A. Grinding Valves

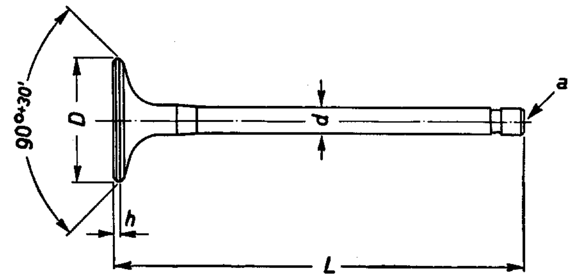

Fig. 05—5/1

Dimensions of Valves

in mm

	Valve-head diameter D	Stem diameter d	Length L	Height of head h	Valve seat angle
Inlet	$\frac{44.2}{44.1}$	$\frac{8.97}{8.95}$	128	1.5	90° + 30'
Exhaust	$\frac{37.2}{37.1}$	$\frac{9.95}{9.93}$	112.75	2.25	90° + 30'

1. Check the valves for run-out at the valve-head and the valve stem. For this purpose, a valve tester must be used (Fig. 05—5/2).

   When taking readings, the valve must be pressed firmly against the end-stop. The valve-cone must turn concentrically with the valve stem. The maximum permissible run-out is 0.03 mm.

   Check the valves for wear.

   If the stem of a valve is worn (inlet valve less than 8.95 mm, exhaust valve less than 9.93 mm) or if the valve head is distorted, the valve must be replaced.

2. Grind the valve cone, at an angle of 90° + 30', on a valve cone grinder (wet-grinder), avoiding turning marks (Fig. 05—5/3).

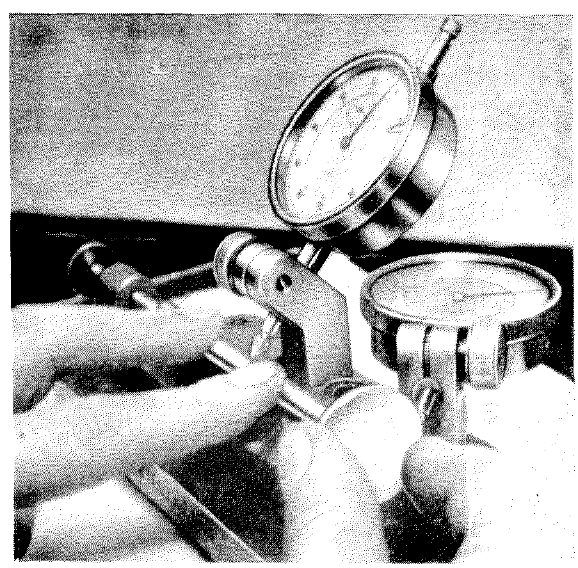

Fig. 05—5/2

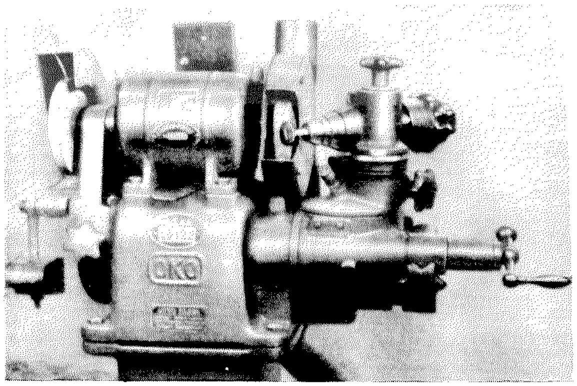

Fig. 05—5/3

Valves on which the dimension h of the valve-head is less than 0.8 mm in the case of the inlet valve and 1.5 mm in the case of the exhaust valve, must be replaced.

3. If the valve stem is mushroomed at the foot "a", it can be re-ground on a valve cone grinder.

   The minimum permissible hardness of the surface "a" is 55 HRc.

