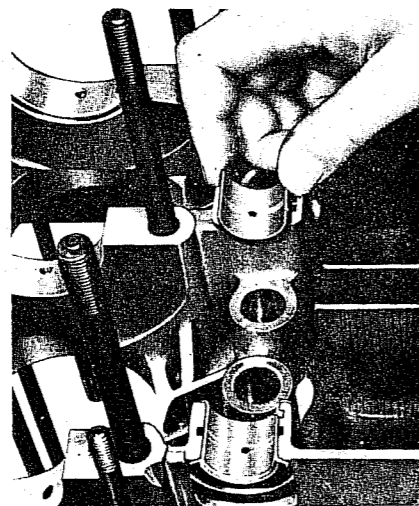


Fig. A.49. Installing the camshaft bearings.

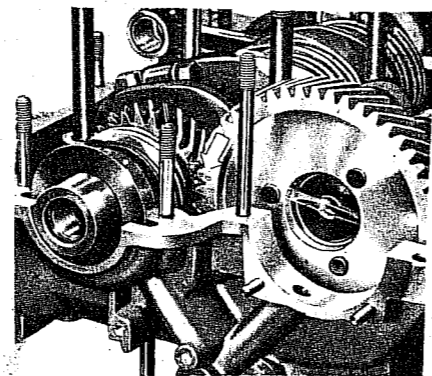


Fig. A.50 Camshaft alignment marks.

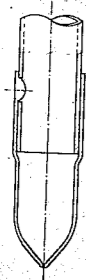


Fig. A.51. Rubber drain valve fitted to the bottom of the oil breather pipe.

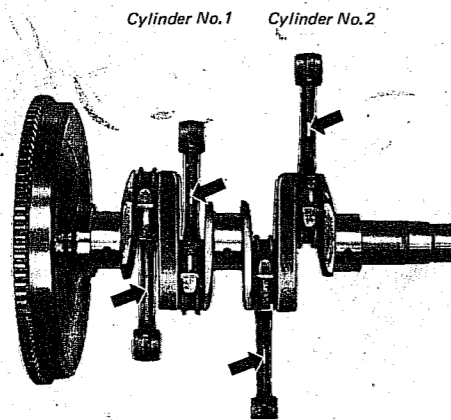


Fig. A.52. The crankshaft assembly must be installed with the marks indicated on the connecting rods facing upwards.

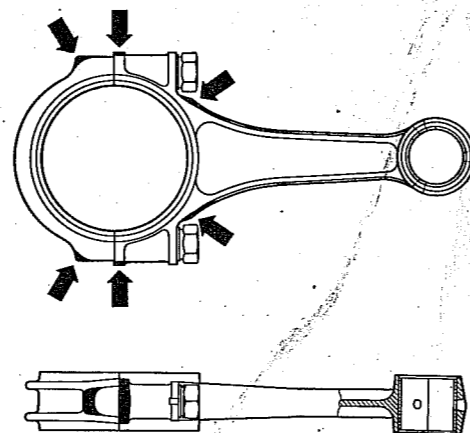


Fig. A.53. If balancing of the connecting rods is necessary, remove metal from points indicated.

**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 on reassembly. 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 bench as the flywheel tries to rotate.
2. Undo the gland nut with a 36 mm socket and suitable bar.
3. Ease off the flywheel, after marking both it and the end of the crankshaft so that they can be re-aligned.

**Inspection**

Heat damage to the clutch face and starter ring teeth damage can both be dealt with by machining. A maximum of 2 mm can be taken off the clutch side of the starter ring teeth and they must be re-chamfered.

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

**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 rawhide mallet. 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 passageways. If possible, blow them out with compressed air.
  3. Check the bores for the cam followers. Limits are :-  
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 bolted up to the correct torque). Limits are given in the table below:
- | Crankcase     | Bores | Limits           |
|---------------|-------|------------------|
| Main bearings | 1-3   | 65.0 - 65.02 mm  |
| " "           | 4     | 50.00 - 50.03 mm |
| Camshaft      | " 1-3 | 27.50 - 27.52 mm |
7. Pay particular attention to the seating surfaces for No. 1 main bearing. Use the new bearing to check that the seating 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), smear non-setting sealing compo and on all the mating surfaces. Make sure that none of it gets on the bearing surfaces or into the oil passageways.
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 remainder of the nuts.
7. Install the oil deflector plate which goes between the crankcase and the oil filler tower. There should be a gasket on either side of it and one surface is marked top (the cut-outs 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 bushes 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 the webs are held.
3. Unbolt the connecting rods and remove them.

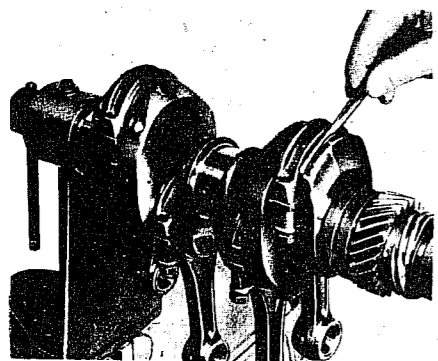


Fig. A.54. Checking the connecting rod axial play with a feeler blade.

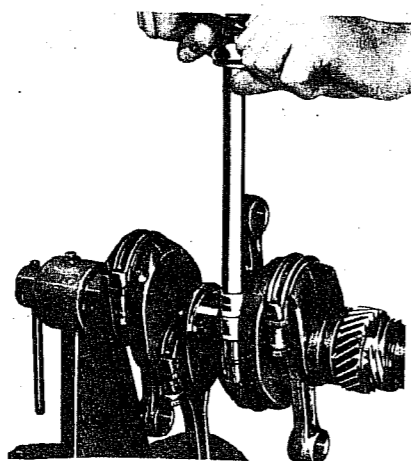


Fig. A.55. Tightening the connecting rod bolts.

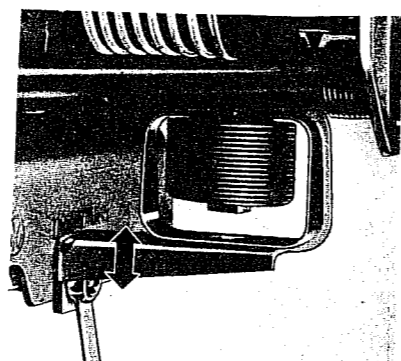


Fig. A.56. Adjustment of the air flaps is achieved by moving the thermostat bracket up or down as required.

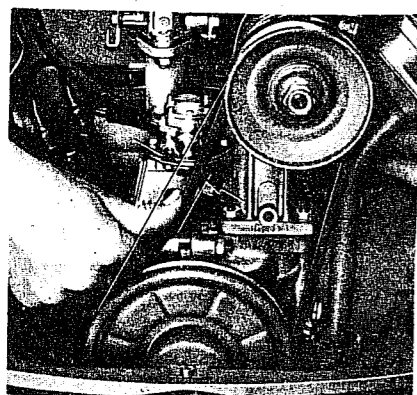


Fig. A.57. Check the drive belt tension at a point midway between the two pulleys.

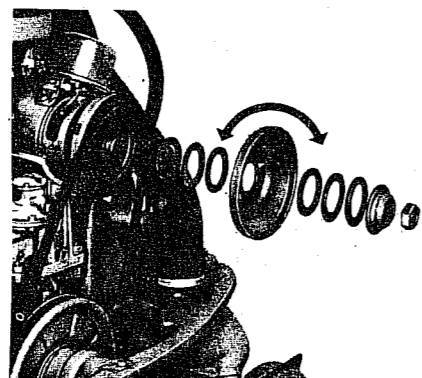


Fig. A.58. Adjustment of the drive belt is achieved by moving the spacer washers as shown.

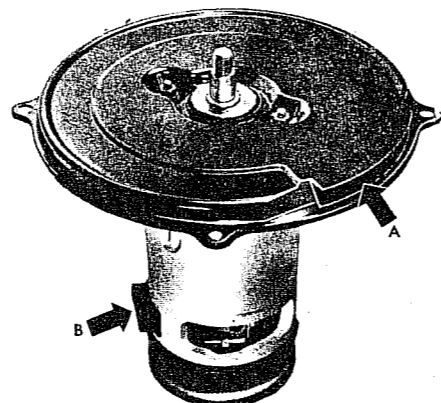


Fig. A.59. If cooling slots (A) are present, install the generator with the slots facing downwards.



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

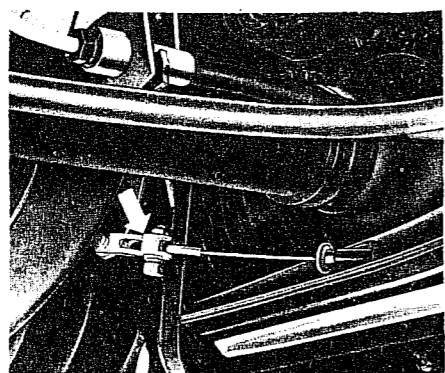


Fig. A.61. Heater cable rear connection.

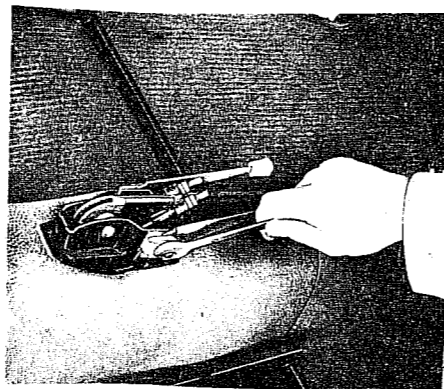


Fig. A.62. Detaching the heater cable at the control lever.

### Inspection

1. Inspect the condition of the crankshaft journals. If necessary, the shaft must be re-ground.
2. Check the camshaft and distributor drive gears.
3. Check the connecting rods 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 slop.

### Removal of the Crankshaft Gears 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 thread.
2. Remove the circlip which retains the gears.
3. Use an extractor to pull off the gears.

### Replacement of Crankshaft Gears and No. 3 Main Bearing

1. Slide the new bearing into position, making sure that the dowel recess is away from the gears.
2. Wrap the crankshaft and place it in a deep freeze or refrigerator.
3. Heat both of the gears in an oil bath to a temperature of about 80 degrees C.
4. Slide on the camshaft 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 passageways. 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. A52).
4. Gradually tighten the bolts to the required torque, tapping the joint regularly to avoid pre-tension (Fig. A55). When the bolts are fully tightened, the rods should fall smoothly under their own weight.
5. Measure the gap between the rod faces and the adjacent web with a feeler gauge (Fig. A54). The limits are :

New : 0.1 to 0.4 mm  
Wear Limit : 0.7 mm

### 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. A50).

4. Check that the dowels are correctly seated in the recesses of the main bearings (Fig. A42). 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 'felt' 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-split 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 thickness is etched on each one, it is advisable to measure this with a micrometer.
6. Install the 3 shims and refit the flywheel with a new metal gasket. Tighten it fully and re-check the end play.

NOTE : 3 shims must always be used.

#### 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 shoulder and the outer flange of the bearing.
2. Select shims which will provide the correct end play.
3. When the crankshaft is assembled in the case, check the end play.

#### Shims Available :

0.24 mm	0.34 mm
0.30 mm	0.36 mm
0.32 mm	0.38 mm

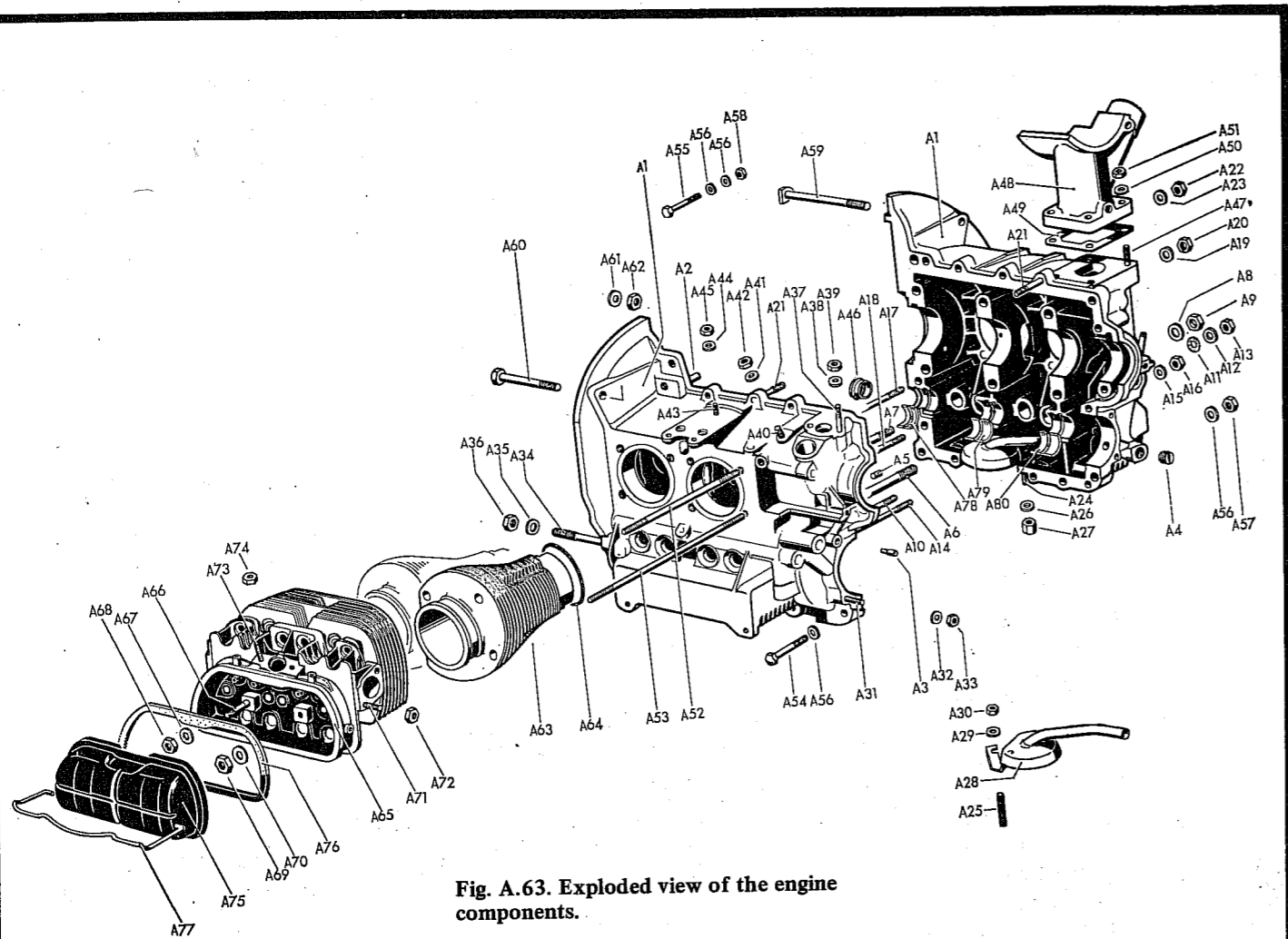


Fig. A.63. Exploded view of the engine components.

A1 Crankcase	A28 Oil pipe with dome	A55 Hex. bolt
A2 Dowel pin	A29 Washer	A56 Spring washer
A3 Oil passage plug	A30 Nut for oil pipe	A57 Hex. nut
A4 Slotted plug	A31 Oil pump stud	A58 Hex. nut
A5 Crankshaft bearing dowel	A32 Washer	A59 Starter motor bolt
A6 Securing stud	A33 Oil pump cover sealing nut	A60 Hex. bolt
A7 Securing stud	A34 Engine mounting stud	A61 Spring washer
A8 Washer	A35 Spring washer	A62 Hex. nut
A9 Hex. nut	A36 Hex. nut	A63 Cylinder
A10 Securing stud	A37 Fuel pump stud	A64 Cylinder gasket
A11 Sealing washer	A38 Fuel pump nut	A65 Cylinder head
A12 Spring washer	A39 Fuel pump nut	A66 Rocker shaft stud
A13 Hex. nut	A40 Distributor stud	A67 Spring washer
A14 Oil pump stud	A41 Spring washer	A68 Hex. nut
A15 Spring washer	A42 Hex. nut	A69 Cylinder head nut
A16 Hex. nut	A43 Oil cooler stud	A70 Washer
A17 Camshaft bearing stud	A44 Spring washer	A71 Exhaust flange stud
A18 Camshaft bearing stud	A45 Hex. nut	A72 Self-locking nut
A19 Spring washer	A46 Camshaft end plug	A73 Inlet manifold nut
A20 Hex. nut	A47 Support stud	A74 Hex. nut
A21 Securing stud	A48 Support	A75 Cylinder head cover
A22 Spring washer	A49 Dynamo support gasket	A76 Cylinder head cover gasket
A23 Hex. nut	A50 Spring washer	A77 Retaining spring
A24 Oil strainer cover nut	A51 Hex. nut	A78 Camshaft bearing shell
A25 Oil strainer stud	A52 Cylinder head stud	A79 Camshaft bearing shell
A26 Oil strainer cover gasket	A53 Cylinder head stud	A80 Camshaft bearing shell
A27 Oil strainer cover cap nut	A54 Hex. bolt	

CRANKCASE OIL SEAL

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

Removal

1. Prise out the old seal.

Installation

1. Lightly chamfer the edges of the oil seal housing with a scraper (Fig. A38).
2. Clean the housing and put a smear of sealing compound around the seal seating surface.
3. Press in the seal very evenly (Fig. A39). It MUST seat squarely.

CAMSHAFT

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

Inspection

1. Examine the lobes for wear. There should be no damage to the surface and the wear pattern should be even across the face of the lobe.
2. Examine the teeth of the gear for wear and check that the gear is firmly rivetted to the shaft.

Replacement Camshafts

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

Installation

1. Fit the bearing shells in position (Fig. A49).
2. Lightly lubricate the bearing surfaces and place the camshaft in one half of the crankcase, taking care that the gear tooth marked 'O' is between the two teeth on the crankshaft gear which have punch marks on them (Fig. A50).

# Technical Data

## GENERAL SPECIFICATIONS

Design	4 stroke, air cooled, internal combustion engine forming one unit with gearbox and differential in rear of vehicle
Number of cylinders	Two pairs horizontally opposed
Bore :	
1200 & 1300	3.03 in (77 mm)
1500	3.27 in (83 mm)
1600	3.36 in (85.5 mm)
Stroke :	
1200	2.52 in (64 mm)
1300, 1500 & 1600	2.72 in (69 mm)
Cylinder capacity :	
1200	1192 c.c. (72.7 cu.in)
1300	1285 c.c. (78.4 cu.in)
1500	1493 c.c. (91.1 cu.in)
1600	1584 c.c. (96.6 cu.in)
Compression ratio :	
1200	7.0 : 1
1300 - Low compression	6.6 : 1
1300	7.3 : 1
1500	7.5 : 1
1600 - Low compression	6.6 : 1
1600 - Prior to April 1968	7.7 : 1
1600 - As from April 1968	7.5 : 1
Model 181	6.6 : 1
Max. performance : (SAE in brackets)	
1200	34 H.P. at 3600 rpm. (41.5 at 3900 rpm.)
1300 - Prior to Aug. 1970	40 H.P. at 4000 rpm. (50 at 4200)
1300 - As from Aug. 1970	44 H.P. at 4100 rpm. (52 at 4600)
1500	44 H.P. at 4000 rpm. (53 at 4200)
1600 - Prior to Aug. 1970	47 H.P. at 4000 rpm. (57 at 4400)
1600 - As from Aug. 1970	50 H.P. at 4000 rpm. (60 at 4400)
Model 181 - 1500	44 H.P. at 3800 rpm. (53 at 4200)
Model 181 - 1600	47 H.P. at 4000 rpm. (57 at 4400)
Max. torque (kgm/rpm and lb.ft./rpm) :	
1200	8.4/200 (65/2400) - DIN
1300 - Prior to Aug. 1970	8.9/2000 (69/2400) - DIN
1300 - As from Aug. 1970	8.7/3000 (67/3000) - DIN
1500	10.2/2000 (78/2600) - DIN
1600 - Prior to Aug. 1970	10.6/3000 (81.7/3400) - DIN
1600 - As from Aug. 1970	10.6/2800 (81.7/3000) - DIN
Model 181	10.0/3800 (72.6/4200) - DIN
Cylinders	Single cylinders of special cast iron, finned
Crankcase	Magnesium cast alloy, built in two halves
Cylinder heads	One pair for each pair of cylinders, aluminium alloy
Valve seat inserts	Shrunk-in, sintered steel
Valve guides	Shrunk-in, special brass
Crankshaft	Forges high quality steel, four plain bearings
Main bearings No. 1,3 and 4	Aluminium bushes, lead coated
Main bearing No. 2 (centre)	Split shells, aluminium alloy
Main bearing diameter - No. 1-3	2.1654 in (55 mm)
Main bearing - No. 4	1.5748 in (40.0 mm)
Flywheel	Forges, with integral starter gear ring

Connecting rods	Forged with "H" section shaft
Big end bearings	Three-layer, thin-wall shells
Small end bush	Pressed-in bronze
Pistons	Light alloy with steel inserts
Piston pins	Fully floating, secured by circlips
Piston rings	2 compression, 1 oil control ring
Valve operating gear	Single camshaft situated in crankcase below crankshaft, valves operated via push rods and rocker arms
Camshaft	Grey cast iron, three bearings
Camshaft bearings	Thin-wall steel with white metal
Camshaft drive	Helical gears - from crankshaft
Valves	1 inlet, 1 exhaust per cylinder
Valve arrangement	Overhead
Valve clearances (cold)	0.004 in (0.10 mm)
Valve springs	1 per valve
Valve timing with valve clearance of 0.04 in (1.0 mm) :	
Inlet opens	6° B.D.T.C. (1200) 7° 30' B.T.D.C. (others)
Inlet closes	35° 30' A.B.D.C. (1200) 37° A.B.D.C. (others)
Exhaust opens	42° 30' B.B.D.C. (1200) 44° 30' B.B.D.C. (others)
Exhaust closes	3° A.T.D.C. (1200) 4° A.T.D.C. (others)
Cooling system	Air cooled by fan on generator shaft.
Fan drive	Belt driven from crankshaft
Cooling air intake	Thermostatically controlled
Air intake amount - 1200	530 ltrs./sec. (19 cu.ft./sec.)
- 1300	550 ltrs./sec. (19 cu.ft./sec.)
- 1500 & 1600	575 ltrs./sec. (21 cu.ft./sec.)

Lubrication	Pressure-feed by gear-type pump
Oil cooling	Oil cooler in fan air stream
Oil pressure control	By relief valve
Oil capacity	4.4 Imp. pts (5.3 U.S. pts; 2.5 l.)

## REPAIR DATA

Cylinder seating depth in cylinder head :	
1200	0.538-0.542 in (13.7-13.8 mm)
1300	As for 1200
1500/1600	0.540-0.544 in (13.75-13.85 mm)
Cylinder out-of-round	0.004 in (0.01 mm)
Piston/cylinder clearance	0.0015-0.0019 in (0.04-0.05 mm)
Wear limit	0.008 in (0.20 mm)
Piston ring side clearance :	
Upper compression ring :	
1200/1300	0.0027-0.0035 in (0.07-0.09 mm)
1500/1600	0.0027-0.0039 in (0.07-0.10 mm)
Wear limit	0.0047 in (0.12 mm)
Lower compression ring :	
All models	0.0019-0.0027 in (0.05-0.07 mm)
Wear limit	0.0039 in (0.10 mm)
Oil control ring :	
All models	0.0012-0.0019 in (0.03-0.05 mm)
Wear limit	0.0039 in (0.10 mm)

Piston ring gaps :	
Compression ring	0.012-0.018 in (0.30-0.45 mm)
Wear limit	0.035 in (0.90 mm)
Oil control ring	0.010-0.016 in (0.25-0.40 mm)
Wear limit	0.037 in (0.95 mm)
Rocker arm inside diameter	0.7086-0.7094 in (18.00-18.02 mm)
Wear limit	0.7102 in (18.04 mm)
Rocker shaft diameter	0.7074-0.7078 in (17.97-17.98 mm)
Wear limit	0.7067 in (17.95 mm)
Valve springs :	
Fitted length - 1200	1.305 in (33.4 mm)
Fitted length - others	1.220 in (31.0 mm)
Fitted load - 1200	90-102 lb (40.8-46.8 kg)
Fitted load - others	117-135 lb (53.2-61.2 kg)
Valve seat width :	
Inlet	0.05-0.063 in (1.3-1.6 mm)
Exhaust	0.067-0.079 in (1.7-2.0 mm)
Valve seats :	
Inlet seat angle	45°
Exhaust seat angle	45°
Outer correction angle	15°
Inner correction angle	75°
Valve guides :	
Inlet - inside dia.	0.3150-0.3157 in (8.0-8.015 mm)
Exhaust - inside dia.	0.3150-0.3157 in (8.00-8.015 mm)
Wear limit	0.3173 in (8.06 mm)
Valve head diameter - Inlet valves	
1200	1.239 in (31.5 mm)
1300	1.299 in (33.0 mm)
1500/1600	1.397 in (35.5 mm)
Valve head diameter - Exhaust valves :	
1200	1.181 in (30.0 mm)
1300	1.181 in (30.0 mm)
1500/1600	1.259 in (32.0 mm)
Valve stem diameters :	
Inlet	0.3125-0.3129 in (7.94-7.95 mm)
Wear limit	0.3109 in (7.90 mm)
Exhaust	0.3114-0.3118 in (7.91-7.92 mm)
Wear limit	0.3098 in (7.87 mm)
Valve stem/guide clearances :	
Inlet	0.002-0.003 in (0.05-0.075 mm)
Wear limit	0.006 in (0.16 mm)
Exhaust	0.0031-0.0041 in (0.08-0.105 mm)
Wear limit	0.006 in (0.16 mm)
Crankcase bore for crankshaft bearings :	
No.1 - No.3 bearings	2.5590-2.5597 in (65.00-65.02 mm)
Wear limit	2.5601 in (65.03 mm)
No.4 bearing	1.9685-1.9697 in (50.00-50.03 mm)
Wear limit	1.9700 in (50.04 mm)
Bore for flywheel seal	3.5433-3.5452 in (90.00-90.05 mm)
Bore for camshaft bearings	1.0825-1.0852 in (27.5-27.52 mm)
Bore for oil pump housing	2.7560-2.7580 in (70.00-70.03 mm)
Camshaft out-of-round	0.0016 in (0.04 mm)
Main journals out-of-round	0.0012 in (0.03 mm)
Crankshaft out-of-round	0.0012 in (0.03 mm)
Crankpins out-of-round	0.0012 in (0.03 mm)
Fan pulley out-of-round	0.0012 in (0.03 mm) max.
Flywheel run out	0.012 in (0.30 mm)

Camshaft :	
Bearing diameter	0.9837-0.9842 in (24.99-25.00 mm)
Run-out at centre bearing	0.0008 in (0.02 mm)
Wear limit	0.0016 in (0.04 mm)
Camshaft/bearing clearance	0.0008-0.0019 in (0.02-0.05 mm)
Wear limit	0.0047 in (0.12 mm)
Thrust bearing end float	0.0016-0.005 in (0.04-0.13 mm)
Wear limit	0.0063 in (0.16 mm)
Camshaft gear backlash	0.00-0.0019 in (0.00-0.05 mm)
Camshaft tappet dia.	0.7463-0.7471 in (18.96-18.98 mm)
Wear limit	0.7452 in (18.93 mm)
Tappet bore dia.	0.7480-0.7489 in (19.00-19.02 mm)
Wear limit	0.750 in (19.05 mm)
Bore/tappet clearance	0.0008-0.0024 in (0.020-0.062 mm)
Wear limit	0.0047 in (0.120 mm)
Crankshaft and connecting rods :	
Bearing dia. Nos. 1-3	2.1640-2.1648 in (54.97-54.99 mm)
Bearing No.4	1.5739-1.5748 in (39.98-40.00 mm)
Crankpin dia.	2.1640-2.1648 in (54.97-54.99 mm)
Bearing running clearances :	
Nos. 1-3	0.0016-0.0047 in (0.04-0.10 mm)
Wear limit	0.007 in (0.18 mm)
No. 2	0.0011-0.0035 in (0.03-0.09 mm)
Wear limit	0.0066 in (0.17 mm)
No.4	0.0019-0.004 in (0.05-0.10 mm)
Wear limit	0.0074 in (0.19 mm)
Crankshaft / No.1 bearing	
End float	0.0027-0.005 in (0.07-0.13 mm)
Wear limit	0.006 in (0.15 mm)
Crankpin/connecting rod clearances :	
End clearance	0.004-0.016 in (0.1-0.4 mm)
Radial clearance	0.0008-0.0031 in (0.02-0.08 mm)
Oil pressure SAE 30 Oil	42 psi (3 kg/sq.cm) - Normal 28 psi (2.0 kg/sq.cm) - Minimum
Oil pressure relief valve spring :	
Fitted length	0.928 in (23.6 mm)
Fitted load	17 lb (7.75 kg)
Oil pressure regulating spring :	
Fitted length	0.661 in (16.8 mm)
Fitted load	9.6 lb (4.35 kg)
Oil pump :	
End float of gears/housing	0.004 in (0.10 mm)
Backlash of gears	0.0-0.008 in (0.0-0.2 mm)
Oil pressure contacts open	2.1-6.3 psi (0.15-0.45 kg/sq.cm)

# Ignition System

**GENERAL**

**DISTRIBUTOR** – Removal & Installation

**CONTACT BREAKER POINTS** – Replacement and Adjustment

**IGNITION TIMING** – Adjustment

**CONDENSER** – Testing & Replacement

**GENERAL**

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

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

**DISTRIBUTOR (Fig. B1)**

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

**Removal**

1. Pull the vacuum hoses off the distributor vacuum unit
2. Disconnect the cable at terminal No. 1 on the ignition coil
3. Remove the distributor cap.
4. Remove the nut and washer which lock the distributor clamp to the crankcase.
5. Pull out the distributor. If it is tight, this will probably be due to the rubber sealing ring which is fitted half-way down the shaft.

DO NOT allow foreign matter to fall into the hole.

**Installation**

Check the following points :

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

**CONTACT BREAKER POINTS**

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

**Removal**

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

**Installation**

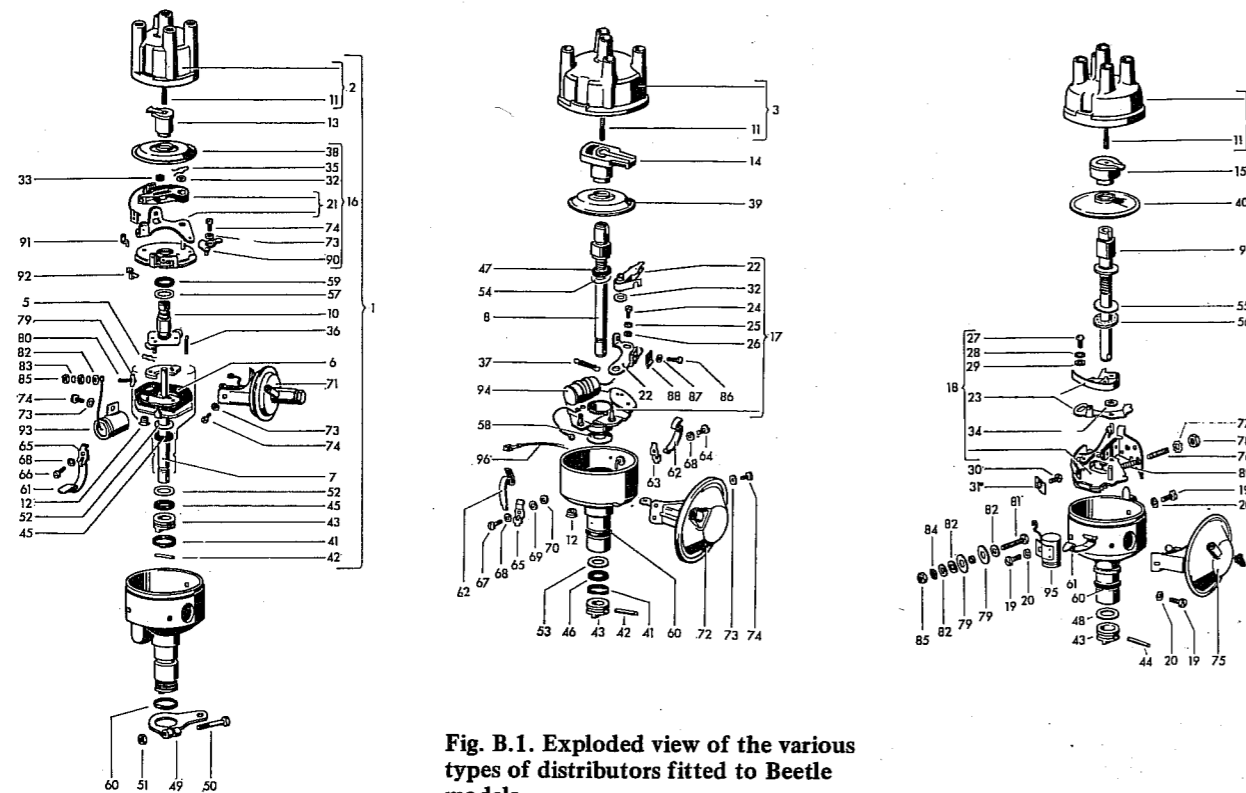
Check the following points :

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

**Adjustment :**

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

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

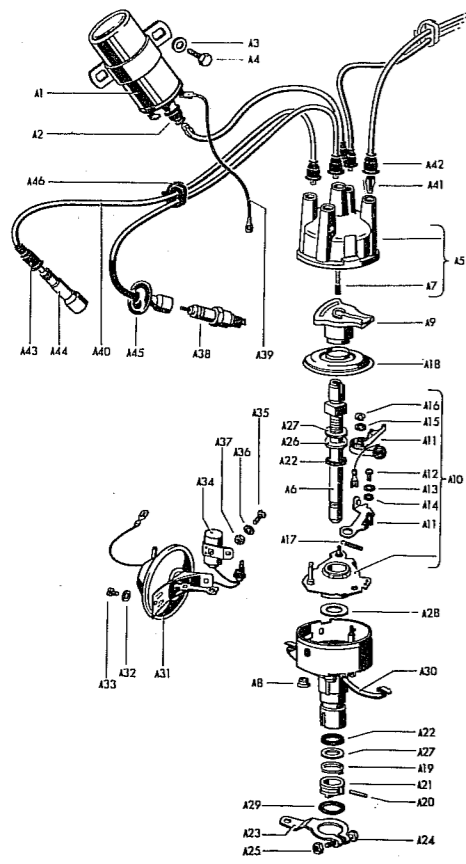


**Fig. B.1. Exploded view of the various types of distributors fitted to Beetle models.**

1. Distributor (early type)
2. Distributor cap (up to Eng. No. 3 912 903)
3. Distributor cap (early type)
4. Distributor cap - 113 905 205 B/J/L
5. Spring clip for flyweights
6. Damping plate
7. Distributor shaft
8. Distributor shaft with cams
9. Distributor shaft with cam
10. Distributor cam
11. Carbon brush with spring
12. Safety screen
13. Rotor
14. Rotor
15. Rotor
16. Contact breaker plate
17. Contact breaker plate
18. Contact breaker plate
19. Screw
20. Shake-proof washer
21. Contact breaker points
22. Contact breaker points
23. Contact breaker points
24. Screw
25. Lock washer
26. Washer
27. Screw
28. Shake-proof washer
29. Washer
30. Bolt
31. Lock plate
32. Shim

33. Washer
34. Insulating disc
35. Spring clip
36. Tension spring
37. Breaker plate return spring
38. Sealing disc
39. Sealing disc
40. Sealing disc
41. Locking ring for drive dog
42. Pin for drive dog
43. Drive dog
44. Dowel pin
45. Distance washer
46. Distance washer
47. Distance washer
48. Distance washer
49. Distributor retainer
50. Bolt
51. Nut
52. Shim plate on shaft
53. Spacer for distr. shaft
54. Spacer on distr. shaft
55. Thrust washer
56. Thrust washer
57. Shim plate
58. Spacer
59. Fibre shim
60. Sealing ring
61. Spring clip
62. Spring clip
63. Retainer
64. Screw

65. Clip
66. Screw
67. Screw
68. Lock washer
69. Spring washer
70. Nut
71. Vacuum unit
72. Vacuum unit
73. Spring washer
74. Screw
75. Vacuum unit
76. Stud
77. Spring washer
78. Nut
79. Insulating washer
80. Bolt
81. Bolt
82. Washer
83. Lock washer
84. Shake-proof washer
85. Nut
86. Bolt
87. Lock washer
88. Threaded plate
89. Return spring
90. Bracket for breaker plate
91. Eccentric bolt for breaker point
92. Spring
93. Condenser
94. Condenser
95. Condenser
96. Cable - coil to distributor



- A1 Coil (6 or 12 volts)
- A2 Rubber cap
- A3 Washer
- A4 Bolt
- A5 Distributor cap - (later model)
- A6 Distributor shaft with cam
- A7 Carbon brush with spring
- A8 Safety screen
- A9 Rotor
- A10 Contact breaker plate
- A11 Set of contact breakers
- A12 Screw
- A13 Shake-proof washer
- A14 Washer
- A15 Shim
- A16 Spring washer
- A17 Return spring for contact plate
- A18 Sealing disc
- A19 Lockring for drive dog
- A20 Pin for drive dog
- A21 Drive dog
- A22 Distance washer for drive dog
- A23 Retainer for distributor
- A24 Bolt
- A25 Nut
- A26 Spacer for distr. shaft
- A27 Spacer for distr. shaft
- A28 Spacer
- A29 Sealing ring
- A30 Spring clip
- A31 Vacuum unit
- A32 Spring washer
- A33 Screw
- A34 Condenser
- A35 Screw
- A36 Spring washer
- A37 Nut
- A38 Spark plug
- A39 Cable - coil to distributor
- A40 Ignition cable
- A41 Connector
- A42 Rubber cap
- A43 Cap
- A44 Spark plug connector
- A45 Spark plug rubber cap
- A46 Holder for ignition cable

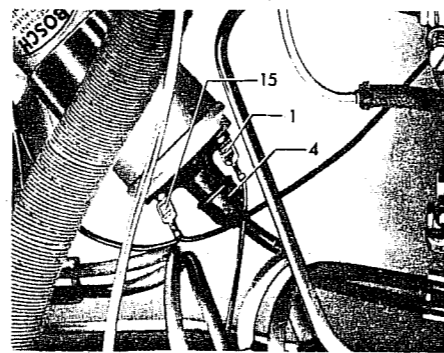


Fig. B.2. Ignition coil connections  
 1. To distributor L.T. terminal (Contact breaker).  
 4. To distributor cap (H.T.)  
 15. To ignition switch.

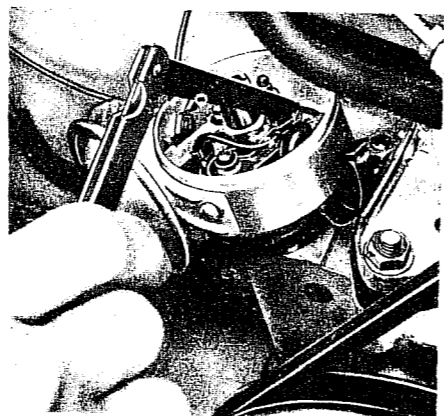


Fig. B.3. Checking the points gap with a feeler blade.

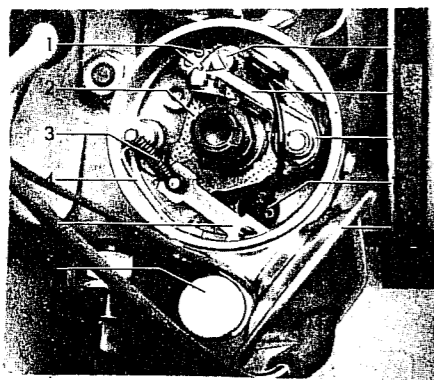


Fig. B.4. Distributor contact breaker plate.

- 1. Pins and slot
- 2. Advance base plate
- 3. Return spring
- 4. Earth connection
- 5. Vacuum pull rod
- 6. Condenser
- 7. Securing screw
- 8. Breaker contact
- 9. Breaker arm spring
- 10. Low tension cable
- 11. Vacuum advance unit

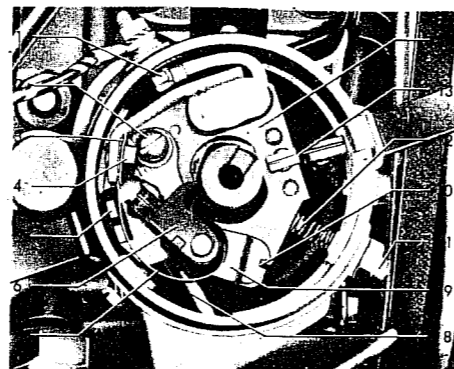


Fig. B.5. Distributor contact breaker plate.

- 1. Terminal stud with cable
- 2. Securing screw
- 3. Contact breaker spring
- 4. Screw
- 5. Stop bracket
- 6. Breaker arm
- 7. Breaker arm spring
- 8. Vacuum unit pull rod
- 9. Fixed contact breaker
- 10. Adjusting slot
- 11. Threaded rod
- 12. Spring
- 13. Leaf spring
- 14. Breaker base plate

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. Lever 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 any cylinder fires. It therefore has a major effect upon performance and economy and it is essential that the timing is correct.

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

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

It is possible to adjust and set the ignition timing with a simple 12 volt test lamp and this procedure should be found adequate for the 1200 engine. However; the more complex vacuum system fitted to 1300 and 1600 engines calls for the use of a stroboscope.

Adjustment - With Test Lamp

1. Remove the distributor cap and rotor arm.
2. Check contact breaker gap.
3. Rotate the engine until the 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 joint between the two crankcase halves.

NOTE : On the 1200 engine, there may be either 1, 2 or 3 notches on the rim of the pulley, all close together. If there is only one notch, use this. If there are 2 notches, use the left hand one (7.5 degrees before Top Dead Centre). If there are 3 notches, two will be seen to be closer together than the third. Use the left hand one of these two, i.e., the middle notch.

4. Connect a test lamp between terminal No. 1 on either the coil or the distributor and a suitable earthing 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 notch lines up correctly.

Adjustment - With Stroboscopic Light

A stroboscope is a high voltage lamp which flashes in time with the engine. Simple versions are usually connected between the distributor and one of the plug leads 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

Vehicle Type	Ignition Setting	Pulley Notch	Vacuum Hose
1300	7.5 deg. B.T.D.C.	left-hand one of two	Disconnected
1300 (stickshift)	7.5 deg. B.T.D.C.	left-hand one of two	Disconnected
1300	5.0 deg. A.T.D.C.	one only	Connected
1300 (stickshift)	5.0 deg. A.T.D.C.	one only	Connected
1600 (with emission control)	0.0 deg.	left-hand one of three	Disconnected
1600	5.0 deg. A.T.D.C.	one only	Connected

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

Testing Condenser Performance

1. Disconnect the main high tension cable between coil and distributor at the distributor cap.
2. Hold the disconnected end of the cable about 10 mm (1/2") from



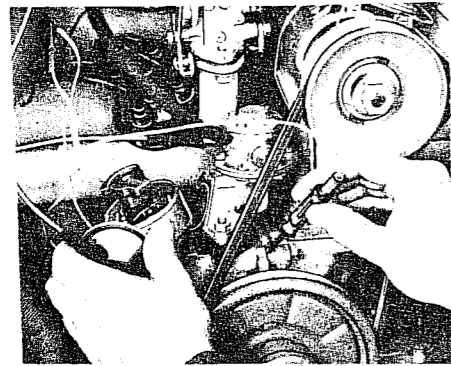


Fig. B.6. Setting the ignition timing using a test lamp.

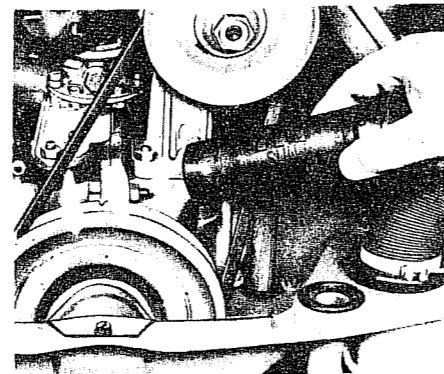


Fig. B.7. Setting the ignition timing using a stroboscopic light.

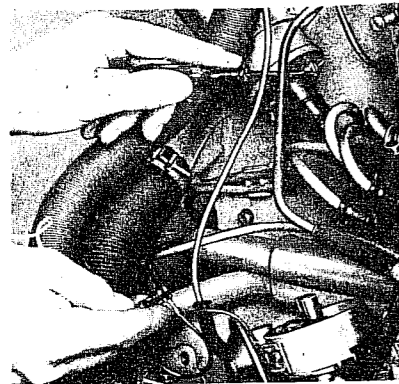


Fig. B.8. Checking the condenser with a test lamp.

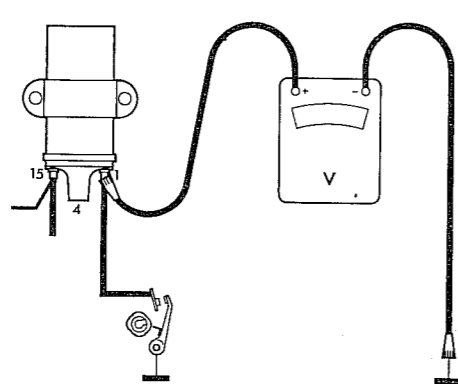


Fig. B.9. Checking the condenser with a voltmeter.

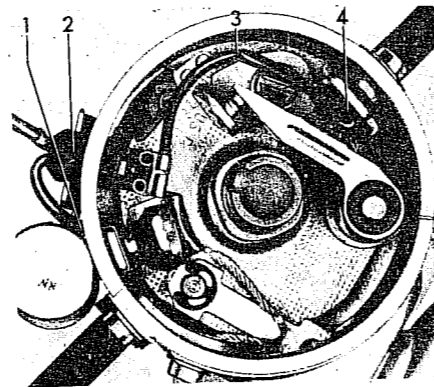


Fig. B.10. Condenser testing points.

1. Condenser
2. Cable entry
3. Cable
4. Insulation on breaker arm spring

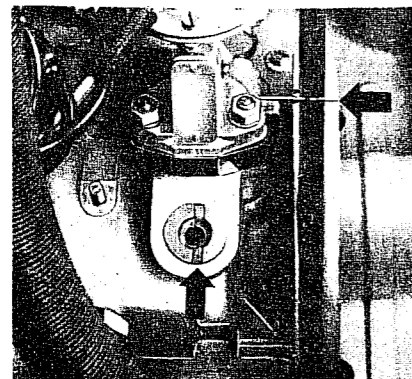


Fig. B.11. Correct alignment of the pulley mark and distributor drive slot for the installation of the distributor.

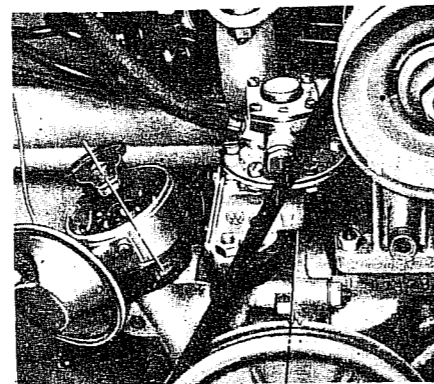


Fig. B.12. Correct position of the distributor after installation (No. 1 cylinder at T.D.C. on the compression stroke.)

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

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

#### Replacement

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

#### Internal Condenser

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

#### External Condenser

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

#### Installation

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

# Technical Data

Ignition Coil :	
1200 (6 volts) . . . . .	111 905 105 L
All others (12 volts) . . . . .	311 905 115 A

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

Distributor Application :	Type	Designation	Advance
1200 - Prior to Aug. 1968 . . . . .	Bosch	113 905 205 K	Vacuum
- Aug. 1968 to Aug. 1970 . . . . .	VW	113 905 205 L	Vacuum
- As from Aug. 1970 . . . . .	Bosch	111 905 205 T	Vacuum
1300 - Prior to Aug. 1968 . . . . .	Bosch	111 905 205 AA	Vacuum
- Aug. 1968 to Aug. 1970 . . . . .	Bosch	113 905 205 K	Vacuum
- Aug. 1970 to June 1971 . . . . .	VW	113 905 205 L	Vacuum
- As from June 1971 . . . . .	Bosch	111 905 205 T	Vacuum
1300 Auto - Prior to Aug. 1969 . . . . .	Bosch	113 905 205 AJ	Cent & double-acting vacuum
- Aug. 1969 to Aug. 1970 . . . . .	Bosch	113 905 205 AL	Cent & single-acting vacuum
- Aug. 1970 to June 1971 . . . . .	Bosch	113 905 205 AB	Cent & vacuum
- As from June 1971 . . . . .	Bosch	113 905 205 AC	Cent & vacuum
1500 - Prior to Aug. 1968 . . . . .	Bosch	113 905 205 AK	Cent & double-acting vacuum
- As from Aug. 1968 . . . . .	Bosch	113 905 205 AM	Cent & single-acting vacuum
1500 Auto - Prior to Aug. 1968 . . . . .	Bosch	113 905 205 K	Vacuum
- Aug. 1968 to Aug. 1969 . . . . .	VW	113 905 205 L	Vacuum
- As from Aug. 1969 . . . . .	Bosch	111 905 205 T	Vacuum
1500 USA - Prior to Aug. 1968 . . . . .	Bosch	113 905 205 P	Cent & Vacuum
- Aug. 1968 to Aug. 1969 . . . . .	Bosch	113 905 205 AA	Cent & vacuum
- As from Aug. 1969 . . . . .	Bosch	113 905 205 AC	Cent & vacuum
1500 USA Auto - Prior to Aug. 1968 . . . . .	Bosch	113 905 205 M	Vacuum
- Aug. 1968 to Aug. 1969 . . . . .	Bosch	113 905 205 T	Vacuum
- As from Aug. 1969 . . . . .	Bosch	113 905 205 P	Cent & vacuum
1600 - Prior to June 1971 . . . . .	Bosch	113 905 205 AA	Cent & vacuum
- As from June 1971 . . . . .	Bosch	113 905 205 AD	Cent & double-acting vacuum
1600 Auto - Prior to June 1971 . . . . .	Bosch	113 905 205 AJ	Cent & double acting vacuum
- As from June 1971 . . . . .	Bosch	113 905 205 AL	Cent & single vacuum
1600 USA - Prior to Aug. 1970 . . . . .	Bosch	113 905 205 AK	Cent & double-acting vacuum
- As from Aug. 1970 . . . . .	Bosch	113 905 205 AM	Cent & single-acting vacuum
1600 USA Auto - Prior to Aug. 1970 . . . . .	Bosch	113 905 205 T	Vacuum
- As from Aug. 1970 . . . . .	Bosch	113 905 205 AJ	Cent & double-acting vacuum
181 . . . . .	Bosch	113 905 205 AD	Cent & double-acting vacuum
		113 905 205 AH	Cent & double-acting vacuum
		113 905 205 AJ	Cent & double-acting vacuum

Ignition Timing :	
1200 - Prior to Aug. 1970 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
- As from Aug. 1970 . . . . .	T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1300 - Prior to Aug. 1970 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
- Aug. 1970 to June 1971 . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
- As from June 1971 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1300 Auto - Prior to June 1971 . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
- As from June 1971 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1500 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1500 Auto - Prior to July 1969 . . . . .	T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
- As from July 1969 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1500 USA . . . . .	T.D.C. at 800 - 900 rev/min (Vacuum Disconnected)
1500 USA Auto - Prior to Aug. 1969 . . . . .	T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
- As from Aug. 1969 . . . . .	T.D.C. at 800 - 900 rev/min (Vacuum connected)
1600 - Prior to June 1971 . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
- As from June 1971 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1600 Auto - Prior to June 1971 . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
- As from June 1971 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
1600 USA . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
1600 USA Auto . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)
181 - 1500 . . . . .	7.5° B.T.D.C. at 800 - 900 rev/min (Vacuum disconnected)
- 1600 . . . . .	5° A.T.D.C. at 800 - 900 rev/min (Vacuum connected)

Spark Plugs :	
Type . . . . .	Bosch W 145 T1, Champion L 88, L 88n or equivalent
Electrode gap . . . . .	0.024 - 0.028 in (0.6 - 0.7 mm)

# Fuel System

## GENERAL

### AIR CLEANER

#### CARBURETTOR - Removal & Installation

#### CARBURETTOR - Disassembly & Assembly

#### AUTOMATIC CHOKE - Removal, Inspection & Installation

#### IDLING ADJUSTMENT

## 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 carburettor. There are flexible hoses between the tank and the rigid line inside the backbone and between the backbone line and the line in the engine compartment. The hoses can be disconnected if they are plugged or clamped.

