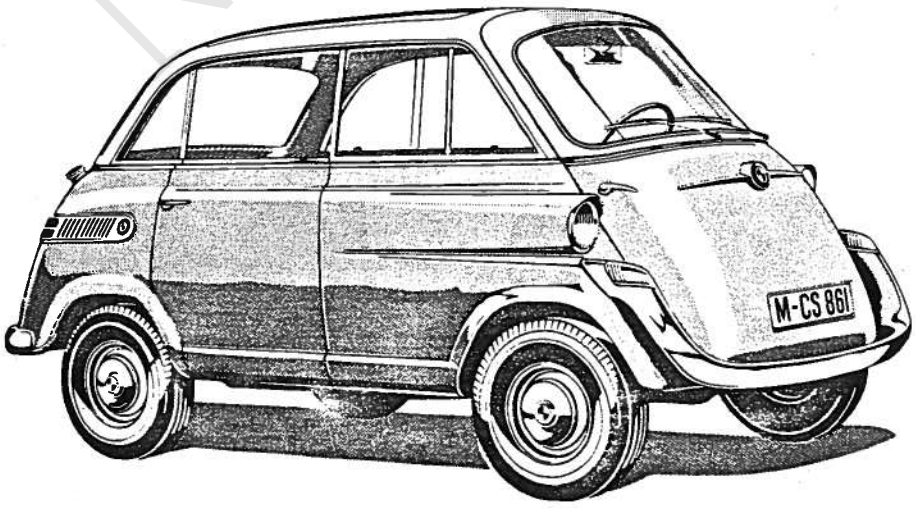
REPARATURANLEITUNG

MANUEL DE REPARATION
REPAIR MANUAL
MANUAL DE REPARACIONES

LIMOUSINE BMW 600



Vorwort

Die vorliegende Reparaturanleitung für die Limousine BMW 600 soll unseren Händlern und ihren Mitarbeitern als Leitfaden für fachgerechte Instandsetzungsarbeiten dienen.
Die Anleitung soll keineswegs die notwendige praktische und theoretische Ausbildung der Monteure in der Kundendienstschule des Werkes ersetzen. Als bleibendes Nachschlagewerk soll sie in den Werkstätten jederzeit Auskunft bei der täglichen Arbeit geben.
Wir empfehlen ferner, die anschaulich bebilderte Ersatzteilliste, welche die Aggregate und ihren Aufbau zeigt, als zusätzliche Informationsquelle mit heranzuziehen.
Einwandfreie Instandsetzungsarbeiten und ein vorbildlicher Dienst am Kunden setzen außerdem eine gut eingerichtete, mit allen notwendigen Werkzeugen versehene Werkstatt und handwerklich ausgebildete Fachkräfte voraus.
Diese Reparaturanleitung und alle durch Rundschreiben laufend bekanntgegebenen technischen Änderungen sollen bei unseren Händlern in die Hände derjenigen gelangen, die die Arbeiten durchführen. Die Unterlagen gehören in die Werkstatt und nicht in die Aktenschränke der Büros.
Wir hoffen, mit diesem Werk eine wertvolle Hilfe zum Nutzen aller Freunde unseres Hauses geschaffen zu haben.

BAYERISCHE MOTOREN WERKE AG.
München 13

Préface

Le présent manuel de réparation pour notre BMW 600 doit servir de guide à nos représentants comme à leurs collaborateurs pour les travaux spécialisés de mise en état de ce véhicule.
Ce manuel ne peut en aucune manière remplacer les connaissances pratiques et théoriques nécessaires acquises par les monteurs à l'école de service clientèle de l'usine. Servant d'ouvrage permanent de référence, il doit donner à tout moment dans les ateliers les renseignements exigés lors du travail quotidien.
Nous recommandons en outre d'utiliser en même temps comme source supplémentaire d'information le catalogue des pièces détachées clairement illustré qui montre les différents ensembles et leurs pièces constitutives en position de montage.
Des travaux impeccables de mise en état du véhicule et un service-client exemplaire supposent de plus un atelier bien installé, équipé de tout l'outillage nécessaire et disposant de mécaniciens ayant une bonne formation professionnelle.
Ce manuel de réparation et les circulaires instruisant de toutes les modifications techniques au fur et à mesure de leur introduction, doivent parvenir chez nos représentants aux mains de tous ceux ont à exécuter les travaux. Ces textes trouvent leur place dans l'atelier et non au bureau des archives.
Nous espérons que cet ouvrage vous aura apporté une aide précieuse pour le plus grand profit de tous les amis de notre maison.

BAYERISCHE MOTOREN WERKE AG.
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Foreword

This Repair Manual has been prepared with the object of providing all BMW Dealers and Service Men with information for the proper repairing of the Limousine BMW 600.
This repair manual should on no account supersede the indispensable practical and theoretical training of service men throughout the annual courses held in the factory's service school. It should as a guide and reference book always be on hand for the daily work in the service shops.
Moreover we suggest to use the conveniently illustrated Spare Parts List, which shows the various main assemblies in their constructional arrangement, as an additional informative book.
Experience has shown that one of the best ways to create Customer Confidence is to offer efficient servicing in a clean workshop equipped with all necessary special tools, on expert advice of skilled mechanics.
This repair manual should, along with the Service Bulletins dealing with the current technical modifications, at the BMW Service Stations be handed over to the operators, who carry out the repair work. The technical records are issued for the workshop and not intended for the office shelves.
We hope the book will be a valuable aid for all concerned with repair work and an instructive reading for the enthusiast.

