

Specifications for Adjustment and Installation

Dimensions in mm (in.)

Group M - Engine

Cylinder Crankcase and Pistons

Cylinder bore	Standard size	80.000 (3.14961)	
		80.019 (3.15036)	
	1st oversize	80.500 (3.16929)	
		80.522 (3.17016)	
	2nd oversize	81.000 (3.18897)	
		81.022 (3.18984)	
	3rd oversize	81.500 (3.20865)	
		81.522 (3.20952)	
Permissible out of roundness of cylinder bore		0.013 (0.00051)	
Permissible taper of cylinder bore		0.013 (0.00051)	
Deviation of bore perpendicular to crankshaft axis in relation to height of cylinder		0.05 (0.002)	
Piston play		0.04 (0.0016)	
Piston diameter		Choose according to cylinder bore making provision for piston play	
Piston ring side clearance in groove Mahle pistons		0.035–0.062 (0.0014–0.0025)	
Nüral pistons		0.030–0.057 (0.0012–0.0022)	
Gap clearance of 1st, 2nd and 3rd piston ring		0.30–0.45 (0.012–0.018)	
Gap clearance of oil ring (Novix slotted ring)		0.25–0.40 (0.01–0.015)	
Permissible difference in weight of pistons used in the engine		4 g (0.14 oz.)	

Crank Gear:

Crankshaft bearings 4

Crankshaft grinding sizes	Crankshaft bearing journal	Connecting rod bearing journal
Standard size	59.96 (2.3606)	47.96 (1.8882)
	59.94 (2.3598)	47.94 (1.8874)
1st undersize	59.71 (2.3508)	47.71 (1.8784)
	59.69 (2.3500)	47.69 (1.8776)
2nd undersize	59.46 (2.3409)	47.46 (1.8685)
	59.44 (2.3401)	47.44 (1.8677)
3rd undersize	59.21 (2.3311)	47.21 (1.8587)
	59.19 (2.3303)	47.19 (1.8579)
4th undersize	58.96 (2.3213)	46.96 (1.8488)
	58.94 (2.3205)	46.94 (1.8480)

Width of crankshaft bearing journals, incl. undersizes	30.00–30.70 (1.18–1.21)
Width of connecting rod bearing journals, incl. undersizes	30.00–30.30 (1.18–1.193)
Permissible out of roundness of crankshaft and connecting rod bearing journals	0.005 (0.0002)
Permissible taper of crankshaft and connecting rod bearing journals	0.01 (0.0004)
Permissible misalignment of connecting rod bearing journals in relation to crankshaft bearing journals and bearing length	0.01 (0.0004)
Permissible out of true of the two center crankshaft bearings with shaft supported on end journals	0.02 (0.0008)
Permissible lateral out of true of fitting bearing journal	0.015 (0.0006)
Permissible vertical out of true of flywheel flange in relation to four crankshaft bearing journals	0.02 (0.0008)
Permissible lateral out of true of flywheel flange in relation to four crankshaft bearing journals, checked at diameter of 90 mm (3.54")	0.012 (0.00047)
Vertical and lateral out of true of crankshaft sprocket	0.02 (0.0008)
Hardness of bearing journals Sclerograph hardness	71–74
Rockwell hardness	57–61 HRc
Basic bore in cylinder crankcase	67.000 (2.63779)
	67.019 (2.63854)
Bore with bearing shells installed (standard size)	59.99 (2.36181)
	60.02 (2.36299)
Overlap of bearing shells	+ 0.01 (0.0004)
Side play of crankshaft bearing journals	0.055–0.075 (0.0022–0.003)
End play of fitting bearing journal	0.040–0.094 (0.0016–0.0037)
Basic bore in connecting rod	54.000 (2.12598)
	54.019 (2.12673)
Bore with bearing shells installed (standard size)	47.99 (1.88937)
	48.02 (1.89055)
Overlap of bearing shells	+ 0.01 (0.0004")
Side play of connecting rod bearing journals	0.055–0.075 (0.0022–0.003)
End play of connecting rod bearing journals	0.110–0.227 (0.0043–0.0089)
	when reconditioned up to 0.5 (0.02)
Basic bore in connecting rod for connecting rod bearing bushing	
Standard size	25.000 (0.98425)
	25.021 (0.98508)
Upsize	25.500 (1.00393)
	25.521 (1.00476)
Bore with bushing pressed in	22.007 (0.86642)
	22.013 (0.86665)
Piston pin diameter	22.000 (0.86614)
	21.994 (0.86591)