4. The type and part number of the valves is stamped on the end of the stem.

B. Testing Valve Springs

The valve springs should be tested either with Spring Test Gage 000 589 00 65 or with some other suitable spring tester. After measuring the free length L, the loads P_1 and P_2 for the lengths L_1 and L_2 must be measured in the case of each spring. If the permissible load tolerances are exceeded, the faulty spring must be replaced.

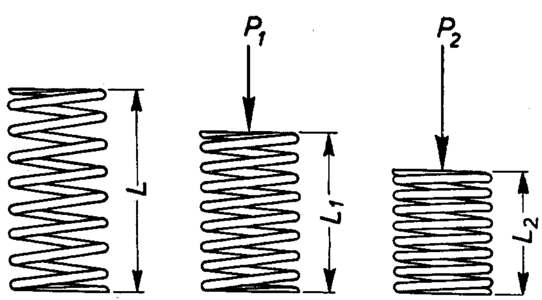

Fig. 05—5/4

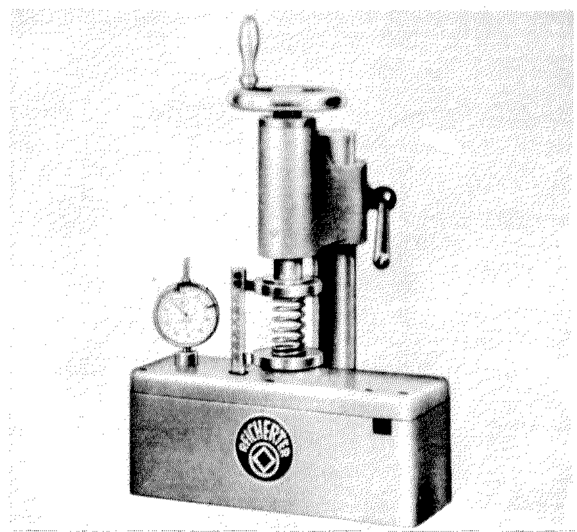

Fig. 05—5/5

Testing Table for Valve Springs

	External diameter	Spring wire section	Length L free	Length L_1 Load P_1 depressed		Length L_2 Load P_2 under final load	
	mm	mm	mm	mm	kg	mm	kg
Inner spring	20.7	2.6	42	34.2	8.9	25.7	18.6^{-2}_{-1}
Outer spring	30.6	4	42	38.4	23.1	29.9	$45.9^{+4.5}_{-2.2}$

C. Sealing Valve Stem

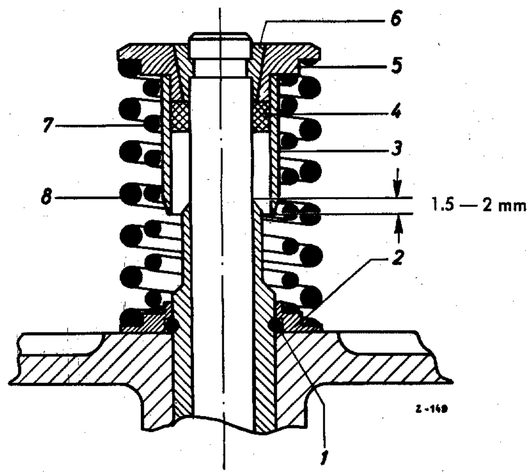

Fig. 05 — 5/6

1 Snap ring
2 Thrust collar
3 Sealing ring retainer
4 Sealing ring
5 Valve spring retainer
6 Valve cone half
7 Inner valve spring
8 Outer valve spring

The inlet and exhaust valves have a valve stem sealing system in which a sealing ring retainer (3), which is soldered to the valve spring retainer (5), covers the valve guide. Furthermore, a sealing ring (4) is incorporated between the sealing ring retainer and the valve stem (Fig. 05 — 5/6).

When checking the valvestem sealing system because of excessive oil consumption, the valve guides should at the same time be checked for tightness in the cylinder head (see Job No. 01 — 5, Section D).

