Service Manual
Maintenance, Tuning, Unit Replacement
Passenger Cars Starting August 1959

Mercedes-Benz
service

Volume 1

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FOREWORD

This Service Manual refers to the passenger cars built from August, 1959 to December 1967 of the Models 190 c, 190 Dc, 200, 200 D, 220 b, 220 Sb, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE, 250 SL, 300 SE, 300 SEb and 300 SEL. It contains pertinent data, dimensions and tolerances as well as special tools for the various individual operations which are listed within the text. The various repair and maintenance procedures outlined herein are procedures designed to be used by trained Mercedes-Benz service and repair station personnel. Supplements as such are no longer available for this Service Manual.

Mercedes-Benz of North America, Inc. recommends that repairs to, and maintenance of Mercedes-Benz automobiles be performed only by Mercedes-Benz trained personnel at authorized Mercedes-Benz repair stations.

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Directions for the Use of the Service Manual

1. Explanation of abbreviations which come after the Model designation:

Lim.	=	Sedan
Cp	=	Coupé
Ca	=	Convertible
. . ./C	=	Coupé and Convertible

   The abbreviations behind the Model designations are only used when there are differences between the sedan version and the convertible or coupé version as is the case in Model 220 SEb. The abbreviations are not used when all 3 versions are identical.

2. All measurements are given in millimeters (mm) unless otherwise specified, e. g. kilogram (kg) or liter (ltr.) etc.

3. Part Numbers are only given for the identification of various versions. **When ordering spare parts always quote the part numbers from the Spare Parts Lists.**

4. The terms "left, right, front or rear" as used in the text refer to the direction of travel if not otherwise designated.

5. The entire contents of this service manual is subdivided into groups, and within the groups into job numbers. The group index on the following page makes finding the various groups more convenient. Each group has an index to show the job numbers.

Index of Groups

General, Technical Data - Group 0

Daimler-Benz, Nachtrag 39, englisch, Kurzfassung

Technical Specifications

Modification: Models as from August 1965 added

Job No.
0-3

Type

Car model	190 c	200	190 Dc	200 D
Chassis type	110.010		110.110	
Engine model	M 121 B.V	M 121 B.XI	OM 621.III	OM 621.VIII
Engine type	121.924	121.940	621.912	621.918

Design Characteristics

Standard version	Two-circuit brake system with power brake
	Front disk brakes
Optional	Floor-mounted gear-shift system
	DB automatic transmission with steering-wheel or floor-mounted gear-shift system
	DB power steering

Engine

Operation	4-cycle carburetor	4-cycle diesel DB precombustion chamber, constant flow principle		
Number of cylinders	4			
Bore/stroke mm	85/83.6	87/83.6		
Total effective piston displacement cm³	1897	1988		
Compression ratio ε	8.7 : 1	9 : 1	21 : 1	
Fire or injection order	1—3—4—2			
Maximum speed rpm	6000		4320	
Engine performance in metric HP according to DIN[1] at rpm / in grHP according to SAE at rpm	80/5000 90/5200	95/5200 105/5400	55/4200 60/4200	
Maximum torque in mkg at rpm DIN rating / in mkg at rpm SAE rating	14.5/2500 15.6/2700	15.7/3600 16.9/3800	11.5/2400 12.0/2400	
Crankshaft bearings — design	Compound plain bearings with steel-backed shells			
Crankshaft bearings — number	3	5	3	5
Connecting-rod bearing design	Compound plain bearings with steel-backed shells			
Valve arrangement	overhead vertical			
Camshaft location	top			
Oil cooling	Oil-water heat exchanger			
Cooling system	Water circulation through pump, thermostat with by-pass pipe, fan and flanged tube radiator			
Lubrication	Forced-feed lubrication by means of gear-type pump			
Oil filter	Main flow filter		Combined main-flow and by-pass filter	
Air cleaner	Silencer filter with paper element		Oil bath silencer filter	

[1]) The metric horsepower specified is actually available at the clutch, since the power used by the engine accessories has already been deducted.

Model			190 c	200	190 Dc	200 D

Electrical Equipment

			190 c	200	190 Dc	200 D
Battery	Voltage (V)	V	12	12	12	
	Capacity (Ah)	Ah	52[1])	44	66	

Dimensions

			190 c	200	190 Dc	200 D
Track	front	mm	1482[2])			
	rear	mm	1485			
Wheel lock	inner		39°			
	outer		32° 30′			
Minimum turning circle diameter		m	approx. 11.4			
Wheel base		mm	2700			
Length of vehicle		mm	4730			
Width of vehicle		mm	1795			
Height of vehicle, curb condition		mm	approx. 1495			
Ground clearance with full load approx.		mm	140	130	140	130

Weights

		190 c	200	190 Dc	200 D
Unladen weight of vehicle according to DIN 70 020, in curb condition, with full fuel tank, spare wheel and tools	kg	1250	1275	1300	1325
Permissible total weight	kg	1750	1775	1800	1825
Permissible axle load front/rear	kg	790/960	795/980	830/970	845/980

Capacities

			190 c	200	190 Dc	200 D
Fuel tank/reserve	fuel approx.	ltr.	52/5	65/9 + 3	52/5	65/9 + 3
Cooling system with heating	water approx.	ltr.	10.1			
Crankcase (without oil filter) max./min.	HD engine oil	ltr.	4/2.5			
Oil filter	HD engine oil approx.	ltr.	0.5		1	
Water pump	Hypoid transmission oil SAE 90	cm^3	10			
Hydraulic clutch actuation	brake fluid approx.	ltr.	0.1[3])			
Mechanical transmission	Automatic transmission fluid (ATF)	ltr.	1.4			
Automatic transmission	Automatic transmission fluid (ATF)	ltr.	4.5[4])			
Rear axle	Hypoid transmission oil SAE 90	ltr.	2.5			
Steering	Hypoid transmission oil SAE 90	ltr.	0.3			
Power steering	Automatic transmission fluid (ATF)	ltr.	1.4			
Front wheel hub	Anti-friction bearing grease (per hub)	g	65—80			
Brake system	Brake fluid approx.	ltr.	0.5[5])			

[1]) 2nd version; 1st version 12 V, 56 Ah.
[2]) On vehicles with front disk brakes. Was 1468 mm on Models 190 c and 190 Dc with front drum brakes.
[3]) 0.05 ltr. on Models 190 c and 190 Dc with supply cylinder in the engine compartment. The right-hand drive Models 200 and 200 D have a common fluid reservoir for brake and clutch actuation.
[4]) Applies to first filling only, for oil changes approx. 1 liter less.
[5]) See also footnote[3]).

Model	190 c		200		190 Dc		200 D	

Speeds, Consumption Figures and Operating Conditions

At rear axle ratio i =	4.10		4.08		3.90		3.92	
Maximum speeds in the individual gears (km/h) timed	mech. transm.	auto-matic transm.	mech. transm.	auto-matic transm.	mech. transm.	auto-matic transm.	mech. transm.	auto-matic transm.
1st gear	42		40	42	32			
2nd gear	68		75	67	55			
3rd gear	111		125	108	86			
4th gear approx.	145	142	160	155	125	123	130	127
Climbing ability (%)								
1st gear theoretical/ slip limit	58/46	55/45.5	61/46.5	57/46.5	38	36	38	36
2nd gear	29	31	29	32	20	21	20	21
3rd gear	17		16	18	12		10.5	12
4 th gear	9.6		10		6.5		6.5	
Acceleration, engaging the individual gears 0—100 km/h Carrying 2 persons (sec.) ± 7 %[1]	17.7	17.8	15.2	15.1	30	30.7	30	30.7
Engine speed at 100 km/h in 4th gear (rpm)	3475	3475 to 3600	3470	3470 to 3610	3310	3310 to 3405	3320	3320 to 3420
Fuel consumption Consumption for average highway travel (ltr./100 km/h)[2]	8.5-13.5		9-14		6.5-9		7-9	
Fuel consumption according to DIN 70030[3] (ltr./100 km)	10.8 at 109 km/h		10.9 at 110 km/h		7.6 at 93.7 km/h		8.1 at 97.5 km/h	
Engine oil consumption (ltr./100 km)	0.15-0.20							
Cooling water working temperature (°C)	70-95							
Fuel	Premium or benzol-gasoline mixture				Diesel fuel DIN 51601			
Antiknock rating (minimum ROZ) for maximum output[4]	96		98		—			
Antiknock rating (minimum ROZ) with maximum retardation of ignition involving a loss of performance	90				—			

[1]) The "±7%" range covers not only differences due to permissible engine performance tolerance but also deviations sometimes produced by the tires. Cars with automatic DB transmission should be accelerated with kickdown in shift position 4.

[2]) On cars with automatic transmission, fuel consumption figures are about 5-10% higher.

[3]) Determined at 3/4 of the maximum speed, at a maximum of 110 km/h with a 10 % increase.

[4]) The gasoline engines are adjusted at our works with commercial fuels to maximum output. If it should be necessary for a limited period of time to use fuels with an antiknock rating below that given for maximum output the ignition must be retarded accordingly in all cases.

Daimler-Benz, Nachtrag 39, englisch, Kurzfassung

B. Models 230, 220 b, 220 Sb, 230 S, 250 S

Type

Car Model	230	220 b	220 Sb	230 S	250 S
Chassis type	110 011	111 010	111 012	111 010	108 012
Engine model	M 180.VI (M 180.X)[1]	M 180.IV	M 180.V	M 180.VIII	M 108.I
Engine type	180 945 (180 949)[1]	180 940	180 941	180 947	108 920

[1]) Designation of engine with INAT carburetor system; installed as from chassis end number 017 649.

Design Characteristics

Standard version	Two-circuit brake system with power brake Front disk brakes	[2])
Optional	Floor-mounted gear-shift system automatic DB transmission with steering-wheel or floor-mounted gear-shift system DB power steering Hydropneumatic compensating spring with level control[3])	

[2]) Two-circuit brake system with front and rear disk brakes. Hydropneumatic compensating spring with level control.
[3]) On Model 250 S installed as standard part.

Engine

	230	220 b	220 Sb	230 S	250 S
Operation	4-cycle carburetor				
Number of cylinders	6				
Bore/stroke mm	82/72.8	80/72.8		82/72.8	82/78.8
Total effective piston displacement cc	2306	2195		2306	2496
Compression ratio ε	9 : 1	8.7 : 1		9 : 1	
Fire or injection order	1—5—3—6—2—4				
Maximum speed rpm	6000				6300
Engine performance in metric HP according to DIN[4]) at rpm	105/5200 (120/5400)[5])	95/4800	110/5000	120/5400	130/5400
in grHP according to SAE at rpm	118/5400 (135/5600)[5])	105/5000	124/5200	135/5600	146/5600
Maximum torque in mkg at rpm DIN rating	17.7/3600 (18.2/4000)[5])	17.2/3200	17.5/3500	18.2/4000	19.8/4000
in mkg at rpm SAE rating	19.0/3800 (20.0/4200)[5])	18.4/3300	19.2/3700	20.0/4200	21.75/4200
Crankshaft bearings design	Compound plain bearings with steel-backed shells				
number	4				7
Connecting-rod bearings design	Compound plain bearings with steel-backed shells				
Valve arrangement	overhead vertical				
Camshaft location	top				
Oil cooling	Oil-water heat exchanger				
Cooling system	Water circulation through pump, thermostat with by-pass pipe, fan and flanged tube radiator[6])				
Lubrication	Forced-feed lubrication by means of gear-type pump				
Oil filter	Main flow filter				
Air cleaner	Silencer filter with paper element				

[4]) The metric horsepower specified is actually available at the clutch, since the power used by the engine accessories has already been deducted.
[5]) Performance data for engine with INAT carburetor system.
[6]) On Model 250 S Visco fan coupling.

Model			230	220 b	220 Sb	230 S	250 S

Electrical Equipment

			230	220 b	220 Sb	230 S	250 S
Battery	voltage	(V)	12[1])				
	capacity	(Ah)	44				

Dimensions

			230	220 b	220 Sb	230 S	250 S
Track	front	mm	1482[2])				
	rear	mm	1485				
Wheel lock	inner		39°				
	outer		32° 30′	33°[3])		32° 30′	
Minimum turning circle diameter		m	11.4	11.5			
Wheel base		mm	2700	2750			
Length of vehicle		mm	4730	4875			4900
Width of vehicle		mm	1795				1810
Height of vehicle, curb condition		mm	1495	1500			1440
Ground clearance with full load	approx.	mm	130	140		145	

Weights

		230	220 b	220 Sb	230 S	250 S
Unladen weight of vehicle according to DIN 70020, in curb condition, with full fuel tank, spare wheel and tools	kg	1305	1320	1345	1350	1440
Permissible total weight	kg	1805	1820	1845	1850	1940
Permissible axle load front/rear	kg	825/980	840/980	855/990	860/990	885/1055

Capacities

			230	220 b	220 Sb	230 S	250 S
Fuel tank/reserve	fuel approx.	ltr	65/9+3[4])				82/12 ÷ 5
Cooling system with heating	water approx.	ltr	14	11.4			
Crankcase (without oil filter) max./min.	HD engine oil	ltr	5.5/3.5				
Oil filter	HD engine oil approx.	ltr	0.5				
Water pump	Hypoid transmission oil SAE 90	cc	10				[5])
Hydraulic clutch actuation	Brake fluid approx.	ltr	0.1[6])				
Mechanical transmission	Automatic transmission fluid (ATF)	ltr	1.4				
Automatic transmission	Automatic transmission fluid (ATF)	ltr	4.5[7])	4.75[7])			
Rear axle	Hypoid transmission oil SAE 90	ltr	2.5				
Steering	Hypoid transmission oil SAE 90	ltr	0.3				
Power steering	Automatic transmission fluid (ATF)	ltr	1.4				
Front wheel hub	Anti-friction bearing grease (per hub)	g	65-80				
Brake system	Brake fluid approx.	ltr	0.5[8])				

[1]) On Models 220 b and 220 Sb 2nd version as from March 65; 1st version was 12/52 until March 65.
[2]) On vehicles with front disk brakes. Was 1470 mm on Models 220 b and 220 Sb with front drum brakes.
[3]) For 2nd version front axle; 1st version 29°.
[4]) The data apply to fuel tanks with immersion pipe level indicators. For Models 220 b and 220 Sb with lever indicator in the fuel tank the value is 65/7+3 ltr. The first tank version of Model 220 b had a capacity of 52/6 ltr.
[5]) Water pump self-lubricating.
[6]) 0.05 ltr. for Models 220 b and 220 Sb with supply cylinder in engine compartment. The right-hand drive Models 230, 230 S and 250 S have a common fluid reservoir for brake and clutch actuation.
[7]) Applies to first filling only, for oil changes approx. 1 liter less.
[8]) See also footnote 6.

Model	230		220 b		220 Sb		230 S		250 S	

Speeds, Consumption Figures and Operating Conditions

At rear axle ratio i =	4.08								3.92	
Maximum speeds in the individual gears (km/h) timed	mech. transm.	automatic transm.	mech. transm.	automatic transm.	mech. transm.	automatic transm.	mech. transm.	automatic transm.	mech. transm.	automatic transm.
1st gear	40	42	42				40	42	46	
2nd gear	75	67	70				75	67	84	74
3rd gear	125	108	114				125	108	138	120
4th gear approx.	170[1]	165[1]	155	150	165	160	175	170	180	175
Climbing ability (%)[2] 1st gear theoretical/slip limit	66/45.5	62/45.5	61/46	58/45.5	65/46	62/46	67/45	63/45	63/47	64/47
2nd gear	31	35	31.5	32	32	34	31	35	31	35
3rd gear	17	20	18.5	18	18.5	19	17	20	17	20
4th gear	11		10.6	9.8	10.6	10	11		11	
Acceleration, engaging the individual gears 0-100 km/h Carrying 2 persons (sec) ± 7 %[3]	14.1 (12.8)[4]	13.7 (12.7)[4]	15	14.6	13.8	13.6	13.1	12.9	13	12.1
Engine speed at 100 km/h in 4th gear (rpm)	3470	3470 to 3625	3415	3415 to 3570	3415	3415 to 3575	3415	3415 to 3580	3300	3300 to 3480
Fuel consumption according to DIN 70030 Consumption for average highway travel (ltr/100 km)[5]	9-15		9-14.5				9-15		10-16	
Fuel consumption according to DIN 70030 (ltr/100 km)[6]	11.2 at 110 km/h				10.7 at 110 km/h		11.2 at 110 km/h		11.7 at 110 km/h	
Engine oil consumption (ltr/100 km)	0.15—0.20[7]								0.15 to 0.25[7]	
Cooling water working temperature (°C)	70-95									
Fuel	Premium or benzol-gasoline mixture									
Antiknock rating (minimum ROZ) for maximum output[8]	98		96				98		98/96	
Antiknock rating (minimum ROZ) with maximum retardation of ignition involving a loss of performance	90									

[1]) Model 230 with INAT carburetor system reaches 175 km/h with mechanical transmission and 170 km/h with automatic DB transmission.
[2]) Model 230 with INAT carburetor system reaches the following climbing ability values:

	1st gear theoretical	1st gear slip limit	2nd gear	3rd gear	4th gear
Mech. transmission	73	45.5	32	18	11.5
Automatic DB transmission	68		37	21	

[3]) The variable range "± 7 %" comprises not only variations in permissible engine output but also possible permissible variations due to tire conditions. Cars with automatic transmissions should be accelerated with kickdown in position 4.
[4]) On Model 230 with INAT carburetor system.
[5]) The fuel consumption of cars with automatic transmission is approx. 5—10 % higher.
[6]) Determined at 3/4 of the maximum speed, at a maximum of 110 km/h with a 10 % increase.
[7]) During fast freeway driving oil consumption may increase up to the maximum value.
[8]) The gasoline engines are adjusted at our works with commercial fuels to maximum output. If it should be necessary for a limited period of time to use fuels with an antiknock rating below that given for maximum output the ignition must be retarded accordingly in all cases. See Job No. 00-7.

C. Models 220 SEb, 250 SE, 220 SEb/C, 250 SE/C, 230 SL, 250 SL

Type

Car model	220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Chassis type	111 014	108 014	Coupé 111 021 Convertible 111 023		113 042	113 043
Engine model	M 127.III	M 129.I	M 127.V	M 129.I	M 127.II	M 129.III
Engine type	127 982	129 980	127 984	129 980	127.981	129.982

Design Characteristics

	220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Standard version	Two-circuit brake system with power brake					
	Disk brakes					
	front	front and rear	front	front and rear	front	front and rear
	—	hydropneumatic compensating spring	—	hydropneumatic compensating spring	—	
Optional	Automatic DB transmission with steering-wheel or floor-mounted gear-shift system					
	floor-mounted gear-shift system		—		mech. 5-gear transmission	
	—					rear axle ratio i = 3.69
	DB power steering					

Engine

	220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Operation	4-cycle gasoline injection					
Number of cylinders	6					
Bore/stroke mm	80/72.8	82/78.8	80/72.8	82/78.8	82/72.8	82/78.8
Total effective piston displacement cc	2195	2496	2195	2496	2306	2496
Compression ratio ε	8.7 : 1	9.5 : 1	8.7 : 1	9.5 : 1		
Injection order	1—5—3—6—2—4					
Maximum speed rpm	6000	6300	6000	6300	6500	
Engine performance in metric HP according to DIN[1]) at rpm	120/4800	150/5500	120/4800	150/5500		
in grHP according to SAE at rpm	134/5000	170/5600	134/5000	170/5600		
Maximum torque in mkg at rpm DIN rating	19.3/3900	22/4200	19.3/3900	22/4200	20/4200	22/4200
in mkg at rpm SAE rating	21/4100	24/4500	21/4100	24/4500	22/4500	24/4500
Crankshaft bearings design	Compound plain bearings with steel-backed shells					
Crankshaft bearings number	4	7	4	7	4	7
Connecting-rod bearing design	Compound plain bearings with steel-backed shells					
Valve arrangement	overhead vertical					
Camshaft location	top					
Oil cooling	Oil-water heat exchanger					
Cooling system	Water circulation through pump, thermostat with by-pass pipe, fan and flanged tube radiator[2])					
Lubrication	Forced-feed lubrication by means of gear-type pump					
Oil filter	Main flow filter					
Air cleaner	Silencer filter with paper element					

[1]) The metric horsepower specified is actually available at the clutch, since the power used by the engine accessories has already been deducted.
[2]) On Models 250 SE, 250 SE/C and 250 SL Visco fan coupling.

Model			220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL

Electrical Equipment

			220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Battery	Voltage	V	12					
	Capacity	Ah	55					

Dimensions

			220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Track	front	mm	1482 [1]				1486	1484
	rear	mm	1485				1487	1485
Wheel lock	inner		39°					
	outer		33°	32° 30'	33°	32°		
Minimum turning circle diameter		m	11.5				10	10.35
Wheel base		mm	2750				2400	
Length of vehicle		mm	4875	4900	4880		4285	
Width of vehicle		mm	1795	1810	1845		1760	
Height of vehicle, curb condition		mm	1505	1440	Coupé 1420		Coupé 1305	
					Convertible 1435 [2]		Roadster 1320	
Ground clearance with full load		approx. mm	140	152			125	

Weights

		220 SEb	250 SE	220 SEb/C Cp	220 SEb/C Cb	250 SE/C Cp	250 SE/C Cb	230 SL	250 SL
Unladen weight of vehicle according to DIN 70 020, in curb condition, with full fuel tank, spare wheel and tools	kg	1375	1480	1410	1510	1490	1575	1295	1360
Permissible total weight	kg	1875	1980	1880	1980	1960	2045	1650	1715
Permissible axle load front/rear	kg	875/1000	910/1070	880/1000	915/1065	890/1070	935/1110	800/850	830/885

Capacities

			220 SEb	250 SE	220 SEb/C	250 SE/C	230 SL	250 SL
Fuel tank/reserve	fuel	approx. ltr	65/7+3	82/12+5	65/7+3	82/12+5	65/9+3 [3]	82/12+5
Cooling system with heating	water	approx. ltr	11.4				10.8	12.9
Crankcase (without oil filter)	HD engine oil max./min.	ltr	5.5/3.5					
Oil filter	HD engine oil	approx. ltr	0.5					
Water pump	Hypoid transmission oil SAE 90	cc	10	[4]	10	[4]	10	[4]
Hydraulic clutch actuation	brake fluid	approx. ltr	0.1 [5]					
Mechanical transmission	Automatic transmission fluid (ATF)	ltr	1.4 [6]					
Automatic transmission	Automatic transmission fluid (ATF)	ltr	4.75 [7]					
Rear axle	Hypoid transmission oil SAE 90	ltr	2.5 [8]					
Steering	Hypoid transmission oil SAE 90	ltr	0.3					
Power steering	Automatic transmission fluid (ATF)	ltr	1.4					
Front wheel hub	Anti-friction bearing grease (per hub)	g	65-80					
Brake system	Brake fluid	approx. ltr	0.5 [9]					

[1]) Was 1470 mm on Model 220 SEb without front disk brakes.
[2]) Was 1440 mm on Model 220 SEb Convertible.
[3]) This value applies to fuel tanks with immersion pipe level indicators; was 65/7+3 for tanks with lever indicators.
[4]) Water pump self-lubricating.
[5]) 0.05 ltr. for Models 220 SEb and 220 SEb/C with supply cylinder in engine compartment. The right-hand drive 250 SE models have a common fluid reservoir for brake and clutch actuation.
[6]) 1.1 ltr. for Models 230 SL and 250 SL with ZF 5-gear transmission.
[7]) Applies to first filling only, for oil changes approx. 1 liter less.
[8]) Use only special oil for topping up rear axles with lock compensation differential — optional extra on Models 250 SE and 250 SL.
[9]) See also footnote 5.

Model	220 SEb	250 SE	220 SEb/C		250 SE/C		230 SL		250 SL		

Speeds, Consumpition Figures and Operating Conditions

With Mechanical Transmission											
Rear axle ratio i =	1st vers. 4.10 2nd vers. 4.08	3.92	1st vers. 4.10 2nd vers. 4.08		3.92		3.75	4.08	3.92	optional equipm. 3.69	4.08
Maximum speeds in the individual gears (km/h) timed	mech. 4-gear transmission							mech. 5-gear transm.	mech. 4-gear transmission		mech. 5-gear transm.
1st gear	42	46	42		46		50[4]	48	47	50	48
2nd gear	70	84	70		84		90	84	86	90	84
3rd gear	114	138	114 (appr. 115)[1]		138		147	133	140	147	133
4th gear approx.	170	190	170		190		200	190	195	200	190
5th gear approx.	—	—	—		—		—	200	—	—	200
Climbing ability (%)			Cp	Cb	Cp	Cb					
1st gear theoretical/slip limit	71/46	72/46.5	71/46	64/46	72/46.5	67/47	75/44[4]	80/44	—/44	—/44	—/44
2nd gear	35	32	35	32	32	30	33	36	35	33	37
3rd gear	19.5	17.5	19.5	18	17.5	17	18	20	20	18	21
4th gear	10.7	11.2	10.7	10	11.2	11	10	12	12.5	11.5	13.5
5th gear	—	—	—	—	—	—	—	9			10
Acceleration, engaging the individual gears 0-100 km/h carrying 2 persons (sec) ± 7 %[1]	12.8	12.0	12.8	13.7	12.0	12.4	11.1	9.7	10		9.7
Engine speed at 100 km/h in direct gear rpm	3415	3300	3415	3350	3300		3190	3475	3340	3140	3475
With Automatic DB Transmission											
Rear axle ratio i =	4.08	3.92	4.08		3.92		3.75		3.92		3.69
Maximum speeds in the individual gears (km/h) timed											
1st gear	42	46	42		46		45		41		43
2nd gear	70	74	70		74		80		76		80
3rd gear	114	120	114 (appr. 115)[1]		120		130		123		130
4th gear approx.	165	185	165		185		195		190		195
Climbing ability (%)			Cp	Cb	Cp	Cb					
1st gear theoretical/slip limit	63/46	68/46.5	68/46	61/46	68/46.5	63/47	70/44		—/44		—/44
2nd gear	36	37	36	33	37	35	37		41		38
3rd gear	20	20.5	20	18	20.5	19.5	19.5		23		21
4th gear	10.1	11.2	10.1	9.4	11.2	11	10		12.5		11.5
Acceleration, engaging the individual gears 0-100 km/h carrying 2 persons (sec) ± 7 %[1]	12.7	11.0	12.7	13.6	11.0	11.4	10.7		11		
Engine speed at 100 km/h in direct gear rpm	3415 to 3585	3300 to 3495	3415 to 3585	3350 to 3520	3300 to 3495		3190 to 3380		3340 to 3530		3140 to 3345
Fuel consumption according to DIN 70 030 Consumption for average highway travel (ltr/100 km)[2]	9-14.5	10-16	9-14.5		10-16						
Fuel consumption according to DIN 70 030[3] ltr/100 km	10.7	11.7	10.7	11.2	11.7		10.2		11.2		
Fuel consumption according to DIN 70 030[3] determined at km/h	110										

For footnotes see next page

Model	220 SEb	250 SE	220 SEb/C	230 SE/C	230 SL	250 SL

Speeds, Consumption Figures and Operating Conditions

Engine oil consumption (ltr/100 km)[4])		0.15-0.20	0.15-0.25	0.15-0.20	0.15-0.25	0.15-0.30	
Cooling water working temperature (° C)		70-95	75-95	70-95	75-95	70-95	75-95
Fuel		Premium or benzol-gasoline mixture					
Antiknock rating (Minimum RQZ)	for maximum output	96	98/96	96	98/96	98	96
	with maximum retardation of ignition involving a loss of performance	90					

[1]) The variable range "± 7 %" comprises not only variations in permissible engine output but also possible variations due to tire conditions. Cars with automatic DB transmission should be accelerated with kickdown in position 4.

[2]) The fuel consumption of cars with automatic DB transmission is approx. 5-10% higher.

[3]) Determined at 3/4 of the maximum speed, at a maximum of 110 km/h with a 10 % increase.

[4]) During fast freeway driving oil consumption may increase up to the maximum value.

[5]) The gasoline engines are adjusted at our works with commercial fuels to maximum output. If it should be necessary for a limited period of time to use fuels with an antiknock rating below that given for maximum output the ignition must be retarded accordingly in all cases. See Job No. 00-7.

[6]) The maximum speed and climbing ability values apply to gear ratios as from August 1966. The appropriate values for gear ratios up to August 1966 were as follows:

[7]) The values given in brackets refer to 220 SEb convertibles.

Model 230 SL	1st gear	2nd gear	3rd gear	4th gear
Maximum speed	45	90	135	200
Climbing ability theoretical/slip limit	80/44	33	19	10

D. Model 300 SE

Type

Car model	300 SE Sedan standard	300 SE Sedan long	300 SE Coupé up to August 1965	300 SE Convertible
Chassis type	112.014	112.015	112.021	112.023
Engine model	1st vers. M 189.III	2nd vers. M 189.V	1st vers. M 189.IV	2nd vers. M 189.VI
Engine type	1st vers. 189.984	2nd vers. 189.986	1st vers. 189.985	2nd vers. 189.987

Design Characteristics

Standard version	Electromagnetic Fan Clutch[1])			
	DB automatic transmission			
	Air suspension			
	Lock differential with limited slippage			
	Front and rear disk brakes — two-circuit brake system with master vac			
	DB power steering			
Optional units	Rear axle ratio i = 3.75		Rear axle ratio i = 3.92	
	Mechanical transmission			
	Air conditioning system			
	—	central pneumatic interlock	—	

[1]) With air-conditioning system installed: "hydraulic fan clutch".

Engine

Operation		4-cycle gasoline injection	
Number of cylinders		6	
Bore/stroke	mm	85/88	
Total effective piston displacement	cc	2996	
Compression ratio		1st vers. 8.7:1; 2nd vers. 8.8:1	
Fire order		1-5-3-6-2-4	
Maximum engine speed	rpm	6000	
Engine performance in metric HP at rpm according to DIN[2]) in grHP at rpm according to SAE		1st vers. 160/5000 185/5200	2nd vers. 170/5400 195/5500
Maximum torque in mkg at rpm, DIN rating in mkg at rpm, SAE rating		1st vers. 25.6/3800 28.3/4000	2nd vers. 25.4/4000 28.1/4100
Crankshaft bearings	design	Compound plain bearings with steel-backed shells	
Crankshaft bearings	number	7	
Connecting rod bearings design		Compound plain bearings with steel-backed shells	
Valve arrangement		overhead inclined 20°	
Camshaft location		top	
Oil cooling		Oil-water heat exchangers	
Cooling system		Water circulation through pump, thermostat with by-pass pipe, fan and flange tube radiator	
Lubrication		Forced-feed lubrication by means of gear-type pump	
Oil filter		Main flow filter	
Air cleaner		Silencer filter with paper element	

[2]) The metric horsepower specified is actually available at the clutch, since the power used by the engine accessories has already been deducted.

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Model	300 SE Sedan standard	300 SE Sedan long	300 SE Coupé	300 SE Convertible

Electrical Equipment

Battery voltage	(V)	12			
Battery capacity	(Ah)	66			

Dimensions

Track front	mm	1482			
Track rear	mm	1490			
Wheel lock inner		39°			
Wheel lock outer		32°			
Minimum turning circle	m	11.7	12.0	11.7	
Wheel base	mm	2750	2850	2750	
Length of vehicle	mm	4875	4975	4880	
Width of vehicle	mm	1795		1845	
Height of vehicle, curb condition	mm	1455		1395	1400
Ground clearance, fully loaded	approx. mm	160			

Weights

The values in brackets apply to cars with a fuel tank capacity of 65 ltr. (1st version)

Unladen weight of vehicle, curb condition, with full fuel tank, spare wheel and tools	kg	1565 (1530)	1615	1590 (1565)	1690 (1665)
Permissible total weight	kg	2065 (2010)	2115	2060 (2035)	2160 (2135)
Permissible axle load front	kg	995 (1010)	1015	985	1020 (1035)
Permissible axle load rear	kg	1070 (1040)	1100	1075 (1050)	1140 (1100)

Capacities

Fuel tank/reserve	Fuel	approx. ltr.	82/7[1])
Cooling system with heating	Water	approx. ltr.	16.8
Crankcase (without oil filter) max./min.	HD Engine oil	ltr.	6/4
Oil filter	HD Engine oil	approx. ltr.	0.5
Water pump	Hypoid transmission oil SAE 90	cc.	10[2])
Hydraulic clutch actuation	Brake fluid	approx. ltr.	0.05[3])
Mechanical transmission	Automatic Transmission Fluid (ATF)	ltr.	1.4
Automatic transmission	Automatic Transmission Fluid (ATF)	ltr.	5.75[4])
Rear axle	Hypoid transmission oil SAE 90	ltr.	2.5[5])
Power-steering	Automatic Transmission Fluid (ATF)	ltr.	1.5
Front wheel hub	Anti-friction bearing grease	(per hub) g	65-80
Brake system	Brake fluid	approx. ltr.	0.5

[1]) 2nd version; 1st version was 65/7 liters.
[2]) As from 170 metric HP engine the water pump is self-lubricating.
[3]) 0.1 liters on vehicles with internal clutch supply cylinder.
[4]) Applies to first filling only, for oil changes approx. 1 liter less.
[5]) Special oil for lock compensation differential with limited slippage.

Model	Sedan and Coupé	300 SE Sedan "Long"	Convertible

Speeds, Consumption Figures and Operating Conditions

Engine 1st Version and rear axle ratio i =		3.92[4])					
Maximum speeds (km/h) in the individual gears timed		autom. DB trans.	mech. trans.	autom. DB trans.	mech. trans.	autom. DB trans.	mech. trans.
	1st gear	42		42		42	
	2nd gear	74		74		74	
	3rd gear	120		120		120	
	4th gear	180[5])	185[5])	180[5])	185[5])	180[5])	185[5])
Climbing ability (%)	1st gear	80[6])	80[6])	80[6])	80[6])	73[6])	77[6])
	2nd gear	42	38	41	37	39	35
	3rd gear	22.5	22	22	21.5	20.5	20
	4th gear	12.2[7])	12.2	12	12	11.2	11.2
Engine 2nd Version and rear axle ratio i =		3.92					
Maximum speeds (km/h) in the individual gears timed							
	1st gear	42		42		42	
	2nd gear	74		74		74	
	3rd gear	120		120		120	
	4th gear	185[5])	190[5])	185[5])	190[5])	185[5])	190[5])
Climbing ability (%)	1st gear theoretical/slip limit	81 (79)[10]) 44.5	85 (83)[10]) 44.5	77/44.5	79/44.5	72/46	76/46
	2nd gear	42	38	41	37	39	35
	3rd gear	22.5	22	22	21.5	20.5	20
	4th gear	12.2		12		11.2	
Engine 2nd Version and rear axle ratio i =		3.75					
Maximum speeds (km/h) in the individual gears timed							
	1st gear	44		44		44	
	2nd gear	78		78		78	
	3rd gear	124		124		124	
	4th gear	195[5])	200[5])	195[5])	200[5])	195[5])	200[5])
Climbing ability (%)	1st gear theoretical/slip limit	73 (72)[10]) 44.5	79 (77)[10]) 44.5	70/44.5	75/44.5	66/46	70/46
	2nd gear	40	36	38.5	34.5	36.5	32.5
	3rd gear	21	20.5	20.5	20	19.5	19
	4th gear	11.2		11	10.8	10.2	
Acceleration time from 0—100 km/h engaging the individual gears, carrying 2 persons (sec) ± 7%[1])		1st vers. = 11.5[8]); 2nd vers. (with R. A. i = 3.92) = 11.2					
Engine speed at 100 km/h in 4th gear (rpm)		1st vers. = 3320; 2nd vers. with R. A. i = 3.92 = 3355; 2nd vers. with R. A. i = 3.75 = 3225					
Fuel consumption Consumption for average highway travel (ltr./100 km)		11-18					
Fuel consumption according to DIN 70030[2]) (ltr/100 km)	with automatic DB transmission	1st vers. = 14.5; 2nd vers. with R. A. i = 3.92 = 13.7; 2nd vers. with R. A. i = 3.75 = 13.0; timed at 110 km/h					
	with mech. transmission	1st vers. = 13; 2nd vers. with R. A. i = 3.92 = 12.5; 2nd vers. with R. A. i = 3.75 = 11.8; timed at 110 km/h					
Engine oil consumption (ltr./100 km)		0.20-0.30)[9])					
Cooling water working temperature (°C)		70-95					
Fuel		Premium or benzol-gasoline mixture					
Antiknock rating (minimum ROZ)	for maximum outpout[3])	96					
	with maximum retardation of ignition involving a loss of performance	90					

[1]) The variable range "± 7 %" comprises not only variations in permissible engine output but also possible variations due to tire conditions. Cars with automatic DB transmission should be accelerated with kickdown in position 4.
[2]) Determined at 3/4 of the maximum speed, at a maximum of 110 km/h with a 10 % increase.
[3]) The gasoline engines are adjusted at our works with commercial fuels to maximum output. If it should be necessary for a limited period of time to use fuels with an anti-knock rating below that given for maximum output the ignition must be retarded accordingly in all cases.
[4]) 3rd version. 1st version was 1:4.10; 2nd version was 1:4.08.
[5]) With super sports-type tires.
[6]) Theoretical value; cannot be obtained during normal operation, owing to road holding.
[7]) On Model 300 SE Coupé 12.5 %.
[8]) On vehicles with mechanical transmission in 4th gear from 20—100 km/h = 21.5 sec.
[9]) During fast freeway driving the oil consumption may increase up to 0.3 ltr./100 km.
[10]) The data in brackets refer to the theoretical climbing ability of 300 SE Coupés.

E. Models 300 SEb, 300 SEL

Type

Car model	300 SEb	300 SEL	300 SE Coupé from August 1965	300 SE Convertible from August 1965
Chassis type	108 015	109 015	112 021	112 023
Engine model	M 189.VIII	M 189.VII	M 189.VI	
Engine type	189 989	189 988	189 987	

Design Characteristics

	300 SEb	300 SEL	300 SE Coupé	300 SE Convertible
Standard version	Electromagnetic fan clutch[1]			
	mech. 4-gear transmission	Automatic DB transmission		
	steel suspension system	Air suspension		
	Front and rear disk brakes — two-circuit brake system with power brake and brake force regulator			
	DB power steering			
	—	electrical window regulator		
	—	central interlock	—	
Optional	automatic DB transmission	mech. 4-gear transmission		
	mech. 5-gear transmission			
	differential with limited lock value			
	rear axle ratio i = 3.69		rear axle ratio i = 3.92	
	air conditioning system			
	central interlock			

[1]) With air-conditioning system installed: "hydraulic fan clutch"

Engine

Operation		4-cycle gasoline injection
Number of cylinders		6
Bore/stroke	mm	85/88
Total effective piston displacement	cc	2996
Compression ratio		8.8:1
Injection order		1-5-3-6-2-4
Maximum speed	rpm	6000
Engine performance in metric HP according to DIN[2] at rpm		170/5400
in grHP according to SAE at rpm		195/5500
Maximum torque in mkg at rpm DIN rating		25.4/4000
in mkg at rpm SAE rating		28.1/4100
Crankshaft bearings	design	Compound plain bearings with steel-backed shells
	number	7
Connecting rod bearings	design	Compound plain bearings with steel-backed shells
Valve arrangement		overhead inclined 20°

[2]) The metric horsepower specified is actually available at the clutch, since the power used by the engine accessories has already been deducted.

Engine

Camshaft location	top
Oil cooling	oil-water heat exchanger
Cooling system	Water circulation through pump, thermostat with by-pass pipe, fan and flange tube radiator
Lubrication	Forced-feed lubrication by means of gear-type pump
Oil filter	Main flow filter
Air cleaner	Silencer filter with paper element

Model	300 SEb	300 SEL	300 SE Coupé from August 1965	300 SE Convertible from August 1965

Electrical Equipment

Battery	Voltage	V	12
	Capacity	Ah	66

Dimensions

			300 SEb	300 SEL	300 SE Coupé	300 SE Convertible
Track	front	mm	1482			
	rear	mm	1485	1490		
Wheel lock	inner		39°			
	outer		32°			
Minimum turning circle diameter		m	11.8	12.2	11.8	
Wheel base		mm	2750	2850	2750	
Length of vehicle		mm	4900	5000	4880	
Width of vehicle		mm	1810		1845	
Height of vehicle, curb condition		mm	1440	1410¹)	1390¹)	1405¹)
Ground clearance, vehicle fully loaded		approx. mm	152	160		

Weights

			300 SEb	300 SEL	300 SE Coupé	300 SE Convertible
Unladen weight of vehicle according to DIN 70020, in curb condition, with full fuel tank, spare wheel and tools		kg	1560	1640	1650	1715
Permissible total weight		kg	2060	2140	2120	2185
Permissible axle load	front	kg	990	1030	1010	1035
	rear	kg	1070	1110	1110	1150

Capacities

Fuel tank/reserve	fuel	approx. ltr		82/12 + 5
Cooling system with heating	water	approx. ltr		16.8
Crankcase (without oil filter) max./min.	HD engine oil	ltr		6/4
Oil filter	HD engine oil	approx. ltr		0.5
Water pump	Hypoid transmission oil SAE 90	cc		self-lubricating
Hydraulic clutch actuation	brake fluid	approx. ltr		0.1²)
Mechanical transmission	4-gear	Automatic transmission fluid (ATF)	ltr	1.4
	5-gear			1.5
Automatic transmission				5.75³)
Rear axle	Hypoid transmission oil SAE 90	ltr		2.5⁴)
Power steering	Automatic transmission fluid (ATF)	ltr		1.5
Front wheel hub	Anti-friction bearing grease (per hub)	g		65—80
Brake system	Brake fluid	approx. ltr		0.57.²)

¹) Plus approx. 50 mm through level control.
²) Common reservoir for clutch actuation and brake system.
³) Applies to first filling only, for oil changes approx. 1 liter less.
⁴) Use only special oil for differential with limited lock value.

Model		300 SEb		300 SEL		300 SE Coupé | Convertible from August 1965			

Speeds, Consumption Figures and Operating Conditions

Rear axle ratio i =		3.92							
Maximum speeds (km/h) in the individual gears, timed		mech. 4-gear transm.	automatic DB transm.		mech. 4-gear transm.	automatic DB transm.	mech. 4-gear transm.	automatic DB transm.	mech. 4-gear transm.
	1st gear	44							
	2nd gear	81	70		81	70	81	70	81
	3rd gear	132	114		132	114	132	114	132
	4th gear	190	185		190	185	190	185	190
Climbing ability (%)	1st gear theoretical/slip limit	38/44.5	88/44.5	78/44	83/44	78/45	83/45	72/45	77/45
	2nd gear	37	43	41	36	41	36	39	34
	3rd gear	20	23	23	20	23	20	22	19
	4th gear	12.2		12				11.5	
Acceleration, engaging the individual gears, 0-100 km/h, carrying 2 persons (sec) ± 7 %[1]		11.7	10.8	11	12	11.1	12	11.4	12.4
Engine speed at 100 km/h in 4th gear (rpm)		3300	3300 to 3440		3300	3300 to 3440	3300	3300 to 3440	3300
Rear axle ratio i =		3.69							
Maximum speeds in the individual gears (km/h) timed		mech. 4-gear transm.	automatic DB transm.		mech. 4-gear transm.	automatic DB transm.	mech. 4-gear transm.	automatic DB transm.	mech. 4-gear transm.
	1st gear	47							
	2nd gear	85	74		85	74	85	74	85
	3rd gear	140	121		140	121	140	121	140
	4th gear	200	195		200	195	200	195	200
Climbing ability (%)	1st gear theoretical/slip limit	78/44.5	73/44.5	70/44	74/44	69/45	73/45	65/45	69/45
	2nd gear	34	40	38	33	38	30	36	31
	3rd gear	18	22	21.5	17.5	21	18	20	17
	4th gear	11.2		11				10.5	
Acceleration, engaging the individual gears 0-100 km/h, carrying 2 persons (sec) ± 7 %[1]		11.8	11	11.3	12.1	11.4	12.2	11.7	12.5
Engine speed at 100 km/h in 4th gear (rpm)		3110	3110 to 3250		3110	3110 to 3250	3110	3110 to 3250	3110
Rear axle ratio i =		4.08							
Maximum speeds in the individual gears (km/h) timed		ZF 5-gear transmission							
	1st gear	44							
	2nd gear	78							
	3rd gear	124							
	4th gear	183							
	5th gear	200							
Climbing ability (%)	1st gear theoretical/slip limit	89/44.5		84/44		84/45		78/45	
	2nd gear	38		37		37		35	
	3rd gear	22		21		21		20	
	4th gear	13		12.5		12.5		12	
	5th gear			10				9.5	
Acceleration, engaging the individual gears 0-100 km/h, carrying 2 persons (sec) ± 7 %[1]		10.9							
Engine speed at 100 km/h in 4th gear (rpm)		3445		3435					
Fuel consumption Consumption for average highway travel (ltr/100 km)		11-18							
Fuel consumption according to DIN 70030[2] (ltr/100 km)	R.A. i = 3.92 automatic trans.	13.7							
	R.A. i = 3.92 mech. trans.	12.5							
	R.A. i = 3.69 automatic trans.	13							
	R.A. i = 3.69 mech. trans.	11.8							

For footnotes see next page

Model	300 SEb	300 SEL	300 SE Coupé | Convertible from August 1965

Speeds, Consumption Figures and Operating Conditions

Engine oil consumption (ltr/100 km)		0.15-0.30[4])
Cooling water working temperature (°C)		70-95
Fuel		Premium or benzol-gasoline mixture
Antiknock rating	for maximum output[3])	96
(Minimum ROZ)	with maximum retardation of ignition involving a loss of performance	90

[1]) The variable range "±7%" comprises not only variations in permissible engine output but also possible permissible variations due to tire conditions. Cars with automatic transmissons should be accelerated with kickdown in position 4.

[2]) Determined at $^3/_4$ of the maximum speed, at a maximum of 110 km/h with a 10% increase.

[3]) The gasoline engines are adjusted at our works with commercial fuels to maximum output. If it should be necessary for a limited period of time to use fuels with an antiknock rating below that given for maximum output the ignition must be retarded accordingly in all cases. See Job No. 00-7.

[4]) During fast freeway driving oil consumption may increase up to the maximum value.

Jacking up the Car

Job No.
0-6

A. **Jacking up at the Front Axle**

When the car is jacked up at the front axle by means of a shop lifting jack, a rubber pad about 150 × 150 mm square and 10 mm thick must be placed between the front axle support and the jack. This is necessary since otherwise there is a danger that the edges of the jack may damage the front axle support.

Place the stands at the left and the right under the chassis base panel near the lateral support tubes for the jack of the car.

Under no circumstances should the car be jacked up under the first cross member of the chassis base panel below the radiator block.

B. **Jacking up at the Rear Axle**

If the car is jacked up at the rear axle, place the shop lifting jack as usual under the center of the rear axle housing.

Place the stands at the left and right under the chassis base panel near the lateral support tubes for the jack of the car.

C. **Jacking up with the Jack of the Car**

Support tubes are provided at the front and at the rear on the chassis base panel on both sides for jacking up the car with the standard car jack. When the car is lifted at the front or at the rear both wheels are lifted off the road and it is therefore advisable, especially when the car is standing on steep grades, to put a chock under the wheel on the opposite (Fig. 0-6/1).

Fig. 0-6/1

A chock can be supplied ex works as optional equipment.