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Prólogo

El presente manual de reparaciones, dedicado a nuestro BMW 600, debe ser entre nuestros representantes y sus colaboradores el compendio para llevar a cabo las reparaciones de nuestros vehículos.
De ninguna manera trata el presente manual de sustituir la enseñanza práctica y teórica recibida por los mecánicos en nuestra escuela del servicio-clientela, sino que trata únicamente de ser el libro de consulta que facilita la ejecución de los trabajos diarios.
Como fuente de información adicional, se recomienda consultar paralelamente la lista de refacciones, la cual muestra con sus numerosas ilustraciones la construcción detallada de las diferentes unidades.
De la consulta de estos dos libros y de acuerdo con la labor organizada del personal especializado que opera en talleres bien montados y dotados de las herramientas especiales, se garantiza un trabajo correcto y un servicio ejemplar que redundan en beneficio del cliente.
Tanto el manual de reparaciones como las modificaciones técnicas dadas a conocer por medio de las circulares, deberán llegar a través de nuestros representantes a las manos de aquellas personas que llevan a cabo las reparaciones. Por lo tanto el lugar que le corresponde a estos documentos está en el taller y no en los archivos de las oficinas.
Esperamos haber logrado con la presente obra una labor de valor práctico para nuestros clientes y amigos.

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Contents

F = Chassis

A = Body

E = Electrical Equipment

S = Special Equipment

Introduction

The operations described throughout this repair manual can, with the necessary special tools, easily be carried out in well equipped workshops, by skilled mechanics.

The book is divided into major groups such as M = Engine, G = Transmission, etc. Each major group is further divided into subgroups in accordance with the layout of the various assemblies and the logical sequence of the corresponding service operations. This appropiate arrangement enables the operator to readily find the chapter he's looking for. The description of the various operations deals particularly with the dismantling, inspection and adjustment work, and where special care is required for the reassembling, this is explained under the remark "Caution".

The usual routine work known to any skilled mechanic is not mentioned in this manual. It goes without saying that on dismantling attention is to be paid to the arrangement of securing washers on screws and nuts, washers, gaskets, etc. With a view to facilitate correct assembly the mating and matched parts should be marked and kept in special service cases until they are needed for reassembly. Where torque limits are specified for bolts and nuts, appropriate torque wrenches must be used for the tightening. The various torque tightnesses are specified for undamaged, oiled threads. The remaining tightening work should be done by means of ring spanners or socket wrenches*) or screw drivers.

*) The abbreviation "SW" used in this connection means the German word "Schlüsselweite" (spanner width).

Because of the interference fits required for ball bearings, valve guides, etc. it is mostly necessary to heat the housings or other parts when assembling. For this purpose it is suggested to use heating furnaces, possibly with temperature regulation, or suitable electrical heating plates, eventually provided with protective shields. The maximum allowable temperature for such castings is approximately 284° F., whereas the cylinder heads resist temperatures up to 536° F. With some experience this heating can be done without special temperature gauges. To control the heating in any way, however, we recommend to provide the parts to be heated by means of "Thermochrome" coloured crayons with paint marks, which indicate a certain temperature range by changing from one colour shade to another.

Removed parts should be carefully cleaned and checked for suitableness and proper conditions. With the scope to promote efficient servicing at reasonable prices, general overhauls should not be offered unless replacement parts cannot be obtained from the factory.

At any and all service operations on the BMW 600 the service man should be mindful of the fact that only the utmost in craftsmanship will be keeping with the traditional reputation BMW products are enjoying all over the world.

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Technical Data

Engine

Type of engine	BMW flat-twin, 4 cycle unit
Engine cooling system	Air cooling with centrifugal blower
Valve actuation	Tappets, push rods and rockers
Valve arrangement	O. H. V. (overhead in cylinder-heads)
Camshaft drive	Spur gears
Material of cylinder barrels	Perlite casting
Material of cylinder heads	Light metal castings with shrunk-in valve seat inserts
Bore	74 mm (2.913")
Stroke	68 mm (2.677")
Cubic capacity	585 c.c. (35.7 cu. in.)
Compression space	approx. 52 c.c. (3.1 cu. in.) in each cylinder
Compression ratio	6,8:1
Compression pressure	128 to 156 lbs./sq. in. (measured with compression tester, the two spark plugs removed, with fully opened throttle valve and starting speed with fully charged battery, engine at normal operating temperatures).
Max. BHP	19.5 HP (acc. to SAE: 26 HP) at 4500 r. p. m.
Specific power output	33.5 HP/liter
Maximum torque	28.2 foot-pounds at 3000 r. p. m.
Mean piston speed	10.2 m/sec. (33.4 ft./sec.) at 4500 r. p. m.
Valve timing (with a valve clearance of 2 mm/.08") Tolerance ± 2.5°	Old settings: Int. valve opens 4° A. T. C. Int. valve closes 36° A. B. C. Exh. valve opens 36° B. B. C. Exh. valve closes 4° B. T. C. New settings: Int. valve opens 22° A. T. C. Int. valve closes 28° A. B. C. Exh. valve opens 41° B. B. C. Exh. valve closes 9° B. T. C.
Valve lash (cold)	Intake 0,15 mm (0.006")
(Running clearance)	Exhaust 0,20 mm (0.008")

Engine lubrication

Lubrication system	Wet sump system pressure feed lubrication
Oil pump	Gear-type oil pump
Oil passages	Drilled holes in engine housing
Oil filter	Full-flow micronic filter with pressure relief valve
Opening pressure of relief valve	35.5 lbs./sq. in.
Lubricant	Branded HD oils for Otto-cycle engines, SAE 10 W 30 in summer and winter
Engine oil capacity	2 liters (.5 U. S. gals./.44 Imp. gals.)
Oil consumption	2300 miles/U. S. gallon = 2800 miles/Imp. gallon approx.

