Removing and Installing Cylinders

32 EN

Special Tools: **P 8a Piston ring compressor 82.5 mm (3¼ in.) dia.**
P 18 Spacer tubes for holding cylinders to crankcase

Removal

1. Remove cylinder head (23 EN).

2. Remove and number push rods. Remove push rod tubes.

3. Remove and number cylinders I through IV.

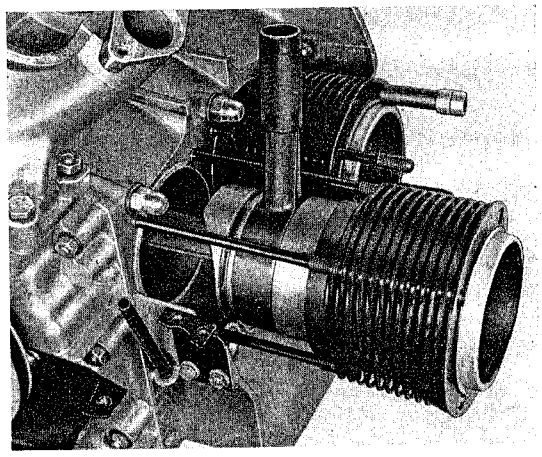

Fig. 165

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Check cylinders and pistons for wear and replace cylinder-piston sets if necessary. (See 33 EN for inspection criteria.)

2. Clean crankcase to cylinder and cylinder to cylinder head joints to insure a proper fit. Using a straight edge, check the surface of the crankcase for trueness. After installing cylinders check alignment across the top of the cylinders. Hold cylinders with P 18 spacers.

3. Use new gaskets at cylinder bases.

4. Check pistons and piston rings and install rings in correct arrangement.

5. Offset ring end gaps by 90° in the 1600 engine and 120° in the 1600 S engine so that end gaps are not in line and the oil ring gap is upward (with respect to installed engine).

6. Lightly oil the cylinder bore and push the cylinder over the piston. Install cylinders so that the cooling fins do not touch the crankcase studs. Rotate cylinders or adjust the studs if necessary.

7. Install push rod tubes and cylinder heads. Remember to install duct plates.

8. Tighten cylinder head nuts in the proper sequence to 3 mkg (22 ft. lb.) torque (23 EN).

33 EN

Checking Cylinders

Special Tools: P 13c Cylinder gauge setting ring

Cast Iron Cylinders

The following tables are valid only for the 1600 engine which is equipped with cast iron cylinders.

Standard Size

Group	Cylinder Tolerance	Piston size
−1	82.485 82.494	82.44
0	82.495 82.504	82.45
+1	82.505 82.514	82.46

First Oversize

Group	Cylinder Tolerance	Piston size
−1 KD	82.985 82.994	82.94
0 KD	82.995 83.004	82.95
+1 KD	83.005 83.014	82.96

These tables show which cylinder and piston sizes fit together.

The piston to cast iron cylinder wall clearance is 0.041 to 0.059 mm (.0016 to .0023 in.).

Wear limit for piston to cylinder wall clearance is 0.2 mm (.0078 in.). This clearance may not be measured by a feeler gauge but must be determined by measuring both piston and bore.

The measurement should be taken approx. 30 mm ($1^3/_{16}$ in.) from the bottom of the bore.

Measurement should be made using a standard bore gauge and setting ring P 13c.

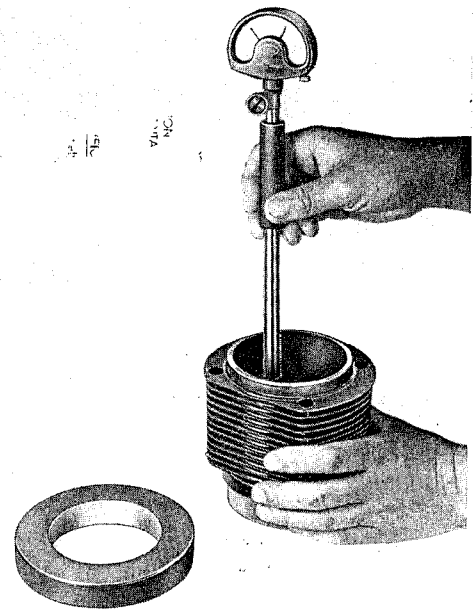

Fig. 166

Cylinders worn close to the wear limit should be replaced.