In the carburettor, the fuel is mixed with air which is pre-heated, if necessary, by the thermo-statically 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 thermostat by a cable. On later models, the flap is controlled by a thermostat inside the air cleaner itself.

## CARBURETTOR

The carburettor mixes fuel and air in the correct ratio. When the accelerator pedal is pressed down, the throttle valve in the throat of the carburettor 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. In the upper part of the carburettor throttle is the choke valve. With a cold engine, this is forced into a closed position by a bi-metal spring which is housed in the ceramic case on the side of the carburettor. 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 connected by a drilling 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 heating element connected to the ignition system. As soon as the ignition is switched on, this begins to heat up and so unwind the bi-metal spring. In this way, the choke valve is gradually opened as the engine warms up. A fast idling cam sets the position of the choke valve when the accelerator pedal is first pressed down.

The 1970 1600 Beetle and all 1971 models are fitted with a modified carburettor, the PICT-3, which is adjusted in a different way to its predecessor, the PICT-2.

## THROTTLE VALVE POSITIONER

### DASHPOT

#### FUEL PUMP - Cleaning the Filter, Removal, Dismantling & 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 flap 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 or the oil will be spilt.
3. Disconnect the fuel line and the vacuum line from the near side of the carburettor.
4. Detach the cable for the automatic choke.
5. Disconnect the throttle cable at the carburettor. The rod-like end of the cable passes through a clamp in the throttle operating arm.
6. Unbolt the carburettor from the inlet manifold (13 mm). Studs in the carburettor flange pass through holes in the inlet manifold flange and have 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 unwinds from the carburettor as it can easily be replaced.

## Installation

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

1. Always use a new gasket between carburettor and inlet manifold - an air leak at this point would cause poor performance and economy.
2. When you reconnect the throttle cable 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 carburettor on to the manifold. Tighten the two nuts evenly 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.

## Disassembly

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

The following parts may now be removed as necessary, cleaned and checked :

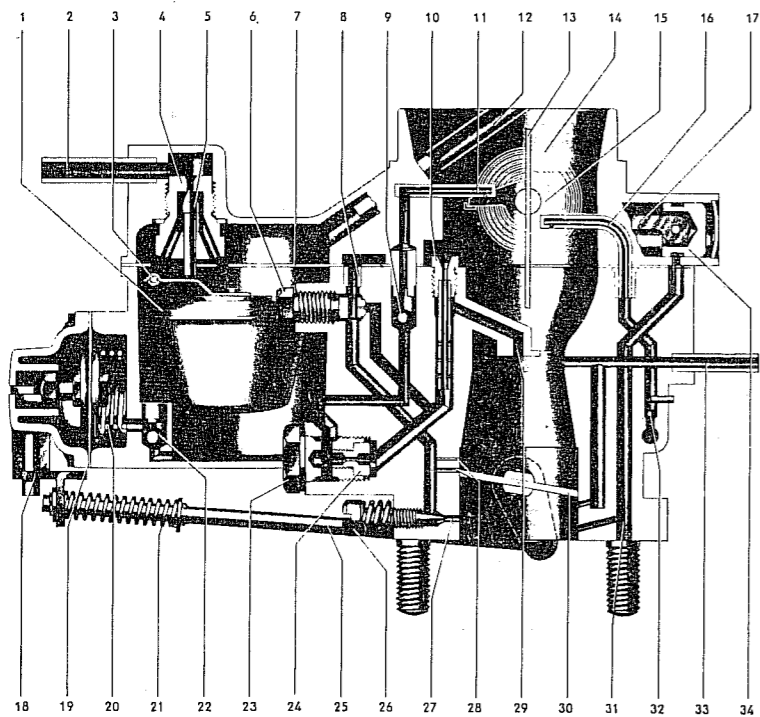


Fig. C.1. Sectional view of the Solex 28 PICT carburettor

1. Float
2. Fuel pipe
3. Float lever spindle
4. Float needle valve
5. Float needle
6. Slow-running fuel jet
7. Sealing washer
8. Slow-running air bleed
9. Ball check valve
10. Air correction jet
11. Power fuel jet
12. Breather
13. Choke valve
14. Bi-metal spring
15. Connecting lever
16. Injector tube
17. Piston operating rod
18. Pump operating lever
19. Pump diaphragm
20. Pump spring
21. Spring
22. Ball check valve for pump
23. Main jet carrier
24. Main jet
25. Connecting link
26. Slow-running mixture screw

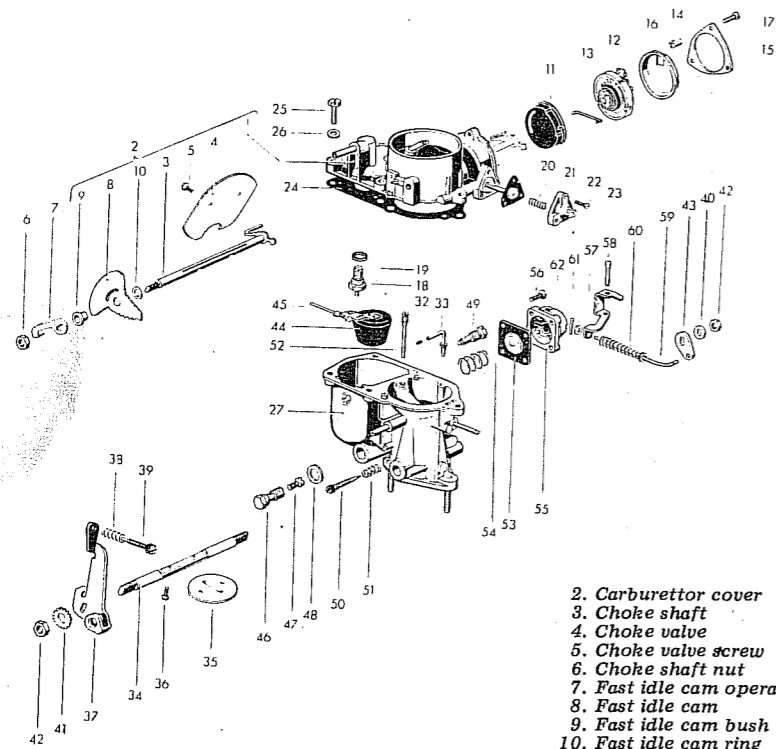


Fig. C.2. Exploded view of the Solex 28 PICT Carburettor.

2. Carburettor cover
3. Choke shaft
4. Choke valve
5. Choke valve screw
6. Choke shaft nut
7. Fast idle cam operating lever
8. Fast idle cam
9. Fast idle cam bush
10. Fast idle cam ring
11. Plastic cap
12. Choke unit
13. Choke unit bar
14. Spacer bush
15. Cover retaining ring
16. Choke unit cover
17. Retaining ring screw
18. Needle valve

19. Sealing washer
20. Vacuum diaphragm
21. Vacuum diaphragm spring
22. Diaphragm cover
23. Screw
24. Carburettor body gasket
25. Upper body screw
26. Spring washer
27. Carburettor main body
28. Carburettor flange gasket
29. Carburettor mounting stud
30. Spring washer
31. Nut
32. Shank screw
33. Injection pipe
34. Throttle valve shaft
35. Throttle valve
36. Throttle valve securing screw
37. Throttle valve lever
38. Slow-running control screw spring
39. Slow-running control screw
40. Washer
41. Lock plate
42. Nut
43. Accelerator pump connecting link
44. Float
45. Float lever pin
46. Main jet carrier
47. Main jet
48. Carrier sealing washer
49. Pilot jet (slow-running)
50. Volume control screw
51. Volume control screw spring
52. Air correction jet
53. Pump diaphragm
54. Diaphragm spring
55. Accelerator pump cover
56. Screw
57. Pump lever
58. Pump lever pin
59. Throttle connector rod
60. Spring
61. Washer
62. Split pin

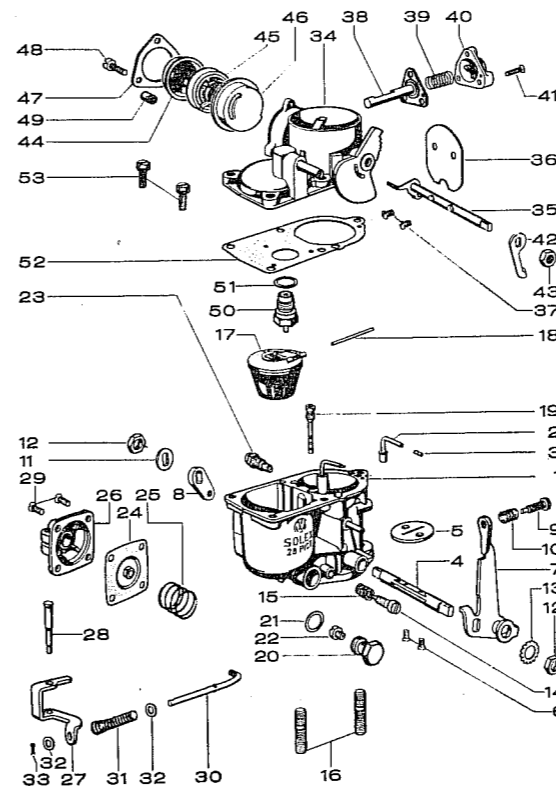


Fig. C.3. Exploded view of the Solex 28 PICT carburettor.

- |                                           |                                 |
|-------------------------------------------|---------------------------------|
| 1. Carburettor main body                  | 28. Pump cover pin              |
| 2. Injection tube                         | 29. Screw                       |
| 3. Shank screw                            | 30. Connecting rod              |
| 4. Throttle valve shaft                   | 31. Spring for rod              |
| 5. Throttle valve                         | 32. Washer                      |
| 6. Screw                                  | 33. Split pin                   |
| 7. Throttle valve lever                   | 34. Carburettor cover           |
| 8. Pump connecting lever                  | 35. Choke valve shaft           |
| 9. Slow-running adjusting screw           | 36. Choke valve                 |
| 10. Spring                                | 37. Screw                       |
| 11. Washer                                | 38. Vacuum diaphragm            |
| 12. Nut                                   | 39. Spring for diaphragm        |
| 13. Washer                                | 40. Cover                       |
| 14. Slow-running volume screw             | 41. Screw                       |
| 15. Spring                                | 42. Fast idle cam operating rod |
| 16. Carburettor flange stud               | 43. Nut                         |
| 17. Float                                 | 44. Plastic cap                 |
| 18. Float spindle                         | 45. Choke unit                  |
| 19. Air correction jet with emulsion tube | 46. Choke unit cover            |
| 20. Main jet carrier                      | 47. Cover retaining ring        |
| 21. Sealing washer                        | 48. Retaining ring screw        |
| 22. Main jet                              | 49. Spacer tube                 |
| 23. Slow-running fuel jet                 | 50. Float needle valve          |
| 24. Pump diaphragm                        | 51. Sealing washer              |
| 25. Diaphragm spring                      | 52. Sealing washer              |
| 26. Pump cover                            | 53. Withdrawal screw            |

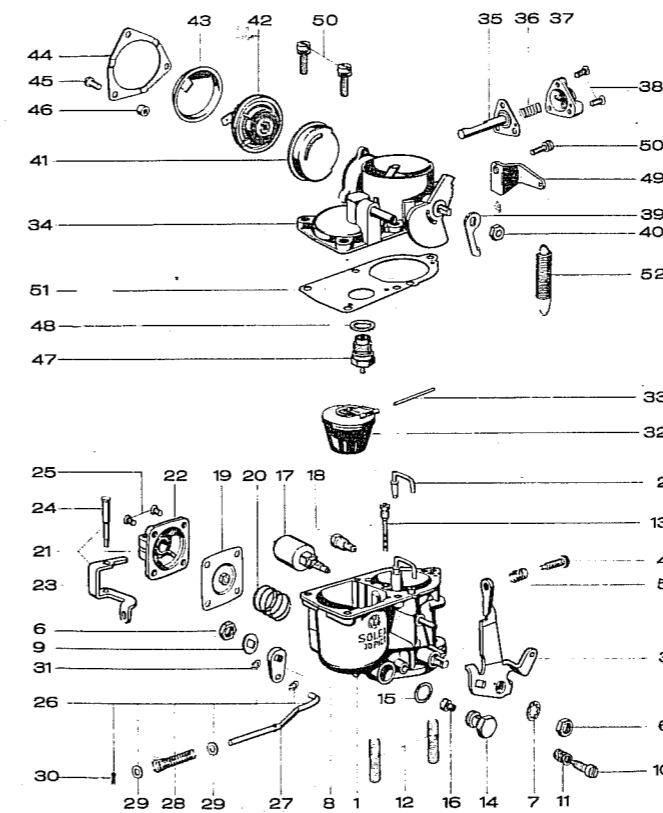


Fig. C.4. Exploded view of the Solex 30 PICT-1 carburettor.

- |                                 |                         |
|---------------------------------|-------------------------|
| 1. Carburettor main body        | 27. Pump operating link |
| 2. Pump injection tube          | 28. Spring              |
| 3. Throttle valve lever         | 29. Washer              |
| 4. Slow-running adjusting screw | 30. Split pin           |
| 5. Spring                       | 31. Clip                |
| 6. Nut                          | 32. Float               |
| 7. Toothed washer               | 33. Float spindle       |
| 8. Connecting lever             | 34. Carburettor cover   |
| 9. Washer                       | 35. Vacuum diaphragm    |
| 10. Volume control screw        | 36. Spring              |
| 11. Spring                      | 37. Valve cover         |
| 12. Stud                        | 38. Screw               |
| 13. Air correction jet          | 39. Relay lever         |
| 14. Main jet carrier            | 40. Nut                 |
| 15. Sealing washer              | 41. Plastic cap         |
| 16. Main jet                    | 42. Choke unit          |
| 17. Pilot jet cut-off valve     | 43. Choke unit cover    |
| 18. Slow-running fuel jet       | 44. Retaining ring      |
| 19. Pump diaphragm              | 45. Screw               |
| 20. Diaphragm spring            | 46. Spacer tube         |
| 21. Pump cover                  | 47. Float needle valve  |
| 22. Pump cover                  | 48. Sealing washer      |
| 23. Pump operating lever        | 49. Bracket             |
| 24. Lever fulcrum pin           | 50. Screw               |
| 25. Screw                       | 51. Carburettor cover   |
| 26. Pump operating link         | 52. Return spring       |

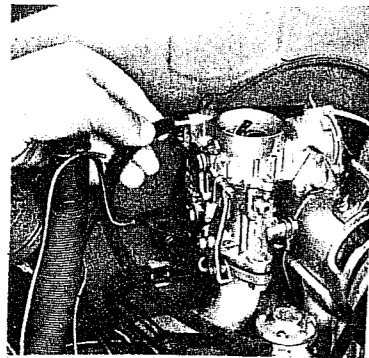


Fig. C.5. Fuel pipe connection at the carburettor.

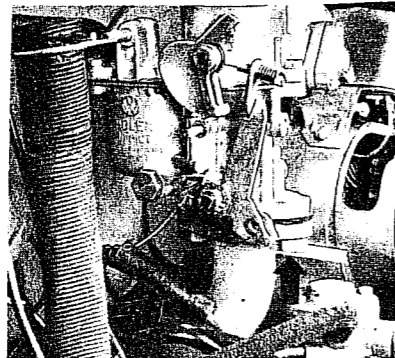


Fig. C.6. Carburettor mounting nuts-arrowed.

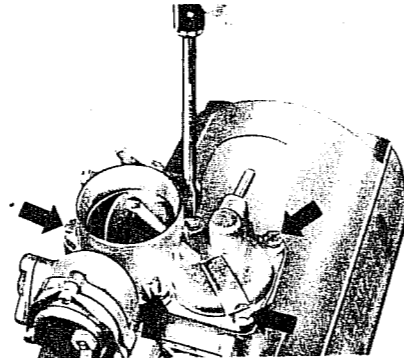


Fig. C.7. Float chamber cover screws.

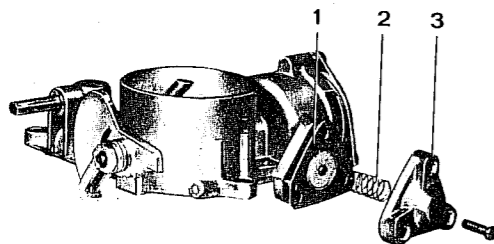


Fig. C.8. Vacuum diaphragm assembly.

1. Vacuum diaphragm
2. Diaphragm spring
3. Diaphragm cover

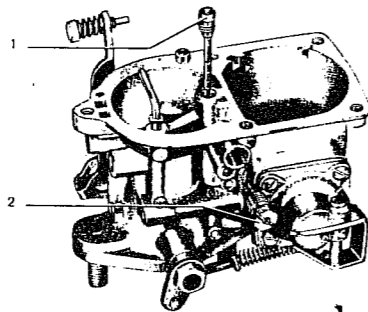


Fig. C.9. Right-hand view of the carburettor body.

1. Air correction jet with emulsion tube
2. Slow-running fuel jet

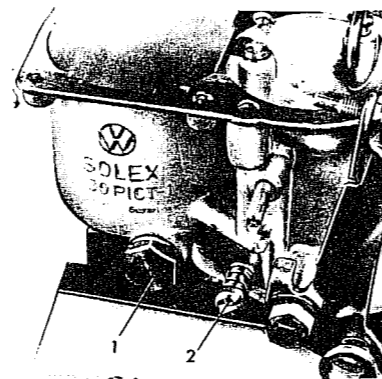


Fig. C.10. Main jet holder (1) and volume control screw (2).

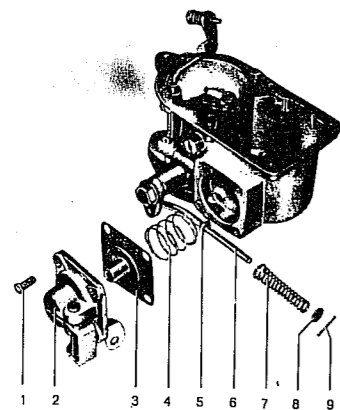


Fig. C.11. Accelerator pump components.

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

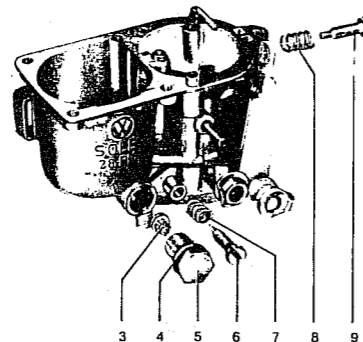


Fig. C.12. Left-hand view of the carburettor body.

3. Main jet
4. Sealing washer
5. Main jet carrier
6. Slow-running volume control screw
7. Spring
8. Spring
9. Throttle lever stop screw

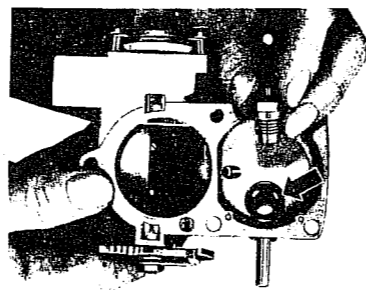


Fig. C.13. Checking the fuel valve seat.

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

Electro-Magnetic 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 turpentine substitute.

#### 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 linkages 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 take off the ceramic unit

##### Inspection

Check that the heating coil 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 turpentine substitute.

##### Installation

Ensure that the hook on the end of the bi-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 (PICT – 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. Warming 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 just starts to drop and then unscrew it about 1/4 – 1/2 a turn, when the engine should run smoothly.

5. If this second 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 snapping the throttle shut. There should be no suggestion of the engine stalling.

#### IDLING ADJUSTMENT (PICT – 3 carburettors only)

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

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

#### THROTTLE VALVE POSITIONER (Fig. C 25)

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

The job of the throttle valve positioner is to ensure that the throttle valve is opened slightly on the over-run, thereby cutting down exhaust emissions.

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

#### DASHPOT (Fig. C 30)

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

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

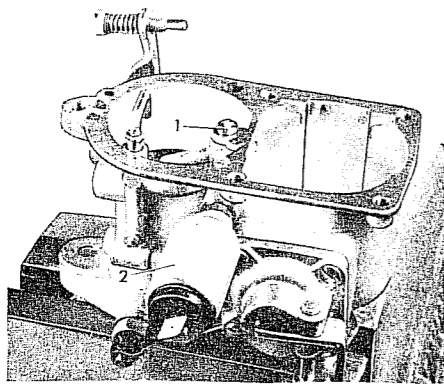


Fig. C.14. Right-hand side of the carburettor body.

- 1. Air correction jet with emulsion tube
- 2. Electro-magnetic pilot jet

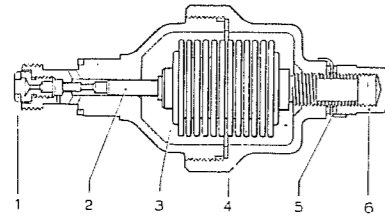


Fig. C.16. Altitude corrector (not generally fitted).

- 1. Main jet
- 2. Needle
- 3. Pressure chamber
- 4. Pressure capsule
- 5. Locking washer
- 6. Adjusting nut

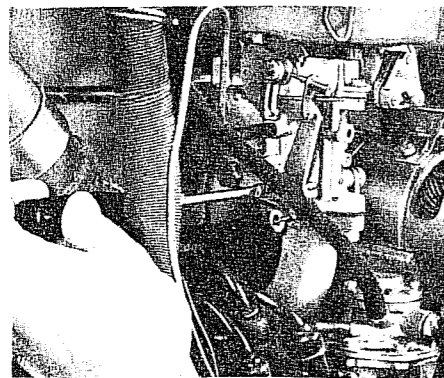


Fig. C.18. Adjusting the volume control screw.

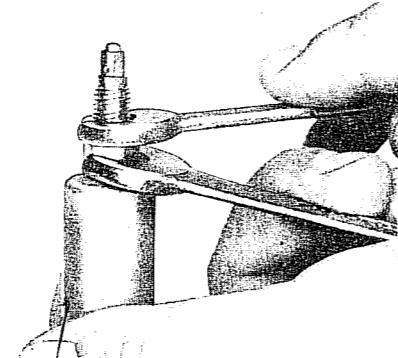


Fig. C.15. Removing the pilot jet.

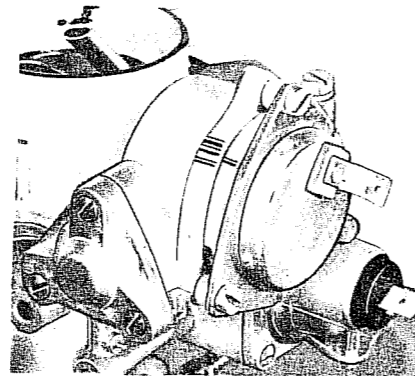


Fig. C.17. Alignment of the choke ceramic cover.

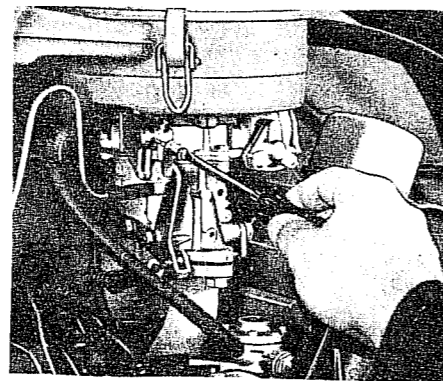


Fig. C.19. Adjusting the slow running adjusting screw.

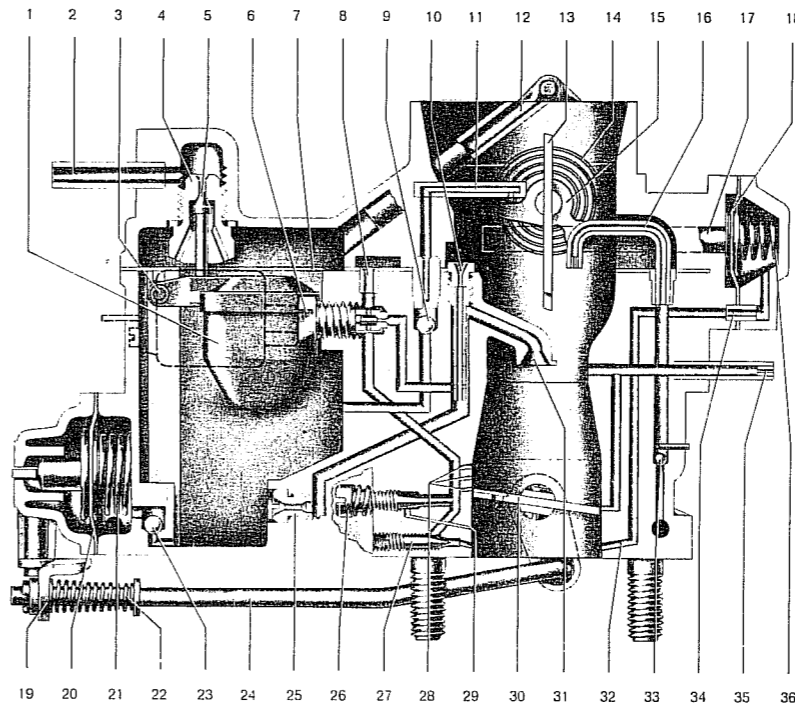


Fig. C.20. Sectional view of the Solex 30 PICT-2 carburettor.

- 1. Float
- 2. Fuel line
- 3. Float lever
- 4. Float needle valve
- 5. Float needle
- 6. Slow-running jet
- 7. Gasket
- 8. Slow-running air bleed
- 9. Ball check valve
- 10. Air correction jet with emulsion tube
- 11. Power fuel jet
- 12. Float chamber vent tube
- 13. Choke valve
- 14. Bi-metal spring
- 15. Operating lever
- 16. Discharge tube
- 17. Diaphragm operating rod
- 18. Vacuum diaphragm
- 19. Pump operating lever
- 20. Pump diaphragm
- 21. Spring for diaphragm
- 22. Push rod spring
- 23. Ball check valve
- 24. Pump connector rod
- 25. Main jet
- 26. Volume control screw
- 27. Fuel metering screw (sealed)
- 28. By-pass port
- 29. Slow-running port
- 30. Throttle valve
- 31. Discharge arm
- 32. Vacuum drilling
- 33. Ball check valve
- 34. Jet in vacuum drilling
- 35. Vacuum connection
- 36. Diaphragm spring

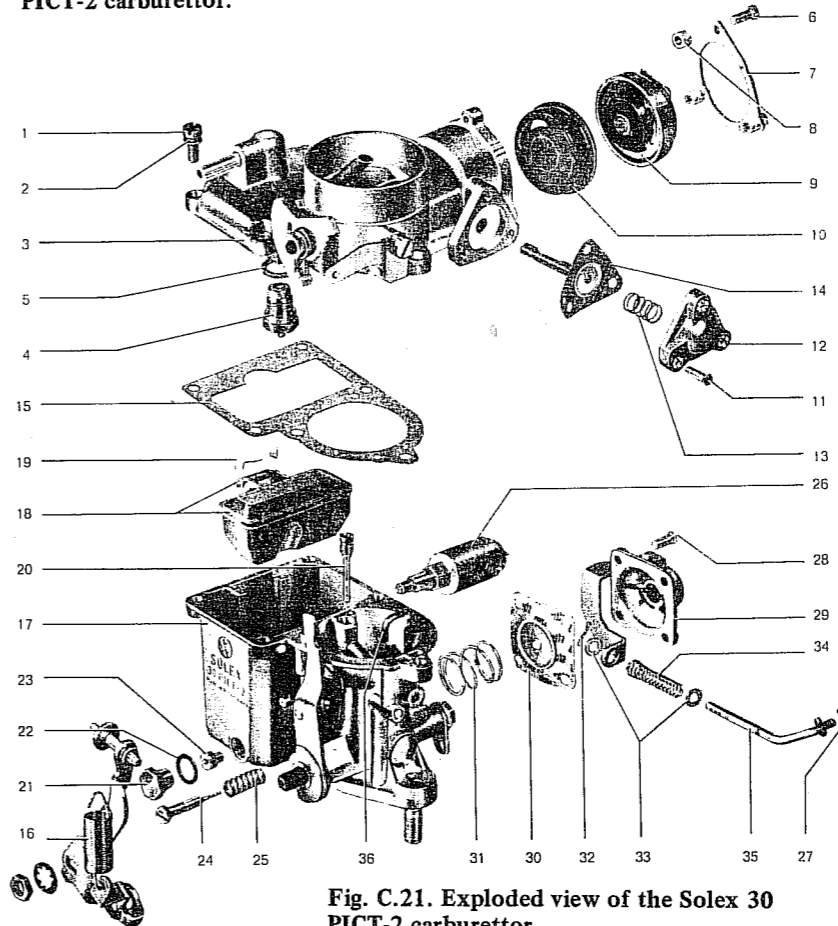


Fig. C.21. Exploded view of the Solex 30 PICT-2 carburettor.

- 1. Carburettor cover screw
- 2. Spring washer
- 3. Carburettor cover
- 4. Washer for float needle valve
- 5. Float needle valve
- 6. Washer
- 7. Float spindle retainer
- 8. Float with spindle
- 9. Air correction jet
- 10. Carburettor main body
- 11. Volume control screw
- 12. Nut
- 13. Lock washer
- 14. Accelerator cable return spring
- 15. Spring
- 16. Plug
- 17. Plug seal
- 18. Main jet
- 19. By-pass screw
- 20. Injector tube
- 21. Pump diaphragm spring
- 22. Pump diaphragm
- 23. Split pin
- 24. Washer
- 25. Connecting rod spring
- 26. Connecting rod
- 27. Clip
- 28. Screw
- 29. Pump cover
- 30. Slow-running jet
- 31. Cut-off valve (note voltage)
- 32. Vacuum diaphragm
- 33. Screw
- 34. Vacuum diaphragm cover
- 35. Vacuum diaphragm spring
- 36. Plastic cap
- 37. Choke unit
- 38. Cover retaining ring
- 39. Spacer tube
- 40. Retaining ring screw

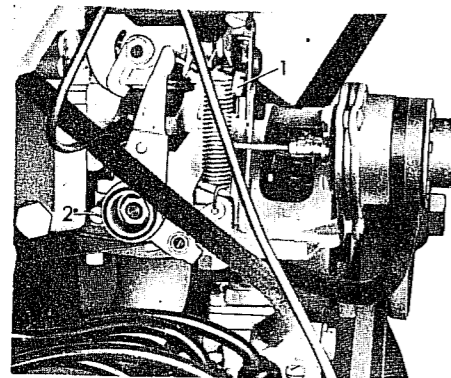


Fig. C.22. Idle adjusting screw (1) and the volume control screw (2)

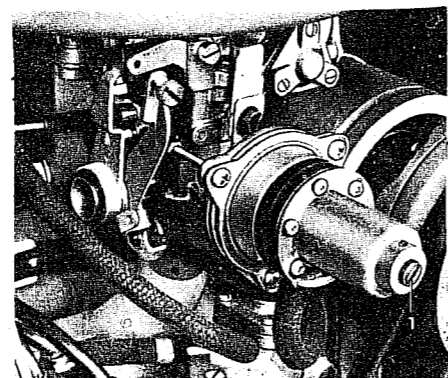


Fig. C.23. Adjusting screw for the throttle positioner.

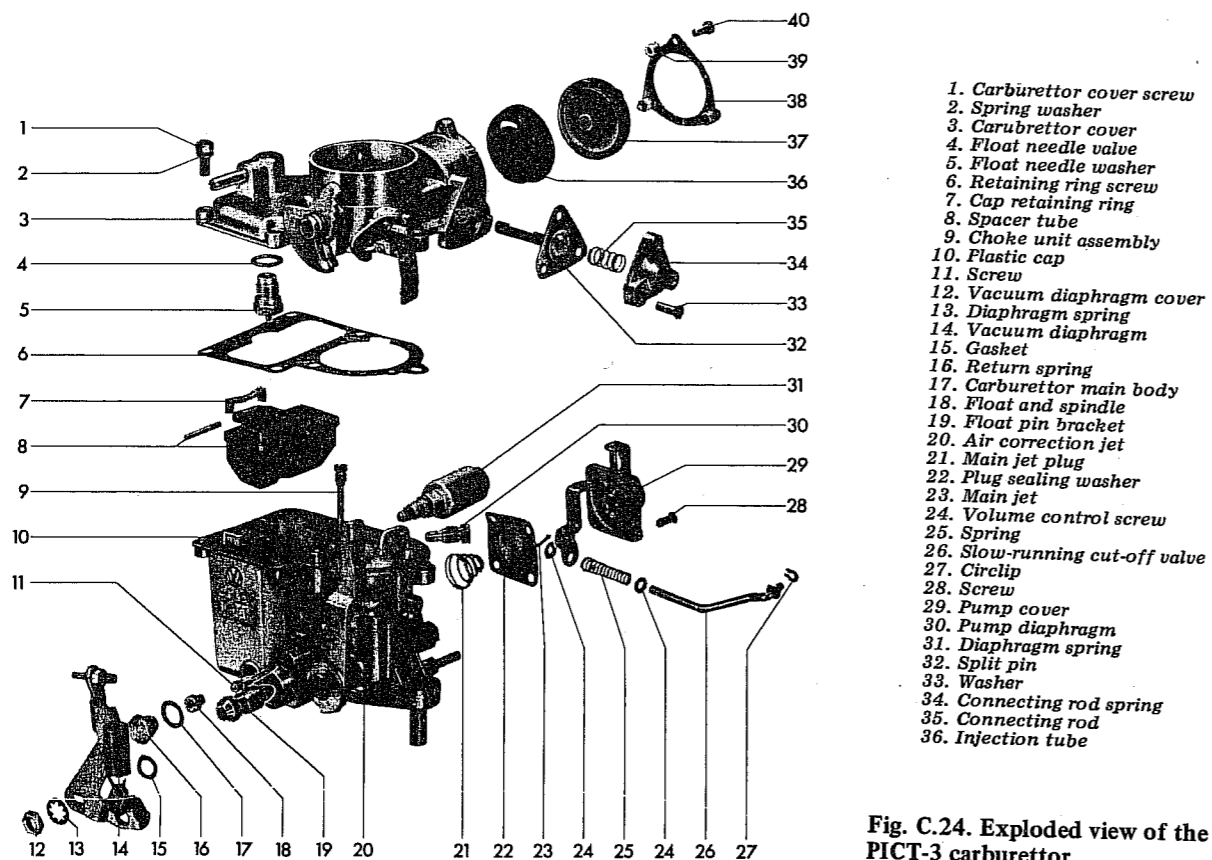


Fig. C.24. Exploded view of the Solex 30 PICT-3 carburettor.

1. Carburettor cover screw
2. Spring washer
3. Carburettor cover
4. Float needle valve
5. Float needle washer
6. Retaining ring screw
7. Cap retaining ring
8. Spacer tube
9. Choke unit assembly
10. Plastic cap
11. Screw
12. Vacuum diaphragm cover
13. Diaphragm spring
14. Vacuum diaphragm
15. Gasket
16. Return spring
17. Carburettor main body
18. Float and spindle
19. Float pin bracket
20. Air correction jet
21. Main jet plug
22. Plug sealing washer
23. Main jet
24. Volume control screw
25. Spring
26. Slow-running cut-off valve
27. Circlip
28. Screw
29. Pump cover
30. Pump diaphragm
31. Diaphragm spring
32. Split pin
33. Washer
34. Connecting rod spring
35. Connecting rod
36. Injection tube

**FUEL PUMP (Fig. C 34)**

The fuel pump operation depends upon a flexible diaphragm which is moved up and down by a push rod.

The 1600 engine has a fuel pump with a pressed steel upper section. This is not removable. Other models have a cast upper section, secured to the lower part by screws. This permits the pump to be divided in order to inspect the 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 slotted screw in the top of the pump.
2. Lift off 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 input line.
2. Remove the two nuts which secure the pump to the crankcase. Lift off the pump.
3. 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.

**Dismantling**

Note that the pumps with a pressed steel upper section cannot be dismantled. The following remarks only apply to pumps with a screwed down upper section.

1. Remove the six screws which retain the upper parts of the pump. Lift off the upper part and remove the diaphragm.
2. 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 in the operating lever 1/2 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.

**Installation**

Note the following points :-

1. Rotate the engine until the pump push rod is at its highest mark.  
Measure the distance between the top of the rod and the top of the intermediate flange. The distance should be 0.5" (13 mm). It can be adjusted by altering the number of gaskets.
2. Tighten both nuts evenly.
3. Check that the fuel lines are securely connected.

**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 suitably shaped piece of wooden rod 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 :-

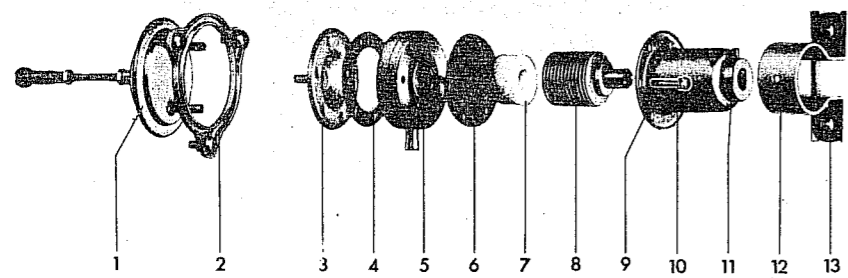
1. Make sure that the gasket around the tank is in good condition and replace it if necessary.
2. Do not forget to replace the breather tube.
3. Pay very careful attention to the re-connection of the fuel line and make sure that it is not twisted.

**ACCELERATOR CABLE**

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

**Removal**

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



1. Operating part
2. Retaining ring
3. Control part cover
4. Gasket
5. Control part
6. Control diaphragm
7. Plastic foam filter
8. Altitude corrector
9. Altitude corrector housing
10. Screw
11. Stud
12. Clamp
13. Rubber mounting

Fig. C.25. Exploded view of the throttle valve positioner.

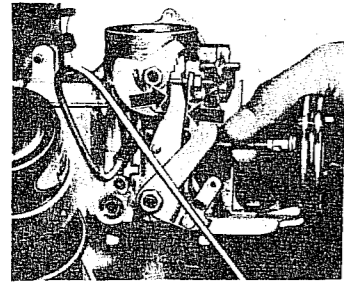


Fig. C.27. Check that the special lever cannot touch at points indicated by the arrows.

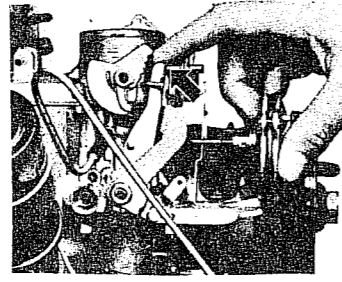


Fig. C.26. Checking the fast idle speed.

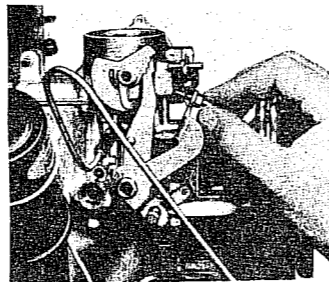
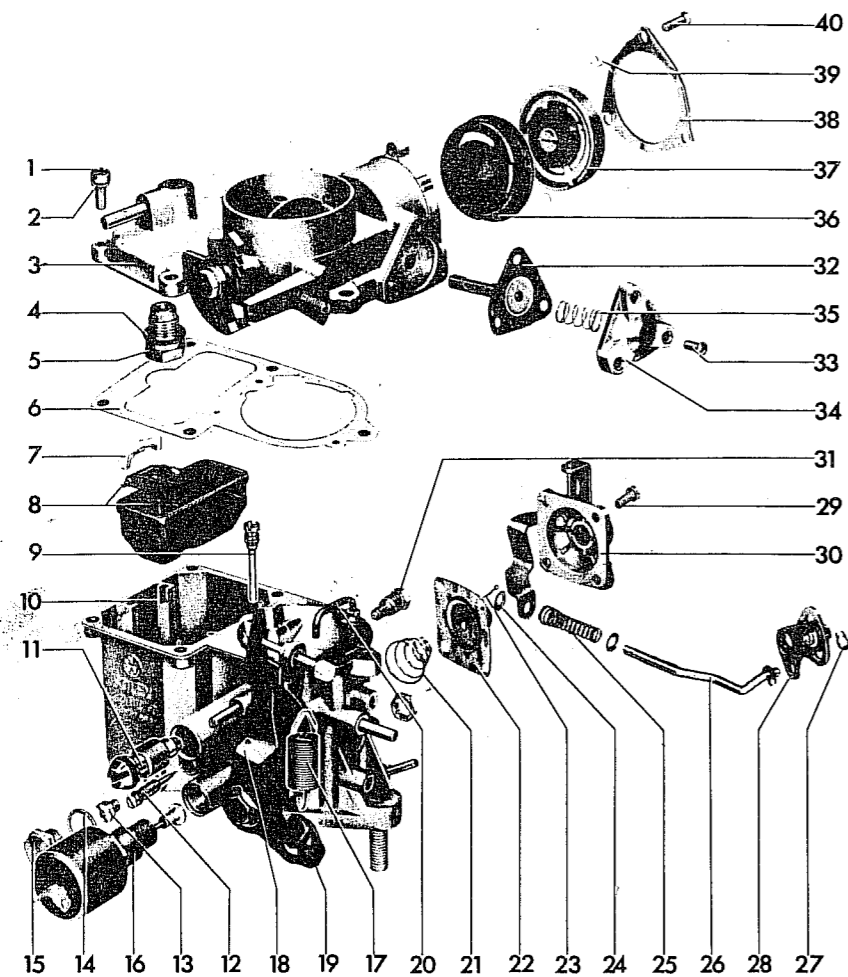


Fig. C.28. Checking the throttle valve closing time.



1. Carburettor cover screw
2. Spring washer
3. Carburettor cover
4. Washer (float needle)
5. Float needle valve
6. Gasket
7. Float spindle bracket
8. Float and spindle
9. Air correction jet with emulsion tube
10. Carburettor main body
11. By-pass screw
12. Volume control screw
13. Main jet
14. Plug sealing washer
15. Plug
16. Slow-running jet and cut-off valve
17. Return spring
18. Fast idle lever
19. Throttle valve lever
20. Injector pipe
21. Diaphragm spring
22. Diaphragm
23. Split pin
24. Washer
25. Connecting rod spring
26. Connecting rod
27. Circlip
28. Bell crank lever
29. Screw
30. Pump cover
31. Slow-running fuel jet
32. Vacuum diaphragm
33. Screw
34. Vacuum diaphragm cover
35. Vacuum diaphragm spring
36. Plastic cap
37. Choke unit assembly
38. Cover retaining ring
39. Spacer tube
40. Screw

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

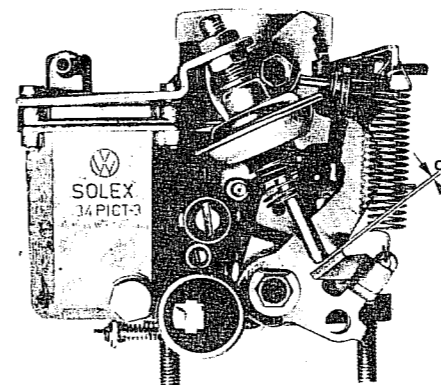


Fig. C.30. North American model carburettor with dashpot.

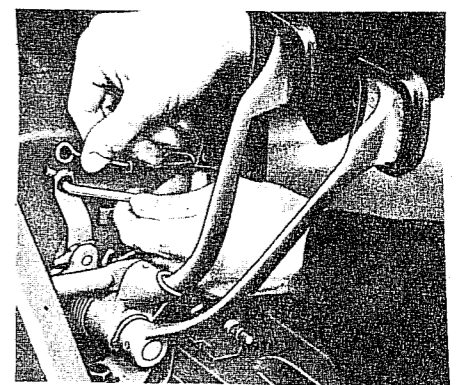


Fig. C.31. Attaching the throttle cable to the accelerator pedal (LHD cars).

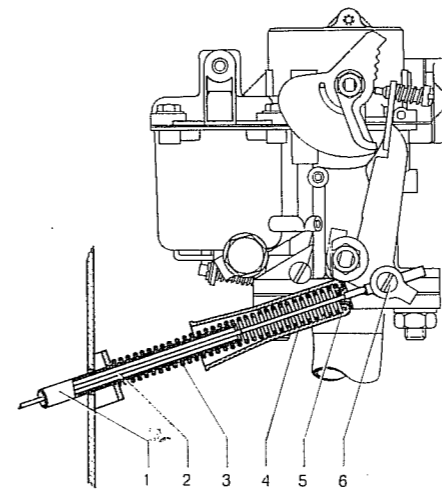


Fig. C.32. Throttle cable connection at the carburettor (Early cars.)

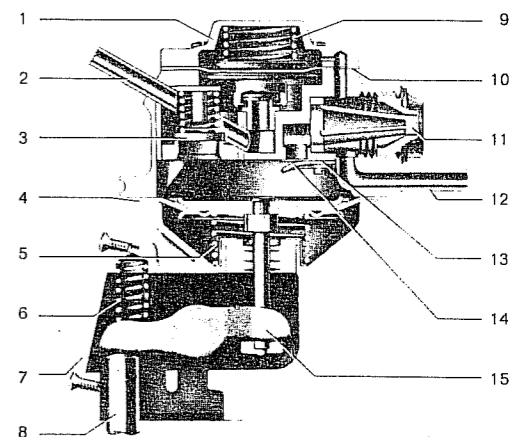


Fig. C.34. Sectional view of the fuel pump.

- |                        |                                   |
|------------------------|-----------------------------------|
| 1. Pump cover          | 9. Spring for fuel-shut-off valve |
| 2. Fuel outlet         | 10. Shut-off valve                |
| 3. Delivery valve      | 11. Fuel strainer                 |
| 4. Pump diaphragm      | 12. Fuel inlet                    |
| 5. Diaphragm spring    | 13. Suction valve                 |
| 6. Rocker lever spring | 14. Suction valve holder          |
| 7. Inspection plate    | 15. Pump rocker lever             |
| 8. Tappet              |                                   |

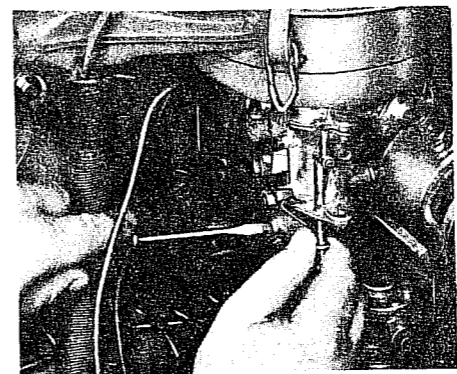


Fig. C.33. Reconnecting the throttle cable to the carburettor.

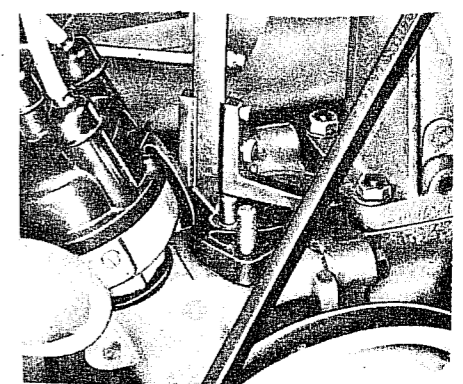
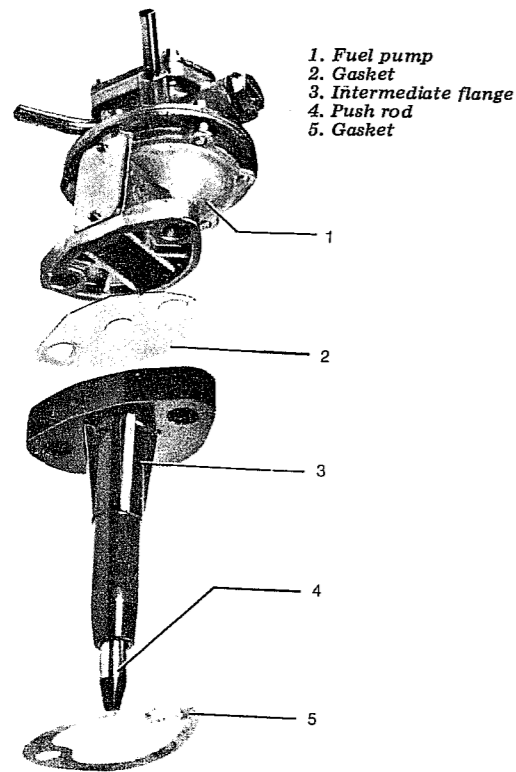


Fig. C.35. Checking the fuel pump stroke with a depth gauge.



1. Fuel pump
2. Gasket
3. Intermediate flange
4. Push rod
5. Gasket

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

- A1. Right-hand pre-heater duct
- A2. Air cleaner assembly
- A3. Air cleaner assembly
- A4. Elbow
- A5. Gasket
- A6. Retaining clip
- A7. Inner valve flap
- A8. Outer valve flap
- A9. Air cleaner flap bearing
- A10. Upper air cleaner bracket
- A11. Lower air cleaner bracket
- A12. Bolt
- A13. Spring washer
- A14. Cable sleeve
- A15. Carburettor pre-heating cable
- A16. Cable clamp
- A17. Accelerator cable clamp
- A18. Sleeve bracket
- A19. Tapping screw
- A20. Screw
- A21. Set screw bush
- A22. Washer
- A23. Nut
- A24. Warm air adaptor hose
- A25. Rubber grommet
- A26. Throttle positioner
- A27. Throttle positioner (later type)
- A28. Throttle positioner connecting rod
- A29. Nut
- A30. Nut (left-hand thread)
- A31. Throttle positioner control valve
- A32. High altitude corrector
- A33. Ball joint
- A34. Intake manifold and pre-heating pipe
- A35. Hose
- A36. Hose
- A37. Throttle positioner retainer
- A38. Throttle positioner retainer (later type)
- A39. Bush for retainer
- A40. Lock washer
- A41. Screw
- A42. Control valve clamp
- A43. Screw
- A44. Square nut
- A45. Tapping screw
- A46. Carburettor flange gasket

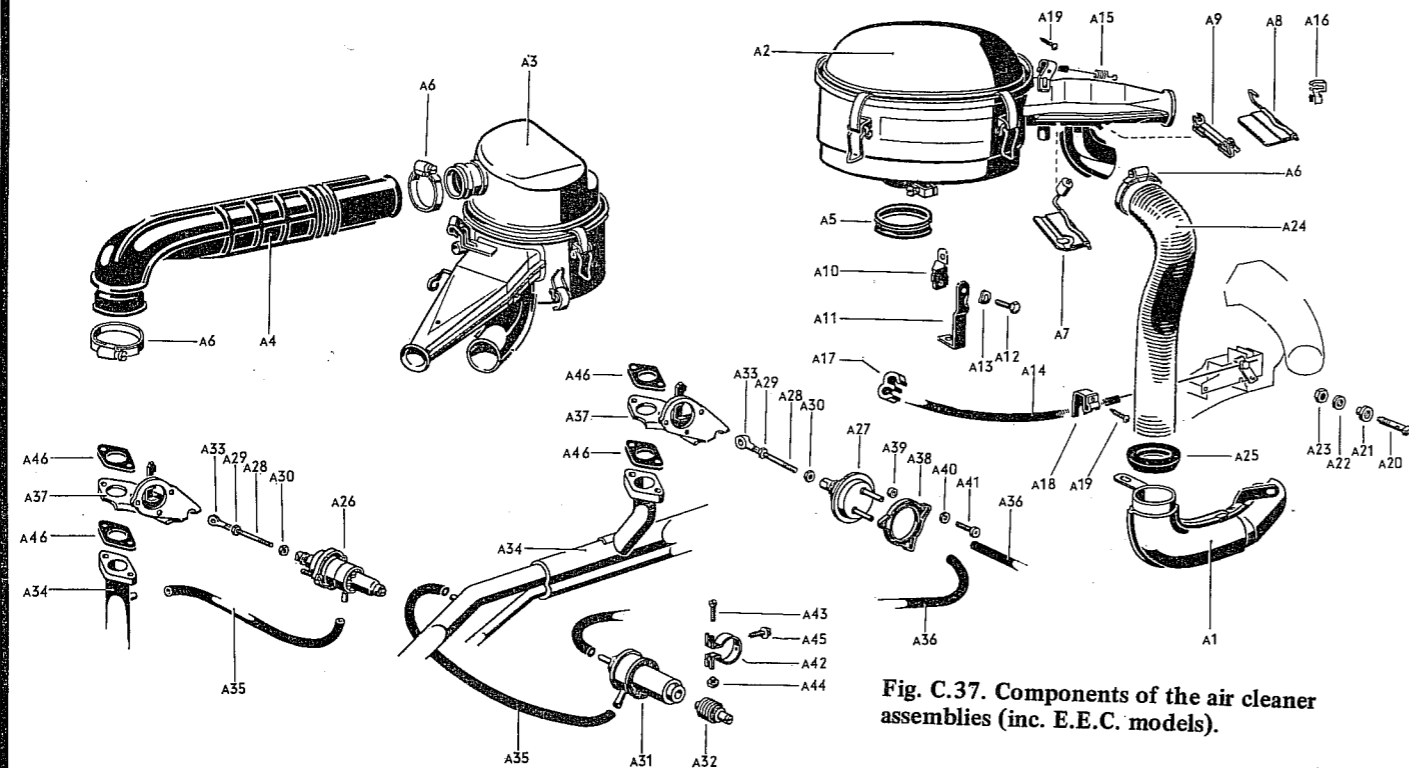


Fig. C.37. Components of the air cleaner assemblies (inc. E.E.C. models).