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Lubrication and Maintenance Jobs

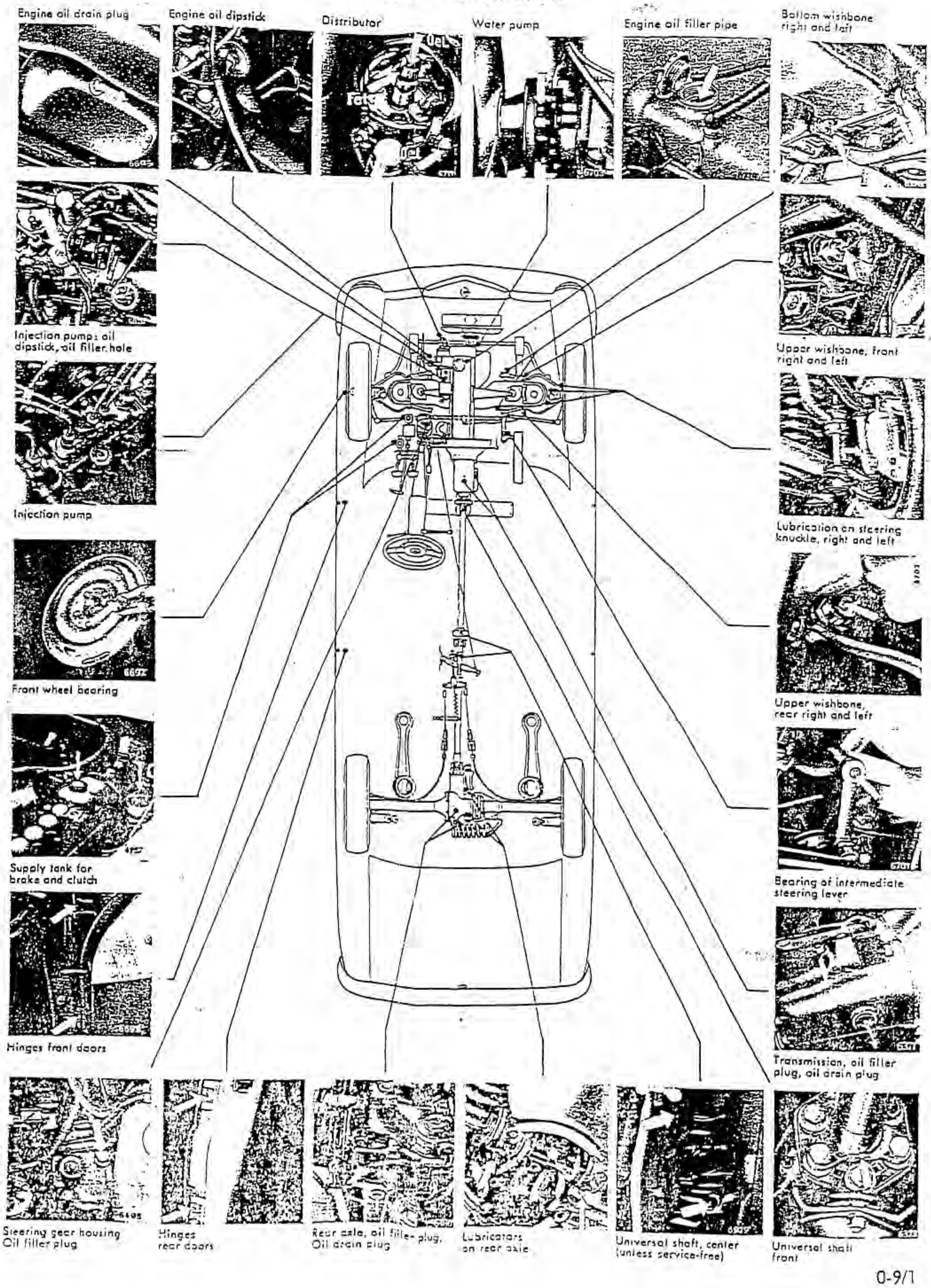
Job. No.
0-9

A. Lubrication Jobs

Item	Job	Plan A after 300 m	Plan B after 2000 m	Plan C every 2000 m	Plan D every 6000 m	Plan E every 12000 m	Spring and Autumn Inspection
Engine	Check oil level and top up, if requ.		all, exc. diesel	all, exc. diesel			
	Oil change	all	diesel only	diesel only	all	all	
Engine-oil filter	Clean main flow insert, replace by-pass cartridges	diesel only¹)			diesel only	diesel only	
	Replace paper element	gas. eng. only			gas. eng. only	gas. eng. only	
Aut. DB Transmission DB Power Steering	Check oil level and top up, if requ.	all with aut. DB transm. or DB power steering	all with aut. DB transm. or DB power steering	all with aut. DB transm. or DB power steering			
Aut. DB Transmission	Oil change with oil at op. temp.					all	
Front axle, steering knuckle, int steering arm, universal shaft, rear axle susp.	Apply grease gun to lubricators		all	all	all	all	
Supply tank for brake and clutch op.	Check brake fluid level, top up, if requ. (If fluid loss is large, check system for leaks)	all	all	all	all	all	
Windshield washer	Refill container	all	all	all	all	all	
Battery	Top up w. dist. water	all	all	all	all	all	
Radiator	Top up w. coolant	all	all	all	all	all	
Supply tank of air suspension system	Drain condensate (Pull drain cock 1–2 secs.)		300 SE only	300 SE only	300 SE only	300 SE only	
Anti-freeze unit of air suspension system	At temp. below + 5° C fill with ethyl alcohol (96%) up to level of knurl, or spirit, in an emergency.		300 SE only	300 SE only	300 SE only	300 SE only	
Non-return throttle valve in choke	Check for easy running, lubricate				diesel only	diesel only	
Heater flap shaft in exhaust manifold	Check for easy running, spray with solvent, e. g. Karamba, if required				Carb. eng. only	Carb. eng. only	
Hand brake intermediate lever	Grease guideway				all	all	
Manual gearbox	Oil change (with oil at op. temp.)	all				all	
Rear axle housing	Oil change (with oil at op. temp.)					all	
Water pump, steering gear housing (standard)	Check oil level, top up, if requ.					all	
Door hinges	Apply grease gun to lubricators					all	
Front wheel bearings	Renew grease in wheel caps					all	
Injection pump	Check oil level and refill, if required (on diesel, operate fuel feed pump several times manually)	on diesel and gasoline inj. engines					
Hand brake lever, Bolt of hand brake comp. lever, Joints and bearing points of steering column shift, Gas lever shaft, Joints of cable levers and bearings of linkages to carburetor, or inj. pump on diesel and gasoline inj. engines and to choke, Hinges, spring bearings and joints for spring lever on engine hood and trunk lid, bowden wire and safety hook of engine hood, hinges (with flap closed only) and cable end of fresh air flap, hinges on flap to fuel filler pipe and pins of door hinges	Lubricate with a few drops of engine oil					all	
Lock and snap hook of engine hood	Check for easy running, grease lightly					all	all
Door locks	Grease slide surfaces of catches slightly, clean taper and grease again slightly					all	all
Trunk lid lock	Grease slide surface slightly						all
Door holder	Grease						all
Seat rails	Clean and grease						all

¹) After 300 miles of driving, acc. to Plan A, exchange fine filter element installed in factory against specified main flow and by-pass elements.

B. Lubrication Chart



C. Maintenance Jobs

Item	Job	Plan A after 300 m	Plan B after 2000 m	Plan C every 2000 m	Plan D every 6000 m	Plan E every 12000 m	Spring and Autumn Inspection
Cylinder head	Retighten bolts with engine warm	all					
Oil sump with aut. DB transm.	Retighten bolts	all with aut. DB transm.					
Engine cooling with heater system	Check hose clips in engine compartment for tight seat	all					
Hand brake	Check adjustment		all				
All V-belts	Check for tension and retighten, if requ.	all	all	all	all	all	
Vehicle wheels and tires	Check for external damage, sight check and interchange, if required. With winter tires change only front wheels right against left. Balance, if possible.			all	all	all	
Tires	Correct tire pressure	all	all	all	all	all	
Oil bath air filter	Check oil qty. and renew, if required clean insert in cover	diesel only	diesel only	diesel only	diesel only	diesel only	
Air filter	Clean paper element				all exc. diesel	all exc. diesel	
Spark plugs — Standard plugs	Clean, adjust electrodes		all std. plugs		all std. plugs		
	Replace					all std. plugs	
Platinum plugs	Check electrode gap, realign, if required, or exchange plugs					all plat. plugs	
Distributor	Adjust points with closing cam angle meter, firing point with scintillation stroboscope				all	all	
	Check points for burns, replace, if required; grease distributor cams slightly, replace grease reserve at point rubbing block (special grease); moisten felt in cam bore with oil, fill lubricator with engine oil					all	
Engine	Adjust idling speed		all		all	all	
	Adjust valve clearance (with engine cold)	all				all	
Clutch	Check free travel on slave cylinder and adjust, if requ.	all w. mech. gearbox			all w. mech. gearbox	all w. mech. gearbox	
Hand and pedal brake	Adjust				all exc. 300 SE	all exc. 300 SE	
Pedal brake	Pull out linings, check thickness				all	all	
Disk brakes	Pull out linings, check dust sleeves for burns, brittleness or moisture from brake fluid (leaky brake cyl.), remove calipers, if requ. Change dust sleeves and seales					all	
Drum brakes	Check thickness of brake linings, remove linings, check brake drums and smooth down with emery, remove accumulated dust, check wheel brake cylinders for leaks, check dust caps for condition					all exc. 300 SE	
Hand brake cables	Check for wear					all	
Pedal and hand brake, clutch w. mech. gearbox, aut. DB transmission	Check for function and operation, (test drive, if requ.)		all		all	all	
All lines conn. hoses on engine and vehicle	Check for leaks, scuff marks, dents, shifting and corrosion	all	all		all	all	
Electrical system	Check all consumers for function				all	all	
Fuel filter — Main filter	Check flow and clean elements, if required					diesel only	
Prefilter	Clean filter bowl, wire screen, base and sealing ring; check seat of filter bowl for leaks						diesel only
Fine filter	Replace paper element (only every 24 000 miles)					gas. inj. only	
Control linkage between mixture controller and injection pump	Check arrangement (after setting valves)					gas. inj. only	

Item	Job	Plan A after 300 m	Plan B after 2000 m	Plan C every 2000 m	Plan D every 6000 m	Plan E every 12000 m	Spring and Autumn Inspection
Shift linkage, gas linkage (aut. DB transmission)	Check: adjustment of gas linkage and kickdown, with vehicle standing on its four wheels (not jacked up)					all with aut. DB transm.	
Front axle	Check toe-in and camber	all				all	
Rear axle	Check camber					all	
Engine and servo units, transmission, rear axle, steering, radiator, main brake cyl. and clutch cylinder	Check for leaks, scuff marks, dents and corrosion	all				all	
Pedal system	Check for piston rod play on clutch master cylinder and main brake cylinder	all				all	
Steering linkage	Check seals of ball heads					all	
Shock absorbers	Check for leaks					all	
Universal shaft	Check joint plate					all	
Steering	Check steering coupling, check steering for play					all	
Engine	Check bolts and nuts for tight seat		all			all	
Front axle, rear axle, steering and body	Check bolts and nuts for tight seat					all	all
Track rods, steering shaft and steering damper	Sight check of nuts and lock washers						all
Slide roof (optional)	Check rails for tight seat, tighten, clean rails-grease slightly with vaseline, clean water drain pipe						all with slide roof
Fuel pump, fuel tank	Drain water and dirt, clean strainer						all
Cooling water areas, radiators	Flush, check for leaks, fill in treated water — antifreeze during frosty weather — Install winter thermostat or normal, as requ.						all
Venting and heating system	Check control valves for easy operation. Replace plastic filter, if required.						all
Preheater for intake air on air filter	Switch on or off						all carb. engines
Battery	Check acid level for acid density and terminals for good seat, grease (acid-proof grease)						all
Cable set, bulbs, lights	Check for scuff marks or condition						all
Ignition system	Check (incl. ignition cable and plugs)						all
Headlights	Check aiming		all exc. 300 SE				all
Door rim, sealing of trunk lid	Clean; coat seal with Orel						all
Molding on trunk lid hinge, wheel housing, spare wheel recess	Clean water drains						all
Frame floor, brake lines	Check for corrosion damage, apply underfloor protection as specified						all
Roadster or cabriolet top	Check condition of impregnation, re-impregnate, if required						roadster or cabriolet only
Vehicle wheels	Check for damage, derust (remove outer covers)						all

Engine - Group 00

Engine

Job No.
00-0

General Specifications, Dimensions, and Tolerances

Modification: Revised and Models 200, 200 D, 230, 230 S, 250 S, 250 SE, 250 SL, 300 SE (170 HP), 300 SEb, 300 SEL, added.

Tappet Clearance

Model		190 Dc, 200 D[1])	190 c, 220 b[2]) 220 Sb, 220 SEb	200, 230, 230 S[2]) 230 SL, 250 S, 250 SE, 250 SL	300 SE[3]) (160 HP)	300 SE (170 HP)[3]) 300 SEb, 300 SEL
Tappet clearance with engine cold	inlet	0.10	0.08	0.08	0.10	0.10
	exhaust	0.40	0.15	0.18	0.20	0.25

[1]) On Models 190 Dc and 200 D the tappet clearance is measured between the rocker arm and the valve shaft end or the cap nut (Fig. 00-3/4). The tappet clearance can also be adjusted with the engine heated up and with a cooling water temperature of 60—80° C; the values increase to: inlet 0.20 mm and exhaust 0.45 mm.

[2]) On Models 190 c, 200, 220 b, 220 Sb, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE and 250 SL the tappet clearance is measured between the sliding surface of the rocker arm and the cam base circle on the camshaft (Fig. 00-3/1).

[3]) On Models 300 SE, 300 SEb, and 300 SEL the tappet clearance is measured between the valve shaft end and the adjustment screw or the ball socket (Fig. 00-3/6).

Distributor Contact Gaps and Closure Angle of Distributor

Model	190 c, 200	220 b, 220 Sb, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE, 250 SL	300 SE 300 SEb 300 SEL
Distributor contact gaps	0.4—0.5	0.3—0.4	0.35—0.45
Closure angle [4])	50° ± 2	$38^{\circ}\,{}^{+3^{\circ}}_{-1^{\circ}}$	49° ± 2° [5])

Note: If possible adjust closure angle to upper tolerance limit when installing new distributor contacts.
Do not change closure angle when reinstalling used contacts.
Replace the distributor contact pairs, if the closure angle deviates by more than —5° (minus 5°) from the nominal value.

[4]) Measure the closure angle at starting or idling speed, if the speed is increased to n = 4000 rpm, the permissible tolerance is —3° (minus 3°).

[5]) The check should be made separately for both associated pairs. To do this, make inoperative one of the two associated pairs by inserting a fiber sheet.

Spark Plugs

For electrode gaps, thread lengths, list of DB-recommended spark plugs etc. see table "Spark Plugs" in the rear cover pocket of "Workshop Tables". For interpretation of spark plug appearance see Workshop Manual Model 190.

Ignition Setting

a) Basic Setting or Assembly Setting for Installing the Distributor
standard version engines with **standard compression**

Model	Compression ratio ε	Distributor Bosch designation	Basic setting 1) Timing light check for ± 1° break gap	Basic setting 1) Stroboscope check at starter speed and with spark plugs installed
190 c	8.7 : 1	VJUR 4 BR 27 T 0 231 115 027	2° BTDC	3° BTDC
190 c	8.7 : 1	IFUR 4 0 231 115 052	4° BTDC	5° BTDC
200	9.0 : 1	IFUR 4 0 231 115 052	5° ATDC	6° BTDC
200	8.6 : 6)	IFUR 4 0 231 115 052	TDC	1° BTDC
220 b 220 Sb	8.7 : 1	VJUR 6 BR 47 T 0 231 116 038	TDC	1° BTDC
220 SEb	8.7 : 1	VJUR 6 BR 45 T VJUR 6 BR 49 T	2° ATDC	TDC
220 SEb	8.7 : 1	VJUR 6 BR 61 T 0 231 116 042 0 231 116 049	4° BTDC	6° BTDC
230 230 S 250 S	9.0 : 1	IFUR 6 0 231 116 038 IFUR 6 0 231 116 048	1° BTDC	3° BTDC
230 SL	9.5 : 1	VJUR 6 BR 49 T	2° BTDC	4° BTDC
230 SL	9.5 : 1	IFUR 6 0 231 116 046 0 231 116 050	6° BTDC	8° BTDC
230 SL	9.5 : 1	IFUR 6 0 231 116 047	3° BTDC	5° BTDC without vacuum
230 SL	9.5 : 1	IFUR 6 0 231 116 051	6° BTDC	8° BTDC without vacuum
250 SE 250 SL	9.5 : 1	IFUR 6 0 231 116 047	3° BTDC	5° BTDC without vacuum
250 SE 250 SL	9.5 : 1	IFUR 6 0 231 116 051	6° BTDC	8° BTDC without vacuum
300 SE 300 SEb 300 SEL	8.8 : 1	ZV/PBUR 6 R 1 T 0 231 141 001 PFUR 6 0 231 141 002	3° BTDC	4° BTDC
300 SE 300 SEb 300 SEL	8.8 : 1	PFUR 6 6) 0 231 141 004	TDC	1° BTDC

1) The timing light check is only used as an assembly setting for the installation of the distributor. For reasons of comparison and to eliminate errors in measurement, check cylinders 1 and 4 in the case of 4-cylinder engines and cylinders 1 and 6 in the case of 6-cylinder engines. The difference between the two values must not exceed 1.5°. If checks are made with the stroboscope at starter speed, the basic adjustment values are 1—2° earlier than if gap checks are made with the timing light.

2) **Caution: For measuring the ignition setting only the adjustment value at an engine speed of 4500 rpm without automatic vacuum control should be used!**
Ignition setting is carried out at 4500 rpm without automatic vacuum control and without load. Then check the movement curve of the automatic governor control at 300, 1500 and 800 rpm, also without automatic vacuum control and without load.

3) Subsequently measure the total adjustment range of the automatic vacuum control without load at 4500 rpm, at the same time advancing ignition setting by the number of degrees specified in the table.

4) On Models 230 SL, 250 SE and 250 SL with distributor delayed ignition and Venturi control unit with a bore behind the throttle valve for automatic vacuum control, measurement of the automatic vacuum control is only carried out without load, with the throttle valve completely closed, i. e. only at idling speed and with the control rod disengaged from the control shaft to the reversing lever on the intake manifold. The ignition setting is retarded, i. e. ignition must be at 2° + 2 after TDC. Correct the adjustment range of the total adjustment range in the case of deviations, see footnote 5).

5) The adjustment range, the total adjustment range of the automatic vacuum control, can be increased by backing off the stop nut on the pull rod which connects the diaphragm in the vacuum box with the distributor plate, and the range can be decreased by screwing the stop nut in.

b) Ignition Setting and Stroboscope Values
standard version engine with **Standard Compression**

Model	compression ratio ε	Stroboscope values at engine speed at rpm under no load[2])[7]) 800	1500	3000	4500	4500	Start of automatic vacuum · control of distributor under no load at engine speed rpm[4])
		with or without vacuum control					
		with and without	without	without	without	with[3])[5])	
190 c	8.7 : 1	8—13°	22—27°	28—32°	41°	÷ 11° ± 3	1000—1200
		8—14°	22—28°	28—34°	42°		
200	9.0 : 1	9—15°	23—29°	29—35°	43°		
	8.6 : 1[8])	4—10°	18—24°	24—30°	38°		
220 b 220 Sb	8.7 : 1	3—13°	18—25°	23—29°	35°	÷ 10° ± 3	220 b 1400—1600 220 Sb 1800—2000
220 SEb		TDC	11—15°	26°	26°	+ 14° ± 3	800—1000
		0—3°				÷ 11° ± 3	
		6—9°	15—21°	28°	28°		
230 230 S 250 S	9.0 : 1	5—15°	20—27°	25—31°	37°	÷ 10° ± 3	230 (180.945) 1400-1600 230 (180.949) 230S, 250S 1800—2000
230 SL	9.5 : 1	4—7°	15—19°	30°	30°	+ 11° ± 3	800—1000
		8°	10—12°				
		4)	13—20°			—	—
			12—19°				
250 SE 250 SL			13—20°				
			12—19°				
300 SE 300 SEb 300 SEL	8.8 : 1	8—15°	21—26°	26°	26°	+ 11° ± 3	800—1000
		8—18°	21—28°	28°	28°		
		2° BTDC	14—24°	28°	28°	+ 8° ± 3	

4) The start of the automatic vacuum control can be changed by screwing the adjusting screw in or out in the vacuum box.

Note: On injection engines the automatic vacuum control should not begin to operate until the throttle valve begins to open. **The throttle valve must be completely closed during idling.**

7) If a fuel with an octane rating lower than 86 ROZ has to be used and pinking occurs at an engine speed between 1500—2500 rpm. ignition must be retarded in order to adapt it to the fuel used. A suggested value for this resetting is: for 1 ROZ the ignition must be retarded by approx. 1° on the crankshaft. Resetting by 1 graduation on the scale of the distributor bearing is the equivalent of 2° on the crankshaft. The ignition setting should be retarded by no more than a maximum of 6°. As soon as fuel with the prescribed octane rating has become available again ignition should be advanced again.

8) Special version according to SA 010784 for fuels between 87-92 ROZ. Deviation from the standard engine: approx. 8.6 as a result of installing a thiker cylinder-head gasket (2.5 mm thick when not compressed). Ignition setting is 38° at 4500 rpm., see table. Front and rear downdraft carburetors 38 PDSI with mixing tube changed and idle cut-out valve with the necessary harness.

9) Only for models with non-automatic transmission.

Ignition Setting

a) Basic Setting or Assembly Setting for Installing the Distributor

special version engines with low compression 220/00-0/17

Model	Compression ratio ε	Distributor Bosch designation	Basic Setting[1]) Timing light check for ±1° break gap	Basic Setting[1]) Stroboscope check at starter speed and with spark plugs installed
190 c	7.0 : 1	VJUR 4 BR 28 T 0 231 115 029	3° BTDC	4° BTDC
200	7.0 : 1	JFUR 4 0 231 115 053	10° BTDC	12° BTDC
200	8.6 : 1[3])	JFUR 4 0 231 115 052	BTDC	1° BTDC
220 b 220 Sb	7.0 : 1	VJUR 6 BR 47 T 0 231 116 038	1° BTDC	3° BTDC
220 SEb	7.0 : 1	VJUR 6 BR 45 T	2° BTDC	4° BTDC
220 SEb	7.0 : 1	VJUR 6 BR 49 T	2° BTDC	4° BTDC
220 SEb	7.0 : 1	VJUR 6 BR 61 T 0 231 116 042 0 231 116 049	6° BTDC	8° BTDC
230 230 S	7.2 : 1	JFUR 6 0 231 116 048	4° BTDC	6° BTDC
250 S	7.7 : 1	JFUR 6 0 231 116 048	4° BTDC	6° BTDC
250 SE 250 SL	7.5 : 1	JFUR 6 0 231 116 051	6° BTDC	8° BTDC without vacuum

For footnotes [1]) to [8]) see pages 00-0/2 and 3.

b) **Ignition Setting and Stroboscope Values**
special version engines with **low compression**

Model	Compression ratio ε	Stroboscope values at engine speed at rpm under no load [7]: 800	1500	3000	4500	4500	Start of automatic vacuum control of distributor under no load at engine speed rpm[6]
		with or without automatic vacuum control					
		with and without	without	without	without	with [3] [5]	
190 c	7.0 : 1	3—8°	18—23°	37—41°	50°	+ 11° ± 3	1000—1200
200	7.0 : 1	13—17°	26—32°	45—51°	60°	+ 11° ± 3	1000—1200
200	8.6 : 1[8]	4—10°	18—24°	24—30°	38°	+ 11° ± 3	1000—1200
220 b 220 Sb	7.0 : 1	5—15°	20—27°	25—31°	37°	÷ 10° ± 3	200 b 1400—1600 220 Sb 1800—2000
220 SEb	7.0 : 1	4°	15—19°	30°	30°	÷ 14° ± 3	800—1000
220 SEb	7.0 : 1	4—7°	15—19°	30°	30°	+ 11° ± 3	800—1000
220 SEb	7.0 : 1	8—11°	17—23°	30°	30°	+ 11° ± 3	800—1000
230 230 S	7.2 : 1	8—18°	23—30°	28—34°	40°	+ 10° ± 3	230 (180.945) 1400-1600
250 S	7.7 : 1	8—18°	23—30°	28—34°	40°	+ 10° ± 3	230 (180.949), 230 S 250 S, 1800—2000
250 SE 250 SL	7.5 : 1	[4]	12—19°	30°	30°	—	—

Distributor Movement Curves

Automatic governor control movement | **Automatic vacuum control movement**

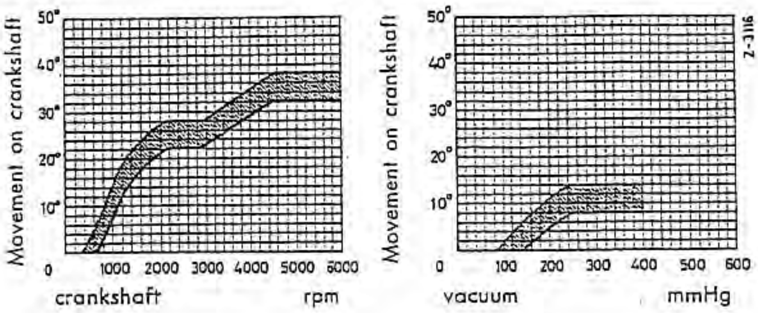


Fig. 00-0/1

Model 190 c (9.0:1)
VJUR 4 BR 27 T
(0231 115 027)

Model 200 (9.0:1)
JFUR 4
(0231 115 052)

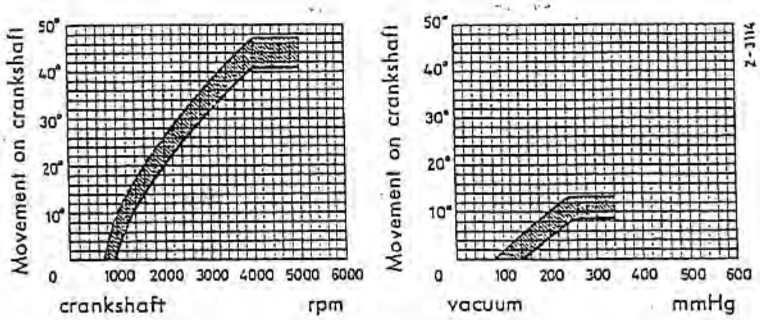


Fig. 00-0/2

Model 190 c (7.0:1)
VJUR 4 BR 28 T
(0231 115 029)

Model 200 (7.0:1)
JFUR 4
(0231 115 053)

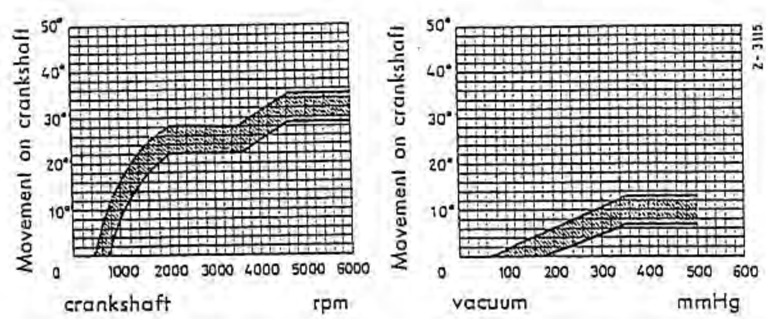


Fig. 00-0/3

Model 220 b, 220 Sb
230, 230 S, 250 S

VJUR 6 BR 47 T
(0231 116 038)
JFUR 6
(0231 116 048)

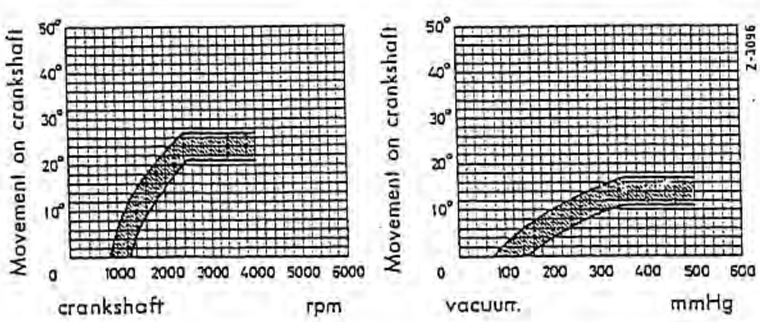


Fig. 00-0/4

Model 220 SEb 1. version

VJUR 6 BR 45 T

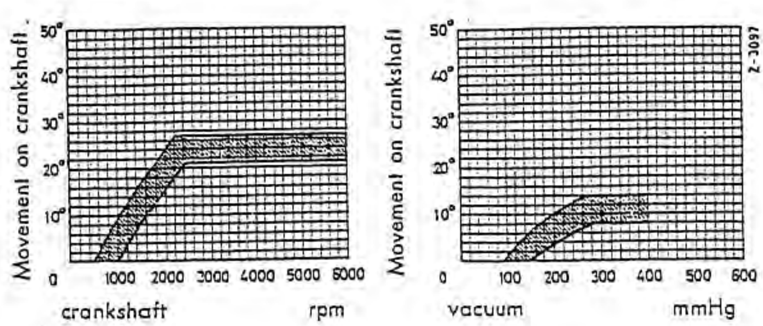


Fig. 00-0/5

Model 220 SEb 2. version
230 SL, 1. version

VJUR 6 BR 49 T

Automatic governor control movement | **Automatic vacuum control movement**

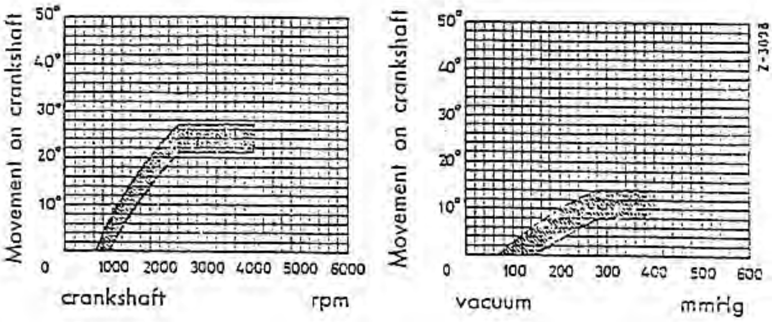


Fig. 00-0/6

Model 220 SEb, 3. version

VJUR BR 61 T
(0231 116 042)

JFUR 6 (R)
(0231 116 049)

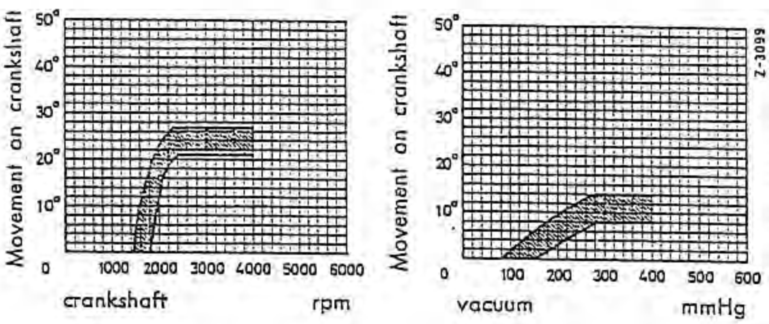


Fig. 00-0/7

Model 230 SL, 2. version

JFUR 6 (R)
(0231 116 046 and 050)

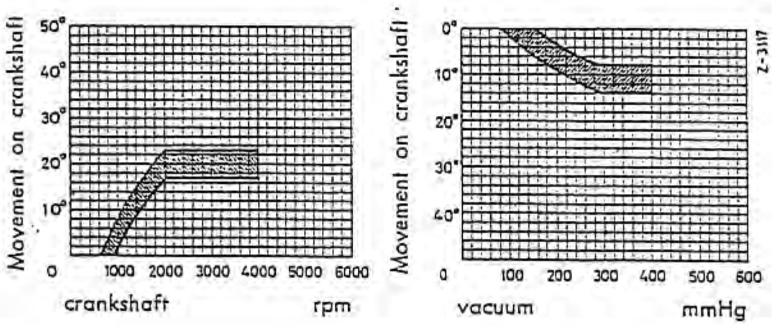


Fig. 00-0/8

Model 230 SL, 3. version
250 SE, 1. version

JFUR 6 (R)
(0231 116 047)

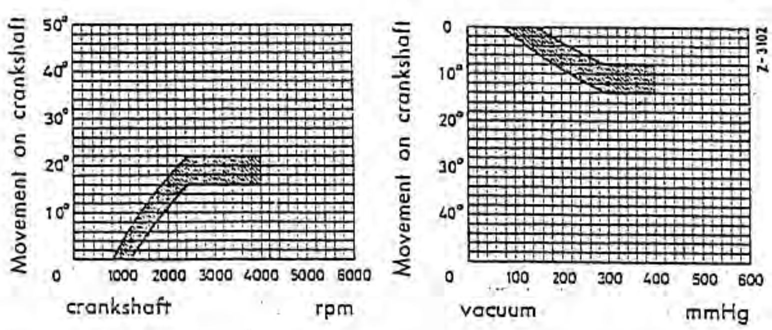


Fig. 00-0/9

Model 230 SL, 4. version
250 SE, 2. version
250 SL

JFUR 6 (R)
(0231 116 051)

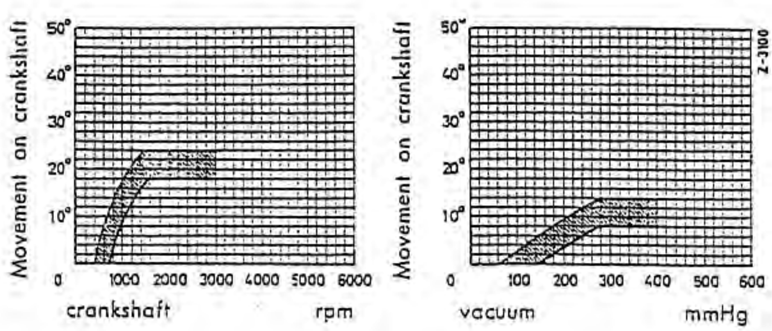


Fig. 00-0/10

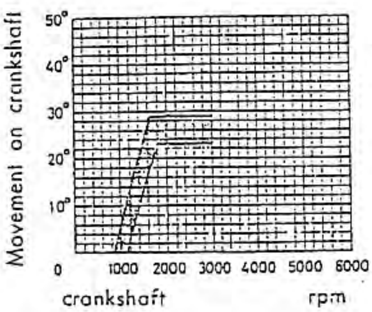
Model 300 SE (160 HP)

ZV/PBUR 6 R 1 T
(0231 141 001)

Model 300 SE (170 HP)
300 SEb, 300 SEL, 1. version

PFUR 6 (R)
(0231 141 002)

Daimler-Benz AG, Nachtrag 30, engl. Kurzfassung



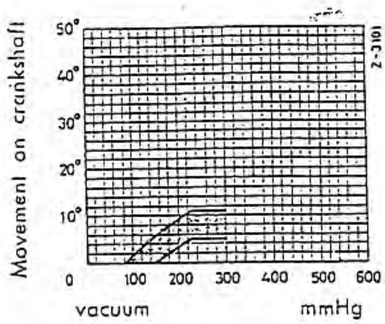


Fig. 00-0/11

Model 300 SEb, 300 SEL 2. version (only for cars with mechanical transmission)

PFUR 6 (R) (0231 141 004)

Position of Crankshaft for Installation of Injection Pump

Model	Position of crankshaft for installation of injection pump	
	with pump set to beginning of delivery stroke[1]	with pump set to end of delivery stroke[1]
190 Dc, 200 D	26° BTDC on compression stroke[2]	—
220 SEb, 300 SE (with 2-cylinder injection pump)	—	TDC[3]
230 SL, 250 SE, 250 SL	—	20° ATDC on suction stroke of 6th cylinder[4]
300 SE, 300 SEb, 300 SEL (with 6-cylinder injection pump)	—	60° ATDC on suction stroke of 6th cylinder[4]

[1] The injection pump is set to end or beginning of delivery stroke when the line mark on the injection pump camshaft is indexed with the line mark on the flange of the injection pump.

[2] On Models 190 Dc and 200 D check and adjust the beginning of delivery stroke in relation to the crankshaft after installing the pump by means of container and overflow pipe and adjust to 26° BTDC on the compression stroke.

[3] On Models 220 SEb and 300 SE with 2-cylinder injection pump it is of no importance whether the piston of the first cylinder is at the intersection dead center or at the ignition dead center. Fine adjustment with container and overflow pipe is not necessary.

[4] **Caution:** The injection pipe arrangement is the reverse of the previous arrangement, i. e. the injection pipe from pump element 1 of the injection pump goes to injection valve 6 of the engine, pump element 2 to injection valve 5, etc.
As a result, the piston of the 6th engine **Cylinder** should be positioned at **20° ATDC** on the suction stroke on Models 230 SL, 250 SE, 250 SL and at **60° ATDC** on suction stroke on Models 300 SE, 300 SEb, and 300 SEL (1st cylinder 20° or 60° after ignition top dead center). Fine adjustment with container and overflow pipe is not necessary.

Details of the Carburetor and Adjustment Data

Model	190 c	220 b	200	230 (180.945)
Carburetor designation	Solex 34 PICB	2 x Solex 34 PICB	2 x Solex 38 PDSI	
Air horn "K"	28	24	28	26
Main jet "Gg"	0145	0120	137.5[1]	135
Air correcting jet "a"	170	200	80[1]	180
Mixing tube "s"	49	44	not replaceable	
Emulsion chamber vent bore	—	—	0.5[8]	0.5
Mixing tube holder (reserve) with polyamide ball valve	5.5		—	
Idle fuel jet "g"	50		62.5[2]	50
Idle air jet or air bore (mm ∅)	1.5	1.0	1.6[2]	1.6
Enriching valve	—	—	—	90[3]
Accelerating pump	No. 72 (neutral)	No. 72 (neutral)	neutral	
Injection amount (cc/stroke)	1.0—1.2	0.9—1.2	0.7—1.0[4]	1.0—1.3[4]
Pump jet "Gp"	80	50	—	
Injection tube	high (0.5 graded)		high (0.5 graded)	high[5] (0.4 graded)
Starter fuel jet "Gs"	230[6]	180	—	
Starter air bore in starter rotary slide valve (mm∅)	6.5[6]	4.0	—	
Float needle valve	2.0	1.5	2.0	
Weight of float (g)	5.7		8.5	
Fuel level (mm)	17—19		[7]	
Bypass bores (mm ∅)	1.2 and 1.2	1.25	1.5 and 1.3[2]	1.5 and 1.3

[1]) For low compression engines ($\varepsilon = 7.0:1$), main jet 147.5, air correcting jet 140.

[2]) Up to chassis end no. 161 599 idle fuel jet 55, idle air bore 1.0 and bypass bores 1.3 and 1.0.

[3]) Up to chassis end no. 006 122 enriching valve 100.

[4]) Front carburetor for vehicles with automatic transmission 0.6—0.9 cc/stroke.

[5]) Front carburetor for vehicles with automatic transmission 0.5 graded.

[6]) Up to chassis end no. -10- 105 281 or -12- 107 377 starter air bore 4.0 and starter fuel jet 180.

[7]) The fuel level is correctly adjusted if a 1.0 mm sealing ring has been installed below the float needle valve.

[8]) For engines according to SA 10 784 ($\varepsilon = 8.6:1$) emulsion chamber vent bore 1.0 mm and idle cut-out valves.

Details of the Carburetor and Adjustment Data

Model	220 Sb	
Carburetor designation	2 x Solex 34 PAITA	
Carburetor stage	I. Stage	II. Stage
Air horn "K"	23	27
Main jet "Gg"	0115[1])	135
Air correction jet "a"	200	190 c with mixing tube
Mixing tube "s"	44	—
Mixing tube holder (reserve) with polyamide ball valve	5.5	—
Enriching jet	60[1])	—
Idle fuel jet "g"	50	—
Idle air jet "u"	1.4[2])	—
Idle air bore (mm Ø)	1.5	—
Accelerating pump	No. 831 (neutral)	
Injection amount (cc/stroke)	1.3—1.7 (must not be corrected by adjusting the connecting rod)	
Pump jet "Gp"	80	
Injection tube	high (0.5 graded)	
Beginning of injection at opening of throttle valve	at once	
Pump diaphragm (see Fig. 00-0/12) — Bolt lenght (mm)	18.7—18.9	
Pump diaphragm (see Fig. 00-0/12) — Plate Ø (mm)	32[3])	
Beginning of full-load enrichment at throttle valve position	1°—4° after throttle valve of Stage II has begun to open[3])	
Starter fuel jet "Gs"	90[4])	
Starter air bore in starter rotary slide valve (mm/stroke)	2[4])	
Float needle valve	2	
Float weight (float made of nylon) (g)	7.3	
Fuel level (mm)	19—21	
Bypass bores (mm Ø)	1.2 and 1.8[2])	
Fuel return valve adjustment (mm)	0.3—0.5	

Footnotes to Table on page 00-0/10

[1]) Up to engine nos. -10-004 841 and -11-000 018 (carburetor No. 4 413 610) only for engines with the 1st version of the intake scoop with 100 mm wide intake scoop opening the carburetor was equipped with a main jet "Gg" 0 112.5 of the 1st stage and an enriching jet 50.

It is important that the carburetor jets should always correspond to the type of scoop installed; if this is not the case fuel consumption will be excessive or build-up will be faulty (see also Job No. 09-1)

Before the enriching jet 60 was installed as a regular feature, a number of engines left our works with a 2nd version scoop and a 1st stage main jet "G" 0115. The larger enriching jet was not installed in these engines.

[2]) Up to engine nos. -10-068 125, -11-004 644 and -12-000 390 idle air jet 1.5 and bypass bores 1.15 and 1.15.

[3]) Up to engine nos. -10-007 060 and -11-000 182 (Solex Carburetor No. 4 509 149) the pump diaphragm had a diameter of 22 mm. In this case, full-load enrichment was adjusted to 65°—70° throttle valve opening.

Carburetors can only be equipped with these new jets if the engine has a 2nd version scoop; in that case care should be taken to ensure that only pump diaphragms with bolts of the specified length are used (see table).

[4]) Up to engine nos. -10-031 160 and -11-003 114 the carburetor was equipped with a starter fuel jet "Gs" 100 and a 3 mm ⌀ starter air bore in the starter rotary slide valve.

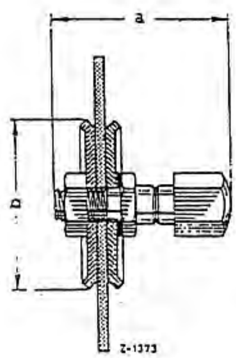


Fig. 00-0/12

Pump diaphragm

a length of bolt
b Plate diameter

Details of the Carburetor and Adjustment Data

Model	220 Sb		230 (180.949) 230 S		250 S	
Carburetor designation	2 x Zenith 35/40 INAT					
Carburetor stage	I. Stage	II. Stage	I. Stage	II. Stage	I. Stage	II. Stage
Air horn "K"	23	27	24	28	24	28
Main jet "Gg"	x 112.5	x 120	x 115	x 120	x 120	x 120
Air correction jet "a"	100	150	100[1])	130	110	120
Mixing tube "s"	4 S	4 N	4 S	4 N	4 S	4 N
Idle fuel jet "g"	45	—	45	—	45	—
Build-up fuel jet	—	50	—	60	—	60
Idle air bore (mm ∅)	1.5	—	1.3	—	1.3	—
Build-up air bore	—	1.0	—	1.0	—	1.0
Injection amount (cc/stroke)	0.8—1.2	—	0.7—1.0	—	0.7—1.0	—
Injection tube	0.5 graded	—	0.5 graded	—	0.5 graded	—
Beginning of injection at opening of throttle valve	5°	—	5°	—	5°	—
Float needle valve	2.0					
Float weight	8.5					
Float adjustment (mm)	18—20		21—23			
Fuel return valve adjustment (mm)	0.3—0.5					
Adjustment of float chamber vent valve	1.5—2.0		Control dimension Mech. transmission 1.8—0.3 Automatic transmission 2.8—0.3			
Pilot throttle gap adjustment	2.6	—	2.4	—	2.4	—
Automatic start mechanism stepped plate adjustment	5		2.5[2])			

[1]) On Model 230 up to chassis end No. 019 242, and on Model 230 S up to chassis end No. 094 927, air correction jet 90.

[2]) Distance between reversing lever and stop screw with the choke valve closed.

Carburetor Altitude Adjustment

At high altitudes, due to the decrease in atmospheric pressure, carburetors equipped with standard jets supply too rich a mixture. To avoid this, install either Solex Altitude Correctors with larger air correction jets, or smaller main jets in the carburetors.

No altitude correctors are available for Models 200, 220 Sb with Zenith carburetor, 230, 230 S and 250 S.

The guiding principle in altitude adjustment should be to choose the smallest possible main jet that ensures a minimum of performance loss. If the jet is too small or if the smaller jet is regularly used for driving at normal altitudes and at full load, there is a danger that the engine overheats because the carburetor supplies too lean a mixture.

a) Solex Altitude Correctors

The installation of the altitude correctors together with the standard main jets ensures that the engines are supplied with the correct fuel-to-air ratio at any altitude and any atmospheric pressure. The installation of the altitude corrector is recommended for cars that are driven both at normal and at high altitudes.

The aneroid compensator incorporated in the altitude corrector automatically regulates the fuel supplied to the main jet in relation to the atmospheric pressure obtaining at any altitude. (Fig. 00-0/13).

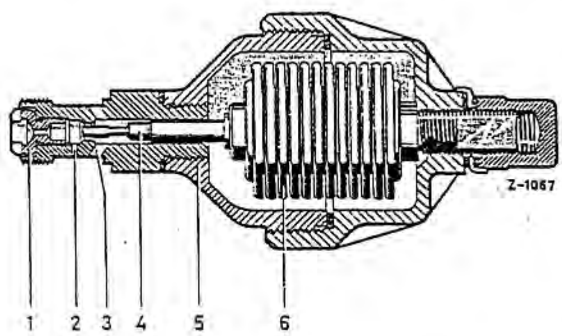


Fig. 00-0/13

1 Main jet
2 By-pass bore
3 Fuel intake bore
4 Needle
5 Housing
6 Capsule pack

Model	Solex altitude corrector		
	Part. No.	By-pass bore	Main jet "Gg"
190 c	000 072 04 05	1.3 mm ∅	0145
220 b	000 072 03 05	1.0 mm ∅	0120
220 Sb[1])	000 072 00 05	0.7 mm ∅	0125[2])

[1]) Only for the 1st stage.

[2]) On Model 220 Sb the main jet "Gg" 0112.5 is installed up to engine end nos. -10-004 841 and -11-000 018 (1st version intake scoop 100 mm wide).
On this version the main jet "Gg" 0112.5 must be installed in the altitude corrector Part No. 000 072 00 05 on Model 220 Sb.

b) Larger Air Correction Jets

The following table shows the size of the air correction jets to be used at given altitudes.

Model	200	200 $\varepsilon = 7.0:1$	230 (180.945)	220 Sb with Zenith Carburetor		230 (180.949) 230 S		250 S	
	Size								
Altitude m				Stage		Stage		Stage	
				I	II	I	II	I	II
1000—1500	90	150	195	120	170	120	150	130	140
1500—2500	110	160	210	140	190	140	170	150	160
2500—3500	115	170	220	160	210	160	190	170	180
above 3500	130	190	240	180	230	180	190	190	180

c) Smaller Main Jets

The tables on carburetor jets and the table below give some indication of the size of the main jets for the various models.

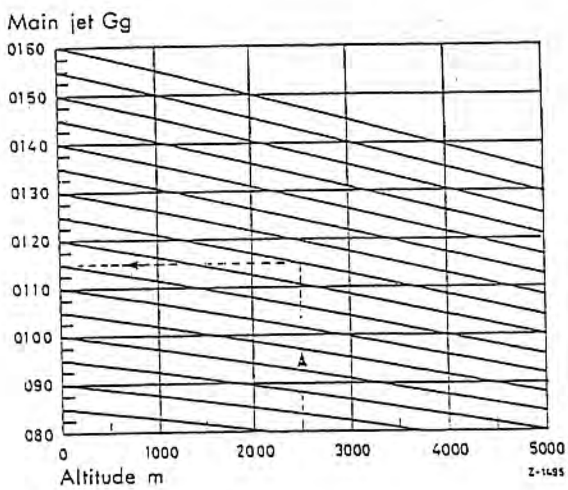


Fig. 00-0/14

Example:

Standard main jet: "Gg" 0125
Main jet at an altitude of 2.500 m: "Gg" 0115
(see broken line)

Compression and Cylinder Leakage

Standard Compression Engines

Model	Compression in atm.[1] standard	Compression in atm.[1] minimum	Compression ratio ε
190 c	9.5—10.5	appr. 8	8.7 : 1
200	10—11	appr. 8.5	9.0 : 1
190 Dc 200 D	22—24	appr. 17	21 : 1
220 b, 220 Sb, 220 SEb	10—11	appr. 8.5	8.7 : 1
230, 230 S 250 S	10—11	appr. 8.5	9.0 : 1
230 SL 250 SE 250 SL	11—12	appr. 9.0	9.5 : 1
300 SE 300 SEb 300 SEL	10—11	appr. 8.5	8.8 : 1

Low Compression Engines

200	9.5—10.5	appr. 8	8.6 : 1
190 c, 200	7.5—8.5	appr. 6	7.0 : 1
220 B, 220 Sb 220 SEb	7.5—8.5	appr. 6	7.0 : 1
230, 230 S	7.8—8.8	appr. 6.5	7.2 : 1
250 S	8.5—9.5	appr. 7.0	7.7 : 1
250 SE 250 SL	8.2—9.2	appr. 6.8	7.5 : 1

[1]) The compression should be measured at normal working temperature (cooling water temperature 20—80° C) and with the throttle valve open. Turn the engine at least 8 times with the starter. **The deviation between the individual cylinders should not exceed a maximum of 1.5 atm. and for diesel engines a maximum of 3 atm.**

Cylinder Leakage Test

With CLT (Cylinder Leakage Testers) at valves, cylinder head gasket, pistons, and piston rings.

Permissible losses: Total not to exceed 25%
At valves and cylinder head gasket, maximum 5%
At pistons and piston rings, maximum 20%

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Spray Pressure of Injection Nozzles and Injection Valves

Model	Bosch designation of injection nozzles and of injection valves	Spray or Opening Pressure in atm. in the case of new injection nozzles or valves	Spray or Opening Pressure in atm. in the case of used injection nozzles or valves: minimum
190 Dc, 200 D	DNO SD 151 1st version DNO SD 1510 2nd version[1])	110—120[2])	110—120[2])
220 SEb (with 2-cylinder injection pump)	EP/DES 5/45	14.5—15.5[3])	13.0—15.5[3])
300 SE (with 2-cylinder injection pump)	EP/DES 6/60		
230 SL	DC 8 C 45 R 1	17.5—18.5[4])	15.0—18.5[4])
250 SE, 250 SL	DC 8 C 45 R 1 DC 8 C 45 R 2[5])		
300 SE, 300 SEb, 300 SEL, (with 6-cylinder injection pump)	EP/DEC 60 R 1	14—16[4])	13—16[4])

Note: If the injection system, nozzles and valves are checked or repaired, please contact the nearest Bosch agency if possible.