Fuel system

Feeding system	By gravity
Fuel tank capacity	23 liters (6. U. S. gal. = 5 Imp. gal.) including 3 liters reserve.
Average fuel consumption (acc. to DIN 70030)	43 miles/U. S. gal. = 52 miles/Imp. gal.
Fuel tap	On fuel filter in engine compartment, with remote control from the driver's seat. The fuel tap must be shut as soon as the engine is stopped. The 1959 model features an automatic solenoid-controlled fuel tap.
Fuel filter	Water-trap inspection glass with micronic filter element
Carburetor air filter	Dry-type micronic filter
Carburetor	Zenith 28 KLP cross draft
Aspiration tube	28 mm (1.1") diam.

Carburetor adjustment

Carburetor type	Zenith 28 KL-P 1	Zenith 28 KL-P 2	Zenith 28 KL-P 3
From Chassis Number onwards	supersedes previous types	125959	139690
Venturi	23 mm. diam.	23 mm. diam.	23 mm. diam.
Main jet HD	152.5	140	155
Air correction jet KD	240	240	220
Emulsion tube MR	No. 3, 29.5 mm	No. 3, 29.5 mm	No. 4, 34.5 mm
Emulsion tube outlet	5.2Φ H8	5.2Φ H8	5.2Φ H8
Emulsion tube bores	2×1.5Φ and 2×1Φ	2×1.5Φ and 2×1Φ	2×1.5Φ and 2×1Φ
Pilot jet g	50	50	50
Pilot jet air bleed LLD	150	160	160
Idle mixture adjusting (control) screw	approx. 1 turn opened	approx. 1 turn opened	approx. 1 turn opened
Pump disch. valve PV	short	long (16 mm.)	short
Pump jet GP	50	70	70
Pump discharge nozzle	8 (0.4Φ)	7 (0.65Φ)	7 (0.65Φ)
Pump inlet check valve	50	55	55
Float needle valve SV	22	22	22
Float weight + needle	15 grams	15 grams	15 grams
Fuel level	3±1 mm.	3±1 mm.	3±1 mm.
Orifice in throttle plate	without	1Φ (mm.)	1Φ
Idle tube	incorporated in emulsion tube	incorporated in emulsion tube	incorporated in emulsion tube
Carburetor body	without overflow groove	with overflow groove	without overflow groove
Carburetor body	bored to 5.7Φ for g (pilot jet)		

Power Train and Chassis

Clutch

Make and type	F & S (Fichtel & Sachs) K 5, single dry plate

Transmission

Design	BMW design, transmission and differential combined in one compact unit. 4 synchronized speeds forward, one reverse.
Gearshift lever	Stick-shift
Gear ratios	

First	3.54 : 1	Overall ratio	19.4 : 1
Second	1.94 : 1	Overall ratio	10.5 : 1
Third	1.27 : 1	Overall ratio	6.9 : 1
Fourth	0.846 : 1	Overall ratio	4.9 : 1
Reverse	3.45 : 1	Overall ratio	18.7 : 1

Final drive	Spiral bevel pinion and ring gear (Palloid)
Ratio	5.43 : 1 (7 and 38 teeth)
Differential	2 planetary differential pinions
Rear axle shafts	Double rubber-coupled rear wheel drive shafts
Push feed	By trailing arms
Lubricant for transmission	Branded Engine Oil SAE 10 W 30, in summer and winter
Capacity	1.25 liters (2.6 U. S. pints/2.2 Imp. pints)

Rear suspension

Design	Independent suspension by oscillating trailing arms, connected with rubber units requiring no maintenance
Springs	Coil springs with hydraulic, telescopic shock absorbers. Spring travel 150 mm (5.9″)

Front suspension

Design	Independent suspension by oscillating leading arms in parallelogram arrangement, providing constant toe-in and camber settings.
Springs	Coil springs with hydraulic, telescopic shock absorbers. Spring travel 120 mm (4.7″)
Front wheel alignment	
Toe-in	2–3 mm = approx. 30′
Camber	1°30′
Caster	16°
Max. lock angle	
Inside wheel	33° } (track difference angle 13°
Outside wheel	20° } with wheels in full lock position)
Checking steering geometry:	With inside wheel turned to 20° away from straight ahead position, outside wheel stands at 16°±1° (track difference angle approx. 4°).
King pin inclination	5°
Wheel turning radius	55 mm (2.16″)
Lubricant	Engine Oil SAE 10 W 30
Capacity of each front suspension oil reservoir	13 c. c.

Wheels and Tires

Wheels	Steel disc with drop center r 3.5 × 10
Tires (tyres) (five-ply)	5.20–10
Tire pressures:	
1–2 occupants	Front 1.1 atm (15 lbs./sq. in.) Rear 1.6 atm (22 lbs./sq. in.)
3–4 occupants	Front 1.2 atm (17 lbs./sq. in.) Rear 1.8 atm (25 lbs./sq. in.)