When installing the valve stem sealing system, the following points should be noted:

a) The groove for the valve cone halves must be free of burrs so that when the valve spring retainer is pushed on, together with sealing ring retainer and sealing ring, the latter will not be damaged.

b) The sealing ring retainer must not cover more than 1.5—2 mm of the valve guide with the valve closed. The check should be carried out with the springs removed, marking the valve guide sleeves.

   If the sealing ring retainer covers more than 1.5—2 mm of the valve guide, there is a danger of oil being sucked up through the dome.

   If the valve seats or the halves have been reconditioned, the specified overlap of the sealing ring retainer in respect of the valve guide (1.5—2 mm) cannot always be obtained. In such cases, valve spring retainers with a 1 mm longer sealing ring retainer may be used (Part No. 180 050 06 23).

c) The valve cone halves must only bear on the shaft at points above and below the groove and not on the bed of the groove.

d) The gap between the two valve cone halves must be the same on each side.

e) When fitting, care must be taken to ensure that the sealing ring retainer does not foul the inner valve spring.

D. Grinding of Camshaft

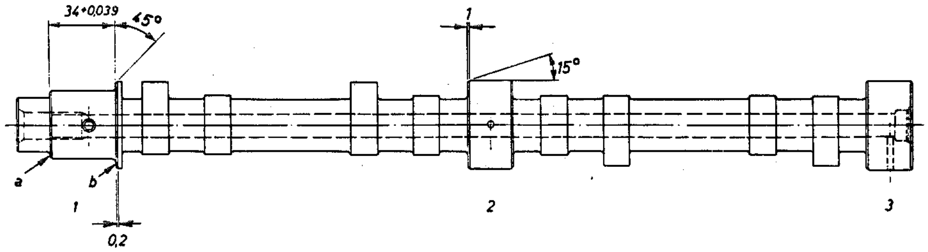

Fig. 05—5/7

The camshaft is carried by three bearing blocks, the bores of which are of various sizes.

The camshaft bearing journals can be re-ground twice. The appropriate bearing blocks with smaller bores are available ready for installation.

The oil for lubricating the bearing surfaces and the cams passes from No. 1 camshaft bearing block through a 4 mm bore in No. 1 camshaft bearing journal into the oil passage in the camshaft and thence to the various bearings.

Before the camshaft is re-ground, the cover for sealing the oil passage at the rear end must be removed. If the internal face is damaged at either or both ends, the internal face must be re-ground on a center grinder or lathe. The camshaft must first be carefully tested to see that it runs true. When the shaft is placed in the end bearings 1 and 3, the maximum permissible eccentricity of the center bearing, the cam base circles, and the timing gear seating is 0.025 mm.

In order that the correct radial play of the camshaft may be maintained, the bores of the camshaft bearings to be fitted must first be measured. The bearing play thus indicates the tolerances to which the journals have to be re-ground.

Bearing Play of Camshaft

in mm

Radial play	End play
0.025 — 0.045	0.050 — 0.128

When re-grinding the first bearing journal, the end thrust contact surface of the shoulder "b" must not be ground off more than 0.1 mm (Fig. 05—5/7). The surface "a" must be ground off the same amount as the shoulder "b" so that the dimension 34.000 to 34.039 mm is scrupulously maintained. If this is not the case, the end play of the camshaft, and consequently the discrepancy in respect of the sprocket alignment, will be too great. The lateral deflection at the surface "a" must not be more than **0.01 mm**.

After grinding the camshaft bearing journals, the camshaft must be inspected for cracks and the hardness of the individual bearing surfaces must be checked.

After grinding, the oil bores must be carefully cleaned and blown out with compressed air.

The aperture at the rear end of the camshaft must then be sealed with a new cover.