6. The cable passes alongside the gearbox just above the path of the clutch cable. It goes into a conduit inside the backbone and there is a rubber boot over the mouth of the conduit to prevent water getting in. Remove this rubber boot.
7. Pull the cable completely out from the front end, taking care not to soil the trim.

Installation

1. Grease the cable thoroughly. Take care as it is installed to prevent the grease picking up dirt.
2. Pass the cable through the inspection hole at the front of the backbone and insert it into the mouth of the conduit. Make sure that it goes in 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 m.m. 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

Carburettor Application :	
1200 — Prior to Aug. 1970 . . . . .	Solex 28 PICT-2
1300 — Prior to Aug. 1970 . . . . .	Solex 30 PICT-2
1500 — Prior to Aug. 1970 . . . . .	Solex 30 PICT-2
Model 181 — 1500 . . . . .	Solex 30 PICT-2
1600 — 1970 USA version . . . . .	Solex 30 PICT-3
1200 — As from Aug. 1970 . . . . .	Solex 30 PICT-3
1300 — As from Aug. 1970 . . . . .	Solex 31 PICT-3
1600 — As from Aug. 1970 . . . . .	Solex 34 PICT-3

1500 / Automatic . . . . .	x 120
1600 . . . . .	x 116
Air correction jet with emulsion tube . . . . .	125 z
Idle air jet drilling . . . . .	140
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Main jet 1500 from Feb. 1968 . . . . .	x 116

## Carburettor Settings — Solex 30 PICT-3

Choke tube . . . . .	24
Main jet . . . . .	x 112.5
Air correction jet with emulsion tube . . . . .	125 z
Slow-running jet . . . . .	65
Cut-off valve for by-pass mixture . . . . .	1.8
Slow-running air jet . . . . .	135
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams

## Carburettor Settings — 30 PICT-3

Choke tube . . . . .	24
Main jet . . . . .	112.5
Air correction jet with emulsion tube . . . . .	170 z
Slow-running jet/Air drilling . . . . .	5.5/150
Excess fuel jet/Air jet drilling . . . . .	45/130
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Float level . . . . .	19.5 mm
Enrichment jet . . . . .	100/100

## Carburettor Settings — Solex 31 PICT-3

Choke tube . . . . .	25.5
Main jet . . . . .	x 125
Air correction jet with emulsion tube :	
Saloon . . . . .	120 z
Karmann-Ghia . . . . .	140 z
Slow-running jet/Air drilling . . . . .	65/150
Excess fuel jet/Air jet drilling . . . . .	50/130
Float needle valve . . . . .	1.5
Float weight . . . . .	8.5 grams
Float level . . . . .	19.5 mm
Enrichment jet . . . . .	1.2 mm

## Carburettor Settings — Solex 34 PICT-3

Choke tube . . . . .	26
Main jet . . . . .	x 130
Air correction jet :	
Manual transmission . . . . .	60 z or 80 z
Automatic Stickshift . . . . .	75 z or 80 z
Slow-running jet/Air drilling :	
Manual transmission . . . . .	65/147.4
Automatic Stickshift . . . . .	65/147.5
USA & Canada . . . . .	60/147.5
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Fuel level . . . . .	18 mm
Enrichment jet . . . . .	85/85
Fuel pump . . . . .	Diaphragm type, mechanically operated
Feed pressure . . . . .	3.5 psi (2.5 WS) at 3400 rpm.
Fuel filter . . . . .	In fuel pump

## Carburettor Settings — Solex 28 PICT-2

Choke tube . . . . .	22.5
Main jet . . . . .	122.5
Slow-running jet . . . . .	g 55
Air correction jet — Prior to Aug. 1967 . . . . .	130 y
— As from Aug. 1967 . . . . .	140 z
Slow-running air bleed . . . . .	2.0 mm
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	5.7 grams
Pump jet . . . . .	0.5 mm
Power fuel jet . . . . .	1.0 mm

## Carburettor Settings — Solex 30 PICT-2 (1300)

Choke tube . . . . .	24
Main jet — Saloon with Manual Trans. . . . .	x 125
— Saloon with Auto. Trans. . . . .	x 120
Slow-running jet . . . . .	55
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Power fuel system (Auto. Trans. only) . . . . .	50 without ball
Air correction jet with emulsion tube . . . . .	125 z

## Carburettor Settings — Solex 30 PICT-2 (1500)

Choke tube . . . . .	24
Main jet . . . . .	x 120
Air correction jet with emulsion tube :	
Karmann-Ghia . . . . .	135 z
Saloon-Convertible . . . . .	125 z
Slow-running jet . . . . .	55
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Power fuel system . . . . .	50 without ball

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

Choke tube . . . . .	24
Main jet . . . . .	x 120
Air correction jet with emulsion tube . . . . .	125 z
Float needle valve . . . . .	1.5 mm
Float weight . . . . .	8.5 grams
Power fuel jet . . . . .	50
Idle air jet drilling . . . . .	140

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

Choke tube . . . . .	24
Main jet :	
1300 . . . . .	x 125
1300 / Automatic . . . . .	x 120
1500 . . . . .	x 120

# Clutch

## GENERAL

### CLUTCH — Removal & Installation

### PRESSURE PLATE ASSEMBLY — Disassembly, Inspection & Assembly

### RELEASE BEARING

### CLUTCH CABLE — Replacement

### CLUTCH FREE PLAY — Adjustment

## GENERAL

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

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

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

The 180 m.m. clutches have six coil springs whilst 200 m.m. clutches have either nine coil springs or a diaphragm spring.

## CLUTCH ASSEMBLY

### Removal

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

### Installation

Note the following points :—

1. The clutch surface on the flywheel must be clean and smooth.
2. Place the centre plate in position and then loosely bolt the pressure plate to the flywheel. The centre plate can now be accurately centred. This can be done by eye, but it is better to use a mandrel which fits accurately into release ring, centre plate and gland nut.
3. After the centre plate has been centred, the six securing bolts can be tightened, each a little at a time to ensure that no distortion occurs.

## PRESSURE PLATE ASSEMBLY

### Dismantling

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

1. Bolt the clutch into a flywheel with the centre plate in position.

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

## Inspection

Note the following points :—

1. If the clutch has been subject to overheating, 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 centre plate is worn or oily, replace it.

## Assembly

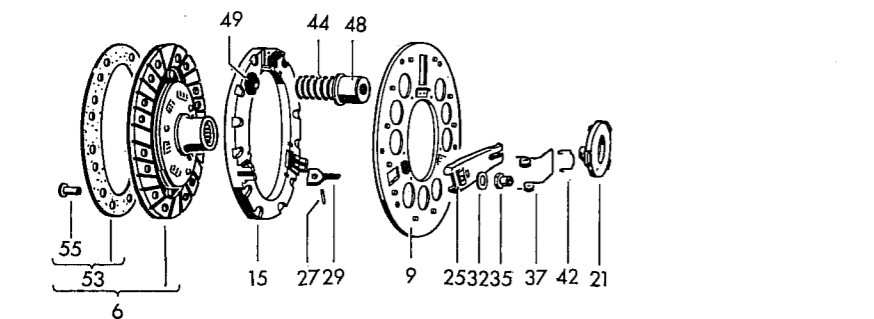
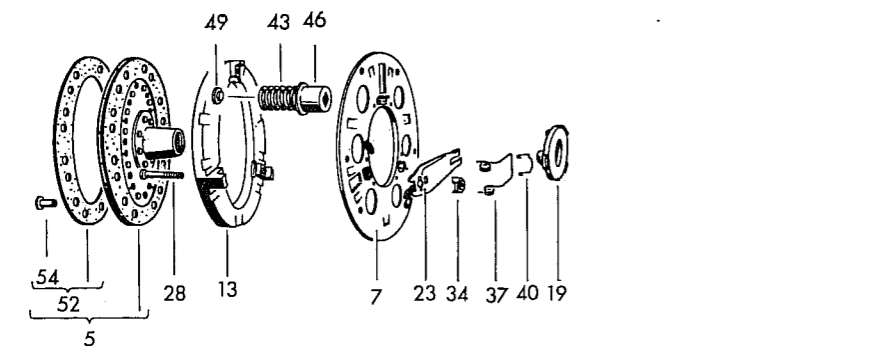
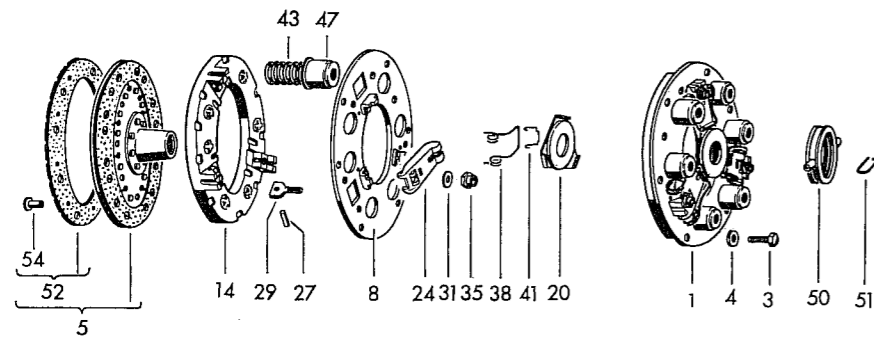
Note the following points :

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

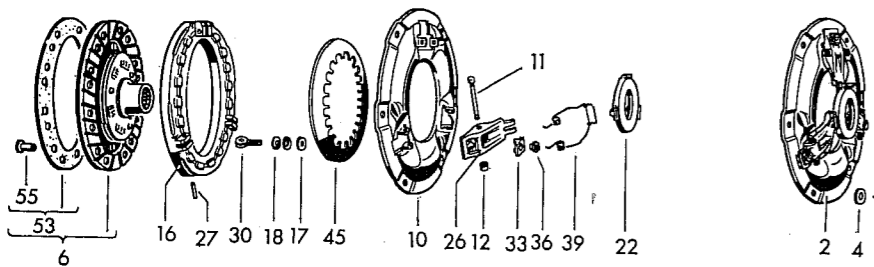
From Engine No. D 0 234 015

34 b.h.p. up to July 1970  
40 b.h.p. up to F 2 200 000  
34 b.h.p. from August 1970

Fig. D.1. Exploded view of the various types of clutches fitted to Beetle models.



44 b.h.p. up to Engine No. H 1 350 000  
47 b.h.p. up to Engine No. B 6 600 000  
50 b.h.p. from Engine No. AD 0 000 001



1. Clutch cover and pressure plate - 180mm.
2. Clutch cover and pressure plate - 200mm.
3. Clutch cover securing screw
4. Spring washer
5. Clutch plate - 180mm.
6. Clutch plate - 200mm.
7. Clutch cover
8. Clutch cover
9. Clutch cover
10. Clutch cover
11. Bolt
12. Bush
13. Clutch pressure plate
14. Clutch pressure plate
15. Clutch pressure plate
16. Clutch pressure plate
17. Washer
18. Concave washer
19. Clutch release ring
20. Clutch release ring
21. Clutch release ring
22. Clutch release ring
23. Clutch release lever
24. Clutch release lever
25. Clutch release lever
26. Clutch release lever
27. Pin
28. Bolt for clutch release lever
29. Bolt
30. Bolt
31. Thrust washer
32. Thrust washer
33. Thrust piece
34. Adjusting nut
35. Adjusting nut
36. Adjusting nut
37. Return spring
38. Return spring
39. Return spring
40. Clutch release ring spring
41. Clutch release ring spring
42. Clutch release ring spring
43. Thrust spring
44. Thrust spring
45. Concave washer
46. Cap
47. Cap
48. Cap
49. Spring seat
50. Clutch release bearing
51. Retaining spring
52. Clutch linings
53. Clutch linings
54. Rivet
55. Rivet

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 in solvent as it is pre-packed with grease.

If the bearing rotates noisily, it must be replaced.

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

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

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

CLUTCH CABLE

The spindle of the clutch pedal passes through the pedal cluster and in through the side of the backbone. This spindle is fitted with a hook. On the other side of the backbone is an inspection cover which conceals the nearside spindle mounting and the arm to which the throttle cable is attached. The clutch cable passes through a conduit in the backbone, through a bowed flexible section and then runs exposed for a short distance before passing through the eye of the clutch operation 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 bowed portion of the conduit at the rear. If this does occur, this 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 lose the sealing grommet 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 or 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 curl 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 backbone 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 grommet 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 an assistant 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 which is secured by bolts in the floor. The push rod which is attached to the brake pedal should have a clearance of 1 m.m. (0.04") in the piston of the master cylinder.

After the brake and throttle pedals have been linked up, replace the inspection cover on the nearside of the backbone.

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.

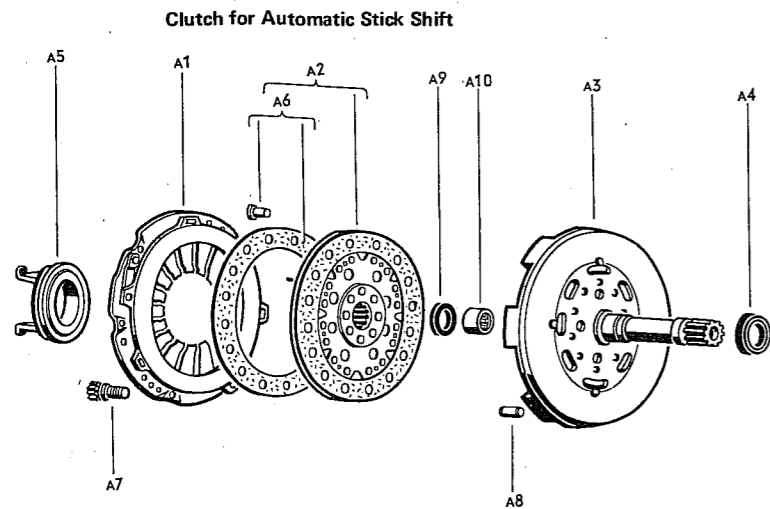
CLUTCH CABLE CONDUIT ADJUSTMENT

The flexible section at the rear of the conduit sags down and the extent to which it does this is critical for proper operation of the clutch (Fig. D 13). The sag is achieved by pre-loading the conduit by placing washers between the after end and its mounting. The sag should amount to 20 - 30 m.m. (0.8 - 1.2") at its mid-point. It is unlikely that this curvature will have been altered whilst 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 requires comparatively little pressure. Then a greater pressure has to be exerted to cause further movement.

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



- A1. Clutch cover and pressure plate
- A2. Clutch plate
- A3. Clutch carrier plate
- A4. Clutch carrier plate seal
- A5. Clutch release bearing
- A6. Clutch linings
- A7. Screw
- A8. Dowel pin
- A9. Seal for needle bearing
- A10. Needle bearing.

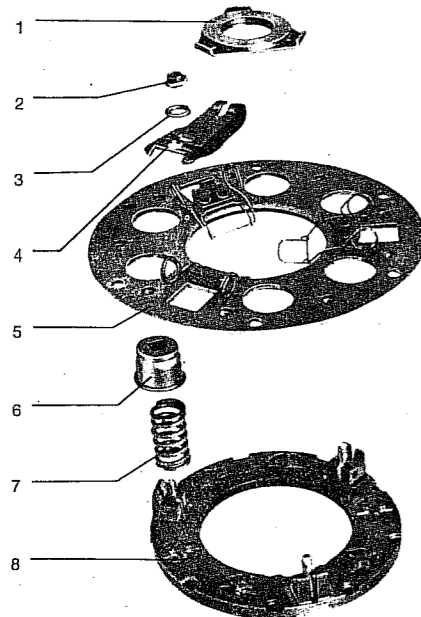


Fig. D.4. Exploded view of the clutch release pressure plate assembly.

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

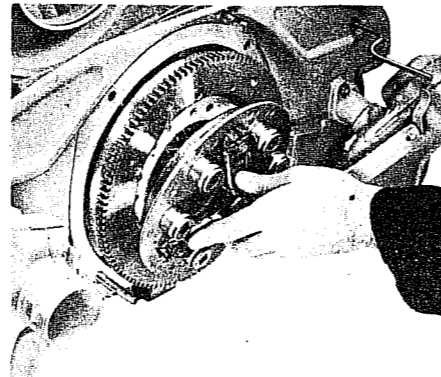


Fig. D.2. Removing the clutch assembly.

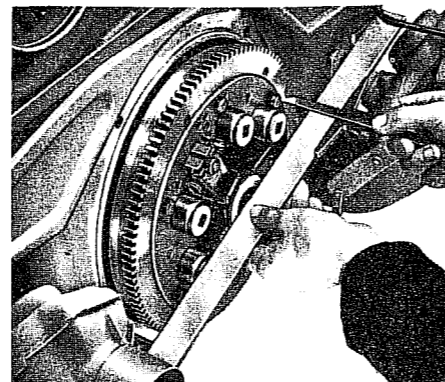


Fig. D.3. Checking the release ring to fly-wheel dimension.

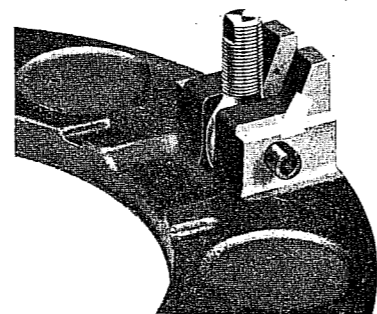


Fig. D.5. Insert the release lever pins so that the slots are positioned as shown.

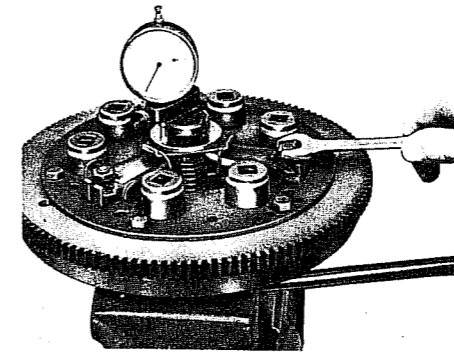


Fig. D.6. Checking the release ring run-out with a dial gauge.

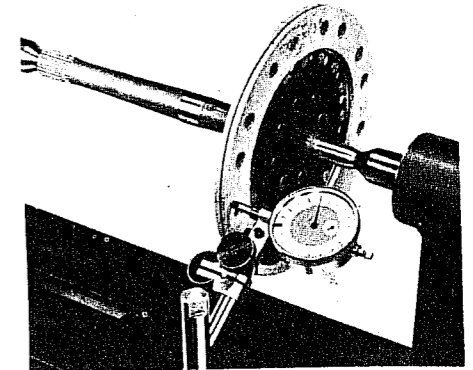


Fig. D.7. Checking the clutch disc run-out with a dial gauge.

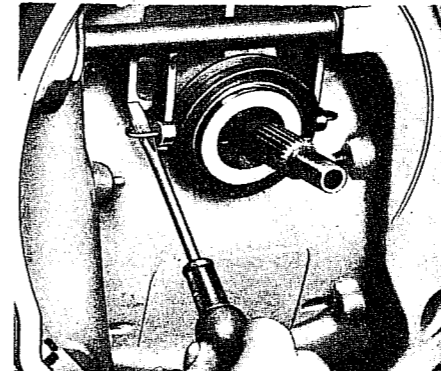


Fig. D.8. Pulling off the release bearing retaining clips.

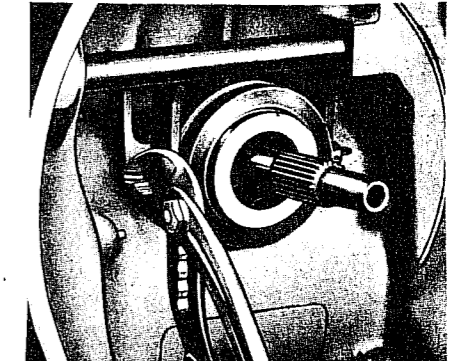


Fig. D.9. Installing the release bearing retaining clips.

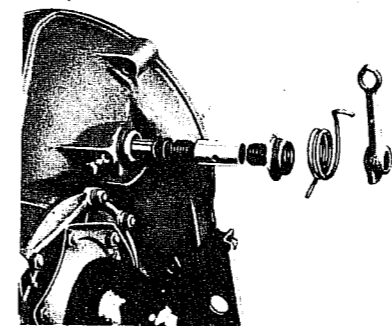


Fig. D.10. Exploded view of the release shaft components.

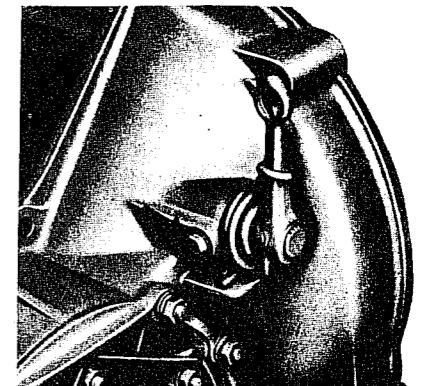


Fig. D.11. Release shaft locating screw - arrowed.

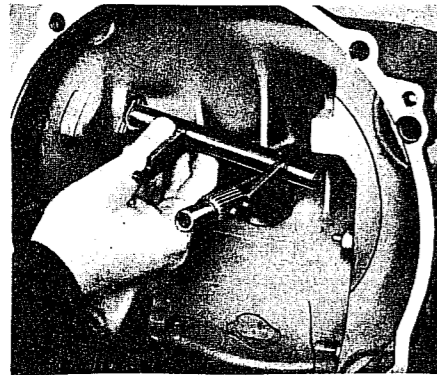


Fig. D.12. Installing the release shaft.

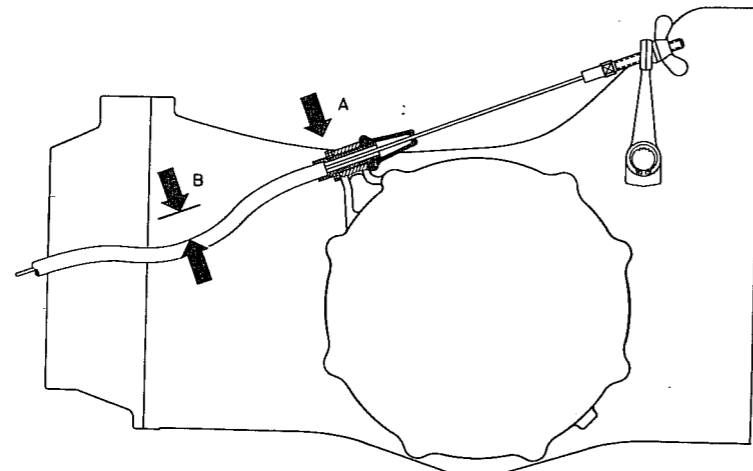


Fig. D.13. Insert shims at "A" to obtain the required clutch cable sag at "B"

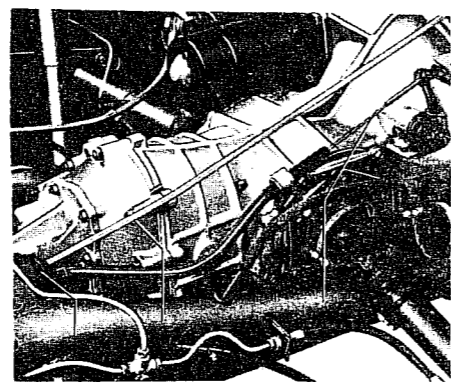


Fig. D.14. Clutch cable in position showing correct amount of sag.  
1. Rubber boot.  
2. Accelerator cable.  
3. Clutch cable.

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

Type - 1200 & 1300 . . . . .	Single disc, dry clutch, coil springs
- 1500 & 1600 . . . . .	Diaphragm spring clutch
Pedal free play . . . . .	0.4 - 0.8 in (10 - 20 mm)
Total lining area :	
1200/1300 . . . . .	43 sq.in. (268 sq.cm.)
1500 . . . . .	56 sq.in. (363 sq.cm.)
1600 . . . . .	52 sq.in. (335 sq.cm.)
Clutch pressure :	
1200/1300 . . . . .	761-816 lb (345-370 kg)
1500 . . . . .	786-863 lb (357.5-392.5 kg)
1600 . . . . .	837-925 lb (380-420 kg)

REPAIR DATA

Clutch out-of-balance . . . . .	15 cm/g max.
Pressure plate run-out . . . . .	0.004 in (0.10 mm) max.
Release plate run-out . . . . .	0.012 in (0.3 mm) max.
Distance between flywheel/ release ring . . . . .	1.0511-1.0747 in (26.7-27.3 mm)
Clutch springs :	
Fitted length . . . . .	1.1495 in (29.2 mm)
Fitted load - light blue . . . . .	132-141 lb (60-64 kg)
- dark blue . . . . .	136-145 lb (62-66 kg)
- white . . . . .	98-109 lb (44.5-49.5 kg)
- red . . . . .	75-81 lb (34-37 kg)
Clutch pedal free-play . . . . .	0.4-0.8 in (10-20 mm)
Clutch driven plate run-out . . . . .	0.03 in (0.8 mm)

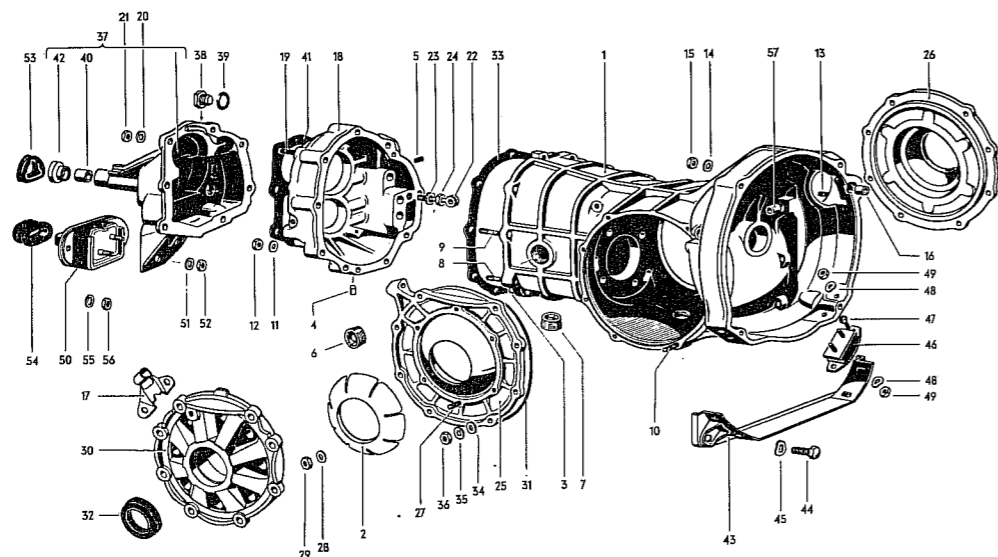


Fig. E.1 Exploded view of the transmission casing.

- |                                                                  |                                          |                                |
|------------------------------------------------------------------|------------------------------------------|--------------------------------|
| 1. Gearbox case                                                  | 19. Gear selector housing stud           | 37. Gear selector housing      |
| 2. Plastic packing between final drive cover and rear axle tube. | 20. Spring washer                        | 38. Plug                       |
| 3. Gear carrier dowel pin                                        | 21. Nut                                  | 39. Gasket                     |
| 4. Retaining plug                                                | 22. Reverse lever support                | 40. Gear selector housing bush |
| 5. Oil filler plug                                               | 23. Spring washer                        | 41. Gasket                     |
| 6. Oil drain plug                                                | 24. Nut                                  | 42. Gasket                     |
| 7. Oil drain plug                                                | 25. Left-hand final drive cover          | 43. Gearbox carrier            |
| 8. Gear carrier stud                                             | 26. Right-hand final drive cover         | 44. Bolt                       |
| 9. Gear carrier stud                                             | 27. Axle tube retainer stud              | 45. Spring washer              |
| 10. Final drive cover stud                                       | 28. Spring washer                        | 46. Rear rubber mounting       |
| 11. Spring washer                                                | 29. Nut                                  | 47. Bolt                       |
| 12. Nut                                                          | 30. Final drive cover (for double axle.) | 48. Spring washer              |
| 13. Starter motor stud                                           | 31. Sealing ring                         | 49. Nut                        |
| 14. Spring washer                                                | 32. Joint flange seal                    | 50. Front rubber mounting      |
| 15. Nut                                                          | 33. Gear carrier gasket                  | 51. Spring washer              |
| 16. Starter motor shaft bush                                     | 34. Washer                               | 52. Nut                        |
| 17. Clutch cable guide plate                                     | 35. Spring washer                        | 53. Gasket                     |
| 18. Gear carrier                                                 | 36. Nut                                  | 54. Rubber bush                |
|                                                                  |                                          | 55. Spring washer              |

# Gearbox & Final Drive

## GENERAL

TRANSMISSION UNIT – Removal & Installation

FINAL DRIVE – Removal & Installation

GEARBOX – Disassembly

MAIN DRIVE SHAFT – Disassembly, Inspection & Assembly

PINION SHAFT – Disassembly, Inspection & Assembly

GEARBOX – Reassembly

## 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 boded mounting and at the rear by a cradle which is bolted to the forks 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 Dealer.

## TRANSMISSION UNIT

### Removal

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

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

### Swing Axle Beetles

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 bolt.
5. Remove the lower nuts from the push rods for the equaliser spring (not on 1200s) and pull the rods out of their plates.
6. Mark the position of the spring plates relative to the housing on the axles 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 Beetles

1. Remove the socket headed screws from the drive shaft flanges (Fig. E 4). 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 Beetles

1. Ensure that the spring plates are attached to the axle tubes correctly by aligning the marks made previously.
2. Do not attempt to tighten the large slotted nuts at the ends of the axle shafts until the car is resting on the ground.
3. Bleed and adjust brakes.

### Double-Jointed Axle Beetles

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. Bleed and adjust brakes.

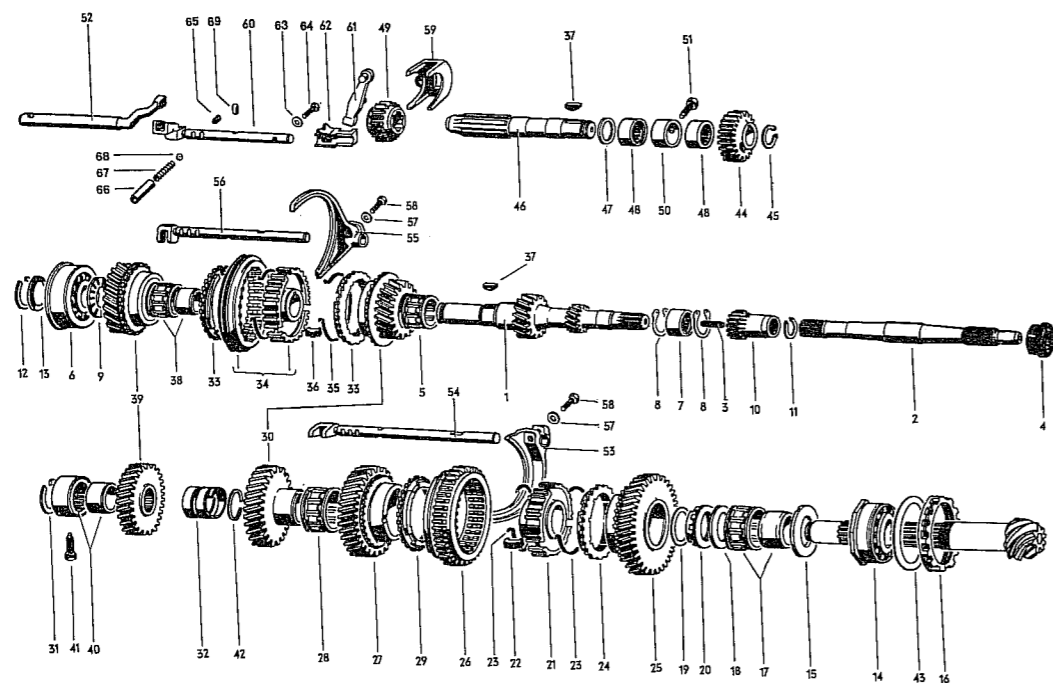


Fig. E.2. Exploded view of the gear train components.

- 1. Front main drive shaft
- 2. Rear main drive shaft
- 3. Connecting stud for shafts
- 4. Oil seal for main drive shaft
- 5. 3rd speed gear needle bearing
- 6. Main drive shaft bearing
- 7. Needle roller bearing
- 8. Lock ring for needle roller bearing.
- 9. 4th speed gearwheel thrust washer
- 10. Reverse gearwheel
- 11. Locking ring
- 12. Locking ring (from Chassis No. 117 812 292)
- 13. Concave washer
- 14. Double taper roller bearing (from Chassis No. 110 2000 001)
- 15. Thrust washer
- 16. Retaining ring
- 17. Needle roller bearing
- 18. Thrust washer
- 19. Shim
- 20. Round nut for drive pinion
- 21. Synchronizer

- 22. Shifting plates for 1st and 2nd gears
- 23. Snap ring for shifting plates
- 24. 1st speed baulk ring
- 25. 1st speed gearwheel
- 26. 1st and 2nd speed operating sleeve
- 27. 2nd speed gearwheel
- 28. Needle roller bearing
- 29. 2nd speed baulk ring
- 30. 3rd speed gearwheels
- 31. Circlip
- 32. Spacer ring
- 33. 3rd and 4th speed baulk rings
- 34. 3rd and 4th speed synchroniser
- 35. Snap ring for shifting plates
- 36. 3rd and 4th speed shifting plates
- 37. Woodruff key
- 38. Needle roller bearing
- 39. 4th speed gearwheels
- 40. Needle roller bearing
- 41. Locking bolt
- 42. Locking ring
- 43. Shim
- 44. Reverse drive gear
- 45. Locking ring

- 46. Reverse gear shaft
- 47. Thrust washer
- 48. Needle bearing for reverse shaft
- 49. Reverse sliding gear
- 50. Spacer sleeve
- 51. Locking bolt for spacer sleeve
- 52. Transmission shift lever
- 53. 1st and 2nd speed selector fork
- 54. 1st and 2nd speed selector shaft
- 55. 3rd and 4th speed selector fork
- 56. 3rd and 4th speed selector shaft
- 57. Spring washer
- 58. Screw for selector fork
- 59. Reverse speed selector fork
- 60. Reverse speed selector shaft
- 61. Reverse lever for reverse gear
- 62. Reverse lever guide
- 63. Spring washer
- 64. Bolt
- 65. Detent ball retaining plug
- 66. Detent ball sleeve
- 67. Detent ball spring
- 68. Detent ball for selector shaft
- 69. Gear locking plunger

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 Dealer. The measuring equipment required is extremely complex and without it is virtually impossible to adjust the unit correctly. It is recommended, therefore, that work of this nature be entrusted to a VW Agent.

Removal

Swing-Axle Beetles

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

Installation

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.

4. Instal the left hand final drive cover. Make sure that both washers are used under each nut.

Double-Jointed Axle Beetles

1. If the bearings have been removed from the final drive covers, put the shims in position and then press in the bearing outer race.
2. Coat the oil seals with oil and press them into the covers.
3. Lightly oil the O-rings and install them.
4. Instal the right hand cover.
5. Slide a new circlip and reverse gear on to the rear part of the main shaft and screw both parts of the main shaft together. Back off one spline, slide on the reverse gear and install the circlip.
6. Fit the differential into the casing.
7. Fit the final drive cover on the ring gear side.
8. Insert the spacer rings and slide the flanges on. Secure them with new circlips. Make sure that the circlip fits properly in its groove.
9. Press 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 gearshift 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 strap.
3. If there are nuts on the end of the pinion and drive shaft, engage two gears at once, straighten the locking plates and remove the nuts (Fig. E 11).
4. Take the circlip for the reverse gear off the drive shaft, pull off the gear and screw the two parts of the shaft apart. (Fig. E 12).
5. Take the reverse gear and the circlip off and take out the drive shaft from the rear, making sure that the oil seal is not damaged.
6. Remove the screws which secure the bearing retainer (Fig. E 13). The lock 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 1/2 gear fork and the 3/4 gear fork and take off the 1/2 gear fork (Fig. E 18). It is best if the gear carrier can be supported in a stand or large vice. If the latter is used, make sure that the machined face is not damaged by the jaws.
12. Remove the shift rod for the 3/4 gear out of the shift fork.

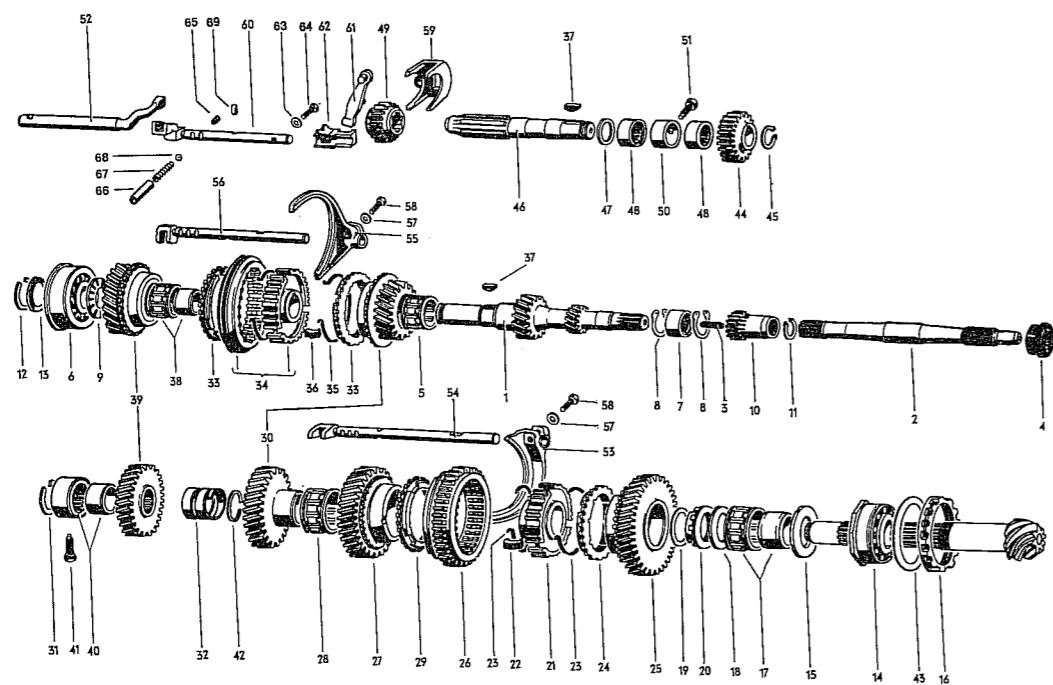


Fig. E.2. Exploded view of the gear train components.

- 1. Front main drive shaft
- 2. Rear main drive shaft
- 3. Connecting stud for shafts
- 4. Oil seal for main drive shaft
- 5. 3rd speed gear needle bearing
- 6. Main drive shaft bearing
- 7. Needle roller bearing
- 8. Lock ring for needle roller bearing.
- 9. 4th speed gearwheel thrust washer
- 10. Reverse gearwheel
- 11. Locking ring
- 12. Locking ring (from Chassis No. 117 812 292)
- 13. Concave washer
- 14. Double taper roller bearing (from Chassis No. 110 2000 001)
- 15. Thrust washer
- 16. Retaining ring
- 17. Needle roller bearing
- 18. Thrust washer
- 19. Shim
- 20. Round nut for drive pinion
- 21. Synchronizer

- 22. Shifting plates for 1st and 2nd gears
- 23. Snap ring for shifting plates
- 24. 1st speed baulk ring
- 25. 1st speed gearwheel
- 26. 1st and 2nd speed operating sleeve
- 27. 2nd speed gearwheel
- 28. Needle roller bearing
- 29. 2nd speed baulk ring
- 30. 3rd speed gearwheels
- 31. Circlip
- 32. Spacer ring
- 33. 3rd and 4th speed baulk rings
- 34. 3rd and 4th speed synchroniser
- 35. Snap ring for shifting plates
- 36. 3rd and 4th speed shifting plates
- 37. Woodruff key
- 38. Needle roller bearing
- 39. 4th speed gearwheels
- 40. Needle roller bearing
- 41. Locking bolt
- 42. Locking ring
- 43. Shim
- 44. Reverse drive gear
- 45. Locking ring

- 46. Reverse gear shaft
- 47. Thrust washer
- 48. Needle bearing for reverse shaft
- 49. Reverse sliding gear
- 50. Spacer sleeve
- 51. Locking bolt for spacer sleeve
- 52. Transmission shift lever
- 53. 1st and 2nd speed selector fork
- 54. 1st and 2nd speed selector shaft
- 55. 3rd and 4th speed selector fork
- 56. 3rd and 4th speed selector shaft
- 57. Spring washer
- 58. Screw for selector fork
- 59. Reverse speed selector fork
- 60. Reverse speed selector shaft
- 61. Reverse lever for reverse gear
- 62. Reverse lever guide
- 63. Spring washer
- 64. Bolt
- 65. Detent ball retaining plug
- 66. Detent ball sleeve
- 67. Detent ball spring
- 68. Detent ball for selector shaft
- 69. Gear locking plunger

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 Dealer. The measuring equipment required is extremely complex and without it it is virtually impossible to adjust the unit correctly. It is recommended, therefore, that work of this nature be entrusted to a VW Agent.

Removal

Swing-Axle Beetles

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

Installation

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.

4. Instal the left hand final drive cover. Make sure that both washers are used under each nut.

Double-Jointed Axle Beetles

1. If the bearings have been removed from the final drive covers, put the shims in position and then press in the bearing outer race.
2. Coat the oil seals with oil and press them into the covers.
3. Lightly oil the O-rings and install them.
4. Instal the right hand cover.
5. Slide a new circlip and reverse gear on to the rear part of the main shaft and screw both parts of the main shaft together. Back off one spline, slide on the reverse gear and install the circlip.
6. Fit the differential into the casing.
7. Fit the final drive cover on the ring gear side.
8. Insert the spacer rings and slide the flanges on. Secure them with new circlips. Make sure that the circlip fits properly in its groove.
9. Press 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 gearshift 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 strap.
3. If there are nuts on the end of the pinion and drive shaft, engage two gears at once, straighten the locking plates and remove the nuts (Fig. E 11).
4. Take the circlip for the reverse gear off the drive shaft, pull off the gear and screw the two parts of the shaft apart. (Fig. E 12).
5. Take the reverse gear and the circlip off and take out the drive shaft from the rear, making sure that the oil seal is not damaged.
6. Remove the screws which secure the bearing retainer (Fig. E 13). The lock 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 1/2 gear fork and the 3/4 gear fork and take off the 1/2 gear fork (Fig. E 18). It is best if the gear carrier can be supported in a stand or large vice. If the latter is used, make sure that the machined face is not damaged by the jaws.
12. Remove the shift rod for the 3/4 gear out of the shift fork.

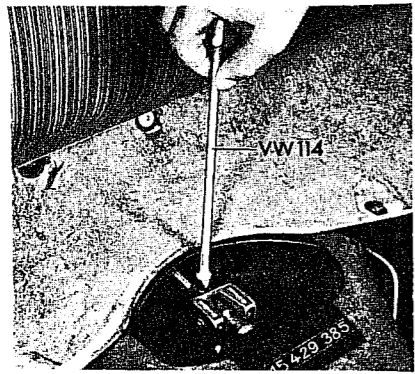


Fig. E.3. Disconnecting the gearchange coupling.

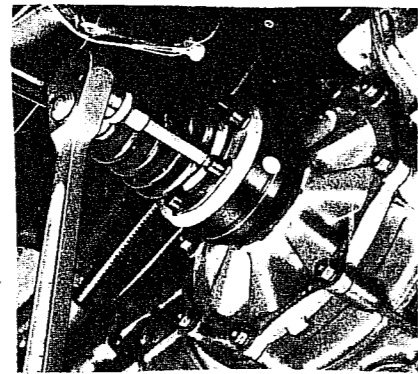


Fig. E.4. Removing the drive shaft flange screws.

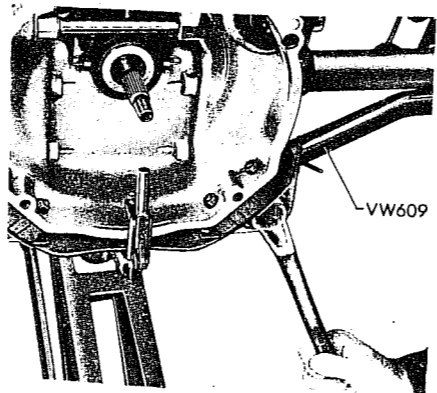


Fig. E.5. Removing the gearbox carrier mounting bolts.

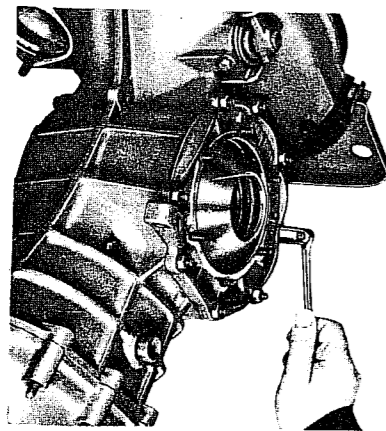


Fig. E.6. Removing the left-hand cover nut.

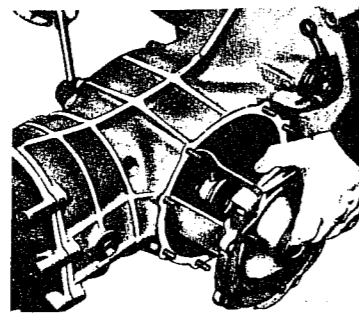


Fig. E.7. Removing the left-hand cover and spindle.

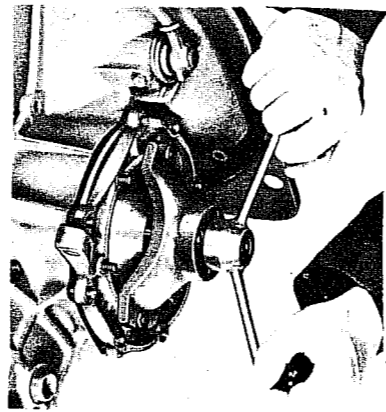


Fig. E.8. Pressing out the differential assembly with an extractor

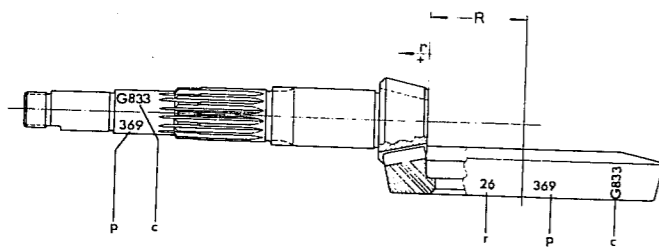
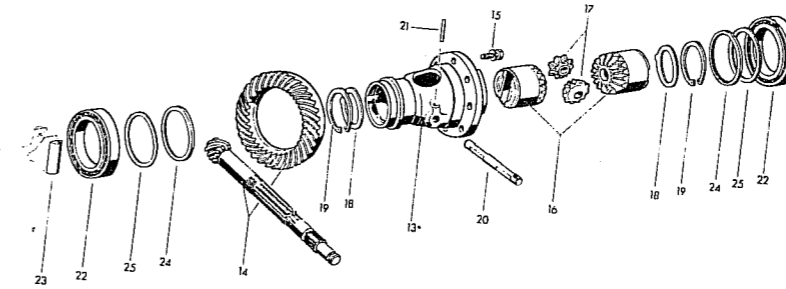
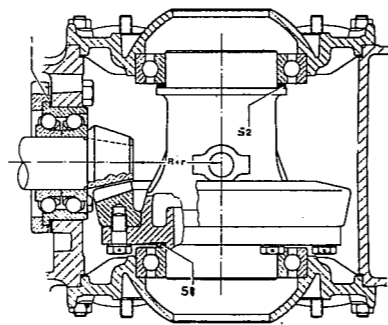


Fig. E.9. Crown wheel and pinion markings and location of adjustment shims.