Steering

Type	Spindle type steering
Steering ratio	15.4 : 1
Track rod	Single-piece track rod
Smallest turning radius (body contour radius)	8.30 meters (27 ft. approx.)
(chassis track radius)	8 meters (25 ft. approx.)

Brakes

Design ATE-BMW	Internal shoe brake with hydraulic operation on all four wheels
Brake drum material	Special iron casting
Brake drum diameter	180 (7.09″)
Brake lining width	30 mm (1.18″)
Brake lining thickness	4 mm (0.16″)
Total friction lining area	440 sq. cm. (68.2 sq. in.)
Brake master cylinder	Located under floor panel, c frame cross member. Fluid reservoir accessible from the interior of the vehicle.
Hand brake	Operates the brakes on the rear wheels, mechanically. Ratchet locking type.

Chassis and Body

Design	Sturdy welded tubular chassis frame with rugged cross members and mountings for power plant, pedal assembly, wheel suspensions and body (all-steel body).

Wheelbase	1700 mm	(66.9″)
Track (Tread), front	1220 mm	(48″)
Track (Tread), rear	1160 mm	(45.7″)
Ground clearance	165 mm	(6.5″)
Bulge (Bulk) clearance	150 mm	(5.9″)
Overall length	2900 mm	(114.2″)
Overall width	1400 mm	(55.1″)
Overall height	1375 mm	(54″)
Overhang front	512 mm	(20.2″)
Overhang rear	686 mm	(27″)

Chassis weight	305 kg	(673 lbs.)
Chassis carrying capacity	595 kg	(1310 lbs.)
Lubrication system	Oil reservoir for each front suspension unit, rear suspension trailing arms are rubber-connected and need no maintenance	
Permissible axle load, front	400 kg	(882 lbs.)
Permissible axle load, rear	530 kg	(1170 lbs.)
Max. total weight	900 kg	(1983 lbs.)
Curb weight	565 kg	(1245 lbs.)
Permissible trailer weight, braked	500 kg	(1100 lbs.)
Permissible trailer weight, unbraked	300 kg	(662 lbs.)

Performance Data

Speed Limits

Mileage registered	Permissible speeds (mph) in the individual gears			
	First	Second	Third	Fourth
0-1800 miles (running-in speeds)	12.5	22	31	43
Over 1800 miles	15	28	43.5	62.5

Cruising and maximum speed 100 km/h (62 mph)

Climbing ability

(values obtained with 4 people)

First over 33%
Second „ 18%
Third „ 9%
Fourth „ 6%

Retardation

(on dry concrete surface)

Braking efficiency 82% (reading taken from Siemens retardation measuring set) = 8,2 m/sec², with approx. 100 pounds pedal pressure, max. vehicle weight (approx. 1983 lbs.) and from approx. 31 mph.

Mean acceleration

Mean time to cover standing 500 m: 31 sec
Mean time to cover standing 1000 m: 52 sec
0–30 mph. 8.5 sec.
0–38 mph. 12.0 sec.
0–44 mph. 17.5 sec.
0–50 mph. 24.3 sec.
0–56 mph. 37.4 sec.

Electrical system

Dynamo starter	Bosch LA–BM 12/130 R (new designation AZ/DJ2 T 13 12/1800 + 0.6 R 3)
Brush tension on commutator	325 – 375 grams (11.5 – 13.2 oz
Dynamo rated output	130/190 watts, with voltage regulation

Dynamo (Generator)

Test specifications with cold generator:

Volts	12 V
Current	13–14 Amps
Nominal voltage speed rate	1300–1350 r.p.m.
Speed rate at output test,	cold 1600 r.p.m. warm 1800 r.p.m.

Voltage regulator

	Old type RS/ZD 60/130/12/4	New type RS/ZD 60–130/12A4
a) Cutout relay		
Closing voltage	12.9–13.7 V	13.0–13.6 V
Cutout current	4–8.0 A	4–9 A
b) Regulator control voltage		
Without load	14.4–15.6 V	14.5–15.5 V
With load	13.3–14.6 V	13.7–15.0 V
Adjusting load	130 W	130 W
Load amperage	12.5 Amps	13 Amps

Starter

Test data with cold generator (measured on test bench)

(With 24 Ah-battery)	Voltage V	Current A	Speed rate r.p.m.
Without load	11.8	9–14	830–900
With load	10.3	122–128	240–260
Lock test	8.6	244–254	–

Starter control	Ignition-starter switch via relay
Switch relay cranking voltage	3.5–4.5 V
Switch relay cutout voltage	1.5–2.5 V
Battery	12 V/24 Amp/hours
Ignition	Battery ignition
Contact breaker gap	0.4 mm (.016")
Contact breaker point tension	600–700 grams (21.2–24.7 oz.)
Dwell angle	approx. 205°
Ignition timing	Centrifugal advance unit
Initial ignition timing	10° before TDC = approx. 18 mm (.71") on flywheel periphery, with idling speed of 800–900 rpm (governor weights in initial position)
Advance unit starts to function	at approx. 850 r.p.m.
Timing range of centrifugal governor	approx. 22°
Maximum spark advance	approx. 32° before TDC = approx. 58 mm (2.28") on flywheel periphery, at approximately 4500 r.p.m.