Piston pin play in connecting rod	0.010–0.016 (0.0004–0.00063)
Permissible difference in weight of connecting rods in the engine	5 g (0.18 oz.)
Permissible deviation of paraxiality of connecting rod relative to a length of 100 mm (3.94")	0.03 (0.0012)
Permissible twist of connecting rod relative to a length of 100 mm (3.94") ..	0.1 (0.004)

Flywheel:

Permissible vertical out of true of flywheel flange in relation to four crankshaft bearing journals	00.2 (0.0008)
Permissible lateral out of true of flywheel flange in relation to four crankshaft bearing journals, checked at diameter of 90 mm (3.54")	0.012 (0.00047)
For mounting, heat starter ring gear to	200° C (390° F)
Permissible lateral out of true of mounted starter ring gear	0.4 (0.016)
Clearance between mounting surface and clutch surface (see Fig. M 14/00)	0.2–0.3 (0.008–0.012)

Cylinder Head and Valves:

		at a compression of	
Compression area		6.5 : 1	7.6 : 1
Cylinder head alone		55.5 ± 1 ccm (3.385 ± 0.06 cu.in.)	44.3 ± 1 ccm (2.702 ± 0.06 cu.in.)
	with cylinder head mounted	66.5 ± ^{2.5} / ₁ ccm (4.056 ± ^{0.15} / _{0.06} cu. in.)	55.5 ± 2 ccm (3.385 ± 0.12 cu. in.)
Height of compression area			18 ± 0.3 (0.71 ± 0.012)
Valve head diameter	Intake		39.2 (1.543)
	Exhaust		35.2 (1.386)
Valve seat angle of valve			90° + 30'
Valve seat angle in cylinder head			90° — 30'
Valve seat width in cylinder head	Intake		1.25–2 (0.05–0.08)
	Exhaust		1.25–2 (0.05–0.08)
Permissible out of true between seat and stem			0.02–0.03 (0.0008–0.0012)
Valve stem diameter	Intake		8.97 (0.3531)
			8.95 (0.3524)
	Exhaust		9.95 (0.3917)
			9.93 (0.3909)
Valve guide bore	Intake		9.000 (0.35433)
			9.015 (0.35492)
	Exhaust		10.000 (0.39370)
			10.015 (0.39429)
Permissible play between valve stem and bore	Intake		0.03–0.065 (0.0012–0.00256)
	Exhaust		0.05–0.085 (0.002–0.00335)
Overlap of valve guide in	Cast iron cylinder head		+ 0.003 (0.00012)
	Light metal cylinder head		+ 0.007 (0.00027)

Valve guide sizes	see Tables 14a and 14b
Valve spring pressure	see Table 13
Valve play	
Intake	0.08 (0.003)
Exhaust	0.20 (0.008)

Recess for valve seat ring in cast iron cylinder head (exhaust only)

Standard size	39.000 (1.53543)
	39.016 (1.53606)
1st oversize	39.500 (1.55511)
	39.516 (1.55574)

Valve seat ring diameter

Standard size	39.140 (1.54094)
	39.130 (1.54055)
1st oversize	39.640 (1.56063)
	39.630 (1.56023)

Engine Timing:

Camshaft bearing journals	1st bearing	2nd and 3rd bearing	4th bearing
Standard size	34.975 (1.37696)	44.975 (1.77066)	45.975 (1.81003)
	34.959 (1.37633)	44.959 (1.77003)	45.959 (1.80940)
Intermediate size	34.875 (1.37303)	44.875 (1.76673)	45.875 (1.80610)
	34.859 (1.37240)	44.859 (1.76610)	45.859 (1.80547)
1st undersize	34.725 (1.36712)	44.725 (1.76082)	45.725 (1.80019)
	34.709 (1.36649)	44.709 (1.76019)	45.709 (1.79956)

Camshaft bearing bore

Standard size	35.000 (1.37795)	45.000 (1.77165)	46.000 (1.81102)
	35.016 (1.37858)	45.016 (1.77228)	46.016 (1.81165)
Intermediate size	34.900 (1.37401)	44.900 (1.76771)	45.900 (1.80708)
	34.916 (1.37464)	44.916 (1.76834)	45.916 (1.80771)
1st undersize	34.750 (1.36811)	44.750 (1.76181)	45.750 (1.80118)
	34.766 (1.36874)	44.766 (1.76244)	45.766 (1.80181)

Side play of camshaft 0.025–0.057
(0.001–0.0022)

End play of camshaft 0.050–0.128
(0.002–0.005)

Side play of rocker arms 0.025–0.043
(0.001–0.0017)

Permissible misalignment of sprockets 0.1 (0.004)

Side play of intermediate gear shaft 0.04–0.074
(0.0016–0.0029)

Side play of helical gear	0.032–0.068 (0.00125–0.0027)
Tooth backlash between helical gear and intermediate gear shaft	0.05–0.15 (0.002–0.006)
Side play of idler gear	0.020–0.062 (0.0008–0.0024)

Adjustment of camshaft sprocket Spacer washer and camshaft bracket are marked by notches

	Type 220	Type 220a	
		Camshaft with number	
		14	14/1
Settings for checks at a valve play of 0.4 mm (0.016").....			
Intake begin	8° 30' before TDC	9° before TDC	12° before TDC
end	48° 30' after BDC	41° after BDC	44° after BDC
Exhaust begin	36° 30' before BDC	51° after BDC	51° before BDC
end	8° 30' after TDC	15° after TDC	15° after TDC
Valve lift in TDC (cross-over dead center)			
Intake valve	0.68 ± 0.2 (0.027 ± 0.008)	0.68 ± 0.2 (0.027 ± 0.008)	0.75 ± 0.2 (0.29 ± 0.008)
Exhaust valve	0.54 ± 0.2 (0.021 ± 0.008)	0.64 ± 0.2 (0.025 ± 0.008)	0.64 ± 0.2 (0.025 ± 0.008)
Ignition timing	5° after TDC	2° after TDC	
Firing order		1 - 5 - 3 - 6 - 2 - 4	

Engine Lubrication:

Play between housing and gear of oil pump

Side play	0.025–0.057 (0.001–0.0022)
End play	0.020–0.062 (0.0008–0.0025)
Tooth backlash	0.05–0.10 (0.002–0.004)
Rate of delivery	see Table 26
Oil relief valve springs	see Tables 27 and 28

Torque Specifications:

Crankshaft bearing screws	8 mkg (56 ft.lb.)
Connecting rod bolts	3.75 mkg (27 ft.lb.) or 0.1 mm (0.004") expansion
Cylinder head screws with engine cold	8 mkg (58 ft.lb.)
with engine warm*	cast iron cylinder head 8 mkg (58 ft.lb.) light metal cylinder head 9 mkg (65 ft.lb.)
Rocker arm bracket screws	3.75 mkg (27 ft.lb.)
Spark plugs	4 mkg (29 ft.lb.)
Flywheel securing screws (use expansion screws only)	5 mkg (36 ft.lb.)

* See also operation No. M 20, cf. 8