- 12. Limited slip differential
- 13. Differential housing
- 14. Crown wheel and pinion
- 15. Crown wheel securing bolt
- 16. Differential side gear
- 17. Differential pinion
- 18. Differential thrust washer
- 19. Locking ring
- 20. Differential pinion shaft
- 21. Differential pinion shaft locking pin
- 22. Differential side bearing
- 23. Fulcrum plate for rear axle shaft
- 24. Shim
- 25. Shim
- 26. Differential housing
- 27. Differential housing cover
- 28. Discs for limited slip differential
- 29. Differential side gear
- 30. Differential pinion
- 31. Pressure ring
- 32. Differential pinion shaft
- 33. Housing bolt

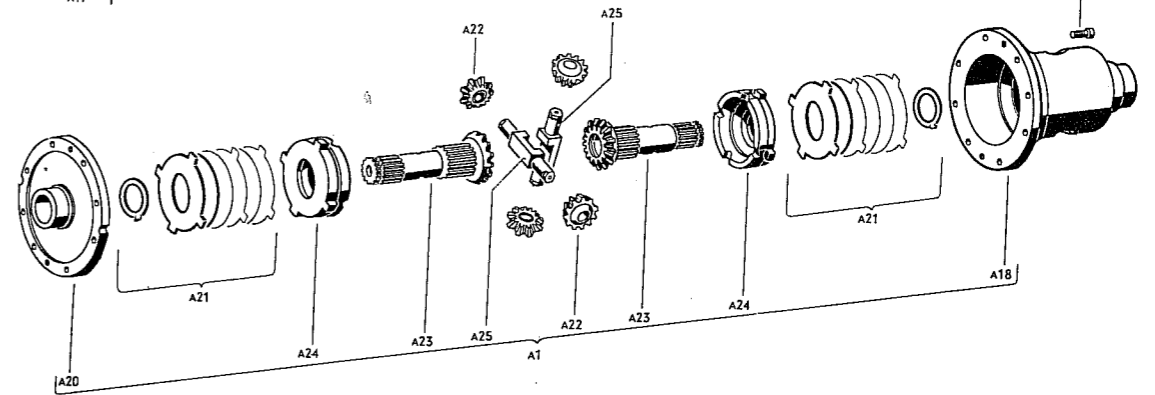
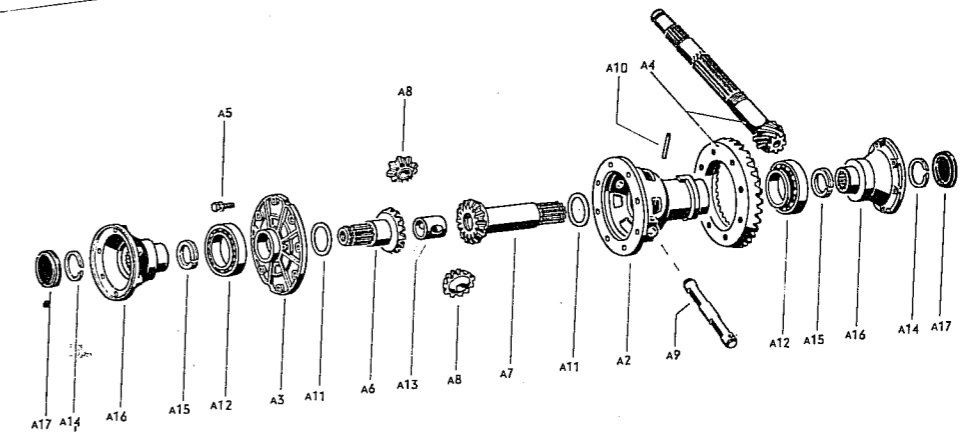
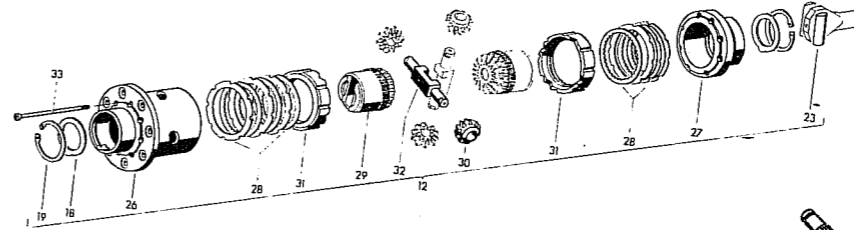


Fig. E.10. Exploded view of the various types of differential assemblies fitted to Beetle models.

- 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 side gear
- A8. Differential pinion
- A9. Differential pinion shaft
- A10. Differential shaft lock pin
- A11. Thrust washer
- A12. Differential taper roller bearing
- A13. Spacer sleeve
- A14. Joint flange circlip
- A15. Joint flange spacer ring
- A16. Joint flange
- A17. Joint flange cap
- A18. Housing
- A19. Screw
- A20. Differential housing cover
- A21. Set of discs
- A22. Differential pinion
- A23. Differential side gear
- A24. Pressure ring
- A25. Differential pinion shaft



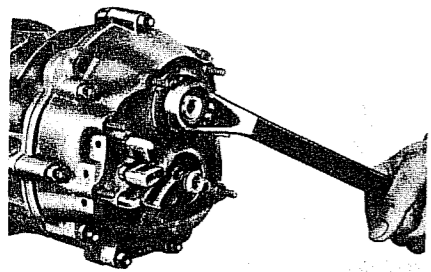


Fig. E.11. Removing the drive pinion nut on early type gearboxes. (On late type gearboxes the shaft is retained by a circlip).

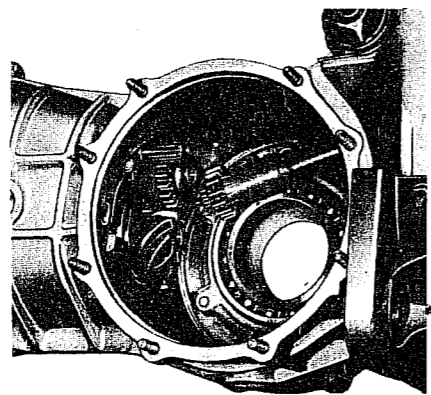


Fig. E.12. Separating the drive shaft.

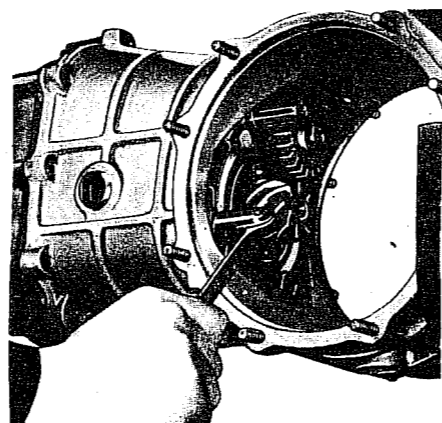


Fig. E.13. Unbolting the drive pinion bearing retainer.

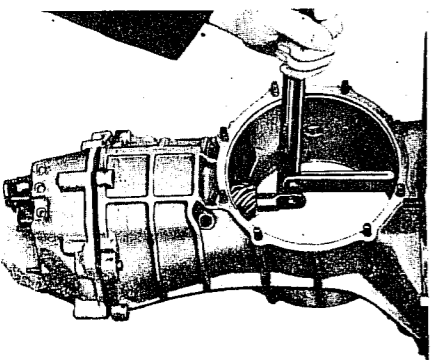


Fig. E.14. Pressing out the gear train and gear carrier. (A wooden block and levers can be used instead of the tool shown.)

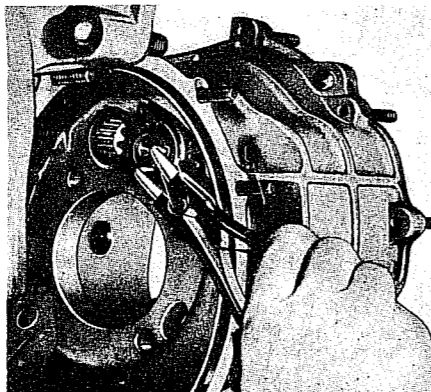


Fig. E.15. Removing the circlip retaining the reverse idler gear wheel.

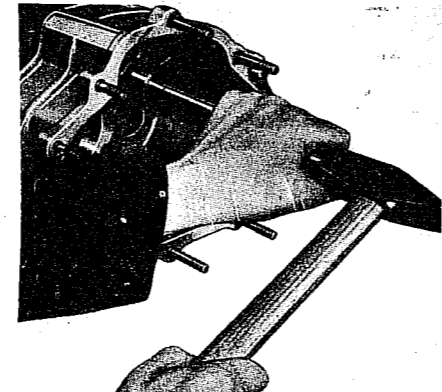


Fig. E.16. Driving out the reverse idler shaft-needle bearing.

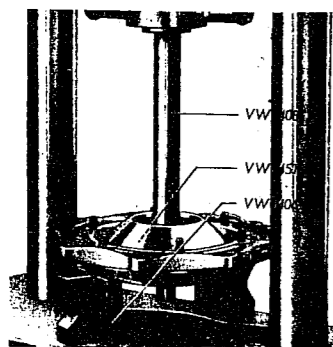


Fig. E.17. Pressing out the differential bearing.

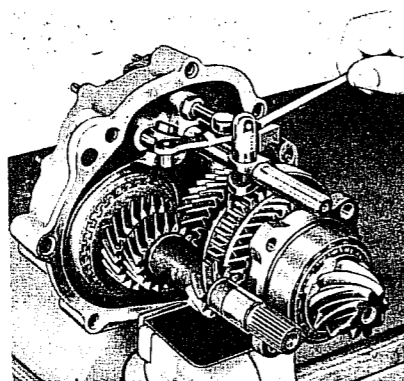


Fig. E.18. Removing the selector fork locking screws.

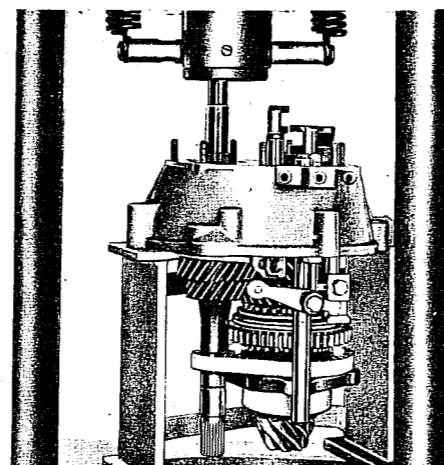


Fig. E.19. Pressing out the main drive shaft.

13. Remove the circlip from around the drive shaft at the selector end of the gear carrier. The 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  $\frac{3}{4}$  shift fork 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.

Normal dimension = 1.0 – 1.9 mm  
Wear limit = 0.6 mm

#### Assembly

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 on to the shaft as far as it will go (Fig. E 26). 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.

#### Dismantling

1. Remove the circlip which is at the opposite end to the pinion. It may help to remove it if the 4th gear is pressed away from it.
2. Press off the inner race for the needle bearing and 4th gear (Fig. E 29).
3. Remove the spacer ring and circlip.
4. Remove 3rd gear, 2nd gear, the synchroniser hub and operating sleeve, the synchroniser rings and 1st gear.
5. Unscrew the round nut and remove the 1st gear needle bearing.
6. Press off the double taper roller bearing and the inner race of the 1st gear needle bearing.
7. Remove the operating sleeve, synchroniser keys and springs.

#### Inspection

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

Normal dimension	=	1.1 – 1.8 mm
Wear limit	=	0.6 mm
3. NOTE : Damaged 3rd and 4th gears must only be replaced in pairs although this only applies to 1st and 2nd gears if the teeth are damaged.

#### Assembly

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

Limits	=	0.10 – 0.25 mm (0.004 – 0.010")
		(Try to keep to bottom limit)
6. Slide on 2nd gear synchroniser ring, 2nd gear with its needle bearing and 3rd gear.
7. Check the axial play of 3rd gear and bring it within the prescribed limits by using a circlip of the correct thickness.
 

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

Circlips are available in the following sizes :

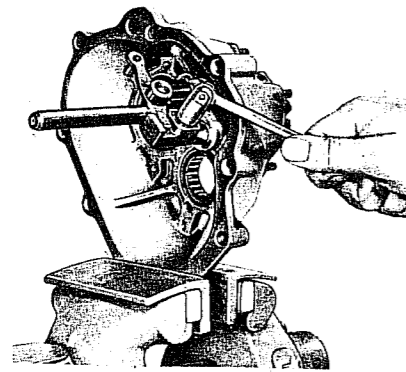


Fig. E.20. Removing the reverse selector lever guide.

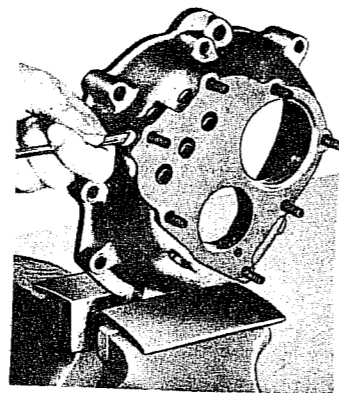
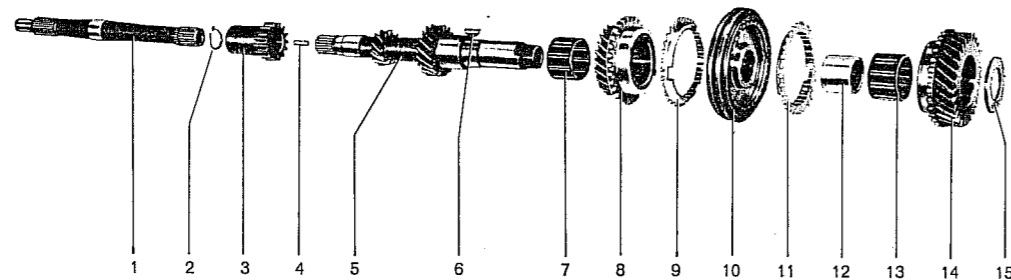


Fig. E.21. Removing the interlock springs.



- |                                  |                                         |
|----------------------------------|-----------------------------------------|
| 1. Rear half of shaft            | 9. Baulk ring (3rd speed)               |
| 2. Reverse gear circlip          | 10. Synchroniser (3rd/4th speeds)       |
| 3. Reverse gear                  | 11. Baulk ring (4th speed)              |
| 4. Connecting stud               | 12. Needle roller bearing inner race    |
| 5. Front main drive shaft        | 13. Needle roller cage (4th speed gear) |
| 6. Woodruff key for synchroniser | 14. 4th speed gearwheel                 |
| 7. Needle roller bearing         | 15. Thrust washer                       |

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

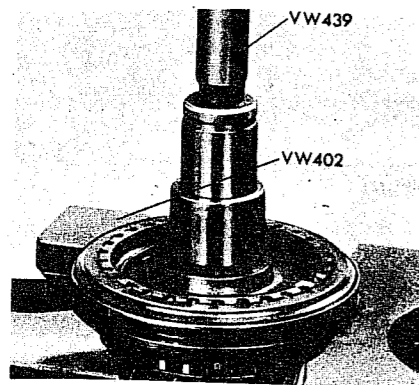


Fig. E.23. Pressing the 3rd speed gear wheel and synchroniser off the main drive shaft.

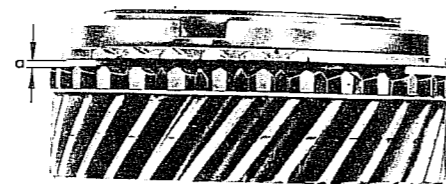


Fig. E.24. Synchroniser to gear wheel clearance.  $a = 0.6 \text{ mm. max.}$

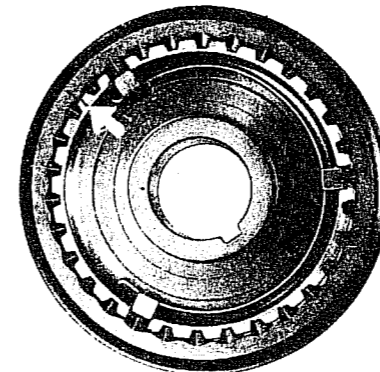


Fig. E.25. Synchroniser hub and sleeve alignment marks.

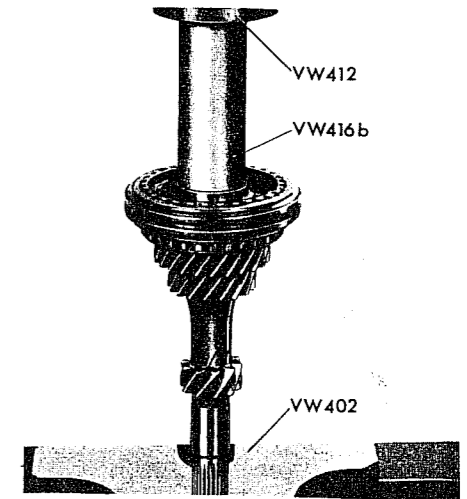
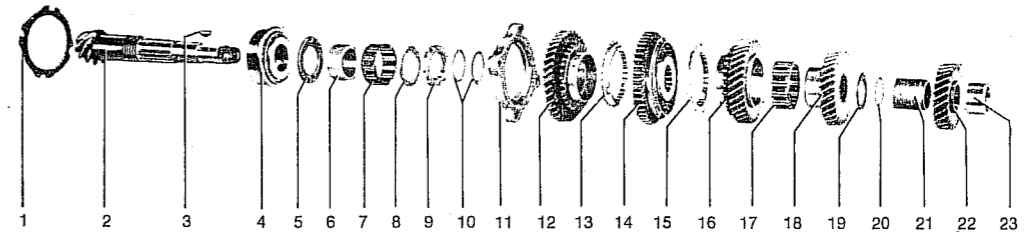
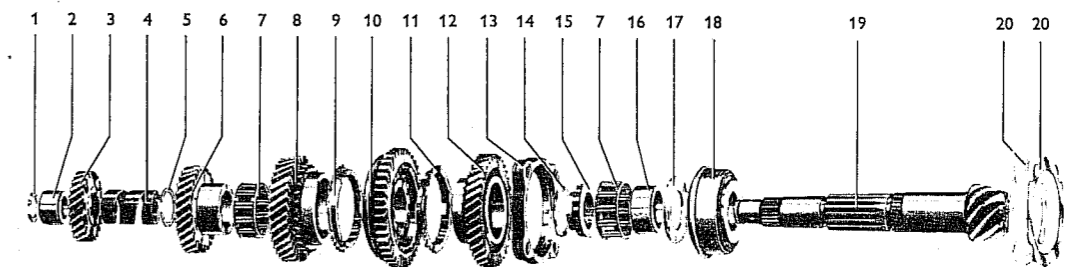


Fig. E.26. Installing the 3rd/4th gear synchroniser.



- |                                  |                               |                                   |                         |
|----------------------------------|-------------------------------|-----------------------------------|-------------------------|
| 1. Shim                          | 7. Needle bearing cage        | 13. Baulk ring (1st speed)        | 19. Concave washer      |
| 2. Drive pinion shaft            | 8. Thrust washer              | 14. Synchroniser (1st/2nd speeds) | 20. Concave washer shim |
| 3. Woodruff key (4th speed gear) | 9. Round nut                  | 15. Baulk ring (2nd speed)        | 21. Spacer sleeve       |
| 4. Bearing                       | 10. Shims (end float control) | 16. 2nd speed gearwheel           | 22. 4th speed gearwheel |
| 5. Thrust washer                 | 11. Bearing retainer          | 17. Needle roller cage            | 23. Inner bearing race  |
| 6. Needle bearing inner race     | 12. 1st speed gearwheel       | 18. 3rd speed gearwheel           |                         |

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



- |                                |                                   |                        |
|--------------------------------|-----------------------------------|------------------------|
| 1. Circlip                     | 8. 2nd speed gearwheel            | 15. Round nut          |
| 2. Inner race                  | 9. Baulk ring (2nd speed)         | 16. Inner race         |
| 3. 4th speed gearwheel         | 10. Synchroniser (1st/2nd speeds) | 17. Thrust washer      |
| 4. Spacer spring               | 11. Baulk ring (1st speed)        | 18. Bearing            |
| 5. Circlip (end float control) | 12. 1st speed gearwheel           | 19. Drive pinion shaft |
| 6. 3rd speed gearwheel         | 13. Retaining ring                | 20. Shims              |
| 7. Needle roller cage          | 14. Spacer washer                 |                        |

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

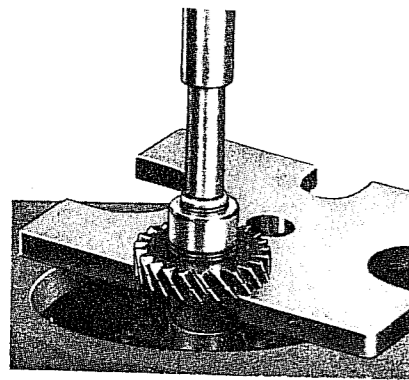


Fig. 29. Pressing the 4th speed gear wheel off the drive pinion shaft.

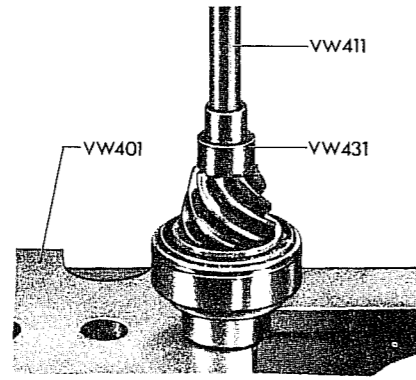


Fig. E.30. Pressing home the pinion bearing.

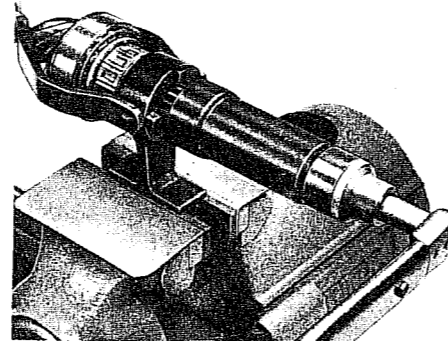


Fig. E.31. Tightening the round nut.

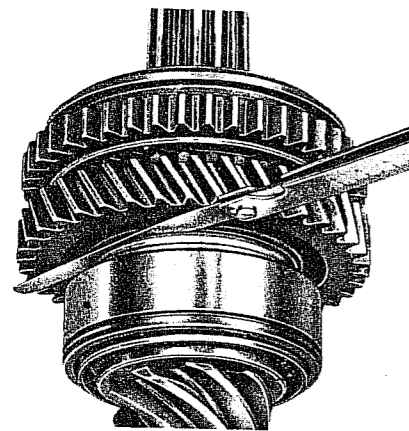


Fig. E.32. Checking the axial play of the 1st speed gear wheel.

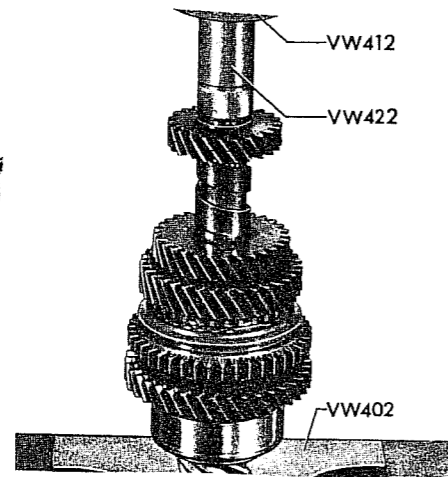


Fig. E.33. Installing the 4th speed gear wheel on the pinion shaft.

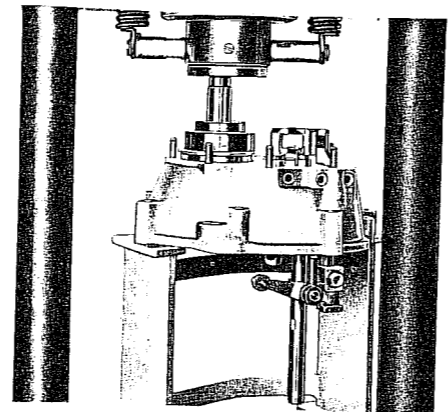


Fig. E.34. Installing the main drive shaft bearing in the gear carrier.

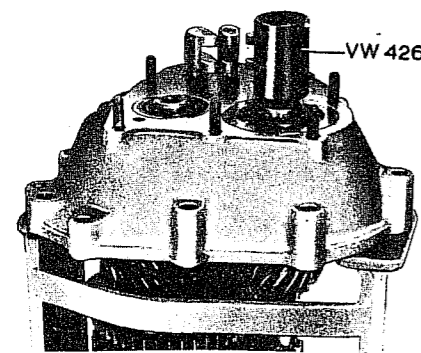


Fig. E.35. Fitting the pinion shaft circlip - Late type pinion shaft.

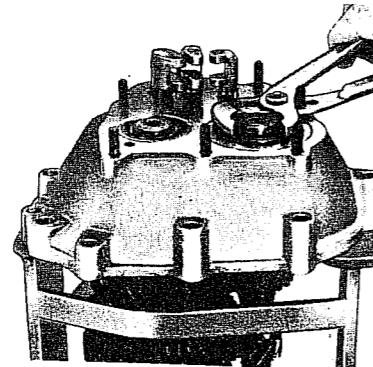


Fig. E.36. Press the circlip fully home in its groove.

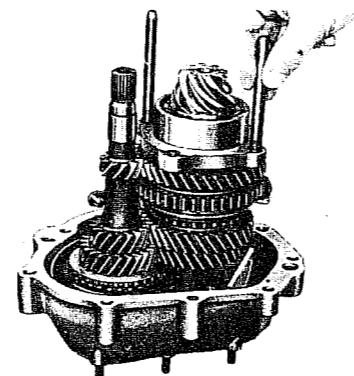


Fig. E.37. Pinion bearing retainer pilot studs.

Thickness (mm)	Part No.	Colour
1.45	113 311 381	plain
1.60	113 311 382	black
1.75	113 311 383	blue
1.90	113 311 384	brown
2.05	113 311 385	grey
2.20	113 311 386	copper

8. Install the spacer spring 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 dished washer over the end of the drive shaft at the selector end and install a NEW circlip. Make sure that it snaps into its groove. This can be done by pressing the circlip all round with a pair of water pump pliers.
4. Install the shift forks for gears 1/2, 3/4 and reverse.
5. Adjust the shift forks. Unless you have access to VW tool 294b, this cannot be done very easily. The following points must be born in mind :
  - a. The 1/2 gear shift fork (the wider one) is installed with its profile towards the gear carrier whilst the 3/4 gear shift fork is installed with its profile away from the gear carrier.
  - b. The shift fork for 1/2 gear must be adjusted so that both gears will engage fully. If the 2nd gear only just engages, re-adjust the fork to provide full 2nd gear engagement at the expense of slight loss of engagement for 1st gear.
  - c. Adjust the 3/4 gear shift fork so that both gears engage an equal amount.
  - d. When the forks are correctly adjusted, tighten the fork locking screws to a torque of 18 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 train into the case.
9. Put the screws into the bearing retainer (with new lock plates) and tighten them to 36 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 ft.lbs (1.5 kg.m).

# Technical Data

## GENERAL SPECIFICATIONS

Gear ratios - Manual :	
1st gear . . . . .	3.80:1
2nd gear . . . . .	2.06:1
3rd gear . . . . .	1.26:1
	(Model 181 - 1.22:1)
4th speed . . . . .	0.89:1
	(Model 181 - 0.82:1)
Reverse gear . . . . .	3.61:1

Gear ratios - Automatic Stickshift :	
"L" . . . . .	2.06:1
"1" . . . . .	1.26:1
"2" . . . . .	0.89:1
"R" . . . . .	3.07:1

Final Drive Ratios :	
1200 . . . . .	4.375:1
1300, Prior to Aug. 1970 . . . . .	4.375:1
1300/44 BHP - Type 11, as from Aug. 1970 . . . . .	4.375:1
1300/44 BHP - Type 14, as from Aug. 1970 . . . . .	4.125:1
1500 . . . . .	4.125:1
1600, Prior to Aug. 1970 . . . . .	4.125:1
1600/50 BHP - Type 15, as from Aug. 1970 . . . . .	4.125:1
1600/50 BHP - Type 14, as from Aug. 1970 :	
- Manual Trans. . . . .	3.875:1
- Auto. Trans. . . . .	4.125:1
All Auto. Trans. models (except above) . . . . .	4.375:1
Model 181 . . . . .	3.875:1

Reduction Gear Ratios (Model 181)	
Prior to Aug. 1970 . . . . .	1.39:1
As from Aug. 1970 . . . . .	1.26:1

## LUBRICATION

Transmission Capacity . . . . .	4.375 imp.pts (5.25 US pts; 2.5 litres)
Reduction Gears capacity (181) . . . . .	0.44 imp.pts (0.5 US pts; 0.25 litres)
Recommended lubricant . . . . .	Hypoy Transmission Oil SAE 80/90 (MIL-L-2105 B)

## REPAIR DATA

Gearbox mainshaft/needle bearing clearance (in flywheel gland nut) . . . . .	0.0047-0.0075 in (0.12-0.19 mm)
Wear limit . . . . .	0.010 in (0.25 mm)
Front main drive shaft run-out (as measured on needle bearing seat for 3rd speed gear) . . . . .	0.0008 in (0.02 mm)
Selector housing bush inner diameter . . . . .	0.5924-0.5916 in (15.05-15.03 mm)
Wear limit . . . . .	0.6004 in (15.25 mm)
Inner selector lever diameter . . . . .	0.5900-0.5916 in (15.00 - 14.96 mm)
Wear limit . . . . .	0.5807 in (14.750 mm)
Gearbox case side cover pre-load on differential side bearings . . . . .	0.055 in (0.14 mm)
Trunnion blocks/axle clearance (as installed in differential side gear) . . . . .	0.002-0.009 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 (12.55-12.57 mm)
Wear limit . . . . .	0.4980 in (12.65 mm)
Starter motor bush-to-shaft clearance . . . . .	0.0035-0.0055 in (0.09-0.14 mm)
Wear limit . . . . .	0.010 in (0.25 mm)
First speed gear end play . . . . .	0.004-0.01 in (0.10-0.25 mm)
Shifting fork-to-synchroniser sleeve clearance (1st to 4th speeds) . . . . .	0.004-0.012 in (0.10-0.30 mm)
Syncrho ring-to-gear distance (measured between teeth) . . . . .	0.043 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

## GENERAL

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

Vehicles with double jointed rear axles (the 1302, 1302'S' and those with automatic transmission) have drive shafts with a constant velocity joint at either end (Fig. F 2). One end of this drive shaft is attached to the transmission whilst the other end is attached to a short wheel shaft. In addition to the spring plate which links the rear axle to the torsion bars, 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 enclosed in a housing which is accessible after the rear drum is removed (Fig. F 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 balls of the bearing.

### Removal

1. Remove the rear drum (see section on Brakes)
2. Remove the four screws which secure the wheel bearing cover. 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.

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

## REAR WHEEL BEARINGS (Double-Jointed Axle Vehicles)

The rear wheel shaft is supported in a housing on the end of the trailing arm by two bearings, an inner ball bearing and an outer roller bearing.

### Removal

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

### Installation

1. Press in the ball bearing.
2. Install the circlip and press in the inner oil seal. If the old one 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.

Fig. F.1. Exploded view of the swing axle type rear suspension.

1. Rear axle tube
2. Gasket for rear axle tube retainer
3. Gasket for rear axle tube retainer
4. Rear axle tube retainer
5. Dust sleeve for axle tube
6. Dust sleeve for axle tube
7. Washer
8. Nut
9. Dust sleeve retaining clip
10. Dust sleeve retaining clip
11. Axle shaft bearing housing
12. Douzel pin
13. Bumper stop
14. Bumper stop for spring plate
15. Bolt
16. Bolt
17. Washer
18. Lock washer
19. Nut
20. Rear axle shaft
21. Slotted nut for shaft
22. Split pin

23. Rear wheel bearing spacer
24. Rear wheel ball bearing
25. Washer
26. Bearing cover gasket
27. Gasket
28. Outer spacer
29. Rear wheel bearing cover
30. Outer oil seal
31. Bearing cover gasket
32. Oil thrower
33. Bearing cover bolt
34. Spring washer
35. Rubber cover
36. Washer
37. Rear brake drum (up to Chassis No. 1 673 410)
38. Rear brake drum (from Chassis No. 4 630 938 to 116 1021 300)
39. Rear brake drum (from Chassis No. 117 000 001)
40. Brake drum oil deflector
41. Rubber bush

42. Rubber stop
43. Operating rod guide
44. Equalizer spring
45. Equalizer support
46. Equalizer spring outer support
47. Equalizer spring rubber bush
48. Lock washer
49. Nut
50. Equalizer spring rubber tube
51. Operating rod for Chassis No. 118 000 001
52. Operating rod for Chassis No. 118 000 001
53. Self-locking nut
54. Damping ring plate
55. Lower sleeve for operating rod
56. Upper sleeve for operating rod
57. Lever for equalizer spring
58. Lever for rubber grommet
59. Lever rubber grommet
60. Damping ring
61. Guide for operating rod
62. Lever for equalizer spring
63. Nut

64. Screw
65. Washer
66. Bolt
67. Lock washer
68. Nut
69. Rear, left-hand torsion bar
70. Spring plate
71. Spring plate
72. Expansion plug
73. Spring plate hub cover
74. Spring plate hub cover
75. Lock washer
76. Bolt
77. Rubber bush
78. Rubber bush
79. Rear shock absorber
80. Shock absorber rubber grommet bush
81. Shock absorber rubber grommet
82. Shock absorber rubber grommet
83. Washer
84. Lock washer
85. Nut

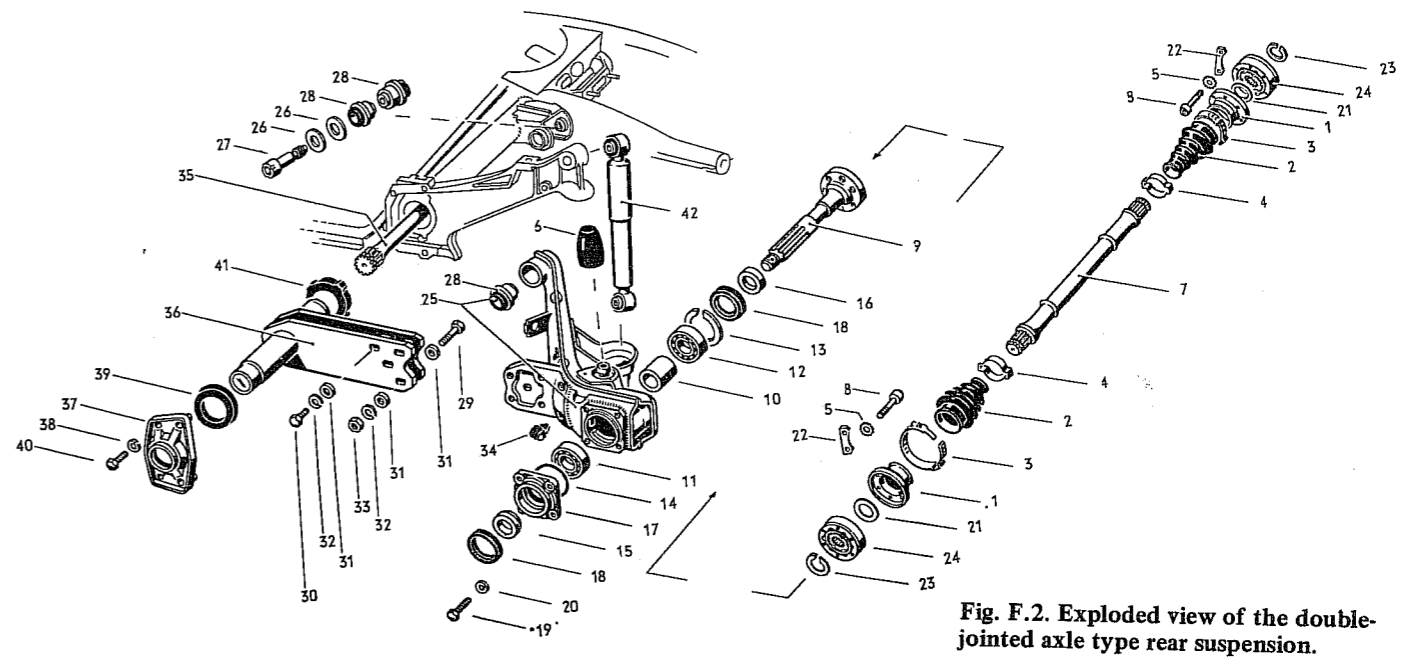
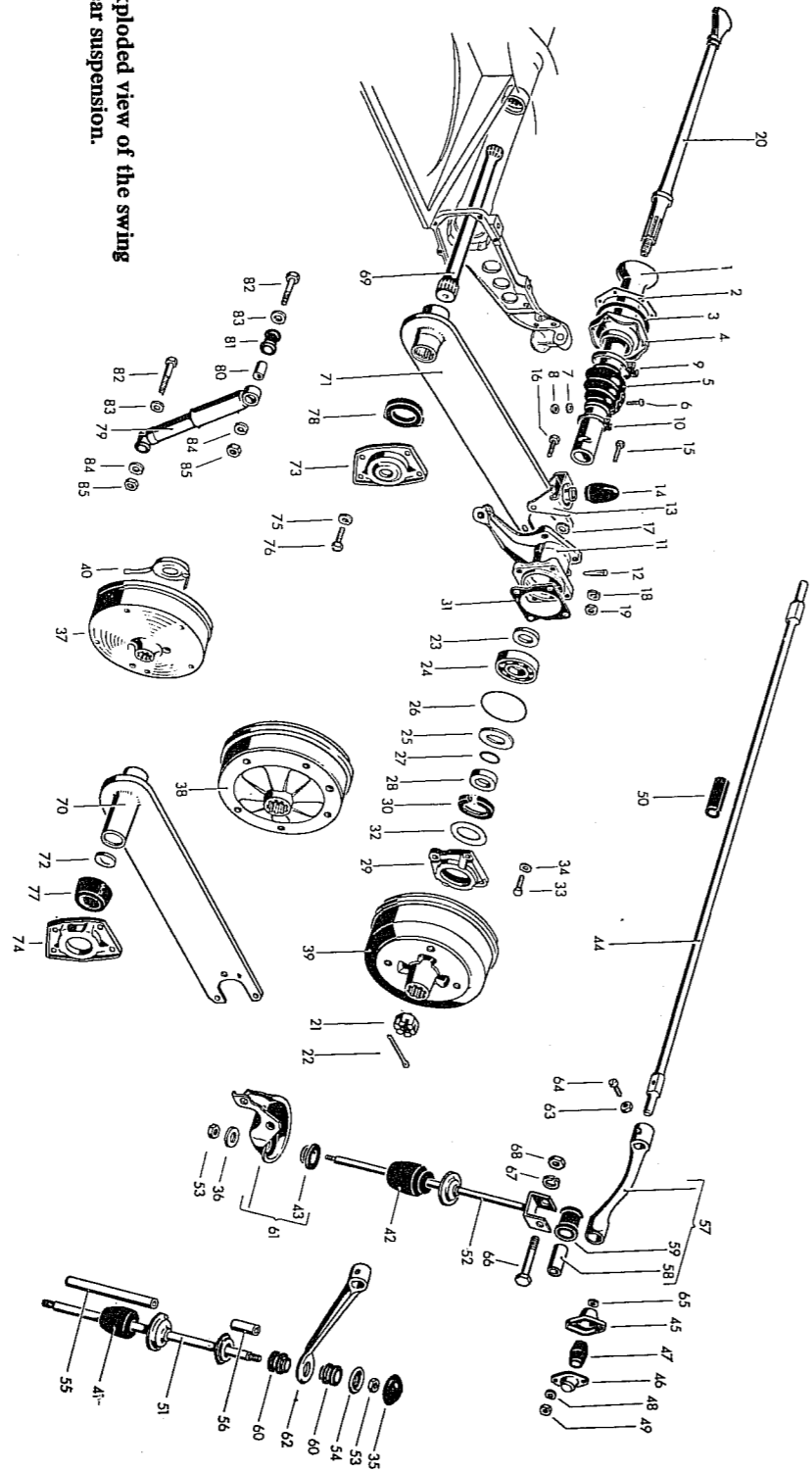


Fig. F.2. Exploded view of the double-jointed axle type rear suspension.

1. Joint cap
2. Dust sleeve for drive shaft
3. Retaining clip for dust sleeve
4. Retaining clip for dust sleeve
5. Lock washer
6. Spring plate rubber stop
7. Drive shaft
8. Screw
9. Rear wheel shaft
10. Distance tube
11. Rear wheel bearing, outer
12. Rear wheel bearing
13. Locking ring
14. Bearing cover gasket
15. Rear wheel bearing spacer

16. Rear wheel bearing spacer
17. Rear wheel bearing cover
18. Rear wheel bearing seal
19. Bearing cover bolt
20. Spring washer
21. Concave washer for drive shaft
22. Spacer plate
23. Circlip for joint flange
24. Constant velocity joint
25. Left-hand control arm
26. Spacer for fitted bolt
27. Fitted bolt for control arm mounting
28. Rubber mounting for control arm

29. Bolt
30. Bolt
31. Washer
32. Spring washer
33. Nut
34. Brake cable bracket
35. Torsion bar
36. Double spring plate
37. Spring plate cover hub
38. Lock washer
39. Outer rubber bush
40. Bolt for cover
41. Rubber bush
42. Rear shock absorber

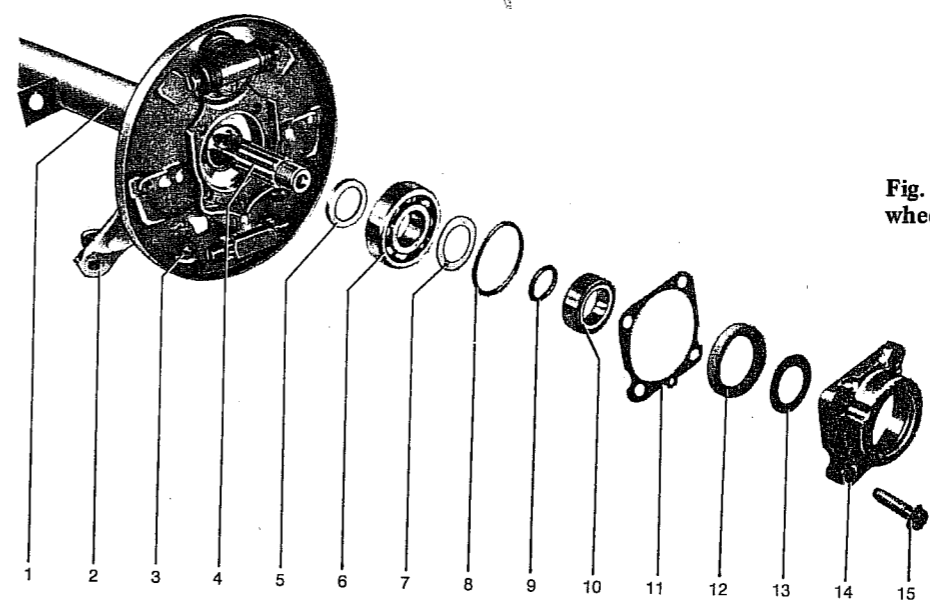


Fig. F.3. Exploded view of the rear wheel bearing assembly - Swing axle.

1. Rear axle tube
2. Bearing housing
3. Brake back plate
4. Axle
5. Inner spacer
6. Ball bearing
7. Washer
8. 'O' seal
9. 'O' seal
10. Outer spacer
11. Paper gasket
12. Oil seal
13. Oil deflector
14. Housing cover
15. Retaining screw

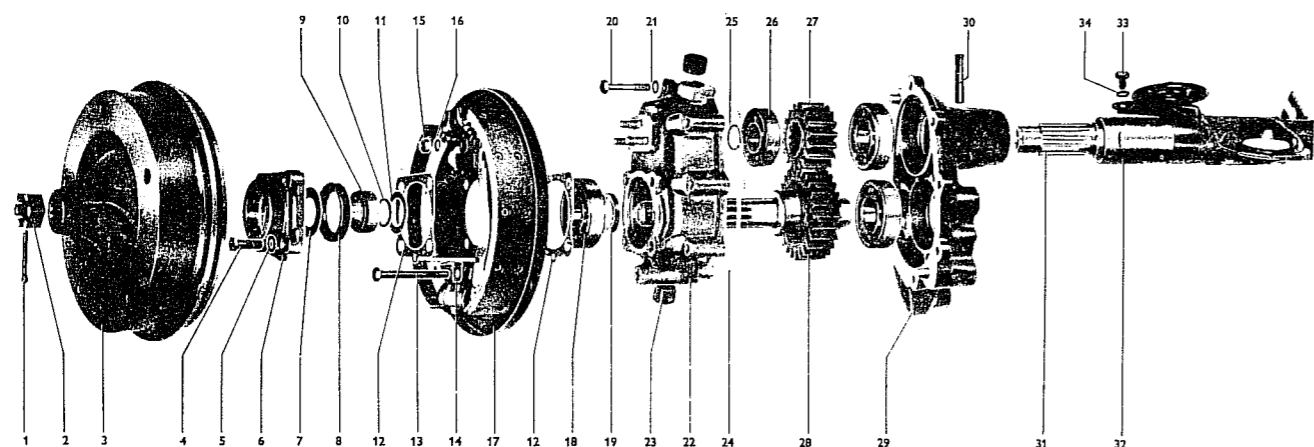


Fig. F.4. Exploded view of the reduction gearbox - 181 models.

- |                         |                             |                                     |
|-------------------------|-----------------------------|-------------------------------------|
| 1. Split pin            | 13. Brake back plate bolt   | 24. Cover gasket                    |
| 2. Castellated nut      | 14. Leaf spring             | 25. Circlip                         |
| 3. Brake drum           | 15. Nut                     | 26. Rear axle shaft bearing (outer) |
| 4. Cover screw          | 16. Spring washer           | 27. Rear axle shaft gear            |
| 5. Spring washer        | 17. Back plate              | 28. Rear wheel shaft with gear      |
| 6. Bearing cover        | 18. Outer bearing           | 29. Reduction gear housing          |
| 7. Oil deflector washer | 19. Inner spacer            | 30. Dowel pin                       |
| 8. Oil seal             | 20. Housing cover bolt      | 31. Rear axle shaft                 |
| 9. Outer spacer         | 21. Spring washer           | 32. Axle tube                       |
| 10. 'O' ring            | 22. Reduction housing cover | 33. Screw                           |
| 11. Washer              | 23. Drain plug              | 34. Spring washer                   |
| 12. Gasket              |                             |                                     |

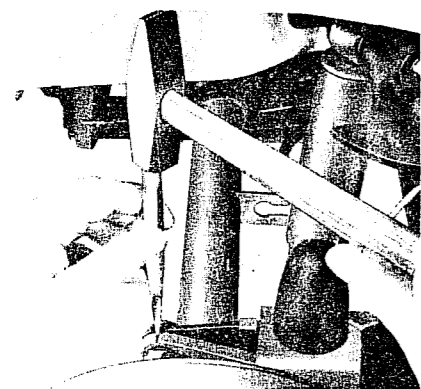


Fig. F.5. Marking the relative positions of the bearing housing and spring plate before removal - Swing axle.

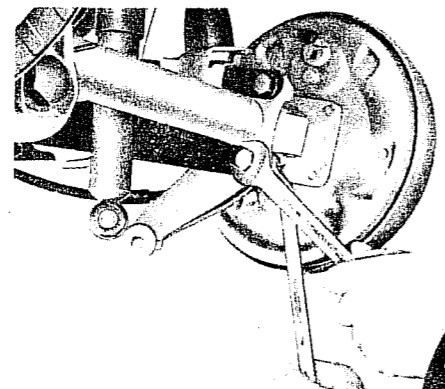


Fig. F.6. Detaching the spring plate from the axle tube. - Swing axle.

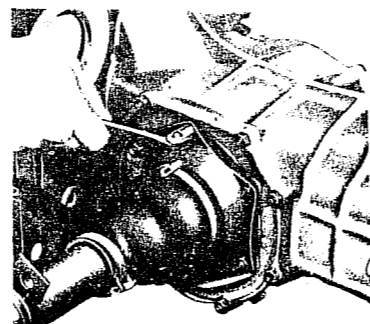


Fig. F.7. Removing the axle tube retainer. - Swing axle.

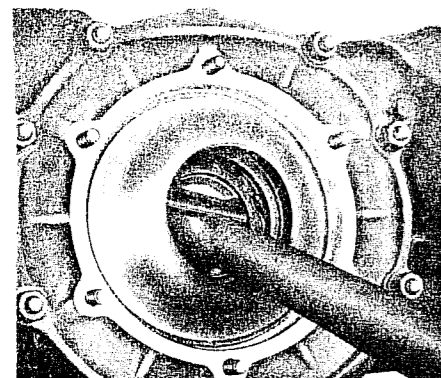


Fig. F.8. Location of the axle shaft circlip. - Swing axle.

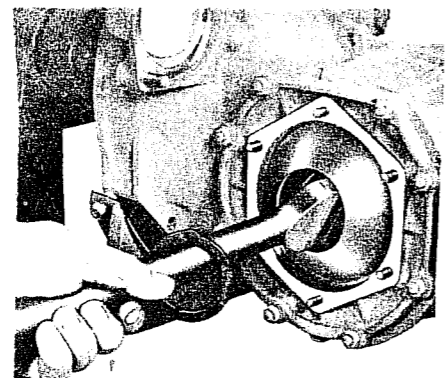


Fig. F.9. Withdrawing the axle shaft. - Swing axle.

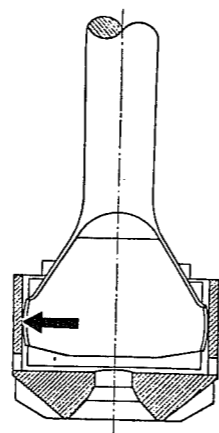


Fig. F.10. Axle shaft to differential gear clearance - Swing axle.

5. Install the spacer sleeve, grease the outer race of the roller bearing and press it in.
6. Press in the inner race of the roller bearing.
7. 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.

REDUCTION GEARS (Type 181 only)

The rear axle shaft and tube of the 181 is shorter than on Beetles in order to accommodate a reduction gearbox next to the hub (Fig. F4). The reduction gearbox can be disassembled without removing the axle from the vehicle.

Disassembly

1. Remove the rear axle nuts, raise and support the rear of the car.
2. Remove the brake drum and brake shoe assembly.
3. Remove the four screws which secure the wheel bearing housing and the 3 which secure the brake adjuster block and take off the housing and the brake back plate. (If the brake line brackets are detached, the brake line can be left attached to the back plate, so avoiding the need to bleed the brakes on assembly).
4. Pull off the rear wheel bearing with an extractor and remove the inner spacer ring behind it.
5. Remove the screws which hold on the reduction gear box cover and tap the cover with a rubber hammer to loosen it. Take off the cover and its gasket.
6. Remove the circlip from the axle shaft and use an extractor to pull the bearing off.
7. Remove the gears and use an extractor to pull out the inner gearbox bearings.

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 outwards.
2. Put the gears in place and drive on 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 spacer and rear wheel bearing. Install the brake back plate with a new paper gasket.
5. Install a new O-ring between the outer spacer ring and the wheel bearing. Oil the outer spacer and then fit the bearing housing complete with oil seal. Make sure that the oil drain hole of the housing is at the bottom.
6. Install brake shoe assembly and drum. Do not fully tighten the rear axle nuts until the vehicle is lowered.

REAR AXLE TUBES AND DRIVE SHAFTS (Swing Axle Vehicles)

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

Installation

1. Carefully clean the inner surface of the axle tube retainer and the surface on which it seats.
2. Check the axle shaft, differential gear and the thrust washer for wear or damage. Replace parts as necessary.  
NOTE: The clearance between the flat end of the axle shaft, measured across the ball shaped sides, and the inner diameter of the differential gear should be 0.01 - 0.03 mm (0.004" - 0.012") (Fig. F 10).
3. Place the fulcrum plates in the differential gear with the end of the axle shaft between them. Measure the clearance between the flat faces of the shaft end and the fulcrum plates (Fig. F 11). The clearance should be 0.1 - 0.3 mm (0.004" - 0.012").
4. Check the rubber boot for damage and replace if necessary. If the axle tube has brackets for the mounting of an equalizer spring, the boot must be carefully prised over the bell shaped end as it will not pass over the mounting bracket.
5. Insert differential gear, fulcrum plates and axle shaft into the side of the transmission, together with the thrust washer and circlip.
6. Slide on the axle tube, ensuring that the correct number of shims are fitted and remembering to install the plastic packing. The number of shims should be such that the tube can just be moved in all directions without jamming at all.

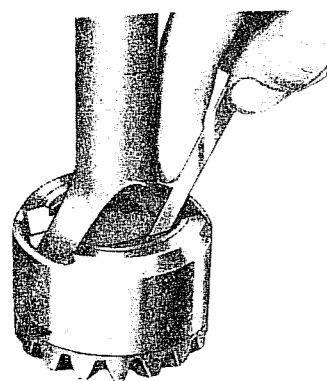


Fig. F.11. Measuring the axle shaft to fulcrum plate clearance. - Swing axle.

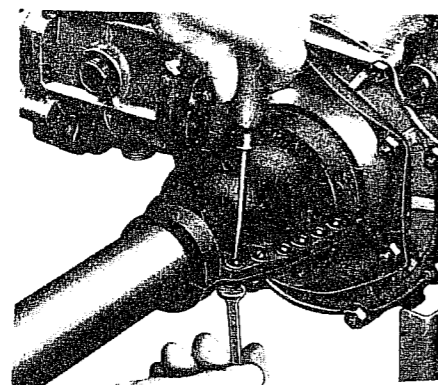


Fig. F.12. Fitting a split dust sleeve to the axle shaft - Swing axle.