Ignition coil test data (Bosch TJ 6/9)

Cranking distance of the spark	5 mm (0.2″) (with half rated voltage and 200 sparks per minute)
Operating distance of the spark (ignition coil at normal operating temperatures)	8 mm (0.3″) (with rated voltage and 4000 sparks per minute)
Maximum number of sparks	8000 per minute (with 6 mm (.24″) spark distance)
Input	9 watts (on one coil)
Spark plugs	Bosch W 240 T 2 (long thread) Beru 240/14/3 u 3
Electrode gap	0,7 mm (.028″)

The aforementioned electric test values have been obtained with Bosch test benches and devices.

Lighting system 12 V

Headlight Bilux bulb (asymmetric traffic [low] beam)	2×	40/45	W	(for BMW 600, US. Model, see corresponding Instruction Manual)
Parking light in headlamp shell	2×	2	W	
Turn signal & stop/tail light				
Tail light	2×	5	W	
Turn signal & stop light	2×	15	W	
Front turn signal light	2×	15	W	
License plate light	1×	10	W	
Interior strip bulb	1×	5	W	
Indicators for high beam, turn signal, generator and two bulbs for speedometer dial illumination	5×	2	W	

Fuse box (on front door, below the trimming panel for the spare wheel).

Protection of the various circuits by: 6 fuses, which are all of a capacity of 8/15 Amps

With the fuses seen from **right** to **left,**

Fuse 1 protects:	Flasher and high beam of one headlamp.
Fuse 2 protects:	Flasher and high beam of the other headlamp and high beam indicator light.
Fuse 3 protects:	Low beam of both headlamps.
Fuse 4 protects:	Tail light right, rear number plate and speedometer dial lights.
Fuse 5 protects:	Tail light left and parking lights.
Fuse 6 protects:	Turn signal flasher, horn, stop light and windshield wiper.

Fits and Clearances

Engine

Crankshaft

Interference fit of the two main bearing inner races on journals	0,01–0,025 mm (.0004″–.001″)
Interference fit of the outer ball bearing (timing gear case side) on journal	0,005–0,025 mm (.0002″–.001″)
Tension of oil seal lip on crankshaft journal (52Ø)	approx. 2 mm (.08″). This tension may if necessary be reduced to 1,5 mm (0.06″) by regrinding the seal ring mating crankshaft surface.
Max. allowable out-of-round on crankshaft journal outer ends, with crankshaft supported on main bearing seats	0,01 mm (.0004″)
Max. allowable eccentricity of the two main bearing journals	0,2 mm (.008″) (corresponds to approx. ± 10′ offset position of crankwebs on crankpin)
Max. allowable out-of-round with installed dynamo armature, measured on commutator	0,04 mm (.0016″)
Flywheel clutch face runout (max.)	0,1 mm (.004″)
Tension of oil seal lip on flywheel hub (28Ø)	approx. 1 mm (.04″). This tension may if necessary be reduced to 0,8 mm (.32″) by regrinding the hub.
Crankpin diameter	$36_{-0,020}$ mm (1.417″–1.416″)

Connecting rod

Fit of connecting rod bearing on crankpin	Without noticeable clearance, but must turn freely.
Diametrical clearance of bearing rollers in roller cage	0,05–0,15 mm (.002″–.006″)
End play of rollers in cage	0,10–0,20 mm (.004″–.008″)
Side clearance of connecting rod on crankpin	0,07–0,09 mm (.0028″–.0035″)
Running clearance between connecting rod bushing and piston pin	0,007–0,020 mm (.00028″–.0008″)

Connecting rod – Twist and Bend total difference (maximum). (Piston pin in small-end bushing and crankpin must be parallel within the specified total difference)	0.1 mm (0.004″), referred to piston pin length

Piston

Fit of pin in piston	Slight snug fit (pin can easily be pushed in by hand, at 68° F.)
Piston pin position in piston	1,5 mm (.06″) offset (small side is pressure loaded on working stroke)
Piston to bore clearance-Bottom of skirt, new limits (piston diameter and installing direction marked on piston head)	0,06–0,07 mm (.0024″–.0028″)
Max. piston to bore clearance, worn limit	not over 0,18 mm (.0071″)
Piston ovality	0,15 $\pm$ 0,015 mm (.0065″–.0053″)

Piston ring gaps (and clearances)

Piston ring 1 (hard chromed)	0,30 mm (.012″) (chamfered inside edge towards piston head!)
Piston ring 2	0,20 mm (.008″)
Oil ring	0,20 mm (.008″)

Piston ring side clearances in piston grooves

Piston ring 1 (hard chromed)	0,04 mm (.0016″)
Piston ring 2	0,03 mm (.0012″)
Oil ring	0,02 mm (.008″)

Cylinder

Cylinder bore diameter standard	74,00 mm (2.9134″) Diameter divergence from specified size marked on side of cylinder flange.
1st oversize	74,50 mm (2.9331″)
2nd oversize	75.00 mm (2.9528″)

Cylinder head

Intake valve seat insert	
material	Special grey cast iron
Shrink fit in cylinder head	0,20–0,22 mm (.0079″–.0087″)
Exhaust valve seat insert	
material	Heat-resistant special steel
Shrink fit in cylinder head	0,16–0,18 mm (.0063″–.0071″)
Cylinder head temperature for installation of new valve seat inserts	428°–518° F.
Valve seat angle on intake and exhaust valve seat insert	45° +30′
Outer correction angle	15°
Valve seat width, intake	approx. 1,6–2,0 mm (.065″–.080″)
Valve seat width, exhaust	approx. 2,0–2,4 mm (.080″–.095″)
Eventual inner correction angle	75°