	Brinell Hardness HB in kg/mm²	Scleroscope Hardness
Bearing journals and cam base circle	217 — 248	36 — 40
Cam nose and lifting flank	minimum 500	minimum 64

Grinding Stage Table for Camshaft

Measurements in mm

Overhaul stages	No. 1 bearing Timing gear end	No. 2 bearing	No. 3 bearing Flywheel end
Standard size	34.975 / 34.959	44.975 / 44.959	45.975 / 45.959
Intermediate stage	34.875 / 34.859	44.875 / 44.859	45.875 / 45.859
1st Overhaul stage	34.725 / 34.709	44.725 / 44.709	45.725 / 45.709

Camshaft Bearing Bores

Measurements in mm

Overhaul stages	No. 1 bearing Timing gear end	No. 2 bearing	No. 3 bearing Flywheel end
Standard size	35.000 / 35.016	45.000 / 45.016	46.000 / 46.016
Intermediate stage	34.900 / 34.916	44.900 / 44.916	45.900 / 45.916
1st Overhaul stage	34.750 / 34.766	44.750 / 44.766	45.750 / 45.766

E. Re-Bedding of Camshaft

Note: The operation of re-bedding the camshaft can only be carried out with the cylinder head removed from the vehicle.

1. After cleaning the disassembled cylinder head, both surfaces — the separating surface and the upper face of the cylinder head — must be inspected to see if they are perfectly even. The maximum permissible degree of unevenness in the longitudinal direction is 0.1 mm and in the lateral direction, 0.01 mm. If it is in excess of this, the cylinder head must be re-faced (see Job No. 01 — 5, Section C).

2. When new camshaft bearing blocks are fitted, it is normal practice to use a complete set. If it happens that the replacement of a single bearing block is sufficient, particular care must be taken to ensure that the bores are perfectly aligned.

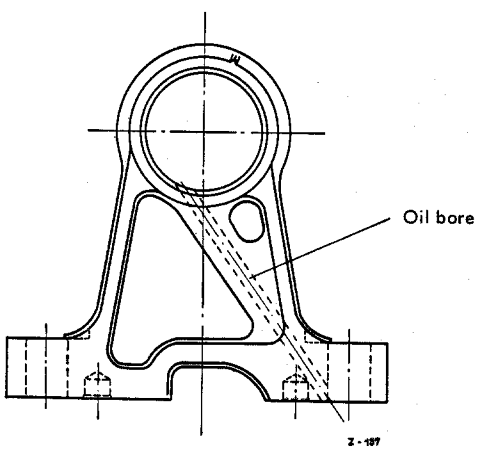

Fig. 05 — 5/8

1 Camshaft bearing, seen from the front

3. Before the camshaft bearing blocks are installed, the bores must be measured and the camshaft re-ground in accordance with the bearing play (see Job No. 05 — 5, Section D).

4. Fix the bearing blocks onto the cylinder head and insert the camshaft — for the time being without oil — into the bores.

   The camshaft must be easy to turn by hand and if it is not, the bearing block causing it to bind must be traced. To do this, one of the two outside bearings should be removed and the camshaft once again tested for free running.

   If the camshaft does not run freely, the removed bearing should be re-installed and the other outside bearing removed instead in order to ascertain which of the bearings is incorrectly aligned.

   The misalignment of the bearing can be corrected by lightly tapping the base of the bearing with a plastic hammer.

   The camshaft must be easy to turn under all circumstances. Particular care must be taken to check this when the cylinder head is fitted, and after the cylinder head attaching bolts have been tightened.

Note: An oil passage runs from the left bolt shank bore of No. 1 camshaft bearing to the bearing bore for the lubrication of the camshaft (Fig. 05 — 5/8). For this reason, the contact surface of No. 1 camshaft bearing must make a perfect seal with the cylinder head surface to avoid any decrease in oil pressure.

Before placing No. 1 camshaft bearing on the cylinder head, the oil passage must in all cases be carefully cleaned.