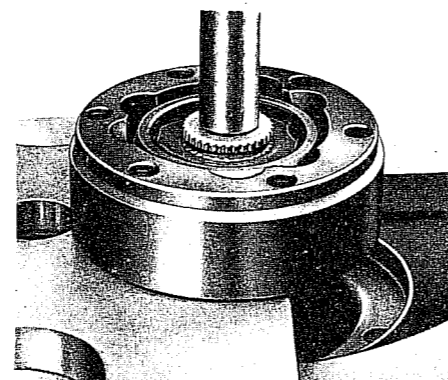


Fig. F.13. Pressing the drive shaft out of the ball hub - D/J axle.

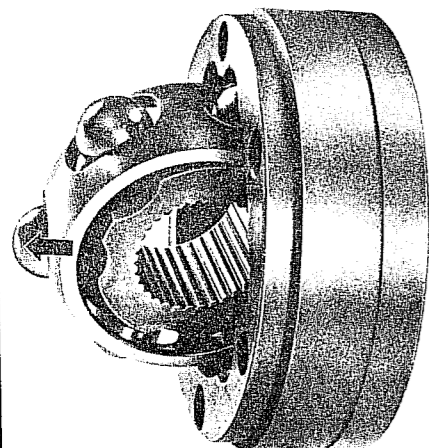


Fig. F.14. Push out the ball hub and ball cage in the direction shown.

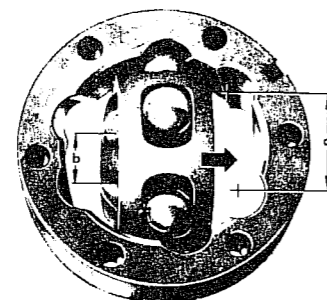


Fig. F.15. Position the hub and ball cage as shown when installing. "a" is the greatest ball centre on the outer ring. "b" is the smallest ball centre on the ball hub.

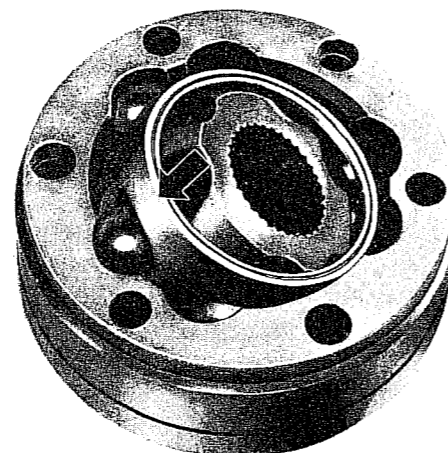


Fig. F.16. Rotate the hub and ball cage into position as shown.

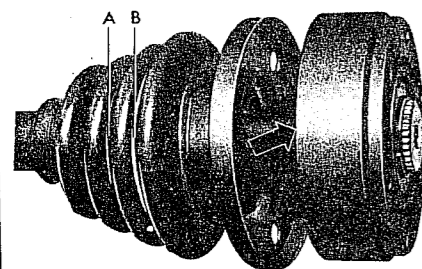


Fig. F.17. The larger diameter of the C/V joint must face the rubber joint cap.

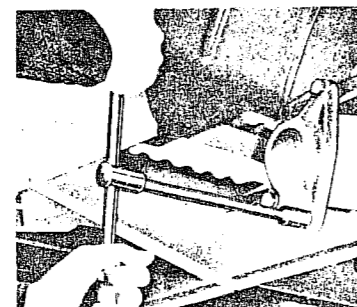


Fig. F.18. Unbolting the torsion bar cover plate - Swing axle.

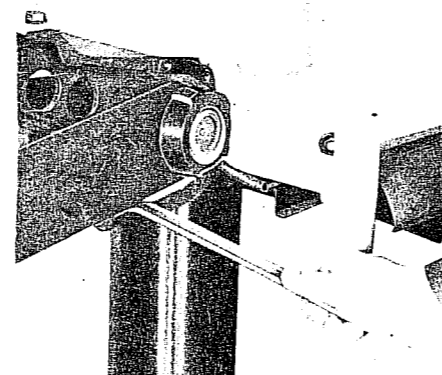


Fig. F.19. Levering the spring plate off the torsion bar. - Swing axle.

7. Position the rubber O-ring on the inside of the retainer and smear both the retainer inside surface and its seating with Molybdenum disulphide grease.
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 Beetle (not 1302) have each half of the rear axle universally jointed to the side of the transmission case. It is essential that dust should not enter this joint and it is covered by a flexible rubber sleeve. One end is clamped on to the axle tube and the other end is clamped to the flange on the side of the transmission case.

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

#### Removal

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

#### Installation

1. Carefully clean the parts where the sleeve is to be attached.
2. Smear both mating faces of the new split sleeve with VW Sealing Compound D 1a. If this is not available, rubber cement of the type which is used for attaching rubber soles to shoes is just as effective. Make sure that the adhesive is spread evenly and does not run inside the sleeve.
3. Place the sleeve in position on the axle, making sure that the split edge is horizontal and points towards the BACK of the car.
4. Bolt up the split edge of the sleeve with the nuts, bolts and washers which are provided with the sleeve (Fig. F 12). Tighten them evenly so that the edge is not distorted. Do not overtighten; this can be easily done as there is only rubber between the nut and the head of the bolt.
5. Place the clips in position at either end of the sleeve and tighten them SLIGHTLY. If you are re-using the original clips, notice how they are assembled. You may find it much easier to use replacement clips or the worm drive type; these are much easier to tighten up accurately, but the cost is higher. If you are using this type, you will have to unwind 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-jointed Axle Vehicles)

Vehicles with double-jointed rear axles have drive shafts with constant velocity joints at either end.

These drive shafts can be removed by unscrewing the socket headed screws which anchor them to the side of the transmission and to the wheel shaft. Installation is simply a reverse of this process.

#### CONSTANT VELOCITY JOINTS (Double-jointed Axle Vehicles)

##### Removal

1. Remove the drive shaft.
2. Loosen the clips which secure the rubber boots and slide back the boots.
3. Remove the circlip from the hub of the joint.
4. Drive the cap off the joint with a drift. **NOTE :** do NOT tilt the ball hub in the outer ring of the joint as the balls can now fall out.
5. Press out the drive shaft from the ball hub and remove the dished washer (Fig. F 13).

##### 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 ring 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 splines of the ball hub should face towards the shoulder on the drive shaft and the larger diameter of the outer ring.

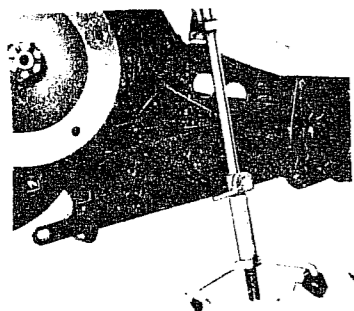


Fig. F.20. Pulling the spring plate into alignment with the axle tube - Swing axle.



Fig. F.21. Mark the relative positions of the spring plate and the trailing arm before disassembly - D/J axle.

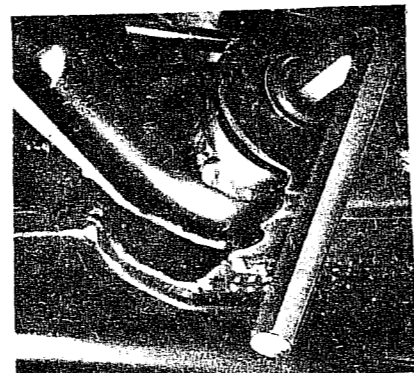


Fig. F.22. Removing the socket screw securing the trailing arm to its mounting bracket - D/J axle.

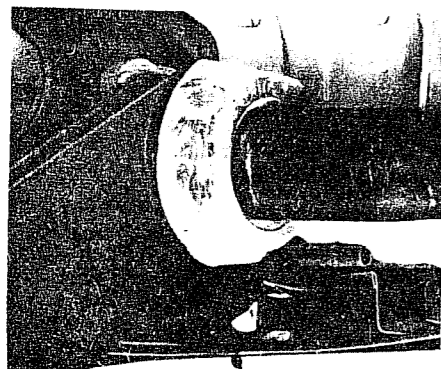


Fig. F.23. The outer rubber bush must be installed as shown. D/J axle.

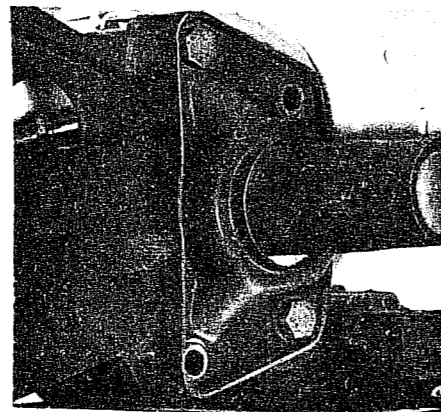


Fig. F.24. Use two extra long screws initially to draw the spring plate cover up to the housing - D/J axle.

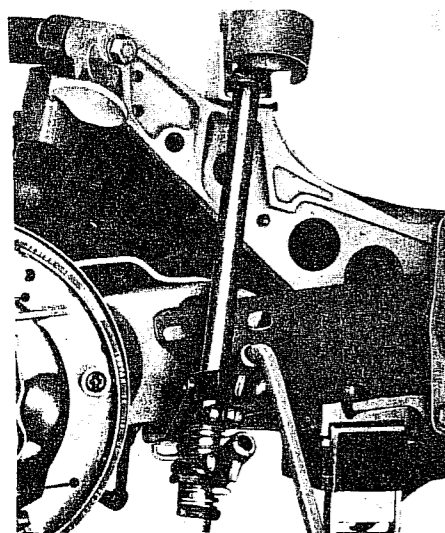


Fig. F.25. Lifting the spring plate into position with a jack - D/J axle.

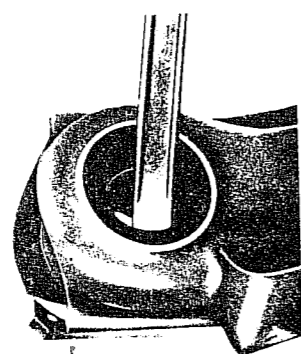


Fig. F.26. Levering out the hub inner oil seal - D/J axle.

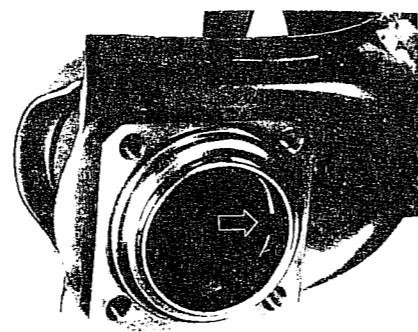


Fig. F.27. Bearing retaining circlip - D/J axle.

The hub and ball cage should be pushed in at right angles to the outer ring as shown in Fig. F 15 and then swing 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 washer and fit a new circlip.
4. Pack the joint with molybdenum disulphide grease. The amount per joint is 60 g 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 hose clips on to the rubber boot and tighten them. NOTE : the hose 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 arms 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 noted by marking 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 jointed rear axle spring plate (see next section).

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

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

Torsion bars are still used as the springing 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 bushes on the spring plate for wear. Replace them if necessary. Coat them liberally with talcum powder before installing them.
2. Note that the rubber bushes as are marked "oben" at the top and that the inner and outer ones are different (Fig. F 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 cover close up to the housing and two extra long screws can be inserted in diagonally opposite holes to draw the cover in (Fig. F 24). The standard screws can then be inserted, 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 these are installed in the correct order. Lock the screw in place by peening the metal shoulder which it bears against.
6. Attach the trailing arm to the spring plate, taking care that the alignment marks line up (Fig. F 21).

#### TORSION BARS (Double-jointed Axle Vehicles)

The rear torsion bars are half the width of the vehicles and fit into a splined anchorage 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 40 splines and the outer end has 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.

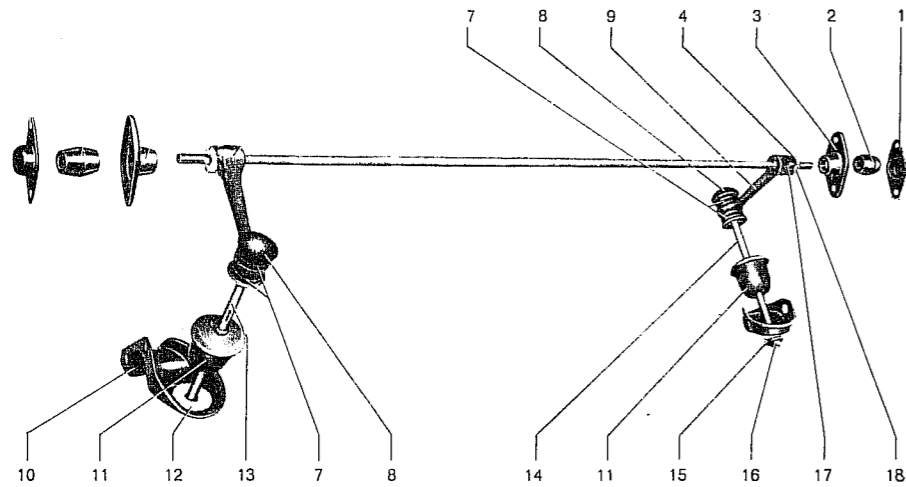
#### Removal

1. Remove the five screws which attach the front part of the rear wing to the body. Remove the bolt between rear wing and running board. Pull the wing away and prop it with a suitable piece of wood. Karmann Ghias have a circular access hole which is removed instead.
2. Remove the spring plate (see previous section).
3. Withdraw the torsion bar.

#### Installation

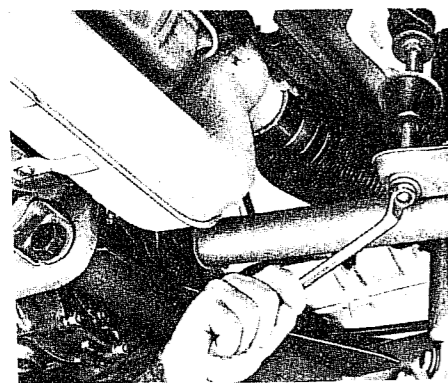
Note the following points :



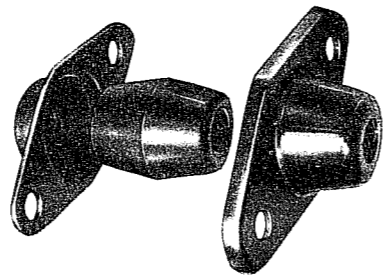


**Fig. F.28. Exploded view of the rear compensating spring. - Swing axle.**

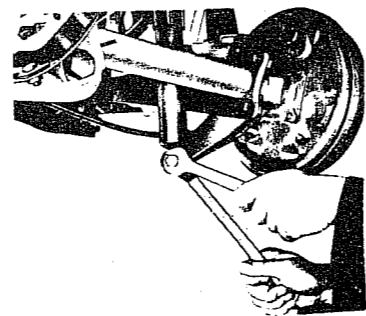
1. Outer bracket
2. Rubber bush
3. Inner bracket
4. Rubber washer
5. Left-hand lever
6. Compensating spring rod
7. Damping ring
8. Protective cap
9. Right-hand lever
10. Left-hand guide
11. Rubber stop
12. Guide ring
13. Left-hand operating rod
14. Right-hand operating rod
15. Washer
16. Nut
17. Locknut
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.**

**REAR SHOCK ABSORBERS**

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

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

1. If the paint on the torsion bar is damaged, corrosion will occur and may provoke fatigue fractures. Any damage to the paintwork must be touched up.
2. Do not mix up the two bars. The end face of each is marked either "L" or "R".
3. When the torsion bar is in place, fit the spring plate on to the end of it so that it hangs freely.
4. Check that the car is level, fore and aft, and transversely.
5. Place a spirit level protractor on the edge of the spring plate and measure its angle to the horizontal. The position of the torsion bar must be adjusted until the angle is correct. (See table).

**REAR COMPENSATING SPRING  
(Swing Axle Vehicles only)**

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

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

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

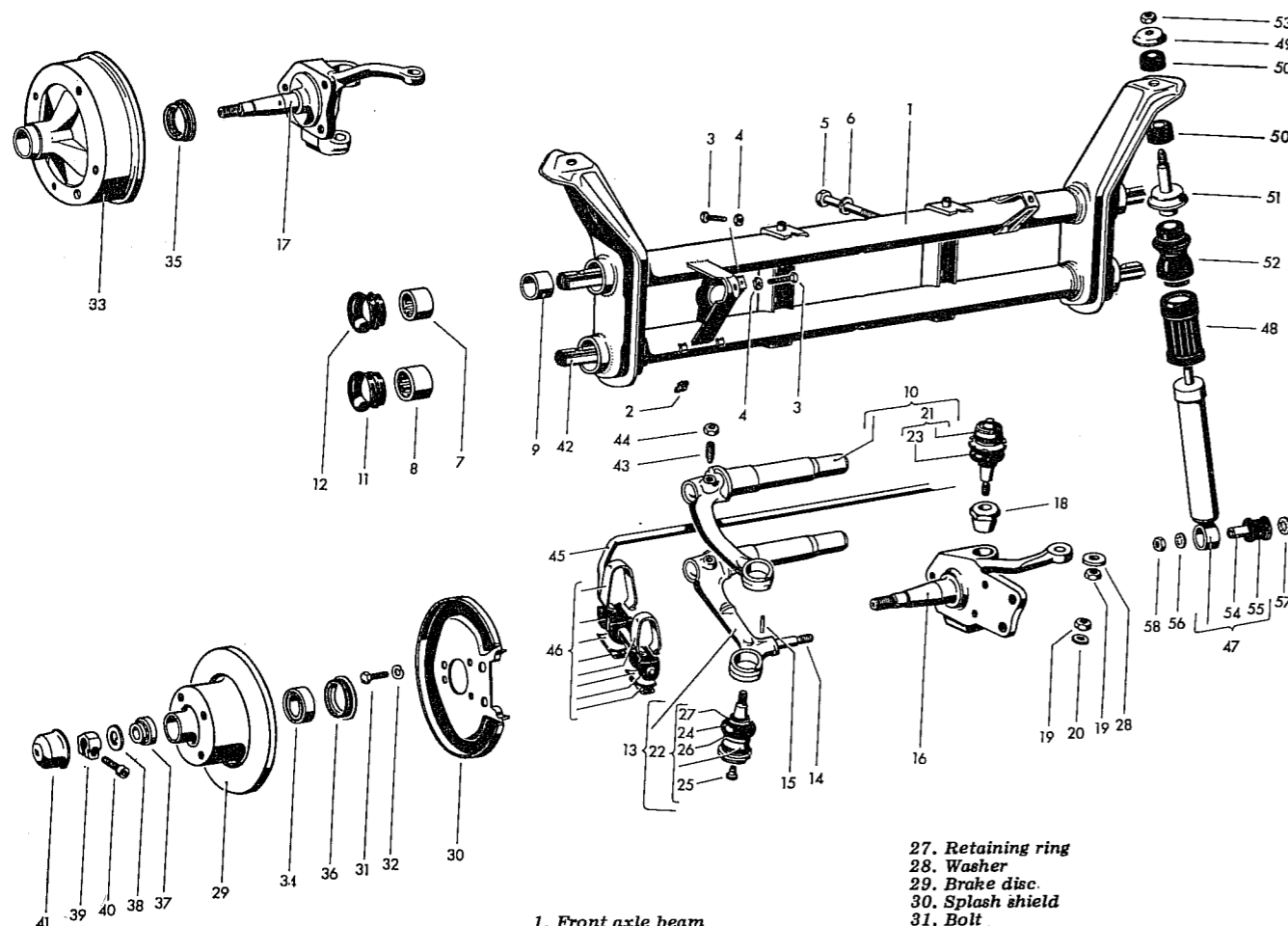
**Technical Data**

Type - 1200, 1300 & 181 models . . . . .	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.
- All models other than above . . . . .	Rigid trailing arms with transverse torsion bars as the suspension medium. Double-jointed axle shaft. Telescopic double acting dampers.

**Rear Suspension Spring Plate Settings**

Swing Axle Models :		
1200 and 1300 . . . . .		17° 30' ± 50'
1500 . . . . .		20° ± 50'
Double-jointed Axle Models . . . . .		20° 30' ± 50'
Models without Equaliser Springs :		
All Beetle Models from the following chassis Nos :		
1-0379 023 . . . . .		13° ± 30'
1-0929 746 . . . . .		12° ± 30'
2232 161 . . . . .		11° ± 30'
2528 668 . . . . .		17° 30' ± 50'
Model 111, 112, 115, 116 . . . . .		18° 30' ± 50' (wide track)
Model 181 . . . . .		27° 30' ± 50'
Models with Equaliser Springs . . . . .		20° ± 50'

# Front Axle & Front Suspension



**Fig. H.1. Exploded view of the front axle assembly - 1200 & 1300 models.**

- 1. Front axle beam
- 2. Grease nipple
- 3. Steering stop bolt
- 4. Hex. nut
- 5. Hex. bolt
- 6. Lock washer
- 7. Torsion arm upper needle bearing
- 8. Torsion arm lower needle bearing
- 9. Torsion arm bush
- 10. Upper, left torsion arm with ball joint
- 11. Seal for lower torsion arm
- 12. Seal for upper torsion arm
- 13. Lower, left torsion arm with ball joint
- 14. Lower shock absorber mounting bolt
- 15. Dowel pin
- 16. L.H. steering knuckle for disc brake models
- 17. L.H. steering knuckle for drum brake models
- 18. Eccentric bush for steering knuckle
- 19. Lock washer
- 20. Washer
- 21. Upper ball joint
- 22. Lower ball joint
- 23. Seal for upper ball joint
- 24. Seal for lower ball joint
- 25. Plug for ball joint
- 26. Retaining ring
- 27. Retaining ring
- 28. Washer
- 29. Brake disc
- 30. Splash shield
- 31. Bolt
- 32. Lock washer
- 33. Front brake drum
- 34. Inner front wheel bearing
- 35. Oil seal for drum brake models
- 36. Oil seal for disc brake models
- 37. Front wheel outer bearing
- 38. Thrust washer (front wheel bearing)
- 39. Clamp nut with screw
- 40. Screw
- 41. Grease cap
- 42. Torsion spring
- 43. Grub screw
- 44. Nut for grub screw
- 45. Stabilizer bar
- 46. Mounting details for stabilizer bar
- 47. Front shock absorber
- 48. Shock absorber protection tube
- 49. Damping ring plate
- 50. Damping ring
- 51. Rubber stop bolt
- 52. Rubber stop
- 53. Nut
- 54. Bush for rubber grommet
- 55. Rubber grommet
- 56. Spring washer
- 57. Spring washer
- 58. Nut

## GENERAL

**WHEEL BEARINGS** – Adjustment

**SHOCK ABSORBERS** (Models other than 1302 & 1302'S') – Removal & Installation

**STEERING KNUCKLES** (Models other than 1302 & 1302'S') – Removal & Installation

**STEERING KNUCKLES** (1302 & 1302'S' Models) – Removal & Installation

**TORSION ARM BALL JOINTS** (Models other than 1302 & 1302'S') – Cleaning, Regreasing & Replacement

**TRACK CONTROL ARM BALL JOINTS** (1302 & 1302'S' Models) – Removal & Installation

**TORSION ARMS** (Models other than 1302 & 1302'S') – Removal & Installation

**TORSION BARS** (Models other than 1302 & 1302'S') – Removal & Installation

**TORSION ARM BEARINGS AND BUSHES** (Models other than 1302 & 1302'S') – Removal & Installation

**SUSPENSION STRUTS** (1302 & 1302'S' Models) – Removal, Disassembly, Assembly & Installation

**TRACK CONTROL ARMS** (1302 & 1302'S' Models) – Removal & Installation

**STABILISER BAR** (Models other than 1302 & 1302'S') – Removal & Installation

**STABILISER BAR** (1302 & 1302'S' Models) – Removal & Installation

**WHEEL ALIGNMENT**

## GENERAL

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

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

The 1302 and 1302'S' models have a coil spring/shock absorber suspension 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 swivels near the centre line of the car and a massive front stabiliser.

## 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 adjusters 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 circlip which retains the end of the speedometer cable must be removed).
3. Loosen the socket screw in the clamp nut.
4. Turning 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 and 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 moving the clamp nut. The gap should be 2.5 - 3.0 mm (0.10 - 0.12") (Fig. H 4).
8. Recheck the play.
9. Refit the wheel bearing caps – they should be free of grease.

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

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

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

### Removal

1. Raise and support front of car and remove front wheels.
2. Loosen the small nut at the upper attachment to the axle side plate. If necessary, slide down the rubber buffer and the protective tube so that you can grip the pin. If the nut still cannot be removed, hold the pin tightly and use a spanner on the flats of the shock absorber shaft to unwind the shaft from the pin (Fig. H 6).
3. Remove the upper mounting nut.
4. Unscrew the nut at the lower mounting point and take off the shock absorber. The rubber bush has a steel liner and this may be seized

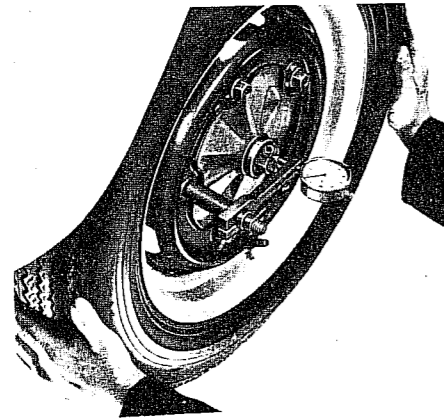


Fig. H.2. Checking the axial play at the front wheel bearing with a dial gauge.

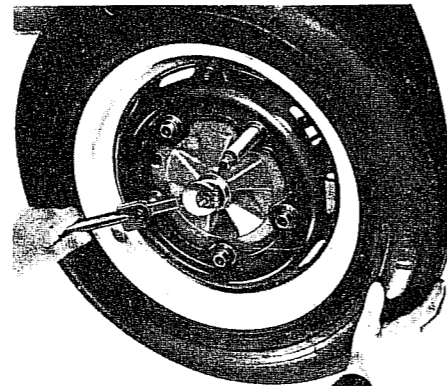


Fig. H.3. Adjusting the front wheel bearings.

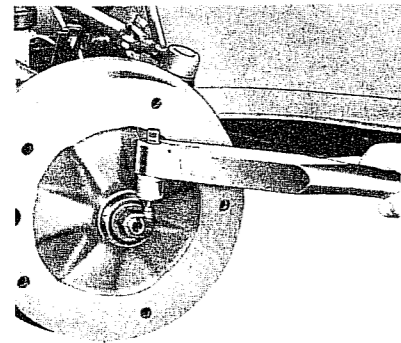


Fig. H.4. Tightening the clamp nut securing screw.

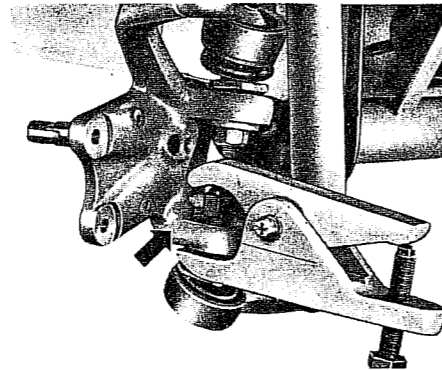


Fig. H.5. Disconnecting the lower ball joint stud from the steering knuckle. Note that the nut is left on the stud to prevent damage to the threads.

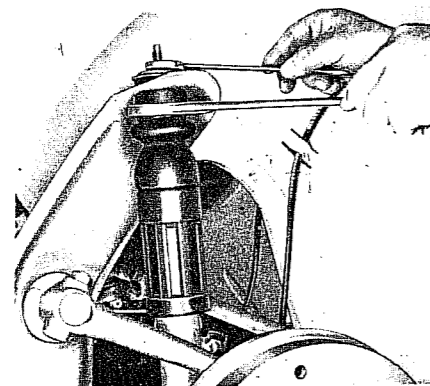


Fig. H.6. Disconnecting the shock absorber upper mounting.

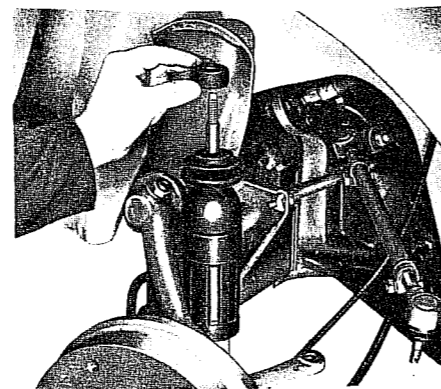


Fig. H.7. Fit the lower damping ring with its shoulder upwards as shown.

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 it if necessary (this will probably require a press). Replace the buffer pin 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 lb.ft (2.0 kg.m)

**STEERING KNUCKLE  
(Models other than 1302 & 1302'S')**

The steering knuckle carries the stub axle and brake assembly. It is attached to the torsion arms 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).  
**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).
3. Remove the brake drum and back plate or the disc and its splash guard (see section on Brakes).
4. 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 stud, screw a nut on to the end of it to protect the thread (Fig. H5).
5. Remove the nut on the lower ball joint and press the ball joint out of the steering knuckle. Once again, a nut should be screwed on to the stud to prevent the thread 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. H11). This bush permits camber adjustment. It will be necessary to have the camber checked after the work is complete.
3. Install the track rod end, tighten the nut and fit a new split pin.
4. Install the brake assembly, ensuring that the brakes pipes are installed without any twist.
5. Adjust the wheel bearings.

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

**Removal**

1. Detach the stabiliser 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 back plate).
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. Installa brake assembly, re-connect brake pipe and adjust wheel bearings.
3. Install stabiliser.

**TORSJONS ARM BALL JOINTS  
(Models other than 1302 & 1302'S')**

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

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

**Replacement**

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

**TRACK CONTROL ARM BALL JOINT  
(1302 & 1302'S' Models)**

There is one ball joint at each side between the steering knuckle and the track control arm.

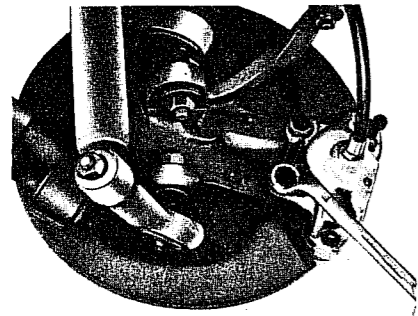


Fig. H.8. Removing the brake calliper on disc-braked models.

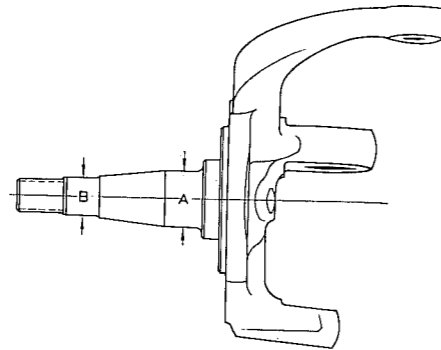


Fig. H.9. Wheel bearing seat dimensions on the steering knuckle.  
A = 26.97 - 26.98 mm. (1.0618-1.0622in.)  
B = 17.45 - 17.46mm. (0.6870-0.6874 in.)

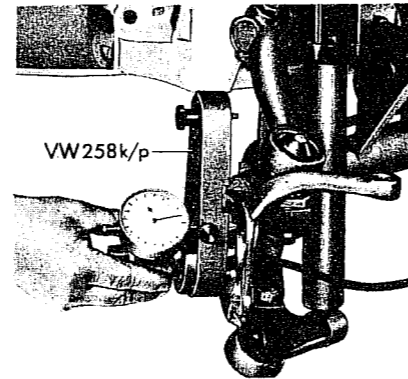


Fig. H.10. Checking the stub axle alignment.

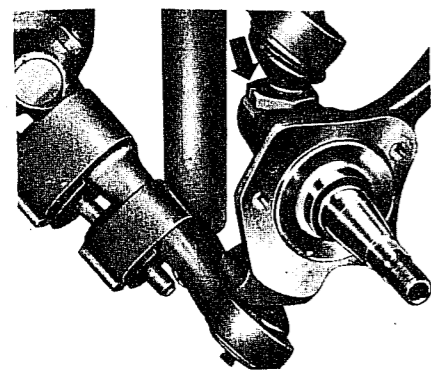


Fig. H.11. The slot in the eccentric bush must face forwards.

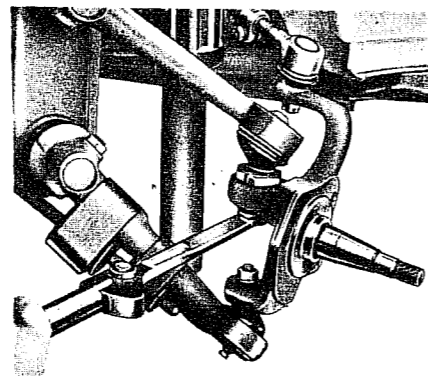


Fig. H.12. Tightening the upper ball joint stud nut.

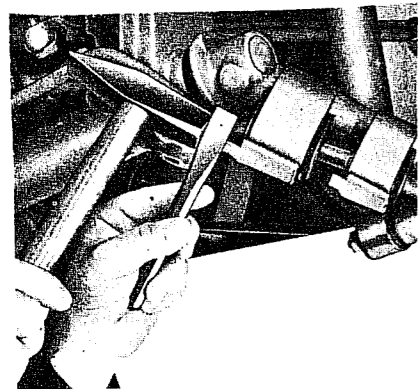


Fig. H.13. Bend up the tabs on the stabiliser clips as shown.

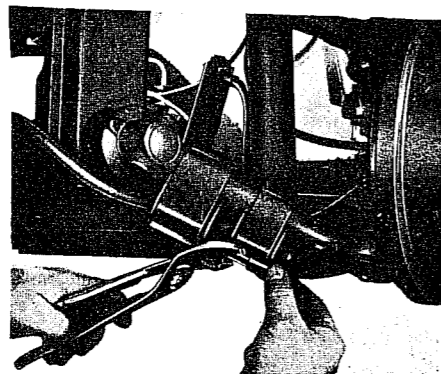


Fig. H.14. Installing the stabiliser clip locking plates.

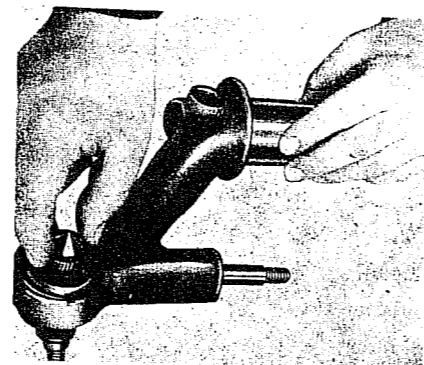


Fig. H.15. Measuring the ball joint wear with Special Tool VW 282 d.

**Removal**

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

**Installation**

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

**TORSION ARMS  
(Models other than 1302 & 1302'S')**

The torsion arms connect the steering knuckle assembly to the torsion bars which are located in the front axle tubes.

**Removal**

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

**Installation**

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

**TORSION BARS  
(Models other than 1302 & 1302'S')**

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

**Removal**

1. Remove the steering knuckles and brakes assemblies complete and

remove the torsion arms on one side.

2. Loosen the lock nuts of the set screws and remove the set screws (Fig. H 17).
3. Use the remaining torsion arms to pull out the torsion bars (Fig. H 18).

**Installation**

1. Note the position of the thinner bars and the direction of the set screw recesses.
2. Thoroughly grease all the leaves and insert them. It may help to tape them together before greasing.
3. Make sure that the recess for the central set screw is aligned properly and then insert set screw, tighten, and tighten lock nut.

**TORSION ARM BEARINGS & BUSHES  
(Models other than 1302 & 1302'S')**

Each torsion arm is mounted in the axle beam by a needle bearing (at the end of the tube) and a metal bush (farther into the tube).

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

**Removal**

1. Raise and support front of car, remove 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 and bush are driven into the tube to the correct depth. In order to ensure this, they must be inserted to the following depths from the extreme end of the axle tube :

Metal bush : upper — 122 - 124 mm  
lower — 132 - 134 mm

Needle bearing : upper — 3.5 - 4.0 mm  
lower — 3.5 - 4.0 mm

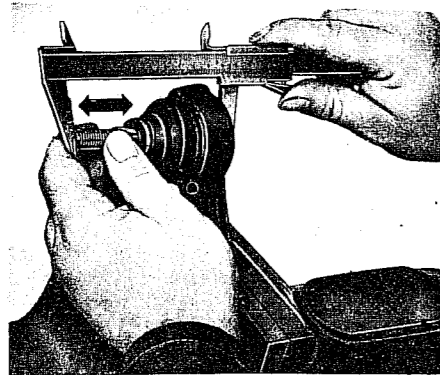


Fig. H.16. Checking the ball joint play.

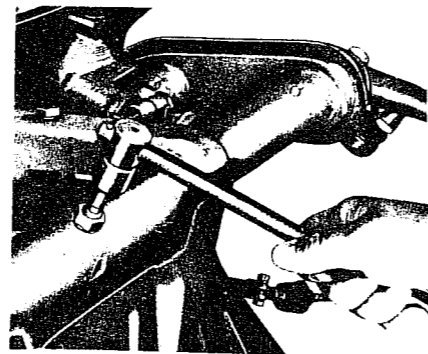


Fig. H.17. Removing the torsion bar retaining socket screw.

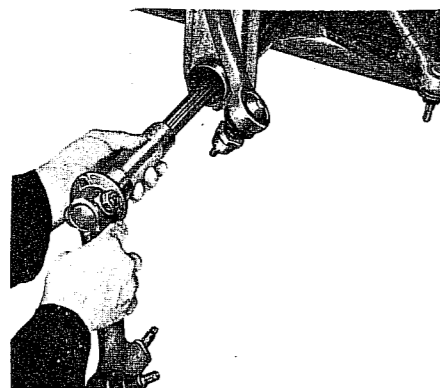


Fig. H.18. Removing the torsion bar and arm.

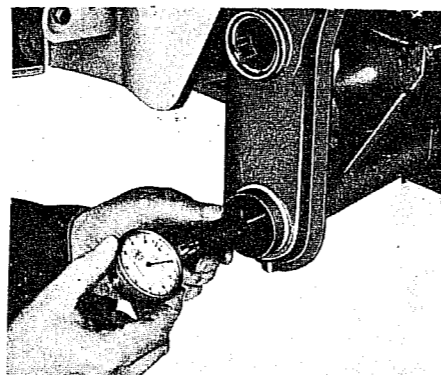


Fig. H.19. Checking the axle tube bore for wear.

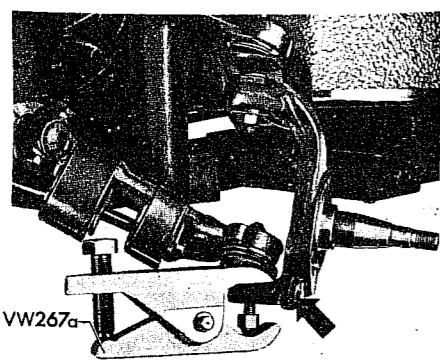


Fig. H.20. Disconnecting the lower ball joint stud from the steering knuckle - 181 models.

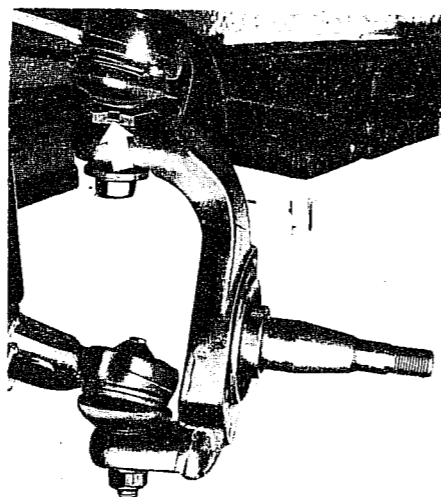


Fig. H.21. The slot in the eccentric bush must be positioned as shown - 181 models.

**SUSPENSION STRUTS**  
(1302 & 1302'S' Models)

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

**Removal**

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

**Shock Absorber Removal**

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

**Shock Absorber Installation**

1. Assemble the shock absorber into the strut, using the compressor.

**Installation**

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

**TRACK CONTROL ARMS**  
(1302 & 1302'S' Models)

The track control arm is the main lower suspension member on these cars.

**Removal**

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

**Installation**

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

**STABILISER BAR**  
(Models other than 1302 & 1302'S')

The stabiliser has an important effect upon the handling of the car. It is attached to the lower torsion arms by two clips on each side.

**Removal**

1. 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 mole wrench is ideal for this.
4. Ben over the tabs on the locking plates (Fig. H 14).

**STABILISER BALL**  
(1302 & 1302'S' Models)

On these models, the stabiliser helps to locate the front wheels.

**Removal**

1. Remove the split pin and nut which lock the stabiliser to the track control arm.
2. 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.

- Bolt the front mounting clip to the frame.
- Tighten the nut on the end of the stabiliser and fit a new split pin.

#### WHEEL ALIGNMENT

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

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

## Technical Data

Type — all except 1302 & 1302'S'	Upper and lower trailing arms with transverse torsion bars as the suspension medium. These bars are parallel and each consist of 8 leaves. A stabiliser bar inter-connects the suspension on either side. Telescopic dampers.
— 1302 & 1302'S' only	Macpherson strut type, the strut on each side comprising a double-acting telescopic dampers integral with the stub axle. Coil springs are concentric with the struts. Strut location by track control arm and radius rod.

#### WHEEL ALIGNMENT

Castor	3°20' ± 40'
Camber	0° 30' ± 20'
King pin inclination	5°
Max. camber difference between sides	0° 30'
Toe-in (wheels not pressed)	0° 30' ± 15'
Toe-in (wheels pressed)	0° 5' ± 15'

#### REPAIR DATA

Torsion arm twist	0.008 in (0.2 mm) max.
Torsion arm to fibre bush clearance	0.008-0.0011 in (0.20-0.27 mm)
Wear limit	0.0128 in (0.35 mm)
Lower ball joints - clearance	0.020 in (0.5 mm)
Wear limit	0.080 in (2.0 mm)
Metal bushes for torsion arm —	
Inside diameter	1.4591-1.4630 in (37.06-37.16 mm)
Wear limit	1.417 in (37.38 mm)
Axle beam upper needle bearing seat diameter	1.8098-1.8106 in (45.97-45.99 mm)
Corresponding needle bearing diameter	1.8110 in (46.00 mm)
Oversize seat diameter	1.8177-1.8185 in (46.17-46.19 mm)

Corresponding oversize needle bearing diameter	1.8189 in (46.2 mm)
Axle beam, lower needle bearing seat diameter	1.9673-1.9681 in (49.97-49.99 mm)
Corresponding needle bearing diameter	1.9685 in (50 mm)
Oversize seat diameter	1.9752-1.9760 in (50.17-50.19 mm)
Corresponding oversize needle bearing diameter	1.9764 in (50.2 mm)

#### WHEELS & TYRES

Wheels size :	
Saloon	4J x 15
Karmann - Ghia	4½J x 15
181, prior to Feb. 1971	4½K x 15
181, as from Feb. 1971	5JK x 14
Tyre size :	
All models (except 181)	5.60-15 (crossply) or 155SR 15 (radial)
181, prior to Feb. 1971	165SR 15 M + S
181, as from Feb. 1971	185SR 14 M + S
Tyre Pressures (crossply tyres) :	
1200, 1300, & 1500	
1-2 persons — front	16 psi (1.1 kg/sq.cm)
— rear	24 psi (1.7 kg/sq.cm)
fully laden — front	17 psi (1.2 kg/sq.cm)
— rear	26 psi (1.8 kg/sq.cm)
1302 & 1302'S' & Convertible :	
1-2 persons — front	16 psi (1.1 kg/sq.cm)
— rear	27 psi (1.9 kg/sq.cm)
fully laden — front	18 psi (1.3 kg/sq.cm)
— rear	27 psi (1.9 kg/sq.cm)
Tyre Pressures (radial ply tyres) :	
All models, irrespective of load	
— front	18 psi (1.3 kg/sq.cm)
— rear	27 psi (1.9 kg/sq.cm)

## Steering

#### GENERAL

- STEERING WHEEL — Removal & Installation
- STEERING COLUMN — Removal & Installation
- STEERING DAMPER — Removal, Inspection & Installation
- TRACK RODS — Removal, Inspection & Installation
- STEERING ADJUSTMENT (Not 1302 & 1302'S' Models)
- STEERING ADJUSTMENT (1302 & 1302'S' Models)
- STEERING BOX — Removal & Installation

#### GENERAL

On models other than the 1302 and 1302'S', the steering column is connected to a worm and roller steering box which is bolted to the front axle beam. The steering column has a flexible coupling and, above this, a safety collapsible section.

The 2 track rods and a steering damper are attached to the drop arm from the steering box.

On the 1302 and 1302'S', the steering box is bolted to the body and is connected to the steering wheel by a shaft which has 2 universal joints. The drop arm from this worm and roller steering box controls a central track rod to which the two outer track rods are connected.

The steering box has a remarkably long service life, providing that the steering gear and front wheel alignment are kept correctly adjusted. The overhaul of the steering box itself requires special equipment and experience which are not normally available. If the normal adjustments do not cause it to operate correctly, it should therefore be exchanged or overhauled by a V.W. Dealer.

#### STEERING WHEEL

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

#### Removal

- Disconnect the negative cable at the battery.
- Ease out the disc in the centre of the horn ring with a screwdriver, disconnect the earth lead to the horn ring and then take out the 3 screws which retain the horn ring. Do not lose the springs or plastic washers. 1200s have a horn button instead of a ring, but the method of removal is the same.
- Use a socket and extension to remove the hexagon nut.

#### Installation

Note the following points :

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

#### STEERING COLUMN

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

#### Removal

- Disconnect the battery.
- Remove the fuel tank.
- Detach the earth cable from the lower end of the column.
- Remove the screw from the clamp which is just above the flexible coupling, and remove the column support clip at the bulkhead.
- Remove the steering wheel and take off the circlip at the top of the column.
- 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 cables are not strained.
- Remove the 2 socket screws which attach the column outer tube at the upper mounting and take out the column and tube

#### Installation

- Check that the upper column mounting is tightly fastened.
- Slide the column outer tube through the rubber bush in the bulkhead.
- 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.
- Install the switch assembly, but do not fully tighten the screws.
- Install the contact ring in the switch assembly ball bearing from below and then install the circlip.
- Refit the clamp at the bottom of the column, using a NEW locking plate.
- Insert the support ring for the column on the front of the bulkhead and secure it by bending down the tabs.
- Centre the steering and refit the steering wheel.

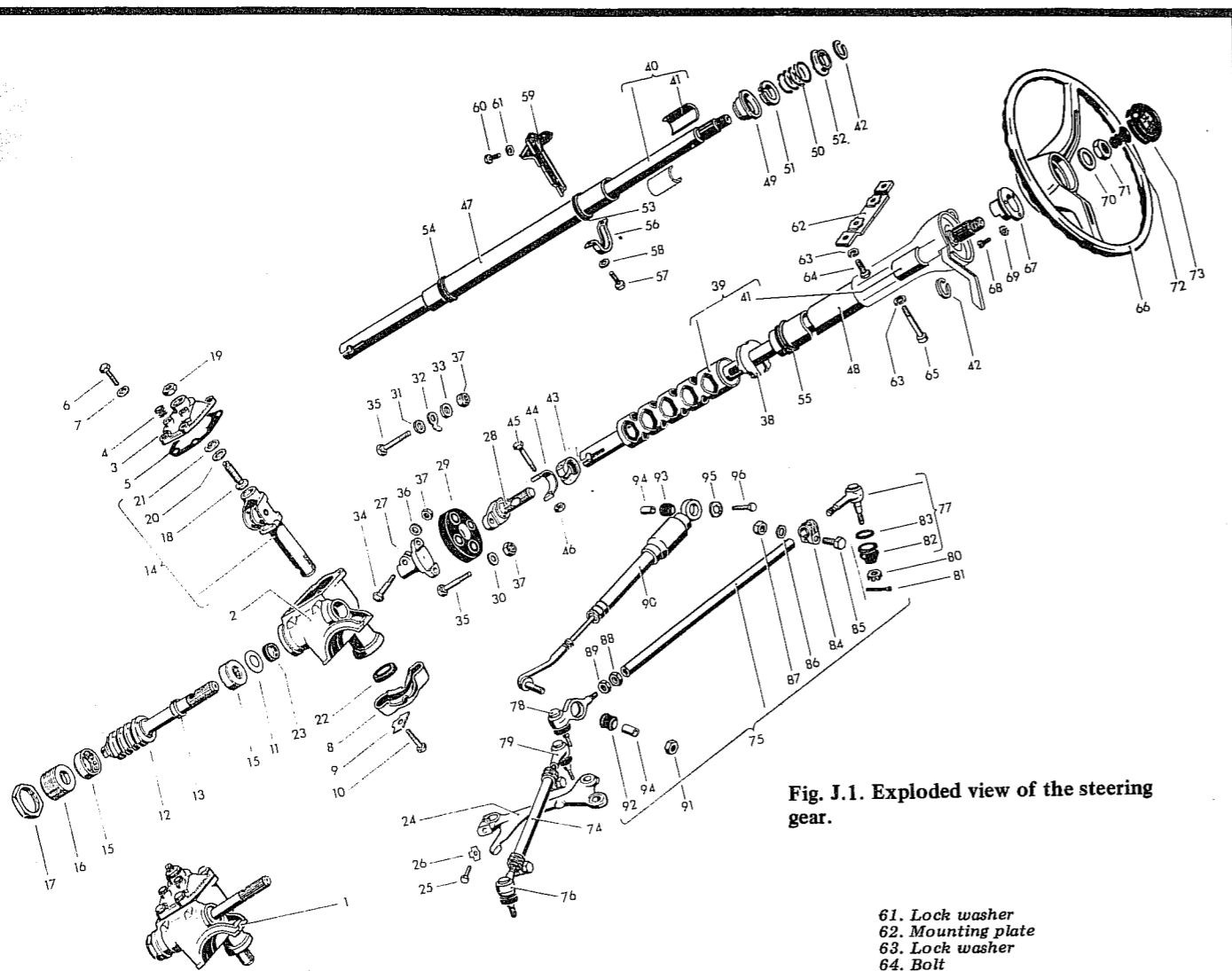


Fig. J.1. Exploded view of the steering gear.

- 1. Steering gear assembly
- 2. Steering gear housing
- 3. Steering gear housing cover
- 4. Retaining plug
- 5. Gasket for steering gear cover
- 6. Bolt
- 7. Spring washer
- 8. Steering gear mounting clamp
- 9. Mounting clamp lock plate
- 10. Bolt
- 11. Steering worm shim
- 12. Steering worm
- 13. Identification ring
- 14. Steering roller shaft
- 15. Steering worm ball bearing
- 16. Steering worm adjusting screw
- 17. Lock nut for adjusting screw
- 18. Steering roller shaft adjusting screw
- 19. Nut
- 20. Steering roller shaft shim
- 21. Locking ring
- 22. Steering roller shaft seal
- 23. Steering worm seal
- 24. Steering drop arm
- 25. Bolt
- 26. Lock plate
- 27. Lower flange
- 28. Upper flange
- 29. Steering coupling disc
- 30. Spring washer

- 31. Spring washer
- 32. Push-on connector
- 33. Washer
- 34. Bolt
- 35. Bolt
- 36. Spring washer
- 37. Self-locking nut
- 38. Thrust ring for steering column
- 39. Steering column
- 40. Steering column
- 41. Locking shell
- 42. Locking ring for steering column
- 43. Steering column clamp
- 44. Lock plate
- 45. Bolt
- 46. Bolt
- 47. Steering column tube
- 48. Steering column tube
- 49. Steering column ball bearing
- 50. Thrust spring
- 51. Thrust ring
- 52. Washer
- 53. Upper rubber mounting
- 54. Lower rubber mounting
- 55. Rubber mounting
- 56. Steering column tube clamp
- 57. Bolt
- 58. Washer
- 59. Steering column support
- 60. Bolt

- 61. Lock washer
- 62. Mounting plate
- 63. Lock washer
- 64. Bolt
- 65. Screw
- 66. Steering wheel
- 67. Self-cancelling ring
- 68. Screw
- 69. Shake-proof washer
- 70. Spring washer
- 71. Nut
- 72. Retaining plug
- 73. Horn ring emblem
- 74. L.H. track rod
- 75. R.H. track rod
- 76. Track rod end
- 77. Track rod end
- 78. Track rod end for steering damper
- 79. Track rod end
- 80. Castellated nut
- 81. Split pin
- 82. Dust seal
- 83. Retaining ring
- 84. Retaining clip
- 85. Bolt
- 86. Spring washer
- 87. Nut
- 88. Taper ring
- 89. Nut
- 90. Steering damper
- 91. Self-locking nut
- 92. Grommet
- 93. Rubber grommet
- 94. Bush for grommet
- 95. Lock plate for damper
- 96. Bolt

- 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 vibration 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 bushes may be worn. They can be removed with a press and new ones fitted.