[1]) Injection nozzles of the 2nd version should be installed in engines with partial-load knock in order to improve the partial-load noise and the starting knock (see also Job No. 00-23)

[2]) On Models 190 Dc and 200 D the difference between the spray pressures of the jets of an engine must not exceed 5 atm.

[3]) On Models 220 SEb and 300 SE with 2-cylinder injection pump the difference in spray pressure between three injection valves belonging to a fuel distributor fitting (distributor group) must not exceed 0.5 ATM, in order to ensure that the fuel is evenly distributed to the various cylinders. To obtain the accurate measurements necessary, use testers with a pressure gage of the 0-25 kp/cm² (see checking of injection valves Job No. 00-15). If the difference exceeds 0.5 atm the injection valve or the whole distributor group with the defective injection valve must be replaced. **When removing the injection valves and distributor fittings mark the injection valves and distributor fittings in their proper order or put the two distributor groups into seperate containers to avoid any possible confusion!**

[4]) The difference between the spray pressures of the injection nozzles of an engine must not exceed 3.0 atm. To obtain the accurate measurements necessary, use testers with a pressure gage of the 0-25 kp/cm² range.

[5]) Ball-seat injection valves
Injection valves R 1 or R 2 should not be interchanged.

Correlation: Venturi Control Unit-Injection Pump

Models 220 SEb, 230 SL, 250 SE, 250 SL, 300 SE, 300 SEb, 300 SEL

Throttle valve angle in degrees (°)	Control angle in degrees (°)
0° 2,5 5 7.5 10	0° 4—4.5 8—8.5 11.5—12.5 15.5—16.5
15 20 30 40	22.5—23.5 29—30 40.5—42 50.5—51.5
50 60 70 80—82	59—60 67—68 73.5—75 79—82

Engine Vent Nozzle

Model	Nozzle or smallest bore Ø of the suction line for the crankcase vent in mm	Venting is effected via a suction line from the cylinder head cover
190 c	9.0[1]	to rubber bend on carburetor
190 Dc	6.0[2]	to Venturi control unit
200 D	10.0[1]	to oil bath air filter
200	11.0[1]	to intake scoop of carburetor
220 b, 220 Sb	6.5[1]	
220 SEb 230 SL	8.0[2][3]	to Venturi control unit
230 SL	11.0[1][4]	
230, 230 S 250 S	11.0[1]	to intake scoop of carburetors[7]
250 SE, 250 SL	11.0[1]	to Venturi control unit
300 SE	7.5[2][5]	
300 SE, 300 SEb, 300 SEL	12.0[1][6]	

Note: In order to prevent any escape of crankcase gases into the open air an oil level gage without vent filter is installed and throughflowing gases are conducted into the suction line ahead of the throttle valve. Ahead of the throttle valve the vacuum increases with increasing engine speed and as a result the throughflowing gases are drawn from the crankcase. Maximum vacuum occurs at maximum engine speed and with the throttle valve fully open. The suction line itself is larger in diameter than the bore in the threaded union so that an undesirable rise in pressure, as a result of increasing the bore of the threaded union and subsequent increase in the amount of through-flowing gases, can be avoided.

[1] In threaded union on cylinder head cover.

[2] In pipe union of Venturi control unit.

[3] On Model 230 SL only on engines with distributor with advanced automatic vacuum control.

[4] On Model 230 SL only on engines with distributor with retarded vacuum control.

[5] On Model 300 SE only on engines with 2-cylinder injection pumps.

[6] On Model 300 SE on engines with 6-cylinder injection pumps.

[7] In contrast to the previous venting system, in which all the gases and the condensate passed through the carburetor into the engine intake manifold, on the new Models 230, 230 S, 250 S (with INAT carburetors) the gases pass through a water seperator in the intake scoop of the carburetor. In the seperator, oil and condensate are seperated off and together with some of the venting gases pass directly through a 1.5 mm nozzle into the engine intake mainfold, completely bypassing the carburetor.

On this version, on which some of the gases enter behind the throttle valve, an increased escape effect of the gases immediately into the engine intake manifold is obtained by the very high vacuum behind the throttle valve whenever the car is overrunning the engine and when idling.

Use of the so-called bypass venting system

Model 230 as from chassis end no. 21 115
Model 230 S as from chassis end no. 96 679
Model 250 S as from chassis end no. 27 658

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Engine Speed Ranges and Idling Switch

Gasoline Engines

Model	Idling speed rpm with non-automatic transmission	Idling speed rpm with automatic transmission selector lever position O or N or P	Idling speed rpm with automatic transmission selector lever position 2, 3, 4 or R	Engine speed rpm at maximum engine performance HP (DIN)	Permissible maximum speed in the individual gears rpm
190 c	800—850	850—900	580—630	5000/80 5000/68 [1]	6000
200				5200/95 5200/83 [1] 5200/87 [4]	
220 b	750—800	850—900	650—700	4800/95 4800/85 [1]	
220 Sb				5000/110 5000/98 [1]	
230 (180.945)				5200/105 5200/92 [1]	
230 (180.949) 230 S				5400/120 5400/106 [1]	
250 S				5400/130 5400/115 [1]	6300
220 SEb	750—800	700—750	700	4800/120 4800/106 [1]	6000
230 SL, 250 SL				5500/150	6500
250 SE				5500/150 5500/135 [2]	6300
300 SE	650—700	680—720	600	5000/160 [2] 5400/170 [3]	6000
300 SEb				5400/170	
300 SEL				5400/170	

Note: For adjustment of idle and carburetor linkage see Job Nos. 00-16 and 00-13.

On models with power steering the engine should run smoothly even with the steering at full lock. If necessary slightly increase the idling speed on engines without additional idle increase.

[1]) Values for low-compression engines.
[2]) with 2-cylinder injection pump.
[3]) with 6-cylinder injection pump.
[4]) Special version according to SA 010784 for fuels between 87-92 ROZ $\varepsilon = 8.6:1$.

Idling switch-switch-off speed without gear engaged 1200-1600 rpm

Diesel engines

Model	Idling speed non-automatic and automatic transmission rpm	Full load maximum speed or beginning of governing rpm	Maximum speed, no load or end of governing rpm
190 Dc 200 D	700—800	4320	5000—5200

Note: For adjustment of idling speed see Job No. 00-19.

Fuel Feed Pump

Carburetor and diesel engines			190 c, 200, 220 b, 220 Sb 230, 230 S, 250 S	190 Dc 200 D
Pump designation			DVG-diaphragm pump	Bosch FP/K 22 M 2/8
Delivery pressure	Measuring point		behind pump outlet	between injection pump and main fuel filter
	Delivery pressure at starter speed	atm	0.12—0.16	—
	Delivery pressure at idling speed	atm	0.15—0.20	0.8—1.5
	at n = 3000 rpm	atm	—	minimum 2.2
Discharge pressure	at idling speed	atm	—	minimum 2.0
	at n = 3000 rpm	atm	—	minimum 2.5
Vacuum	Measuring point		in front of pump inlet	
	Vacuum	atm	0.3—0.4	—
	at starter speed	mm Hg	230—320	—
	at idling speed	atm	—	0.2—0.4
Clearance between cam and tappet		mm	0.4—0.5	—

Gasoline injection engines		220 SEb, 300 SE with 2-cylinder injection pump	230 SL, 250 SE, 250 SL 300 SE, 300 SEb, 300 SEL with 6-cylinder injection pump
Pump designations		Electr. Bosch feed pump FP/ESB 5 RC 25/12 A 1 044 220 007 044 220 008	
Measuring specifications		with the engine stopped and a minimum of 11 volts at the feed pump	
Delivery pressure	Measuring point	behind the fine fuel filter	
	atm	0.6—0.8	0.8—1.1
discharge pressure	with a dummy plug on the fuel line	behind the damper unit in the fuel return line	behind the fuel overflow valve on the injection pump
	atm	minimum 1.2	minimum 1.3
output¹)	Measuring point	behind the damper unit in the fuel return line	behind the fuel overflow valve on the injection pump
	1 litre	in a minimum of 15 seconds	

¹) When measuring the output, the fuel tank should be at least half full.

Fuel Overflow Valve

for diesel and gasoline injection engines

Model		Opening pressure of fuel overflow valve in atm.
190 Dc 200 D	at idling speed	0.8—1.5
	at 3000 rpm	minimum 2.2
230 SL, 250 SE, 250 SL 300 SE, 300 SEb, 300 SEL		0.8—1.1

Note: On Models 190 Dc, 200 D, 230 SL, and 300 SE with 6-cylinder injection pump R 12 the fuel overflow valve has been screwed to the injection pump.
On Models 250 SE, 250 SL, 300 SEb, 300 SEL, and 300 SE with injection pump R 19 the fuel overflow valve has been pressed into the threaded union of the return pipe on the injection pump.
Models 220 SEb and 300 SE with 2-cylinder injection pump have no overflow valve. The bore in the threaded union at the entrance to return pipe unit has been designed to serve as a throttle instead of the fuel overflow valve.

Intake Pipe Vacuum Values and Exhaust-Gas Test Values

Gasoline engines-no load

Model	Vacuum in mm Hg				Exhaust-gas test values (percentage) according to Sun[1]) CO			
	at engine speed rpm (no load)							
	idling	1500	3000	4500	idling[2])	1500	3000	4500
190 c	470—520	510—560		480—530				
200								
220 b	440—490	500—550	510—560	480—530	79—81[1]) [2]) / 4.5—3.5	80—85[1]) / 4.0—1.0	82—87[1]) / 0.3—0.2	84—89[1]) / 1.5—0.05
220 Sb	430—490			490—540				
230	380—420	460—500	500—550	460—500				
230 S								
250 S	350—400	430—480	500—550					

Note: When measuring make sure that both cooling water and oil temperature of the engine are definitely above 80°.

[1]) Applicable only to "Sun" Exhaust-Gas Tester.

[2]) On Models with automatic DB transmission the exhaust gas values should be checked again at idling speed with the gear engaged. On gasoline engines the lean tolerance limit should be aimed at on principle in order to ensure even idling.

Exhaust-Gas Adjustment Values

Gasoline injection engines under load during normal running				
Test	250 SEb, 300 SE (160 HP) with 2-cylinder injection pump		230 SL, 250 SE, 250 SL, 300 SE (170 HP), 300 SEb, 300 SEL with 6-cylinder injection pump	
	Exhaust-gas test values			
	% SUN	% Bosch	% SUN	% Bosch
Full load rpm[1]) in 3rd gear	78—80	5.0—4.0	80—83	4.0—2.0
Lower partial load 1500 rpm[2]) in 3rd gear and at 300 mm Hg vacuum	83—86	2.0—0.5	81—84[5])	3.0—1.5[5])
Upper partial load 2500 rpm[3]) in 3rd gear and at 300 mm Hg vacuum[6])	84—87	1.5—0.2	84—87[6])	1.5—0.2[6])
At idle and 420—480 mm Hg on engines[4]) with 2-cylinder injection pump 300 mm Hg—400 mm Hg on engines with 6-cylinder injection pump	79—81	4.5—3.5	79—81	4.5—3.5

Note: When measuring make sure that both cooling water and oil temperature are definitely above 80° C.

[1]) Adjust at control rod end.

[2]) Adjust at black screws.

[3]) On engines with 2-cylinder injection pump adjust at white screws. Adjustment on engines with 6-cylinder injection pump: the white screws must not be turned with the injection pump installed; remove injection pump and adjust on injection pump test bench.

[4]) On Models with automatic DB transmission check exhaust-gas values again at idling speed with the gear engaged. On injection engines the values may be adjusted to the rich tolerance limit in order to ensure even idling.

[5]) Value for Model 230 SL 83—86 % SUN or 2.0—0.5 % Bosch.

[6]) Both values, i. e. vacuum and exhaust-gas value must be reached.

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*Modification: Corrections marked **

Valve Timings for Test Measurements with a Test Clearance of 0.40 mm

Model	Camshaft	Inlet valve		Exhaust valve		Minimum distance between inlet valve and piston with the crankshaft adjusted to 5° after intersection TDC (mm)
	Code number	opens BTDC	*closes ABDC	*opens BBDC	closes ATDC	
190 c	42 3) 46 4) 49 5)	10°	46°	44°	12°	0.9
190 Dc 200 D	02 3) 12 4) 13 5) 17 6)	12.5°	41.5°	45°	9°	1.0 7)
200	50 6)	11°	53°	47°	21°	
220 b 220 Sb 220 SEb	61 2) 70 3) 79 4) 82 5)	10°	46°	44°	12°	
230 230 S	86	11°	53°	47°	21°	
230 SL	76 4) 84 5)	10°	58°	51°	23°	0.9
250 S 250 SE 250 SL	86	11°	53°	47°	21°	
300 SE 8)	39 3) 42 5)	7°	47°	49.5°	11.5°	
300 SE 9) 300 SEb 300 SEL	46	18°	58°	53°	15°	

Note: Valve timings for test measurements with a test clearance of 0.4 mm, i. e. the values given above are calculated for an assumed tappet clearance of 0.40 mm. When measuring, the normal tappet clearance must be taken up by means of a feeler gage or a similar tool which will result in more accurate measurements.

1) The Code Number marking the individual camshafts is stamped on the camshaft end face.
2) Hollow shaft.
3) Solid shaft for external lubrication with annular grooves on the bearings.
4) Solid shaft for external lubrication without annular grooves on the bearings except bearing I.
5) Solid shaft for external lubrication without any annular grooves on the bearings.
6) Cams
7) On Model 200 D the minimum distance = 1.5 mm between the exhaust valve and the piston at a crankshaft position of 5° before the intersection TDC must also be measured.
8) With engine type 189.984 and 189.985 (160 HP).
9) With engine type 189.986 and 189.987 (170 HP).

Minimum Oil Pressure

For motor-car engines the permissible minimum oil pressure is 0.6 kp/cm² at an idling speed of 750 rpm. and an oil temperature of 80° C (SAE 10 W oil). Thus engines with a genuine oil pressure below 0.6 kp/cm² at idling speed are no longer reliable in operation.

Before removing the engine, an additional check should be made to determine whether the oil pressure is actually below 0.6 kp/cm². Connect a calibrated instrument of small measuring range directly to the oil filter union with a short connecting line of at least 4 mm Φ. The oil filter element should be cleaned beforehand since a clogged filter element would adversely affect the pressure.

Further causes of inadequate oil pressure may be: fouled or leaky oil relief valve, bearing wear, faulty oil pump, loose or leaky main oil flow passage plug or a porous oil passage.

Operating Oil Pressure

At a cooling water temperature of 80° C the standard operating oil pressure is between 2 and 6 kp/cm², depending on oil viscosity and engine speed.

Oil Consumption

The oil consumption of the engine can only be judged after a certain mileage and in the beginning consumption may be in excess of the specified average value. Frequent driving at high engine speed also results in additional consumption. The oil level should therefore be checked regularly.

For average engine oil consumption see Job No. 0-3, for high oil consumption see Job No. 00-30.

Fuel Consumption

Consumption depends on driving speed. The values given in the table were obtained at uniform speeds with two passengers in the cars and on a flat road.

Compared with smart driving and long-distance runs, higher fuel consumption will always have to be allowed for in heavy city traffic, on short runs, slow driving in a line of cars, frequent accelerating and braking and, in addition, at very low outside temperatures and snow. Thus consumption depends to a large degree on driving habits and on external circumstances.

For average consumption and fuel consumption according to DIN 70 030 see Job No. 0-3.

Hints on Economical Driving

Do not play too much with the gas pedal. Never accelerate more than is necessary to maintain the speed required.

Do not drive too much in low gears. Do not always exploit the full acceleration and top engine speeds in the various gears.

Take curves at moderate speeds. Taking curves at high speeds exerts a greater wear on your tires than many miles on a straight road.

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Tightening Torques in mkp

Engine		190 Dc 200 D	190 c 200	220 b 220 Sb	230 230 S
Cylinder head screw	with engine cold[1])	9	8		
	with engine hot[2])	9	9		
Threaded bolt in cylinder head for rocker arm mounting		—	10		
Threaded bolt in cylinder head for rocker arm mounting minimum		—	1.5		
Rocker arm block screws[4])		3.75	—		
Spark plugs or glow plugs		5	3—3.5		
Precombustion chamber in cylinder head		15 + 3	—		
Nozzle in nozzle holder and nozzle holder in cylinder head		7÷1	—		
Nut for connector on nozzle holder		7—1	—		
Hexagon or Poli stop nut on drive shaft of injection pump or on the idling gear shaft for fixing the idling gear and the drive sleeve for the distributor		7	—		
Pipe union for pressure valve on injection pump[4])		3.0 + 0.5	—		
Cap nuts of injection pipes		2.5	—		
Connecting rod bearing bolts[7])		3.75	3.75		6
Crankshaft bearing bolts[9])		9	9		8
Shoulder screw or clamp nut on crankshaft front		18	18		21 + 1
Nuts or screws for flywheel or driven plate on crankshaft[10])		5.5 + 0.5	5.5 + 0.5	on mech. transmission	6.5 + 0.5 on mech. and automatic[11]) transmission
		4.5 + 0.5	4.5 + 0.5	on automatic transmission	
Fixing screw for lower part of oil pan		0.8	0.8		
Fixing screws of engine supports on crankcase		5 + 0.5	6		
Fixing screw for lower part of oil filter		4—0.5	3.5		
Oil pressure valve in crankcase		4	4		
Shoulder screw for fixing clamp nut, Generator on crankcase		6.5	6.5		
Nut for Vee-pulley/generator		3.5 ÷ 0.5	3.5 ÷ 0.5		

For Footnotes [1]) to [11]) see Page 00-0/26

Tightening Torques in mkp

Engine		220 SEb	250 S	250 SE 230 SL 250 SL	300 SE 300 SEb 300 SEL
Cylinder head screw	with engine cold[1])	8			10 [3])
	with engine hot[2])	9			11[3])
Hexagon socket screws M 10 for camshaft bearing		—			4.5 — 0.5
Threaded bolt in cylinder head for rocker arm mounting		10			—
Threaded bolt in cylinder head for rocker arm mounting, minimum		1.5			—
Rocker arm block screws[4])		—			3.75
spark plugs or glow plugs		3—3.5			
Hexagon or Poli-stop nut on drive shaft of injection pump or on idling gear shaft for fixing the idling gear and the drive sleeves for the distributor		5 + 0.5	—	5 + 0.5	—
Screw or nut for fixing flange of injection nozzle		0.8 ± 0.2	—		0.8±0.2
Injection nozzles in cylinder head or in suction pipe		—		3—3.5	—
Pipe union for pressure valve on injection pump[6])		3.0 + 0.5	—	3.0 ÷ 0.5	
Cap nuts of injection pipes		2.5	—	2.5	
Connecting rod bearing bolts[7])		3.75	6 [8])		3.75
Crankshaft bearing bolts[9])		8			5 ± 0.2
Shoulder screw or clamp nut on crankshaft front		21 ÷ 1			28 ÷ 2
Fixing screws for Vee Pulley on vibration damper		—			2.5 + 0.5
Nuts or screws for flywheel or driven plate on crankshaft[10])		6.5 + 0.5	9.5 ÷ 0.5 on mech. and automatic[11]) transmission		4.5±0.2
Fixing screws for lower part of oil pan		0.8			
Fixing screws of engine supports on crankcase		6			4.5 + 0.5
Fixing screw for lower part of oil filter		3.5			
Oil pressure valve in crankcase		4			
Shoulder screw for fixing clamp nut, Generator on crankcase		6.5			—
Nut for Vee pulley/generator		3.5 + 0.5			

For Footnotes[1]) to [11]) see Page 00-0/26.

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Footnotes for Table "Tightening Torques Engine" on Pages 00-0/26 and 27.

Torque wrenches should not be used above 50—75 P. C. off their capacity (e. g. for A 3.75 mkg tightening torque a torque wrench with a range of 0—6 mkg should be used).

[1]) Before fitting the cylinder head screws apply graphite oil (Auto Kollag) to the threads and to the contact surfaces of the cylinder head screws and the washers.

The instructions for the tightening sequence and for the tightening stages of the cylinder head screws should be strictly adhered to (see Page 00-0/21).

[2]) After installing the cylinder head warm up the engine under slight load until the cooling water temperature reaches 80° C. Run the engine for approx. 5 minutes at this cooling water temperature and then tighten the cylinder head screws with the engine warm according to the values listed above.

Carry out second retightening after another 300—1000 km

Caution: When retightening the cylinder head screws there is a danger of omitting the necessary retightening because the unscrewing torque is usually higher than the prescribed tightening torque and it may thus be possible for the torque value in the first tightening phase to be above the nominal tightening torque.

In order to ensure that the cylinder head gasket is really fitted with the prescribed screw tightening torque the retightening of the cylinder head screws should be carried out as follows:

Each screw should be slightly loosened in the sequence laid down in the screw schedule and should then be tightened to the prescribed tightening torque. Under no circumstances should all screws be unscrewed in one operation and then tightened.

[3]) Cylinder head screws M 10 (Nos. 15 to 20, see page 00-0/21) should be tightened to 5 mkp with the engine cold and to 6 mkp with the engine warm.

[4]) When tightening the rocker arm block screws the rocker arms must not be under load from the camshaft.

[5]) The nuts for fixing the flange of the injection valves should be tightened in such a way that the distance between the upper edge of the plastic flange and the contact surface of the intake pipe is 33 ± 1.0 mm.

[6]) In order to ensure proper seating of the sealing rings of the pipe unions, tighten the pipe unions to 3.0 mkp and back them out again, then tighten them to 3.0 mkp and back them out before finally tightening them to 3.0 ÷ 0.5 mkp. Care should be taken to ensure that threads of the pipe unions are coated with tallow before they are screwed in.

Apart from this, the fixing screw of the clamping jaw lock between the pipe unions should be tightened with a tightening torque of no more than 0.9 mkp (because excessive tightening may cause leakage at the elements of the low-pressure and high-pressure side as a result of distortion of the injection pump housing).

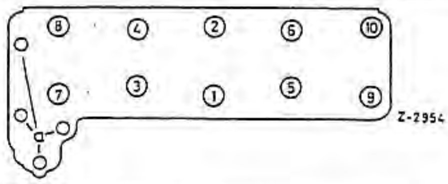
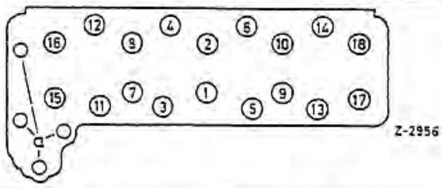
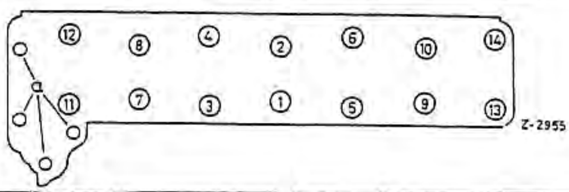
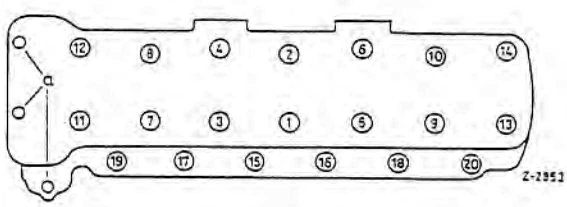
[7]) The connecting rod bearing bolts (without lock washers) are tightened with the prescribed tightening torque. Before tightening the bolts, liberally coat the threads of the bolts and the nuts with oil.

[8]) On Model 230 SL with connecting-rod bearing bolts 121 038 03 71 (10 mm ⌀) the tightening torque is no more than 3.75 mkp.

[9]) The main bearing bolts are tightened without lock washers. On Model 300 SE tighten the collar bolt for fastening the crankshaft bearing caps with a torque of 5 mkp if this bolt has to be screwed in.

[10]) On Models 190 c, 190 Dc, 220 b, 220 Sb, 220 SEb, 230 SL use only 12 K stretch screws Part No. 621 032 00 71 when repairs are carried out. When a 10 K stretch screw is installed the tightening torque is 4.5 ÷ 0.5 mkp.

[11]) On Model 230 SL 6.5 + 0.5 mkp.

Table for Tightening Sequence and Tightening Stages of Cylinder Head Screws M 12					
Model	Diagram for tightening sequence of cylinder head screws	Tightening stages, tightening torque in mkp			
		1st tightening	2nd tightening	3rd tightening	check
190 c 200		with engine cold			at CWT[1]) 80° C
		4	6	8	9
190 Dc 200 D		4	6	9	9
220 b 220 Sb 220 SEb 230 230 S 230 SL 250 S 250 SE 250 SL		4	6	8	9
300 SE 300 SEb 300 SEL		M 12 screws 1 to 14			
		4	7	10	11
		M 10 screws 15 to 20			
		2	4	5	6

Note: The other screws "a" with M 8 thread should be tightened by means of a hand wrench.
Slackening of the cylinder head screws is the reverse of the tightening procedure.

[1]) CWT = Cooling water temperature.

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Removal and Installation of Engine together with Transmission

Job No.
00-1

Modification: Assembly Instructions for Cars with Power Steering and Air Suspension added

Removal:

1. Remove the hood.
   In the case of the 1st version hood attachment release the pressure on the torsion bar (1) on the hood with Removal Tool 111 589 02 61 (6) and remove the collar bolt (5) (Fig. 00-1/1).

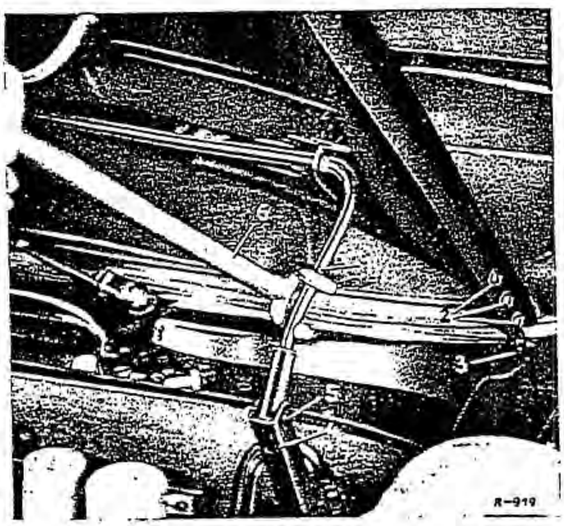


Fig. 00-1/1

1 Torsion bar	4 Lever
2 Hexagon screws	5 Collar bolt
3 Hinge	6 Removal Tool 111 589 02 61

2. Remove the battery, drain the cooling water and remove the radiator (see Job No. 50-1), disconnect the heating hoses.
   On cars with automatic transmission disconnect the connections at the oil cooler and close with dummy plugs.

3. On gasoline and diesel engines unscrew the air intake silencer. On injection engines remove the upper part of the air intake silencer.

4. Disconnect all fuel hoses and the vacuum hose to the power brake. On cars with power steering and air suspension disconnect oil hoses and air lines. Close the connections with dummy plugs.

5. Disconnect the hose for the oil pressure gage.

6. On gasoline engines disconnect the choke cable from the carburetor. On diesel engines disconnect the idle control cable and the start-stop cable. Detach the accelerator linkage.

7. Disconnect the ground cable from the battery to the engine and the ground cable from the engine to the car body. Disconnect all other electric cables.

8. Detach the gearshift linkage (Fig. 00-1/2).

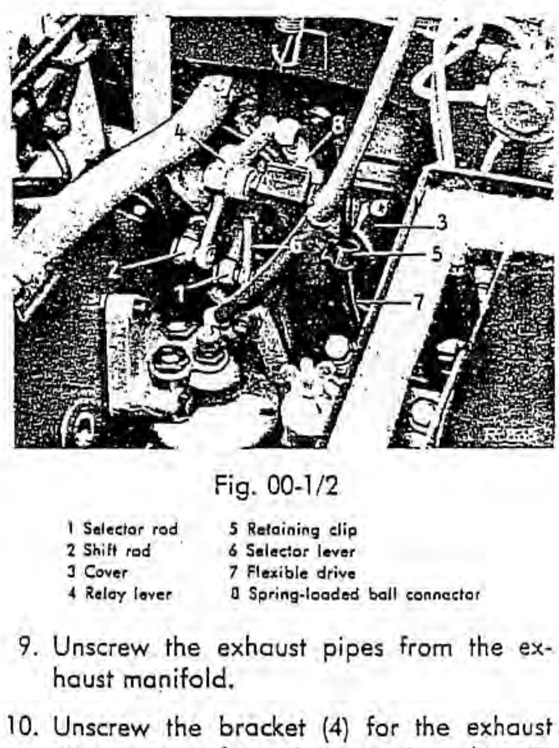


Fig. 00-1/2

1 Selector rod	5 Retaining clip
2 Shift rod	6 Selector lever
3 Cover	7 Flexible drive
4 Relay lever	8 Spring-loaded ball connector

9. Unscrew the exhaust pipes from the exhaust manifold.

10. Unscrew the bracket (4) for the exhaust pipe support from the mounting plate (9) on the transmission, loosen the clamping screw (7), and push the bracket downward (Fig. 00-1/3).

11. Pass a suitable lifting cable under the engine, at the front at the Vee-pulley and at the rear at the oil pan, and tighten the cable gently until it takes the weight (see Fig. 00-1/7).

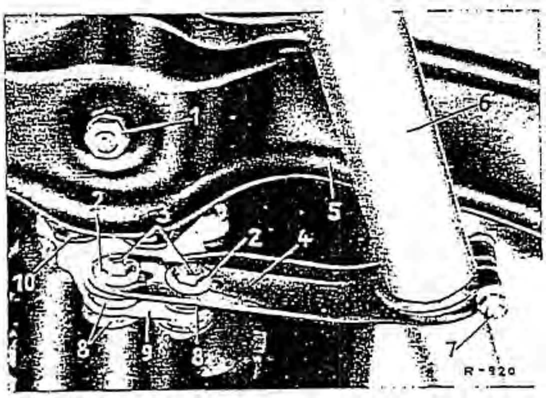


Fig. 00-1/3

1 Hexagon nut
2 Washer
3 Hexagon screw
4 Bracket for exhaust pipe
5 Support
6 Exhaust pipe
7 Hexagon screw (clamping screw)
8 Rubber washer
9 Mounting plate
10 Engine support

12. Mark the position of the rear support (12) in relation to the chassis base panel (20) and remove the support from the rubber mounting and the chassis base panel (Fig. 00-1/4).

    Detach the center brake cable from the brake lever and take it out of the cable guide of the front axle support and the support (12). Then remove the support (Fig. 00-1/4).

13. Unscrew the engine support with the rubber mounting from the transmission case rear cover. Disconnect the speedometer drive.

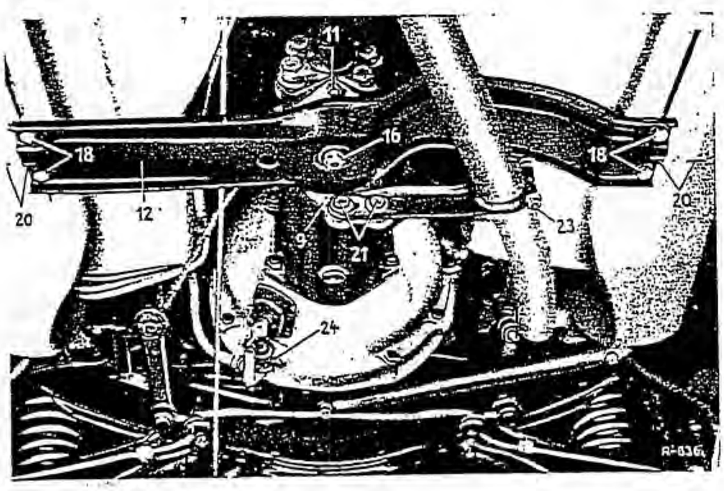
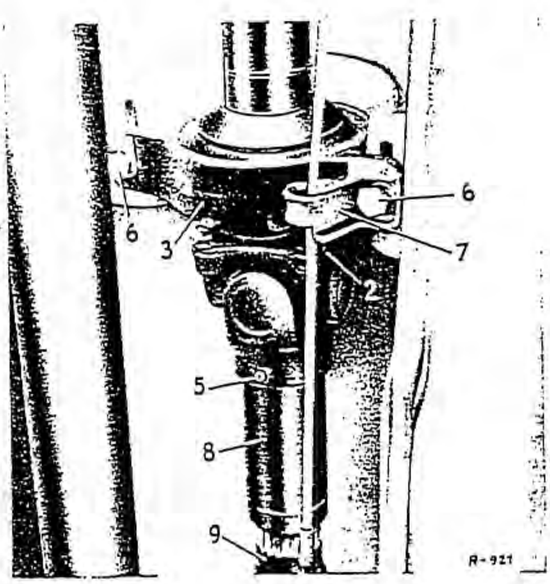


Fig. 00-1/4

9 Mounting plate
11 Rubber mounting
12 Rear support
16 Hexagon nut
18 Hexagon screw
20 Position markings
21 Hexagon screw
23 Hexagon screw
24 Extraction cylinder



14. Mark the position of the bearing bracket for the propeller shaft intermediate bearing on the chassis base panel.
    Then screw out the two fixing screws (6) together with washers (Fig. 00-1/5).

15. Disconnect the propeller shaft together with the shaft plate at the transmission and push to the rear.

Fig. 00-1/5

2 Joint flange of front propeller shaft
3 Bearing bracket
5 Grease fitting for slip coupling
6 Hexagon screws for fastening the bearing bracket to the chassis base panel
7 Cable bracket
8 Slip coupling with universal joint of rear propeller shaft
9 Rear propeller shaft

16. On cars with mechanical transmission detach the return spring (10) from the clutch throw-out fork (11) and the extraction cylinder (5). Then unscrew the extraction cylinder from the clutch housing and remove the pressure pin.

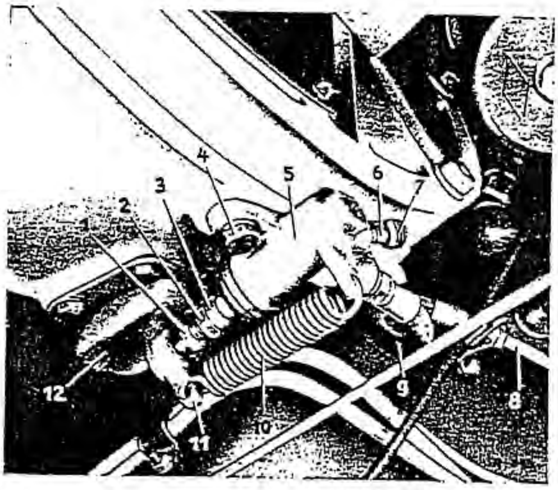


Fig. 00-1/6

1 Push rod	7 Protective cap
2 Hexagon nut	8 Line
3 Pressure pin	9 Hose
4 Hexagon screw	10 Return spring
5 Extraction cylinder	11 Throw-out fork
6 Bleed screw	12 Rubber cuff

17. Unscrew the hexagon screws at the front engine suspension at the left and right, holding the rubber mountings steady with an SW 22 Wrench (see Fig. 22-1/1).

18. Slightly raise the engine with the transmission with a hoisting rig and tilt it to an angle of appr. 45°. In this position lift out the engine with the transmission (Fig. 00-1/7).

Installation:

19. Lower the engine together with the transmission at an angle of appr. 45° until the transmission is behind the steering linkage. Then place a jack under the transmission and lower the engine at the front until it is seated on the engine mountings.

Note: The oil pan must not foul the steering linkage.

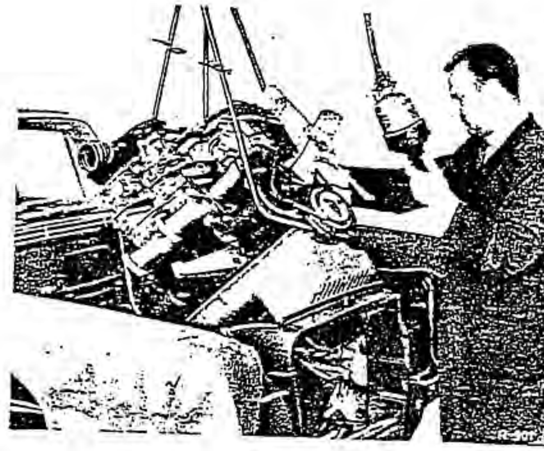


Fig. 00-1/7

20. Screw the hexagon screws for the front engine support at the left and the right into the engine mountings. Remember the spring washer.

21. Raise the jack under the transmission until the propeller shaft can be flanged to the transmission. Then place the sealing ring on the transmission main shaft, push the propeller shaft forward and flange it to the transmission. Cotter the castle nuts (see Job No. 26-1).

22. Connect the flexible speedometer drive.

23. Attach the propeller shaft intermediate bearing to the chassis base panel, noting the positions marked during removal.

24. Attach the mounting plate and the engine support to the transmission.
On Models 220 SEb Convertible and 300 SE Convertible adjust the limit stop at the rear engine mounting (see Job No. 24-1).

25. Screw the support to the rear engine mounting and to the chassis base panel, noting the positions marked during removal (see Fig. 00-1/4).

26. Adjust the limit stop at the rear engine mounting (see Job No. 24-1).

27. On cars with mechanical transmission attach the extraction cylinder to the clutch housing, installing at the same time the push rod between the pressure pin and the throw-out fork.

Adjustment of Tappet Clearance

Job No.
00-3

Models starting August 1965 added

The tappet clearance should only be adjusted and checked **with the engine cold.**

On all gasoline and gasoline injection engines of **Models 190 c to 250 SL** the tappet clearance is measured between the **sliding surface of the rocker arm** and the **cam base circle of the camshaft**, on **Models 300 SE, 300 SEb and 300 SEL** between **valve shaft end** and **adjusting screw or ball socket**, on **Models 190 Dc and 200 D** between **rocker arm** (6) and **cap nut** (7) (see Figs. 00-3/1, 4 and 6).

On Models 190 Dc and 200 D the tappet clearance can be adjusted **with the engine warm** (cooling water temperature 60–80° C) (see Job No. 00-0).

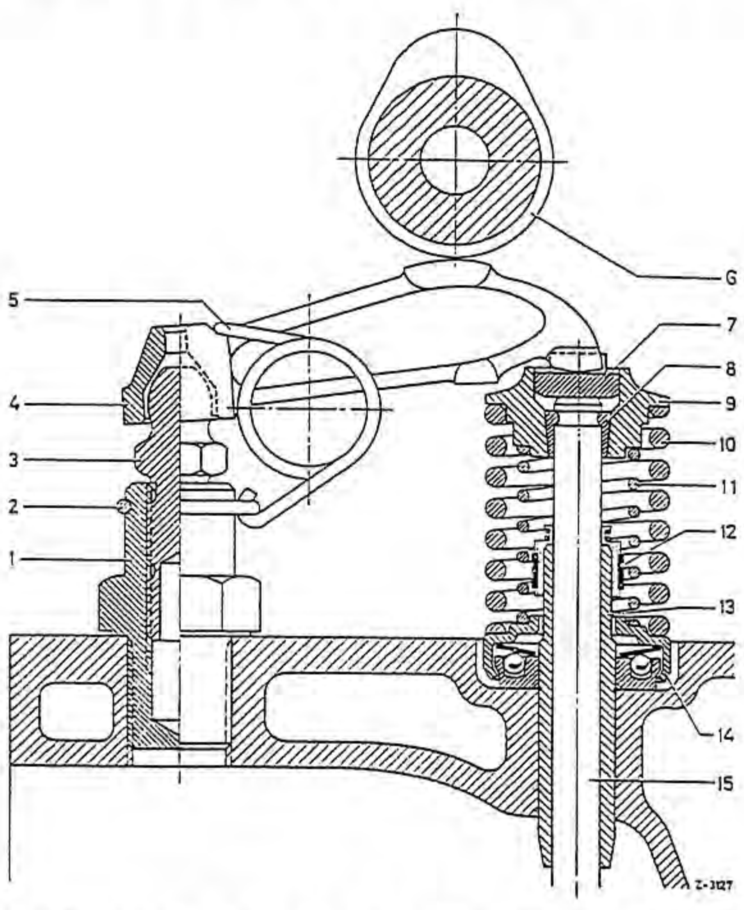


Fig. 00-3/1

Valve arrangement on Models 190 c, 200, 220 b, 220 Sb and 220 SEb 230, 230 S, 230 SL 250 S, 250 SE and 250 SL

The different valve stem sealing systems, including the valve rotators are shown in Figs. 05-2/3-10.

1 Ball pin base
2 Annular spring
3 Ball pin head
4 Rocker arm
5 Spring clamp
6 Camshaft
7 Pressure piece
8 Valve cone half
9 Valve spring retainer and sealing ring retainer
10 Outer valve spring
11 Inner valve spring
12 Valve sealing ring
13 Valve guide
14 Valve rotator
15 Valve

1. Detach the air vent line at the cylinder head cover and after loosening the tensioning screws remove the cylinder head cover.

Note: On Models 230 SL, 250 SE, 250 SL, 300 SEb, 300 SEL as well as on Model 300 SE and on Model 220 SEb with the 2nd version control the control shaft must be removed (see Job No. 00-16). In the case of gasoline engines the carburetor scoop must be removed as well.

2. On Diesel and on 300 SE engines the tappet clearance is always adjusted at ignition TDC and in the firing order of the individual cylinders.

The firing order is 1-5-3-6-2-4 in the case of the 6-cylinder-engines and 1-3-4-2 in the case of the 4-cylinder-engines, beginning with the first cylinder.

Position of inlet and exhaust valves

← *Direction of travel*

E E E E E E
A O O A A O O A A O O A
O O O O O O
1st 2nd 3rd 4th 5th 6th cylinder

Fig. 00-3/2

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3. On all gasoline and gasoline injection engines of Models 190 c to 250 SL move the cam of the camshaft which operates the tappet being adjusted to the position where the lobe of the cam is not pressed against the rocker arm but is on the opposite side and at right angles to the sliding surface of the rocker arm, i. e. the base circle of the cam faces the sliding surface of the rocker arm (Fig. 00-3/1).
Screw out the spark plugs and turn the crankshaft at the shoulder screw fastening the Vee-pulley and the counter-weight to the crankshaft; use an SW 22 socket and at ratchet to turn the crankshaft in the direction in which the engine turns.

Note: In the case of Models 300 SE, 300 SEb and 300 SEL use a suitable length of round iron to turn the crankshaft. To do this 12 holes with 8 mm ⌀ have been bored at the circumference of the vibration damper plate.

4. To measure and adjust the tappet clearance insert the tolerance feeler band between the sliding surface of the rocker arm and the cam base circle on Models 190 c, 200, 220 b, 220 Sb, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE and 250 SL, between valve shaft end and adjusting screw or ball socket on Models 300 SE, 300 SEb and 300 SEL between rocker arm and cap nut on Models 190 D and 200 D.

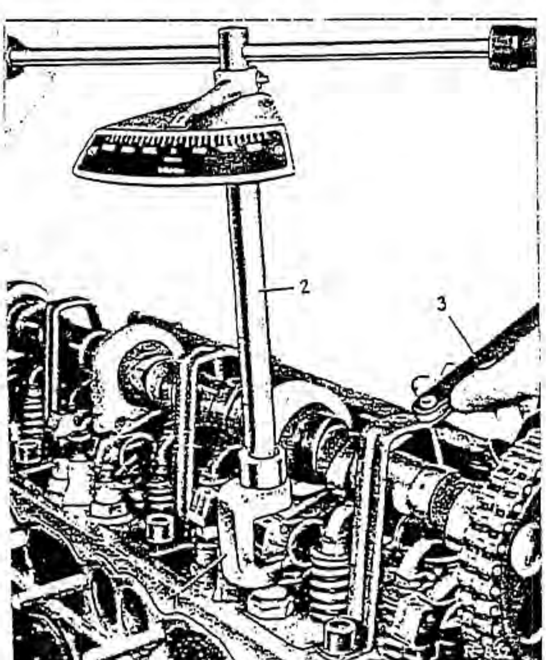

Fig. 00-3/3

Adjustment of tappet clearance

1 Adapter for tappet clearance adjustment 111 589 00 01 00
2 Torque wrench
3 Valve gage holder with tolerance feeler band

The tappet clearance is adjusted correctly if the tolerance feeler band can only just be pulled through.

5. If a correction of the tappet clearance is necessary,
a) on **Models 190 c, 200, 220 b, 220 SB, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE and 250 SL** adjust the tappet clearance by turning the ball pin head (3) at the hexagon collar (SW 14) by means of Adapter 111 589 00 01 (1) and a torque wrench (0-6 mkp) (2) (Figs. 00-3/1 and 3). If the tappet clearance is too small, increase it by screwing in the ball pin head. If the tappet clearance is too large, decrease it by screwing out the ball pin head. When the ball pin head (3) is turned in the base (1) the adjusting torque must be at least 1.5 mkp (Fig. 00-3/1).

If the adjusting torque is less, either the ball pin head (3) or the ball pin base (1) or both parts must be replaced. If the tappet clearance is too small and the ball pin head with hexagon SW 14 cannot be screwed further into the ball pin base, a thinner pressure piece (7) can be installed in the valve spring retainer (9) (Fig. 00-3/1). The standard thickness of the pressure pieces is 4.5 mm but they are also available 3.5 mm and 2.5 mm thick. To replace the pressure piece the rocker arm must be removed (see Job No. 05-1).

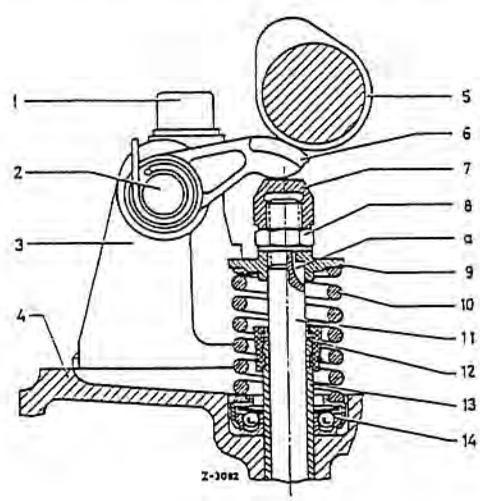

Fig. 00-3/4

Valve arrangement on Models 190 Dc and 200 D

a Groove invalve shaft
1 Extending screw
2 Rocker arm shaft
3 Rocker arm block
4 Cylinder head
5 Camshaft
6 Rocker arm
7 Cap nut
8 Hexagon nut
9 Valve spring retainer and sealing ring retainer
10 Valve spring
11 Valve stem
12 Valve seal
13 Valve guide
14 Valve rotator

b) on **Models 190 Dc and 200 D**

Fit the special wrench (17) over the hexagon of the valve spring retainer.
Slacken the hexagon nut (8) on the valve by means of the special wrench (14) holding the cap nut (7) steady with the special wrench (16). Then adjust the prescribed tappet clearance by turning the cap nut (7) using the special wrench (16) (see Job No. 00-0), holding the valve steady by means of the special wrench (17) fitted over the hexagon of the valve spring retainer (9). After adjusting the cap nut (7) lock it by tightening the hexagon nut (8) and once again check the tappet clearance (see Figs. 00-3/4 and 5).

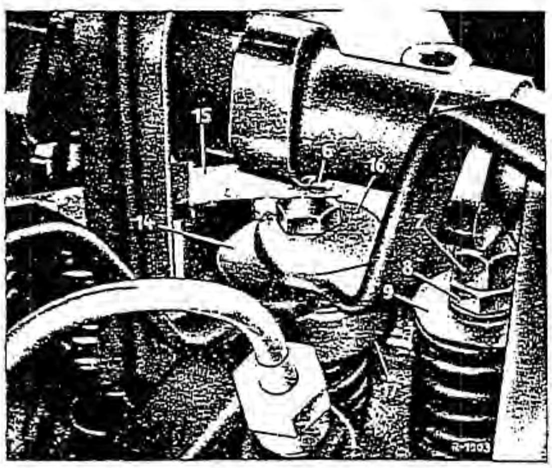

Fig. 00-3/5

Tappet clearance adjustment on Models 190 Dc and 200 D

6 Rocker arm
7 Cap nut
8 Hexagon nut
9 Valve spring retainer and sealing ring retainer
14 Special Wrench Part No. 621 589 01 01 00 for slackening and tightening the hexagon nut (8)
15 Tolerance feeler band
16 Special Wrench Part No. 621 589 01 01 00 for adjusting and steadying the cap nut (7)
17 Special Wrench Part No. 621 589 00 03 00 for steadying the valve at the valve spring retainer (9)

c) on **Models 300 SE, 300 SEb and 300 SEL**

Unscrew the hexagon nut on the rocker arm and adjust the prescribed tappet clearance by turning the adjusting screw (1 or 20) (Fig. 00-3/6).

6. Put on the cylinder head cover and tighten by means of the tensioning screws.

   When putting on the cylinder head cover make sure that the gasket is properly seated.

7. Connect air vent line to cylinder head cover.

   Note: On Models 230 SL, 250 SE, 250 SL, 300 SEb, 300 SEL and on Models 300 SE and 220 SEb with the 2nd version control linkage install the control shaft (see Job No. 00-16). In the case of gasoline engines attach the carburetor scoop.