F. Testing of Chain Tensioner

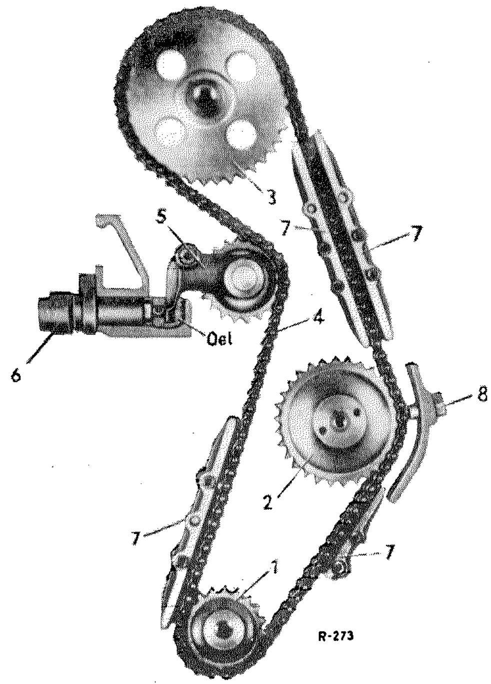

Fig. 05—5/9

1 Crankshaft timing gear
2 Idling gear
3 Camshaft timing gear
4 Twin roller chain
5 Tension sprocket bearing
6 Chain tensioner
7 Chain guide
8 Lock bolt

Normally, a special testing appliance is required to check the accurate functioning of a chain tensioner. For practical purposes, however, a comparison between a new chain tensioner in perfect condition and the one which is supposed to be faulty, will suffice for the purpose. The chain tensioner is placed in a receptacle, filled up with engine oil, and bled. After bleeding, it should be possible to compress the chain tensioner only very slowly and by exerting considerable force.
Chain tensioners which can be compressed easily, usually produce a rattle in the chain. If there is a whine in the chain, it can be assumed that the chain tensioner is not elastic enough.
It is advisable to replace faulty chain tensioners as a complete assembly. If individual parts are obtained for replacement, the thrust pin (2) and the thrust sleeve (7) can only be supplied together since both parts must be selected so as to match perfectly (Fig. 05—5/10).

The following causes may also be responsible for noises in the chain:

a) The tension sprocket bearing is fouling the oil case in the cylinder head.

When installing the tension sprocket bearing, care must be taken to ensure that the tension sprocket bearing can move freely in the oil case and that it does not strike against any part of the cylinder head.
To check this, turn the crankshaft in the direction the engine is turning until the left half of the chain is tensioned. At this point the tension sprocket bearing in the oil case in the cylinder head must be able to be moved sufficiently toward the engine center line and must not strike against anything so that the right half of the chain is also fully tensioned. If the tension sprocket bearing strikes against anything too soon, this can be remedied by re-finishing the nose A or the inner radius B of the tension sprocket bearing (see Fig. 05—5/12).
It is of course equally important to ensure that the tension sprocket bearing does not strike against anything on the side of the engine away from the center line either.

b) The chain tensioner is not properly bled.

To bleed the chain tensioner, the following procedure should be carried out:
Press back the tension sprocket bearing as far as it will go, using Bleeder Lever 187 589 02 63 or in an emergency, a screwdriver, and fill up the cylinder head oil case with warm engine oil (see Fig.

01 — 4/14). Now gradually release the sprocket bearing with the lever or screwdriver, at the same time continually filling up with oil, so that the oil case is always full of oil and the chain tensioner cannot suck in air.

Then "pump" the tension sprocket bearing until no more air bubbles can be seen at the chain tensioner. The important thing is to maintain the necessary oil level in the oil case during the bleeding process.

When the chain tensioner is completely bled, further pumping becomes impossible; considerable force is required to compress the chain tensioner even at the beginning of the operation.

Bleeding of the chain tensioner should be carried out with great care, since imperfect bleeding leads to chain noises when the engine is idling. Insufficiently bled chain tensioners may also cause the engine to idle unevenly.

c) There is not enough oil in the oil case.