**Installation**

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

**TRACK RODS**

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

**Removal**

- 1. Remove the split pins from the tie rod nuts with pliers and undo the nuts.
- 2. Press the tie rod ends out of the steering arms on the steering knuckles. You should use an extractor for this. (Fig. H 5). Leave the nut on the end of the stud so that the thread is not damaged. Make sure that the rubber seals around the joints are 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.

**Installation**

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

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

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

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

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

**Axial Play of Worm Spindle**

This can be checked by turning the spindle to and fro at the flexible coupling (Fig. J 4). Play can be eliminated as follows :

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

**Roller / Worm Play**

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

- 1. Remove the inspection cover behind the spare wheel.
- 2. Turn the steering wheel 90 degrees from the straight ahead position.
- 3. Loosen the lock nut and turn in the adjusting screw until the roller can just be felt to contact the worm.
- 4. Re-tighten the lock nut without altering the adjusting screw position.
- 5. Lower the front wheels and check that, in the straight ahead position, 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.

**Roller Axial Play**

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.

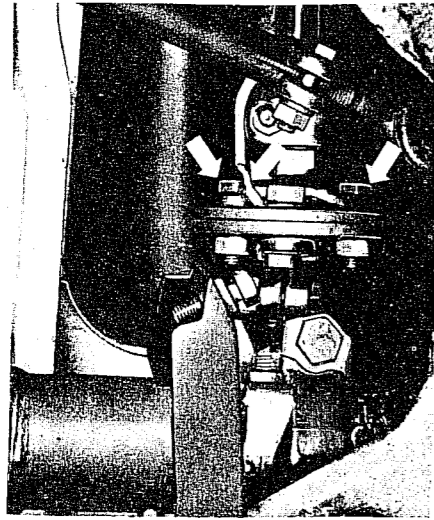


Fig. J.8. Flexible coupling bolts and earth lead.

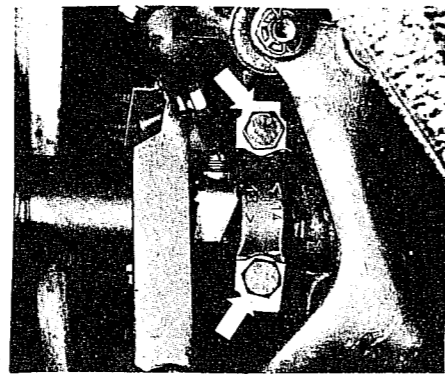


Fig. J.9. Steering column mounting bracket. Locking plates arrowed.

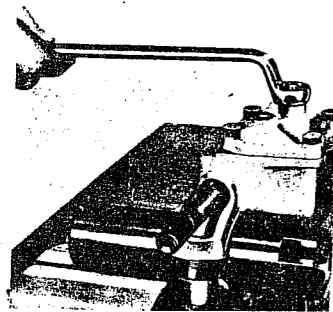


Fig. J.10. Releasing the locknut on the roller and worm play adjusting screw.

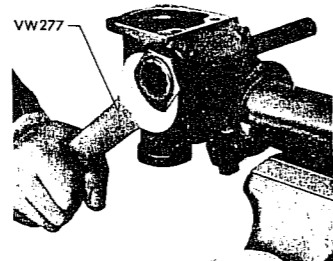


Fig. J.11. Releasing the locknut on the worm spindle axial play adjustment screw.

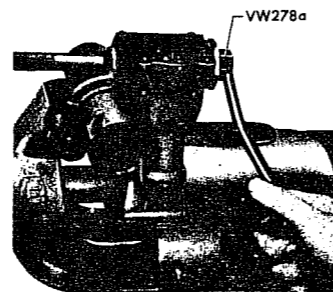


Fig. J.12. Unscrewing the worm spindle axial play adjustment screw.

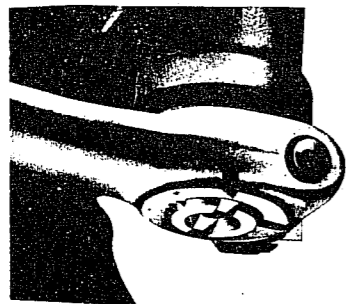


Fig. J.13. On installation, the lower surface of the drop arm should be flush with the bottom of the slot in the roller shaft.

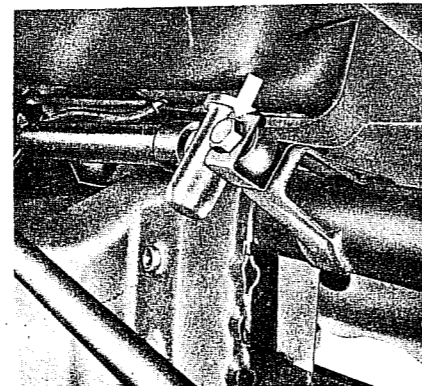


Fig. J.14. Steering damper attachment point on the axle beam.

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

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

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

#### Roller/Worm Play

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

#### Universal Joint Play

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

#### Axial Play at Worm Spindle

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

### STEERING BOX

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

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

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

#### Removal (not 1302 & 1302'S')

1. Raise and support the front of the car and remove the front wheels.
2. Prise up the locking tabs on the bolt 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 fuel tank 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, 1300s and 1500s, the number 13 should be on the left with its arrow facing forwards. On the 1500 Karmann 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 & 1302'S' Models)

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

#### Installation

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



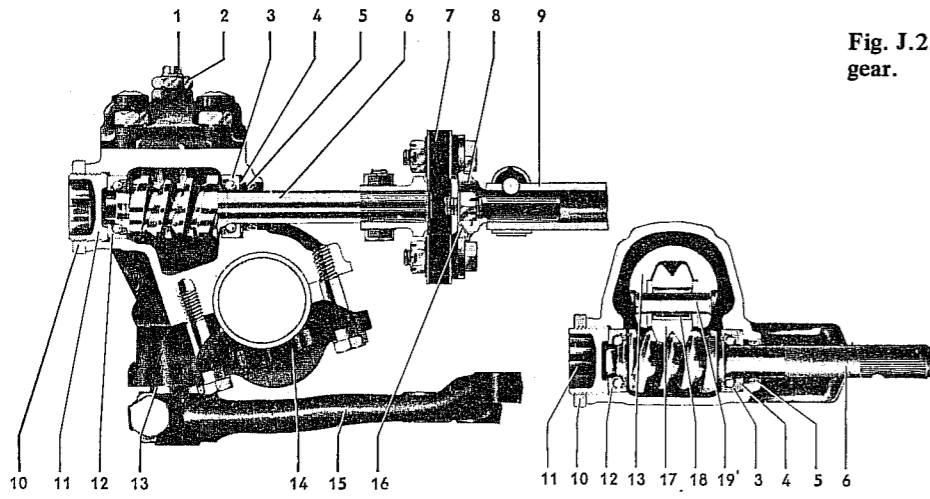


Fig. J.2. Sectioned view of the steering gear.

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

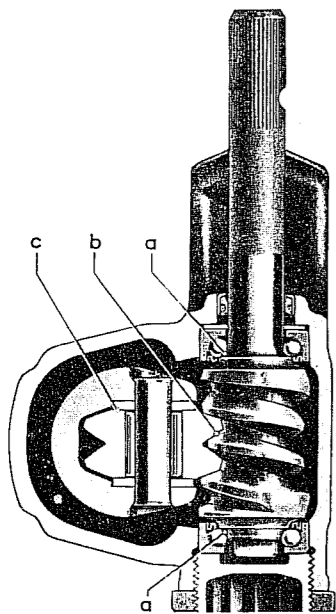


Fig. J.3. Critical play areas in the steering gear.  
a. Worm spindle axial play  
b. Worm and roller play.  
c. Roller axial play.

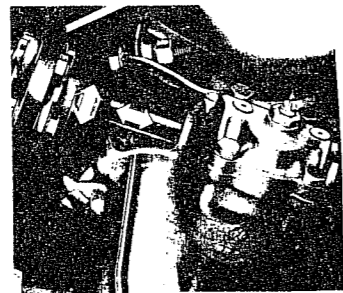


Fig. J.4. Check the play in the steering gear as shown.

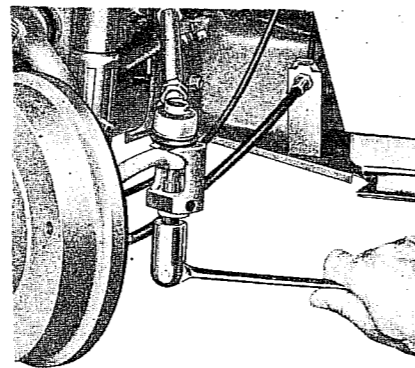


Fig. J.6. Disconnecting the track rod ball joint from the steering arm.

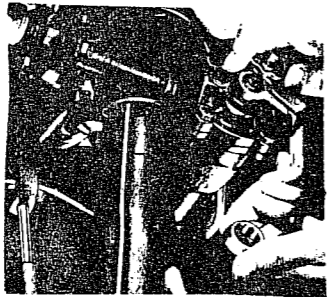


Fig. J.5. Adjusting the play between the roller and worm.

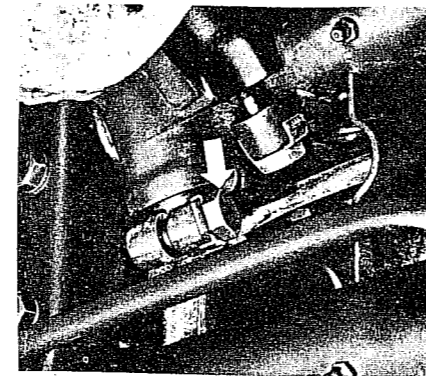


Fig. J.7. Drop arm clamp bolt.

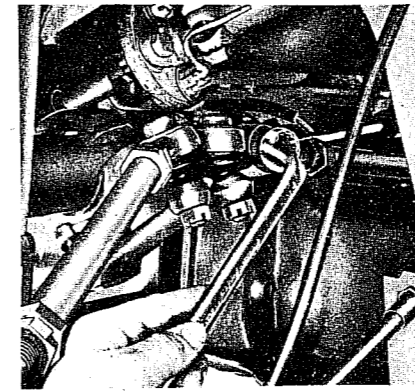


Fig. J.15. Steering damper attachment point on the track rod.

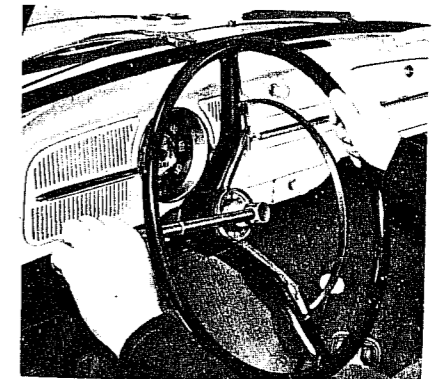


Fig. J.16. Removing the steering wheel nut.

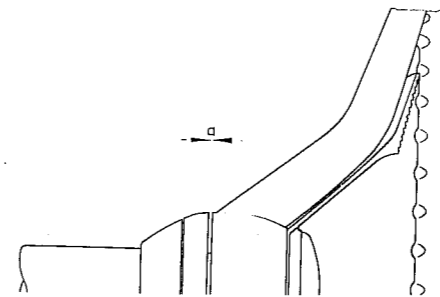


Fig. J.17. Correct clearance between steering wheel hub and indicator switch.  
a = 1.0 - 2.0 mm. (0.04 - 0.08 in.)

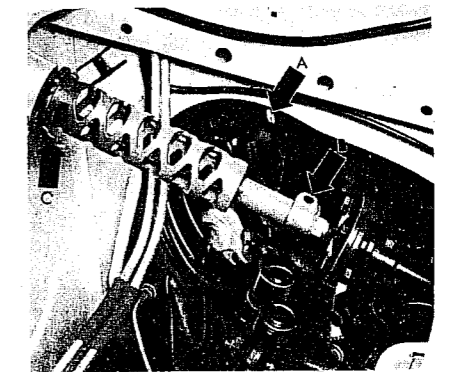


Fig. J.19. Details of the safety steering column.  
A. Earth connection.  
B. Column clamp.  
C. Column support clamp.

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

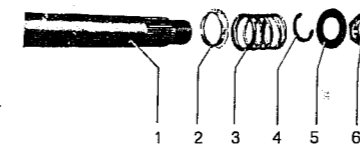


Fig. J.18. Assembly sequence for the components at the upper end of the steering shaft.

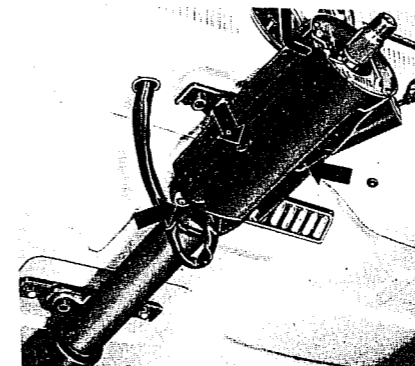


Fig. J.20. Safety steering column upper attachment points.

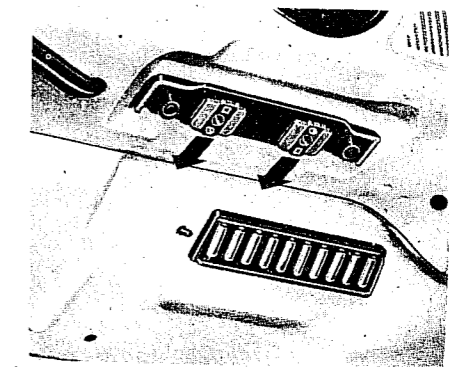


Fig. J.21. The upper mounting bracket must be fitted with the slotted side facing the direction shown.

## Technical Data

Type . . . . .	Worm & roller with divided track rods & steering damper
Steering Geometry :	
Toe-in (wheels not pressed) . . . . .	0° 30' ± 15'
Toe-in (wheels pressed) . . . . .	0° 5' ± 15'
Toe-out angle at 20° steering lock :	
RHD models on left lock . . . . .	2° 15' ± 30'
RHD models on right lock . . . . .	1° 35' ± 30'
LHD models on left lock . . . . .	1° 20' ± 30'
LHD models on right lock . . . . .	2° 10' ± 30'
Wheel lock angle (unladen) :	
Inner . . . . .	34° ± 2°
Outer . . . . .	28° ± 1°
Turning Circle (kerb) :	
All models except 1302 & 1302'S' . . . . .	10.5 m
1302 & 1302'S' . . . . .	9.0 m
Turning Circle (walls) :	
All models except 1302 & 1302'S' . . . . .	11.0 m
1302 & 1302'S' . . . . .	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 & Relining

##### 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

##### BLEEDING THE HYDRAULIC SYSTEM

##### HAND-BRAKE CABLES — Replacement

### GENERAL

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

The 1600 Beetle has disc brakes at the front. Other models have drums at the front and all have rear drum brakes.

The greatest emphasis must be put on the inspection and maintenance of the braking system. No other part of the car is more important. In particular, the level of fluid in the double reservoir and the thickness of brake pads and linings must be checked at regular intervals.

### FOOT-BRAKE ADJUSTMENT

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

It is very important to ensure that each shoe is the same distance from the drum. If this were not so, one lining would make contact before the other and the car would slew round. Straight line braking depends to a large extent upon regular, careful and equal adjustment of the brakes.

1. Remove all the hub caps and wedge the wheels.
2. Release hand-brake.
3. Press the brake pedal several times. This will centralise the shoes in the drums.
4. Jack up one side of the car.
5. Rotate one wheel until one of the adjusters can be seen through the inspection hole. These are in the back plate, covered by plastic plugs.

It may not be easy at first to see the adjusters through the inspection hole. However, they are made of brass and, if cleared of dust, they show up against the rest of the braking mechanism. It is very necessary to have a lamp or torch which you can shine through the hole.

6. Pass 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 rotate the adjuster. (Fig. K 2 shows the direction in which it should be rotated, 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.

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

7. Back off the adjuster until drag is no longer felt.
8. Move to the other adjuster in the same drum and repeat the procedure. Note that you have to turn the adjuster in the opposite direction.
9. When you have dealt with one wheel, move to the other one on the same side and repeat the work. This will only apply to all drum brake vehicles. You can then lower the car, wedge the side which you have dealt with and then lift and adjust the other side.

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 crash stops may be necessary to bed them down evenly.

Whilst you are doing this job, keep your eyes open for signs of trouble such as fluid or oil leaks at the drums. Faults of this nature will require removal of the drum, and adjustment will not overcome the trouble.

### ADJUSTMENT OF HAND-BRAKE

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

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

Fig. K.1. General layout of the braking system (Single-line system).

1. Brake pedal
2. Master cylinder
3. Brake fluid reservoir
4. Brake light switch
5. Brake line
6. Three-way connector
7. Brake hose bracket
8. Brake hose
9. Wheel cylinder
10. Handbrake lever
11. Cable and guide tube
12. Front wheel brake
13. Rear wheel brake

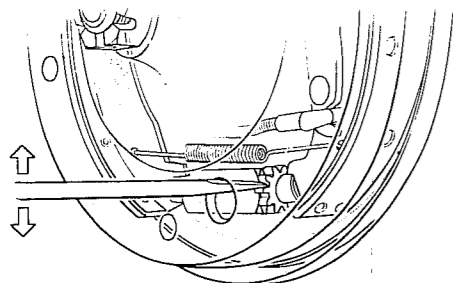
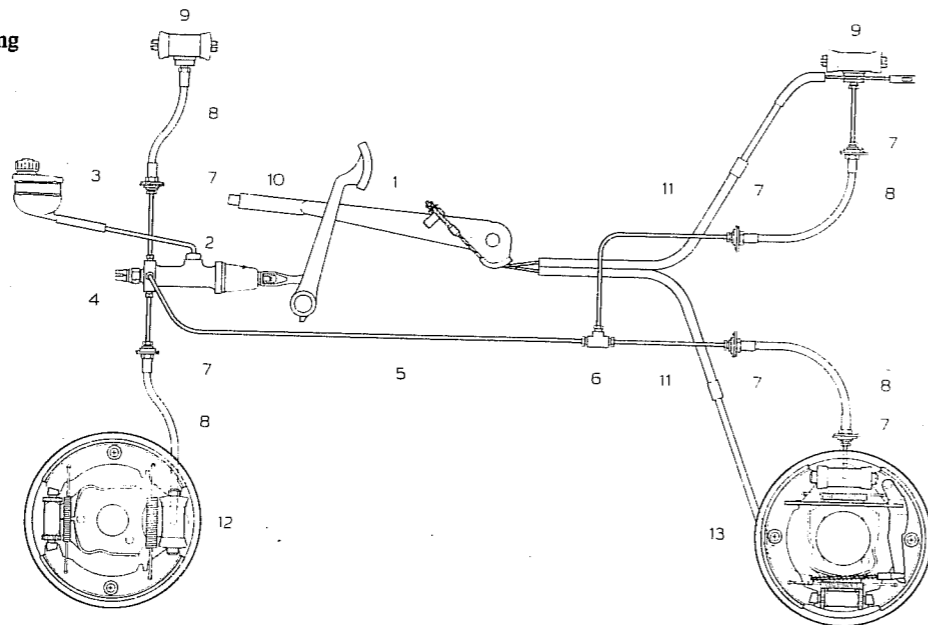


Fig. K.2. Adjusting the drum brakes.

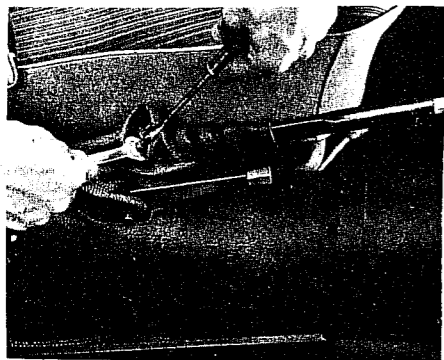
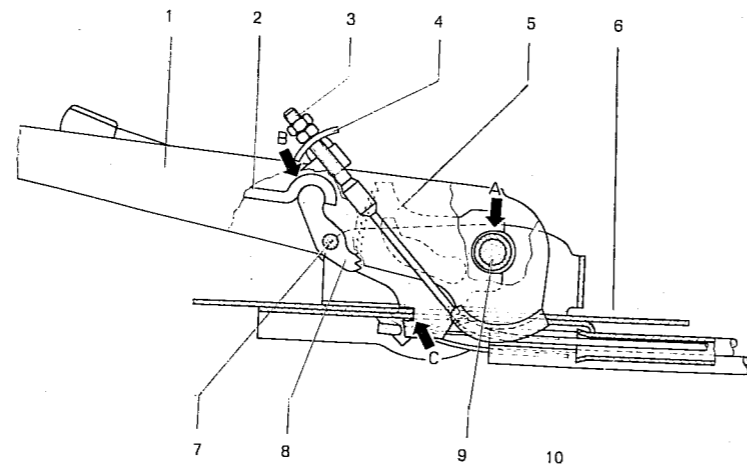


Fig. K.4. Adjusting the handbrake cable.



- |                       |                      |
|-----------------------|----------------------|
| 1. Handbrake lever    | 6. Frame             |
| 2. Pawl rod           | 7. Pawl pin          |
| 3. Handbrake cable    | 8. Pawl              |
| 4. Compensation lever | 9. Lever pin         |
| 5. Ratchet segment    | 10. Cable guide tube |

Fig. K.3. Handbrake lever mechanism.

3. The threaded end of the cable has two 10 mm nuts on it. (Fig K 3). 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. K 4), but it is much better to use two 10 mm spanners, one on each nut, to loosen the lock nut.
4. Turn the lower, adjusting nut until the rear wheel locks on the fourth click of the lever ratchet. Check this by trying to turn the wheel by hand. It should just run 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.

#### FRONT BRAKE DRUMS

Each drum is fitted with two bearings and these fit on to a tapered stub axle. If the brake shoes are slackened off sufficiently, the drum will slide off quite easily. If it is at all stiff, you can bolt the wheel back on to it and use this to pull it off.

#### Removal

1. Jack up the car and support it securely.
2. Remove the wheel.
3. If you are dealing with the nearside of the car, remove the circlip which holds the end of the speedometer cable in place (this can be seen projecting through the square hole in the small inner hub cap).
4. Remove the inner hub cap. A cold chisel and hammer will ease it out if it is stiff.
5. Inside the hub cap will be seen the securing nut which is locked by a socket screw. Loosen the socket screw and unwind the nut.  
NOTE: There is a left hand thread on the nearside.
6. Slacken off the brake shoes by means of the adjusters and slide the drum off the stub axle. The inner race of the inside bearing will probably remain on the axle together with a spacer which fits behind it.

#### Installation

1. Clean all exposed parts, paying particular attention to the stub axle, bearings, spacer and the rubbing surface of the drum.
  2. Centralise the brake shoes.
  3. Slide the drum into place.
- IMPORTANT: When the drum is removed, the bearings should be cleaned and lubricated.
4. When the drum is in place, the bearings must be very carefully adjusted according to the procedure detailed in the section on front wheel bearings.

#### 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 lb.ft — 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 this 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 components 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.

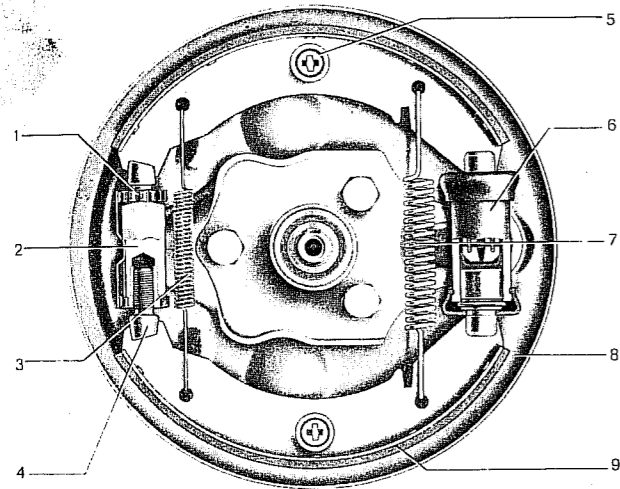
The force which has to be applied to undo this nut is so large that it is difficult to hold the axle in position. The car should be in gear, the hand-brake on and wedges jammed between tyre and ground.

#### 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 hacksaw and drive it out with a drift.
2. Mark the end of the axle shaft and the nut with a file to ensure correct tightness 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 clout 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.

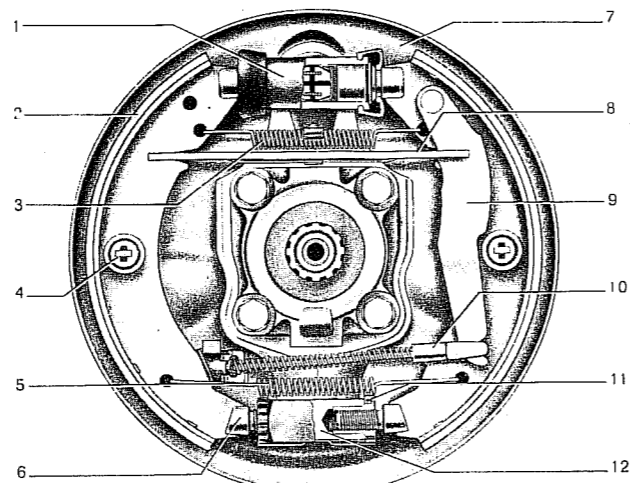
#### Installation

1. Thoroughly clean the inside of the drum and the splines of the axle. After the splines have been cleaned, lubricate them thoroughly with oil or thin grease.
2. Fit the oil deflector in place in the drum with its tube in its hole and the securing tab through the aperture in the face.
3. Make sure that the brake shoes are centralised.
4. Slide drum on to the shaft.
5. Re-fit 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 lb.ft, but if you have not one available, you must ensure that the lines scribed on the nut and axle line up correctly.
6. Fit a new split pin.
7. The brakes must be adjusted after carrying out this procedure.



- |                             |                             |
|-----------------------------|-----------------------------|
| 1. Adjusting nut            | 6. Cylinder                 |
| 2. Anchor block             | 7. Brake shoe return spring |
| 3. Brake shoe return spring | 8. Brake back plate         |
| 4. Adjusting screw          | 9. Brake shoe with lining   |
| 5. Guide spring             |                             |

Fig. K.5. Drum front brake assembly.



- |                           |                     |
|---------------------------|---------------------|
| 1. Wheel brake cylinder   | 7. Brake back plate |
| 2. Brake shoe with lining | 8. Connecting link  |
| 3. Upper return spring    | 9. Handbrake lever  |
| 4. Steady pin with spring | 10. Handbrake cable |
| 5. Lower return spring    | 11. Adjusting nut   |
| 6. Adjusting screw        | 12. Anchor block    |

Fig. K.6. Rear brake assembly.

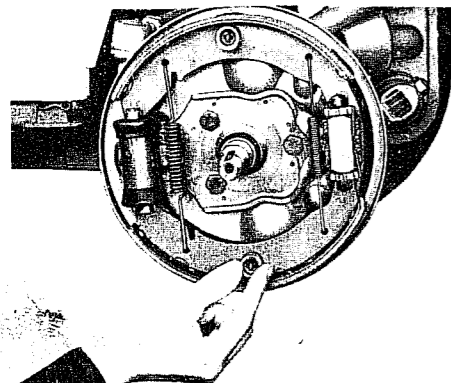


Fig. K.7. Releasing the brake shoe steady pins.

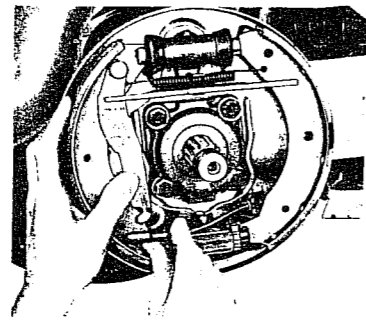


Fig. K.8. Disconnecting the handbrake cable.

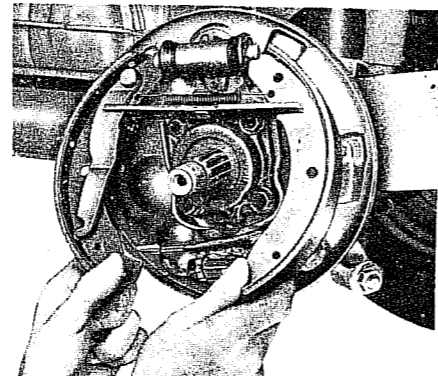


Fig. K.9. Removing the rear brake shoes.

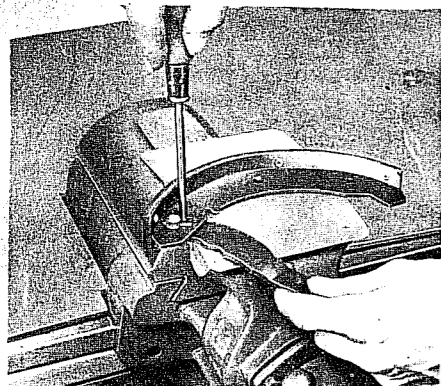


Fig. K.10. Detaching the handbrake operating lever from the rear shoe.

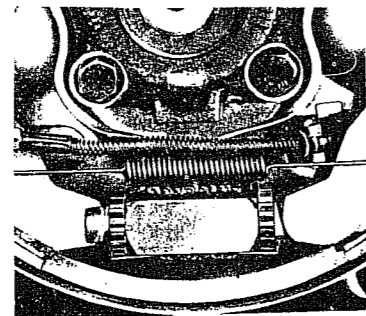


Fig. K.11. Shoe return spring correctly fitted.

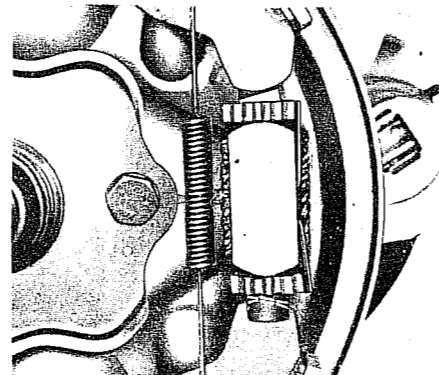


Fig. K.12. Correct position of the shoe ends in the cylinder adjusters.

## BRAKE SHOES

The brake linings are mounted on brake shoes and these are pressed against the rubbing surface of the brake drum by the action of the wheel cylinders. The linings are either rivetted or bonded into place; rivetted linings can be replaced, but where they are bonded, the shoes must be exchanged.

### Removal

1. Remove the brake drum.
2. Remove the small coil spring and cap which retain each shoe (Fig. K 7). A pin with spade end passes through the back plate and then through the spring plate. If the plate is gripped with pliers, it can be pressed in and rotated to free the pin.
3. 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 hand-brake cable must be lifted off the operating lever which pivots on one of the shoes (Fig. K 8).

### Installation

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

Note the following points :

1. The handbrake operating lever must be removed from the shoe on which it pivots before this shoe can be relined (Fig. K 10)
2. V.W. genuine linings come complete with rivets. Use only these rivets.
3. The linings must be rivetted down evenly, working from the middle of the shoe.
4. The ends of the linings must be chamfered after fitting. (See fig. K 13).

## BRAKE BACK PLATES

The shoes and wheel cylinders are mounted on a back plate. The shoes and wheel cylinders must first be removed before the plate can be taken off. The front back plates are secured by screws to the steering knuckle. The rear back 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 bulkhead behind the foot pedals. 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 of vital importance as failure here will affect the whole braking system.

1. Jack up the car, support it securely and remove the front wheel.
2. Pull the lines which lead to the reservoir out of the master cylinder. They enter at the top of the cylinder, through 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 strips paint !
4. Disconnect the cables from the stop lamp switches.
5. Unscrew the brake lines from the master cylinder. These unions may be very difficult to unscrew. 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 bulkhead.
8. Undo the two bolts on the bulkhead which hold the cylinder in position - note the spacers inside the bulkhead !
9. Lift out the cylinder from the front of the bulkhead.

### Installation

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

1. There must be a certain amount of play (1 mm) between the push rod 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 sleeves 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)

Pressure which is built up in the master cylinder by the action of the brake pedal is transmitted via the brake fluid in the brake lines to the four 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

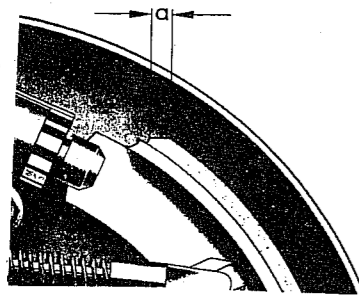


Fig. K.13. New linings must be chamfered at the ends as shown

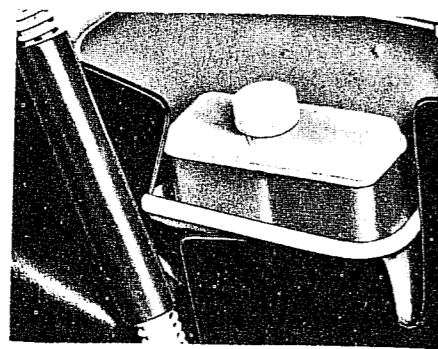


Fig. K.14. Brake fluid reservoir - Beetle models.

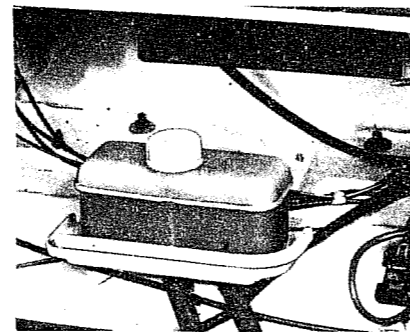


Fig. K.15. Brake fluid reservoir - Karmann-Ghia models.

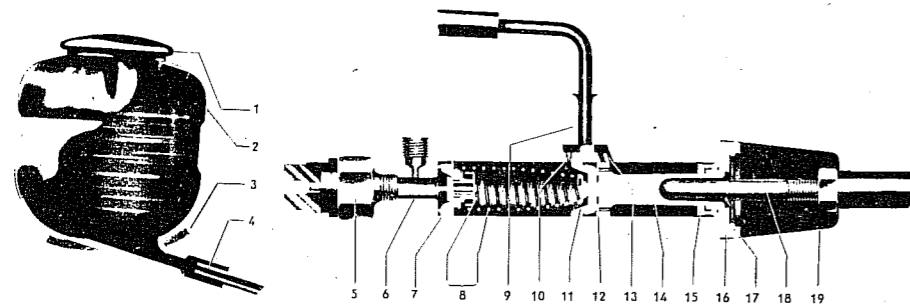


Fig. K.16. Sectioned view of the single-line master cylinder.

1. Cap seal
2. Cap
3. Brake fluid reservoir
4. Brake light switch
5. Master cylinder body
6. Check valve
7. Piston return spring
8. Rubber plug
9. Sealing washer
10. Compensation port
11. Main piston cup
12. Piston washer
13. Intake port
14. Piston
15. Piston secondary cup
16. Piston stop washer
17. Snap ring
18. Piston push rod
19. Rubber boot

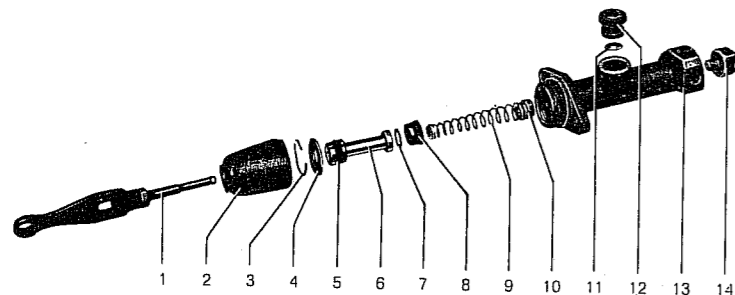


Fig. K.17. Exploded view of the single-line master cylinder.

- |                  |                         |
|------------------|-------------------------|
| 1. Push rod      | 8. Cylinder main cup    |
| 2. Rubber boot   | 9. Piston return spring |
| 3. Snap ring     | 10. Spring seat         |
| 4. Stop washer   | 11. Sealing washer      |
| 5. Piston cup    | 12. Plug                |
| 6. Piston        | 13. Cylinder body       |
| 7. Piston washer | 14. Brake light switch  |

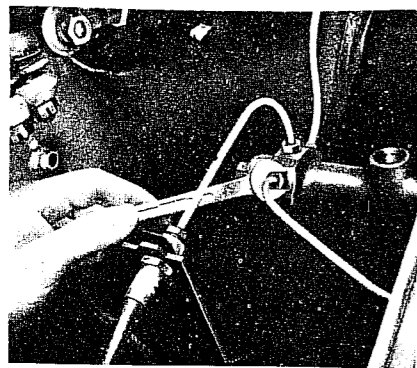


Fig. K.18. Disconnecting the brake lines from the master cylinder (single-line system).

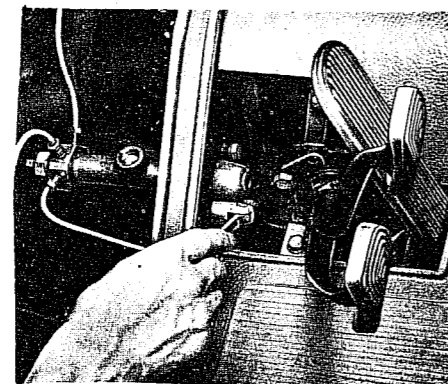


Fig. K.19. Removing the master cylinder.

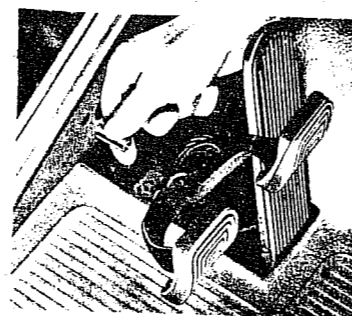


Fig. K.20. Refitting the distance tube. (Do not drop into bulkhead.)

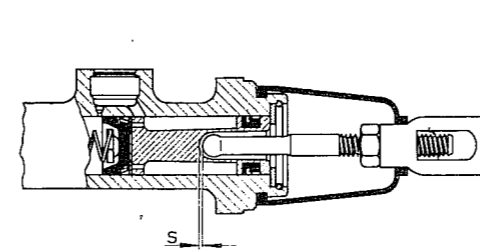


Fig. K.21. Push rod to master cylinder clearance. S = 1.0mm. (0.04 in.).

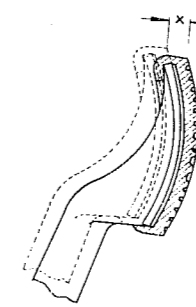


Fig. K.22. Free-play at the brake pedal "X" should be 5-7mm. (0.2-0.28 in.).

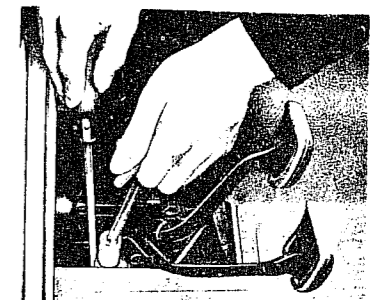


Fig. K.23. Adjusting the push rod clearance by moving the pedal stop plate.

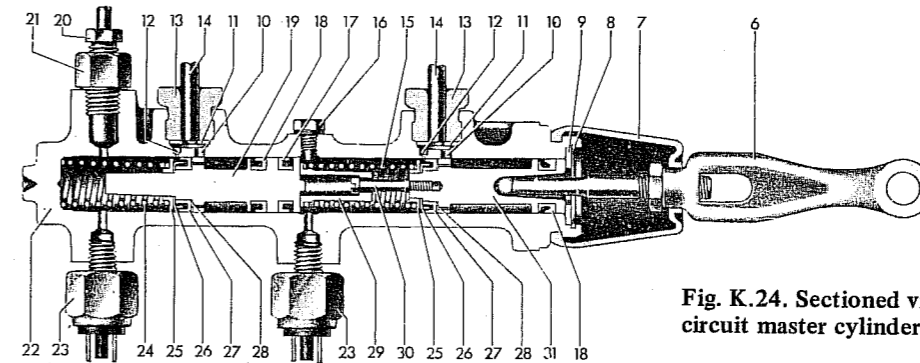


Fig. K.24. Sectioned view of the dual-circuit master cylinder.

- |                          |                             |                           |
|--------------------------|-----------------------------|---------------------------|
| 1. Screw cap             | 12. Compensation port       | 22. Master cylinder body  |
| 2. Brake fluid reservoir | 13. Plug                    | 23. Brake light switch    |
| 3. Brake fluid line      | 14. Feed line               | 24. Front piston spring   |
| 4. Seal                  | 15. Rear piston spring      | 25. Spring plate          |
| 5. Union nut             | 16. Stop screw and seal     | 26. Support ring          |
| 6. Push rod              | 17. Seal                    | 27. Primary cup           |
| 7. Rubber boot           | 18. Secondary cup           | 28. Cup washer            |
| 8. Snap ring             | 19. Front piston            | 29. Stop sleeve           |
| 9. Stop washer           | 20. Brake line union nut    | 30. Stroke limiting screw |
| 10. Feed port            | 21. Residual pressure valve | 31. Rear piston           |
| 11. Plug sealing washer  |                             |                           |

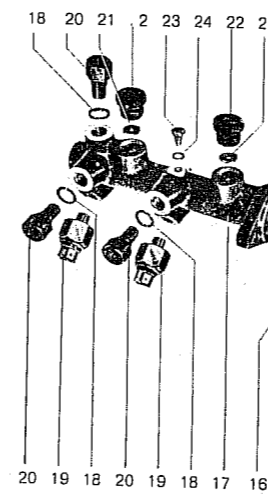


Fig. K.25. Exploded view of the dual-circuit master cylinder.

- |                        |                                  |
|------------------------|----------------------------------|
| 1. Push rod            | 13. Stroke limiting screw        |
| 2. Rubber boot         | 14. Seal                         |
| 3. Snap ring           | 15. Front piston                 |
| 4. Stop washer         | 16. Front piston spring          |
| 5. Secondary cup       | 17. Cylinder body                |
| 6. Rear piston         | 18. Residual pressure valve seal |
| 7. Cup washer          | 19. Brake light switch           |
| 8. Primary cup         | 20. Residual pressure valve      |
| 9. Support washer      | 21. Sealing plug washer          |
| 10. Spring plate       | 22. Sealing plug                 |
| 11. Rear piston spring | 23. Stop screw                   |
| 12. Stop sleeve        | 24. Stop screw seal              |

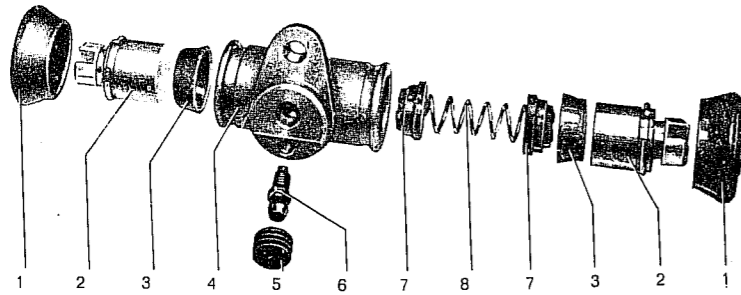


Fig. K.26. Exploded view of the wheel cylinder.

- |                   |                  |
|-------------------|------------------|
| 1. Rubber boot    | 5. Dust cap      |
| 2. Piston         | 6. Bleeder valve |
| 3. Piston cup     | 7. Cup expander  |
| 4. Wheel cylinder | 8. Spring        |

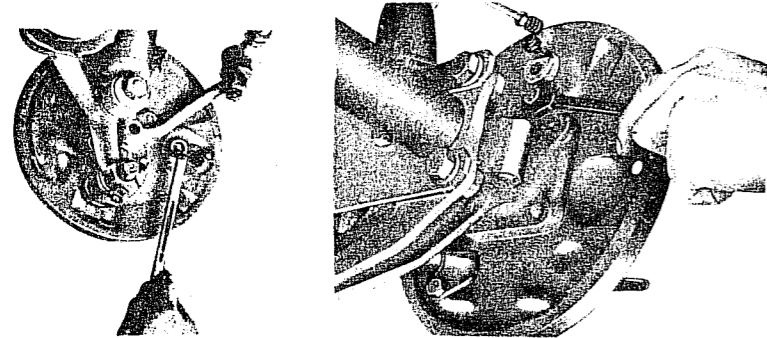


Fig. K.27. Unbolting the front wheel cylinder.

Fig. K.28. Unbolting the rear wheel cylinder.

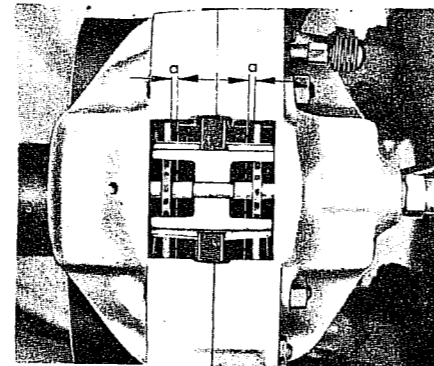


Fig. K.30. Thickness of the brake pads "a" must not be less than 2.0mm. (0.08 in.)

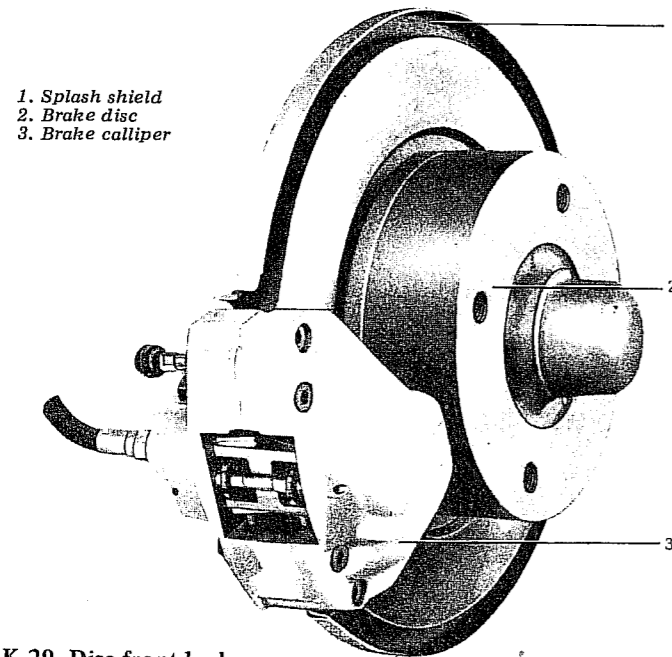


Fig. K.29. Disc front brake.

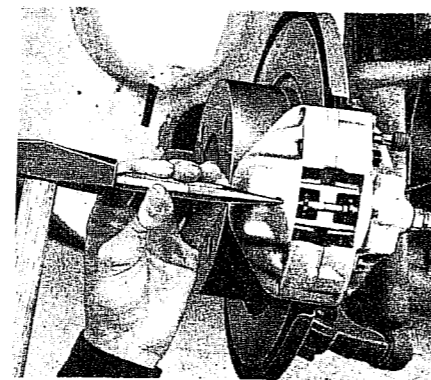


Fig. K.31. Removing the pad retaining pins.

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 slotted 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 brakes become defective owing to fluid leaking past the rubber cup and entering the drum or if any slight leak is apparent when the shoes are relined.

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

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

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

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

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

When the cylinder parts are re-assembled, they should all, including the bore, be lubricated with V.W. brake cylinder paste or brake fluid. The utmost care 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 calliper (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 calliper (Fig. K 32). The pin holes will provide a grip.

**Installation**

1. Force both pistons in the calliper back into the housing so that there is room for the pads to be inserted (Fig. K 33).  
NOTE : There is a likelihood that the brake fluid reservoir will overflow when this is done, due to fluid being forced back into it. To avoid this happening, syphon off some of the fluid from the reservoir using a plastic bottle with a thin spout.
2. Remove the piston retaining plates and clean out the pad apertures and other parts. Use methylated spirit and a small stiff brush. Other solvents must NOT be used.
3. Re-install the piston retaining plates. They are shaped so that they engage with the piston. If they do not do so, the position of the piston should be corrected by rotating it (Fig. K 34).
4. Insert the pads and then drive in the 2 locating pins (Fig. K 36). These pins should not be driven in too far, so drive them with the face of a hammer; do not use a punch which might sink 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 CALLIPERS**

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

**Removal**

1. Raise and support the front of the car and remove the front wheels.
2. Check that the brake callipers have cooled down properly.
3. Lever up the locking tabs and unscrew the two hexagon screws which attach the calliper to the steering knuckle (see Fig. H 8).
4. Slide off the calliper. 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 calliper in a vice with soft jaws and lever out the seal spring ring (Fig. K 39).
3. Lever 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 passageways are continuous.
5. Remove the rubber seal with a soft instrument.
6. Clean all the parts, using only methylated spirit or brake fluid.
7. Check the cylinders for damage. If any is apparent, the whole calliper 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.

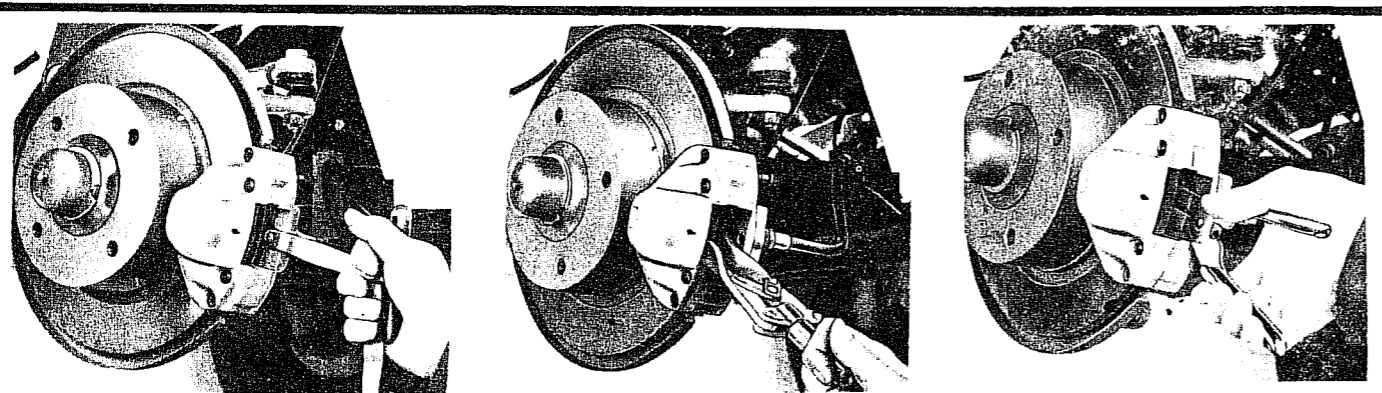


Fig. K.32. Removing the brake pads.

Fig. K.33. Forcing the pistons back into their cylinders.

Fig. K.34. Rotating the pistons to their correct positions.