Each cylinder is marked with its size group at the cylinder girth, i.e. "0" or reconditioned cylinders "+1 KD".

The nominal size (D_1) is marked on the piston face (Fig. 167, 182).

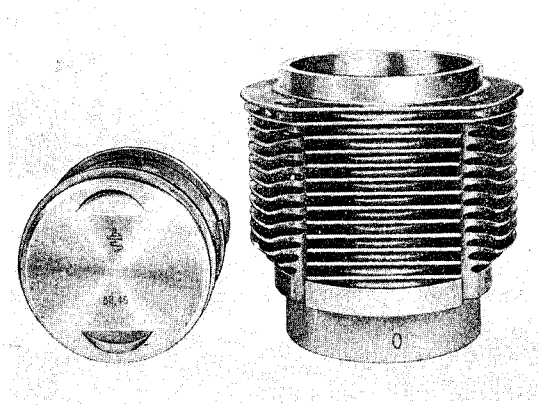

Fig. 167

Light Alloy Cylinders

The 1600 S engine is equipped with light alloy cylinders of the sizes shown in the following table.

Matched cylinder and piston pairs are stamped with the same group identification letter. The pistons are marked on the crown and the cylinders on the base.

Only cylinders and pistons of the same size group may be paired.

Piston and Cylinder sizes for 1600 S engine in mm.

Group	Cylinder dia.	Piston dia.
A	82.460—82.465	82.440—82.445
B	82.465—82.470	82.445—82.450
C	82.470—82.475	82.450—82.455
D	82.475—82.480	82.455—82.460
E	82.480—82.485	82.460—82.465
F	82.485—82.490	82.465—82.470
G	82.490—82.495	82.470—82.475
H	82.495—82.500	82.475—82.480
I	82.500—82.505	82.480—82.485
K	82.505—82.510	82.485—82.490

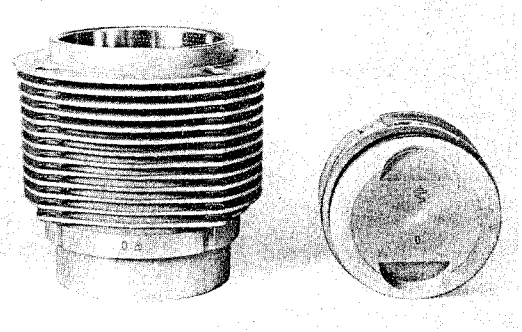

Fig. 168

Cylinder bores are measured using a standard bore gauge and setting ring P 13c.

This measurement is taken approx. 30 mm ($1^3/_{16}$ in.) from the bottom of the bore.

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The piston-cylinder clearance, when new, is 0.015 to 0.025 mm or an average of 0.02 mm (.0008 in.). The wear limit is 0.10 mm (.004 in.).

Piston-cylinder pairs which have reached or exceeded the wear limit must be replaced by a pair of the same size group.

Note:

Light alloy cylinders are not all the same height but are available in four different sizes.

Only cylinders of equal height may be installed under one cylinder head. The cylinder height group is marked on the cylinder base inside a small triangle (Fig. 168) in sizes 5, 6, 7 or 8.

34 EN

Removing and Installing Pistons

Special Tools:

P 1a	**Electric piston heater**
P 2	**Piston pin drift**
P 20	**Piston ring gap file**
VW 121b	**Piston ring pliers**

The pistons have offset piston pins and must therefore be installed in the engine with the front marking toward the flywheel. The marking shows a crankshaft, flywheel, and arrow which must be oriented so that the arrow points to the flywheel of the engine.

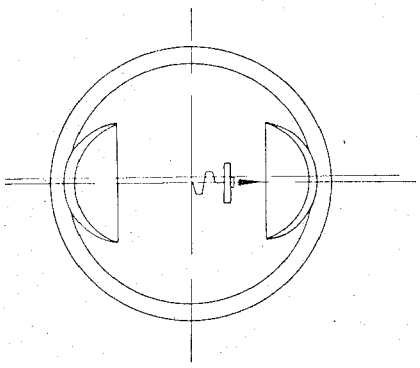

Fig. 169

By off-setting the piston pins it is possible for the piston to be forced against the thrust face of the power stroke before combustion takes place. The connecting rod angle reaches a perpendicular relation to the piston before TDC and thereby transfers the pressure from the compression stroke thrust face to the power stroke thrust face under low pressure. This slight movement normally occurs at the same time combustion takes place causing a slight noise. By off-setting the piston pin this movement is accomplished silently under relatively low pressures. Worn pistons which normally cause objectionable noise are kept quiet.