During normal running it is possible that on bad roads or when the vehicle is suddenly stopped, oil will splash over the web and then the chain tensioner might even suck in air. In order to ensure that sufficient oil always remains in the oil case, the web can subsequently be made higher. For this purpose, the insert plate (4), together with the rubber gasket (5), is placed over the web and screwed onto the cylinder head with the hexagon socket screw (6). Two washers (7) must be installed between the cylinder head and the insert plate in order to ensure that the insert plate fits perfectly.

If the height of the web is H = 28 mm, the rubber gasket (5) (Part. No. 121987 00 46) is installed. If the height of the web is H = 32 mm, the rubber gasket (5) (Part No. 121 987 00 46) should be cut through in the middle in a longitudinal direction and only one half of it installed.

Furthermore, a new tension sprocket bearing (3) must be used when installing the insert plate (4). It is not permissible for the tension sprocket bearing to be re-machined.

The following are the parts necessary for the installation of the insert plate:

1 Insert plate, Part No. 121 016 00 41
1 Rubber gasket, Part No. 121 987 00 46
1 Washer, 8.4 DIN 433
1 Tension sprocket bearing, Part No. 121 050 09 10
1 Hexagon socket screw M 8 × 22 DIN 912 — 8 G

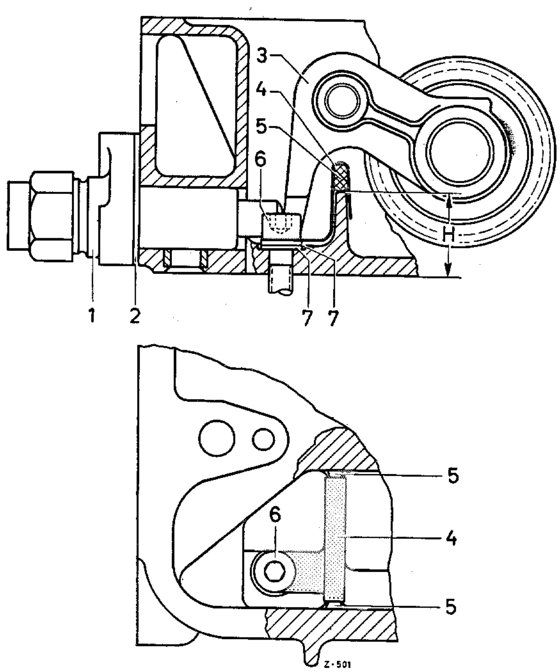

Fig. 5 — 5/9 a

1 Chain tensioner
2 Gasket
3 Tension sprocket bearing 121 050 09 10
4 Insert plate 121 016 00 41
5 Rubber gasket 121 987 00 46
6 Hexagon socket screw M 8×22 DIN 912 — 8 G
7 Washer, 8.4 DIN 433

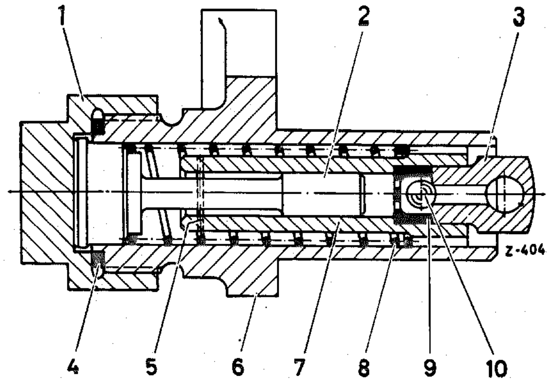

Fig. 05—5/10

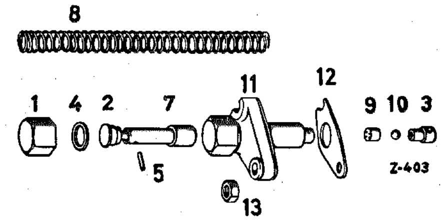

Fig. 05—5/11

1 Cover cap
2 Pressure pin
3 Head
4 Sealing ring
5 Dowel pin
6 Chain tensioner housing
7 Pressure sleeve
8 Pressure spring
9 Ball retainer
10 Steel ball
11 Chain tensioner assembly
12 Gasket
13 Hexagon nut

Disassembly:

1. Unscrew the cover cap (1) and take the pressure pin (2), together with the pressure sleeve (7), out of the chain tensioner housing.