8. Run the engine and check the cylinder head cover for leakage at the jointing surface.

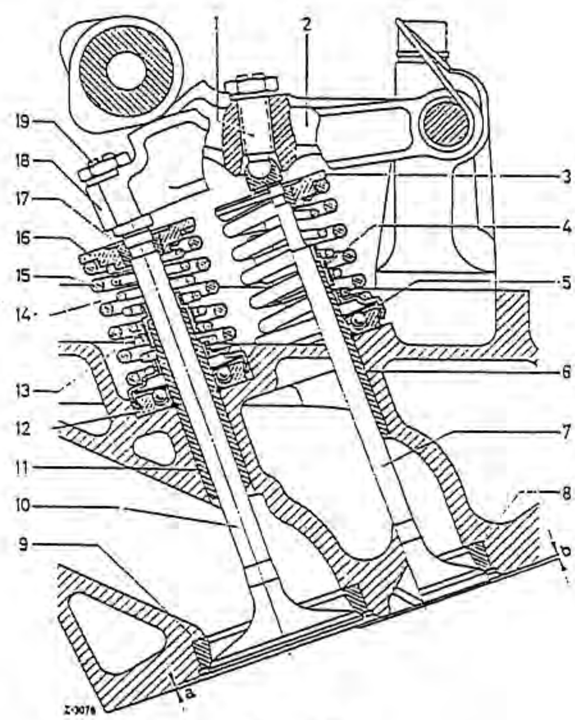

Fig. 00-3/6

Valve arrangement on Models 300 SE, 300 SEb and 300 SEL

1 Adjusting screw and ball cup for exhaust valve
2 Rocker arm (exhaust)
3 Valve spring retainer and sealing ring retainer for exhaust valve
4 Valve sealing ring
5 Valve rotator
6 Valve guide (exhaust)
7 Exhaust valve
8 Valve seat ring (exhaust)
9 Valve seat ring (inlet)
10 Inlet valve
11 Valve guide (inlet)
12 Valve rotator
13 Valve sealing ring
14 Inner valve spring
15 Outer valve spring
16 Valve spring retainer (inlet)
17 Valve cone halves
18 Rocker arm (inlet)
19 Adjusting screw (inlet)

a = Distance between jointing surface cylinder head and inlet valve spring retainer
b = Distance between jointing surface cylinder head and exhaust valve spring retainer

Compression and Cylinder Leakage Measurement

Job No.
00-5

When complaints are received about engine performance, e. g. inadequate output, unsatisfactory starting, high oil consumption, excessive smoke formation, irregular running, etc., checking operations should always include a compression test. Whenever the deviation as between individual cylinders exceeds 1.5 atm. in gasoline engines or 3.0 atm. in diesel engines, a CLT should be used for an additional leakage test.
Both compression and cylinder leakage test should only be performed with the engine warm; when the engine is cold the measurements are unreliable since they do not reflect engine performance under operating conditions.

A. Compression Test

1. Check the tappet clearance and adjust if necessary (see Job No. 00-3).

2. Bring the engine up to normal working temperature (cooling water temperature 70-80° C).

3. Remove the spark plugs or glow plugs. On a diesel engine also unscrew the injection pipes and cover up the injection pump and injection nozzle unions.

4. Turn the engine a few times with the starter to eliminate any oil carbon deposits or soot. This procedure is recommended to prevent soot from clogging the compression recorder.

5. On gasoline engines press the rubber cone of the compression recorder into the spark plug bore of the cylinder to be tested. On diesel engines screw the connector (1) into the glow plug bore of the cylinder to be tested; tighten well to provide a leakproof seal. For testing cylinders 2 and 3 attach the angular connector (2), Part. No. 000 589 00 90 00 to the connector (1) by means of the cap nut. Then attach the hose (3) of the compression recorder (4) to either the connector (1) or the angular connector (2) (Fig. 00-5/1).

6. To measure the compression, turn the engine 8 times by means of the starter, with the throttle valve wide open (gas pedal fully depressed) to ensure a satisfactory cylinder charge.

7. Test all cylinders the same way; remember to turn the chart in the compression recorder before starting on the next cylinder.

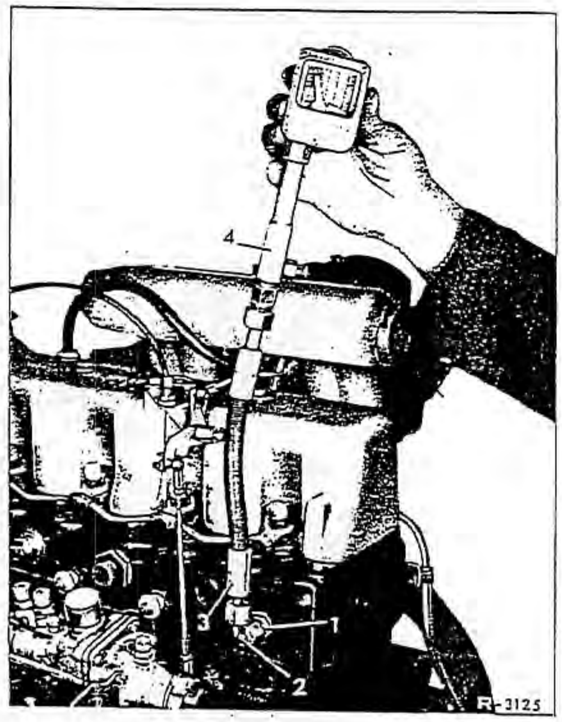

Fig. 00-5/1

1 Connector
2 Angular connector 000 589 00 90 00
3 Movable hose
4 Compression recorder 000 589 69 21 00

Make sure that there is as little difference as possible in the number of times the engine is turned for individual cylinder measurements. (For measuring values see Job No. 00-0). Whenever the deviation as between individual cylinders exceeds 1.5 atm. in gasoline engines or 3.0 atm. in diesel engines, a CLT should be used for an additional leakage test, (see Section B below).

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B. Cylinder Leakage Test

1. With the engine at normal working temperature, remove all spark plugs or glow plugs.

2. Hold the throttle valve or control valve wide open and remove the air cleaner (for escape noise check on intake pipe see para 8).

3. Remove the filler cap from the oil filler neck to check on escape noise from crankcase.

4. Remove the radiator cap; fill up if cooling water is too low for a proper check on air bubbles in the cooling water.

5. Now attach the hose (1) of the cylinder leakage tester (CLT) to the compressed-air supply and calibrate the tester (see operating instructions for tester). Then screw the appropriate connector (6) into the spark plug or glow plug thread of cylinder no 1 and attach the pressure hose (4) to the free opening of the connector (6).

7. With the engine stationary couple the CLT pressure hose (4) to the pressure hose (3). Watch the fan during the process and again check the TDC mark.

Caution: If the crankshaft should have moved beyond the dead center in the **direction of rotation** it should be rotated further in the same direction by 1¾–2 turns until the TDC mark on the counterweight again corresponds with the pointer (see Fig. 00-9/1).

However, if the crankshaft should have moved **contrary to the direction of rotation,** it should be turned in the proper direction until the TDC mark on the counterweight coincides with the pointer.

Now repeat the procedure described in para 7.

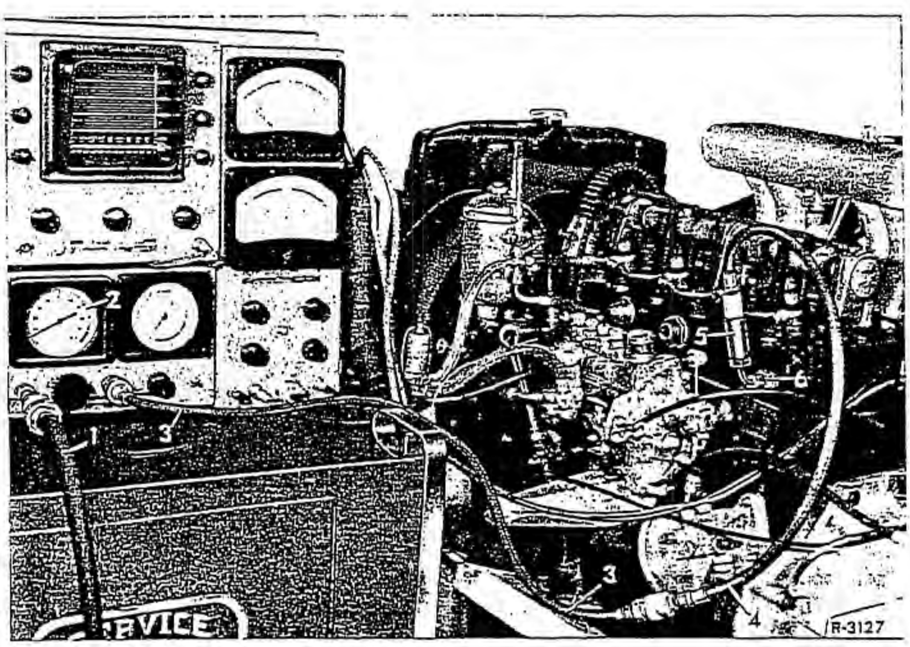


Fig. 00-5/2

1 Hose
2 Pressure gage of CLT
3 Hose
4 Hose
5 Angle piece
6 Connector

6. Advance the 1st cylinder piston to ignition dead center by turning the crankshaft in the **direction of rotation** until the TDC mark on the crankshaft or on the counterweight corresponds with the pointer on the crankcase and both the inlet and the exhaust valve of the 1st cylinder are closed.

8. Read off "percentage of pressure loss" on the pressure gage (2). Listen carefully to determine whether air escapes through the carburetor or the intake pipe, through the exhaust pipe or the exhaust manifold, or through the crankcase.

At the same time watch for air bubbles in the cooling water (for measuring values see Job No. 00-0).

9. Uncouple pressure hoses (3) and (4). Turn the crankshaft until the next piston is at ignition dead center or until the next TDC mark on the counterweight coincides with the pointer on the crankcase.

Firing order
on 4 cylinder engines 1-3-4-2
on 6 cylinder engines 1-5-3-6-2-4.

Note: For gasoline engines with a TDC mark on the crankshaft counterweight only for the first cylinder it is advisable to use the timing angle measuring instrument for determining the ignition TDC of the other cylinders. Attach the timing angle measuring instrument in the normal way, switch on the ignition, turn the crankshaft until the pointer of the timing angle measuring instrument drops from the contact resistance position and the piston has practically reached TDC.

For diesel engines it is advisable to use the whistle that goes with the instrument:

After screwing in the connector (6) – see para 5 – add the angle piece (5), insert the hose (4) in the angle piece and attach the whistle to the free end of the hose (4). Turn the crankshaft until the whistle blows (compression stroke); go on turning the crankshaft slowly until the whistle stops (piston is at ignition TDC). Remove the whistle.

10. Unscrew the connector from the tested cylinder and screw it into the cylinder next in firing order. Repeat the procedures described in paras 7, 8, and 9 until all cylinders have been tested (for measuring values see Job No. 00-0).

11. If the recorded pressure loss exceeds the values given in Job No. 00-0, liberally wet the piston head in the cylinder concerned with oil (approx. 100 cc) to eliminate pressure loss above the piston.

Repeat the test.

If the pressure loss still exceeds 5%, the air escapes via leaking valves, defective cylinder head gasket or cracks in the cylinder head.

Note: **A leaking inlet valve** can be detected by a blowing noise in the carburetor or the intake pipe.

A leaking exhaust valve can be detected by a blowing noise in the exhaust manifold.

When leaking valves are found check the tappet clearance again; in the case of valves with defective valve rotators (Rotocap) the first procedure is to replace the rotator; the rotating action reseals the valves. Success or failure of this repair should only be tested after about 3000 km. If there is no satisfactory improvement, remove the cylinder head and remachine the valve system.

A leaking cylinder head gasket or cracked cylinder head will be shown up by air bubbles in the cooling water. If the cylinder head gasket has a leak in the web between two cylinders, there will be a clearly audible blow from the tested cylinder through the open spark plug or glow plug opening of an adjacent cylinder. If that is the case remove the cylinder head and replace the cylinder head gasket. If the gasket is undamaged check the cylinder head for cracks (pressure test with the engine warm).

12. If this reduces the excessive pressure loss from say 35% to a maximum of 5%, the fault must be with the pistons, piston rings, or cylinder working surfaces.

Since there is a chance that pressure may be lost through accidentally superimposed piston ring gaps, it is advisable to postpone larger repairs and to make another leakage test after approx. 1000 km. If the values have not improved, remove the cylinder head, check the condition of the cylinder working surfaces, in particular check them for wear, and if necessary remove the pistons (see Section C, Evaluation of Cylinder Working Surfaces).

Note: When a cylinder inspection light is available, inspect the defective cylinder. If scores are found on the cylinder wall, remove the cylinder head.

C. Evaluation of Cylinder Walls

a) Visual Inspection

Very often it is not easy for the repair shops to decide whether scored or streaky cylinder walls are evidence of extensive damage requiring removal or repair of the engine, or of comparatively harmless wear. The following pictures and interpretations will help in solving this problem.

With regard to marks on the cylinder walls the first important difference is between "optical streaks" and "seizure streaks". As a rule "optical streaks" are about 3 mm wide, are produced by the piston ring gaps and do not destroy the honing structure; "seizure streaks", however, obliterate the honing structure.

Figs. 00-5/3 – 6 show a variety of typical damage patterns.

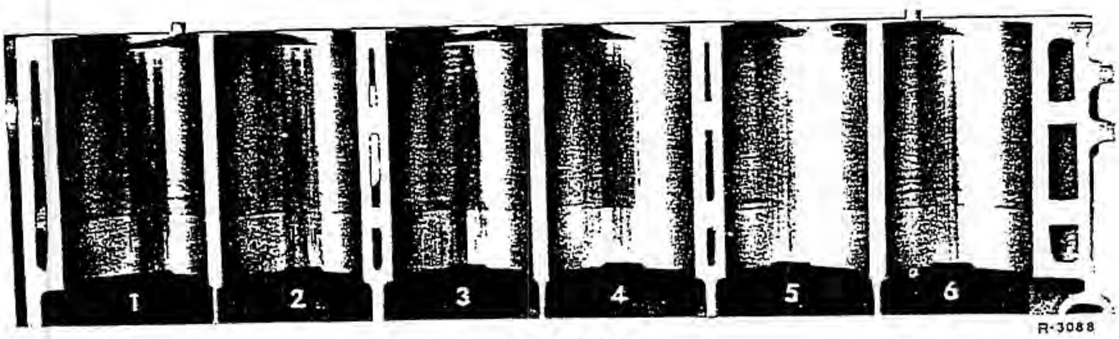


Fig. 00-5/3

Cylinders 1—3	Piston shaft has seized. Honing structure is destroyed. Engine must be removed.
Cylinder 4	Oil ring and piston shaft seizure. Honing stracture is destroyed. Engine must be removed.
Cylinders 5 and 6	Piston shaft is scratched. Honing structure not destroyed. Engine can remain in operation.

Fig. 00-5/4

Ring seizure in longitudinal derection, approx. 30 mm wide. The step produced by the oil ring can clearly be seen. Honing structure is destroyed. Engine must be removed.

Fig. 00-5/5

Oil ring seizure extended around total half of cylinder bore. Honing structure is destroyed. Engine must be removed.

Fig. 00-5/6

Medium oil ring seizure. Honing structure still clearly visible. Engine can remain in operation.

Note: "Longitudinal streaks" (in the piston pin direction) cannot be caused by shaft scratches or seizure, since there is no contact between piston skirt and cylinder wall.

In case of complaints be sure to enclose examination sheet of cylinder bores – of 650 057 00 a – with guarantee and goodwill claim form.

The examination sheet should contain the following details:

cylinder affected

width of streaks

height of streaks: up to first ring

up to oil ring

piston skirt

position of streaks: right front (pressure side)

left rear (counterpressure side)

The Examination Sheets may be ordered under the number OF 650 09 057 00a through normal literature ordering channels.

b) Measuring of Cylinder Bores

In addition to the visual inspection, measuring of the cylinder bores is imperative, in particular when complaints are received about "high oil consumption". Use an internal micrometer to measure the cleaned cylinder bores at the 6 measuring points or when the pistons have not been removed and are at bottom dead center at measuring points 1, 2 and 3 (Fig.00-5/7); measurements should be taken once in the piston pin axis direction (transverse direction A) and then in the vertical direction B. Measuring point 3 is just above the piston at BDC.

Any degree of out-of-roundness of 0.04 mm or above, any major wear in the center of the cylinder, i. e. 0.03 mm at measuring points 3 and 4 as compared with measuring point 6, or any general wear of approx. more than 0.12 mm between measuring points 1 and 6 or the original bore are bound to increase oil consumption. For high oil consumption see also Job No. 00-30.

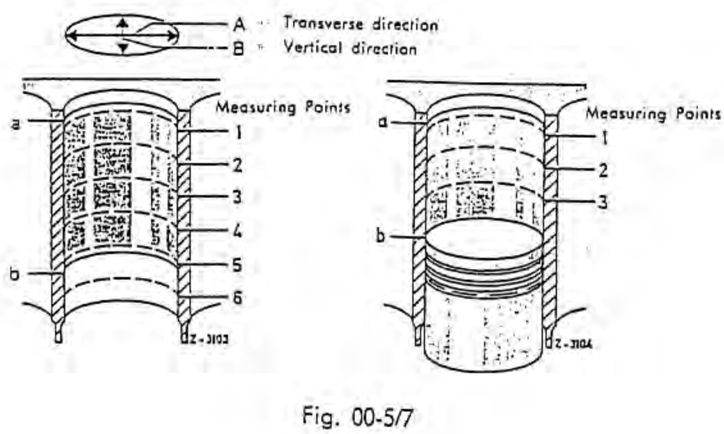


Fig. 00-5/7

a top reversal point of 1st piston ring
b bottom dead center of piston
c bottom reversal point of scraper ring

Note: 0.01 mm wear per 10 000 km can be considered normal as a comparative measurement between measuring point 1 (directly below the top reversal point (a) of the 1st piston ring) and measuring point 6 (below the bottom reversal point (c) of the scraper ring).

Befundblatt Zylinderbohrungen
Examination Sheet of Cylinder Bores
Feuillet d'examen des parois de cylindres
Hoja de comprobación de cilindros

Kundendienst
Service

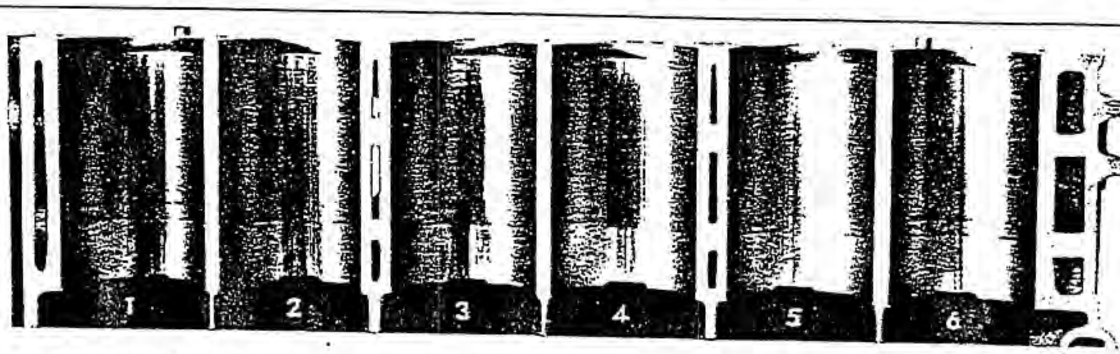
Besitzer Owner Propriétaire Proprietario

2) Niederlassung/Vertretung

3) Tag 4) Rep.-Auftrag Nr.

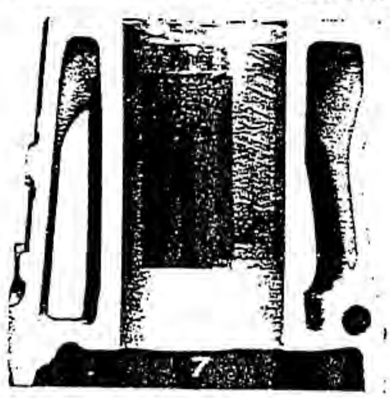
5) Platz 6) Pol. Kennzeichen 7) Erstzulassung 8) Typ 9) Fahrgestell-Nr. 10) Tachometerstand

11) Kopie 12) Eingebracht durch 13) Angenommen Zeit 14) Angenommen durch 15) Motor-Nr. 16) Unverbindl. Termin



R-3088

Zyl. 1-3 Kolbenschaft hat gefressen. Honbild ist zerstört. Motor muß ausgebaut werden.
Zyl. 4 Kolbenschaftfresser und Ölringfresser. Honbild ist zerstört. Motor muß ausgebaut werden.
Zyl. 5-6 Kolbenschaft aufgerissen. Honbild noch durchgehend erhalten. Motor kann weiterlaufen.
Cylinder 1-3 Piston shaft has seized. Honing structure is destroyed. Engine must be removed.
Cylinder 4 Piston shaft and oil ring seizure. Honing structure is destroyed. Engine must be removed.
Cylinder 5 and 6 Piston shaft is scratched. Honing structure not destroyed. Engine can remain in operation.
Cylindres 1 à 3 Jupe de piston grippée. Glaçage endommagé. Le moteur doit être déposé.
Cylindre 4 Jupe de piston et segment racleur grippés. Glaçage endommagé. Le moteur doit être déposé.
Cylindres 5 et 6 Jupe de piston gratté. Glaçage encore en bon état. Le moteur peut continuer à être utilisé.
Cilindros 1-3 El pistón se ha agarrotado. Ya no existen señales del bruñido. Hay que desmontar el motor.
Cilindro 4 Agarrotamiento del pistón y del aro rascador de aceite. Ya no existen señales del bruñido. Hay que desmontar el motor.
Cilindros 5-6 Pistón desgarrado. Existen señales completas del bruñido. Motor puede seguir trabajando.

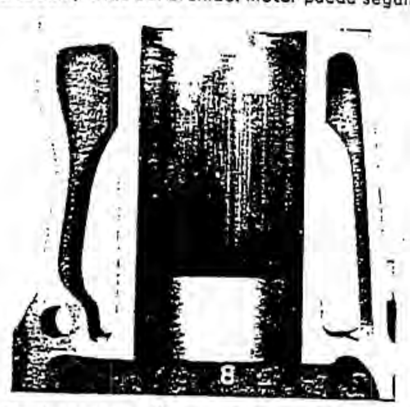


Stegseitiger Ringfresser ca. 30 mm breit. Deutlich ist der Absatz durch den Ölring erkennbar. Honbild ist zerstört. Motor muß ausgebaut werden.

Ring seizure in longitudinal direction, approx. 30 mm wide. The step produced by the oil ring can clearly be seen. Honing structure is destroyed. Engine must be removed.

Grippage du segment du côté paroi mitoyenne sur une largeur d'env. 30 mm. On reconnait clairement l'épaulement provoqué par le segment racleur. Glaçage endommagé. Le moteur doit être déposé.

Agarrotamiento de los aros en el lado del alma de material entre los cilindros de aprox. 30 mm de anchura. Se puede ver claramente la interrupción que proviene del aro rascador de aceite. Ya no existen señales del bruñido. Hay que desmontar el motor.

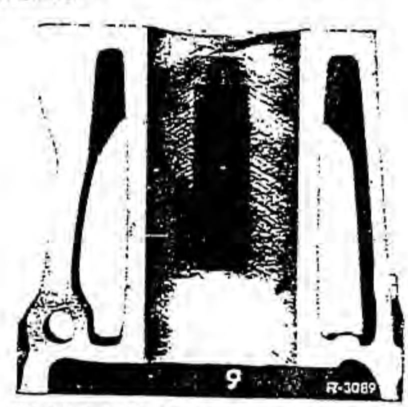


Ringfresser vom Ölring auf die gesamte Zylinderhälfte ausgedehnt. Honbild ist zerstört. Motor muß ausgebaut werden.

Oil ring seizure extended around total half of cylinder bore. Honing structure is destroyed. Engine must be removed.

Le grippage du segment racleur s'est étendu sur toute la moitié du cylindre. Glaçage endommagé. Le moteur doit être déposé.

El agarrotamiento que proviene del aro rascador de aceite se ve en todo su recorrorido del cilindro. Ya no se ven las señales del bruñido. Hay que desmontar el motor.



Mittelstarker Ölringfresser. Honbild ist noch deutlich sichtbar. Motor kann weiterlaufen.

Medium oil ring seizure. Honing structure still clearly visible. Engine can remain in operation.

Grippage d'importance moyenne du segment racleur. Glaçage encore bien visible. Le moteur peut continuer à être utilisé.

Agarrotamiento mediano que proviene del aro rascador de aceite. Se ven aún claramente las señales del bruñido. Motor puede seguir trabajando.

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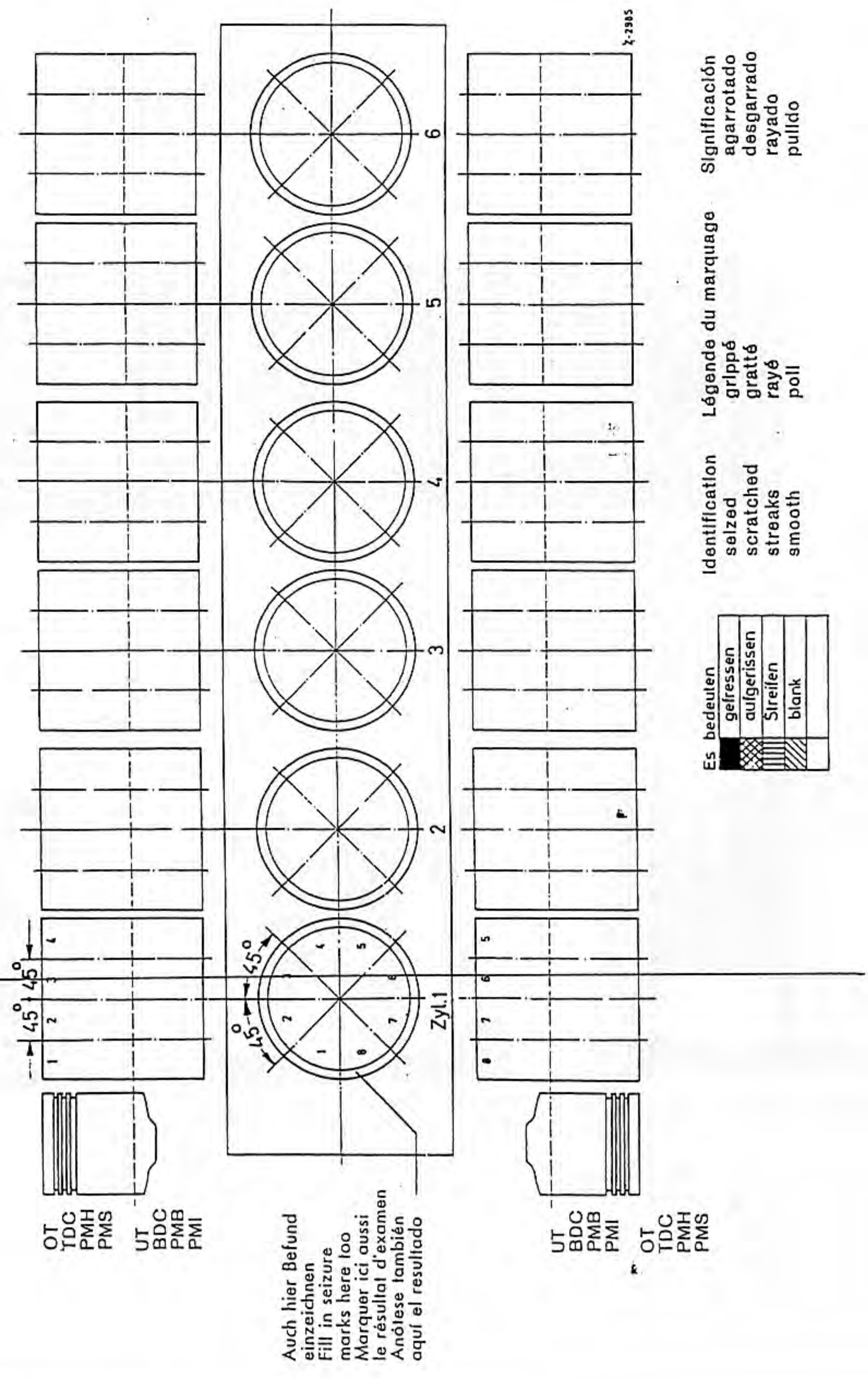
2) Branch/Agency Succursale/Représentation Sucursal/Representación	3) Date Date Fecha	4) Repair Order No. No. d'ordre de réparation No. de la orden de reparación	5) Place Place Puesto	6) Licence Number No d'immatriculation Matrícula
7) Original Registration Première immatriculation Primera matriculación	8) Type Type Tipo	9) Chassis No. Châssis No No. del chasis	10) Speedometer Reading Kilométrage Kilometraje	11) Copy Copie Copia
12) Delivered by Remis par Entregado por	13) Time of Reception Heure de réception Hora de recepción	14) Received by Réceptionné par Recibido por	15) Engine No. No de moteur Motor No.	16) Date, not binding Prêt le, sans engagement Plazo, sin compromiso



Measurement and Adjustment of Timing Angle

Job No.
00-6

A. Measurement of Timing Angle

1. Measure the timing angle at starter or idling speed. In the case of distributors with two pairs of contact breakers (300 SE Models), measure the timing angles separately at the two pairs of contact breakers (A and B) (Fig. 00-6/1). Proceed as follows: Put one pair of contacts out of action by inserting a small fiber sheet, set the timing angle tester to "6 cylinders" and check the timing angle at starter or idling speed.

   For adjustment angles see Job No. 00-0.

   If the measured value differs from the specified value by more than —5°, replace the contact breaker pairs (see Section B).

   Do not vary the timing angle for used contacts.

2. Measure the timing angle at n = 4 000 rpm. The timing angle may safely decrease by —3° at this speed.

   In the case of distributors with two pairs of contact breakers measure the timing angle of both pairs together.

B. Replacing of Contact Breakers and Adjustment of Timing Angle

Removal:

1. Remove distributor plate and distributor rotor.

2. Remove the pair or pairs (A and B) of contact breakers. Proceed as follows: Remove the wire locking rings from the pivot pins, unscrew the locking screws (6 and 13) and the cable terminal screw (12), pull the two pairs of contact breakers from the pivot pins and remove the cable (Fig. 00-6/1).

Installation:

3. Installation is the reverse of the removal procedure.

When installing new pairs of contact breakers make sure that the contacts are absolutely parallel when closed, i. e. that there is complete contact between the surfaces.

4. Adjust the gaps of the contact pair or pairs. Loosen the locking screws (6) for the contact breaker pair (A) and (13) for the contact breaker pair (B) and use the eccentric screws (7) and (14) to adjust the contact breaker gap to approx. 0.4 mm. Tighten the locking screws (6 and 13).

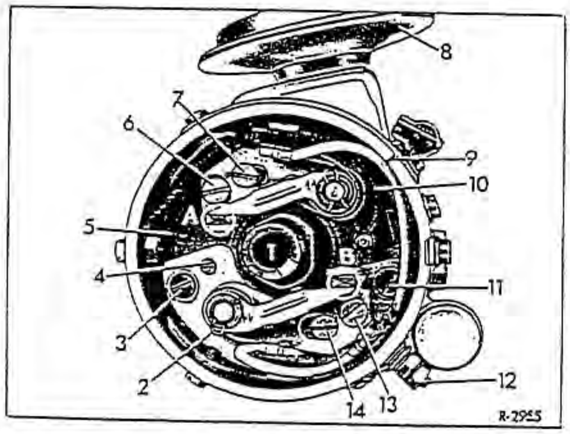


Fig. 00-6/1

Double contact breaker distributor with two pairs of contact breakers

A Contact breaker pair (contact closed)
B Contact breaker pair (contact open)

1 Distributor shaft with 3 cams
2 Intermediate plate adjustable on base plate with contact breaker pair B
3, 11 Locking screw of intermediate plate with contact breaker pair B
4 Eccentric adjustment bolt for correcting the firing interval between the two contact breaker pairs
5 Base plate with contact breaker pair A
6, 13 Locking screw of contact breaker pairs
7, 14 Eccentric adjustment screw for contact gap or timing angle adjustment
8 Vacuum box with diaphragm
9 Notch on distributor housing rim of distributor for cylinder 1
10 Pull rod for vacuum control
11 Locking screw of intermediate plate with contact breaker pair B
12 Screw for cable connection terminal 1 (low voltage cable from ignition coil)

5. For measuring the timing angle see Section A.

6. Adjust the timing angle: Repeat the measuring procedure described in Section B, para 4 until the correct timing angle and the same value for both contact pairs is achieved. If the timing angle is too small reduce the contact gap; if it is too large, increase the contact gap. For adjustment values see Job No. 00-0.

Wherever possible adjust the timing angle to the upper tolerance limit.

Ignition Timing

Job No.
00-7

Modification: revised

1. The ignition must be set by means of a flash stroboscope to the exact value prescribed for a certain speed: disconnect the vacuum line from the distributor and check the ignition setting on cylinder no. 1 by means of revolution counter and flash stroboscope. Accelerate the engine to n = 4500 rpm and read off the value at the counterweight or the vibration damper (Fig. 00-7/1) (for adjustment value see Job No. 00-0). If necessary turn the distributor until the prescribed value is reached.

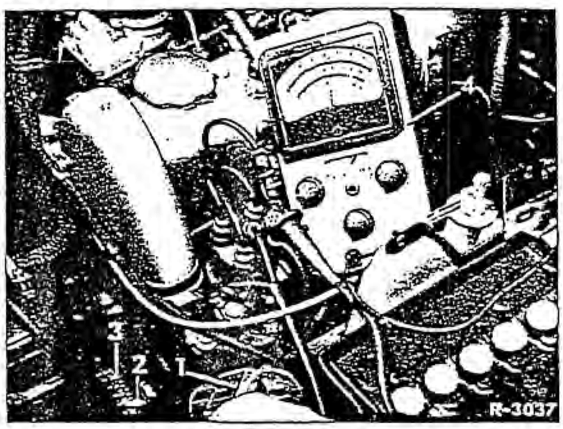


Fig. 00-7/1

1 Flash stroboscope
2 Pointer
3 Graduation on counterweight
4 Revolution and timing angle tester

2. On distributors with two pairs of contact breakers (300 SE Models) check the angular distance of the two pairs of contact breakers (Fig. 00-6/1). Also check the ignition setting of cylinder no. 6. If there is a difference of more than 2° on the crankshaft between the ignition setting of cylinders 1 and 6 (see Job No. 00-0) the angular distance must be corrected as follows:

   Change the relative position of the intermediate plate (2) and the pairs (A and B) of the contact breakers and loosen the locking screws (3) and (11) and change the position of the intermediate plate (2) or the pair of contact breakers (B) in relation to the pair of contact breakers (A) by turning the eccentric bolt (4) (see Fig. 00-6/1).

   If the intermediate plate (2) was adjusted the timing angle must be measured and if necessary adjusted as described in Job No. 00-6.

   Since any adjustment of the timing angle affects the angular distance, timing angle and angular distance must be corrected in their relation to one another until the prescribed values have been reached.

Note: The best way to adjust the 180° angular distance of the two pairs of contact breakers is to use a distributor test stand.

   If a test stand is not available it is advisable to use Graduated Disk 000 589 25 23 00 and a timing light.

   It goes without saying that every readjustment of the distributor should be preceded by a general check for worn sliding pieces, excessive radial play of the distributor shaft (1), a loose base plate (5) etc. (Fig. 00-6/1). Any defects should be remedied right away.

3. **Checking the beginning and range of the automatic vacuum control.**

a) Beginning of automatic vacuum control.

The automatic vacuum control of the distributor under no load must set in at the prescribed engine speed (see Job No. 00-0), i. e. the automatic vacuum control must set in when the throttle valve is beginning to open, and not earlier. On injection engines the throttle valve must be completely closed at idling speed.

Beginning of the automatic vacuum control can be corrected by screwing in or out the adjustment screw on the vacuum box (8) (Fig. 00-6/1).

b) Range of automatic vacuum control

Measure the total range of the automatic vacuum control of the distributor under no load (for values see Job. No. 00-0). The range can be increased by screwing out the stop nut on the pull rod connecting the diaphragm in the vacuum box (8) to the base plate (5); the range can be decreased by screwing the stop nut in (Fig. 00-6/1).

If pinking occurs in the speed range 1500–2500 rpm when carburetor engines are run on a fuel with an octane rating lower than 96 ROZ (98 ROZ in the case of injection engines), the ignition setting must be retarded to adjust it to the octane rating of the fuel used.

As a rule the adjustment should be made as follows: Retard the ignition setting by approx. 1° on the crankshaft for 1 ROZ below standard.

Adjustment by one graduation on the distributor bearing scale changes the ignition setting by 2° on the crankshaft. Maximum retardation is 6° at n = 4500 rpm.

The ignition must be re-set to the previous value as soon as fuel with the prescribed octane rating becomes available again.

Checking and Adjusting the Beginning of the Effective Stroke of the Diesel Injection Pump

Job No.
00-8

The accurate adjustment of the beginning of the effective stroke or the position of the crankshaft in relation to the beginning of the effective stroke of the injection pump is of decisive importance for the performance and the proper running of the diesel engine. For adjustment values see Job No. 00-0.

On gasoline injection engines, fine adjustment with the overflow pipe is not necessary.

The beginning of the effective stroke is checked and adjusted by means of the overflow method as follows:

1. Set the piston of the first cylinder to ignition dead center. The piston reaches this position when the pointer (2) registers with the TDC mark on the counterweight (1) (Fig. 00-8/1), and both the inlet and the exhaust valves of the first cylinder are closed. In this position there is no pressure on the rocker arms 1 and 2 and the valves 7 and 8 of the fourth cylinder are both in operation, i. e. the exhaust valve closes and the inlet valve opens.

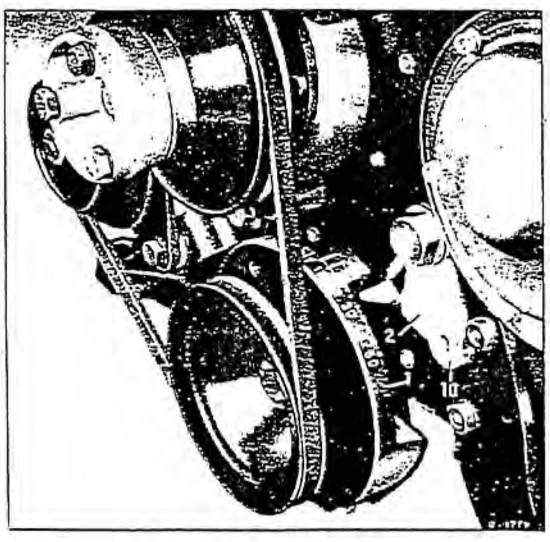


Fig. 00-8/1

1 Counterweight
2 Pointer
10 Locking screw with pivot pin for chain guide

2. Turn the crankshaft 1¾ turns in the direction of rotation. As a matter of principle the engine should always be turned in its direction of rotation to prevent the flyweights from being forced out of their initial position and to keep the chain under tension.

3. Unscrew the injection pipe from the pipe union of the first pump cylinder, screw out the pipe union (1) and remove the rubber sealing ring (2), the coil spring (3) and the pressure valve (Fig. 00-8/2).

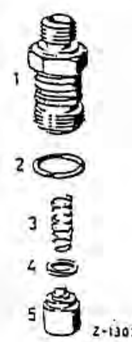


Fig. 00-8/2

1 Pipe union
2 Sealing ring (rubber)
3 Coil spring
4 Sealing ring
5 Pressure valve holder with pressure valve

Screw the pipe union in again and screw on overflow pipe (5), Part No. 636 589 02 23 00 (Fig. 00-8/3).

4. Detach the starting and stopping cable from the adjusting lever (2) of the injection pump to make sure that the adjusting lever and the control rod are in the full load position; move the adjusting lever and thus the control rod several times in the stop direction as far as the limit stop and release it again (Fig. 00-8/3).

When checking the beginning of the effective stroke it is imperative that the control rod should be in the full load position since in the case of injection pumps with "double" control edge the beginning of the effective stroke will be constant only in this position.

In this connection reference must be made again to our instruction to measure the beginning of the effective stroke according to the overflow method since the capillary tube method is less reliable.

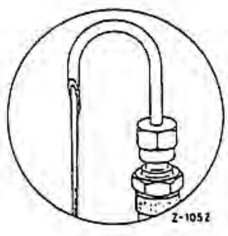


Fig. 00-8/4

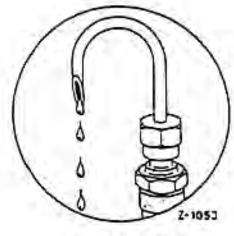


Fig. 00-8/5

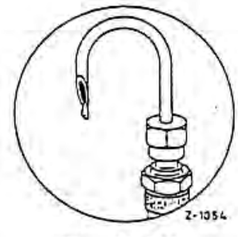


Fig. 00-8/6

5. Connect the fuel tank (7) to the injection pump, fill it with clean fuel and open the stop cock of the fuel tank (Fig. 00-8/3).

   The fuel will now flow from the overflow pipe (5) (see Figs. 00-8/3 and 4).

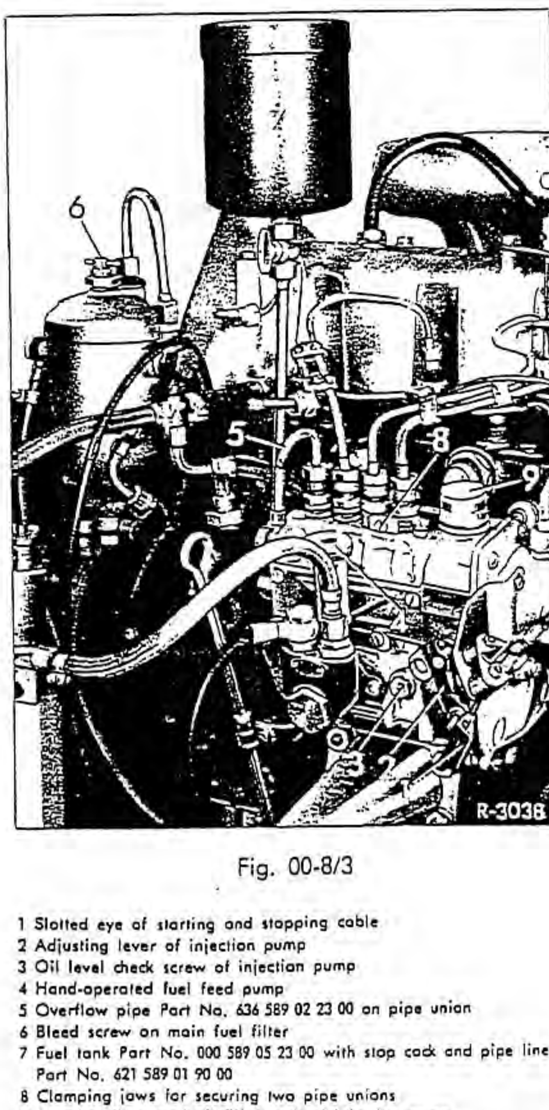


Fig. 00-8/3

1 Slotted eye of starting and stopping cable
2 Adjusting lever of injection pump
3 Oil level check screw of injection pump
4 Hand-operated fuel feed pump
5 Overflow pipe Part No. 636 589 02 23 00 on pipe union
6 Bleed screw on main fuel filter
7 Fuel tank Part No. 000 589 05 23 00 with stop cock and pipe line Part No. 621 589 01 90 00
8 Clamping jaws for securing two pipe unions
9 Breather filter and oil filler neck of injection pump

Note: For checking purposes the fuel tank (7) is not necessarily required: the bleed screw (6) on the main fuel filter can be backed out as for bleeding and the fuel reserve will be sufficient for one or two checks. Refill the main fuel filter by means of the hand-operated fuel pump (4).

6. Now go on turning the crankshaft slowly in the direction of rotation until the fuel just begins to stop dripping (see Fig. 00-8/5). One more drop may follow after about 15-20 sec. (see Fig. 00-8/6). In this position the pump plunger just covers the inlet bore in the pump cylinder, i. e. the plunger of the first cylinder of the injection pump is just at the beginning of its effective stroke.
   If in this plunger position the pointer registers with the appropriate graduation on the counterweight, the beginning of the effective stroke of the injection pump has been properly set in relation to the crankshaft position (Fig. 00-8/1).

7. To repeat the check turn the crankshaft exactly two turns in the direction of rotation. Towards the end of the second turn move the crankshaft slowly until the fuel is on the point of no longer flowing or dripping from the overflow pipe (Figs. 00-8/4, 00-8/5 and 00-8/6).

8. If this check should prove negative, readjust the beginning of the effective stroke: detach the injection pump from the attaching flange just enough for the pump to be moved.

9. Correct the beginning of the effective stroke in relation to the crankshaft position by moving the injection pump in the appropriate direction.

   Moving the injection pump toward the engine advances the beginning of the effective stroke, moving the pump away from the engine retards it.

   The injection pump is at the beginning of the effective stroke in relation to the desired and set crankshaft position when the fuel just begins to stop dripping from the overflow pipe. One more drop may follow after approx. 15-20 sec. (Fig. 00-8/6).

Tighten the injection pump in this position by means of two hexagon nuts and check the adjustment again (see para 7).

Note: If necessary disconnect the injection pipes from the pump to facilitate movement of the pump.

10. When the adjustment is found to be correct firmly tighten all hexagon nuts attaching the pump to the flange.

11. Unscrew the fuel tank (7) and the overflow pipe (5) (Fig. 00-8/3).

12. Unscrew the pipe union and install the pressure valve, a **new** sealing ring (4), the coil spring and an undamaged rubber sealing ring (2) (Fig. 00-8/2). Coat the thread of the pipe union with tallow, screw it in again and tighten with a **torque of 3.0 mkp. To ensure a proper fit of the sealing ring loosen the pipe union and retighten it with a torque of 3.0 mkp, loosen it again and finally tighten it with a torque of 3.0 + 0.5 mkp.**

Malfunction and faults may occur with both the pump and the engine if the tightening torque for the pipe union is either too high or too low.

Note: Absolute cleanliness is of paramount importance when the pressure valve is installed since dirt particles may produce engine trouble.

13. Install the clamping jaws (8) between the pipe unions **taking care to ensure that the tightening torque for the fixing screws does not exceed 0.9 mkp;** excessive tightening may distort the injection pump housing and produce leakage of the elements on the low and high pressure side (Fig. 00-8/3).

14. **Connect the injection pipe and tighten with a torque of 2.5 mkp.**

15. Bleed the fuel system.

16. Attach the starting and stopping cable to the adjusting lever (1) (Fig. 00-8/7) of the injection pump and check the adjustment of the cable (see Job No. 00-9).

Note: When attaching the starting and stopping cable remember that there must be a clearance of approx. 2.0 mm between the adjusting lever pin of the injection pump and the rear part of the slotted eye when the glow starter and stop switch is in the drive position. Do not forget to check the bowden cable in the slotted eye for ease of movement after installation.

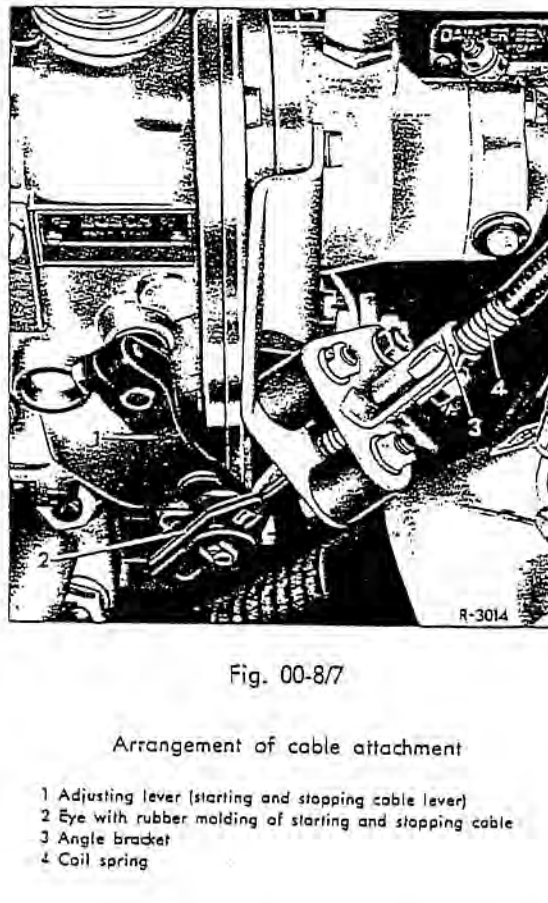


Fig. 00-8/7

Arrangement of cable attachment

1 Adjusting lever (starting and stopping cable lever)
2 Eye with rubber molding of starting and stopping cable
3 Angle bracket
4 Coil spring

17. Run the engine for a short time, check the unions for leakage, turn the idle control knob over to the right and switch off the engine.
If adjustment should prove difficult, i. e. if start and stop positions cannot be set satisfactorily, it is permissible slightly to reduce the starting delivery in favour of an accurate stop position.

Testing of Valve Timing

Job No.
00-9

Modification: Revised

Checking of the valve timing is too inaccurate at the prescribed tappet clearance (normal running tappet clearance). Thus for test measurements the timings are given at an **assumed** tappet clearance at 0.4 mm. For values see Job No. 00-0.