Valve guides and Valves

Material (valve guide)	Bronze
Cylinder head temperature required for pressing in the valve guides	428°–518° F. (For guide replacement alone, approx. 266° F suffice)
Bore in valve guide, after shrinking-in, recooling and reaming	$7\ ^{+0,005}_{-0,010}$ mm (.2752″–.2758″)
Valve stem diameter	$7\ ^{-0,050}_{-0,065}$ mm (.2736″–.2730″)
Valve stem to valve guide clearance (Int. and Exh.)	0,040–0,070 mm (.0016″–.0028″)
Wear limit	0,15 mm (.0059″)
Valve head diameter:	
Intake valve	34 mm (1.339″)
Exhaust valve	32 mm (1.260″)
Minimum valve head edge thickness when regrinding	0,7 mm (.028″)
Maximum valve face runout	0,03 mm (.0012″)

Valve springs	inner	outer
Wire diameter	2.50 mm (.098″)	3,80 mm (.150″)
Coil outer diameter	23,50 mm (.925″)	33.30 mm (1.311″)
Valve spring free length	33.25 mm (1.309″)	42,30 mm (1.665″)
Valve spring pressure (lbs.) and specified test length (inches)	10.4 lbs./1.142″ 27.6 lbs./ .876″	40.8 lbs./1.339″ 79.4 lbs./1.035″

Rocker arms and Tappets

Rocker arm bushing to rocker shaft clearance	0,01–0,045 mm (.0004"–.0018")
Side play of rocker arms	0,01–0,02 mm (.0004"–.0008")
Valve tappet to tappet guide bushing clearance	0,02–0,04 mm (.0008"–.0016")

Camshaft

Interference fit of ball bearing inner race (20Φ) on camshaft (flywheel side)	0,005–0,025 mm (.0002"–.0010")
Interference fit of ball bearing inner race (25Φ) on camshaft (timing gear side)	0,005–0,02 mm (.0002"–.0008")
Interference fit of timing gear on camshaft	0,05–0,08 mm (.002"–.003") (To press on the gear, heat same to approx. 176° F.)
Backlash between crankshaft gear and camshaft gear	0,01–0,03 mm (.0004"–.0012") (replacement only by pairs, see M 7/13.)

Engine housing

Interference fit of bearing bushing (flywheel side) in engine housing	0,020–0,030 mm (0.0008"–0.0012")
Interference fit of main bearings (outer races 80Φ and 85Φ) in bearing bushing	
(grey cast iron bush)	0.001–0.0012" Bushing installed in engine housing
(leight metal bushing)	0.0016–0.002" Bushing installed in engine housing
Interference fit of the outer ball bearing in gearcase cover	0,005–0,035 mm (.0002"–.0014")
Interference fit of camshaft front bearing (flywheel side) in engine housing	0,020–0,030 mm (0.0008"–0.0012")
Interference fit of camshaft rear bearing (timing gear side) in bearing bushing	0,005–0,015 mm (0.0002"–0.0006")

Torque Limits

Cylinder head bolts	28.9–32.5 foot-pounds
Flywheel retaining bolts	36.2–39.8 foot-pounds
Dynamo armature cone to crankshaft	36.2 foot-pounds
Centrifugal regulator cone to dynamo armature and to crankshaft, respectively	25.3 foot-pounds

Clutch

Clutch disc runout (max.)	0,5 mm (0.02") (supported on splined measuring arbour)
Clutch release bearing runout (max.), clutch fitted to flywheel	0,4 mm (0.015")
Distance between clutch release bearing and bell housing mating surface (measure b), new limits	4,5–5,5 mm (0.18"–0.22")

Transmission

Main drive shaft (Input shaft)

Interference fit of the two ball bearing inner races on main drive shaft	0,005–0,020 mm (.0002–.0008")
Interference fit of third and fourth speed gear on main drive shaft	0,020–0,070 mm (.0008"–.0028")
Oil seal seat 22 Φ	may if necessary be reground to 21.5Φ
Max. allowable out-of-round of main drive shaft supported at the two ends (centering bores)	0,04 mm (.0016") on center ball bearing seat and on oil seal seat.
End play of main drive shaft in housing (the outer ball bearing of main drive shaft absorbs the axial thrust)	0,2 mm (.008") (Adjustment of end play see G 2/2.).

Pinion shaft (Output shaft)

Interference fit of ball bearing and double-row taper bearing	0,005–0,020 mm (.0002–.0008")
Interference fit of the two clutch gears	0,01–0,035 mm (.0004"–.0014")
Fit of needle bearing bushings on pinion shaft (27Φ, 27,2Φ and 28Φ)	0.005 loose – 0.005 tight (.0002"–.0002")
End play of speed gears on pinion shaft	
1st speed gear	0,07–0,30 mm (.0028"–.012")
2nd to 3rd speed gear	0,20–0,30 mm (.008"–.012")
4th speed gear	0,15–0,25 mm (.006"–.010")
Radial clearance of speed gears (needle bearings)	0,01–0,03 mm (.0004"–0012")
Backlash of gear pairs	0,12–0,15 mm (.0048"–.006")

Speedometer drive pinion

Pinion axle end to housing clearance	
on 10 mm ⌀	0,013–0,050 mm (.00052″–.002″)
on 22 mm ⌀	0,020–0,065 mm (.0008″–.0026″)