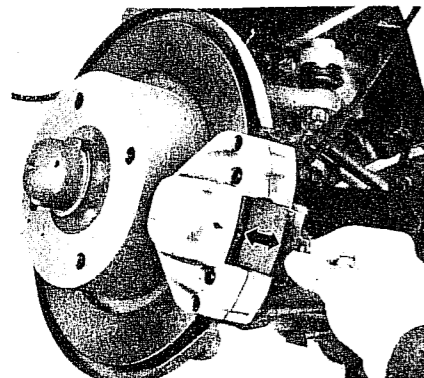


Fig. K.35. Check that the brake pads are free to move in their recesses.

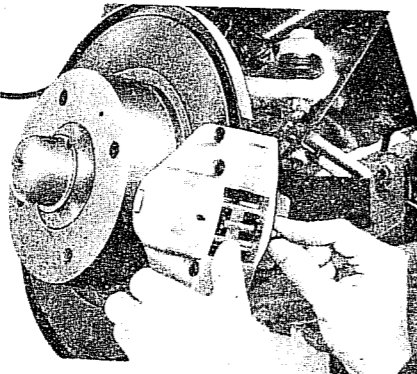


Fig. K.36. Installing the pad retaining pins.

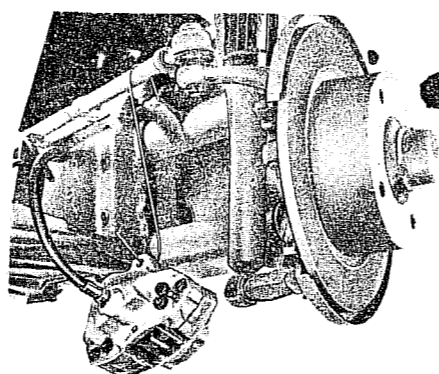


Fig. K.37. Support the calliper as shown to prevent strain on the hose.

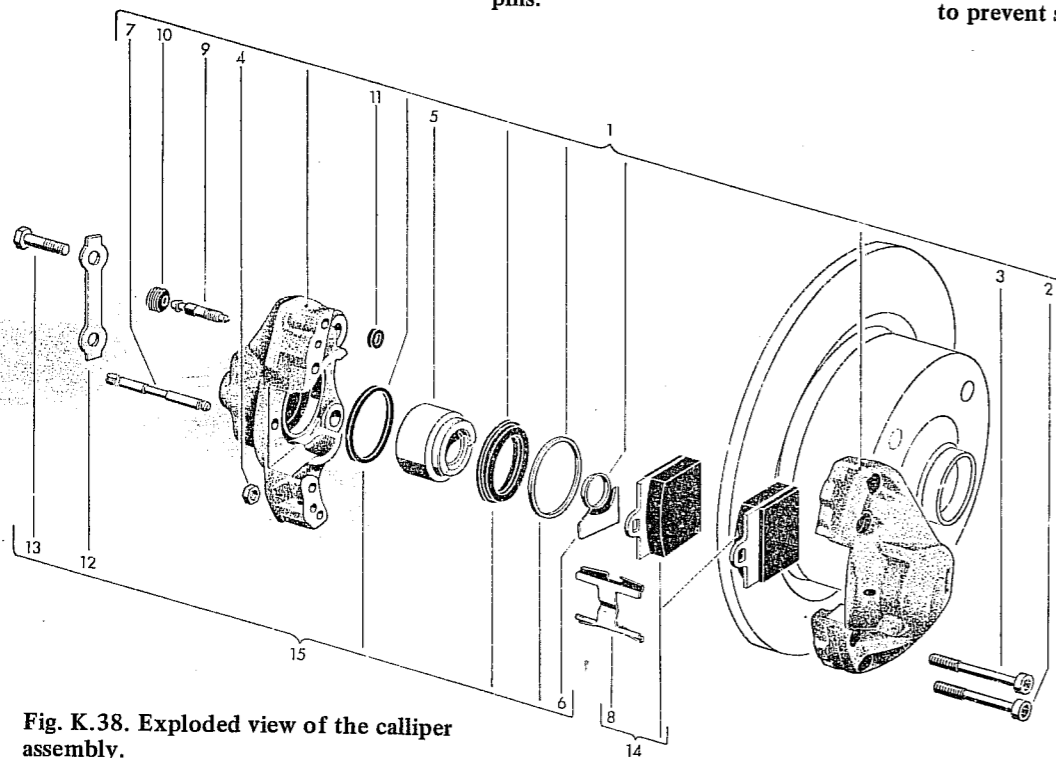


Fig. K.38. Exploded view of the calliper assembly.

1. Brake calliper
2. Mounting bolts
3. Mounting bolts
4. Nut
5. Calliper piston
6. Piston retaining plate
7. Brake pad retaining pin
8. Brake pad retaining spring
9. Calliper bleeder valve
10. Dust cap
11. Gasket
12. Lock washer
13. Calliper securing bolt
14. Brake pads
15. Calliper seals

9. Install a new seal and spring ring. (New seals and rings will be in the calliper overhaul kit).
10. Ensure that the piston is correctly positioned so that the retaining plate fits properly against it. Rotate it if necessary.

**Installation**

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

**BRAKE DISCS**

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

**Removal**

1. Raise and support front of car and remove the front wheels.
2. Remove the brake calliper as described above
3. Remove the speedometer cable circlip on the left hand side and lever off the wheel bearing caps.
4. Loosen the socket screw in the wheel bearing clamp nut and unscrew the nut (note the left hand thread on the left side).
5. Remove disc complete with wheel bearings.

**Installation**

1. Install the disc and bearings and then adjust the bearing (see section on Front Suspension).
2. Check the run-out of the disc with a dial gauge (Fig. K 41). The play should be checked 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 calliper as described previously.

**BRAKE PIPES**

The brake lines carry the hydraulic fluid from the master cylinder to the four wheel cylinders. Three come 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 conditions 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 hoses; 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 screw-driver 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 plate snaps 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 walled 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 soaking with easing oil in advance. The short lines will present no problem, so only details for the long pipe are given.

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

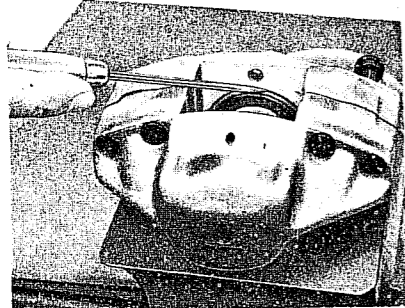


Fig. K.39. Removing the dust cover spring ring.

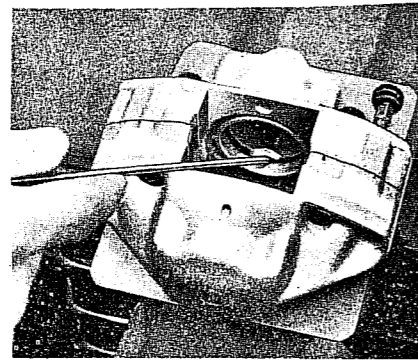


Fig. K.40. Extracting the rubber seal.

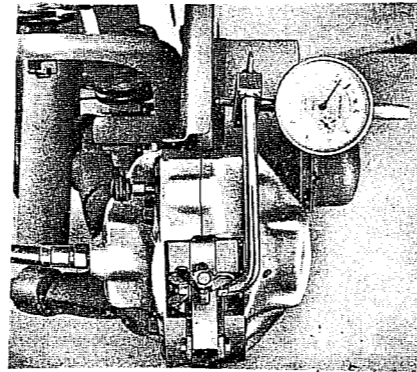


Fig. K.41. Checking the brake disc run-out with a dial gauge.

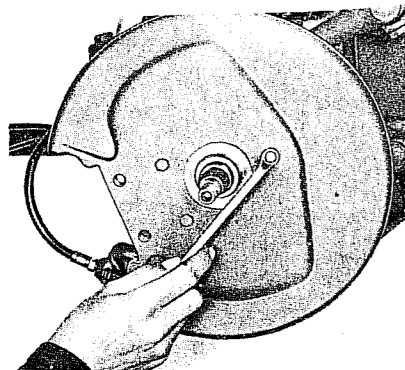


Fig. K.42. Removing the brake disc splash shield.

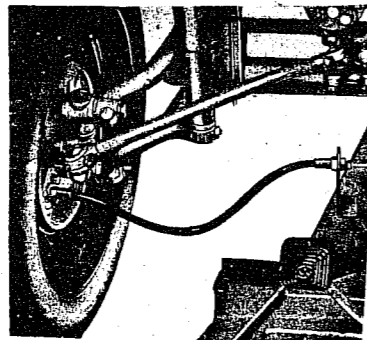


Fig. K.43. Correct installation of the front brake hose.

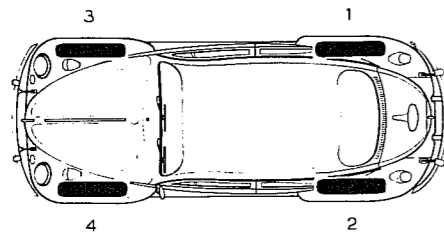
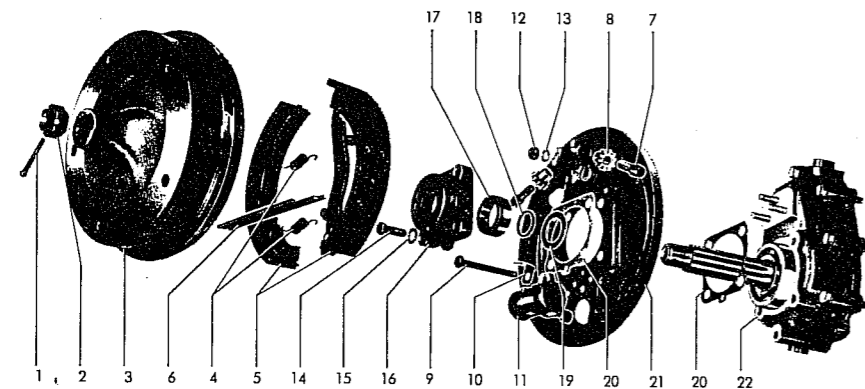


Fig. K.45. Bleeding sequence for the single-line brake system.



1. Split pin
2. Castellated nut
3. Brake drum
4. Shoe retracting springs
5. Brake shoe with handbrake lever
6. Connecting link
7. Adjusting screw
8. Adjusting wheel
9. Bolt
10. Leaf spring
11. Wheel cylinder
12. Nut
13. Spring washer
14. Bolt
15. Spring washer
16. Bearing cover
17. Distance piece
18. Seal
19. Washer
20. Gasket
21. Back plate
22. Bearing and reduction gear housing

Fig. K.46. Exploded view of the rear brake assembly on Type 181 models.

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 push out of the hole.
7. The line is held in the angle between backbone and floor by simple clamps which can be prised up with a screw-driver. 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 so as to remove it easily. Don't forget that it is full of hydraulic fluid and that this is a paint 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 cluster and into the car. Pass the end through the hole in the rear bulkhead, but make no effort to secure the ends at this stage.
3. Carefully adjust the position of the line so that it nestles in the groove left by the old cable and passes cleanly under the pedal cluster and through all the three holes. Tighten the securing clamps along its length, but take care not to squash the soft walls of the tube.
4. The two ends of the line can now be screwed into place. This is rather more difficult than it looks 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. That part of the line which passes along the floor must be coated in a similar manner to the original. Thick undersealing compound or mastic 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 massive air lock which has been introduced. Most of this will be eliminated from the rear bleed valves, but the front part of the system must be bled in case air has passed into it.

#### BLEEDING THE HYDRAULIC SYSTEM

Whenever any part of the hydraulic braking system is disconnected, air gets into the system. This gives the brakes 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 9" - 1' long and 1/4" 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 the air bubbles which you are trying to

eliminate. Make sure then that you have a good supply of new fluid (make sure that it is the recommended good quality fluid) and keep the reservoir topped up during the whole operation. If the reservoir level falls too low, more air will be sucked in. The method shown in Fig. K 44 is ideal.

1. Fill reservoir with new fluid if it is not already full.
2. Remove the rubber dust cap from one of the bleeder valves, on the back of the brake drum. Clean around the valve.
3. Pour 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. This process can then be repeated for each of the other three wheels. Follow the order shown in Fig. K 45. Vehicles with dual circuit systems follow order: right front, left front, right rear, 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 false economy. Remember, the braking system is the most important part of the car, and, apart from anything else, old fluid tends to have absorbed water and this will boil under heavy braking and also cause corrosion.

#### HAND-BRAKE CABLES

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

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

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

#### Removal

1. Wedge the rear wheel of the opposite side. Release hand-brake lever. Undo the two nuts on the threaded end of the cable.
  2. Remove rear brake drum, making sure that the shoes have been fully released from their normal position by the adjuster ratchets.
- NOTE:** From this point, the rubbing surface of the drum and the shoes is exposed. Contamination by oil or grease must be avoided
3. Allow the shoes to hang away from the back-plate. Wrap a piece of wire around the wheel cylinder to prevent the pistons expanding.



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

#### Installation

- Thoroughly grease the cable. From now on, it will be difficult to ensure that the greasy cable does not pick up dirt and so it should be handled with care.
- Hook the eye of the cable over the operating lever and re-assemble the locating piece. Replace the shoes and all springs.
- Pass the cable into the conduit. In order to attach the forward end of the cable, it may be necessary to dismantle the hand-brake lever.
- Slide the rubber boot up the lever, out of the way.
- Remove the nuts from the remaining cable.
- Prise off the circlips which locate the pivot rod.
- Push 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 lead 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 re-assemble 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. K4).

## Technical Data

Type . . . . . Foot-brake operates hydraulically on all four wheels. Drum front brakes on 1200, 1300, 1302 & 181 models. Disc front brakes on all others. Drum rear brakes on all models. Drum brakes are of the one leading, one trailing shoe & type. Hand-brake operates mechanically on the rear wheels only.

#### Brake Master Cylinder

Single-line system :	
Bore . . . . .	0.687 in (17.46 mm)
Stroke . . . . .	1.299 in (33 mm)
Duel-circuit system :	
Bore . . . . .	0.750 in (19.05 mm)
Front circuit stroke :	
drum braked models . . . . .	0.610 in (15.5 mm)
disc braked models . . . . .	0.550 in (14.0 mm)
Rear circuit stroke :	
drum braked models . . . . .	0.490 in (12.5 mm)
disc braked models . . . . .	0.550 in (14 mm)
Push rod length . . . . .	Adjustable
Pedal travel . . . . .	min 7.5 in (190 mm)
Clearance push rod to piston . . . . .	0.04 in (1.0 mm)
Brake pedal free travel . . . . .	0.2-0.28 in 5-7 mm)

#### Front Wheel Brakes

Brake drum diameter . . . . .	9.059 + 0.008 in (230.1 + 0.2 mm)
Wear limit . . . . .	9.114 in (231.5 mm)
Permissible skimmed diameter . . . . .	9.102 + 0.008 in (231.2 + 0.2 mm)
Wear limit . . . . .	9.114 in (231.5 mm)
Max. permissible bellling . . . . .	0.004 in (0.1 mm)
Max. permissible ovality . . . . .	0.004 in (0.1 mm)

Wheel cylinder diameter . . . . .	0.875 in (22.2 mm)
Brake lining thickness :	
New . . . . .	0.16 - 0.15 in (4.0 - 3.8 mm)
Oversize . . . . .	0.18 - 0.17 in (4.5 - 4.3 mm)
Brake lining width . . . . .	1.57 in (40 mm)
Total lining area . . . . .	55.5 sq.in (358 sq. cm)

Brake disc diameter . . . . .	277 mm
Thickness (new) . . . . .	0.374 - 0.004 in (9.5 - 0.1 mm)
Max. permissible skimming (per side) . . . . .	0.02 in (0.5 mm) max.
Min permissible disc thickness . . . . .	0.335 in (8.5 mm)
Thickness tolerance . . . . .	0.0008 in (0.02 mm) max.
Lateral run-out . . . . .	0.008 in (0.2 mm) max.
Calliper piston diameter . . . . .	40.0 mm
Front pad thickness . . . . .	0.394 in (10 mm)
Running clearance . . . . .	0.002 - 0.008 in (0.05 - 0.2 mm)
Friction pad area (4) . . . . .	12.2 sq.in (72 sq.cm)

#### Rear Wheel Brakes

Brake drum diameter . . . . .	9.055 + 0.008 in (230 + 0.2 mm)
Permissible skimmed diameter . . . . .	9.098 in (231.1 mm)
Max. taper . . . . .	0.004 in (0.1 mm)
Max. ovality . . . . .	0.004 in (0.1 mm)

Wheel cylinder diameter :	
Saloon, Karmann-Ghia . . . . .	0.687 in (17.46 mm)
Model 181 . . . . .	0.750 in (19.05 mm)
Brake linings	
Thickness, new . . . . .	0.16 - 0.15 in (4.0 - 3.8 mm)
Thickness, oversize . . . . .	0.18 - 0.17 in (4.5 - 4.3 mm)
Width . . . . .	1.57 in (40 mm)
Total lining area . . . . .	55.5 sq. in (358 sq. cm)

## Electrical Equipment

#### GENERAL

#### BATTERY - Maintenance

#### GENERATOR - Removal & Installation, Replacement of brushes, Disassembly, Assembly & Polarising

#### REGULATOR - Removal & Installation

#### STARTER MOTOR - Removal & Installation

#### STARTER SOLENOID - Removal & Installation

#### GENERAL

All Beetles, except 1200s in certain countries, are fitted with a 12 volt electrical system.

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

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

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

NOTE :- In the case of 1200 models with 6 volt electrical system, reference should be made to INTEREUROPE WORKSHOP MANUAL No. 122 where this system is described in full.

#### Topping Up

Water is lost when a battery is in use and it is essential to replace it at regular intervals. If this is not done, the level of the electrolyte will fall below the level of the plates and the full capacity of the battery will not be in use. In addition to this, the plates will quickly deteriorate if they are not kept covered.

If you have difficulty in obtaining distilled water, remember that the water which collects in the drip tray of a domestic refrigerator as you defrost it is quite suitable.

Warning : We repeat, never top up with acid unless some has definitely been lost as a result of spillage.

#### Lack of Use

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

Sulphation can occur even if the car is used regularly. If the supply of current from the generator is too low, the battery may seldom become fully charged and sulphation can slowly occur. This will not occur if the generator output is correct, the regulator set properly and the battery connections in good condition.

#### HEADLAMPS - Removal & Installation

#### BRAKE LIGHTS

#### HORN

#### STEERING COLUMN SWITCH ASSEMBLY

#### FLASHER RELAY

#### SPEEDOMETER AND FUEL GAUGE

#### SPEEDOMETER CABLE - Replacement

#### Testing

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

#### 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 spilt and left, the water slowly evaporates from it and causes the acid to become more concentrated. Because of this it is essential to threat any spillage, however small. Any splashes can be neutralised with a liberal application of baking powder dissolved in water. If no alkali is available, use plenty of water.

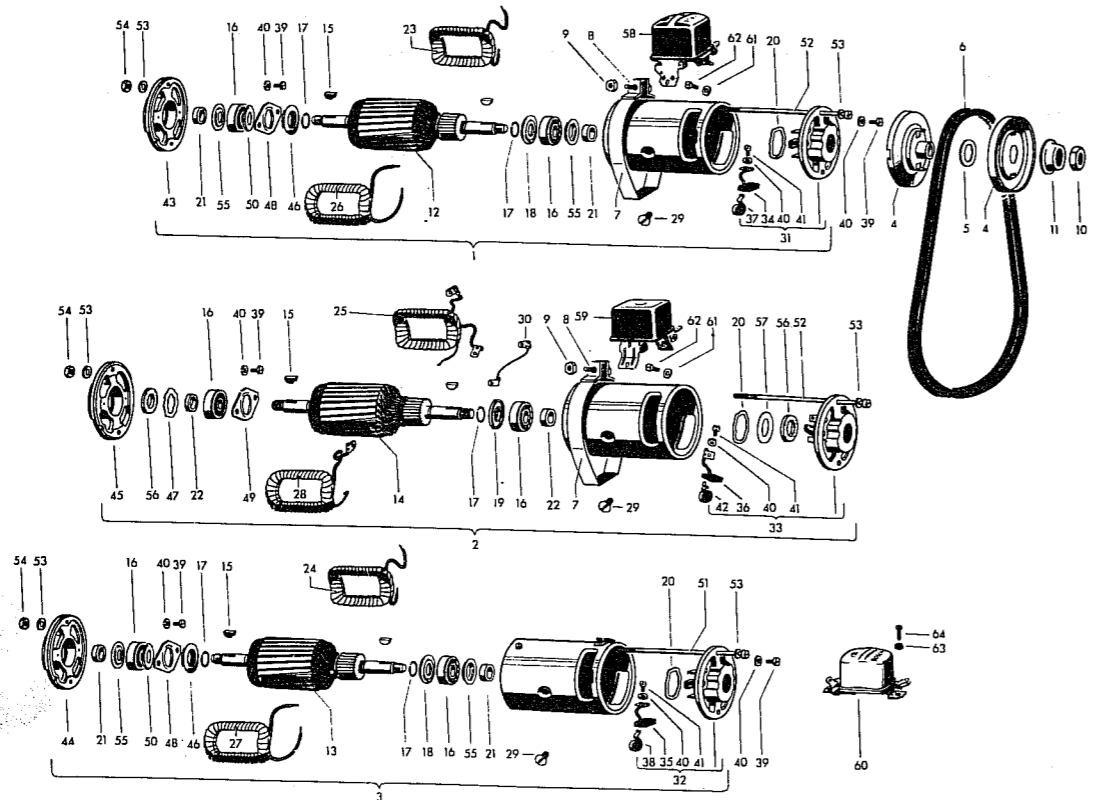
#### GENERATOR (Fig. L 1)

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 commonest piece of maintenance, replacing the brushes, without removing the generator.

#### Removal

- Remove the lower cooling duct cover beneath the right hand bank of cylinders.
- Remove the screw which holds the thermostat to its bracket and unwind the thermostat from its rod.



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

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

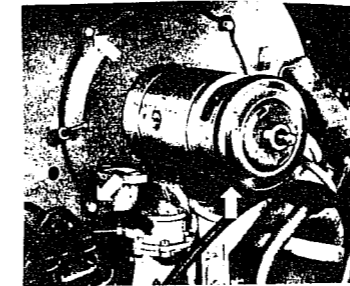


Fig. L.2. Location of the screws securing the generator and fan assembly to the fan housing.

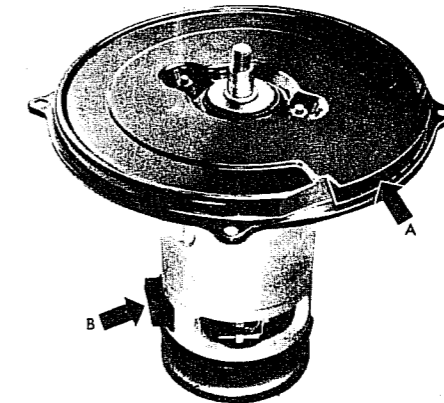


Fig. L.3. If cooling slots (A) are present, install the generator with the slots facing downwards.

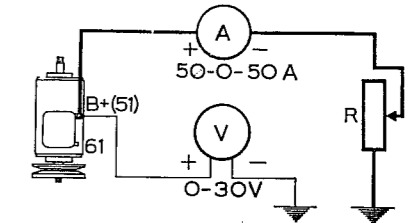


Fig. L.4. Charging system test circuit.

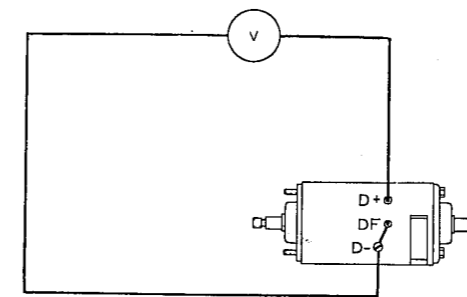


Fig. L.5. Generator no-load test circuit.

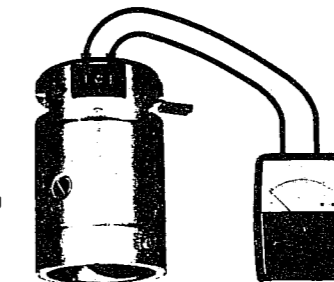


Fig. L.6. Testing the generator field coils with an ohmmeter.

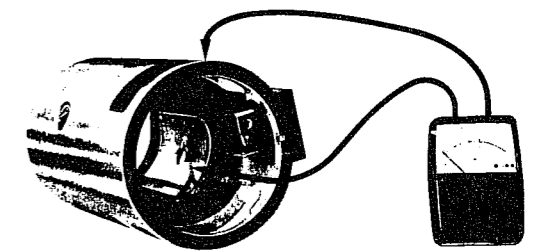


Fig. L.7. Testing the insulation of the field coils.

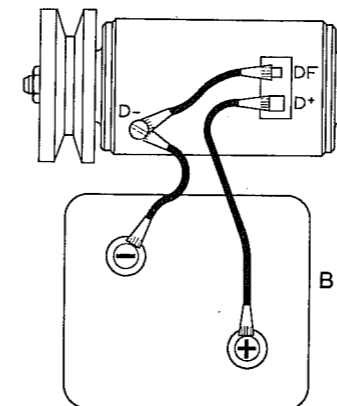


Fig. L.9. Connections for polarising the generator.

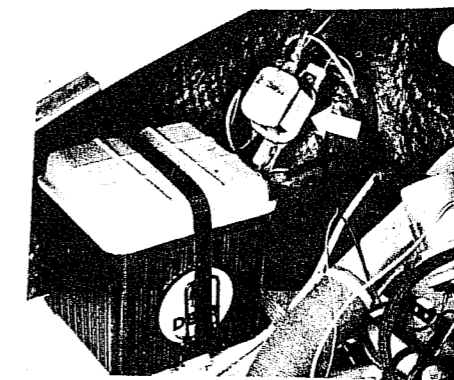


Fig. L.10. Regulator location on Karmann-Ghia models.

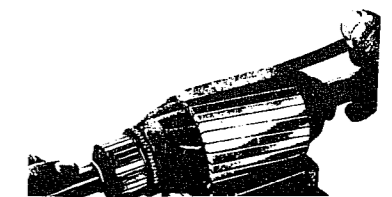


Fig. L.8. Testing the armature on a 'growler'.

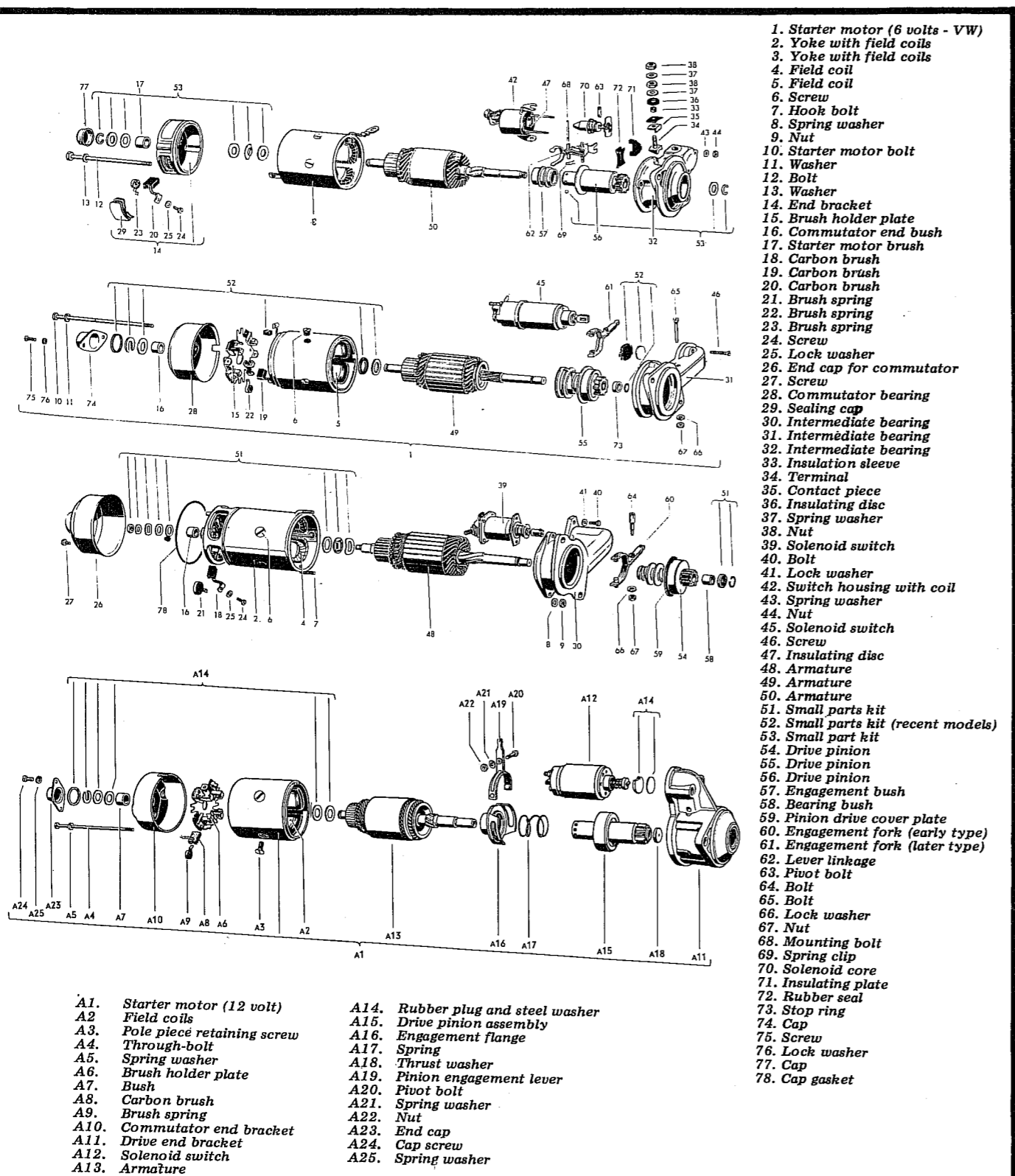


Fig. L.13. Exploded view of the various types of starter motor fitted.

- Remove the carburettor, and the fan belt.
- Remove the large diameter flexible pipes which connect the fan housing to the heat exchangers.
- Remove the screw at either side of the fan housing.
- On 1300 and 1600s, remove the rod which connects the two sets of air control flaps behind the fan housing.
- Lift the fan housing and remove the four screws which attach the fan assembly to it (Fig. L 2).
- 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 :

- Check that the generator and crankshaft pulleys are in line.
- 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 brush. If necessary, remove the generator first.

- Remove the slotted screw which secures the connecting tag on the brush. Take care not to drop the screw and washer into the generator.
- 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**

- Remove the remaining half of the pulley from the spindle. Take care not to lose the key.
- Hold this end of the spindle in a vice, using SOFT jaws and undo the large nut which holds the fan on to the spindle.
- Remove the fan (note the key) and note the position of the various washers and spacers.
- Unscrew the two long screws which hold the ends of the generator together.
- Lift off the end plates and remove the armature.
- 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 :

- Lift out the brushes so that the commutator end of the armature can be inserted into the end plate.
- The end plates have grooves which engage with projections on the casing.
- Check that the armature spins very freely.
- Do not forget to insert the keys for fan and pulley.

**Polarising**

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 DF on the connector block and to D- (the screw on the casing), and the positive terminal of the battery must be connected to D+ on the connector block.

**REGULATOR**

The regulator cannot be serviced except with very specialised 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		Regulator
D+	to	D+
DF	to	DF

In addition, terminal B+/51 on the regulator is connected to the positive terminal of the battery and to terminal 30 of the car's electrical system and terminal 61 on the regulator is connected to the generator warning lamp in the speedometer.

**STARTER MOTOR (Fig. L 13)**

The starter motor is mounted alongside the gearbox and is secured by the right hand upper engine mounting bolt and a stud which projects from the bell housing.

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

**Removal**

- Raise the side of the car and remove the rear wheel.
- Disconnect the negative cable at the battery.
- Push back the flexible heater pipe near the starter motor.
- Pull off the thinner cable from the terminal on the motor solenoid.

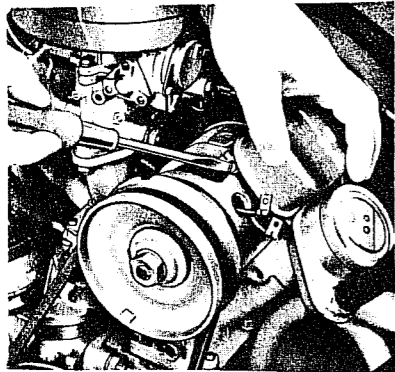


Fig. L.11. Removing the regulator (where fitted to generator).

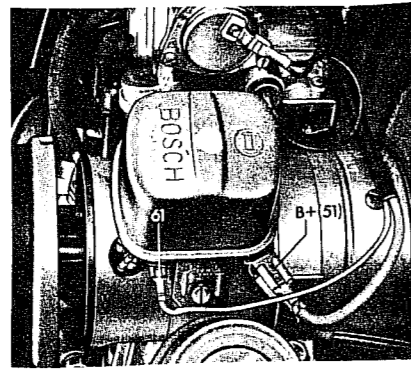


Fig. L.12. Regulator connections.

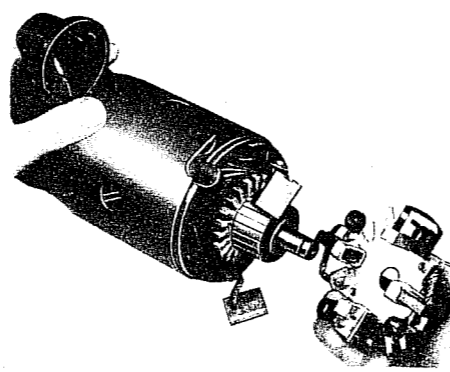


Fig. L.14. Removing the brush holder plate from the starter motor.

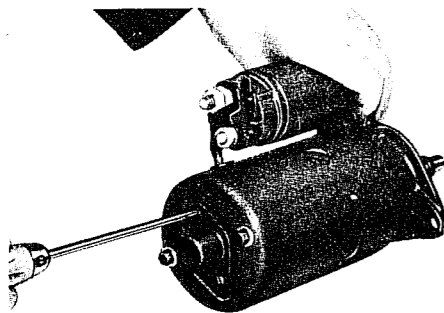


Fig. L.15. Removing/Installing the starter motor end cap.

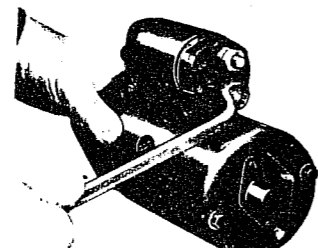


Fig. L.16. Removing the solenoid connecting link.

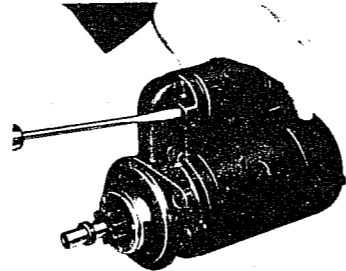


Fig. L.17. Removing the solenoid retaining screws.

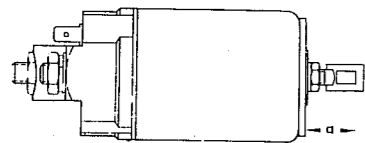


Fig. L.18. Check dimension "a" before fitting the solenoid.  
a = 19 +/- 0.1mm. (0.748 +/- 0.004 in.).

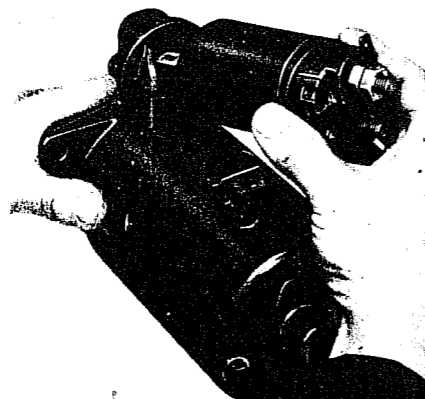


Fig. L.19. Engaging the solenoid pull-rod in the actuating lever.

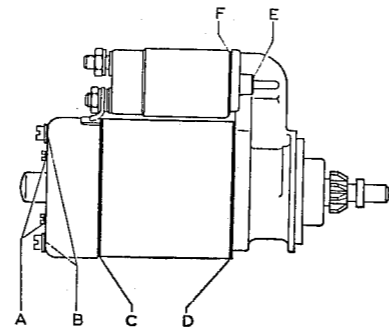


Fig. L.20. Seal the starter motor at the points indicated during assembly.

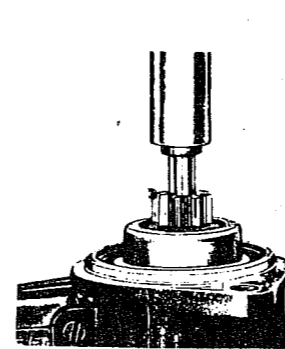


Fig. L.21. Removing the starter motor drive pinion stop ring.

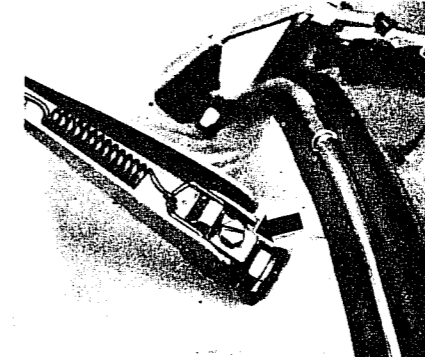


Fig. L.22. Wiper arm clamp screw (Late models have a splined spindle.)

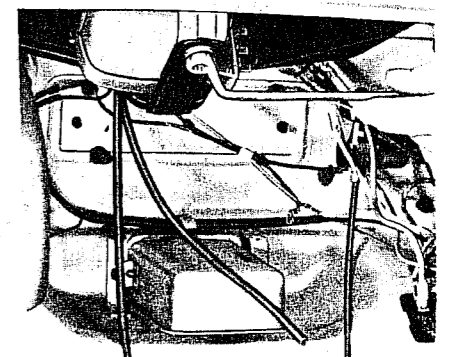


Fig. L.23. Removing the wiper motor and mounting bracket.

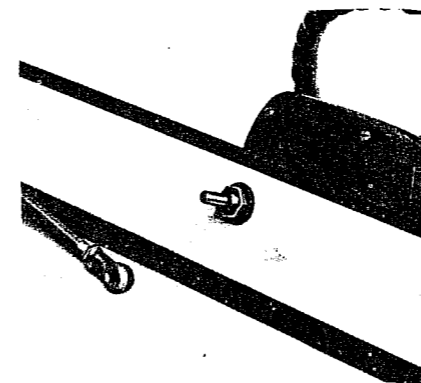


Fig. L.24. Wiper arm connecting rod detached on Type 181 models.

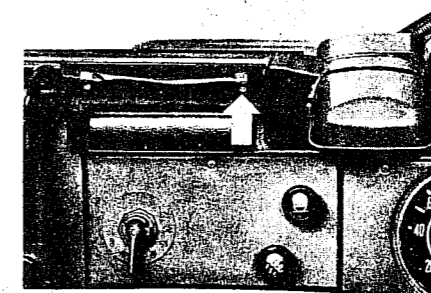


Fig. L.25. Location of the wiper motor cable clip.

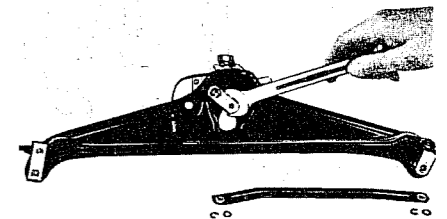


Fig. L.26. Wiper motor and mounting bracket.

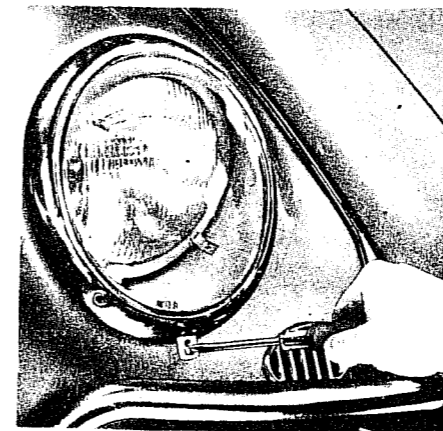


Fig. L.27. Removing the headlamp retaining screw.

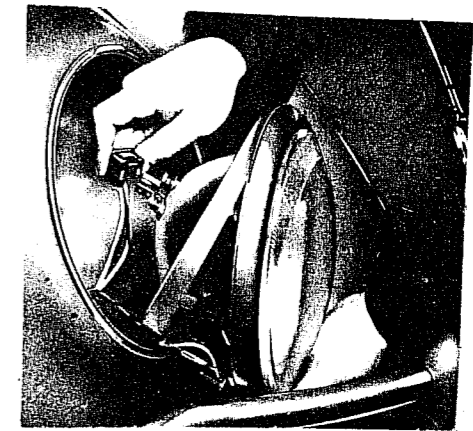
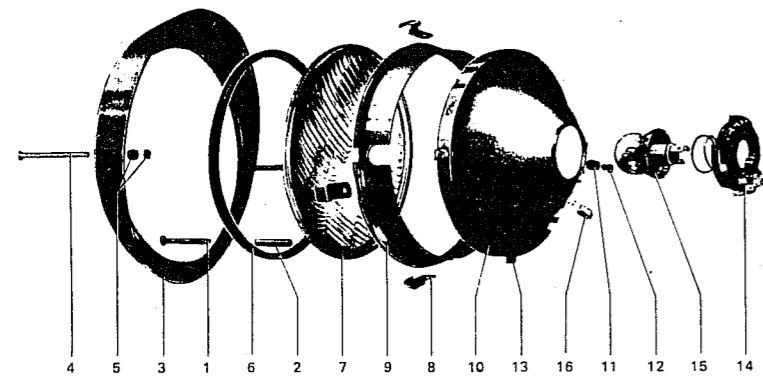
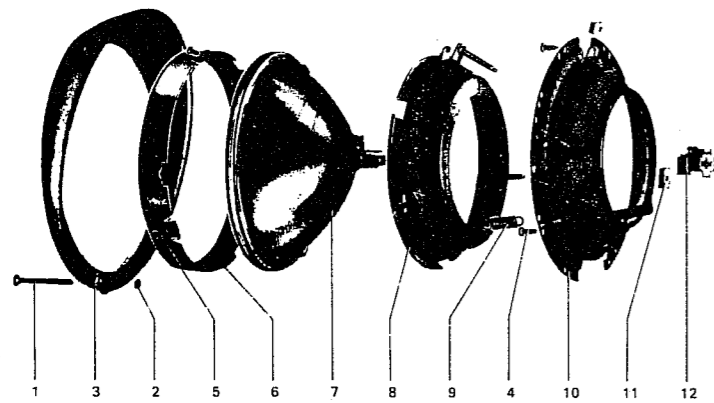


Fig. L.28. Detaching the connector block on sealed-beam units.



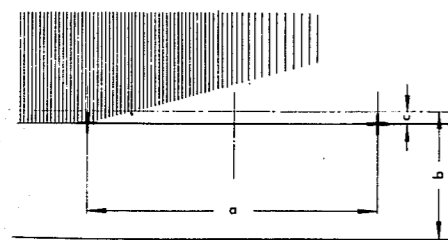
1. Securing screw
2. Spacer tube
3. Headlamp rim
4. Setting screw
5. Rubber bush
6. Lens seal ring
7. Lens
8. Retaining ring
9. Reflector retaining ring
10. Reflector
11. Rubber bush
12. Support
13. Rubber support for reflector
14. Cap
15. Headlamp
16. Pilot lamp bulb

Fig. L.29. Exploded view of the asymmetrical type headlight unit.



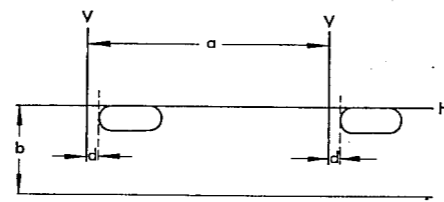
1. Securing screw
2. Rubber sealing ring
3. Bezel
4. Screw
5. Self-tapping screw
6. Retaining ring
7. Sealed-beam unit
8. Adjustable cradle
9. Spring
10. Retaining ring
11. Threaded plate
12. Terminal guide

Fig L.30. Exploded view of the sealed-beam type headlight unit.



- a. Distance between headlamp centres  
Type 1 — 41.1 in. (1044 mm.)  
Type 1 Karmann-Ghia — 48.8 in. (1240 mm.)  
Model 181 — 49.2 in. (1250 mm.)
- b. Headlamp centres from ground level  
c. 2.0 in. (50.8 mm.)

Fig. L.31. Headlight alignment diagram for asymmetrical type headlights.



- a. Distance between headlamp centres:  
(as for asymmetrical low beam lamps)
- b. Headlamp centre from ground level  
d. 2.0 in. (50.8 mm.)
- H. Horizontal line for centre of headlamps  
V. Vertical line for centre of headlamps

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

5. Unscrew the nut on the other terminal and take off the cable.
6. Remove the nut from the lower mounting stud.
7. Remove the nut from the upper engine mounting bolt on that side (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 unhooked from the operating lever. (Fig. L 17).

#### Installation

Check the following points :

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

#### HEADLAMPS

European Beetle Headlamps are of the pre-focus type employing a bulb whilst cars 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 rotated.

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

#### Installation

Ensure that the sealed beam unit is correctly positioned.

Ensure that the lug on the flange of the bulb engages with the slot in the reflector.

Do not attach the three pin connector block until the bulb is locked in position.

#### BRAKE LIGHTS

These lamps only operate when the ignition is switched on. Pressure sensitive switches in the brake master cylinder switch on one filament of the double filament brake / rear parking bulbs.

The brake light switch can be unscrewed if necessary after removing the driver's side front wheel. Place a finger over the hole as it is removed to prevent loss of brake fluid.

Remember — brake fluid strips paint!

Note — the brakes must be bled after replacing the switch.

#### HORN

The horn is situated under the left hand front wing. It may be removed after unscrewing the mounting bolt. The two push — on connectors are covered by rubber sleeves to prevent the ingress of water, but corrosion at these terminals is often a cause of the horn malfunctioning.

#### STEERING COLUMN SWITCH ASSEMBLY

Headlamp dipping and flashing and, on the latest models wiper / washer operation are controlled by levers on the steering column switch assembly.

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

#### FLASHER RELAY

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

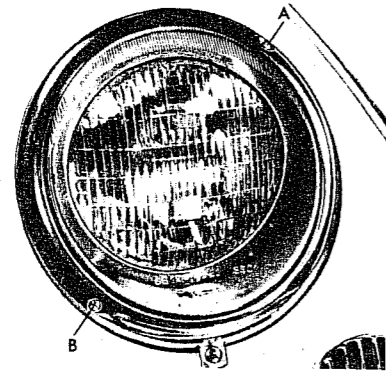
The relay cannot be serviced and if it proves defective it must be replaced.

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

#### SPEEDOMETER AND FUEL GAUGE

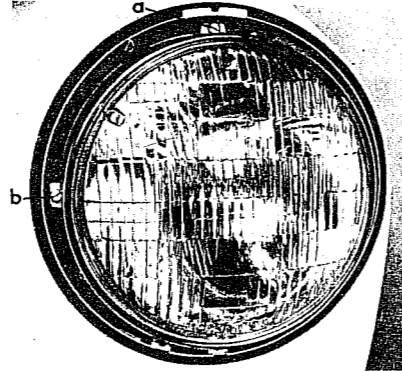
The combined speedometer / fuel gauge is attached to the instrument panel by two screws. Once these have been loosened, the unit can be retated slightly and then pulled out through the luggage compartment.

Faulty units should be exchanged.



- A. Vertical setting:  
Turn to left to raise, turn to right to lower
- B. Horizontal setting:  
Turn to right to move beam to left.  
Turn to left to move beam to right

Fig. L.33. Headlight adjusting screws - Beetle models.



- A. Vertical setting:  
Turn to right to raise beam  
Turn to left to lower beam
- B. Horizontal setting:  
Turn to right to move beam to right  
Turn to left to turn beam to left

Fig. L.34. Headlight adjusting screws - Karmann-Ghia models.

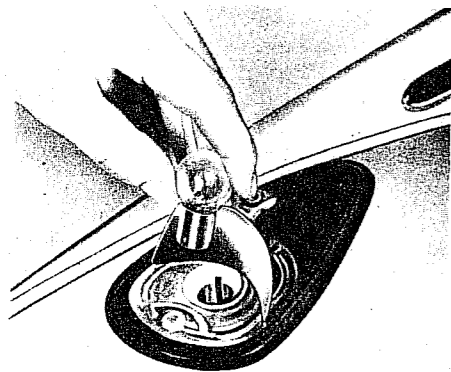
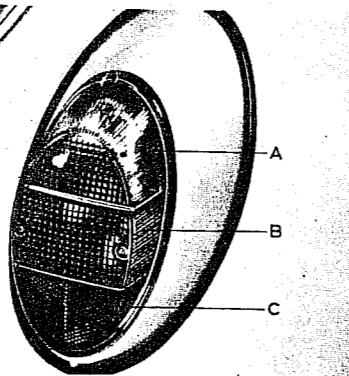
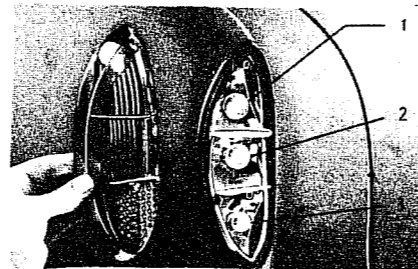


Fig. L.35. Removing the front direction indicator bulb.- Beetle models.



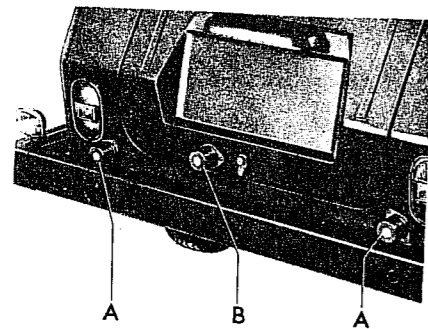
- A. Direction indicator
- B. Stop/tail light
- C. Reflector

Fig. L.36. Rear light unit - 1200 models.



- 1. Direction indicator bulb
- 2. Stop light bulb
- 3. Tail light bulb

Fig. L.37. Rear light unit - Karmann-Ghia models.



- A. Black-out tail lights
- B. Black-out brake lights

Fig. L.38. Black-out lights fitted to Type 181 models.

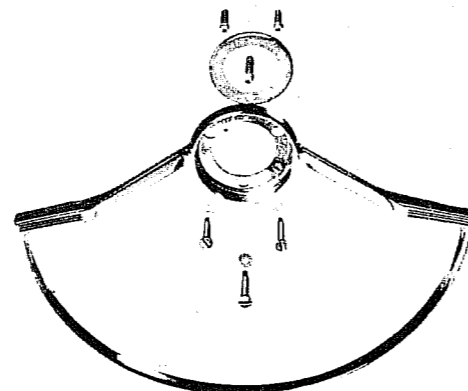


Fig. L.39. Horn ring mounting. Note springs and insulating washers.

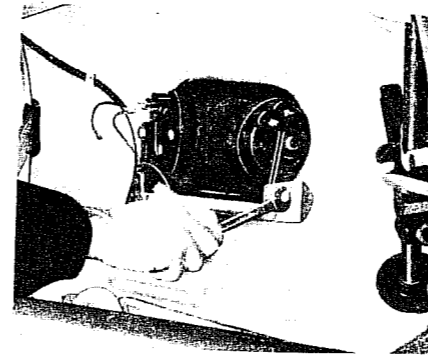


Fig. L.40. Removing the horns - Karmann-Ghia models.

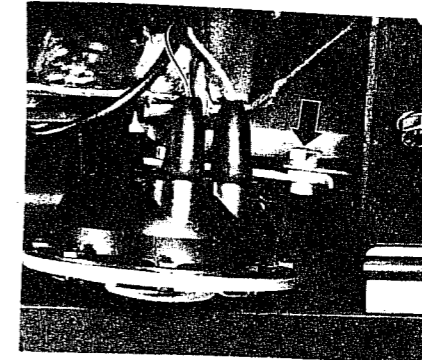


Fig. L.41. Horn mounting bolts - Type 181 models.