As a rule it will be sufficient to measure the valve timings on the inlet and exhaust valves of the 1st cylinder.

For this test proceed as follows:

1. Remove cylinder head cover.
2. Unscrew spark plugs or glow plugs.
3. Attach a graduated disk (360°) to the camshaft or crankshaft and attach a pointer at the engine (Fig. 00-9/1).

   If the graduated disk is attached to the camshaft the values read off the disk must be doubled.

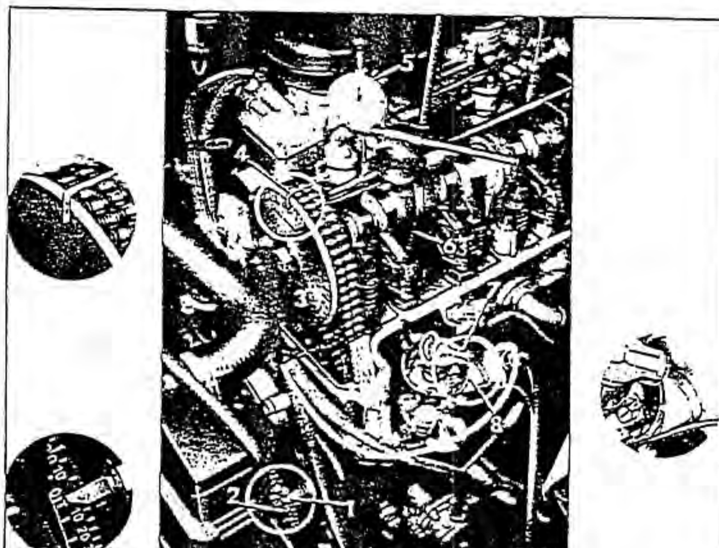


Fig. 00-9/1

1 Pointer for graduation on crankshaft
2 TDC mark or graduation on counter-weight of crankshaft
3 Graduated disk Part No. 180 589 07 23 00
4 Pointer for graduated disk on camshaft
5 Dial micrometer with feeler and holder Part No. 121 589 00 21 00
6 Bracket for cylinder head cover
7 Distributor rotor arm
8 Mark on distributor housing for 1st cylinder

4. Move the piston of the 1st cylinder to TDC (ignition TDC); to do this turn the crankshaft in the direction of engine rotation until the TDC mark on the vibration damper or the counter-weight registers with the pointer and in the case of gasoline engines until the distributor rotor arm points to the mark for the 1st cylinder on the distributor housing (Fig. disk in this position (Fig. 00-9/1).
5. Turn the graduated disk until the pointer points to the 0° mark. Tighten the graduated disk in this position (Fig. 00–9/1).
6. Turn the crankshaft in the direction of engine rotation until the cam nose of the associated valve points away in a vertical direction from the contact surface of the rocker arm (Fig. 00-3/1).
7. In order to take up the tappet clearance insert a feeler gage between rocker arm cone and pressure piece or grooved nut on diesel engines and between valve shaft end and adjustment screw or ball socket in the case of 300 SE engines (Fig. 00-9/2).

   The feeler gage must be thick enough to ensure that the normal tappet clearance is definitely taken up. It does not matter if the valve is slightly raised from its seat.

8. Attach the dial micrometer to the cylinder head in such a way that the feeler rests against the valve spring retainer of the 1st cylinder inlet valve with a pre-tension of at least 2 mm (Fig. 00-9/2). Set the micrometer to 0. It is advisable to start measurements on the inlet valve (Fig. 00-9/1).

Note: To prevent appreciable errors in measurement the feeler of the dial micrometer must be exactly perpendicular on the valve spring retainer. In addition it is necessary for the chain tensioner to be properly bled.

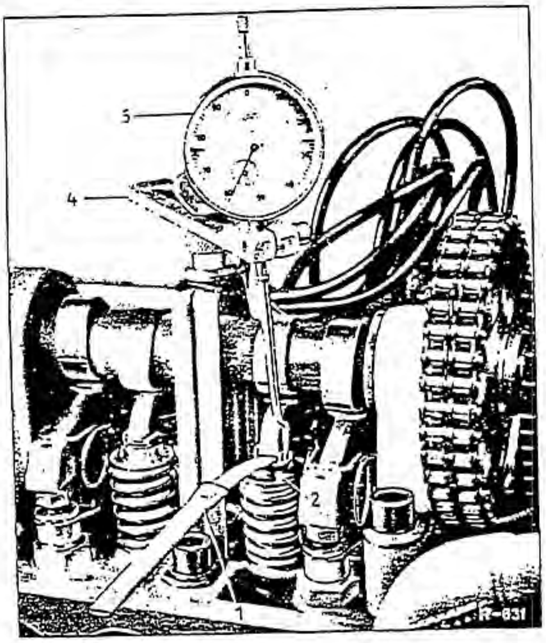


Fig. 00-9/2

1 Feeler gage
2 Valve spring retainer
3 Feeler
4 Dial gage holder
5 Dial micrometer

9. Now turn crankshaft in the direction of engine rotation until the dial micrometer registers 0.4 mm less, i. e. indicates the number 60 (Fig. 00-9/2). Now read off the initial tension of the dial micrometer from the pointer for full millimeters and on the graduated disk **read off the moment the valve begins to open.** (For valve timings see Job No. 00-0).

   If the graduated disk was attached to the camshaft the values read off must be doubled.

10. Again turn crankshaft in direction of engine rotation until on closing the valve is still raised 0.4 mm, i. e. the dial micrometer again indicates the value 60 and the same initial tension (see pointer for full millimeters) as at the moment when the valve began to open. **Read off the end of valve closing on the graduated disk.**

    After reading off the timing angle make a second check by turning the crankshaft as far as the cam base circle; the dial micrometer must now return to 0.

Caution: While these measurements are being made neither the engine nor the crankshaft must be turned contrary to the direction of rotation since this would result in appreciable errors in measurement.

11. The valve timings of the exhaust valve are checked in the same way and the valves of all other cylinders can also be checked in this way.

12. If it should be necessary to correct the valve timings by lengthening the twin roller chain, either an offset Woodruff key or a new roller chain must be installed.

Note: Please pay attention to the following points when installing an offset Woodruff key:

Offset of the Woodruff key toward the right (seen in the direction of travel) accelerates valve opening, offset toward the left retards valve opening. An 0.2 mm offset produces a change on the crankshaft by approx. 1° 30'. Offset by one tooth on the camshaft sprocket produces a change of 18° on the crankshaft.

13. After having checked and corrected valve timings measure the distance between inlet valve and piston at a crankshaft position of 5° **after TDC** in the intersection dead center for minimum distance see Job No. 00-0).

    On diesel models 190 Dc and 200 Dc also measure the distance between exhaust valve and piston at a crankshaft position 5° **before TDC** in the intersection dead center.

    When making these measurements both dial micrometer and graduated disk are attached in the same way as for measuring valve timings. To measure the distance between **inlet** valve and piston for instance on Model 200 D move the piston of the cylinder to be measured to 5° **after TDC** (intersection dead center) and set the dial micrometer to 0 under an initial tension of 3.0 mm. The inlet valve is now depressed until it rests against the piston. In this position the dial micrometer pointer should have moved back by at least 1.0 mm – see table in our example.

Note: Intersection dead center = TDC before suction stroke.

If the distance between the valves and the piston is smaller than the distance listed in the table, remove the cylinder head and check whether the insufficient distance may be due to oil carbon deposits on the piston head or the valve spring retainer; if this is not the case the valve seat must be deepened to avoid the danger of the valve knocking against the piston head at higher engine speeds.

Offset Woodruff keys are availabe with an offset of

2°	≈ 0.7 mm,	Part No. 621 991 94 67	for a correction of approx. 4° on the crankshaft
3° 20′	≈ 0.9 mm,	Part No. 621 991 02 67	for a correction of approx. 6½° on the crankshaft
4°	≈ 1.1 mm,	Part No. 621 991 01 67	for a correction of approx. 8° on the crankshaft
5°	≈ 1.3 mm,	Part No. 621 991 00 67	for a correction of approx. 10° on the crankshaft

Moving the camshaft by one tooth results in a deviation of valve timings of approx. 18° on the crankshaft.

Example: If on model 200 D the inlet valve opens at 6° on the crankshaft there is a difference of 6½ crankshaft degrees of the camshaft as compared with the crankshaft.

A deviation of 6½° on the crankshaft can be corrected by installing a Woodruff key with 3° 20′ offset.

When the chain is moved by one tooth on the camshaft sprocket toward the left, seen from in front, the installation of a Woodruff key with a 3° 20′ offset in the reverse order will result in a deviation of the camshaft or a correction of valve timing by approx. 1½° on the cranshaft.

14. **After installing an offset Woodruff key correct the ignition timing on gasoline engines and the beginning of the effective stroke on diesel engines (see Job No. 00-7 and 00-8).**

15. Remove graduated disk and dial micrometer with holder.

16. Install cylinder head cover.

Caution! When installing the cylinder head cover check the gasket for tightness.

17. Screw in spark plugs or glow plugs.

18. Run the engine and check the cylinder head cover for leakage at the jointing surface.

Adjustment of Cable Connecting Glow Starter Switch to Injection Pump

Job No.
00-10

Adjustment should be carried out as follows:

1. Disconnect ground cable at negative terminal of battery.

2. Depress button of push/pull switch (stop position) and have an assistant check the position of the adjusting lever controlling the injection pump. In this position, the adjusting lever must be pushed completely forward (Fig. 00-10/1, S = stop position, and Note para 6).

3. Pull button of push/pull switch through slight resistance into extreme stop position (starting position) and have an assistant check the position of the adjusting lever controlling the injection pump. In this position, the pin of the adjusting lever must come to rest against the far end of the eye (as opposed to the near end in stop position), with the adjusting lever completely pulled back (Fig. 00-10/1, A = starting position).

4. Release button of push/pull switch; switch is spring-loaded and will automatically return to **driving position.** In **both driving and pre-glowing position, the pin of the adjusting lever must remain clear of the eye ends** with a minimum clearance of 2 mm (Fig. 00-10/1).

Note: The cable is adjustable by moving the coil spring (4, outer sleeve) at the angle bracket (3). The adjusting lever (1) must be firmly mounted on the ignition pump shaft (Fig. 00-8/7).

With the adjustment of the cable completed, check adjusting lever of injection pump for smooth movement. Also, check whether adjusting lever is clearly in full load position.

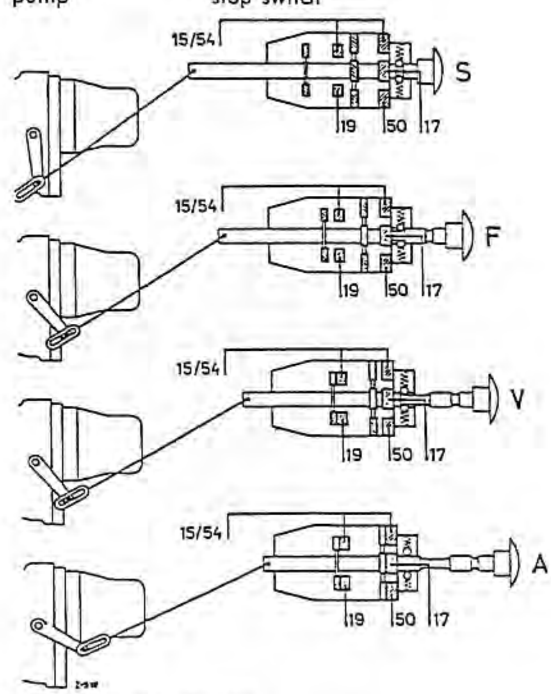


Fig. 00-10/1

S = Stop position
F = Driving position
V = Pre-glowing position
A = Starting position

5. Connect ground cable to negative terminal of battery.

6. Start engine, leave running for short period, turn idling control knob to extreme right and switch off engine. If adjustment proves problematical, i. e. if start **and** stop positions cannot be adjusted properly, a small amount of the starting delivery may be sacrificed in favor of a properly adjusted stop position.

Note: On depressing the button of the push/pull switch (stop position), diaphragm (10) is pressed against the butt bolt (17) by way of double-link rocker (9) (Fig. 00-10/2), actuated by adjusting lever (1) (Fig. 00-8/7) and the cable.

As a result auxiliary spring (18) is compressed and **control rod (8) moved in the direction of STOP until the plungers reach the zero delivery zone and the engine stops.**

At the same time, double-link rocker (9) has lifted off the stop stud (20) of the full-load stop.

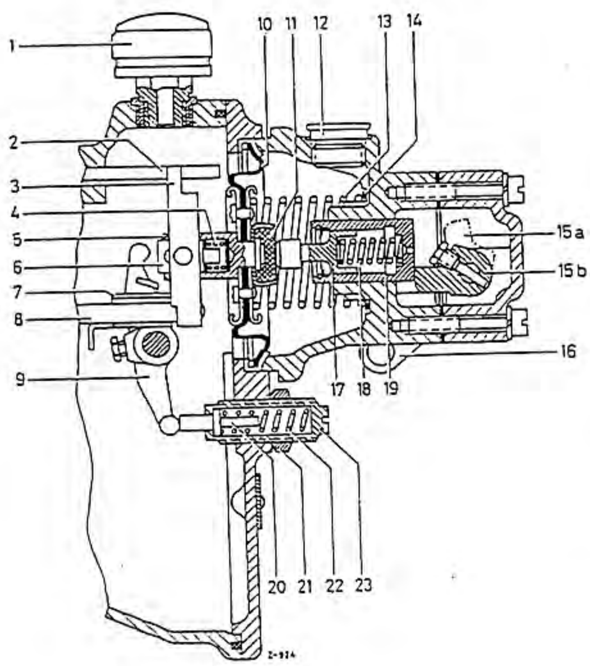


Fig. 00-10/2

Idling position

1 Air cleaner
2 Guide rod
3 Guide lever
4 Compensator spring
5 Diaphragm sleeve
6 Thrust pin of compensator spring
7 Start-metering stop
8 Control rod
9 Double-link lever
10 Diaphragm
11 Rubber buffer
12 Vacuum union at vacuum chamber
13 Control spring
14 Backing ring
15a Switch cam, full-load position
15b Switch cam, idling position
16 Lever for automatic auxiliary governor system
17 Stop stud (butt bolt)
18 Auxiliary spring
19 Butt bolt housing or spring housing, sliding
20 Stop stud for full-load stop
21 Setting nut
22 Spring
23 Full-load stop screw

Checking of Fuel Level and Injection Amount

Job No.
00-11

Modification: Zenith Carburetor added

A. Measuring and Adjusting of Fuel Level

Measurement and adjustment of fuel level are the same as for the previous carburetors with the exception of Model 220 Sb with Zenith carburetor. In the case of the Zenith çarburetor the distance is measured from the separating surface of the plate block (with seal) to the top edge of the float.

Measuring and Adjustment Values

Model	Carburetor designation	Fuel level or float adjustment (mm)
190 c	Solex 34 PICB	17—19
220 b		
220 Sb	Solex 34 PAITA	19—21
	Zenith 35/40 INAT	18—20

B. Measuring and Adjusting of Injection Amount

Before measuring the injection amount of the accelerating pump, check the following points:

a) Ease of Movement of Connecting Rod and Pump Arm

Both the connecting rod or the reversing lever and the pump arm must be able to move freely.

b) Beginning of Injection

When the throttle valve begins to open, a strong jet of fuel must emerge immediately, or on Model 220 Sb with Zenith carburetor after a throttle valve opening of 5°, from the injection tube. Should this not be the case, check the whole pump system, in particular the injection tube, the pump diaphragm, the rubberised-fabric gasket ad the ball valves for leaks and proper assembly.

c) Direction of Fuel Jet on Injection

The jet of fuel must hit the opposite throttle valve opening without touching the mixing tube holder or the pre-atomiser (Fig. 00-11/1).

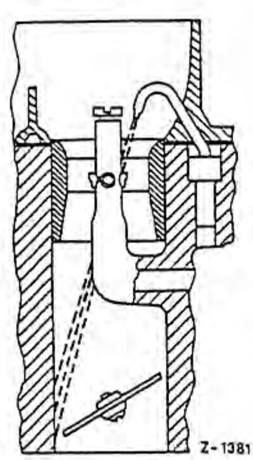


Fig. 00-11/1

Direction of fuel jet

If necessary the direction of the jet of fuel can be corrected by bending the injection tube.

It is advisable to measure the injection amount by means of Measuring Container 180 589 10 21, which has a capacity sufficient for one pump stroke. When this measuring container is used for Solex carburetors it is not necessary to remove the carburetor cover or to replace the injection tube by a measuring tube. On Model 220 Sb with Zenith carburetor unscrew the carburetor cover and the pre-atomiser.

Measuring and Adjustment Values

Model	Carburetor designation	Injection amount cc/stroke
190 c	Solex 34 PICB	1.0—1.2
220 b		0.9—1.2
220 Sb	Solex 34 PAITA	1.3—1.7 Correcting by adjustment of the connecting rod is not permissible!
	Zenith 35/40 INAT	0.8—1.2 (cannot be adjusted)

Models 190 c, 220 b

For Carburetor 34 PICB the injection amount is adjusted not by means of the adjusting nut but by inserting or removing washers between the pump arm and the cotter pin on the connecting rod of the accelerating pump.

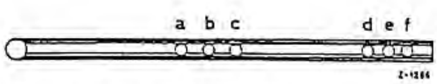


Fig. 00-11/2

Connecting rod

For the basic setting of the injection amount the cotter pins must be in bores 'a' and 'f'. On recent cars the holes a, b, and c have been replaced by raised limit stops for the spring (Fig. 00-11/2).

The injection amount is increased by inserting washers between the pump arm and the cotter pin and is decreased by removing washers.

If the injection amount is below the prescribed figure, the pump diaphragm must be replaced. When a new pump diaphragm has been installed or when shims have been added or removed, the injection amount should be checked as a matter of routine.

Model 220 Sb

In the case of Solex Carburetor 34 PAITA on Model 220 Sb, any adjustment of the connecting rod of the accelerating pump changes not only the injection amount but also the delivery point of full-load enrichment. The connecting rod should only be adjusted in accordance with the prescribed data for the delivery point of full-load enrichment; if this is adjusted correctly, the necessary injection amount of the accelerating pump is obtained automatically, provided always that the whole pump system is working properly.

C. Checking and Adjusting the Delivery Point for Full-Load Enrichment

Measuring and Adjustment values

Model	Carburetor designation	Remarks (see also Job No. 07—0)	Beginning of full-load enrichment at a throttle valve opening of
220 Sb	Solex 34 PAITA	1st Version (Carburetor with accelerating-pump diaphragm disk of 22 mm diameter	65°—70°
		2nd Version (Carburetor with accelerating-pump diaphragm disk of 32 mm diameter)	1°—4° after throttle valve of Stage II has begun to open

a) 1st Version

1. Detach the spring-loaded push rod (8) from the throttle valve lever (9) (Fig. 00-13/2). Back out the idle adjustment screw (11) until the throttle valve of Stage 1 is completely closed.
2. Unscrew the hexagon nut on the throttle valve lever and fit a suitable graduated disk on the throttle valve shaft by means of the threaded bolt. Attach the metal pointer to the starter mechanism by means of the cylindrical screw.
3. Adjust the graduated disk in such a way that **when the throttle valve is completely closed** the pointer points to 0° on the graduated disk.
4. Fit a hose (inside diameter appr. 8 mm) to the mixing tube holder of Stage 1.
5. In place of the main jet plug of Stage 1 screw in a main jet plug with soldered up front and side openings.
6. Screw out the pump jet and screw in instead a suitable pipe union and attach a suitable hose about 1/2 meter long to the pipe union.

Note: The two hoses must be of fuel-resistant material.

7. In order to check the beginning of the full load enrichment put the hose attached to the mixing tube holder in a container filled with water and blow into the hose attached to the pipe union, at the same time slowly opening the throttle valve until numerous air bubbles suddenly rise from the hose in the container filled with water. This is the delivery point for full load enrichment. It should occur at a throttle valve opening of 65°–70°.

Note: Repeat the process several times in order to obtain accurate values. Just before the delivery point is reached the throttle valve lever should be moved very slowly. If full load enrichment occurs too early or too late the delivery point should be adjusted by screwing in (later delivery point) or screwing out (earlier delivery point) the adjusting nuts on the connecting rod of the accelerating pump.

b) 2nd Version

1. Fit a hose over the mixing tube holder of stage 1, as described above in Section a). In place of the main jet plug of stage 1, screw in a main jet plug closed in front and at the side. In place of the pump jet, screw in a pipe union of the same size and connect a hose.
2. Now check the delivery point, as described in Section a) para 7; it should be 1–4° after the initial opening of the stage 2 throttle valve. The delivery point is adjusted as described in the note to para 7.

Note: After some experience, the graduated disk can be dispensed with. The most important point is to make sure that full-load enrichment does not occur too early.

Adjustment of Gasoline Engine

Job No.
00-13

Modification: Progressive accelerator linkage and Zenith carburetor added

Model 190 c

a) Adjustment of Accelerator Linkage

1. Check the throttle valve shaft for freedom of movement. To do this detach the push rod (9) from the throttle valve lever (11) and detach the return spring (10) (Fig. 00-13/1).

2. Turn out the idle adjustment screw (8) on the throttle valve lever until the throttle valve is completely closed. Then turn in the idle adjustment screw until the throttle valve lever is just about to open. From this position turn in the screw one turn.

3. Press the throttle valve lever to full load position and check whether the aperture limiting screw (12) rests against the full load stop of the carburetor housing.

4. Attach the push rod (9) and the return spring (10) to the throttle valve lever. Again check the throttle valve position moving the accelerator linkage by depressing the accelerator pedal from inside the car.

b) Adjustment of Idle

1. To adjust the idle, screw the idle mixture adjustment screw (7) right in, then back it out exactly two turns.

2. After warming up the engine (cooling water temperature at least 70° C) adjust the idle to 750-800 rpm by means of the idle adjustment screw (8), using a revolution counter.

3. Adjust the idle mixture adjustment screw by turning it slowly in and out so that
a) the engine turns smoothly and
b) the highest possible idle speed is reached.

4. Then adjust the idle speed to 750-800 rmp by means of the idle adjustment screw (8).

5. By making a further slight correction with the idle mixture adjustment screw try to improve the idle. If necessary, adjust the idle speed once more with the idle adjustment screw.

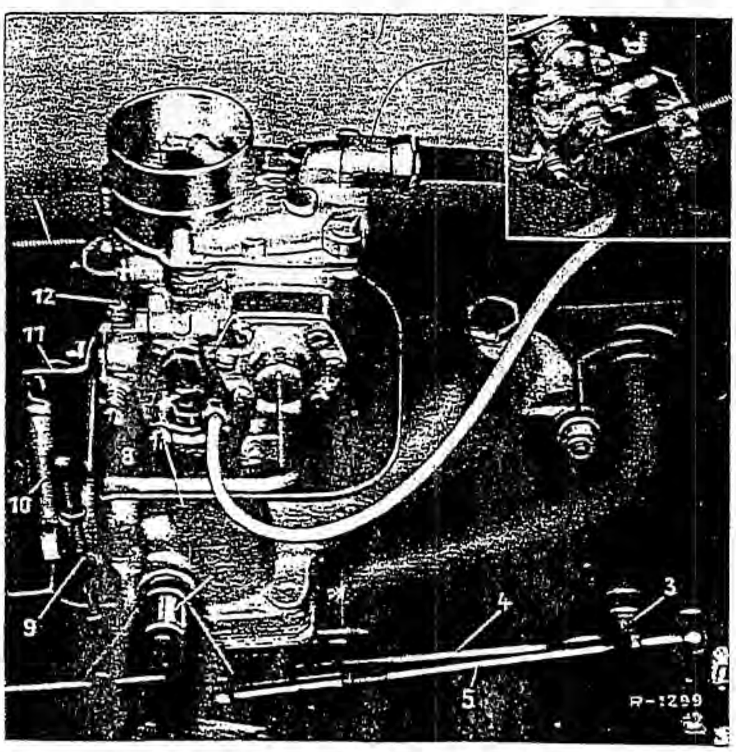


Fig. 00-13/1

Carburetor Model 190 c

1 Clamping screw
2 Clamping screw
3 Control lever
4 Rod
5 Rod
6 Control lever
7 Idle mixture adjustment screw
8 Idle adjustment screw
9 Push rod
10 Return spring
11 Throttle valve lever
12 Aperture limiting screw
13 Choke control

Models 220 b, 220 Sb

a) Adjustment of Accelerator Linkage

The desing and adjustment of the accelerator linkage is the same in Models 220 b and 220 Sb. Before adjusting the idle it is advisable to check the basic adjustment of the accelerator linkage and if necessary to readjust the accelerator linkage.

1. Detach the push rods (2) and (6), check their length and adjust them. The length of push rod (2) should be 85 mm from center ball socket to center ball socket.
   The length of push rod (6) should be 188 mm from center ball socket to center ball socket.
   After adjustment apply grease to the ball sockets of the push rods (2) and (6) and press the ball sockets home again. Now detach the spring-loaded push rod (8) from the front and rear carburetors. Check the carburetor linkage and the throttle valve shafts for freedom of movement and if necessary detach the return springs (10) (Figs. 00-13/2 and 00-13/3).

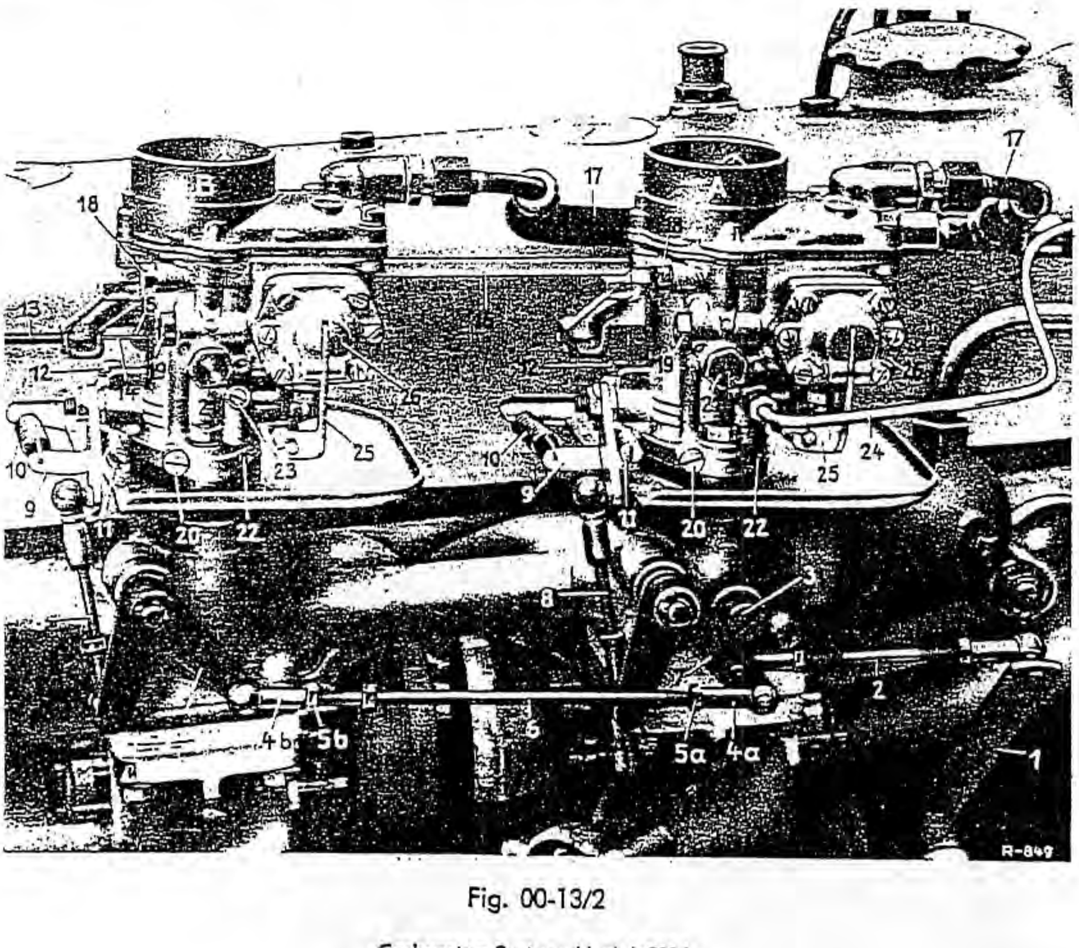


Fig. 00-13/2

Carburetor System Model 220 b

1 Double lever
2 Push rod
3 Eccentrik screw
4a Ball socket, left-hand thread
4b Ball socket, right-hand thread
5a Hexagon nut, left-hand thread
5b Hexagon nut, right-hand thread
6 Push rod
7 Relay lever
8 Spring-loaded push rod
9 Throttle valve lever
10 Return spring
11 Idle adjustment screw
12 Aperture limiting screw
13 Coil spring for choke control
14 Choke control
15 Clamping screw for choke control
16 Connecting road
17 Fuel line
18 Idle fuel jet
19 Pump jet
20 Idle mixture adjustment screw
21 Main jet
22 Union for testers
23 Screw plug
24 Vacuum line distributor
25 Pump arm
26 Accelerating pump

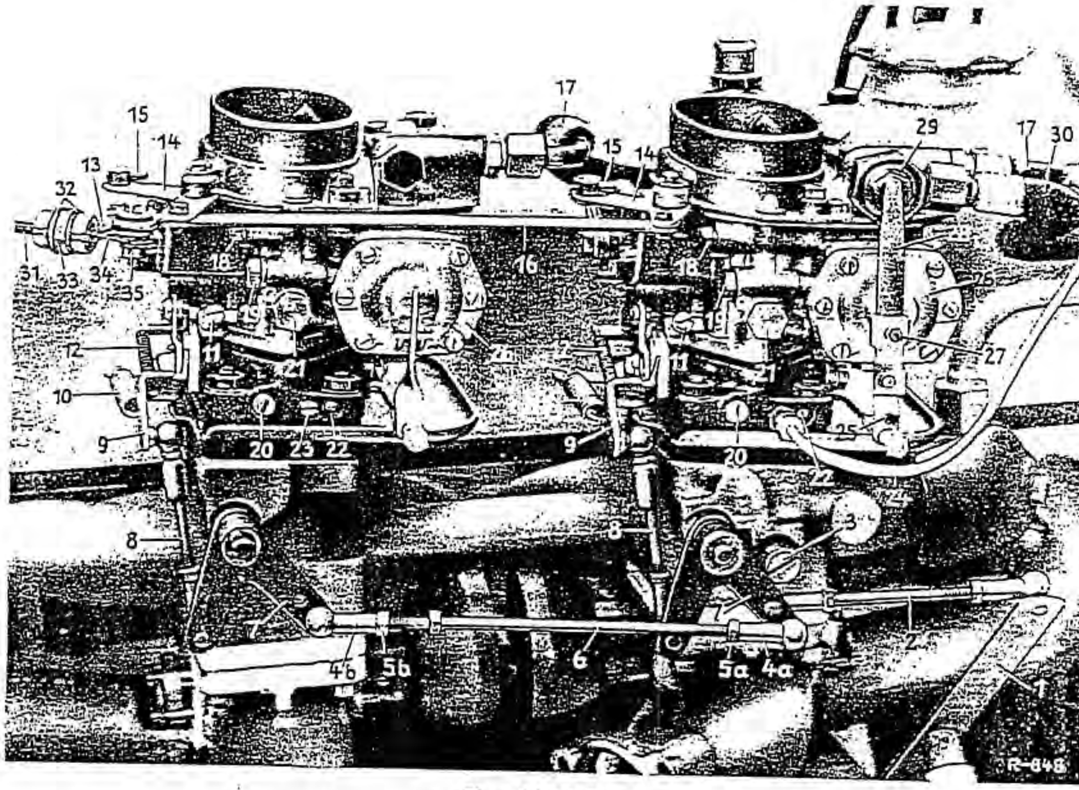


Fig. 00-13/3

Model 220 Sb with Solex Carburetor 34 PAITA

1 Double lever
2 Push rod
3 Eccentric screw
4a Ball socket, left-hand thread
4b Ball socket, right-hand thread
5a Hexagon nut, left-hand thread
5b Hexagon nut, right-hand thread
6 Push rod
7 Relay lever
8 Spring-loaded push rod
9 Throttle valve lever
10 Return spring
11 Idle adjustment screw
12 Return spring
13 Clamp
14 Relay lever
15 Connecting rod (to starter lever)
16 Connecting rod
17 Fuel pressure line
18 Idle fuel jet
19 Pump jet.
20 Idle mixture adjustment screw
21 Main jet of stage 1
22 Union for testers
23 Screw plug
24 Vacuum line, distributor
25 Pump arm
26 Accelerating pump
27 Adjustment screw and lock nut
28 Spring-loaded pump arm head
29 Fuel return valve
30 Fuel return line
31 Coil spring for choke control
32 Rubber bushing
33 Adjusting nut
34 Choke control
35 Clamping screw for choke control

2. Press the throttle valve lever (9) as far as the full load stop. In the case of the carburetor for Model 220 b the aperture limiting screw (12) must rest against the full load stop of the carburetor housing and the throttle valve must be completely opened (Fig. 00-13/2).
In the case of the carburetor for Model 220 Sb the stop lever on the throttle valve shaft of Stage 2 must rest against the carburetor housing, and both the throttle valve of Stage 1 and the throttle valve of Stage 2 must be completely opened (Fig. 00-13/3).

3. Turn out the idle adjustment screw (11) on the throttle valve lever of the two carburetors until the throttle valve is completely closed. Then turn in the idle adjustment screw until the throttle valve is just about to open. Now turn in the adjustment screw **one turn** (Figs. 00-13/2 and 00-13/3).

4. Adjust the spring-loaded push rods (8) or (1).
On engines without progressive linkage adjust the eccentric screw (3) in such a way that the slot of the eccentric screw is at right angles to the front relay lever and the eccentric part points upward (see Figs. 00-13/2 or 00-13/3).
On engines with progressive linkage screw in a fillister head screw M 8 DIN 85 (4) with a 16 mm head. If this should not be available, make an M 8 screw with a 16 mm ⌀ cylindrical head (4) (see Fig. 00-13/4).

5. Apply the relay lever to the eccentric screw or the head of the fillister head screw and check to make sure that the throttle valve lever rests against the idle adjustment screw. Then adjust the two spring-loaded push rods in such a way that the ball sockets of the push rods can be fitted to the ball pins of the throttle valve levers and the relay levers without forcing. Apply grease to the ball sockets and press them home. Unscrew the fillister head screw.

Note: The spring-loaded push rods should be neither too long nor too short. If a push rod is too long the throttle valve is opened, and if the push rod is too short the spring of the spring-loaded push rod is stretched.
In the case of the progressive linkage the quadrant lever (9) serves as a stop so that a stop bolt on the intake pipe is no longer required (Fig. 00-13/4).

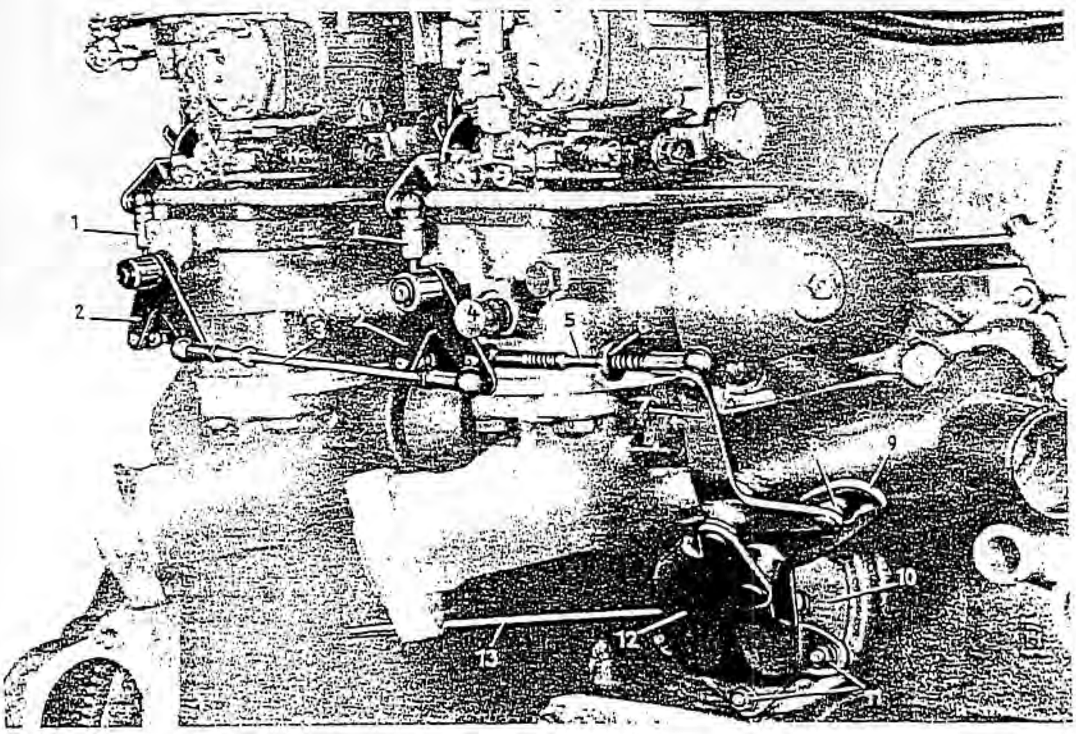


Fig. 00-13/4

Model 220 Sb with Solex Carburetor 34 PAITA and progressive linkage

1 Spring-loaded push rod
2 Relay lever
3 Push rod
4 Adjustment screw or fillister head screw M 8 DIN 85
5 Push rod
6 Adjusting ring
7 Relay lever
8 Roller
9 Quadrant lever
10 Cylinder cover
11 Threaded bolt
12 Bearing bracket

6. Check again the throttle valve position by depressing the accelerator pedal from inside the car (see figure 2).

Model 220 Sb with Zenith Carburetor 35/40 INAT

1. Detach the push rods (9) and (13). Check the control levers and the throttle valve shafts for freedom of movement.
   Check the full-load stop using the reversing lever (7) to push the throttle valve lever (2) until it rests against the carburetor housing (Fig. 00-13/5).

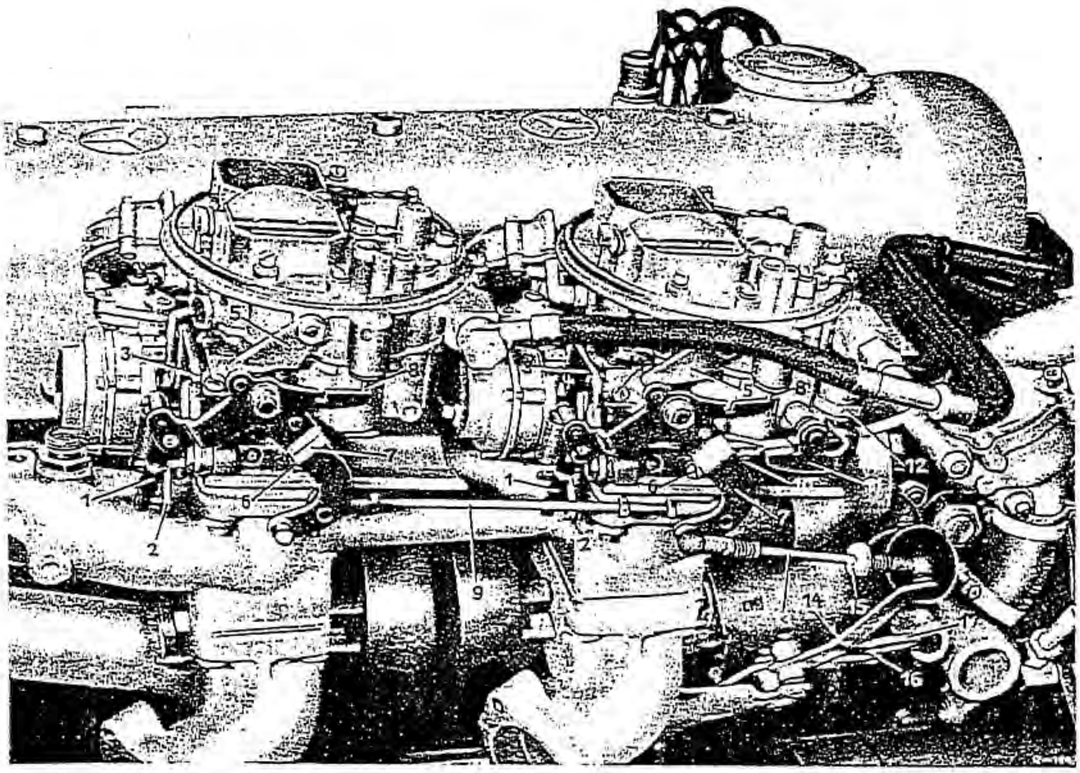


Fig. 00-13/5

Model 220 Sb with Zenith Carburetor 35/40 INAT

1 Connecting rod
2 Throttle valve lever
3 Quadrant lever
4 Idle adjustment screw
5 Pump arm
6 Idle mixture adjustment screw
7 Reversing lever
8 Float chamber vent valve
9 Push rod
10 Adjustment screw
11 Lever
12 Fuel return valve
13 Push rod
14 Relay lever
15 Adjusting ring
16 Roller
17 Quadrant lever

2. Adjust the idle adjustment screw (4) of the two carburetors. When the engine is cold first cut out the automatic start mechanism by opening the choke valve by hand and at the same time accelerating for a short timme by means of the reversing lever. Unscrew the idle adjustment screw (4) on the throttle valve lever (2) until the throttle valve is completely closed. Then turn in the idle adjustment screw until the throttle valve is just about to open (Fig. 00-13/5). Now turn in the adjustment screw (4) **one turn.**

3. Adjust the plastic connecting rods (1) to 40 mm and attach (Fig. 00-13/5).

4. Adjust the push rod (9) in such a way that it fits the ball pins of the reversing ievers without forcing. While doing this the throttle valve levers of both carburetors should rest against the idle stop screw.

5. Again check whether the control linkage is working properly by depressing the accelerator pedal from inside the car.

b) Adjustment of Idle

The idle adjustment and the adjustment of the idle speed is the same for the engines of Models 220 b and 220 Sb.

1. Screw the idle mixture adjustment screw (20) or (6) right in and back it out again $1\frac{1}{2}$ turns on the carburetor for Model 220 b and two turns on the carburetor for Model 220 Sb (Figs. 00-13/2, 00-13/3 and 00-13/5).

2. Warm up the engine to normal working temperature (cooling water temperature appr. 80° C).

3. On engines with progressive control detach the push rods (5) or (13) (Figs. 00-13/4 and 00-13/5).
   On engines without progressive control turn the eccentric screw (3) until there is sufficient distance between the eccentric screw and the relay lever (7) for the adjustment of the idle (Figs. 00-13/2 and 00-13/3).

4. Adjust the idle to n = 750—800 rpm by evenly adjusting the idle adjustment screw (11) or (4) on the two carburetors, using a revolution counter (Figs. 00-13/2, 00-13/3 and 00-13/5).

5. Adjust the two idle mixture adjustment screws by turning them **evenly** in and out so that
   a) the engine turns smoothly and
   b) the highest possible idle speed is reached.

6. Now adjust the idle speed once more to n = 750—800 rpm by means of the idle adjustment screws.

7. By making a further slight correction with the idle mixture adjustment screws try to improve the idle. If necessary, adjust the idle speed once more with the idle adjustment screws.

8. On Model 220 Sb with a Zenith carburetor check the float chamber vent. When the throttle valve is in idle position the reversing lever (7) should lift the pin of the valve (8) by **1.5—2** mm. If this is not the case bend the reversing lever (7) by means of a pair of pliers, making sure that after bending the reversing lever points in an accurately vertical direction to the valve pin (Fig. 00-13/5).

9. On engines with progressive control attach the push rod (5) or (13). Then use the adjusting ring (6) or (15) to adjust the relay lever (7) or (14) in such a way that the roller (8) or (16) in the quadrant lever (9) or (17) **rests against the limit stop without any tension** (Figs. 00-13/4 or 5). If the adjustment is correct the engine should run in idle position at the prescribed idle speed and should react immediately to any movement of the quadrant lever.
   On engines without progressive control turn the eccentric screw (3) in such a way that there is a play of approx. 0.2 mm between the eccentric screw and the relay lever (7) (Figs. 00-13/2 and 3).

10. In the case of a Solex carburetor check whether the two starter mechanisms which are connected by the connecting rod (16) work properly (Figs. 00-13/2 and 3).

11. In Model 220 Sb check whether the vacuum valves of Stage 2 and the shock-absorbers are working properly. The cushioning effect of the shock-absorbers must be noticeable almost down to the end of the stroke. If necessary, check the oil level of the shock-absorbers and top up.

Note: The "Synchro-Test" appliance produced by the firm Moto-Meter can be used to check the correct adjustment of the accelerator linkage.

Fuel-Feed Pump and Overflow Valve

Job No.
00-14

Measuring suction and compression effect of fuel-feed pump and checking overflow valve.

A. Carburetor Engines

1. Use a vacuum/pressure gage to measure the degree of vacuum of the fuel pump. Remove the two fuel lines from the fuel pump and connect up the vacuum gage to the **pump intake.**

2. Short the ignition circuit, using a jumper cable between cable terminal 1 (ignition coil, distributor) and ground.

3. Turn the engine over with the starter and read off the vacuum on the vacuum gage (for specified vacuum values see Job No. 00-0).

Note: If the specified vacuum values are not obtained there may be the following faults in the system:

Defective pump diaphragm, leaking pump valves, valve springs either too weak or broken, spring under diaphragm too weak or broken.

4. Measure feed pressure of the fuel pump with vacuum gage and pressure gage, the pressure gage being connected to the discharge union of the fuel pump.

5. Turn the engine over with the starter and read off the delivery pressure on the pressure gage (for specified pressure values see Job No. 00-0).

Note: Over the entire range of engine speeds the delivery pressure remains more or less constant.

6. If the values are differing from the specified vacuum or delivery pressure values replace fuel pump.

If the specified values are still not obtained with the new pump measure the clearance between the tappet (4) of the fuel feed pump (start of delivery stroke) and the cam (1) at BDC (see Fig. 00-14/1).

Use a depth gage to measure the distance "a" between the separating surface and the cam (1) when the latter is at BDC.

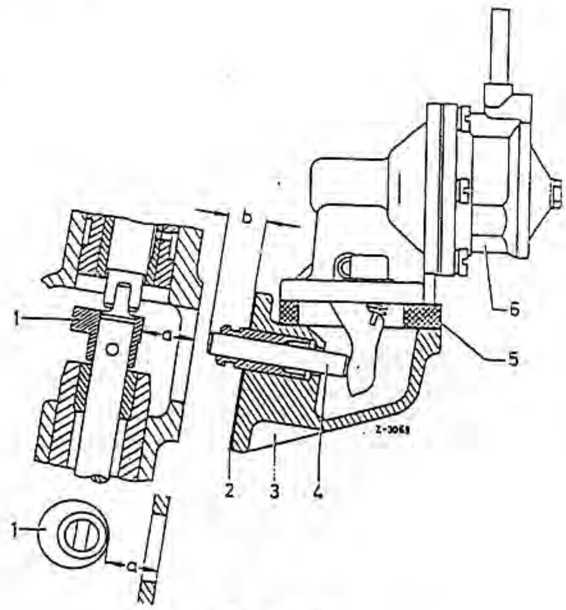


Fig. 00-14/1

a = Distance between cylinder crankcase and cam at BDC
b = Distance between sealing flange and tappet when the latter is at the start of its delivery stroke

1 Cam on oil-pump drive-shaft
2 Paper seal
3 Jointing flange
4 Tappet
5 Insulating flange with seals
6 Fuel feed pump

Then measure the distance "b" between the end of the tappet – with the tappet at the start of delivery stroke – and the sealing flange (see Fig. 00-14/1). The difference in the two dimensions a and b is the clearance between the cam and the tappet.

Clearance should be 0.4-0.5 mm.
Clearance is adjusted by removing or adding shims (sealing flange).

Note: Excessive delivery pressure may force the float needle valve which would result in too high a fuel level.

Excessive delivery pressure is only produced by insufficient clearance between cam and tappet or by hardening of the pump diaphragm.

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If delivery pressure is too low the amount of fuel delivered is insufficient for the engine. Correct excessive pump pressure by adding shims, insufficient pressure by removing shims.

However, at least one paper gasket (2) is always required between the intermediate flange of the fuel feed pump and the crankcase.

If the delivery pressure cannot be properly adjusted although clearance between cam and tappet is correct, check the fuel feed pump itself.

B. Gasoline Injection Engines

1. **Measure delivery pressure of fuel feed pump:** disconnect fuel line (1) from starter valve (2), connect fuel feed pump tester (3) to fuel line (1) and plug the other end (4) of the tester hose (Fig. 00-14/2).