2. Check the pressure spring (8) on the pressure pin and on the pressure sleeve; the pressure spring must **not** be removed for checking but should remain installed.

Testing Table for Spring:

Length L free	Length L_1	Load P_1	Length L_2	Load P_2
	loaded		under final load	
mm	mm	kg	mm	kg
118	44	1.85	38	1.9—2.05

3. The pressure pin and the pressure sleeve must not be disassembled. The following is the reason:

   When the dowel pin (5) is knocked in, a burr is formed in the bore. If the pressure pin is pulled out, the burr will cause scoring of the surface of the pressure pin. This scoring alone is sufficient to reduce the period of circulation of the oil sufficiently to render the chain tensioner unserviceable.

   When faults occur, therefore, the pressure pin must always be replaced together with the pressure sleeve.

   The individual replacement of the head, the ball and the ball retainer is not advisable. If faults occur in these parts, the complete pressure pin assembly, together with pressure sleeve and including the ball retainer, the ball and the head should be replaced.

Reassembly:

4. When assembling, take care to ensure that the pressure spring does not jam, that the dowel pin is tightly seated and does not foul the spring and that the sealing ring is correctly placed.

5. Place the chain tensioner in a receptacle, fill it up with engine oil, bleed it and check that it is functioning efficiently.

Note: When installing the chain tensioner in the engine, the chain tensioner **must not be filled with oil** as otherwise the housing would be forced when the nuts are tightened up. The bleeding process must then be repeated with the chain tensioner installed in the engine. When this is done, there must be sufficient engine oil in the oil case in the cylinder head.

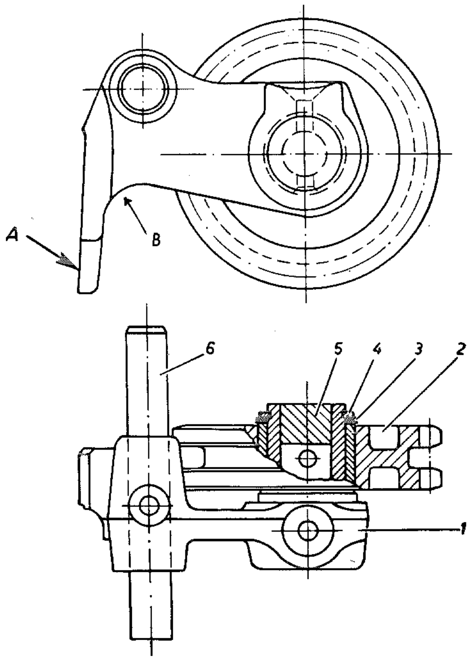

Fig. 05 — 5/12

1 Tension sprocket with pivot pin
2 Tension sprocket with bushing
3 Washer
4 Snap ring
5 Taper plug
6 Pivot pin for tension sprocket bearing in cylinder head

1. Remove the snap ring (4) and the washer (3), then pull off the tension sprocket.
2. After disassembling and cleaning the individual parts, thoroughly rinse out the bore in the pivot pin which is closed by the taper plug (5). If necessary, bore out the taper plug (5), remove the sludge, and drive in a new taper plug.
3. Usually, the nose of the tension sprocket bearing is worn at the place where it rests against the contact piece of the chain tensioner (see A in Fig. 05 — 5/12). Re-finish the worn parts.