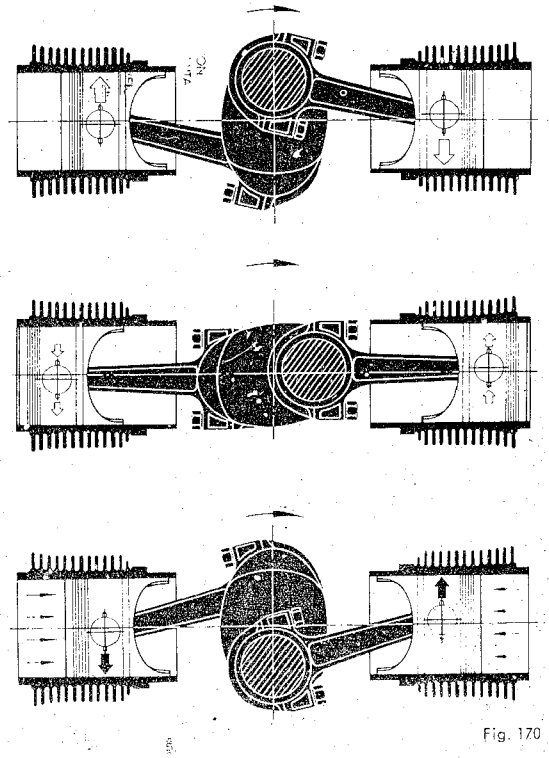

Fig. 170

Removal

1. Remove cylinders (32 EN).
2. Mark pistons I through IV to simplify correct installation.

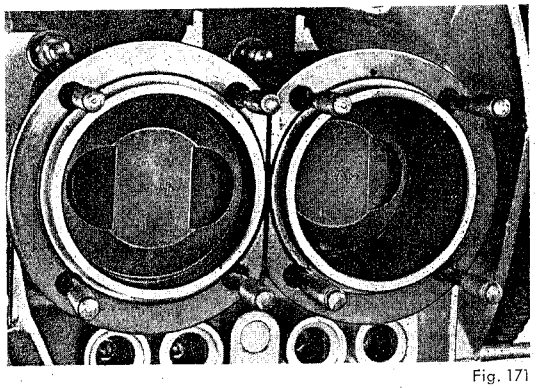

Fig. 171

3. Remove piston pin retaining rings being careful not to drop them into the crankcase.

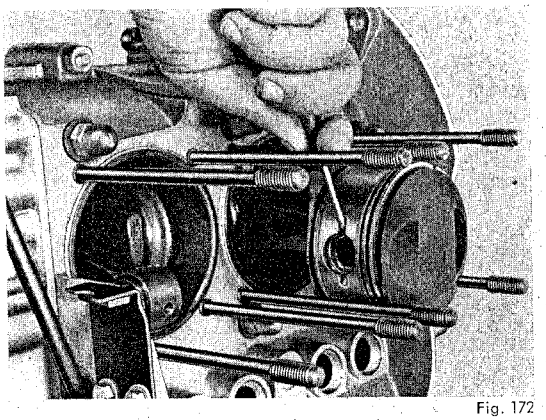

Fig. 172

4. Heat pistons to approximately 80° C (175° F).

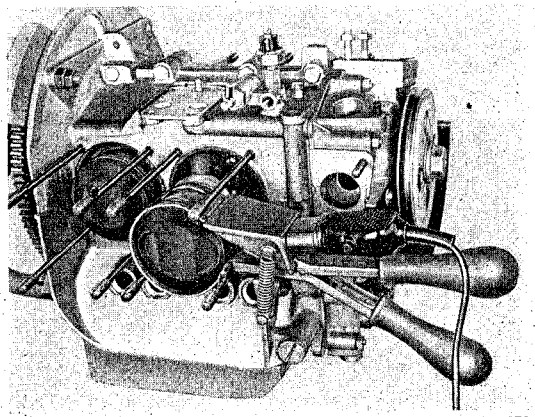

Fig. 173

5. Push out piston pins using drift P 2.

Fig. 174

6. Remove piston rings (if required) using piston ring pliers.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. The connecting rods must be in correct alignment.