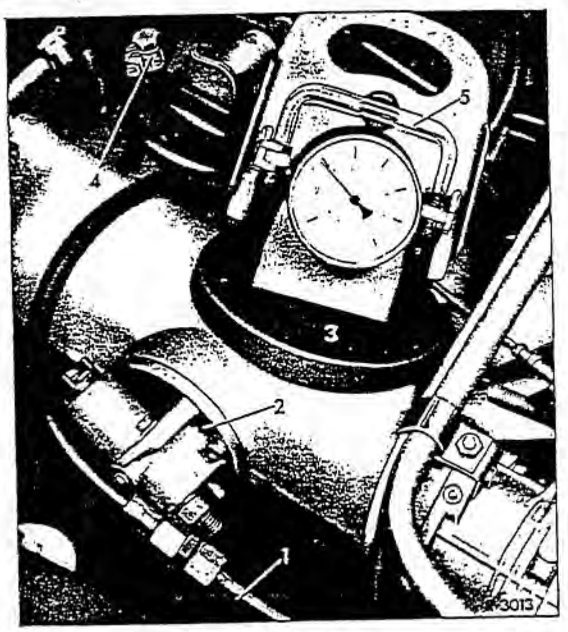


Fig. 00-14/2

Shown on Model 230 SL

1 Fuel line from injection pump to starter valve
2 Starter valve
3 Fuel Feed Pump Tester 000 589 49 21 00
4 Plugged hose
5 Glass tube

Switch on the ignition and measure delivery pressure with the **engine not running** and a minimum terminal voltage at the fuel feed pump of 11 volts. For measuring value see Job No. 00-0.

2. **If delivery pressure is too low,** carry out the following procedures until the cause has been found:

a) Replace fuel filter element

b) Measure **final delivery pressure of fuel feed pump:** on engines with 6-cylinder injection pump close the fuel line between overflow valve (fuel outlet of injection pump) and return pipe damper unit by compressing the hose.

On engines with 2-cylinder injection pumps, which instead of an overflow valve have a throttle bore in the threaded union on the inlet side of the return line damper unit, close the threaded union at the outlet side of the damper unit (1) with a dummy plug (Fig. 00-14/3).

Switch on the ignition and measure the final delivery pressure with the engine not running and a minimum terminal voltage at the fuel feed pump of 11 volts. For measuring values see Job No. 00-0.

If the final delivery pressure is too low, the fuel feed pump is defective or there is a leak between fuel feed pump and measuring point.

c) Check overflow valve for dirt deposits and proper operation (valve must be easy to lift).

d) Check hoses of the fuel feed line (in particular hose from fuel tank to fuel feed pump) for kinks.

e) Check strainer of screw plug in fuel tank for dirt deposits.

f) Check the whole fuel system for leaks.

3. **If delivery pressure is too high** check the whole fuel system behind the measuring point for botlenecks (overflow valve not opening, return line compressed).

4. **Measure the fuel feed pump output:** remove dummy plug from closed line and put end of line in a measuring beaker (Fig. 00-14/1).

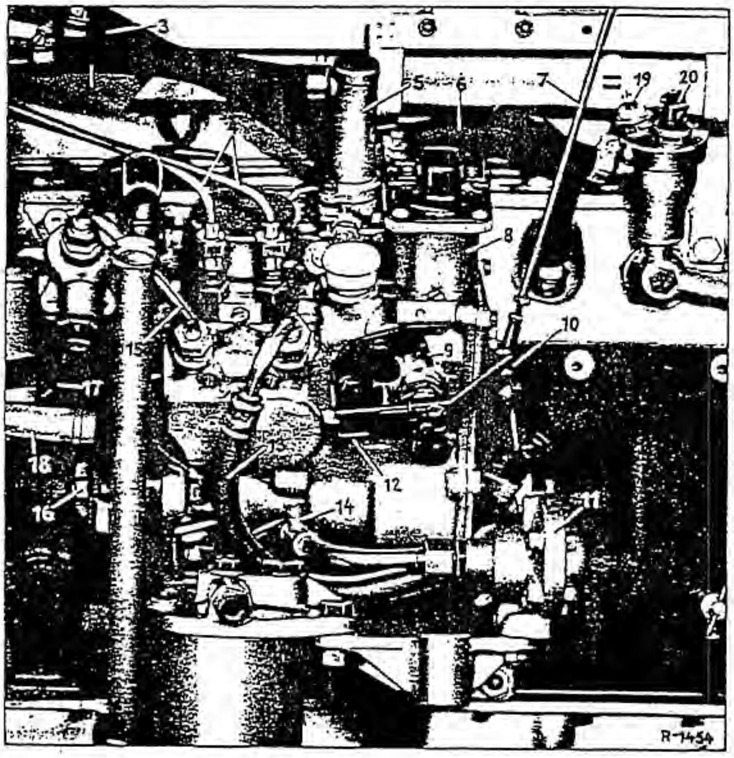


Fig. 00-14/3

2-cylinder injection pump Model 220 SEb

1 Damper unit (return line)
11 Damper unit (feed line)
13 Fuel hose (feed line)
14 Fuel line union cold start valve
15 Fuel line (return line)

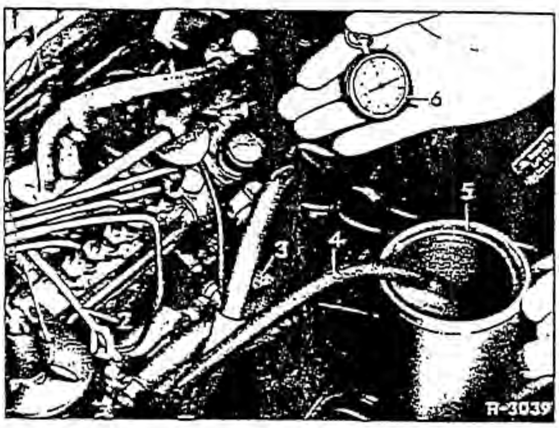


Fig. 00-14/4

6-cylinder injection pump Model 230 SL

1 Overflow valve (fuel outlet of injection pump)
2 Fuel line from overflow valve to return reservoir
3 Return line damper unit
4 Hose section
5 1 liter measuring beaker
6 Stop watch

Switch on the ignition and measure the time required for delivering 1 liter of fuel with a stop watch. For measuring values see Job No. 00-0. Output can only be measured if the fuel tank is at least half full.

Note: In gasoline injection and diesel engines the function of the fuel pump is to convey the fuel, without bubble formation and at a predetermined pressure, into the priming chamber of the injection pump. If the throughput of the pump is inadequate engine defects are bound to arise. It is mainly when an engine is used in the full-load range and at high rotation speeds that it requires a certain inflation pressure in order to cope successfully with the fuel requirements of the pump elements. This inflation pressure is kept at a constant value by a check valve which does not open until a certain pressure has been reached and which is located at the end of the injection pump (priming chamber). (For opening pressure of the fuel overflow valve see Job No. 00-0).

The fuel pump tester made by the firm of F. Herth and Busch, Offenbach nr. Frankfurt/Main, enables every possible test to be carried out on the pump (Figs. 00-14/2 and 5).

The tester enables the vacuum and the delivery pressure or delivery end pressure of diesel engines to be tested and the exact opening pressure of the overflow valve of diesel and gasoline injection engines. The tester is also fitted with a glass tube which functions as a sight glass and while these measurements are being taken it is possible to see whether the fuel passing through the pump contains air bubbles.

C. Diesel Engines

1. **Measure inflation pressure (priming chamber) of injection pump – this being the equivalent of the opening pressure of the overflow valve;** connect up tester between fuel discharge (4) on main filter and fuel intake (3) on injection pump (Fig. 00–14/5).

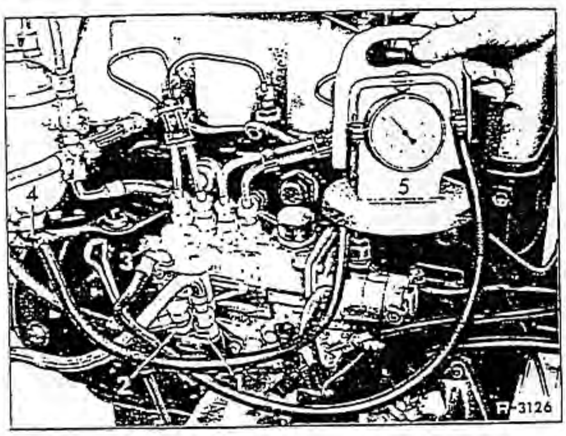


Fig. 00–14/5

1 Fuel feed pump — fuel inlet (suction side)
2 Fuel feed pump — fuel outlet (delivery side)
3 Injection pump — fuel inlet
4 Main fuel filter — fuel outlet
5 Fuel feed pump testing device

2. Bleed the fuel system with hand pump.

3. Now read off pressure on tester at idle and at an increased speed of n = 3000 rpm. It is only if the reading is less than 2.2 atm. at a rotation speed of 2000 to 3000 rpm that the feed pressure of the fuel pump need be taken (see Para. 4).

   If the reading is 3.0 atm. or even higher a check should be made on whether the overflow valve is opening properly or whether there is a constriction beyond the overflow valve (possibly a crushed return line or similar).

Note: When these checks are being carried out an eye should be kept on the glass tube of the tester to make sure that there is no air in the fuel. If air bubbles should be seen in the fuel there is a leakage somewhere in the system and will be necessary in the first place to ascertain the degree of vacuum (see Para. 7).

4. **Determination of End-of-Delivery Pressure of the Feed Pump at Idling Speed.**

   The indication of the end-of-delivery pressure of the feed pump is obtained by squeezing the hose between the tester and the injection pump. If the injection pump is in perfect working order the pressure should be at least 2.5 atm. at 300 rpm.

   If the reading is below 2.5 atm. repair the pump or, if necessary, replace the valves or even the entire pump. Repeat procedure of Para. 4.

5. If the value is in excess of 2.5 atm. and the opening pressure of the overflow valve is below 2.2 atm. at 3000 rpm (see Para. 3) the overflow valve must be removed, cleaned and checked for leaks. If it is in order, increase the initial tension of the compression spring by adding shims between compression spring (2) and screw plug (5) (see Fig. 00–14/6). Repeat procedure of Para. 4.

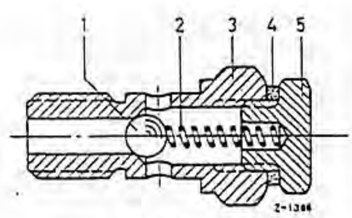


Fig. 00–14/6

Overflow valve

1 Ball
2 Compression spring
3 Housing
4 Sealing ring
5 Screw plug

6. **Check degree of fouling of main fuel filter – i. e. head of pressure in front of it.**

   Connect up tester between fuel intake (5) of main filter and fuel discharge (2) at feed pump (Fig. 00–14/5).

   The head of pressure against the filter thus measured at 3000 rpm must be only a little higher, approx. 0.2–0.3 atm., than the pressure on the other side (see procedure of Para. 3).

   If the pressure gradient is found to be higher than the above the filter element is clogged and must be replaced.

7. **To measure the vacuum** connect up the tester between the fuel intake at the feed pump and the fuel line from the fuel tank.

Bleed fuel system with hand pump.

Measure vacuum with engine idling. Squeeze hose between tester and fuel pipe and take the gage reading of the fuel pump vacuum (for specified value see Job No. 00–0).

If this value is not obtained repair the fuel pump or if necessary replace valves or even the entire pump. Repeat measurement.

Now, with the engine idling – and at an increased engine speed of 3000 rpm take a look at the glass tube of the tester to see whether the fuel flowing through contains air or is entraining bubbles (see Fig. 00–15/5). If bubbles can be seen in the fuel there is a leak somewhere between the fuel tank and the pump.

Even a small amount of air in the fuel system may cause trouble and all connecting hoses between the fuel lines from fuel tank to injection pump should be carefully checked for porosity, hairline cracks, chafed spots, aging hoses, badly fitted and slack hose clips or possibly a leaking fuel pre-filter. Any of these things may cause air to enter the fuel system.

At all events hose clips should be tightened up and, where necessary, the seals and hoses belonging to the fuel pre-filter should be replaced and the fuel system bled.

In addition to their other properties, the hoses must be absolutely impervious to the action of fuels and it cannot, therefore, be too strongly stressed that only hoses from the Spare Parts Department in Stuttgart-Untertürkheim must be used.

When the leak on the suction side has been eliminated connect up the tester on the discharge side according to Para. 6 and watch the fuel flowing through the sight glass tube of the tester at 3000 rpm. **The presence of bubbles shows** that the leak is in the fuel pump. It is absolutely imperative that a leaky pump be either repaired or replaced.

In vehicles fitted with felt-sealed fuel filter inserts the filter cover can also be rema-chined in the manner shown in Fig. 00–23/2 so that there may be no doubt whatever about the completeness of the fit, and thus of the seal, between filter cover and filter element sealing ring (see Job No. 09–3).

Checking of Fuel Injection System

Job No.
00-15

A. Injection Pump

Accurate checking and adjusting of the injection pump is only possible on an injection pump test bench specially equipped for this pump. It should be noted that arbitrary adjustment of the pump may cause defects in the engine. Damaged or faulty injection pumps should be sent for repair to the firm of Robert Bosch or a Bosch agency or to a Daimler-Benz branch.

Injection pumps are supplied and tested together with the fuel distributor fittings and the injection valves. For this reason the injection pump may only be replaced **complete with Distributor Fittings and Injection Valves.**

a) Checking Ease of Movement of Control Assembly and Fuel Control Rod

In order to check the control assembly for ease of movement detach the two push rods at the adjustment lever. The adjustment lever should then be pushed as far as the full load stop. Let the lever move backward slowly until it rests against the idle stop, exerting a slight counter pressure on the lever. During this operation the adjustment lever must not catch.

On the R 1 Injection Pumps there is positive connection between the fuel control rod and the control assembly (on the R 2, R 3, and R 4 pumps the connection is non-positive). In the case of these pumps it is therefore not sufficient to check the control assembly for ease of movement but the fuel control rod, too, must be checked for ease of movement. To do this, detach the two push rods at the adjustment lever, unscrew the protective cap for the fuel control rod at the front of the injection pump, screw an M 5 screw into the fuel control rod and use this screw to move the fuel control rod backward and forward. There should be no noticeable resistance.

In the case of the R 1 Injection Pump the ease of movement of the fuel control rod can also be checked with the engine running. Accelerate the engine by operating the adjustment lever on the injection pump and move the adjustment lever back to the idle stop; in the idle position the same idle speed must always be obtained.

At the same time the fuel control rod can be observed which should always return to the same initial position. In order to be able to follow the movements of the fuel control rod closely, screw an M 5 screw into the front end of the rod.

Ease of movement of the fuel control rod can also be checked with the help of the idle air throttle in the venturi control unit. If after operating the adjustment lever (acceleration and deceleration) the idle speed can be considerably increased by backing out the idle air throttle, the fuel control rod does not move freely.

Injection pumps in which either the fuel control rod or the control assembly catches, must be replaced.

b) Checking Operation of Inlet Air and Cooling Water Thermostat

If a thermostat is defective, the working pin (2) does not project sufficiently (and can be easily pressed in) so that the engine receives too much fuel when warm (Fig. 00-15/1). The result is high fuel consumption, uneven idle and a bad warm start. If the mixture enrichment is too great because of a defective cooling water thermostat, the warm engine will no longer start even with the accelerator pedal fully depressed. Enrichment caused by a defective inlet air thermostat has no unfavorable influence on the starting response of a warm engine. The thermostats are checked for faults as follows:

As is described in Job No. 07-10, Section C, the pump has a stop bolt for the cooling water thermostat and a stop screw for the inlet air thermostat (see nos. 59 and 62 in Fig. 07-10/7).

As soon as the stop bolt or the stop screw is moved in the way described there, with the engine running at normal working temperature, a defective thermostat will change the idle.

Another check can be made on the thermostat itself. Measure the dimension "a" with a load of 3 kg on the working pin (2) and at a temperature of 20° C; "a" should be 6 ± 0.08 mm (Fig. 00-15/1).

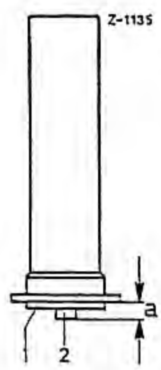


Fig. 00-15/1

a = 6 ± 0.08 mm
1 Housing
2 Working pin

For every increase in temperature of 10° C the working pin travels 0.5 mm so that at 80° C it projects 9 mm.

Note: In some pumps thermostats have been installed which travel only 0.2 mm. Such thermostats are marked "GLF" on the upper face.

The stop bolt and the stop screw are not lead-sealed but locked against unauthorized adjustment by a wire. The lock wire can be removed but should be fixed again after the check has been made.

c) Checking of Cold Start Magnet

When the starter is being operated at a cooling water temperature below 45 ± 3° C the cold start magnet automatically causes the fuel control rod to be moved to starting delivery.

The operation of the cold start magnet can be checked by observing the movement of the fuel control rod during starting. To do this, unscrew the protective cap for the fuel control rod at the front of the injection pump.

When the engine is not running, the fuel control rod is in the rear position, during starting it is in the front position.

If the fuel control rod does not move to full load, the cold start magnet is defective, provided that the current supply and the thermo switch in the cooling water outlet connection are not at fault.

When a cold start magnet is replaced, measure the dimension "a" and adjust the new magnet to this dimension (Fig. 00-15/2). The dimension "a" can only be measured and adjusted if the bar is moved as far as it will go, either electrically or by hand. To adjust the bracket, loosen the lock nut (2) and move the bracket (3) until the dimension "a" is obtained.
When installing the magnet make sure that the open side of the bracket points to the control assembly cover. In order to check the correct adjustment of the cold start magnet, measure the clearance of the fuel control rod in starting position when the circuit is closed. It must be 0.5 + 0.2 mm.

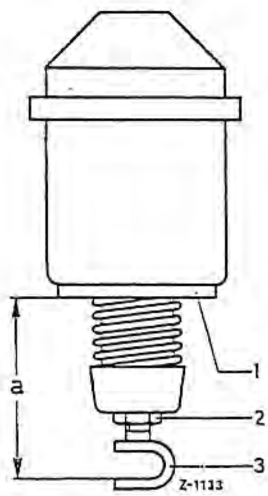


Fig. 00-15/2

1 Cold start magnet
2 Lock nut
3 Bracket

The cold start magnet can be replaced without unscrewing the control assembly cover.

d) Testing of Check Valve for Leak-off Oil Lock

The check valve on the injection pump can be disassembled for cleaning.

The opening pressure is 0.5 atm.

When screwing the valve to the injection pump take care to tighten the hollow screw well since otherwise oil may be lost.

e) Cleaning of Injection Pipes
The injection pipes must be completely free from dirt particles and impurities.
When new pipes are to be installed and there is no guarantee that they are absolutely clean, they must be flushed out beforehand. An old diesel injection pump and diesel injection nozzles can be used for this purpose. The pipes must be flushed out for some time and at a pressure of about 100 atm. with as large a quantity as possible of clean, filtered diesel oil.
Blowing out with compressed air or flushing without pressure is not sufficient.

Injection Pipes from Injection Pump to Fuel Distributor Fittings
These Pipes should be replaced after a Mileage of 70 000 km
When the pipes are being replaced, the injection valves, the fuel distributor fittings, and the injection pipes should be cleaned as follows:
Knock the dry injection valves with the connectors against a piece of wood in order to remove any dirt particles that may have accumulated in the filter. Afterwards give the connector a thorough wash in gasoline.
Flush out the fuel distributor fittings with **Gasoline** contrary to the direction of flow, using a hand-operated nozzle tester.
Clean the injection pipes as described above.

Before the new pipes between the injection pump and the fuel distributor fittings are installed, it is necessary to check their free cross-section. The internal diameter of the two pipes for the front and the rear distributor fitting should be 3.5 mm and must be the same for the two pipes. Any difference in the internal diameter of the two pipes will result in uneven fuel distribution to the front and rear cylinder groups and consequently in an unsatisfactory idle. For this reason, pipes with too small a diameter must be bored to the prescribed diameter. **After this operation, the pipes must under all circumstances be properly cleaned.**

B. Fuel Distributor Fittings and Injection Valves

Fuel distributor fittings and injection valves are selected in the factory in such a way that the injection amount is the same for the three injection valves supplied by one distributor fitting. These associated parts are marked with letters and are only supplied as a complete set (Fig. 00-15/3).

In addition the front set of an assembly (fuel distributor fitting and injection valves for cylinders 1 to 3) is marked with a red dot.

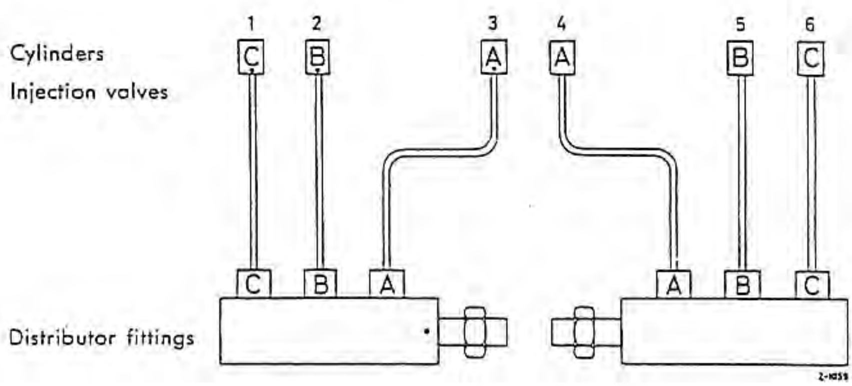


Fig. 00-15/3

Attention should be given to these marks during installation to prevent uneven fuel distribution to the individual cylinders and resulting bad running conditions of the engine.

For the same reason, the fuel distributor fitting and the injection valves must never be replaced individually but **only as a set.**

To facilitate stock keeping, replacement distributor fittings and replacement valves are supplied without the red dot which should however be subsequently applied to the distributor fitting and the three injection valves when the front set (for cylinders 1 to 3) is replaced.

Note: On the first engines for Model 220 SE the distributor fittings and the valves were marked with the number of the cylinder.

a) Checking of Injection Valves

The injection valves can be checked for correct injection pressure by means of a standard commercial tester and test oil.

Before checking the valves make sure that **both tester and test oil are absolutely clean. The same applies to the filter of the tester** which must be cleaned if necessary. Furthermore, the tester should be operated several times without the valve to ensure that any dirt particles that may be lodged in the device are flushed out. During the actual check the pump lever of the tester should be moved up and down smartly so that the nozzle can spray properly.

Modification: On page 00-15/6 Part Numbers added for the distributor group on Model 300 SE and on page 00-15/7, 3rd line, tightening torque modified and in the last line but two delivery amount modified.

1. Sight Check of Injection Valve Jet

The shape of the jet can be checked by depressing the pump lever quickly (2-3 strokes per second) while the pressure gage is not operative. The jet must be evenly and well atomized and must be completely cone-shaped.

If the jet drips, if it is too broad or not completely cone-shaped, the injection valve is not working properly.

If one injection valve does not meet the above requirements, the complete distributor group should be exchanged or replaced.

2. Spray or Opening Pressure of Injection Valves

With the pressure gage in operation slowly depress the hand pump lever (1 stroke per sec.) and read off the spray pressure on the pressure gage when the valve begins to open or to spray.

Caution! When the pressure gage is in operation, increase the pressure very slowly and above all decrease it very slowly since otherwise the pressure gage may be damaged.

The spray or opening pressure of the injection valves should be 13.0 to 15.5 atm. to ensure even fuel distribution to the individual cylinders. **The difference in spray pressure of the three injection valves (distributor group) of one fuel distributor fitting must not exceed 0.5 atm.**

If the difference exceeds 0.5 atm. exchange or replace the complete distributor group with the defective valve.

3. Leak Check of Injection Valves

With the pressure gage in operation slowly depress the hand pump lever until the pointer on the pressure gage shows 3 atm. below the spray pressure measured before. The injection valve is leak-proof if no drop falls from the mouth of the injection valve.

If any one injection valve leaks the complete distributor group must be exchanged or replaced together with the defective valve.

b) Distributor Group

The even distribution of the amount of fuel delivered can be measured on a Bosch pump test stand or as follows:

The distributor group to be tested (fuel distributor fitting and three injection valves) is connected to a two-cylinder pump of the type used in the car. For this purpose properly working injection valves should be used whose spray pressure does not differ by more than 0.5 atm. Place a measuring glass under each injection valve.

The difference (maximum scatter) in the amount of fuel delivered by the injection valves should not exceed 2.5 cc/1000 strokes when idling (350 rpm of the injection pump) or 3.0 cc/1000 strokes at full load (1000 rpm of the injection pump).

The prescribed cold start amount per injection valve should be:

Model	Cold start amount/injection valve in cc/100 strokes		
	average	minimum	
220 SE 220 SEb	11-13	8	at 40 rpm of the injection pump and with Bosch test oil OL 61 v 1
300 SE	14-16	11	

If the differences at idle or full load exceed these values or if the fuel amount specified for a cold start is not obtained, exchange or replace the complete distributor group.

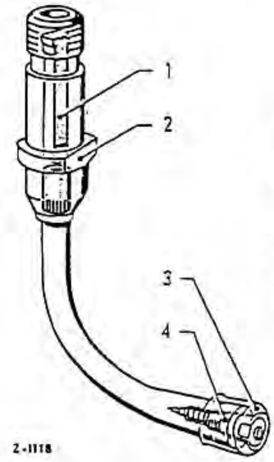


Fig. 00-15/4

Injection valve

1 Filter
2 Pipe union
3 Metal cap
4 Valve element

It has recently become possible to exchange a complete distributor group for Model 220 SEb Part No. 000 078 01 95/80 (Bosch Designation EPVT 1 P 12 Z injection valves with strainer) or Part No. 000 078 00 95/80 (Bosch Designation EPVT 1 P 11 Z injection valves with bar filter) and for Model 300 SE Part No. 000 078 02 95-80 (Bosch Designation EPVT 1 P 13 Z) (Fig. 00-15/3), that is a complete distributor group can by exchanged against a repaired distributor group in which the three injection valves (Fig: 00-15/4) have been fitted with new valve elements (4), the injection valve tubes with pipe union (2) and the associated fuel distributor fitting have been cleaned and the repaired distributor group has been checked for even fuel distribution.

If distributor groups are not available for exchange, any Bosch agency can replace the valve elements (4) of the damaged injection valves (Fig. 00-15/4), while retaining the injection valve tubes and pipe unions which had been removed, and reinstall them together with the associated fuel distributor fitting.

Before installing a distributor group or injection valves with new valve elements carefully flush the injection valves with a tester (for measuring the spray pressure) in order to ensure that the needle of the injection valve does not stick because of resin deposits after long storage.

Before installing the injection valve holder check the surface of the holder (10) and the surface on the intake pipe for damage. The surfaces must be absolutely even; leaks may occur if they are not. The gasket between the holder (10) and the intake pipe must always be replaced and must be fitted with Teroson sealing compound. When installing the flange (9) which holds the injection

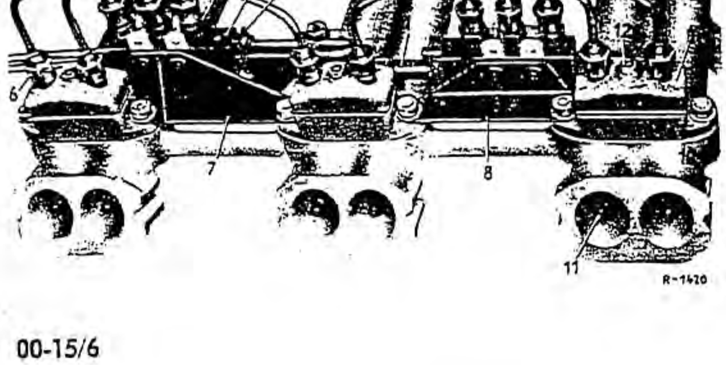


Fig. 00-15/5

1 Pressure pipe connection
2 Locking plate
3 Fuel distributor fitting
4 Pressure pipe connection
5 Injection pipe
6 Cap nut
7 Support for front distributor fitting
8 Support for rear distributor fitting
9 Flange
10 Injection valve holder
11 Injection valves

valves in the holder (10), the hexagon nut for fastening the flange (9) and the holder (10) must not be tightened beyond 0.8÷0.2 mkg (Fig. 00-15/5).

The cap nuts (6) should be tightened to approx. 2.5 mkg.

It is advisable after installation to make a leak check of the holders (10) of the injection valves by a gasoline spraying test with the engine running.

Note: When checking or repairing any components of the injection system it is advisable always to consult the nearest Bosch agency.

C. Fuel System

a) Fuel Feed Pump

Before exchanging or replacing an electric fuel feed pump which seems to be defective always measure the delivery pressure and the delivery amount and check the pump chamber and the check valve for leaks.

Other repairs such as turning off the commutator, replacing carbon brushes and the slide ring seal should only be carried out by a Bosch agency because of the particular features of the fuel feed pump.

Only fuel feed pumps with improved ball bearing cover on the pump side should be installed. These pumps have the End Designation /1/B or A 1; the exchange pumps have the End Designation /1/B or A 1 or only /1 and in addition a blue dot below the direction arrow on the pump cover.

The two Models /1 and /1/B differ mainly in their field and armature coils and the carbon brush. Feed pump /1 has carbon brush WSK 16 Z 11 Z, and feed pump /1/B or A 1 has carbon brush WSK 16 Z 8 Z.

Checking Delivery Pressure

The delivery pressure, which is measured between fuel filter and damper unit, should be **not lower than 0.4 atm.** with a minimum terminal voltage at the feed pump of **10 volts** and an input at the feed pump of **3.1-3.5 amp.** If the pressure is loweer than 0.4 atm., either the filter is clogged or the output of the pump is insufficient. In either case the first thing to do is to check the permeability of the filter.

The easiest method is to replace the filter element by a new element and to measure the delivery pressure again. If the pressure is now considerably higher than before, the filter element was clogged. If after the replacement of the filter element the delivery pressure is not or only slightly higher than before, either the fuel feed pipe (narrow passage), the fuel strainer in the fuel tank (clogged) or the pump itself may be responsible.

If it is found that the pump itself is obviously responsible for the low delivery pressure or low output, the fuel feed pump must be replaced or exchanged.

Note: The delivery pressure and the delivery amount should be measured with the engine **not running.**

Measuring Delivery Amount

When measuring the delivery amount the fuel tank should be at least half full in order to ensure that the damper vessel in the fuel tank is always filled with fuel even when the return pipe has been detached.

The delivery amount should be measured **behind the return-line damper unit,** using a new filter element in the fuel filter. To do this, detach the return pipe and place a container under the pipe outlet. Then switch on the ignition for a period of 1 minute. During this period, the delivery amount should be **not less than 3.3** liters with a minimum terminal voltage at the feed pump of **10 volts** and an input at the feed pump of **3.1-3.5 Amp.**

Leak Check of Fuel Feed Pump

The pump chamber of the fuel feed pump is sealed against the electrical part (electric motor) by a slide ring seal. To check this seal watch the leak-off pipe (4). when the pump has run warm (see Fig.07-10/23). The leak-off pipe must not be clogged. If drops form at comparatively short intervals the slide ring seal is damaged and the pump must at once be exchanged or replaced.

If dirt is suspected between the pump cover or housing and the impeller unscrew the pump cover (6) and carefully remove the impeller (with a provisional copper wire hook) (Fig. 00-15/7. Mark the position of the pump cover before removal since it must be reinstalled in exactly the same position as before. Care should also be taken to ensure that the Woodruff key for the impeller is not lost.

Clean the pump chamber; the pump cover must be free from dirt and ridges. If necessary it must be honed on a surface plate. Slight signs of wear on the cover are permissible but not grooves or scores.

The key must be fully serviceable otherwise it should be replaced. With the impeller installed the maximum play should be 18°.

The impeller must show no signs of damage, the vanes must have sharp edges and no score marks.

The contact surface of the impeller in the pump housing must likewise be fully serviceable. In particular there must be no score or scratch marks between the two passage outlets. If dirt is found, clean with a wooden stick and a leather cloth.

Place the key in position and install the impeller in such a way that the inclined part of the vanes points toward the pump housing. Use a new O-ring and reinstall the pump cover in its previous position.

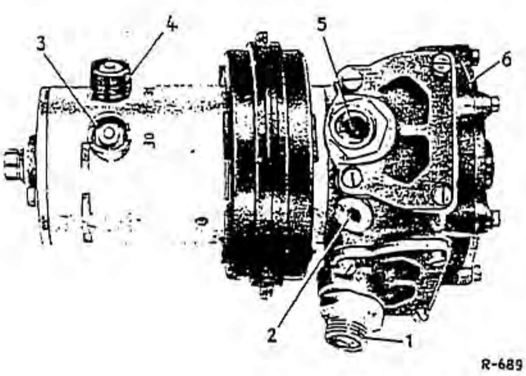


Fig. 00-15/7

1 Threaded union with check valve (delivery side)
2 Screw plug
3 Terminal 30
4 Terminal 31
5 Threaded union (suction side)
6 Pump cover

Testing of Check Valve

Test the check valve in the threaded union (1) of the fuel feed pump by blowing air into it.
A leaking check valve in the threaded union (1) (delivery side) can be replaced, but only together with the threaded union.

The threaded union (5) on the suction side has no check valve (see Fig. 00-15/7).

b) Fine Fuel Filter

Clogged filters may be the cause of unsatisfactory starting of a hot engine and of uneven running of the engine. If the engine falters at high rpm, this may also be due to a clogged fuel filter.

To check the fuel filter for dirt follow the procedure outlined for checking the delivery pressure. Only cellular paper filter elements may be installed (see Fig. 07-10/24).

c) Damper Units

If fuel noise occurs in the pipes, check the diaphragm of the damper units. Cracked and damaged diaphragms should be replaced.

During assembly the following points should be noted:

To improve sealing between housing and cover, a groove has been cut into the sealing surface of the housing (5) (Fig. 00-15/8). On the first version installed in Model 220 SE, in addition to the groove in the housing, a rim was added to the sealing surface of the cover (4). Furthermore, in this version a paper gasket (9) was added between housing and cover to prevent excessive pressure on the diaphragm by the rim on the cover; without the gasket it might tear. In no case, however, must a paper gasket be used in the 2nd version of the damper unit with a rimless cover since that would decrease the pressure on the diaphragm too far.

Where a cover with rim is installed it is advisable to replace it by a cover with smooth sealing surface.

When a threaded union is replaced make sure that a proper new union is fitted. Fig. 00-15/8 shows the damper unit for the feed line (from the fuel filter). In the damper unit for the return pipe the threaded, union (7) has a 6 mm bore and the threaded union (8) a 3.5 mm bore on Models 220 SE and 220 SEb and a 2.0 mm bore on Model 300 SE.

The threaded unions must not be installed with sealing compound or sealing grease, since there would be a danger of such particles getting into the gasoline system and damaging or impeding the proper functioning of the injection system.

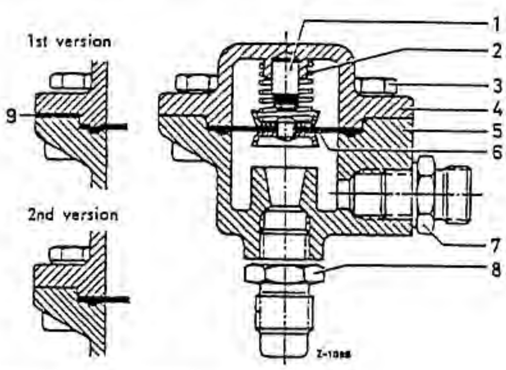


Fig. 00-15/5

1 Plug
2 Pressure spring
3 Hexagon screw with spring washer
4 Cover
5 Housing
6 Diaphragm
7 Threaded union with sealing ring (outlet)
8 Threaded union with sealing ring (inlet)
9 Paper Gasket

d) Electro-Magnetic Cold Start Valve

It often happens that cold start valves are unnecessarily removed from a vehicle or replaced only because e. g. on the 1st version of the start valve fuel drops appear between the electric magnet and the valve housing or in the connecting hose between the start valve and the intake pipe.

a) **If there is an outside leak** between the electric magnet and the valve housing replace the rubber ring (3). To do this screw off the electric magnet and replace the rubber ring (3) Part No. 001 997 78 40 on the 1st version, Part No. 001 997 75 40 on the 2nd version (Figs. 00-15/9 and 00-15/10).

b) **In the case of inside leaks** always make a leak check. A slight loss of gasoline of 0.3 cc/min at a gasoline pressure of 0.5 to 0.6 atm is permissible. Such a small leak has no influence on the engine, that is on gasoline consumption and idling performance.

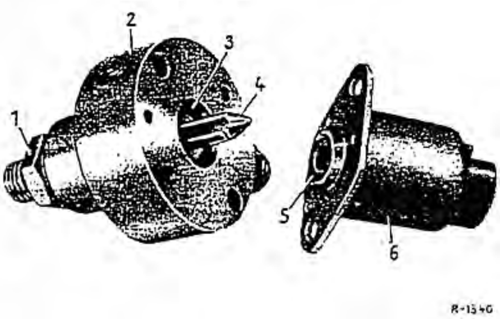


Fig. 00-15/9

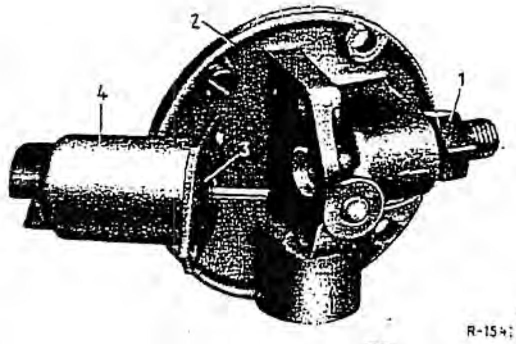


Fig. 00-15/10

Start Valve

1st Version

1 Threaded union
2 Valve housing
3 Sealing ring
4 Valve cone holder
5 Bushing
6 Electric magnet

2nd Version

1 Threaded union
2 Valve housing
3 Sealing ring
4 Electric magnet

Leak checks can be made as follows using the checking device Part No. 111 589 13 21 00 consisting of a measuring tube (1) (glass tube with 0.1 cc graduation), a connecting pipe (3) with a cap nut and a length of hose (2) (see Figs. 00-15/11 and 12):

On the 1st version start valve unscrew the fuel hose from the start valve and instead attach the connecting pipe (3) with hose (2) and measuring tube (1) (Fig. 00-15/11).

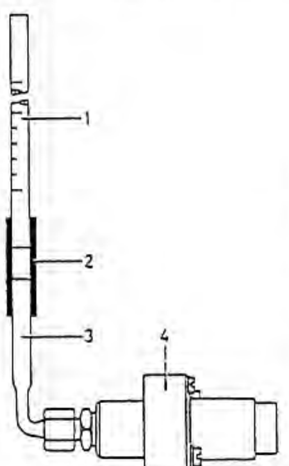


Fig. 00-15/11

Start Valve

1st Version

1 Measuring tube (glass tube)
2 Connecting hose
3 Connecting pipe with cap nut
4 Start valve
5 Fuel feed pipe

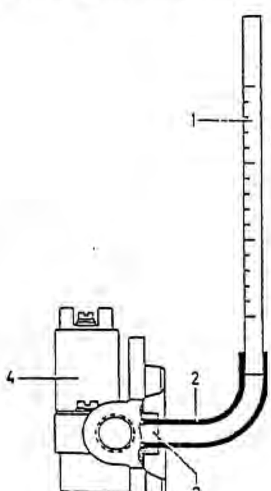


Fig. 00-15/12

Start Valve

2nd Version

1 Measuring tube (glass tube)
2 Hose
3 Atomizing jet
4 Electric magnet
5 Fuel feed pipe
6 Valve housing

On the 2nd version start valve unscrew the start valve from the intake pipe. Slide the hose (2) with the measuring tube (1) over the atomizing jet (3) (fig. 00-15/12).

Switch on the ignition. Connect a cable to the positive terminal of the battery. Open the start valve for a short time by establishing contact by means of the cable connected to the battery until a fuel column is visible in the measuring tube (1).

Now measure the rise of the fuel column in the measuring tube (1) with the start valve closed during a period of exactly 1 minute. The fuel loss may be as much as 0.3 cc/min; if this amount is exceeded unscrew the threaded union (1) and remove, clean and, if necessary, re-lap the valve (Figs. 00-15/9 and 10). If there is still a leak of more than 0.3 cc/min replacement of the start valve is justified.

Adjustment of Fuel Injection Engine

Job No.
00-16

Modification: Model 230 SL added, Model 220 SE cancelled, text revised

A. Adjustment of Control Linkage

Between the adjustment lever (15) on the injection pump and the throttle valve lever (1) on the venturi control unit there is a certain definite correlation which is of decisive importance for proper engine performance (Fig. 00-16/1).

This correlation must be checked and if necessary adjusted in the case of engine trouble, e. g. jerky running of the car or excessive fuel consumption, and when the control shaft (11), the injection pump, the venturi control unit or the intake pipe has been installed.

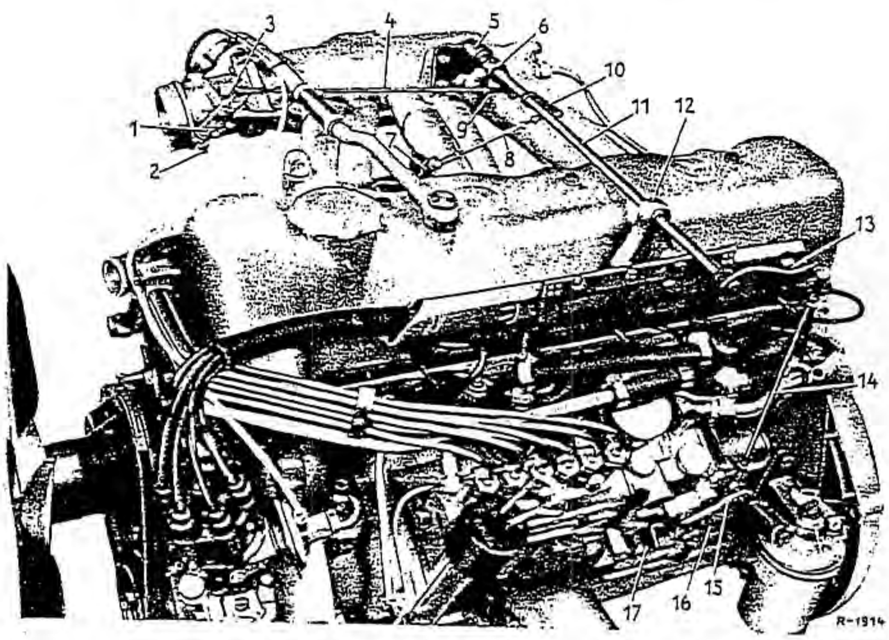


Fig. 00-16/1

Model 230 SL

1 Throttle valve lever
2 Full-load stop screw
3 Idle stop screw
4 Control rod
5 Bearing sleeve
6 Control lever
7 Control lever
8 Control rod
9 Adjusting pin bore
10 Control lever
11 Control shaft
12 Bearing bracket
13 Control lever
14 Control rod
15 Adjustment lever
16 Idle stop
17 Full-load stop

The control linkage can only by checked and adjusted with the help of Adjusting Device Part No. 127 589 01 23 which consists of a graduated disk with pointer and a lever for the injection pump and a plug for the control lever (see Figs. 00-16/2—4). In addition, Graduated Disk and Pointer Part No. 111 589 04 23 are required for the venturi control unit (see Fig. 00-16/5).

For Models 230 SL and 300 SE with six-cylinder pump, the lever (3), which acts as a drive for the graduated disk on the injection pump, must be modified as shown in Fig. 00-16/6 by welding two lugs to the lever and beveling the upper right corner of the lever.

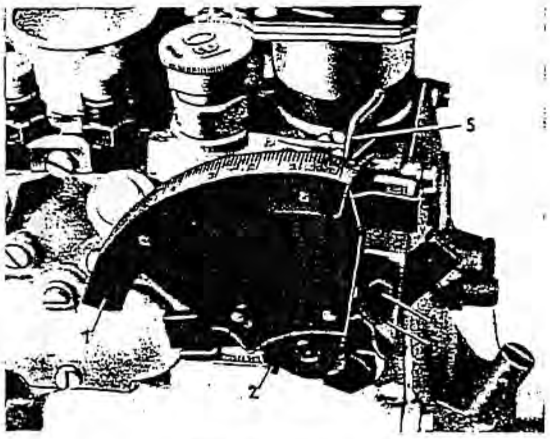


Fig. 00-16/2

ZEB Injection pump
Models 220 SEb and 300 SE

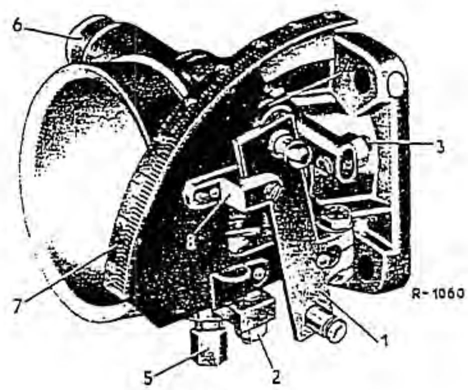


Fig. 00-16/5

1 Throttle valve lever
2 Idle stop screw
3 Full-load stop screw
4 Idle air throttle
5 Vacuum connection for distributor
6 Connection for engine vent line
7 Graduated disk Part No. 111 589 04 23
8 Bracket

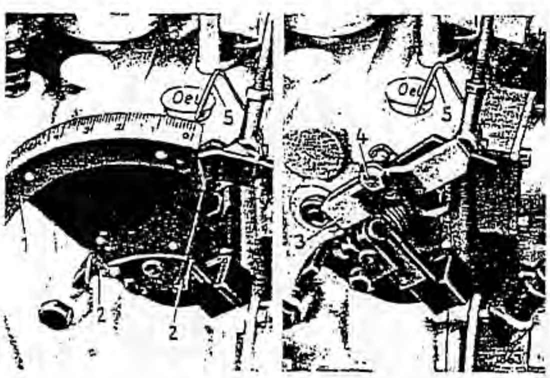


Fig. 00-16/3

Model 230 SL

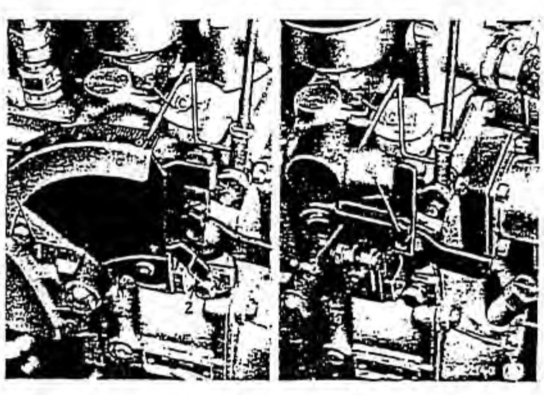


Fig. 00-16/4

Model 300 SE with
six-cylinder injection pump

1 Graduated disk
2 Bracket
3 Lever
4 Hexagon screw
5 Pointer

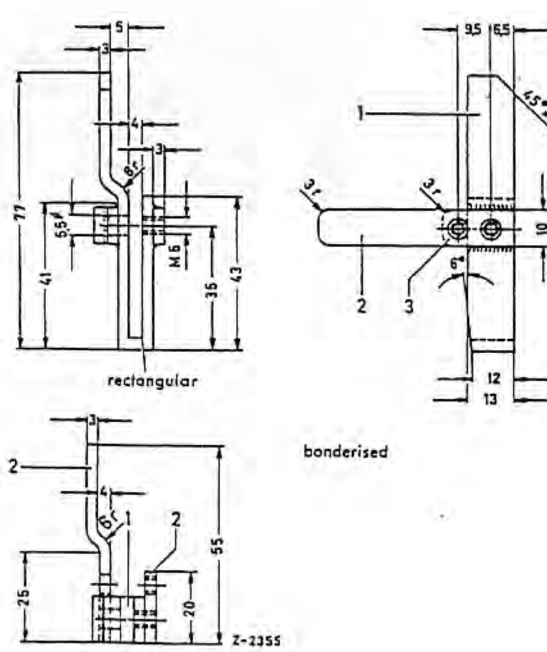


Fig. 00-16/6

modified lever 3

The following procedures are required for checking and adjusting the control linkage:

1. Place Graduated Disk 111 589 04 23 on the axle of the throttle valve shaft and fasten it to the throttle valve lever (Fig. 00-16/5). Then fasten the wire pointer by means of the upper left fixing nut for the venturi control unit and bend it in such a way that **with the throttle valve completely closed** it points to the 0° mark.

Note: On venturi control units with reversed opening of the valve the graduated disk has to be read off starting from the rear.

2. Attach the graduated disk (1) to the axle of the adjustment lever on the injection pump and attach the pointer to a fixing screw of the start magnet. Then bend the pointer to point to the 0° mark when the adjustment lever rests against the idle stop screw (Figs. 00-16/2—4).

3. Actuate the control shaft and adjust the graduated disk on the venturi control unit to the throttle valve angle given in the table and read off the angle indicated on the graduated disk on the injection pump. This angle must be within the tolerances given in the table in the column "control angle". Small differences can be removed by readjusting the control rods (4) and (14). In the full load position the adjustment lever (15) on the injection pump must rest against the full load stop (17), whereas there must be a clearance of about 1 mm between the throttle valve lever (1) and the full load stop screw (2) (Fig. 00-16/1).

4. If the values given in the table cannot be obtained by readjusting the rod or if larger differences are found, the control linkage must be readjusted: Detach the control rod (4) at the control lever (6). Push the adjusting pin into the bore (9) in the lug of the intake pipe thus fixing the ball-head of the control lever (6) in its position. Then adjust the control rod (14) in such a way that the adjustment lever (15) on the injection pump rests against the idle stop (16).