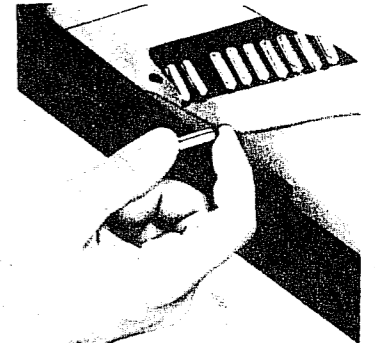


Fig. L.42. Fuse box location beneath the fascia panel.

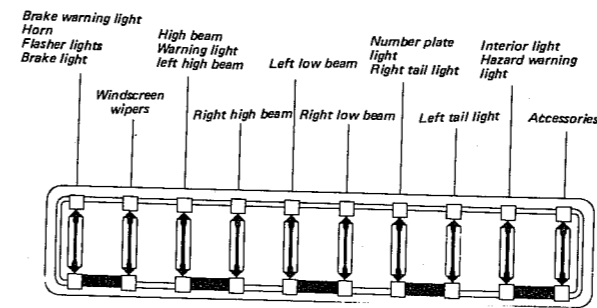
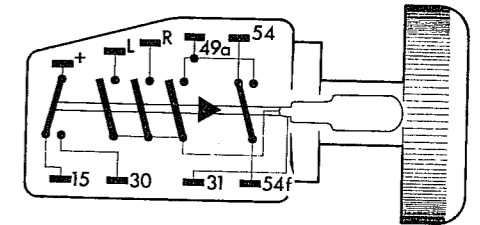
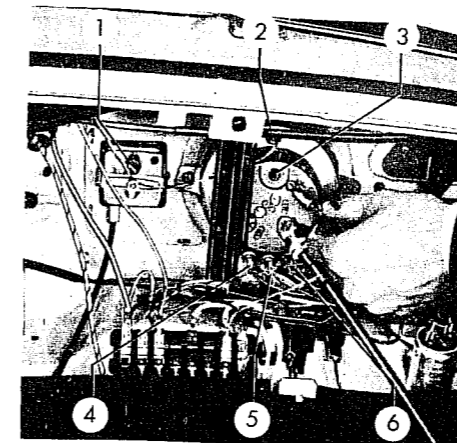


Fig. L.43. Arrangement of fuses in the fuse box.



- + to flasher relay terminal + or +49
- L to flasher switch and flasher lamps, left
- R to flasher switch and flasher lamps, right
- 49a to flasher switch and to hazard warning light relay terminal 49a
- 54 to brake (stop) light switch
- 54f to brake (stop) light terminal 54 (if used)
- 31 Earth cable
- 30 to fuse box terminal 30
- 15 to fuse box terminal 15

Fig. L.44. Hazard warning switch connections.



- 1. Fuel gauge light
- 2. Speedometer light
- 3. Driving beam warning light
- 4. Oil pressure warning light
- 5. Flasher warning light
- 6. Charging warning light

Fig. L.46. Bulb locations in the instrument panel.

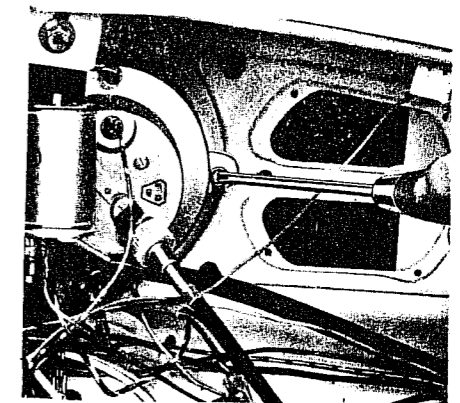


Fig. L.45. Removing the speedometer from the rear of the instrument panel.

## SPEEDOMETER CABLE

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

### Removal

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

### Installation

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

## 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	

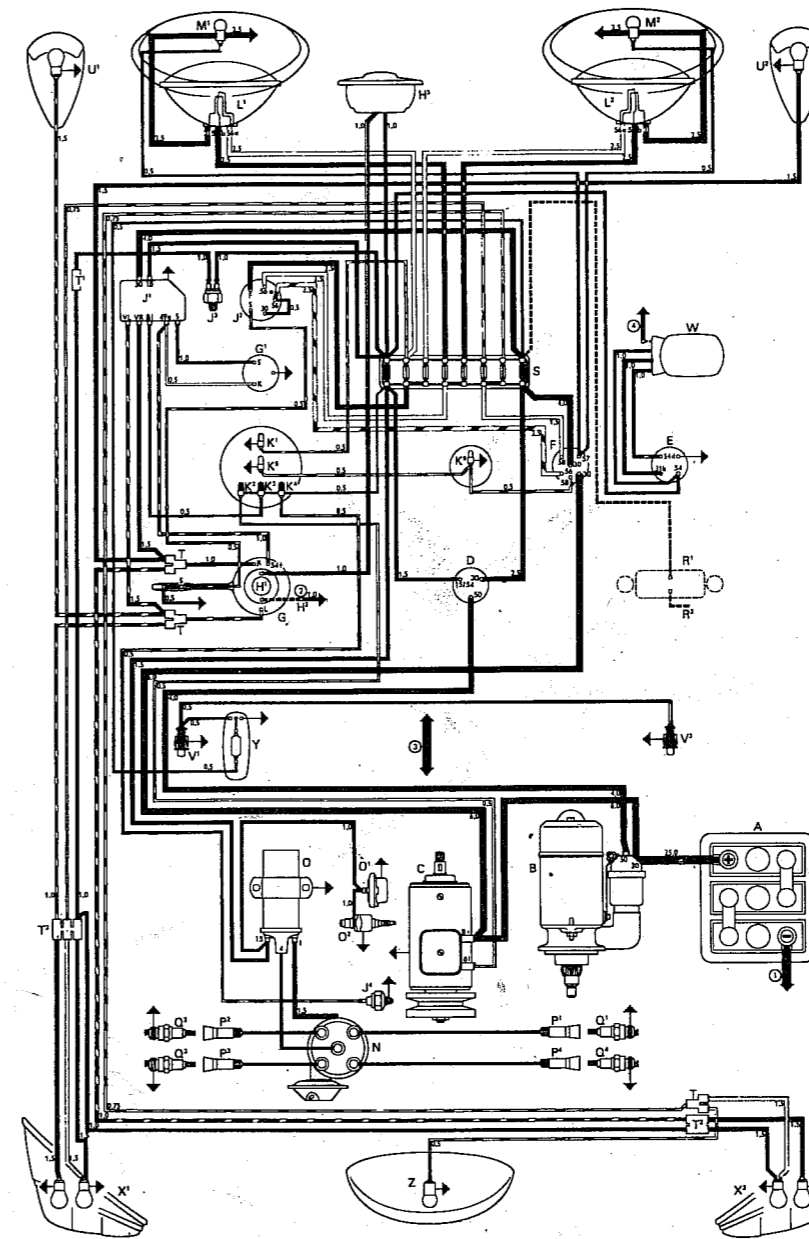
Charging system :		
	GENERATOR	REGULATOR
1200 (6V) . . . . .	111 903 021 H	111 903 801 F
	111 903 021 J	113 903 801 G
Basic versions (M 610) . . . . .	131 903 021	131 903 801
	211 903 031	211 903 803
US versions (M611) . . . . .	211 903 031	211 903 803
Police versions (M613) . . . . .	113 903 031 F	113 903 803 D
1300 & 1500 - early . . . . .	211 903 031 A	211 903 803 B
- late . . . . .	113 903 031 G	113 903 803 E
181 . . . . .	113 903 031 G	113 903 803 E
(Fully suppressed version) . . . . .	211 903 031 E	113 903 803 C
M52 - as from May 1968 . . . . .	111 903 021 K	111 903 801 D

Starter Motor :		
	TYPE	NOMINAL OUTPUT
1200 (6V) . . . . .	111 911 021E (Bosch)	0.5 BHP
	111 911 021F (VW)	0.5 BHP
1300, 1500, 1600 - from Aug. 1967 . . . . .	111 911 023A (VW)	0.7 BHP
	311 911 023B (Bosch)	0.7 BHP
- from Aug. 1969 . . . . .	311 911 023C (Bosch)	0.7 BHP
- from March 1970 . . . . .	311 911 023D (Bosch)	0.7 BHP
Automatic Trans. Models . . . . .	003 911 023A (Bosch)	0.8 BHP
181 . . . . .	003 911 023A (Bosch)	0.8 BHP

### BULB APPLICATION CHART :

Front :	
Headlights . . . . .	40/45 watts
Parking lights . . . . .	4 watts
Direction indicator lights . . . . .	21 watts
(where combined with parking light) . . . . .	21/5 watts
Rear :	
Stop / tail lights . . . . .	21/5 watts
Block-out stop / tail lights (type 181) . . . . .	2 watts
Direction indicator lights . . . . .	21 watts
License plate light (Beetle) . . . . .	10 watts
License plate light (Type 181) . . . . .	5 watts
License plate light (Karmann-Ghia) . . . . .	5 watts
Reversing lights . . . . .	25 watts
Rear fog light (Type 181) . . . . .	18 watts
Interior :	
Warning lights . . . . .	1.2 watts
Panel lights . . . . .	1.2 watts

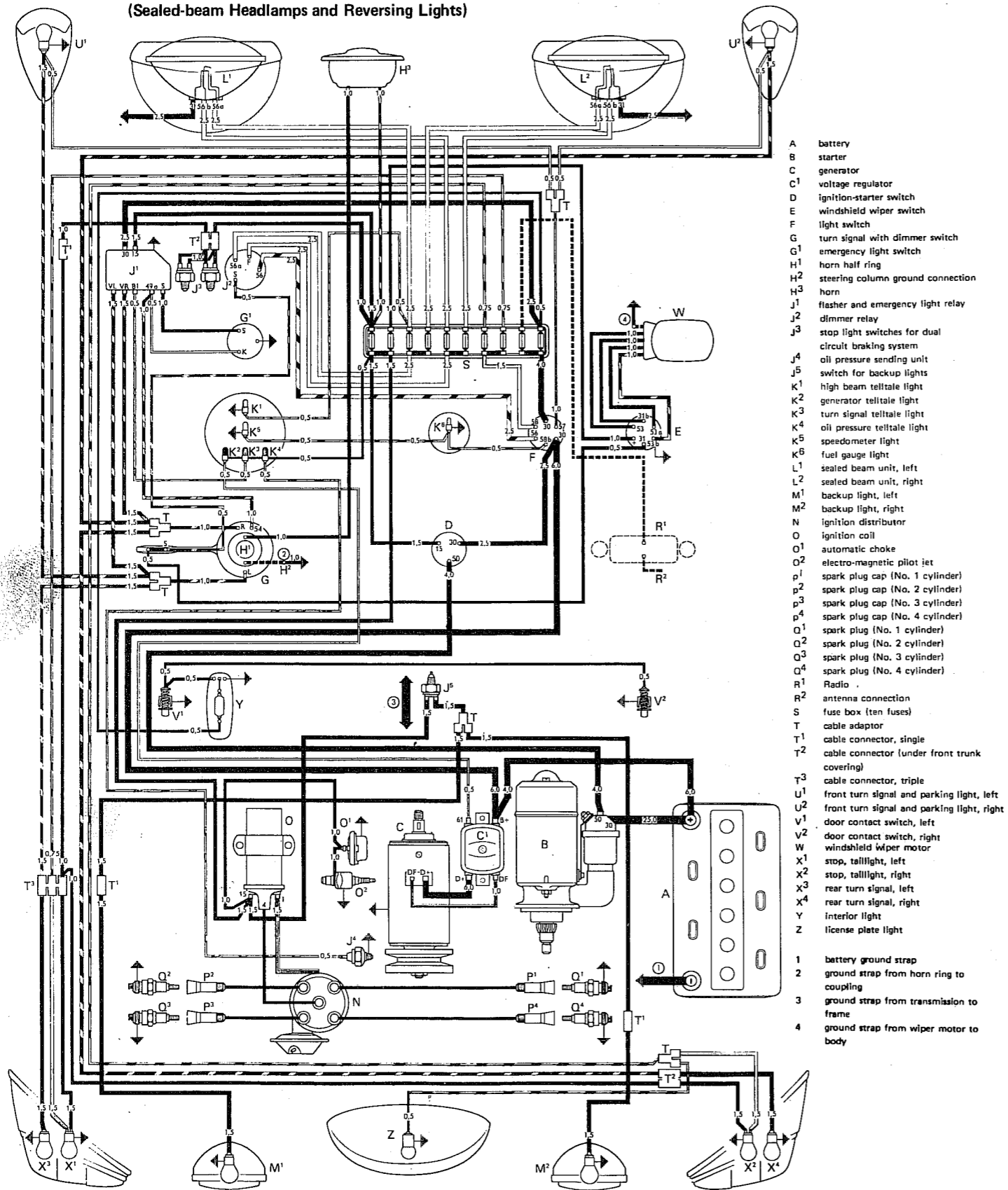
## WIRING DIAGRAM FOR SALOON MODELS WITH 6 VOLT SYSTEM (Sealed-beam Headlamps)



- A battery
- B starter
- C generator
- D ignition-starter switch
- E windshield wiper switch
- F light switch
- G turn signal with dimmer switch
- G1 emergency light switch
- H1 horn half ring
- H2 steering column ground connection
- H3 horn
- J1 flasher and emergency light relay
- J2 dimmer relay
- J3 stop light switch
- J4 oil pressure sending unit
- K1 high beam telltale light
- K2 generator telltale light
- K3 turn signal telltale light
- K4 oil pressure telltale light
- K5 speedometer light
- K6 fuel gauge light
- L1 sealed beam unit, left
- L2 sealed beam unit, right
- M1 parking light, left
- M2 parking light, right
- N ignition distributor
- O ignition coil
- O1 automatic choke
- O2 electro-magnetic pilot jet
- p1 spark plug cap (No. 1 cylinder)
- p2 spark plug cap (No. 2 cylinder)
- p3 spark plug cap (No. 3 cylinder)
- p4 spark plug cap (No. 4 cylinder)
- Q1 spark plug (No. 1 cylinder)
- Q2 spark plug (No. 2 cylinder)
- Q3 spark plug (No. 3 cylinder)
- Q4 spark plug (No. 4 cylinder)
- R1 radio
- R2 antenna connection
- S fuse box (white fuses: 8 Amp.; red fuses: 16 Amp.)
- T cable adaptor
- T1 cable connector, single
- T2 cable connector, double
- T3 cable connector, triple
- U1 front turn signal, left
- U2 front turn signal, right
- V1 door contact switch, left
- V2 door contact switch, right
- W windshield wiper motor
- X1 stop, turn signal and taillights, left
- X2 stop, turn signal and taillights, right
- Y interior light
- Z license plate light
- 1 battery ground strap
- 2 ground strap from horn ring to coupling
- 3 ground strap from transmission to frame
- 4 ground strap from wiper motor to body

VW 1200 and VW 1300 SALOON AND CONVERTIBLE MODELS

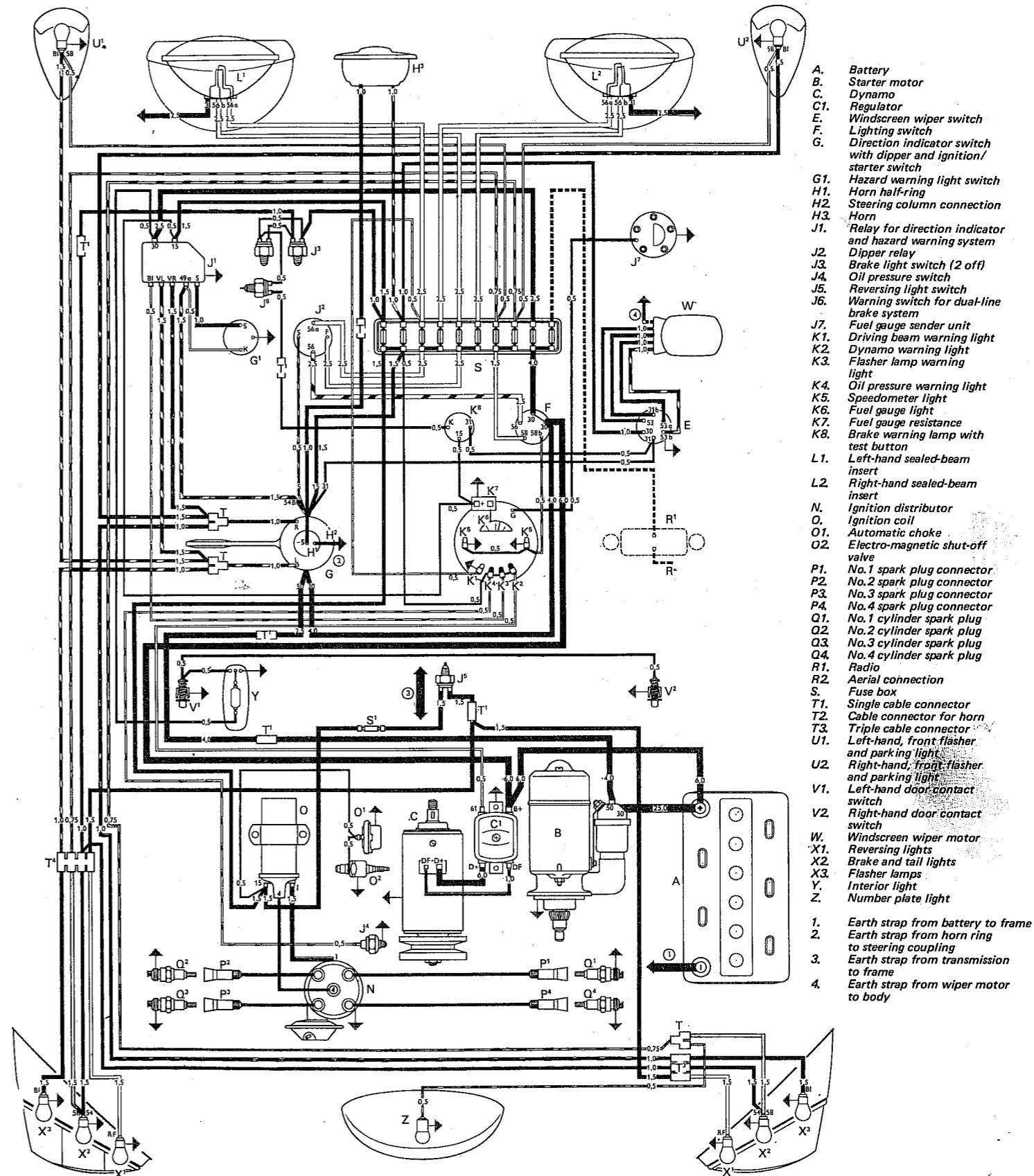
**WIRING DIAGRAM FOR SALOON MODELS WITH 12 VOLT SYSTEM  
(Sealed-beam Headlamps and Reversing Lights)**



- A battery
  - B starter
  - C generator
  - C1 voltage regulator
  - D ignition-starter switch
  - E windscreen wiper switch
  - F light switch
  - G turn signal with dimmer switch
  - G1 emergency light switch
  - H1 horn half ring
  - H2 steering column ground connection
  - H3 horn
  - J1 flasher and emergency light relay
  - J2 dimmer relay
  - J3 stop light switches for dual circuit braking system
  - J4 oil pressure sending unit switch for backup lights
  - J5 switch for backup lights
  - K1 high beam telltale light
  - K2 generator telltale light
  - K3 turn signal telltale light
  - K4 oil pressure telltale light
  - K5 speedometer light
  - K6 fuel gauge light
  - L1 sealed beam unit, left
  - L2 sealed beam unit, right
  - M1 backup light, left
  - M2 backup light, right
  - N ignition distributor
  - O ignition coil
  - O1 automatic choke
  - O2 electro-magnetic pilot jet
  - P1 spark plug cap (No. 1 cylinder)
  - P2 spark plug cap (No. 2 cylinder)
  - P3 spark plug cap (No. 3 cylinder)
  - P4 spark plug cap (No. 4 cylinder)
  - Q1 spark plug (No. 1 cylinder)
  - Q2 spark plug (No. 2 cylinder)
  - Q3 spark plug (No. 3 cylinder)
  - Q4 spark plug (No. 4 cylinder)
  - R1 Radio
  - R2 antenna connection
  - S fuse box (ten fuses)
  - T cable adaptor
  - T1 cable connector, single
  - T2 cable connector (under front trunk covering)
  - T3 cable connector, triple
  - U1 front turn signal and parking light, left
  - U2 front turn signal and parking light, right
  - V1 door contact switch, left
  - V2 door contact switch, right
  - W windscreen wiper motor
  - X1 stop, tallight, left
  - X2 stop, tallight, right
  - X3 rear turn signal, left
  - X4 rear turn signal, right
  - Y interior light
  - Z license plate light
- 1 battery ground strap
  - 2 ground strap from horn ring to coupling
  - 3 ground strap from transmission to frame
  - 4 ground strap from wiper motor to body

**VW 1500 SALOON AND CONVERTIBLE MODELS**

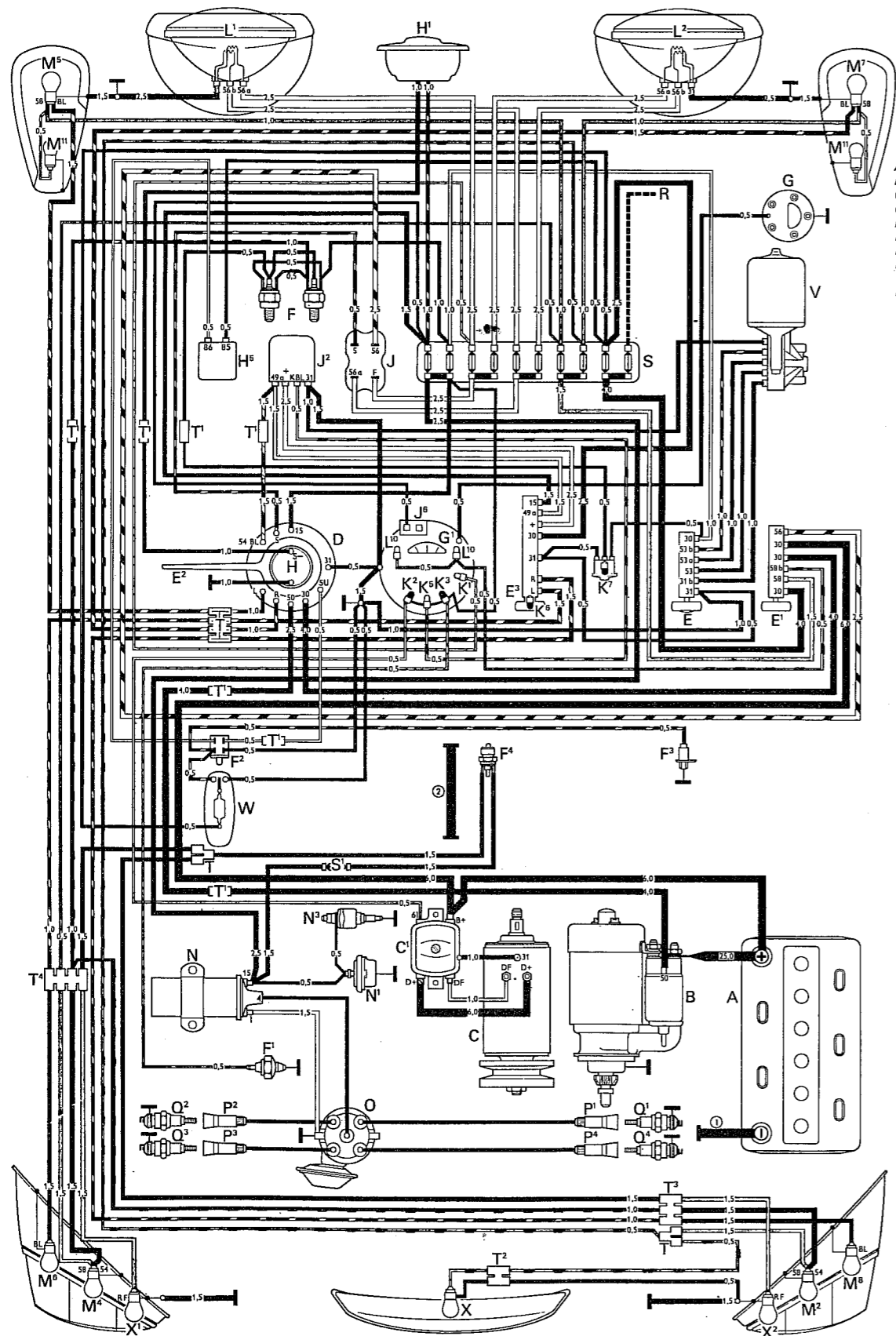
**WIRING DIAGRAM FOR VW 1500 SALOON AND CONVERTIBLE  
MODELS WITH 12 VOLT SYSTEM (U.S.A.)**



- A Battery
  - B Starter motor
  - C Dynamo
  - C1 Regulator
  - F Lighting switch
  - G Direction indicator switch with dipper and ignition/starter switch
  - G1 Hazard warning light switch
  - H1 Horn half-ring
  - H2 Steering column connection
  - H3 Horn
  - J1 Relay for direction indicator and hazard warning system
  - J2 Dipper relay
  - J3 Brake light switch (2 off)
  - J4 Oil pressure switch
  - J5 Reversing light switch
  - J6 Warning switch for dual-line brake system
  - J7 Fuel gauge sender unit
  - K1 Driving beam warning light
  - K2 Dynamo warning light
  - K3 Flasher lamp warning light
  - K4 Oil pressure warning light
  - K5 Speedometer light
  - K6 Fuel gauge light
  - K7 Fuel gauge resistance
  - K8 Brake warning lamp with test button
  - L1 Left-hand sealed-beam insert
  - L2 Right-hand sealed-beam insert
  - N Ignition distributor
  - O Ignition coil
  - O1 Automatic choke
  - O2 Electro-magnetic shut-off valve
  - P1 No.1 spark plug connector
  - P2 No.2 spark plug connector
  - P3 No.3 spark plug connector
  - P4 No.4 spark plug connector
  - Q1 No.1 cylinder spark plug
  - Q2 No.2 cylinder spark plug
  - Q3 No.3 cylinder spark plug
  - Q4 No.4 cylinder spark plug
  - R1 Radio
  - R2 Aerial connection
  - S Fuse box
  - T2 Cable connector for horn
  - T3 Triple cable connector
  - U1 Left-hand, front flasher and parking light
  - U2 Right-hand, front flasher and parking light
  - V1 Left-hand door contact switch
  - V2 Right-hand door contact switch
  - W Windscreen wiper motor
  - X1 Reversing lights
  - X2 Brake and tail lights
  - X3 Flasher lamps
  - Y Interior light
  - Z Number plate light
- 1 Earth strap from battery to frame
  - 2 Earth strap from horn ring to steering coupling
  - 3 Earth strap from transmission to frame
  - 4 Earth strap from wiper motor to body



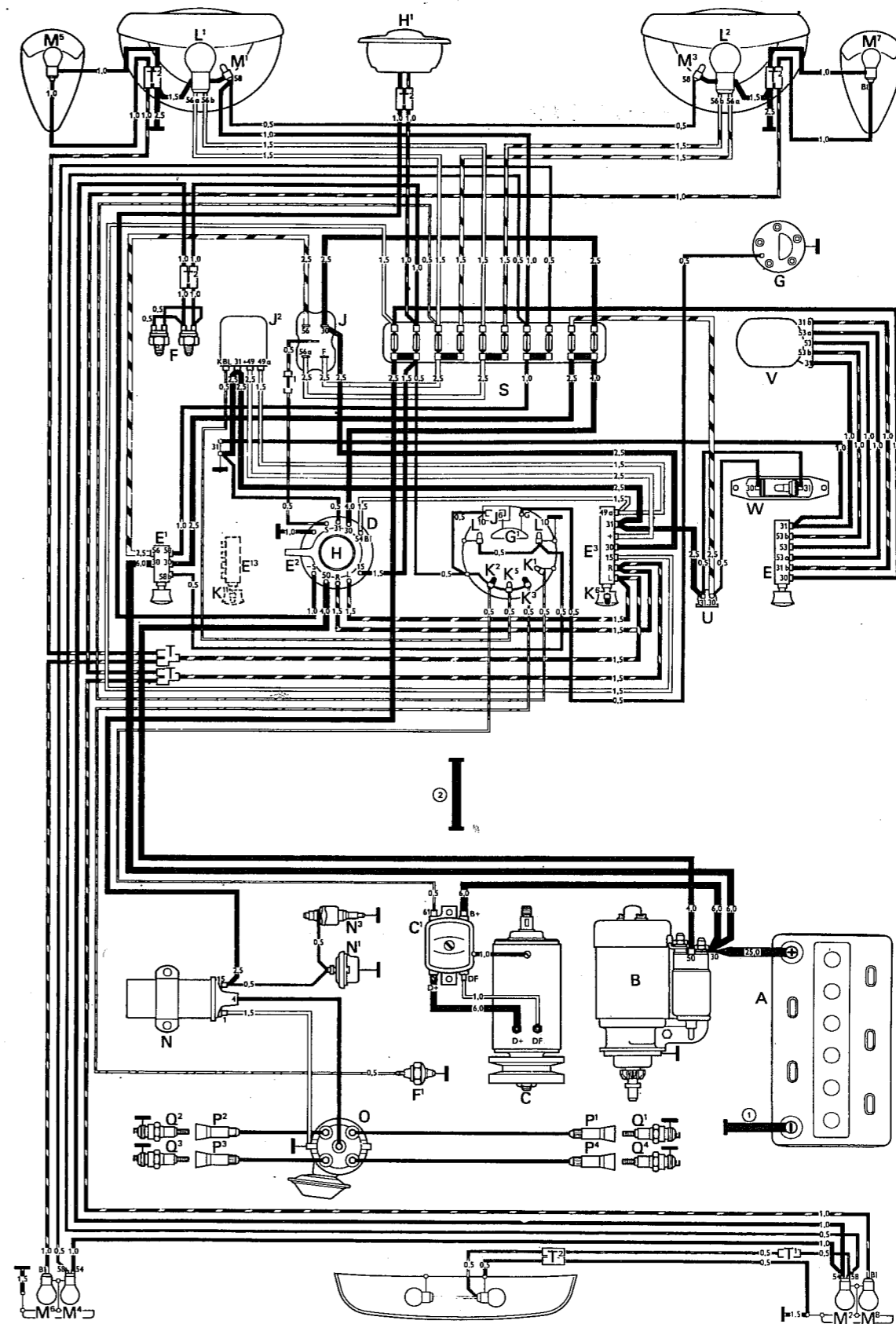
WIRING DIAGRAM FOR Type 1/1600 - From August 1969



- A. Battery
- B. Starter motor
- C. Dynamo
- D. Regulator
- E. Ignition/starter lock
- F. Windscreen wiper switch
- E1. Lighting switch
- E2. Direction indicator switch with switch for dipped lights
- E3. Hazard warning light switch
- F. Brake light switch with warning switch
- F1. Oil pressure switch
- F2. Door contact switch with ignition key warning device buzzer
- F3. Door contact switch, right
- F4. Reversing light switch
- G. Fuel gauge sender unit
- G1. Fuel gauge
- H. Horn half-ring
- H5. Buzzer for ignition key warning device
- J. Hand dip switch relay
- J2. Hazard warning light relay
- J6. Fuel gauge vibrator
- K1. Driving beam warning light
- K2. Dynamo charging warning light
- K3. Oil pressure warning light
- K5. Flasher lamp warning light
- K6. Warning lamp for hazard warning system
- K7. Dual circuit brake system warning light
- L1. Left-hand sealed beam insert
- L2. Right-hand sealed beam insert
- L10. Instrument panel light
- M2. Right-hand tail/brake light
- M4. Left-hand tail/brake light
- M5. Left-hand, front flasher and parking light
- M6. Left-hand, rear flasher light
- M7. Right-hand, front flasher and parking light
- M8. Right-hand, rear flasher light
- M11. Front side marker light
- N. Ignition coil
- N1. Automatic choke
- N3. Electro-magnetic shut-off valve
- O. Ignition distributor
- P1. No.1 spark plug connector
- P2. No.2 spark plug connector
- P3. No.3 spark plug connector
- P4. No.4 spark plug connector
- Q1. No.1 cylinder spark plug
- Q2. No.2 cylinder spark plug
- Q3. No.3 cylinder spark plug
- Q4. No.4 cylinder spark plug
- R. Radio
- S. Fuse box
- S1. Reversing light fuse
- T. Cable adaptor
- T1. Single cable adaptor
- T2. Double cable adaptor
- T3. Triple cable adaptor
- T4. Quadruple cable adaptor
- V. Windscreen wiper motor
- W. Interior light
- X. Number plate light
- X1. Left-hand reversing light
- X2. Right-hand reversing light

1. Earth strap from battery to frame
2. Earth strap from transmission to frame

WIRING DIAGRAM FOR VW MODEL 181 - From 1969



- A. Battery
- B. Starter motor
- C. Dynamo
- D. Regulator
- E. Ignition/starter switch
- F. Windscreen wiper switch
- E1. Lighting switch
- E2. Direction indicator switch and switch for dipped lights and headlamp flasher
- E3. Hazard warning light switch
- E3. Heater booster switch
- F. Brake light switch
- F1. Oil pressure switch
- G. Fuel gauge sender unit
- G1. Fuel gauge
- H. Horn button
- H1. Horn
- J. Relay for dipped lights and headlamp flasher
- J2. Hazard warning light relay
- J6. Fuel gauge vibrator
- K1. High beam warning light
- K2. Dynamo charging warning light
- K3. Oil pressure warning light
- K5. Direction indicator warning light
- K6. Hazard warning light warning lamp
- K11. Heater booster warning light
- L1. Left-hand headlamp bulb
- L2. Right-hand headlamp bulb
- L10. Instrument panel light
- M1. Left-hand parking light
- M2. Right-hand parking light
- M3. Right-hand tail/brake light
- M4. Left-hand tail/brake light
- M5. Left-hand, front flasher lamp
- M6. Left-hand, rear flasher lamp
- M7. Right-hand, front flasher lamp
- M8. Right-hand, rear flasher lamp
- N. Ignition coil
- N1. Automatic choke
- N3. Electro-magnetic cut-off valve
- O. Ignition distributor
- P1. No.1 spark plug connector
- P2. No.2 spark plug connector
- P3. No.3 spark plug connector
- P4. No.4 spark plug connector
- Q1. No.1 cylinder spark plug
- Q2. No.2 cylinder spark plug
- Q3. No.3 cylinder spark plug
- Q4. No.4 cylinder spark plug
- S. Fuse box
- T. Cable adaptor
- T1. Single cable connector
- T2. Double cable connector
- U. Socket
- V. Windscreen wiper motor
- W. Map reading light
- X. Number plate light

# Trouble Shooting

## Engine

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v
ENGINE WILL NOT CRANK	*	*	*	*																		
ENGINE CRANKS SLOWLY	*	*	*																			
ENGINE CRANKS BUT DOES NOT START				*	*	*	*						*									
ENGINE STARTS BUT RUNS FOR SHORT PERIODS ONLY				*	*			*	*													
ENGINE MISFIRES AT LOW SPEED				*	*			*		*		*										
ENGINE MISFIRES AT HIGH SPEED				*	*						*	*										*
ENGINE MISFIRES AT ALL SPEEDS				*	*	*				*	*	*	*	*								*
ENGINE MISFIRES 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																			*	*	*	*
PINKING			*	*																		*
COMPRESSION LEAK				*				*	*	*	*	*	*	*	*	*						*

### PROBABLE CAUSE

- Fault in the starting system — Refer to the ELECTRICAL EQUIPMENT section for diagnosis.
- Engine oil too thick.
- Stiff engine.
- Mechanical seizure.
- Fault in the ignition system — Refer to the IGNITION SYSTEM section for diagnosis.
- Fault in the fuel system — Refer to the FUEL SYSTEM section for diagnosis.
- Incorrect valve timing.
- Compression leak.
- Air leak at inlet manifold.
- Restriction in exhaust system.
- Poor valve seating.
- Sticking valves.
- Leaking cylinder head gasket.
- Worn camshaft lobes.
- Incorrect tappet clearance.
- Worn or damaged cylinder bores, pistons and/or piston rings.
- Worn valve guides.
- Damaged valve stem seals.
- Leaking oil seal or gasket.
- Incorrectly installed spark plug.
- Cracked cylinder.
- Broken or weak valve springs.

### REMEDIES

- Drain oil and replace with correct oil.
- Add small quantity of oil to the fuel and run engine gently.
- Strip engine and renew parts as necessary.
- Retime engine.
- Trace and seal.
- Trace and seal.
- Remove restriction.
- Regrind seats.
- Free and trace cause.
- Renew gasket.
- Fit new camshaft.
- Adjust tappets.
- Exchange engine.
- Replace valve guides.
- Replace seals.
- Replace gasket.
- Replace plug with correct one.
- Renew cylinder block.
- Replace springs.

# Trouble Shooting

## Lubrication System

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n
EXCESSIVE OIL CONSUMPTION	*	*	*	*										*
LOW OIL PRESSURE				*	*	*	*	*	*	*	*	*	*	*

### PROBABLE CAUSE

- Worn or damaged cylinder bores, pistons and/or piston rings.
- Worn valve guides.
- Damaged valve stem seals.
- Leaking oil seal or gasket.
- Faulty oil pressure gauge, switch or wiring.
- Relief valve defective.
- Oil pick-up pipe strainer blocked.
- Oil filter over-flow valve defective.
- Worn oil pump.
- Damaged or worn main and/or big-end bearings.
- Incorrect grade of engine oil.
- Oil level low.
- Oil level too high.
- Oil leak or the pressurised side of the lubrication system.

### REMEDIES

- Regrind cylinder bores and fit new oversize pistons and rings.
- Replace valves and guides.
- Replace seals.
- Seal leak or replace gasket.
- Trace and rectify.
- Check and replace if necessary.
- Remove blockage.
- Check and replace if necessary.
- Replace pump or parts.
- Renew bearings.
- Replace oil with correct grade.
- Top up oil.
- Drain off surplus oil.
- Trace and remedy.

## Cooling System

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
OVERHEATING	*	*					*	*	*	*	*	*	*	*	*
ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE															

### PROBABLE CAUSE

- Insufficient coolant.
- Drive belt slipping or broken.
- Radiator fins clogged.
- Cooling fan defective.
- Water pump defective.
- Thermostat jammed shut.
- Thermostat jammed open.
- Ignition timing too far retarded.
- Excessive vehicle load or dragging brakes.
- Internal passage in the engine and/or radiator blocked.
- Hoses blocked.
- Carburettor mal-adjustment.
- Excessive carbon deposit in the cylinders.
- Insufficient engine oil or use of inferior grade of oil.
- Excessive radiator area.

### REMEDIES

- Top up radiator.
- Tighten belt or renew.
- Unclog fins.
- Trace fault, rectify or renew.
- Replace water pump.
- Replace thermostat.
- Replace thermostat.
- Retime ignition.
- Unload car, check brakes.
- Trace and clear.
- Trace clear blockage.
- Adjust correctly.
- Decarbonise engine, top overhaul.
- Top up with correct grade. Drain if necessary.
- Partially blank off in winter only.

# Trouble Shooting

## Ignition System

	SYMPTOMS																	
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
ENGINE CRANKS BUT DOES NOT START	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*
ENGINE STARTS BUT RUNS FOR SHORT PERIODS ONLY	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES AT LOW SPEED	*				*	*	*											
ENGINE MISFIRES AT HIGH SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES AT ALL SPEEDS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES ON ACCELERATION AND FAILS TO REV.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ROUGH IDLE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE RUNS ROUGH AT HIGH SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LACK OF POWER	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
POOR ACCELERATION	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LACK OF TOP SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
EXCESSIVE FUEL CONSUMPTION	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
PINKING	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

### PROBABLE CAUSE

- Battery discharged or defective.
- Contact breaker points need cleaning or renewing.
- Incorrect contact breaker points.
- Contact breaker spring weak.
- Spark plugs need cleaning or renewing.
- Incorrect spark plug gaps.
- Wrong type of spark plug fitted.
- Static ignition timing incorrect.
- Coil or capacitor defective.
- Open circuit or loose connection in the L.T. circuit.
- Open circuit, short to earth or loose connection on the coil H.T. lead.
- Open circuit, short to earth or loose connection on the spark plug leads.
- Plug leads incorrectly connected.
- H.T. leak on coil, distributor cap or rotor, due to oil, dirt, moisture or damage.
- Centrifugal advance not functioning correctly.
- Vacuum advance not functioning correctly.
- Worn distributor cam or distributor shaft bush.
- Using wrong grade of fuel.

### REMEDIES

- Recharge or replace battery.
- Clean or renew.
- Fit correct points.
- Renew contact breaker set.
- Clean or renew plugs.
- Adjust gaps.
- Fit correct plugs.
- Retime ignition.
- Replace as necessary.
- Trace and rectify.
- Trace and rectify.
- Trace and rectify.
- Connect correctly.
- Clean with dry lint free rag.
- Examine and oil sparingly.
- Check and rectify.
- Replace defective parts.
- Change to correct grade of fuel.

# Trouble Shooting

## Fuel System

### SYMPTOMS

	SYMPTOMS																					
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v
ENGINE CRANKS BUT DOES NOT START	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE STARTS BUT RUNS FOR SHORT PERIODS ONLY	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES AT LOW SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES AT HIGH SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES AT ALL SPEEDS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE MISFIRES ON ACCELERATION AND FAILS TO REV.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ROUGH IDLE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ENGINE RUNS ROUGH AT HIGH SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LACK OF POWER	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
POOR ACCELERATION	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LACK OF TOP SPEED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
EXCESSIVE FUEL CONSUMPTION	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
PINKING	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BACKFIRE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

### PROBABLE CAUSE

- Fuel tank empty.
- Fuel line blocked.
- Fuel pump defective.
- Blockage in carburetter.
- Air lock in fuel line.
- Fuel filter blocked.
- Carburetter needle valve jammed.
- Water in carburetter.
- Erratic fuel flow due to blockage.
- Idling speed too low.
- Incorrect setting of choke control.
- Incorrect carburetter fuel/float level.
- Carburetter icing.
- Air leak at inlet manifold.
- Incorrect grade of fuel.
- Carburetter accelerator pump defective.
- Throttle linkage mal-adjusted.
- Incorrect adjustment of idling mixture.
- Air filter clogged.
- Incorrect ignition timing.
- Carburetter piston sticking.
- Wrong carburetter jets fitted.

### REMEDIES

- Fill tank.
- Blow out obstruction with compressed air.
- Replace pump.
- Remove blockage.
- Trace and bleed out.
- Clean filter.
- Free needle.
- Drain out water, dry out.
- Remove blockage.
- Adjust throttle stop screw.
- Reset control.
- Adjust level.
- Wait for ice to melt. If persistent, trace cause.
- Trace leak and seal.
- Dilute fuel with highest octane rating obtainable.
- Trace fault and rectify.
- Adjust correctly.
- Adjust mixture control.
- Clean filter.
- Retime ignition.
- Oil carburetter.
- Replace with correct jets.

# Trouble Shooting

## Clutch

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
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 - CHATTER ON ENGAGEMENT								*									*	

### PROBABLE CAUSE

- Insufficient free-play in release linkage.
- Clutch disc facing worn or hardened.
- Grease or oil on clutch disc facing.
- Weak or broken pressure plate coil springs or diaphragm spring.
- Air in hydraulic system.
- Insufficient free-travel at clutch pedal.
- Excessive free-play in release linkage.
- Misalignment of clutch housing.
- Clutch disc hub binding on splines of gearbox input shaft.
- Clutch disc facing loose or broken.
- Pressure plate mating surface warped.
- Clutch cover distorted.
- Looseness in transmission or suspension.
- Clutch disc distorted.
- Loose drive plate hub.
- Release bearing defective.
- Release arm bent.
- Low hydraulic fluid level.

### REMEDIES

- Adjust linkage.
- Replace clutch disc.
- Clean and remedy cause.
- Renew springs.
- Bleed system.
- Adjust travel.
- Adjust or renew worn parts.
- Realign housing.
- Remove cause of binding.
- Replace clutch disc.
- Fit new parts.
- Replace cover.
- Take up play.
- Renew disc.
- Replace hub.
- Renew bearing.
- Straighten or renew.
- Top up hydraulic fluid.

## Steering

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
STEERING STIFFNESS	*	*	*	*	*	*													
STEERING SLACK				*		*	*	*	*	*	*								
STEERING WANDER	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
WHEEL SHIMMY		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CAR PULLS 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 column bearings too tight or column bent or misaligned.
- Steering linkage joints worn or loose.
- Front wheel bearings worn or incorrectly adjusted.
- Slackness in front suspension.
- Road wheel nuts loose.
- Steering wheel loose.
- Steering gear mounting bolts loose.
- Steering gear worn.
- Shock absorbers defective or mountings loose.
- Road wheels imbalanced or tyres unevenly worn.
- Suspension springs weak or broken.
- Brakes pulling on one side.
- Chassis frame or suspension misaligned.
- Improper driving.

### REMEDIES

- Inflate and balance tyres.
- Inject lubricant.
- Lubricate.
- Check steering geometry.
- Adjust correctly.
- Adjust/renew defective parts.
- Tighten or replace joints.
- Adjust or renew bearings.
- Tighten to correct torque.
- Tighten nuts to correct torque.
- Tighten to correct torque.
- Tighten to correct torque.
- Replace worn parts.
- Replace with new.
- Balance wheels.
- Renew springs.
- Balance brakes.
- Realign.
- Arrange tuition on driving.

# Trouble Shooting

## Braking System

### SYMPTOMS

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w
BRAKE FAILURE		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRAKES INEFFECTIVE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRAKES GRAB OR PULL TO ONE SIDE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRAKES BIND				*									*	*	*	*	*	*	*	*	*	*	
PEDAL SPONGY				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
PEDAL TRAVEL EXCESSIVE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
EXCESSIVE PEDAL PRESSURE REQUIRED	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
HYDRAULIC SYSTEM WILL NOT MAINTAIN PRESSURE								*	*											*	*		*
BRAKE SQUEAL DEVELOPS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRAKE SHUDDER DEVELOPS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
HANDBRAKE 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 discs scored.
- Incorrect brake fluid.
- 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 tyre pressures.
- Brake disc or drum distorted or cracked.
- Brake back plate or calliper mounting bolts loose or looseness in the suspension.
- Wheel bearings incorrectly adjusted.
- Weak, broken or improperly installed shoe return springs.
- Uneven brake lining contact.
- Incorrect brake lining adjustment.
- Pistons in wheel cylinder or calliper seized.
- Weak or broken brake pedal return spring.
- Master cylinder defective.
- Fluid reservoir overfilled or reservoir air vent restricted.
- Servo vacuum hose disconnected or restricted, or servo unit defective.
- Wheel cylinder or calliper defective.

### REMEDIES

- Replace linings or pads.
- Replace with correct linings or pads.
- Clean thoroughly.
- Renew drums or discs.
- Bleed out old fluid and replace with correct type.
- Top up reservoir.
- Bleed brake system.
- Trace and seal.
- Trace and clear blockage.
- Correct as necessary.
- Adjust and balance tyre pressures.
- Renew disc or drum.
- Tighten as necessary to correct torque.
- Adjust wheel bearings.
- Renew or install correctly.
- Trace cause and remedy.
- Adjust correctly.
- Free and clean.
- Renew spring.
- Replace master cylinder and seals.
- Lower fluid level. Clear air vent.
- Check and replace hose. Renew servo unit if defective.
- Replace as necessary.







CONVERSION TABLE

mm	ins	mm	ins	mm	ins	mm	ins	mm	ins
.01	.000394	.51	.020079	1	.030370	51	2.007870	105	4.133848
.02	.000787	.52	.020472	2	.078740	52	2.047240	110	4.330700
.03	.001181	.53	.020866	3	.118110	53	2.086610	115	4.527550
.04	.001575	.54	.021260	4	.157480	54	2.125980	120	4.724400
.05	.001969	.55	.021654	5	.196850	55	2.165350	125	4.921250
.06	.002362	.56	.022047	6	.236220	56	2.204720	130	5.118110
.07	.002756	.57	.022441	7	.275590	57	2.244090	135	5.314950
.08	.003150	.58	.022835	8	.314960	58	2.283460	140	5.511800
.09	.003543	.59	.023228	9	.354330	59	2.322830	145	5.708650
.10	.003937	.60	.023622	10	.393700	60	2.362200	150	5.905500
.11	.004331	.61	.024016	11	.433070	61	2.401570	155	6.102350
.12	.004724	.62	.024409	12	.472440	62	2.440940	160	6.299200
.13	.005118	.63	.024803	13	.511810	63	2.480310	165	6.496050
.14	.005512	.64	.025197	14	.551180	64	2.519680	170	6.692900
.15	.005906	.65	.025591	15	.590550	65	2.559050	175	6.889750
.16	.006299	.66	.025984	16	.629920	66	2.598420	180	7.086600
.17	.006693	.67	.026378	17	.669290	67	2.637790	185	7.283450
.18	.007087	.68	.026772	18	.708660	68	2.677160	190	7.480300
.19	.007480	.69	.027165	19	.748030	69	2.716530	195	7.677150
.20	.007874	.70	.027559	20	.787400	70	2.755900	200	7.874000
.21	.008268	.71	.027953	21	.826770	71	2.795270	210	8.267700
.22	.008661	.72	.028346	22	.866140	72	2.834640	220	8.661400
.23	.009005	.73	.028740	23	.905510	73	2.874010	230	9.055100
.24	.009449	.74	.029134	24	.944880	74	2.913380	240	9.448800
.25	.009843	.75	.029528	25	.984250	75	2.952750	250	9.842600
.26	.010236	.76	.029921	26	1.023620	76	2.992120	260	10.236200
.27	.010630	.77	.030315	27	1.062990	77	3.031490	270	10.629900
.28	.011024	.78	.030709	28	1.102360	78	3.070860	280	11.023600
.29	.011417	.79	.031103	29	1.141730	79	3.110230	290	11.417300
.30	.011811	.80	.031496	30	1.181100	80	3.149600	300	11.811000
.31	.012205	.81	.031890	31	1.220470	81	3.188970	310	12.204700
.32	.012598	.82	.032283	32	1.259840	82	3.228340	320	12.598400
.33	.012992	.83	.032677	33	1.299210	83	3.267710	330	12.992100
.34	.013386	.84	.033071	34	1.338580	84	3.307080	340	13.385800
.35	.013780	.85	.033465	35	1.377949	85	3.346450	350	13.779500
.36	.014173	.86	.033858	36	1.417319	86	3.385820	360	14.173200
.37	.014567	.87	.034252	37	1.456689	87	3.425190	370	14.566900
.38	.014961	.88	.034646	38	1.496050	88	3.464560	380	14.960600
.39	.015354	.89	.035039	39	1.535430	89	3.503930	390	15.354300
.40	.015748	.90	.035433	40	1.574800	90	3.543300	400	15.748000
.41	.016142	.91	.035827	41	1.614170	91	3.582670	500	19.685000
.42	.016535	.92	.036220	42	1.653540	92	3.622040	600	23.622000
.43	.016929	.93	.036614	43	1.692910	93	3.661410	700	27.559000
.44	.017323	.94	.037008	44	1.732280	94	3.700780	800	31.496000
.45	.017717	.95	.037402	45	1.771650	95	3.740150	900	35.433000
.46	.018110	.96	.037795	46	1.811020	96	3.779520	1000	39.370000
.47	.018504	.97	.038189	47	1.850390	97	3.818890	2000	78.740000
.48	.018898	.98	.038583	48	1.889760	98	3.858260	3000	118.110000
.49	.019291	.99	.038976	49	1.929130	99	3.897630	4000	157.380000
.50	.019685	1 mm	.039370	50	1.968500	100	3.937000	5000	196.850000