2. Clean pistons. Remove carbon deposits from piston crown and ring grooves without scratching the pistons. Signs of uneven wear and carbon deposits on one side of the piston may indicate poor connecting rod alignment.

3. Check piston rings for damage and insure that end gaps and ring groove clearances are as specified. If necessary replace piston or rings.

4. Measure pistons. Each piston is marked with its size group on its crown (Fig. 167 and 168). Measurements are taken as shown in Fig. 182 and 183.
   Measure pistons perpendicular to piston pin axis.

The size groups for pistons are listed in the tables given in section 33 EN.

Nominal clearance for new pistons in the 1600 engine is 0.05 mm (.002 in.), and 0.02 mm (.0008 in.) for the 1600 S engine. If measurements indicate that the clearance is nearing the wear limit, the piston-cylinder pair should be exchanged for a new pair of the same size. If no sign of wear is evident in the cylinder it is sufficient to replace the piston with one of the same size group or letter group.

5. Fit compression and oil scraper rings.

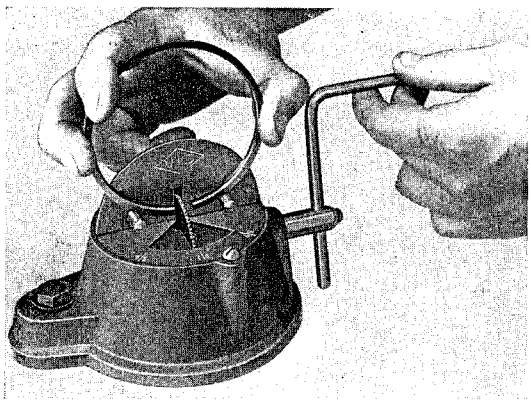

Fig. 175

6. Measure end gaps with a feeler gauge by inserting rings in the bore (push ring down with a piston).

Fig. 176

The correct gap for all rings in the 1600 engine is 0.25 to 0.50 mm (.011 to .021 in.); and for all rings in the 1600 S engine 0.10 to 0.45 mm (.004 to .018 in.).

Install rings so that the gaps are offset by 120° in the 1600 S engine and 90° in the 1600 engine. The oil scraper ring gap should be upward with respect to normal engine position.

Fig. 177

Check ring side clearance in ring grooves with a feeler gauge. The correct ring groove clearances are given on pages E 107 and E 108.

Rings must be installed using ring pliers to prevent piston damage and ring breakage.

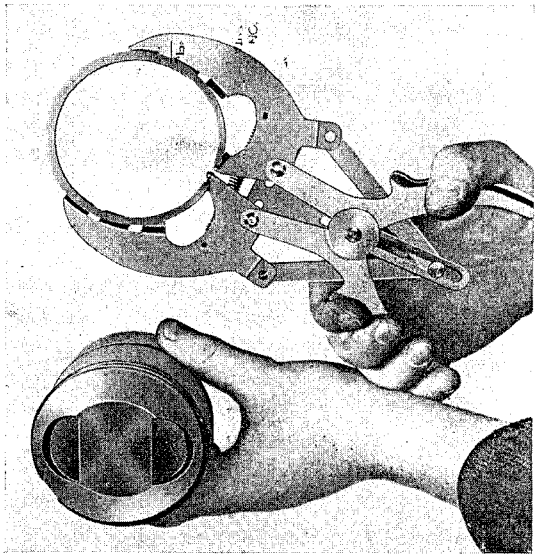

Fig. 178

The three compression rings for the pistons of the cast iron cylinders (1600 engine) are identical and are installed with the marking "TOP" toward the piston crown.

The compression rings for the pistons of the light alloy cylinders (1600 S engine) are not alike. The marking "TOP" of the first compression ring must be installed toward the piston crown. The second ring must be installed with the oil groove downward (away from the piston crown).