Transmission and Differential housing

Interference fit of ball bearing outer races (two bearings 6205 of main drive shaft, bearings 6305 and 3306 of pinion shaft and two bearings 6208 of differential assembly).	0,001–0,035 mm (.00004″–.0014″)

Differential assembly

Fit of ball bearing inner races on hub of differential case and on side gear retainer (differential case cover)	0,005–0,025 mm loose (.0002″–.0010″)
Interference fit of differential pinion shaft in differential case	0–0,012 mm tight (0–.00048″)
Clearance between differential side gear shafts and differential case and differential cover, respectively	0,020–0,080 mm (.0008″–.0032″)
Interference fit of shim (behind differential side gear) in differential case and differential cover	0,003–0,070 mm (.00012″–.0028″)
Differential pinion bore to differential pinion shaft clearance	0,010–0,060 mm (.0004″–.0024″)
Backlash between differential side gear and differential pinion	Minimum 0,1 mm (0,004″)
Backlash between crown gear and pinion	0,10–0,15 mm (.004″–.006″), in accordance with gear tooth contact pattern.
End play of differential side gear with installed three-legged flange	0,1 mm (.004″) (with differential side gear thrust against the differential pinion the teeth must mesh without any roughness. The axial thrust is absorbed by the thrust washer behind the three-legged flange).
Seal ring seat (40⌀) on three-legged flange (tension of oil seal lip)	The flange hub may, when found with scored surface, be reground to 39,5 mm (1.948″) ⌀.

Torque limits for bolts

Castle nut for three-legged flange on differential side gear	87 foot-pounds
Drive gear (crown wheel) mounting bolts	25 foot-pounds

Fit of ball bearing inner races on rear axle shaft	
Inner ball bearing	0.01 to 0.03 mm (0.0004″–0.0012″) loose
Outer ball bearing	0.01 to 0.03 mm (0.0004″–0.0012″) loose
Fit of ball bearing outer race in trailing arm	
Inner ball bearing	0.015 mm loose to 0.015 mm tight (0.0006″ to 0.0006″)
Outer ball bearing	0.015 mm loose to 0.015 mm tight (0.0006″ to 0.0006″)
Thicknesses of shims to correct position of wheel bearings	0.18–0.20–0.24 mm (0.0071–0.0079–0.0095″)
Tension of sealing ring lip on rear axle shaft (30 mm ⌀)	0.8–1.4 mm (0.032″–0.056″). Can if necessary be reduced to 0.5 mm (0.02″) by grinding the mating surface on rear axle shaft.
Tension of sealing ring lip on rear wheel drive flange (58 mm ⌀)	1.0–1.6 mm (0.04″–0.064″). Can if necessary be reduced to 0.7 mm (0.028″) by grinding the mating surface on drive flange.
Torque limit for nuts of three-legged flange to rubber joint coupling bolts	32.5 foot-pounds
Torque limit for nuts SW 19 of trailing arm silent-bloc mounting bolts	47 foot-pounds
Torque limit for the mounting bolts SW 14 of brake support plate	21.7 foot-pounds

Rear coil spring

Wire diameter	11 mm (0.44″)
Coil outer diameter	96 mm (3.78″)
Coil spring free length	320 mm (12.6″)
Coil spring pressure with a test length of 210 mm (8.2″)	551 pounds

Rear shock absorber

Test stroke of test machine	25 mm (0.9843″)	75 mm (2.9528″)
R.P.M. number	100	100
Tensile force	121 pounds	275 pounds
Pressure force	22 pounds	44 pounds
Installing length from center of silent-bloc eye to dust shield top edge	287.5 mm (11.3″)	
Max. length, extended	334 mm (12.7″)	
Min. length, compressed	225 mm (8.85″)	

Torque limit for lower mounting nut SW 17 of rear shock absorber	25.3 foot-pounds

Rear wheel alignment

Camber	0°
Toe-in on each roadwheel	15′ ± 15′ = approx. 2.5 mm (0.1″)

Front suspension

Fit of ball bearing inner races on oscillating arm	
Inner ball bearing	0.015 mm loose to 0.010 mm tight (0.0006″ to 0.0004″)
Outer ball bearing	0.010 mm loose to 0.010 mm tight (0.0004″ to 0.0004″)
Fit of ball bearing outer races in wheel hub	
Inner ball bearing	0.015 mm loose to 0.015 mm tight (0.0006″ to 0.0006″)
Outer ball bearing	0.015 mm loose to 0.015 mm tight (0.0006″ to 0.0006″)
Thicknesses of shims to correct position of wheel bearings	0.18–0.20–0.24 mm (0.0071–0.0079–0.0095″)

Front coil spring

Wire diameter	8.5 mm (0.33″)
Coil outer diameter	62.5 mm (2.46″)
Coil spring free length	280 mm (11″)
Coil spring pressure with a test length of 202 mm (7.95″)	440 pounds

Front shock absorber

Test stroke of test machine	25 mm (0.9843″)	75 mm (2.9528″)
R.P.M. number	100	100
Tensile force	55 pounds	286 pounds
Pressure force	11 pounds	22 pounds
Installing length from center of silent-bloc to piston rod end	310 mm (12.2″)	
Max. length, extended	343 mm (13.5″)	
Min. length, compressed	260 mm (10.2″)	
Torque limit for hex. nut SW 24 of shock absorber mounting bolt	101 foot-pounds	