Correlation:

venturi control unit — injection pump on Models 220 SEb and 300 SE

Throttle valve angle	Control angle
0°	0°
2.5	4—4.5
5	8—8.5
7.5	11.5—12.5
10	15.5—16.5
15	22.5—23.5
20	29—30
30	40.5—42
40	50.5—51.5
50	59—60
60	67—68
70	73.5—75
80—82	79—82

Remove the adjusting pin and adjust also the control rod (4) in such a way that the throttle valve lever (1) of the venturi control unit rests against the idle stop (3). Re-attach the control rod (4).
If there is any play between the ball heads of the control rods, control rod (4) should be given a certain amount of initial tension (Fig. 00-16/1).

Note: On the first version of Model 220 SEb the control linkage was installed below. This type of linkage should be adjusted as follows:
In the idle position use a plug to fix the control lever in its position at the left bearing of the control shaft. Then adjust the control rods in such a way that the adjustment lever on the injection pump and the throttle valve lever on the venturi control unit rest against their idle stops. Remove the plug.

5. On engines with progressive linkage check the limit stop of the roller (4) in the quadrant lever (5) and if neccessary adjust as follows:
Adjust the pull rod (3) in such a way that the roller (4) lightly rests against the limit stop in the quadrant lever (5) without exerting any force (Fig. 00-16/7).

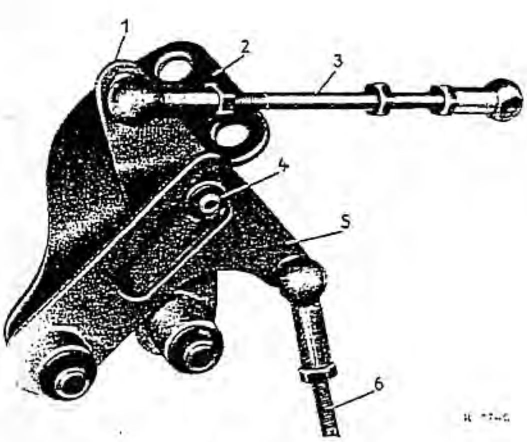


Fig. 00-16/7

Progressive control linkage

1 Control lever	4 Roller
2 Bracket	5 Quadrant lever
3 Pull rod	6 Push rod

6. Some engines of Model 230 SL have been provided with a dashpot. The adjustment of the dashpot should be checked as follows:

   Slowly actuate the control shaft until the control lever (7) is just about to lift from the dashpot pin (6) (Fig. 00-16/8).

   The graduated disk should now indicate a 4° opening of the throttle valve. If this is not the case, the dashpot should be adjusted by means of the hexagon nuts (3) in such a way that the pin (6) lightly rests against the control lever (7) at a 4° opening (Fig. 00-16/8).

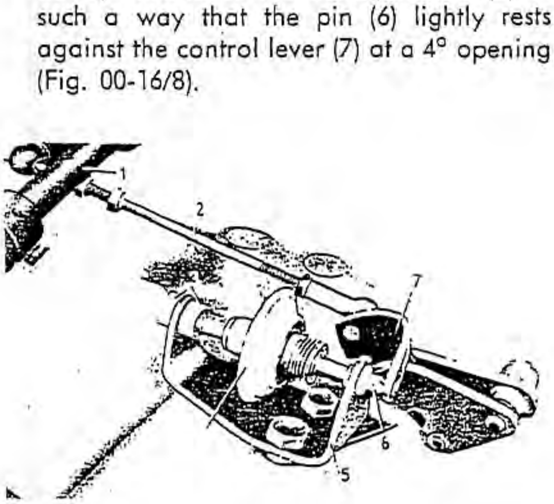


Fig. 00-16/8

Dashpot

1 Control shaft	4 Vacuum box	7 Control lever
2 Push rod	5 Plate	
3 Hexagon nut	6 Pin	

7. Check again as described in para 3. If major differences should be found even then, they may be due to the following causes:

a) Either the control shaft (11) or the ball heads of the control rods are worn. The control rods are bent.

Remedies:

Replace the control shaft or the ball heads of the control rods as required. Straighten or replace the bent control rods. When removing the control shaft proceed as follows:
Pull the control shaft (11) out of the bearing bushing (5) toward the left; if this should prove difficult insert a screw driver between the right control lever (6) and the bearing bushing (5) and press off the shaft. Then unscrew the nuts from the bearing bracket (12) and remove the control shaft together with the bearing bracket (Fig. 00-16/1).

Note: **The control shaft must not be forced out of the bearing bushing in an upward direction,** since this would damage the snap ring for fastening the ball socket to the control shaft.

b) The idle stop screw on the venturi control unit has been tampered with.

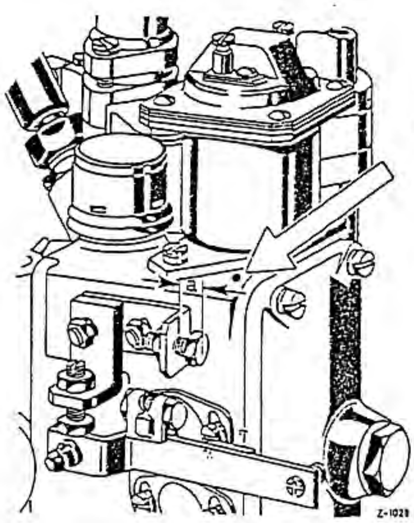
Remedies:

By turning the idle stop screw (3) adjust the throttle valve in the venturi control unit in such a way that with the throttle valve lever (1) resting against the idle stop screw the throttle valve is completely closed without however seizing in the venturi control unit (see Fig. 00-16/1).

c) The idle stop screw on the injection pump has been tampered with **(only on Model 220 SEb with ZEA injection pump).**

Remedies:

The idle stop screw on the injection pump must never be adjusted since this would change the basic setting of the injection pump. In order to make it possible to ascertain whether the



Dimension "a" stamped here

Fig. 00-16/9

ZEA Injection pump

idle stop screw has bee tampered with, the dimension "a" from the angle to the screw head in the pump housing has been stamped beside the start magnet in the ZEA pump version (see arrow in Fig. 00-16/9). E. g. number 95 means that the dimension "a" = 9.5 mm. If the measured value does not correspond to the stamped dimension, an exception can be made to the rule and the idle stop screw may be adjusted to the specified dimension. Injection pumps without the stamped dimension can only be checked and adjusted on an injection pump test bench.

B. Adjustment of Idle

Engine idle can only be satisfactory if the ignition system, the fuel system and the adjustment of the control linkage are in perfect working order. In case of doubt check the following points before adjusting the idle:

Distributor (contact gap – angle of closure – distributor arm),

Spark plugs (specified type – correct thermal value – electrode gap),

Ignition cable harness and ignition lead plug, Interference suppressors (see instructions on interference suppression in spark plug table),

Ignition timing,

Fuel filters (clogging),

Fuel feed pump (delivery pressure or delivery amount),

Adjustment of control linkage,

Injection valves (spray pressure – jet shape – leakage),

Distributor group (minimum cold start amount and even distribution of the fuel amount delivered).

Note on Model 220 SE:

In the case of Distributor VJUR 6 BR 32 T whose centrifugal governor advance curve is at the upper limit of the tolerance range, centrifugal governor advance already begins at a speed of n = 650 rpm. For this reason the ignition point must also be checked at idle speed in the case of engines equipped with a Distributor VJUR 6 BR 32 T. The ignition point must not be in advance of 4° BTDC. If the ignition point occurs earlier, ignition can be retarded as far as 26° BTDC at a speed of n = 3,000 rpm.

In the case of engines whose distributor has too early a centrifugal governor advance and whose idle is not satisfactory even when the ignition has been retarded by 1–2°, the distributor must be replaced. It goes without saying that a Distributor VJUR 6 BR 49 T can be installed instead.

Unsatisfactory idle may also be due to a leak in the intake manifold, the injection valve holders or the vacuum pipe to the ATE Power Brake. When making a leakage test of these parts check whether the vacuum pipe is properly attached to the ATE Power Brake by the hollow screw.

It is possible to adjust the fuel-air mixture for the idle by means of the idle air throttle (4) on the venturi control unit and the spring-loaded idle control knob (6) on the injection pump in such a way that the engine runs smoothly and the desired speed is obtained (see Job No. 00-0 and Fig. 00-16/15). Incorrect composition of the mixture, in addition to causing an irregular idle, may also produce jerky running of the car at low speeds (between 20 and 40 km/h in fourth gear). See also Section "C. Readjustment of Speed Build-Up", b.

Caution! The spring-loaded idle control knob on the injection pump must only be operated when the engine is not running since the knob rotates as soon as it engages in the slot of the adjusting screw on the centrifugal governor (No. 6 in Fig. 00-16/15 and No. 10 b in Fig. 00-16/16).

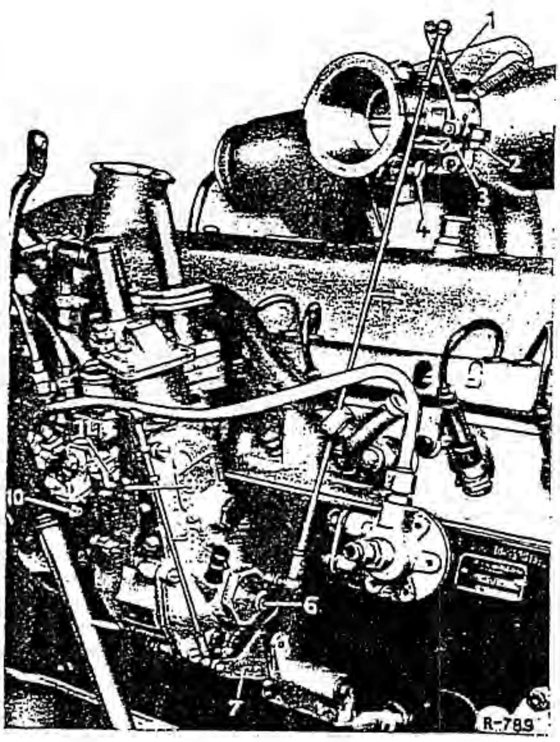


Fig. 00-16/15
Model 220 SE with ZEA injection pump

1 Throttle valve lever
2 Idle stop screw with lock nut
3 Full load stop
4 Idle air throttle
5 Pull rod
6 Spring-loaded idle control knob
7 Control lever
8 Push rod
9 Adjustment lever
10 Full load stop screw
11 Idle stop screw

With the engine **at working temperature** the adjustment is made as follows:

1. Check the adjustment of the control linkage and if necessary correct (see Section A).

Note: On Model 300 SE detach the control rod (15) at the top before adjusting the control linkage and the idle. After adjustment push the relay lever (5) toward the rear so that it rests against its stop. If necessary correct the length of the control rod (15) so that it can easily be pressed in without moving the relay lever (5) or the lever (13) (see Fig. 00-16/20). The control rod (15) is fitted with a right-hand and left-hand thread.

2. Adjust the idle to the prescribed value by means of the idle air throttle (4) on the venturi control unit (Fig. 00-16/15).

   If the engine runs properly no further correction is necessary.

   If the engine speed fluctuates the fuel-air mixture is too rich. If the engine vibrates the mixture is too lean.

3. **Stop the engine**
   Press in the spring-loaded idle control knob (10b) and turn it until it engages the slot of the adjustment screw (10a) on the centrifugal governor; now turn the knob one notch **to the left if the mixture is too rich,** and turn it one notch **to the right if the mixture is too lean** (Fig. 00-16/6).

Note: The adjustment screw (10a) must only be moved from notch to notch and at the most up to 3 notches to the left or to the right of the basic position (1 notch = $1/6$ turn of the adjustment screw). If an adjustment by 3 notches has not produced any result return the adjustment screw to its initial position and check as described in para 4, note.

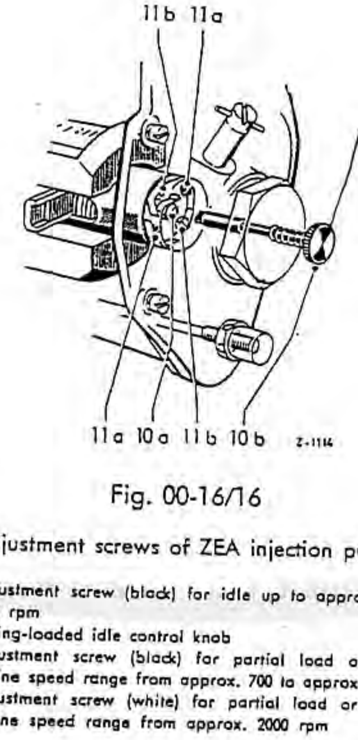


Fig. 00-16/16

Adjustment screws of ZEA injection pump

10a Adjustment screw (black) for idle up to approx. 1000 rpm
10b Spring-loaded idle control knob
11a Adjustment screw (black) for partial load or medium engine speed range from approx. 700 to approx. 4000 rpm
11b Adjustment screw (white) for partial load or upper engine speed range from approx. 2000 rpm

4. Readjusted the idle to the prescribed speed by means of the idle air throttle. If the engine still does not run smoothly repeat the correction until the engine has been properly adjusted.

Note: If the adjustment has taken too long it may be necessary to drive the car a short distance to free the spark plugs.
Unsatisfactory idle may also be due to a leak in the intake pipe, the injection valve holders or the vacuum pipe to the ATE-power brake. When these parts are checked for leaks pay particular attention to the vacuum line attachment to the ATE-power brake by means of the hollow screw.

5. **Checking of Idle Adjustment:**

a) On Models 220 SEb and 300 SE with automatic transmission check the idle engine speed with the selector lever in positions "4" and "R". Apply the hand brake and engage the selector lever. When the selector lever is engaged the idle engine speed must be the same as in lever position "0", i. e. the same as the prescribed idle speed adjusted in accordance with paras 2–4 (see Job. No. 00-0); it may fall by a maximum of 30 rpm.
If the prescribed idle speed is not obtained check the working of the lifting magnet (1) (Figs. 00-16/19 and 00-16/20) and the two oil pressure switches (3) and (4) on the transmission (Fig. 00-16/18).

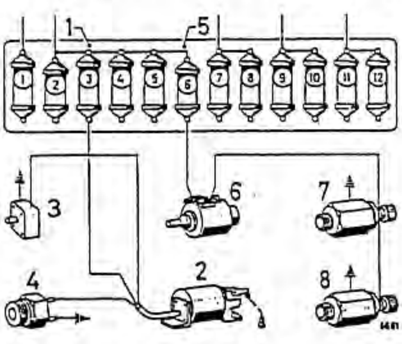


Fig. 00-16/17

Circuit diagram for lifting magnet and oil pressure switch on Model 220 SEb

1 Fuse 3
2 Double lifting magnet
3 Lifting switch (idle switch)
4 Kickdown switch
5 Fuse 6
6 Lifting magnet
7 Oil pressure switch, forward
8 Oil pressure switch, reverse

If the lifting magnet and the two oil pressure switches are in good working order shift the selector lever again to position "4" with the hand brake applied and by adjusting the two nuts (2) (Figs. 00-16/19 and 20) lengthen the push rod of the lifting magnet as much as is required to obtain an idle speed corresponding to that in lever position "0";

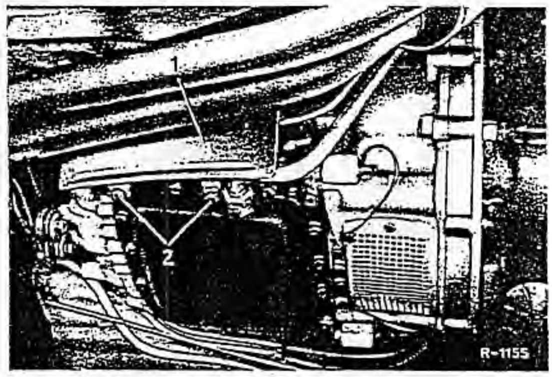


Fig. 00-16/18

1 Baffle plate
2 Fixing screws
3 Oil pressure switch, forward
4 Oil pressure switch, reverse

it may be lower by a maximum of 30 rpm.
Shift the selector lever to position "0". In this position of the selector lever check the idle speed. It must be the same as the idle speed adjusted in accordance with paras 2–4.

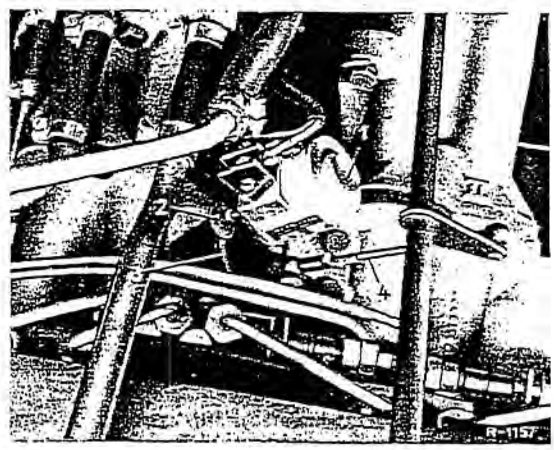


Fig. 00-16/19

1 Lifting magnet
2 Shoulder nut
3 Relay lever
4 Control rod

b) On Model 300 SE with automatic transmission and **power steering** check the idle speed. Apply the hand brake, shift the selector lever of the transmission to position "4" and turn the steering either left or right to full lock. During this operation the idle speed must not fall below 600 rpm. If it is lower loosen the hexagon screw (6) and push it slightly downward in the lever slot (7) and retighten (Fig. 00-16/20). When the screw is moved downward the idle speed of the engine increases, and it falls when the screw is moved upward. If a minimum idle speed of 600 rpm is not obtained the basic setting should be carried out as follows: Check the operations again as described in Section a. Shift the selector lever to position "0" and adjust the steering to center position. Then check the dimension "a" (see Fig. 00-16/20) from the separating surface of the bracket to center yoke end and if necessary correct. The dimension "a" should be 35 mm. Loosen the hexagon screw (6) and push it into the center of the slot in the lever (7) and retighten.

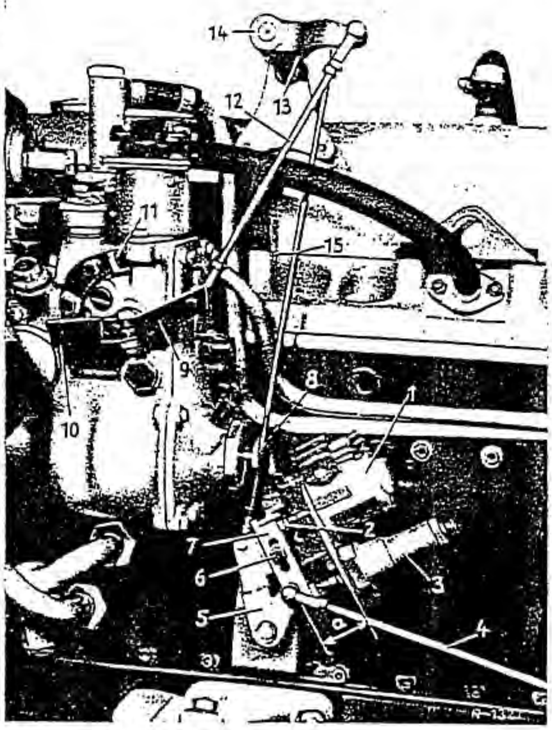


Fig. 00-16/20

Model 300 SE with ZEB injection pump

1 Lifting magnet
2 Hexagon nut
3 Pressure cylinder
4 Control rod
5 Relay lever
6 Hexagon screw
7 Lever
8 Spring-loaded idle control knob
9 Adjustment lever
10 Idle stop
11 Full load stop
12 Control rod
13 Control lever
14 Control lever
15 Control rod
a Distance between separating surface to center yoke end

Detach the control rod (15) at the top, push the relay lever (5) toward the rear until it rests against its stop. If necessary correct the length of the control rod (15), so that it can easily be pressed in without moving the relay lever (5), the lever (13) or the control shaft (Fig. 00-16/20). Then check and if necessary correct again as described in Sections a and b.

6. When the adjustment is completed, the following points, which are of the utmost importance for the idle adjustment, should be checked during a road test:

   a) Accelerate the car to approx. 60–80 km/h, then brake. (Cars with automatic transmission should be accelerated in selector lever position "4"). If after braking and declutching the engine should stall, the fuel-air-mixture is still slightly too rich and the idle speed must be adjusted to the maximum prescribed idle speed. If the engine had been adjusted to this idle speed already the idle adjustment screw on the injection pump can be moved one notch to the left (lean mixture) by means of the idle control knob.

   b) Slightly accelerate the car in 1st gear on a level road, release the accelerator pedal and let the car. coast at idling speed. Repeat the procedure in 2nd gear. If the car runs jerkily under these extreme conditions, this may be due to too rich or too lean a mixture. Adjust the mixture accordingly.

Note: The road test as described under b only applies to cars with a mechanical transmission.

   c) Idle adjustment and road test should be repeated until the idle is satisfactory.

C. Readjustment of Speed Build-up

a) Engine Spit-back During Acceleration of Cold Engine

If the injection pump is correctly adjusted, there will be not spit-back when the cold engine is accelerated. A certain amount of spit-back, which is of no importance however, may accur when the throttle valve is quickly opened at low engine speeds.

On Model 220 SE with R 2 injection pump, spit-back may be caused by a mixture which is too lean for the cold engine. In this case the remedy is as follows: add **one** ground steel washer 0.4 mm thick (Part No. 127 074 00 52) between the cooling water thermostat (39) and the injection pump housing (Fig. 00-16/22). During the warming-up period the engine then receives more fuel and more air and the enrichment cut-off temperature is increased from appr. 60° to appr. 68° C.

On injection pumps ZEA R 2, R 3, R 4, R 6, R 7, and on injection pumps ZEB R 11, R 12, and R 13 the warming-up device is factory-adjusted to a cut-off temperature off appr. 68° C. The washer 127 074 00 52 must therefore not be used for these pumps.

b) Unsatisfactory Speed Build-up with Engine warm

If despite correct idle adjustment, speed build-up is not satisfactory when the engine is warm, the mixture can be enriched in the lower partial load range as follows:

On injection pumps ZEA R 2, R 3, R 4, R 6, R 7 and on injection pumps ZEB R 11, R 12 and R 13 by turning the two **black** partial load adjustment screws (11 a) **to the right** one, two or a maximum of three notches (Fig. 00-16/21). Adjustment of the partial load adjustment screws (11 a) also changes the idle mixture in the high idle speed range. When the adjustment has been made, it is ther efore necessary to check the idle and if necessary to turn the idle adjustment screw (11 a) back.

Note: Since on almost all pumps the first partial-load spring comes into action immediately idling speed is exceeded, it may be impossible under certain circumstances to reduce the idle any further by releasing the pressure of the idle spring or by turning back the idle adjustment screw (10 a).
In that case the only remedy is a compromise between idle and partial-load adjustment.

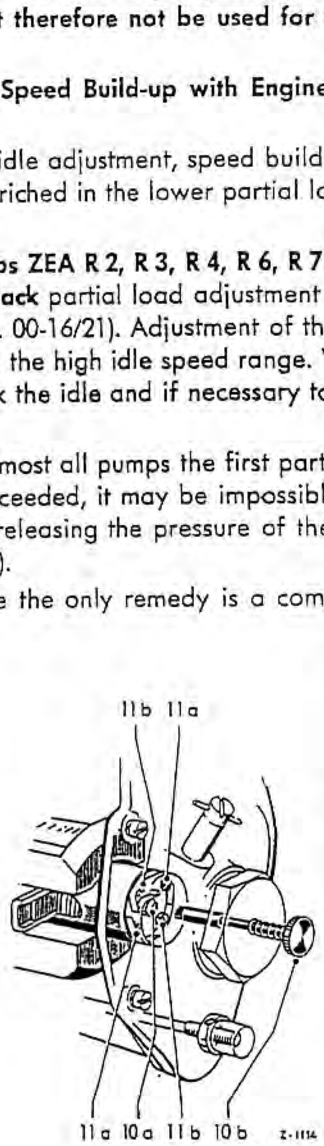


Fig. 00-16/21

Adjustment screws of ZEA injection pump

10a Adjustment screw (black) for idle up to approx. 1000 rpm
10b Spring-loaded idle control knob
11a Adjustment screw (black) for partial load or medium engine speed range from approx. 700 to approx. 4000 rpm
11b Adjustment screw (white) for partial load or upper engine speed range from approx. 2000 rpm

If in the case of a Model 220 SE car whose engine is correctly adjusted and has given no trouble, difficulties occur at high outside temperatures (uneven idle, engine stalling, spit-back during speed build-up), the cause may be too lean a mixture induced by the inlet air thermostat.
In such cases, where the idle and the speed build-up are satisfactory at low outside temperatures and where one of the above-mentioned difficulties occurs at high outside temperatures, the trouble can be overcome by replacing the standard guide bolt by a spring-loaded guide bolt (41 a) (Fig. 00-16/22). By installing a spring-loaded guide bolt, the adjustment range of the inlet air thermostat is limited to 30–35° C (see also Job No. 07-10, Section C, under "inlet air thermostat").

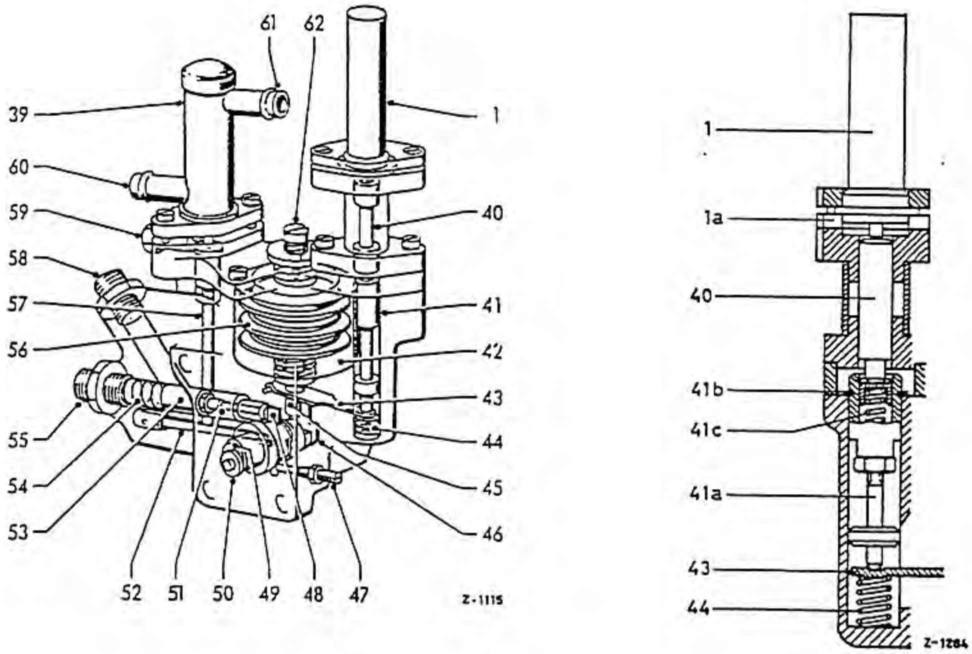


Fig. 00-16/22

Correcting device of ZEA injection pump

1 Inlet air thermostat
1a Insulating flange (as of R 3 Pump)
37 Cooling water thermostat
40 Pin
41 Guide bolt
41a Spring-loaded guide bolt
41b Snap ring
41c Spring
42 Compensator basket
43 Lever
44 Spring
45 Bolt
46 Guide plate
47 Stop screw
48 Drive lug
49 Eccentric bushing
50 Eccentric shaft
51 Guide pin
52 Lever
53 Control slide valve
54 Spring
55 Supplementary-air inlet from air filter
56 Aneroid compensators
57 Guide bolt
58 Supplementary-air outlet to intake manifold
59 Stop bolt for cooling water thermostat
60 Cooling water inlet
61 Cooling water outlet
62 Stop screw for inlet air thermostat

When installing the spring-loaded guide bolt proceed in the case of the ZEA pump as follows:

1. Remove the inlet air thermostat (1) together with the intermediate flange and the pin (40) (Fig. 00-16/22).

2. Take out the guide bolt (41) and measure the distance "a" (Fig. 00-16/22 and 23). Then adjust the spring-loaded guide bolt (41 a) to a length exactly corresponding to this distance, making the measurement between the two contact surfaces. To do this, loosen the lock nut and turn the head part until the distance "a" is obtained. Tighten the lock nut and check the distance "a" again.

3. **Check to make sure that the stop screw (62) is in its normal position (anti-clockwise against the stop) (Fig. 00-16/22).**

4. Install the spring-loaded guide bolt (41 a), which has been adjusted to the correct length, into the housing and attach the intermediate flange by means of the pin (40). Then push down the guide bolt untill the snap ring (41 b) of the spring-loaded guide bolt rests against the housing without exerting pressure on the piston of the guide bolt.
   Then measure the distance "b" (On the first 90 models of the R 3 pumps, include the thickness of the insulating flange in the measurement). Deduct 6.5 mm from distance measured. The difference then corresponds to the thickness of the shims (41 d) to be installed below the snap ring (41 b) of the spring-loaded guide bolt (Fig. 00-16/23).
   The shims (41 d) may be installed with a tolerance of –0.25 mm.
   Suitable shims are available in three different thicknesses:

   0.8 mm thick, Part No. 127 074 03 52
   0.3 mm thick, Part No. 127 074 02 52
   0.1 mm thick, Part No. 127 074 01 52
   The spring-loaded guide bolts has the Part No. 000 141 00 69.

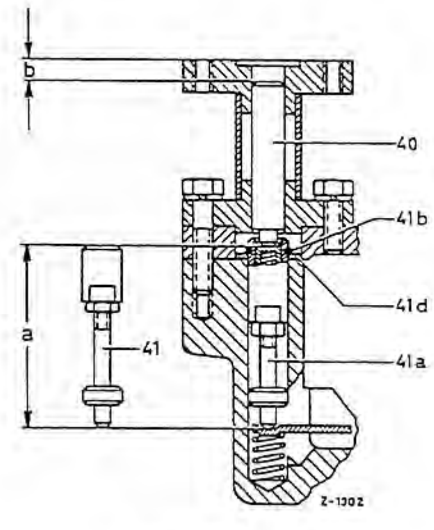


Fig. 00-16/23

Position shown at 30° C air temperature. There is no play between housing or shims and the snap ring. Distance "b" = 6.5 + 0.25 mm.

40 Pin
41 Guide bolt
41a Spring-loaded guide bolt
41b Snap ring
41d Shim

5. After adding the shims, again measure the distance "b" with the bolt pushed down to the stop. Taking into account the permissible tolerance of 0.25 mm, the distance "b" should be 6.5–6.75 mm.
   Since at an air temperature of 30° C the working pin of all thermostats projects 6.5 mm, the lean-mixture limitation produced by the inlet-air thermostat is fixed at 30 to 35° C on all injection pumps fitted with a spring-loaded guide bolt.
   When the inlet-air thermostat is thus limited in its action, it can influence the composition of the mixture only up to that temperature. At temperatures above 30–35° C, the movement of the working pin in the thermostat is taken up by the piston of the spring-loaded guide bolt.

On the R 3, R 4, R 6 and R 7 Injection Pumps a spring cup is installed as a standard part (see Job No. 07-10). It is only on approximately the first 90 R 3 Injection Pumps that this spring cup is missing. These R 3 Injection Pumps, which are marked with a red dot on the stop screw (62), have a rigid guide bolt which is adjusted 4 mm short. Furthermore the stop screw (62) on these pumps is screwed in as far as the stop and the lever (43) is thus fixed in the 20° C position. R 3 Injection Pumps marked with a blue dot on the stop screw have the spring cup installed.

Note: Apart from the blue dot on the stop screw, injection pumps with a spring cup differ from other pumps by the adjustment screw (44b) (see Fig. 07-10/17).

All R 1 and R 2 Injection Pumps as well as all R 3 Injection Pumps without spring cup should be subsequently fitted with a spring-loaded guide bolt when an opportunity presents itself. **The letter "b" (limited travel) should be stamped on the cover of the corrector assembly of all injection pumps subsequently** fitted with a spring-loaded guide bolt.

When measuring the rigid guide bolt (41) on the R 3 Injection Pump, add 4 mm to the dimension "a" since on the first 90 R 3 Pumps, as was mentioned above, the rigid guide bolt was adjusted 4 mm short.

D. Checking Supplementary Air Control Slide Valve

As described in Job. No. 07-10, Section C, the supplementary air and larger amount of fuel required during the warming-up period is steadily decreased until at a cooling-water temperature of about 65–68° C, enrichment ceases altogether.

If the control slide valve closes the supplementary air canal prematurely, with the fuel enrichment adjusted correctly, the mixture will be too rich. As a consequence the engine will fail to build up speed, especially in the 60° cooling-water temperature range, and may even stall. This can easily be corrected by properly adjusting the control slide valve. Proceed as follows:

1. First determine the colling-water temperature at which the supplementary air pipe is closed. To do this it is necessary to screw off the small air filter on the injection pump. While the engine is warming up, put your thumb on the supplementary air pipe to the injection pump at regular intervals in order to determine the cooling-water temperature at which the air intake is stopped. Since the slide valve travels 1.1 mm in the case of the ZEA pump and 0.4 mm in the case of the ZEB pump when the change in temperature is 10° C, the difference between the cooling-water temperature as determined and 68° C is an indication of the length by which the slide valve must be shortened or lengthened.

Example:

Actual cooling-water temperature = 54° C
Correct cooling-water temperature = 68° C

Difference = 14° C

1° temperature change = 0.11 mm slide valve travel on ZEA pump
= 0.04 mm slide valve travel on ZEB pump
14° temperature change = 14 × 0.11 = 1.54 mm slide valve travel on ZEA pump
= 14 × 0.04 = 0.56 mm slide valve travel on ZEB pump

Consequently the slide valve must be shortened by 1.54 mm in the case of the ZEA pump and 0.56 mm in the case of the ZEB pump.

a) ZEA Injection Pump

2. To remove the slide valve on the ZEA pump unscrew the threaded union (55) and take out the spring (54) (Fig. 00-16/22). Turn in a coil spring with an outside diameter of 12 mm, in the opposite direction to the twist, then lock it by turning it in the direction of twist and pull out together with the slide valve. Do not use sharp-edged objects, such as screws, which would damage the bore.

   Measure the overall length of the slide valve. Then loosen the lock nut and screw the slide valve in until the overall length has been reduced by the previously determined amount, in our example by 1.54 mm. After tightening the nut, check the overall length again.

b) ZEB Injection Pump

In the case of ZEB injection pumps unscrew the cooling water thermostat from the control slide valve housing and measure the distance (a) from the separating surface of the control slide valve housing to the adjustment screw (2) (Fig. 00-16/24). Then pull the notched pin (3) out of the control slide valve housing and the eccentric stop bolt (4) as far as the oil filler screw. Then pull the control slide valve (5) together with the adjustment screw out of the control slide valve housing and, depending on the temperature difference between the cooling water temperature measured and the prescribed value of 68° C, turn the adjustment screw in or out. Turn the screw in if the temperature is below 68° C, turn it out if it is higher.

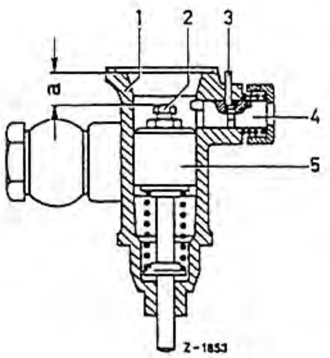


Fig. 00-16/24

Control slide valve housing with control slide valve on ZEB injection pump

1 Control slide valve housing
2 Adjustment screw
3 Notched pin
4 Eccentric stop bolt
5 Control slide valve
a Distance from separating surface control slide valve housing to adjustment screw

3. Before reinstalling the control slide valve check it for ease of movement and if necessary hone it slightly.

4. Reinstall all parts and check whether the slide valve closes at the prescribed cooling water temperature. If necessary correct the adjustment.

During installation mount the eccentric stop bolt (4) so that the eccentric bolt is at the top. Install the cooling water thermostat with sealing compound.

Trouble Shooting Hints for the Injection System

Job No.
00-18

Before beginning to search for faults in the injection system always check the ignition system. This involves the following:

1. Check the closure angle of the distributor and if necessary adjust the distributor contact gaps (see Job No. 00-0).
2. Check and if necessary adjust the ignition setting with a stroboscope at the specified engine speed and with the engine idling under no load and without automatic vacuum control (see Job No. 00-0).
3. Check the spark plugs (thermal value, electrode gaps, and appearance). Any considerable difference in the spark plug appearance suggests injection valve or distributor fitting trouble.
4. Check the overall resistance of the various ignition circuits; this must not be more than 13 000 ohms.
5. Check and if necessary adjust the correlation between the adjustment lever of the injection pump and the throttle valve on the venturi control unit (see Job No. 00-16). When making this check actuate the linkage from the control shaft in order to eliminate any possible play.

This list makes no claim to completeness. It goes without saying that the battery should be in properly charged condition and that the engine should be using one of the oils specified by us.

Cause	Remedy
Engine does not start	
Fuel feed pump not running	Check electric circuit, if necessary replace feed pump (before installing a new fuel feed pump prime the suction side of the feed pump with approx. 10 cc of fuel).
Fuel feed pump running but inoperative	Prime the suction side of the feed pump, if necessary replace feed pump.
Fuel filter fouled	Replace fuel filter element.
Engine difficult to start when cold	
Incorrect operation	When starting the cold engine do not depress the accelerator. As soon as the engine fires, accelerate slowly but release the ignition key only when the engine is firing regularly. If the engine has not started after approx. 10 seconds, give the battery a rest and turn the ignition key back to position "1" in order to overcome the starter locking switch. After a short interval start again, depressing the accelerator at the same time.

Cause	Remedy
Incorrect operation	Once the engine has started quickly depress the accelerator once, then release it in order to prevent excessive engine speeds. Do not put the engine on load before the oil pressure gauge begins to operate.
Supplementary air filter on injection pump fouled	Replace supplementary air filter.
Auxiliary start mechanism failing (for functional details see Job No. 07-10).	Check circuit to start magnet and if necessary replace either start magnet, thermo-switch, or thermo-time switch (depending on start mechanism version, for which see Job Nos. 00-15 and 07-10). Check circuit and fuel supply to starting valve and if necessary replace either starting valve or thermo-time switch or thermo-switch (depending on start mechanism version, for which see Job No. 07-10). Check the electrical system of the start mechanism and if necessary replace relay (see wiring diagram in Job No. 07-10). Check starting valve for dirt and if necessary clean (Job No. 00-15).
Engine difficult to start at temperatures below 15° C and on short runs	
Spark plugs fouled or wet	Install platinum spark plugs and if necessary modify cold start mechanism.
Engine difficult to start when hot	
Incorrect operation	When starting a warm or hot engine the accelerator pedal should be depressed rightaway.
Start magnet or starting valve inoperative	Check circuit and if necessary replace start magnet or solenoid switch on starting valve or (circular) time-switch relay.
Control rod jamming in start position (easily observable after removing the cover cap of the control rod pilot bush on the drive side of the injection pump).	Check whether time-switch relay breaks contact after 1 second, if necessary replace. When the relay breaks contact check whether the start magnet returns to initial position, if necessary replace start magnet (see Job No. 00-15).
Sealing rings between pressure valve holders of the injection pump and pipe unions leaky (only on high-mileage engines, in particular with ZEA pumps).	Check the sealing rings for leaks and if necessary replace.
Engine does not continue to build up speed in idle when cold	
Control slide valve for supplementary air in aneroid compensator jamming	Free up control slide valve (see Job No. 00-16).
Supplementary air filter on injection pump fouled	Replace air filter.
Magnet valve of auxiliary start mechanism fails to close	Check start valve for leaks and if necessary replace (see Job No. 00-15).
Control rod jamming	Remove cover cap, check control rod for ease of movement, if necessary replace injection pump (see Job No. 07-12).

Cause	Remedy
Uneven idle running with engine warm	
Idle air throttle in venturi control unit not properly adjusted	Adjust idle air throttle in such a way that the engine runs evenly (see Job No. 00-16).
Engine takes in excess air	Check intake pipe, power brake and power brake lines for leaks.
Cooling water thermostat or cooling water feed lines on injection pump blocked or do warm up	Clean thermostat housing and cooling water feed lines.
Cooling water thermostat on injection pump defective	Put thermostat out of action by turning the stop bolt half a turn toward the right (see Job No. 07-10), if necessary replace thermostat.
Magnet valve of auxiliary start mechanism fails to close	Check starting valve for leaks and if necessary replace (see Job No. 00-15).
Injection valves or distributor fittings faulty	Flush out injection valves and check distributor fittings (see Job No. 00-15). Before installing new injection valves degrease them by flushing them out.
Lubricating oil level in injection pump too high. Excessive oil level prejudices governor function	Check oil level in injection pump, and measure the oil pressure in the engine (should not exceed 7.0 atm at 5,000 rpm and 80° C oil temperature). If necessary shorten the spring of the engine oil relief valve to 40 mm.
Engine stops	
Filter on fuel tank screw plug fouled	Remove filter or screw plug and clean (see Job No. 47-3).
Fine fuel filter fouled	Replace filter element.
Injection valves or distributor fittings faulty	Flush out injection valves and check distributor fittings (see Job No. 00-15). Before installing new injection valves degrease them by flushing them out.
Uneven speed build-up with engine warm (jerky running and spit back)	
Incorrect adjustment of injection pump	Readjust build-up (see Job No. 00-16), if necessary remove injection pump and check or adjust on injection pump test bench.
Noises in fuel lines	
Damper unit defective	Repair or replace damper unit (see Job No. 00-15).
Outward fuel leakage on starting valve	
Seal leaking	Replace seal (see Job No. 00-15).

Tuning of Diesel Engine

Job No.
00-19

Modification: Revised, in particular Section C „Adjustment of Maximum Speed under No-Load Condition"

The passenger-car diesel engines are equipped with an injection pump which is controlled by a pneumatic governor. The pneumatic governor can only function properly if the engine is in good condition from the mechanical point of view. For this reason **the following procedures should be carried out before the engine or the injection pump is adjusted:**

1. **Check compression** (Job No. 00-5), and if necessary also

   a) check and adjust tappet clearance (Job No. 00-3)

   b) measure cylinder leakage (Job No. 00-5).

2. **Check start of delivery** (Job No. 00-8) and if necessary adjust start of delivery

   a) by turning the injection pump

   b) by moving it toward or away from the engine.

3. **Check air cleaner** and if necessary clean it.

4. **Check pneumatic governor of injection pump** and if necessary replace diaphragm (Job No. 07-26).

5. **Check oil level in injection pump** and if necessary correct. If oil or an oil-fuel mixture should emerge from the oil level check bore, back off the 4 fixing screws of the vacuum control housing, slightly lift the housing and let the fuel drain from the vacuum chamber (Fig. 00-19/4).

   In order to ensure that the fuel-oil level in the injection pump does not rise again above the oil level check bore turn the overflow pipe at the rear of the pump downward. To do this back off the hollow screw about 2 mm, use a screwdriver to bend the pipe away from the engine, and turn downward (when the pump has been removed from the engine, saw off pipe bend). Tighten hollow screw, oil level check screw and the 4 fixing screws of the vacuum control housing.

Note: It goes without saying that all these tests and the preliminary jobs are not required in every single case.

The various checking and adjustment procedures have been carefully arranged in such a way that they can be carried out individually, in groups, or as a full-scale job.

A. Idling Speed Adjustment

1. Turn idling control knob on instrument panel to extreme right so that idle adjustment cable (4) is sufficiently slack at angle relay lever (3) in this position; if necessary disengage setting ring and refasten (Fig. 00-19/1).

2. Connect revolution counter. Remove screw plug (oil pump drive) for this purpose and replace by adapter (1) (Fig. 00-19/2).

Note: If required, revolution counter and adapter (1) can be obtained from Messrs Gann, Apparate- und Maschinenbau GMBH, 7 Stuttgart, Moehringer Straße 159.

3. Warm up the engine.

Note: Idling speed can only be adjusted with the engine at operating temperature (minimum cooling water temperature 80° C).

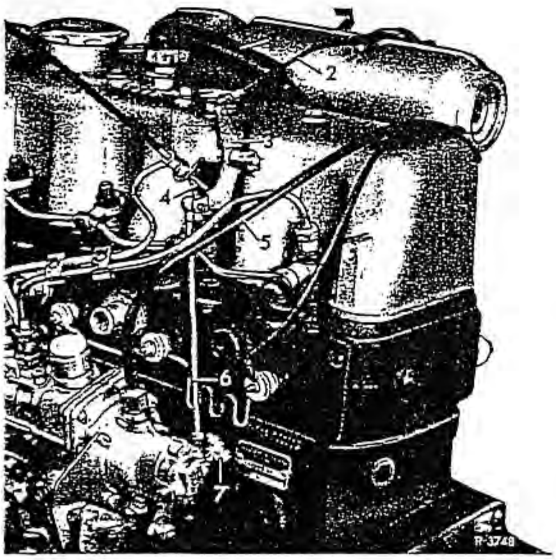


Fig. 00-19/1

1 Vent line of crankcase ventilation system
2 Connecting rod (appr. length 310 mm) to control valve lever
3 Angle relay lever
4 Idle adjustment cable
5 Vacuum line between injection pump governor and Venturi control unit
6 Connecting rod (appr. length 205 mm) to additional mechanical control lever (butt bolt)
7 Lever of additional mechanical control (butt bolt)

4. Adjust idling speed by screwing idle stop screw (4) at Venturi control unit in or out (Fig. 00-19/3). For idling speed see Job No. 00-0.

If the speed drop is insufficient, check vacuum line (5) for leakage (Fig. 00-19/1).

An idling speed adjustment is impossible with a leak in the vacuum system because the vacuum effect is inadequate to shift the control rod sufficiently far in the STOP direction.

Note: If an adapter with revolution counter or a hand revolution counter is not available to determine the engine speed, in order to obtain a smooth and even idling speed from a diesel engine, it is advisable to increase the idling speed rather than to keep it too low. The idling speed thus adjusted will also relieve the soft suspension systems of the engine and exhaust.

5. **Adjustment of idle control cable.** To make the adjustment, turn idling control knob on instrument panel to extreme right. Fasten adjusting ring on cable to provide a clearance of 0.1 to 0.2 mm between adjusting ring and angle relay lever so that the idle stop screw comes to rest positively against the stop provided at the Venturi control unit. With the adjustment thus obtained, check whether idle control cable (4) moves freely in the slot in the stop bracket of the angle relay lever (3) (Fig. 00-19/1) when the engine is accelerated.

6. Adjust linkage of additional mechanical control (see Section B below).

B. Adjustment of Additional Mechanical Control (Butt Bolt Control System)

1. Adjust idling speed (see Section A).

2. Detach connecting rod (2) between Venturi control unit and angle relay lever (3) and adjust it to a length of 310—311 mm, measured from center ball socket to center ball socket. Attach connecting rod (2).

3. Adjust connecting rod (6) between angle relay lever (3) and injection pump. To do this detach connecting rod (6) from angle relay lever (3), push it downward as far as the stop and adjust the connecting rod in such a way that it must be raised 4 mm before the ball socket can be attached.

Note: Through the medium of the additional mechanical control, the butt bolt (17) serves to limit control rod vibrations generated in the lower speed and load ranges and at idling speed. The butt bolt is controlled by a switch cam (15 or 15a — Fig. 00-19/4) actuated via the control rod (2 and 6 — Fig. 00-19/1) and is constantly shifted into a position correlative to that of the throttle valve.

If the connecting rod (6) or the lever (7) is raised more than 4 mm there may be "snoring" of the engine at idling speed and under partial load (Fig. 00-19/1). If the lift is less than 4 mm, adjustment at maximum speed under no-load and full-load conditions may be affected.

When measuring idle load end of governing (maximum speed under no load) the diaphragm (10) must be able to move freely and must not come to rest against the butt bolt (17) (Fig. 00-19/4).

C. Adjustment of Maximum Speed under No-Load Condition

1. Connect revolution counter. Remove screw plug (oil pump drive) for this purpose and replace by adapter (1) (Fig. 00-19/2).

Note: If required revolution counter and adapter (1) can be obtained from Messrs Gann, Apparate- und Maschinenbau GmbH, Stuttgart, Möhringer Straße 159.

2. Warm up engine, fully depress accelerator pedal and measure maximum speed under no load by means of revolution counter.

Fig. 00-19/3

Venturi control unit with control and check valves

1 Full-load stop screw
2 Front control valve
3 Connecting rod from front control valve lever to angle lever for injection pump butt bolt operation
4 Idle stop screw
5 Vacuum line to injection pump
6 Check valve lever with stop for automatic opening and rubber damping (in this position the check valve is open)
7 Follower on rear control valve lever for automatic opening of check valve
8 Rear control valve lever
9 Connecting rod (approx. 250 mm long) to reversing lever, push rod, control shaft, pedal lever, foot-plate
10 Power brake line to vacuum pump

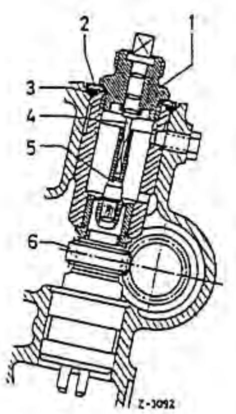


Fig. 00-19/2

Revolution counter and oil pump drive assembly

1 Revolution counter drive or adapter
2 Cover plate
3 Rubber ring
4 Follower or connecting piece between adapter and helical gear
5 Cylindrical screw with hexagon socket
6 Helical gear (driving oil pump and revolution counter)

3. **If the maximum speed under no-load condition** as specified in Technical Data **is not obtained,** open the control valve by backing off the full-load stop screw until the prescribed speed is reached (Fig. 00-19/3).