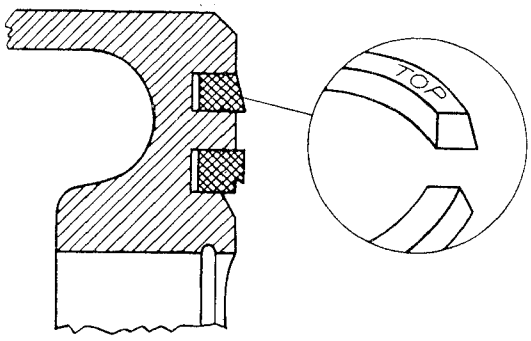

Fig. 179

7. Insert piston pin lock rings on the flywheel side first.
8. Inspect and install piston pins.
   The piston pin has an interference fit in the piston. If the pin can be pushed into the cold piston by hand, a pin of a larger diameter is to be used. A color marking inside the piston on the pin boss indicates the correct pin diameter.
   black: 21.994 to 21.997 mm (.86590 to .86602 in.)
   white: 21.997 to 22.000 mm (.86602 to .86614 in.)
   The piston pin clearance in the connecting rod bushing, when new, should be 0.020 to 0.036 mm (.0008 to .0014 in.). The wear limit is 0.050 mm (.002 in.). When the clearance exceeds the wear limit install a new piston pin and bushing. When the piston has been heated to a temperature of 80° C (175° F) in an oil bath or electric piston heater, the piston pin must slide into place under light pressure. The pin should be pushed through in one motion until it stops on the retaining ring.
9. Insert second retaining ring.

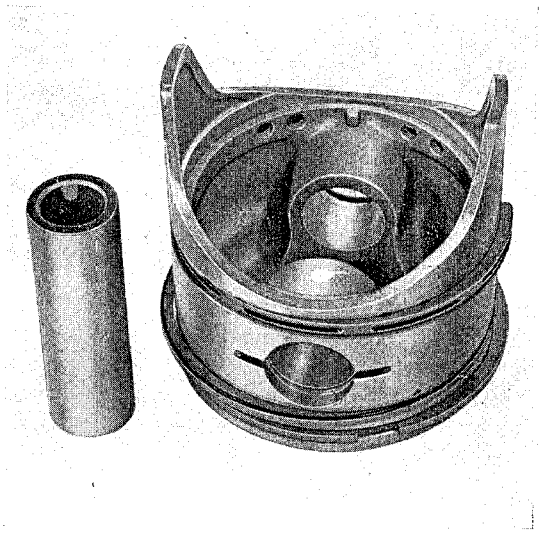

Fig. 180

Checking Pistons

35 EN

The nominal diameter of the piston is shown by the size group marking on the piston crown for 1600 engines, and the letter designation for the 1600 S engines.

The various size designations are listed on pages E 52, E 53, and E 58.

Measurements are made as shown in Fig. 182 and 183.

To achieve measurements of the highest accuracy, it is recommended that a dial gauge adjusted with the aid of gauge blocks be used.

Pistons showing gouging or seizing damage cannot be reused. However if the cylinder does not show any sign of wear, the piston may be replaced by one of the same size group without requiring a new cylinder.

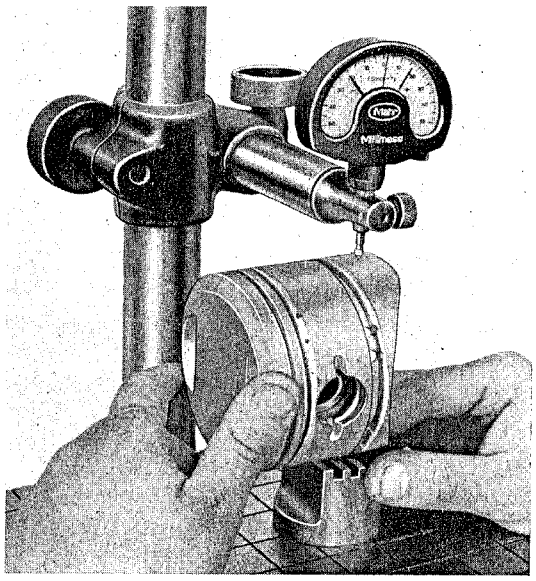

Fig. 181