Steering knuckle king pin

Interference fit of king pin bushings in front axle carrier	0.015 to 0.055 (0.0006″ to 0.0022″)
Bore of pressed-in bushings, co-axially reamed to measure (20 Ø F7)	$20\ ^{+0.040}_{+0.020}$ mm (0.7882″ to 0.7890″)
Clearance of king pin to bushings	0.02 to 0.05 mm (0.0008″ to 0.0020″)
Axial clearance of front axle carrier to frame stub	0 to 0.05 mm (0 to 0.002″)

Swing arm bearing

Bore for needle bearing bushings in front axle carrier	$32\ ^{-0.025}_{-0.050}$ mm (1.2594″–1.2603″) New needle bearing bushings have an accurately machined outer diameter, so when pressing-in the bushings the prescribed interference fit is automatically obtained.
Thicknesses of shims to adjust axial clearance of swing arm	1.5–1.55–1.60–1.65–1.70 mm (0.0591–0.0611–0.0630–0.0650–0.0669″)
Axial clearance of swing (oscillating) arm in front axle carrier	0.03 to 0.13 mm (0.0012″ to 0.0052″)

Brake plate stay

Interference fit of bearing bush in front axle carrier	0.015 to 0.055 mm (0.0006″ to 0.0022″)
Bore of pressed-in bushing, reamed to measure (22 Ø H7)	$22\ ^{+0.020}$ mm (0.8661 to 0.8669)
Diameter of brake plate stay shaft	$22\ ^{-0.020}_{-0.040}$ mm (0.8646″ to 0.8654″)
Clearance of brake plate stay shaft to the bushings	0.020 to 0.060 mm (0.0004″ to 0.0024″)
Control measure for depth of silent-bloc pressed in the eye of brake plate stay	$64.5\ ^{\pm 0.2}$ mm ($2.54\ ^{\pm 000.8}$″)
Torque limit for brake plate to stay mounting nut SW 19	57.9 foot-pounds

Roadwheels

Allowable unbalance of front wheel with tire fitted (red spot of tire to valve!)	10 grams measured on rim edge
Sizes of available balancing weights	20; 30; 40; 50 and 60 grams

Steering

Radial distance of directional flasher turn-off cam to switch finger of flasher	Approx. 0.5 mm (0.02″)
Fit of outer race of angular contact ball bearing in steering gearbox cover	0.02 mm loose to 0.02 mm tight (0.0008″ to 0.0008″)
Interference fit of inner race of angular contact ball bearing on steering worm	0 to 0.02 mm tight (zero to 0.0008″)
Fit of outer race of angular contact ball bearing in eye of steering gear arm	0.015 mm loose to 0.005 mm tight (0.0006″ to 0.0002″)
Fit of inner race of angular contact ball bearing on bolt in steering gear arm eye	0 to 0.02 mm tight (zero to 0.0008″)
Lateral fit of steering gear arm eye in yoke of steering worm sliding nut	Without noticeable side clearance. If necessary, rectify front face of yoke bolt bushing sligthly and tighten bolt nut securely
Interference fit of steering shaft bearing bushes in frame tube	0.015 to 0.08 mm (0.0006″ to 0.0032″)
Bore of pressed-in steering shaft bushings, co-axially reamed to measure (25 Ø H7)	25 $^{+0.020}$ mm (0.9843″ to 0.9851″)
Diameter of steering arm shaft	25 $^{-0.020}_{-0.035}$ mm (0.9835″ to 0.9829″)
Diameteral clearance of steering arm shaft to bushings	0.02 to 0.055 mm (0.0008″ to 0.0022″)
Axial (side) clearance of steering arm shaft (arms fitted) in its bearings	Without noticeable side play
Torque limit for steering wheel fastening nut	30 foot-pounds

Brakes

Interference fit of bearing bush in brake support plate	0.05 to 0.165 mm (0.002″ to 0.0065″)
Bore of pressed-in bearing bush, reamed to measure (30 Ø H7)	30 $^{+0.020}$ mm (1.1810″ to 1.1818″)
Clearance of bearing bush on swing arm	0.01 to 0.045 mm (0.0004″ to 0.0018″)
Brake drum diameter	180 mm (7.09″)
Drum maximum boring limit	181 mm (7.125″) If necessary refinish to 2 repair diameters: 1st repair diameter 180.5 mm (7.1062″) 2nd repair diameter 181.0 mm (7.125″)
Allowable brake drum ovality	Max. 0.10 mm (0.004″)
Allowable brake drum taper	Max. 0.08 mm (0.0032″)

Master cylinder 8859K38 21/32" OD

Nominal diameter 5/8″	15.87 mm (.625)
Maximum allowable cylinder bore diameter	15.97 mm (0.628″)
Minimum allowable piston diameter	15.74 mm (0.619″)
Piston to cylinder clearance (maximum)	0.23 mm (0.0092″)

Wheel cylinders, front 8850K711 3/4" OD

Nominal diameter 11/16″	17.46 mm (.6875)
Maximum allowable cylinder bore diameter	17.56 mm (0.691″)
Minimum allowable piston diameter	17.33 mm (0.682″)
Piston to cylinder clearance (maximum)	0.23 mm (0.0092″)

Wheel cylinders, rear 8859K34 17/32" OD

Nominal diameter ½″	12.70 mm (.5)
Maximum allowable cylinder bore diameter	12.80 mm (0.50″)
Minimum allowable piston diameter	12.57 mm (0.493″)
Piston to cylinder clearance (maximum)	0.23 mm (0.0092″)