Tension Sprocket and Bearing

Measurements in mm

Diameter of pivot pin 6	Bore in tension sprocket bearing	Diameter of pivot pin 1	Finish dimension of bushing in tension sprocket	Rough-turning dimension of bushing in tension sprocket
9.995 / 9.986	10.000 / 10.015	19.980 / 19.959	20.000 / 20.021	19.600 / 19.730

4. Check the pivot pins and bores for wear.

   Radial play of tension sprocket (2) 0.020—0.062 mm

   Radial play of pivot pin (6) in tension sprocket bearing 0.005—0.029 mm

   If the bushing in the tension sprocket is worn, it should be pressed out and a new bushing with a rough-turned bore pressed in. The bushing must project 0.75 mm at the rear (Fig. 05 — 5/13).

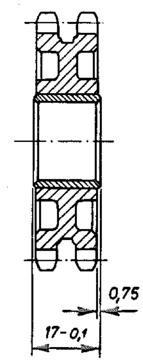

Fig. 05 — 5/13

Before pressing in a new bushing, set up the tension sprocket by means of a mandrel in the bore and lightly re-finish the teeth at their circumference (permissible eccentricity 0.02 mm). After re-finishing the teeth, press in the new bushing and then again set up the tension sprocket, this time with a chuck adapter gripping the circumference of the teeth and finish-turn the bore of the bushing (20.000—20.021 mm).

Run-out of sprocket when set up on mandrel, measured at the circumference: max. 0.02 mm

Eccentricity of sprocket, measured at the circumference: max. 0.02 mm.

If the tension sprocket bearing shows signs of wear at the pivot pin or in the pivot pin (6) bore, the tension sprocket bearing must be replaced.

5. After re-installing the tension sprocket bearing in the cylinder head, fill the oil cavity in the tension sprocket bearing with oil for the initial running of the engine and then bleed the chain tensioner.

H. Testing of Rocker Arm and Rocker Arm Mounting

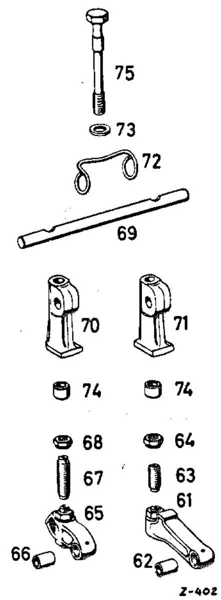

Fig. 05—5/14

61 Rocker arm for inlet
62 Bushing
63 Adjusting screw
64 Hexagon nut
65 Rocker arm for exhaust
66 Bushing
67 Adjusting screw
68 Hexagon nut
69 Rocker arm shaft
70 Rocker arm block for No. 1 and No. 3 cylinders
71 Rocker arm block for No. 2 and No. 4 cylinders
72 Spring clamp
73 Washer
74 Guide sleeve
75 Stretch screw

Rocker Arm Mounting

Measurements in mm

Base bore in rocker arm	External diameter of bushing	Rough-turning dimension of bushing Internal diameter	Finish dimension of bushing Internal diameter	Rocker arm shaft diameter	Bore in rocker arm block
12.000 / 12.018	12.039 / 12.028	9.6	10.000 / 10.015	9.987 / 9.972	9.985 / 10.000

Tightening torque of the stretch screws (75) = 3.75 mkg.

Rocker Arms

1. Check the contact surfaces of the rocker arms. If the contact surfaces are badly worn, the rocker arms should be replaced.

2. Check the bore of the rocker arms. Worn bushings should be replaced.

   Press out the old bushing and press in a new bushing.

   Do not finish-turn the bushing bore before the new bushing has been pressed into position.

   The bore must be parallel to the sliding surface. The permissible deviation is 0.01 over a measuring length of 100 mm.

Rocker Arm Shaft

3. Check the rocker arm shafts for wear at the bearing surfaces for the rocker arms. Worn rocker arm shafts should be replaced.

Rocker Arm Block

4. Check the bore in the rocker arm block. If the bore is worn, the rocker arm block should be replaced.