4. If the control valve is already fully open, increase the initial tension of the injection pump control spring by adding a supporting ring (Fig. 00-43/4, Item 14). Now measure maximum speed under no-load condition; make further adjustments, i. e. use supporting rings of different thicknesses and repeat speed checks until the maximum speed under no-load condition corresponds with the speed specified in the Technical Data.

The addition of a supporting ring of 1 mm thickness yields an average of 120 to 150 rpm depending, of course, on the performance characteristics of individual control springs. Supporting rings are available in the following thicknesses:

0.5 mm thickness — Part No. 000 077 03 52
1.0 mm thickness — Part No. 000 077 04 52
2.0 mm thickness — Part No. 000 077 05 52

Note: Any arbitrary increase in the initial tension of the control spring is not permissible. **Maximum speeds higher than specified** (see Job No. 00-0) **are not permissible** for mechanical reasons and because of the possible danger of dragging oil and dirt from the air cleaner.

It is imperative that the maximum speed under no-load should be measured and if necessary adjusted whenever the initial tension has been changed.

d) Unsatisfactory performance.

In any case correct maximum speed under no-load condition by screwing in the full-load stop screw (1) (Fig. 00-19/5).

Caution: When adjusting the full-load stop screw make sure that it projects no more than 2 mm from the control valve lever. If it projects any further, air throttling brings about a loss in performance (Fig. 00-19/5).

If the maximum speed under no-load condition should still be excessive remove as many of the

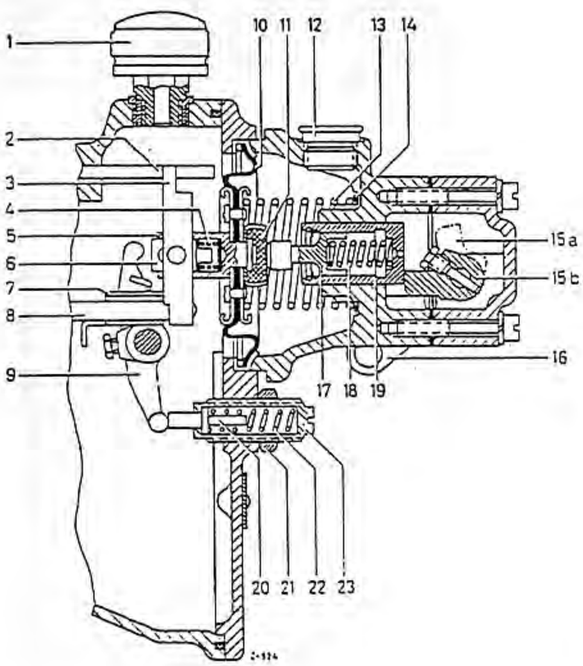


Fig. 00-19/4

Idling position

1 Air cleaner
2 Guide rod
3 Guide lever
4 Compensator spring
5 Diaphragm sleeve
6 Compensator pin
7 Start-metering stop
8 Control rod
9 Double-link rocker
10 Diaphragm
11 Rubber buffer
12 Vacuum union at vacuum chamber
13 Control spring
14 Supporting ring
15a Switch cam, full-load position
15b Switch cam, idling position
16 Lever for automatic auxiliary governor system
17 Stop stud (butt bolt)
18 Auxiliary spring
19 Butt bolt housing or spring housing, sliding
20 Stop stud for full-load stop
21 Setting nut
22 Spring
23 Full-load stop screw

5. **If the maximum speed under no-load conditions exceeds** the speed specified in the Technical Data (see Job No. 00-0), this may be due to the fact that firstly the control valve is open too far and that secondly the control spring is under too much initial tension because of supporting rings. Undesirable consequences:

a) Shorter service life of engine.

b) Excessive smoke effect at high engine speeds: vacuum is too low to move the control rod in the direction "stop".

c) Excessive fuel consumption.

supporting rings (14) behind the control spring as is necessary to reduce speed to the specified value (see Job No. 00-0).

Removal of a 1 mm supporting ring decreases engine speed by an average of 120—150 rpm.

There is a good reason for removing supporting rings: excessive initial tension of the control spring increases the vacuum required to bring about engine governing speed which means that the control valve would have to be closed beyond the permissible limit with the result that

a) Performance at high speed would be unsatisfactory

b) The excessive vacuum would unduly advance the end of the governing process under normal operating conditions.

It is imperative that the maximum speed under no-load should be measured and if necessary adjusted whenever the initial tension has been changed.

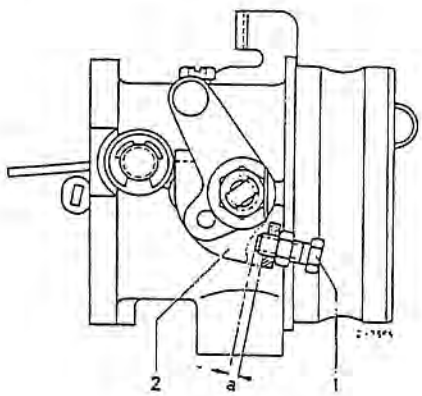


Fig. 00-19/5

1 Full-laod stop screw
2 Control valve lever
a = max. 2 mm

Note: The top speed range of an engine is divided into two different speed characteristics, viz. the maximum speed at full-load and the maximum speed at no-load. On no account should this **maximum speed be exceeded over a prolonged period of time** since this would endanger not only the engine but also subassemblies driven by it.

If, for example, the throttle is opened up full while the vehicle is stationary or traveling downhill, the engine speed will exceed its full-load maximum. The vacuum is now increased to such an extent that the diaphragm or the double-link rocker (9) is lifted off the full-load stop and the diaphragm or control rod is shifted further in the STOP direction toward the butt bolt (Fig. 00-19/4).

Although the governor becomes effective when the full-load stop is cleared (the injection amount is reduced), engine speed will still continue to increase because of the limited load. Engine speed will increase until the diaphragm has been drawn back to the point where the plungers move across the partial load and idling position into the zero delivery zone.

The diaphragm or the control rod respectively moves in exactly the same way as would be the case when the engine is switched off, across the injection pump (Fig. 00-19/4). A further increase of the engine speed with the governor at this position is therefore no longer possible (end of governing process).

Note: This description shows clearly **that the position of the butt bolt** or the lever oft the additional mechanical control respectively **is of decisive importance for the maximum speed under no-load.**

D. Check-up on Maximum Speed under Full-Load Condition (Start of Governing Process)

When dealing with a complaint about the final speed of the vehicle, in addition to the adjustment of the maximum speed under no-load condition for reasons of operational safety, also check the maximum speed under full-load condition (start of governing process) or the permissible top speed in operation (2nd and 3rd gear) against the speedometer reading.

Permissible top speeds in km/h according to speedometer readings

190 Dc 200 D	in 2nd gear	58
	in 3rd gear	91

If these permissible top speeds are not attained, check the speedometer reading if necessary.

If results are inadequate or the complaint about the performance of the vehicle is maintained, carry out tests and adjustments on the engine, the injection pump system and the fuel system (see Sections A, B, C, E and Job. No. 00-14).

Note: The maximum speed under full-load condition, also referred to as rated speed, is the speed the engine is expected to produce at maximum performance. At this speed, the control valve is fully open against the full-load stop. Initially, at low speed, the vacuum chamber has a low vacuum.

The necessary vacuum required for controlling action and the force required to pull the control rod back in the STOP direction will not be completely generated until the control valve is fully open and maximum speed under full-load condition is reached. As soon as the engine has reached maximum speed under full-load, the control rod commences to move back in the STOP direction and, hence, the limitation of the maximum speed under load is initiated (start of governing process).

E. Exhaust Gas Test for Carbon Monoxide Adjustment of Injection Pump with a CO Exhaust Gas Tester

a) With Performance Test Stand

Until now, adjustments of diesel injection pumps have had to be carried out on injection pump test benches and it was necessary for this purpose to remove an injection pump only to install it again afterwards.

In order to provide a system under which the adjustment of injection pumps can be corrected to specification **without involving the removal of the injection pumps,** a test method was devised for use on the many performance test stands operated by the agencies; the method can be described briefly as follows:

1. Connect up exhaust gas tester according to instructions.
2. Run engine on the performance test stand in 2nd gear under full load at a speed of n = 4000 rpm. (Use a revolution counter to measure the speed). As soon as stationary conditions have been obtained take the measurement and read off exhaust gas value. The exhaust gas value/carbon monoxide percentage should be 0.20 ± 0.05 % CO.

Caution: After every measurement under full load run the engine at idling speed for about 1 minute before switching off.

When several measurements are taken, the oil temperature tends to become excessive despite the use of the blower (max. temperature 110° C) with the result that cracks may appear in the cylinder head if the engine is switched off immediately.

3. If the prescribed exhaust gas value of 0.20 ± 0.05 % CO is exceeded or is not obtained, enter the read-off carbon monoxide value in the graph (Fig. 00-19/6) and adjust the full-load stop screw for the control rod stop on the injection pump in accordance with the turns obtained from the graph.

Example: The test reveals a CO content of approximately 0.4 per cent: enter this result in the graph then draw a vertical line from the point of intersection of the exhaust gas curve and establish from the bottom of the graph by how much the full-load stop screw should be screwed out or in. The above example requires that the full-load stop screw must be screwed in by a fair half turn. Repeat the test procedure according to 2 and make the required corrections according to 3 until the carbon monoxide content is down to 0.20 ± 0.05 per cent. A further means of verification is represented by the perform nce curve which expresses the performance trend in percentage.

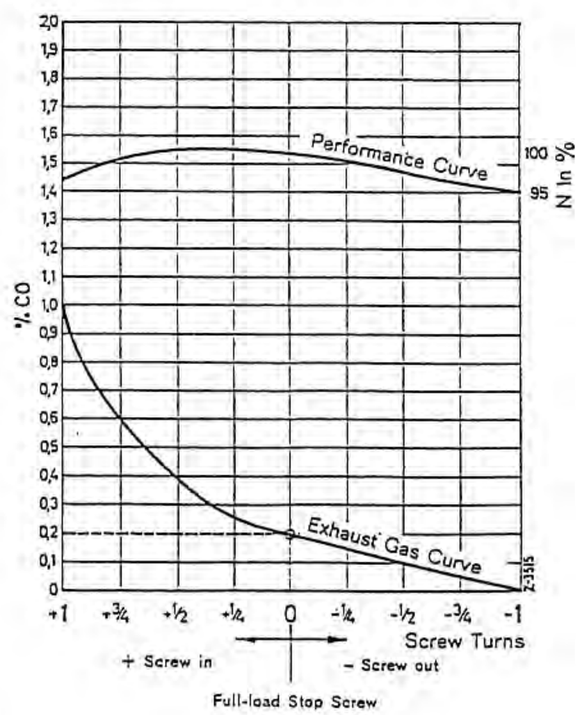


Fig. 00-19/6

4. Run engine on the performance test stand in 2nd gear under full load at a speed of n = 4800 rpm. As soon as stationary conditions have been obtained take the measurement and read off exhaust gas value and performance.

   The exhaust gas value/carbon monoxide percentage should not exceed 1.0 %. CO and the performance should not be below 33 HP.

Note: If the exhaust gas value should still be above 1 % CO, carefully adjust the closure angle of the control valve by screwing in the full-load stop screw (1) (Fig. 00-19/3). This will increase the vacuum and will pull the governor diaphragm in the "stop" direction.

5. If engine performance does not fall below 33 HP and if the carbon monoxide content is within the range described in paras 2 and 4, the engine has been satisfactorily tuned on the performance test stand.

b) Adjustment by Road Test

1. Use a shop-made holder (Fig. 00-19/7) to accommodate the following measuring instruments in front of the instrument panel:

   an exhaust gas tester

   a mechanical revolution counter.

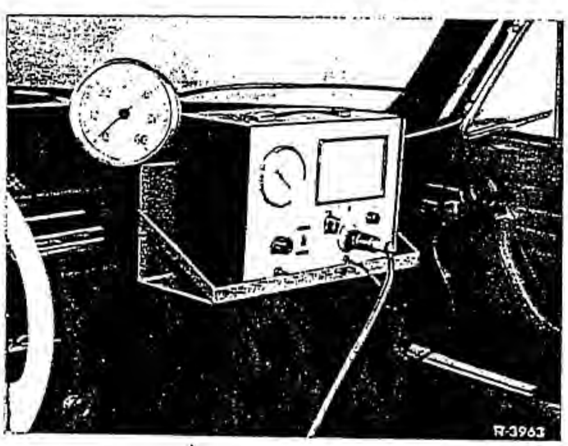


Fig. 00-19/7

Note: If a Bosch CO Tester is used, install the metering pump in the trunk compartment (Fig. 00-19/8). Use adhesive tape to secure the hoses for the test runs and make sure that the probes and hoses are safely attached to the exhaust pipe.

The arrangements shown in Figs. 00-19/7 and 00-19/8 should be interpreted as suggestions; it goes without saying that other exhaust gas testers and revolution counters can be used in any suitable arrangement.

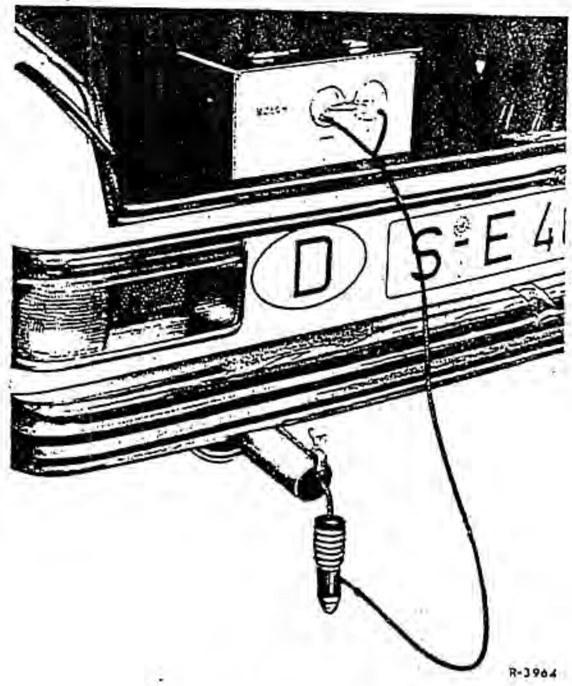


Fig. 00-19/8

2. Make a road test with the calibrated measuring instruments switched on: any more or less level road or street will do since travelling speeds should not be in excess of 60 km/h.

   When the engine has warmed up and the cooling-water temperature has gone up to 80° C, drive the car in 2nd gear under full load at 4000 rpm.

   Adjust the measuring point by simultaneously actuating the brake pedal with the left foot and the accelerator pedal with the right foot.

   Keep the 2nd gear full load measurement period to a minimum since the service brake has to absorb the full load; nevertheless you have to wait for the instrument pointer to steady so that you can read off the exhaust gas value, which should be 0.20 ± 0.05 % CO.

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3. If the measured exhaust gas value is above or below the specified value, adjust as described in Section a), para 3. It may be advisable to take the necessary tools and carry out the adjustment jobs on a trial run.

4. Drive the car at an engine speed of n = 4800 rpm and take the check measurements under full load. Read off the exhaust gas value as soon as the measuring point has been reached. For exhaust gas value and adjustment see Section a), para 4. To check engine performance and start of governing process, drive the car on a level road; it should reach a minimum speed of 58 km/h and there should be no smoke.

5. The injection pump has been adjusted satisfactorily when exhaust gas values and performance are within the range laid down in paras 2 and 4.

F. Checking of Smoke Effect by Way of Road Tests

If no other means are available the smoke effect can be checked by road tests as follows:

Accelerate the car in 2nd or 3rd gear on a level road or on a slight gradient from a lower speed up to the end of governing. Whilst doing this, the color of the exhaust gas should be kept under observation and this should be done by either a passenger in the vehicle or by tailing in another vehicle. If the exhaust gas is black and remains clearly visible 1 m behind the vehicle or more, the maximum delivery rate is too high. To reduce the smoke effect carry out the procedures described in Sections A—E as far as applicable.

Note: Before making the smoke test under acceleration, warm up the engine and with the car stationary thoroughly clear the exhaust pipe from carbon deposits by fully opening the throttle five to ten times.

G. Improvement of Smoke Ejection Effect

If there should still be a smoke ejection effect after the procedures described in Sections A to E have been carried out, it may be advisable to make a leak test of the pneumatic governor and to check the spray pressure of the injection nozzles. Under these circumstances idling speed should never be below 800 rpm and the start of delivery of the injection pump should be 2° below the specified adjustment.

Bleeding of Diesel Engine Fuel System

Job No.
00-22

A fuel supply free from air bubbles to the injection pump is an absolute prerequisite for the smooth running of a diesel engine. Air trapped in the fuel system may lead to considerable knock and loss of power of the engine and, in certain cases, to starting problems.

Bleeding of the fuel system only becomes necessary when the fuel tank has been run dry or fittings or lines were taken off. Bleeding may also become necessary though, when the fuel pump takes in air during operation.

Proceed as follows:

1. Back off bleed screw (6) at main fuel filter one or two threads (Fig. 00-22/1).

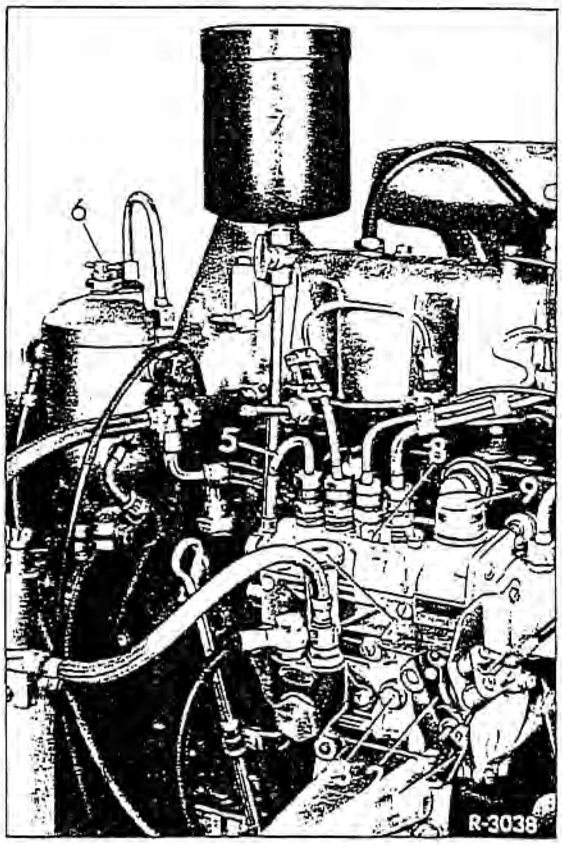

Fig. 00-22/1

6 Bleed screw of main fuel filter
4 Hand feed pump

2. Unlock operating cap of hand-operated fuel feed pump (4) by a counter-clockwise twist and pump until **bubble-free** fuel flows from the bleed screw opening (6). Tighten bleed screw and continue pumping until the injection pump overflow valve (fuel return) opens up – this becomes evident from a rasping noise. Push operating cap of hand-operated fuel feed pump down and lock in position by a twist in clockwise direction.

   Never fail to lock operating cap of the hand-operated fuel feed pump properly. The pump plunger presses against a sealing ring, thus sealing the pump completely. With the operating cap unlocked, the hand-operated fuel feed pump tends to leak during operation so that air may enter the system.

3. Start engine and check all connections for tightness.

Note: At the highest point of the main fuel filter next to the bleeder screw (6), there is an adapter with an air vent line which contains a throttle with 1 mm diameter. This air vent line raises the fuel level inside the filter considerably so that disturbances by taking in air at low fuel tank level are eliminated.

Caution: Do not use a **hollow screw** to fasten the cross fitting to which are attached the filter air vent line, the flexible hose of the leak-off pipe, the flexible hose (return line) from the overflow valve on the injection pump and the return line to the fuel tank.

Diesel Engine Knocking

Job No.
00-23

Diesel engine knocking is a mere combustion noise. In contrast to the Otto carburetor engine pinking, the knocking effect is created at the initial combustion point without causing the engine any harm.

The knocking effect is created by spontaneous combustion of fuel constituents present in the combustion chamber during an unduly extended ignition lag. The causes of an extended ignition lag and subsequent fuel accumulation may be found in the fuel ignition quality, the character and grade of fuel vaporization, the engine temperature, and the onset of fuel injection.

In order to diagnose engine knocking properly, it is essential to distinguish knocking at idling speed and in the partial-load range.

Once the operating condition is established, under which the knocking effect becomes apparent, it will be easier to determine the source of the fault.

To facilitate orientation we demonstrate below typical operating conditions accompanied by engine knocking, the cause, and the remedy.

When handling complaints about engine knocking it is **essential that every known measure to rectify the fault is taken.** Only then will there be any chance of lasting success.

Cause	Remedy
Engine Knocking at Idling Speed Rough running of the cold engine, particularly in new vehicles or following the installation of new or cleaned injection nozzles.	
New or cleaned injection nozzles have, at the early stage, a wider throttle aperture and therefore produce a slightly stronger injection effect	After a relatively short running period (maximum 1,000 km) the throttle aperture will carbonize slightly, which automatically reduces the noise.
Engine Knocking at Partial-load in the Low Speed Range This is found mainly in a cold engine (start knocking) and becomes less intensive as the engine warms up.	
1. Use of fuel with low cetane rating, or change-over or winter grade diesel fuel, or home-mixed diesel-cum-gasoline fuel.	After consultation with the customer test engine with different brand of fuel. Positive results have also been achieved by adding once or twice approximately 1 liter HD grade diesel oil to a full tank, or any other suitable additive with decarbonizing characteristics.
2. Charging pressure in the pre-chamber of the injection pump or opening pressure of fuel overflow valve too low.	Check charging pressure in pre-chamber of injection pump and delivery pressure of fuel feed pump at idling speed and at 3,000 rpm (proceed according to Job No. 00-14, Section C).
3. Air pad in fuel and injection system	Measure vacuum and delivery pressure of fuel feed pump and inspect fuel flow through glass tube of gage for air bubbles. If air bubbles are present in the fuel, find source of leakage and rectify fault (see Job No. 00-14, Section C).
4. Wrong pointer installed (only possible on Model 200 D).	On Model 200 D remove pointer and check dimension (a = 27 mm) (Fig. 00-23/1).
Note: There is a possibility that on the first cars of Model 200 D pointers for Model 190 D were installed. If that should be the case the mark on the crankshaft counterweight will not coincide with the begin of delivery of the injection pump (retarded by 2—3° on the crankshaft).	Checked pointers should be marked with a white dot on the arrow.
5. Start of delivery maladjusted.	Adjust start of delivery on cylinder No. 1 (see Job No. 00-8).
6. Offset start of delivery of cylinders or injection pump elements.	**Check start of delivery on cylinders 1 and 4.** If offset rate between cylinders 1 and 4 exceeds 2° on the crankshaft, replace injection pump.

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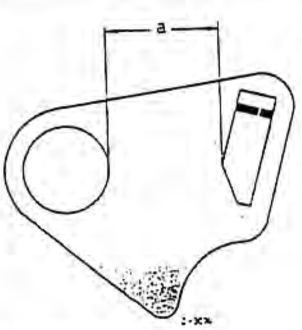
Cause	Remedy
Engine Knocking at Partial-load in the Low Speed Range This is found mainly in a cold engine (start knocking) and becomes less intensive as the engine warms up.	
7. Engine knocking, influenced by filter, while vehicle is in motion.	Replace fuel filter by feltplate filter, Part No. 000 477 54 15 (see Job No. 09-3). When using filter elements with felt sealing rings, remachine filter cover in accordance with Fig. 00-23/2 (see also Job No. 09-3).
8. Engine knocking, influenced by injection lines, while vehicle is in motion.	Replace injection lines by lines with 1.5 mm internal diameter, Part No. 621 070 08 33, . . . 09 33, . . . 10 33, 11 33 (For tightening torques see Job No. 00-0).
9. Throttle aperture of injection nozzles too narrow (carbonized).	Remove nozzles, check and clean or replace if necessary (see Job No. 07-22).
Engine Knocking at Partial-load in the Medium and Upper Speed Range This is encountered at 50 to 70 km/h in 3rd gear and increases as the engine warms up.	
1. Chain tensioner draws in air, chain looses tension. This causes the timing chain and injection timer to vibrate. Chain may tend to clank. This will result in changed valve timing and the start of delivery becomes retarded.	Check chain tensioner and replace if necessary (see Job No. 05-10).
2. Considerable pounding marks at the hub of the injection timer, flyweights scored or turned blue, burring and marks on the segmental plates (machining marks of the segmental plates no longer visible, pounding marks caused by flyweights.	Remove injection timer, check assembly, replace parts or injection timer if necessary. **Note:** Install only injection timers with divided governor weights.
Rough Knocking and Vibrating of Engine	
1. Injection nozzle sticking.	Carry out running and sound tests, remove sticking injection nozzle, check, clean or replace if necessary (see Job No. 07-22).
2. Fuel present in vacuum chamber of governor of injection pump due to leakage between pipe union and pressure valve holders.	Replace copper seals between pipe unions and pressure valve holders Unscrew oil-level check plug from injection pump, disengage fixing bolts of governor housing, lift same slightly and allow any fuel that may have penetrated into the vacuum chamber of the governor to drain off (see Fig. 00-19/4). If necessary, trim overflow pipe at back of pump and bend downward. Fasten fixing bolts of governor housing and screw oil-level check plug back in place.
3. Loss of compression.	Check tappet clearance and compression, if necessary check cylinders for leakage (see Job No. 00-5).



Pointer for Model	Part No.	Dimension
190 Dc	121 032 01 15	a = 25.0 mm
200 D	121 032 02 15	a = 27.0 mm

Fig. 00-23/1

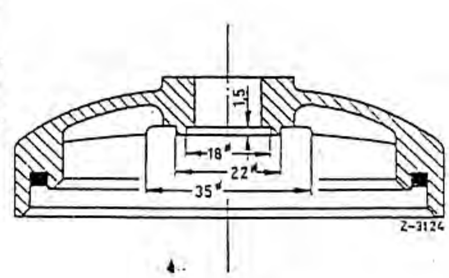


Fig. 00-23/2

Minimum Diesel-Engine Start Temperature

Job No.
00-25

On models 190 Dc and 200 D the lowest temperature at which it is normally possible to start the diesel engine is approx. – 16° to – 17° C; this value refers to an engine that has cooled down completely to the ambient temperature. But the cooling process normally takes up to about 12 hours and vehicles used under normal conditions are not usually left standing for periods as long as this; moreover, minimum temperatures are usually encountered during the early hours of the morning and in practice, therefore, it is often possible to start the engine at ambient temperatures below this "minimum" as well.

But it is only possible to depress the critical temperature in this way under the following conditions:

1. The engine must be fillet with SAE 10 W oil. This thinner type of oil must have been put in in plenty of time – i. e., well before the beginning of the cold season.
2. The battery must be at least three-fifths full.
3. The engine must be using winter diesel fuel; if necessary, a certain amount of ordinary gasoline, kerosene or tractor fuel (avoid super-gasoline and benzene-benzol mixtures) should be added in order to preserve the low viscosity of the oil (see Operating Instructions).
4. Make sure that the fuel systems is in order (theremust be no air in the lines, the overflow valve must be fuel-tight etc., see Job No. 00-14, Section C).
5. Make sure that the preheating system is in good operating condition.
6. Make sure that the start of delivery is accurately set (see Job No. 00-8).
7. Make sure that the pump is delivering the proper amount of fuel for starting and that there is sufficient travel in the control rod or timing lever of the pump (see Job No. 00-9). If necessary install new rubber molding 110 302 02 68 (with shorter slot) (now installed as a standard part).
8. Make sure that the preheat has been kept on for long enough (up to approx. 1 minute).

At temperatures below those indicated it is usually only possible to start the diessel engine by the use of special measures such as those suggested below. Some of these measures in combination increase the effect and it may, therefore, happen that this critical temperature can be depressed quite a lot.

Suggested Methods of Starting Standard Engines

Method	Improvement
1. Connect up another battery in parallel with the first (positive to positive, negative to negative).	(depending on size and condition) critical temperature down approx. 5° C
2. Use a warm battery; one way is to keep the battery in a heated place.	critical temperature down approx. 3° C
3. Charge the battery fully from an outside source of current.	critical temperature down approx. 3° C
4. Put hot cooling water into the radiator.	critical temperature down approx. 3-4° C
5. Use SAE 5 W engine oil.	critical temperature down approx. 5° C

The above oil is normally only available in northern countries. The same effect can be obtained by adding approx. a quarter liter of gasoline to the SAE 10 W engine oil. When the engine has been run up to its normal temperature, the gasoline gradually evaporates. If, however, the engine has only been run for a short time this diluting process should not be carried out repeatedly or else the oil will ultimately become too diluted. A rough and ready rule is that the process of adding gasoline should only be repeated after a total running time of about an hour or alternatively after covering some 30 km.

Suggested Methods Involving Special Equipment

1. A larger battery may be fitted as an optional extra; this may be either an 84 or an 88 ampere-hour thin-plate battery (not to be confused with the previous standard 84 ampere-hour battery).
2. More powerful generator, preferably the three-phase generator 490 W rated output, which is now standard equipment.
3. An electric coolant heater may be used.

Complaints of Impaired Diesel Engine Performance

Job No.
00-26

Where complaints are made of impaired engine performance the points brought up should be checked at the outset on a performance roller test stand or else a trial run should be made. In a trial run a comparison is made (over a known point-to-point distance under identical driving conditions) of the top speeds of the allegedly faulty vehicle and a vehicle of satisfactory performance. If either of the above two suggested test methods does, in fact, reveal impaired engine performance the following points should be checked:

1. Find out whether the check valve is **opening completely.** Free up this valve and, if necessary, repeat the test with the check valve held rigidly in position (see Fig. 00–19/3).

2. Check adjustment of mechanical auxiliary regulation and, if necessary, correct it (see Job No. 00–19, Section B).

3. Check that with the start-stop cable in the drive position the timing lever of the injection pump is quite definitely over at full load (see Job No. 00-10).

4. Check full-load maximum rpm. (start of injection pump governing process) and also maximum engine rpm. at no-load (end of governing process) (see Job No. 00–19, Sections C and D).

5. On Model 200 D remove pointer marking start of delivery and check dimension a = 27 mm (see Fig. 00–23/1).

Pointer for Model	Part No.	Dimension a
190 Dc	121 032 01 15	25.0 mm
200 D	121 032 02 15	27.0 mm

Checked pointers should be marked by putting a white dot on the arrow.

Note: It is possible that some of the first Model 200 D cars are equipped with a Model 190 Dc pointer. If that is the case the mark on the crankshaft counterweight will no longer coincide with the start of delivery of the injection pump (retarded 2–3° on the crankshaft).

6. **Check start of delivery on cylinder No. 1** (see Job No. 00–8).

7. **Check start of delivery on cylinder No. 4** (advance one turn). If the displacement between cylinders nos. 1 and 4 is greater than 2° on the crankshaft replace the injection pump.

8. Clean the air cleaner, check tappet clearance and compression, and, if necessary, carry out a compression-leak test (see Job No. 00–5).

9. Check delivery pressure – i. e., "inflation" pressure (priming chamber) of injection pump and delivery end pressure of fuel feed pump at idling speed and at a racing free-engine speed of 3000 rpm. (carry out procedures laid down in Job No. 00–14, Section C.)

10. Check the vacuum and feed pressures of the fuel pump and watch the glass tube of the gage to see if the fuel flowing past contains air or not. If there are air bubbles in the fuel find the leaks and stop them (see Job No. 00–14, Section C).

11. Check exhaust system for damage and denting (particularly below the rear axle).

12. Check carbon monoxide content of exhaust gases (see Job No. 00–19, Section E).

13. Check valve timing (see Job No. 00-9).

14. Take off cylinder head. Sight-check the cylinder bores and carry out a bore dimension check (see Job No. 00–5, Section C). Remove valves, smooth off any roughened edges in the suction and exhaust ports, particularly at the changeover points of the valve-seat rings – this in order to eliminate any obstacles to the passage of suction or exhaust gas. Also install the gaskets between cylinder head and intake/exhaust manifolds on both the intake manifold and exhaust manifold and mark around the contour. The gaskets must be 0.5 mm larger than the ports. If at any point the metalwork of cylinder head, intake manifold or exhaust manifold should show a visible margin appreciably greater than this the surfaces should be machined down – if possible to the point at which intake manifold, exhaust manifold and cylinder head are congruent.

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Machining down so as to impinge on the full section of the gasket (not to mention machining even beyond!) is definitely undesirable.

15. Machine the working surfaces of the valves.

16. Check the kilometer indications on the speedometer and correct any lag there may be in the readings.

17. Jack up the vehicle and check whether the wheels turn freely (there may be some obstacle to their free movement such as a jammed wheel cylinder).

Trouble-Shooting Hints for the Diesel Engine

Job No.
00-30

Before starting any trouble-shooting on the diesel engine the following checking and testing procedures should be carried out as a matter of course:

1. Adjust tappet clearance (see No. 00-3).
2. Check compression pressure and cylinder sealing (see Job No. 00-5).
3. Check start of delivery (see Job No. 00-8).
4. Check inflation pressure (priming chamber) of injection pump, also vacuum and feed pressure of the pump (see Job No. 00-14, Section C).
5. Tune engine (see Job No. 00-19).

The foregoing makes no claim to being complete. It goes without saying that the battery should be properly charged and that both the lubrication oil and the fuel used should be of the types laid down in our specifications.

Cause	Remedy
Engine Fails to Start	
Too little fuel reaching engine; control lever of injection pump does not go right over to start; alternatively, fuel feed pump not supplying enough fuel.	Adjust length of cable from preheat/start-stop switch (see Job No. 00-9). Measure delivery pressure and delivery end pressure of fuel feed pump (see Job No. 00-14, Section C).
No fuel reaching engine; injection pump control rod jammed in position zero feed.	Free up control rod.
Engine cooled down right through block.	See Job No. 00-25 "Minimum Diesel-Engine Start-Temperature".
Pressure-loss occurring between piston and cylinder, resulting in inadequate compression; leaking valves; damaged cylinder-head gasket or cracks in cylinder head.	Determine compression and pressure-loss of individual cylinders (see Job No. 00-5).
Glow plug failure in one or a number of cylinders, with consequent ignition failure.	Have a second man hold the starter knob in the preheat position and then use a screw-driver to spark off individual glow plugs by briefly touching the bus bars to ground. If one of the plugs fails to produce a spark it is faulty or has a short to ground. Replace a faulty plug.
Uneven, jerky running with hard metallic noise and considerable blue smoke	
Broken ball pin in the prechamber or jamming injection nozzle.	Remove nozzle, test it and if necessary clean or replace it. Check prechamber in situ and then if necessary replace it (see Job Nos. 07-22 and 01-5).

Cause	Remedy
Uneven, jerky running with a heavy droning noise and very thick blue smoke	
Cracks in the diaphragm of the vacuum pump for the power brake. Engine oil passes via the damaged diaphragm over onto the vacuum side of the vacuum pump and thence through the connecting hose to the intake manifold as far as the intake stubs of cylinders 1 and 2. The oil, most of which is transported when the car is overrunning the engine and which thus finds its way into the intake stubs, is burnt together with the fuel, thus causing a very considerable temperature rise in the main combustion chamber which may cause burn-out of the burner.	Remove prechambers, check their condition and if necessary replace them (see Job No. 01-5). Remove intake manifold and connecting hose leading from the vacuum pump of the power brake to the intake manifold. If these parts are thickly covered with oil replace the diaphragm of the vacuum pump (see Job No. 07-30).
Engine running backward (can be seen from thick smoke produced under hood, or, more accurately, from the air cleaner)	
The diesel engine may run backward under the following conditions of incorrect use: 1. If with the vehicle rolling backward (for example when turning or starting off uphill' a forward gear is engaged or the reverse gear when the car is rolling forward or again when in a forward gear the engine has been brought to a complete stop through overload and is then swung in the reverse direction by the load. 2. There is another set of circumstances under which the engine may run backward — namely, when the driver has first of all attempted to start the engine without preheat and then, after finding out that it is too cold to start, returns the starter knob **no further than to the preheat position.** It may then happen that the start of the preheat process coincides exactly with the extreme point of the engine swing, thus resulting in an abnormally advanced ignition which is sufficient to swing the engine in the reverse direction. Thus, **after an attempt has been made — in vain — to start the engine without preheat the starter knob must be pushed all the way back to the stop position until the engine has actually come to a halt before the preheat process is initiated again.**	Switch off the engine as quickly as possible by pressing home the starter knob or stall the engine by engaging a gear. If it was possible to stop the engine straight away the engine can be made ready for normal use again (with the usual proviso as to responsibility and with the customer's permission) once the following procedures have been carried out. 1. Turn the crankshaft by hand and check the condition of bearings and pistons. 2. Determine the compression of the individual cylinders. 3. Once points 1 and 2 have been satisfactorily cleared change the oil, replace the oil cleaner element and the oil-bath air cleaner insert and check the flaps in the Venturi control unit for ease of movement. If the Venturi control unit has no check valve it is advisable to replace it by a Venturi control unit with check valve (see Fig. 00-19/3). 4. Run the engine, check the oil pressure and give the car a road-test.
Engine becoming too hot	
Not enough water in the radiator.	Gradually top up with water with engine running and heating on.
Thermostat opens too late.	Check thermostat and if necessary replace it.
Vapor bubbles due to obstructed vent line between water pump and cylinder head.	Clean out the bores of the vent line and the two hollow screws.
Delivery of water pump inadequate.	Repair or replace water pump.
Cylinder head gasket leaky.	Replace cylinder head gasket.
Cooling system clogged.	Clean out cooling system.
Valves not making tight seal.	Grind valves.
Hairline cracks in cylinder head.	Take off cylinder head, pressure-test it while warm and if necessary replace it.
Start of delivery too late.	Correct start of delivery.

Cause	Remedy
Excessive oil consumption	
(For average oil consumption figures see Job No. 0-3). Where complaints have been made of excessive oil consumption the true oil consumption of the vehicle should be determined by measurement under accurate, reproducible conditions of checking, and where the complaint is in respect of a Guarantee, the Inspection Sheet should be attached to the Control Form of the Guarantee or the Negotiated Agreement.	
Oil loss.	Check the cylinder-head cover, oil cleaner, oil lines, front or rear crankshaft oil seal and eliminate any cause of oil loss found.
Damaged valve stem seals.	Replace valve stem seals (see Job No. 05-2).
Excessive play between valve stem and valve guides.	Replace valve guides.
Excessive positive pressure in crankcase resulting from excessive blow-by.	Increase minimum bore-diameter of crankcase venting system by 0.5 mm or possibly more (see Engine Venting System, Job No. 00-0).
Piston ring broken or cylinder bore worn out-of-round; excessive wear of piston/cylinder bores.	Disassemble engine, carry out dimension-check of cylinder bores (see Job No. 00-5, Section C) and replace any broken piston rings or alternatively, install a set of rings of the latest design.
Cracks in the diaphragm of the vacuum pump for the power brake. Engine oil passes via the damaged diaphragm over onto the vacuum side of the hose to the intake manifold as far as the intake stubs of cylinders 1 and 2. The oil, most of which is transported when the car is overrunning the engine and which thus finds its way into the intake stubs, is burnt together with the fuel, thus causing a very considerable temperature rise in the main combustion chamber which may cause burn-out of the burner.	Remove prechambers, check their condition and if necessary replace them (see Job No. 01-5). Remove intake manifold and connecting hose leading from the vacuum pump of the power brake to the intake manifold. If the inside walls are thickly covered with oil replace the diaphragm of the vacuum pump (see Job No. 07-30).
Oil in water	
Cylinder head gasket leaking at the transition bore of the oil passage from the crankcase to the cylinder head.	Replace cylinder-head gasket.
A porous place or a hairline crack in the wall of the main oil passage in the crankcase.	Remove engine and pressure-test crankcase while warm; if necessary replace crankcase.
Water in oil	
Cylinder-head gasket leaking.	Replace cylinder-head gasket.
Separating surface of cylinder head or crankcase uneven or distorted.	If the unevennesses are of any considerable extent the separating surface concerned should be face-ground or face-milled.
Plug under camshaft bearing support leaking.	Seal core plug.
Cylinder head leaking (hairline crack).	Pressure-test cylinder head while warm; if necessary replace it.

Noises

If the conditions under which the noise appears are known and if at the same time the nature of all variations of the noise is known it is easier to reach a decision on the underlying causes of the complaint.

The following are potential causes of noise:

Excessive tappet clearance.
Formation of flats and scores on rocker arms and camshaft.
Humps on the camshaft or furrowing on the rocker arms.
Inadequate valve spring tension.
Stretched chain.
Inadequate tension of chain tensioner.
Poor chain alignment.
Defective chain guide.
Loose valve seat ring.
Excessively worn, oscillating injection timer[1]).
Excessively worn vacuum pump for power brake.
Broken ball pin or burnt-out burner in prechamber.
Injection nozzle jammed.
Damaged crankshaft or connecting rod bearings.
Crankshaft end play.
Wear on pistons and cylinders.
Front crankshaft seal.
Water pump.
Generator.
Diesel engine knock (see Job No. 00-23).

1) In order to make certain whether a given noise is caused by the injection timer or not we recommend the following test: With the engine speed varying between 1200 and 2000 rpm, pull the air hose off the suction side of the vacuum pump, alternately opening and shutting the air intake. If the noise is caused by the injection timer it will become louder with the engine speed falling off and the air intake open.

Cylinder Head – Group 01

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Cylinder Head

Job No.
01-4

Models 190 Dc and 200 D

A. Removal and Installation

The cylinder head should only be removed with the engine cold in order to prevent distortion.

Removal:

1. Drain cooling water, paying attention to additives.
2. Detach the water hose from the cooling water return pipe socket, the vent line from the water pump to the cylinder head, and the feeding line from the heat exchanger on the cylinder head.
3. Remove vent line, oil bath air cleaner and cylinder head cover.
4. Detach vacuum line, injection lines and leakage oil line. Back off the fixing screws of the main fuel filter and move filter out of the way.
5. Detach exhaust manifold at the exhaust pipe flange.
6. Detach the connecting cable to the glow plugs and unscrew the heat sensor for the cooling water thermometer.
7. Loosen the stretch screws fastening the rocker arm blocks and remove the rocker arm blocks together with the rocker arms, at the same time turning the camshaft in such a way that the rocker arms are under no load.
8. Remove the inside chain guide (9) in the cylinder head. To do this loosen the fixing screw and pull out the support bracket (Fig. 01-4/2).
9. Unscrew the fixing screw for the camshaft sprocket, holding the camshaft sprocket steady at the same time. Remove the chain tensioner (3) and remove the camshaft sprocket (1), paying attention to the shim and the woodruff key. Put the chain in the chain case.
10. Loosen and remove the cylinder head screws working from the outside toward the inside. Do not forget the four hexagon socket screws at the front of the cylinder head.
11. Lift off the cylinder head and remove the gasket.
12. For cleaning, checking and preliminary procedures see Section B.
13. For cylinder head gasket see Section C.
14. For disassembly and reassembly according to assessment see Section D.

Installation:

15. Set the engine to compression TDC of the 1st cylinder. To do this lift the chain out of the chain case and turn the engine in its direction of rotation until fuel escapes from the pipe union of the first injection pump cylinder and continue turning until the piston of the 1st cylinder is at TDC.
16. Again carefully clean crankcase and cylinder head at the separating surface. Put on new cylinder head gasket and place cylinder head in position (see Section C).
17. Put the bracket for the cylinder head cover on the cylinder head. Oil threads and contact surfaces of the cylinder head screws as well as the washers.
18. Tighten the cylinder head screws in the proper sequence and step by step as shown in Fig. 01-4/1.

Diagram for tightening sequence and tightening stages of the cylinder head screws.

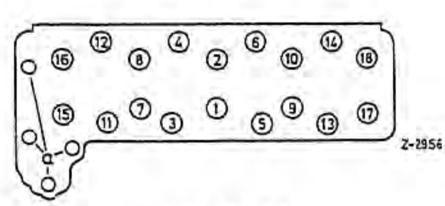

Fig. 01-4/1

1st tightening	4 mkp	
2nd tightening	6 mkp	
3rd tightening	9 mkp	
4th tightening	9 mkp	(checking at 80° C cooling water temperature)

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For retightening cylinder head screws see Para 36.

When the cylinder head screws have been tightened the camshaft must be easy to turn by hand.

19. Screw in the four hexagon socket screws (a) at the front of the cylinder head and tighten by means of the hexagon socket wrench Part No. 186 589 08 07 00. Attach ground lead for the glow plugs to the screw under the main fuel filter.

20. Insert woodruff key in the camshaft and put on the shim. Turn the camshaft in such a way that the marks on the shim and on the 1st camshaft bearing coincide.

21. Use a hook to pull the chain out of the chain case and press the camshaft sprocket together with the chain on the camshaft. Pay attention to the marks on the shim and the camshaft bearing.
The left half of the chain must be tensioned since otherwise the camshaft adjustment may be changed when the engine is turned. Install washer and lock washer and tighten the hexagon screw.

22. Check the end play of the camshaft.

If the end play is unsatisfactory the camshaft should be reground at the front face or at the face.

23. Install the inside chain guide (9) in the cylinder head (Fig. 01-4/2).

24. Use a new seal for the chain tensioner and screw it to the cylinder head **without filling up the oil.**

25. Use bleeder lever, Part. No. 187 589 02 63 00, or if not available a screwdriver to press the tension sprocket bearing as far as it ill go and fill the oil case in the cylinder head with engine oil. Now slowly release the bearing by means of the lever or a screwdriver, at the same time topping up with oil in order to ensure that the oil case is always full and that the chain tensioner cannot draw in air.
Slowly pump the tension sprocket bearing (2) and the tension sprocket until the chain tensioner is free from air bubbles. The important point is that during bleeding the oil case should always be filled with a sufficient amount of oil.

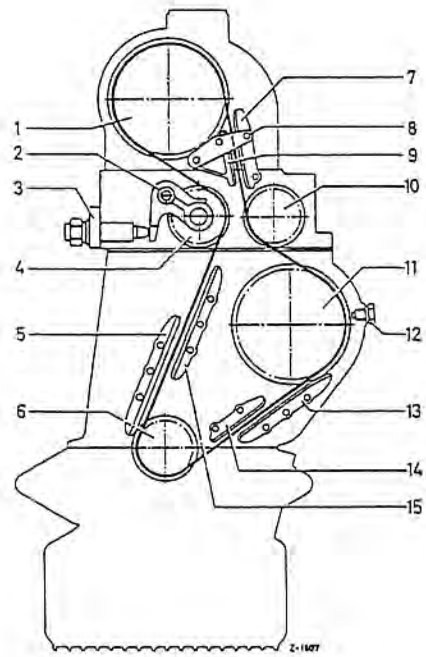

Fig. 01-4/2

1 Camshaft sprocket
2 Sprocket bearing and tension sprocket
3 Chain tensioner
4 Tension sprocket
5 Chain guide, outside
6 Crankshaft sprocket
7 Chain guide, outside
8 Support bracket for chain guide, inside
9 Chain guide, inside
10 Reversing sprocket
11 Intermediate gear
12 Locking screw
13 Chain guide, outside
14 Chain guide, inside
15 Chain guide, inside

When the chain tensioner is properly bled there should be no free travel at all; from the start the chain tensioner can only be compressed with the use of extreme force.

Extreme care should be used in bleeding the chain tensioner since improperly bled chain tensioners may cause chain noise when the engine is idling. (See also "Checking of Chain Tensioner", Job No. 05-11).

26. Insert the fitted sleeves fort the rocker arm blocks in the cylinder head bores and drive them in. The fitted sleeves should fit snugly.

27. Install the rocker arm blocks together with the rocker arms and tighten the bearing block or stretch screws with a tightening torque of 3.75 mkp.

Note: When installing the assembled rocker arm blocks the camshaft should always be turned in such a way that the rocker arms are under no load.

28. Adjust the tappet clearance with the engine **cold** (see Job No. 00-3).

29. Attach vacuum line, injection lines and leakage oil line. Fasten the main fuel filter.

30. Attach the connecting cable for the glow plugs and screw in the heat sensor for the cooling water thermometer.

31. Install the water hose on the cooling water return pipe socket, the vent line from the water pump to the cylinder head and the feed line to the heat exchanger on the cylinder head.

32. Attach the exhaust manifold to the exhaust pipe flange.

33. Install the cylinder head cover, the vent tube and the bearing block together with the angle lever of the additional control. Make sure that the cylinder head cover gasket is properly seated. Also make sure that on acceleration the cable (4) can move freely in the seat of the stop angle on the angle lever (6) (see Fig. 00-19/1).

34. Attach the control linkage (see Job No. 00-19/1, Section B) and install the oil bath air cleaner.

35. Fill up the cooling water and pay attention to any additives.

36. **Retighten cylinder head screws as follows:**

Warm up the engine under light load to 80° C cooling water temperature. After running the engine for another 5 minutes at this cooling water temperature retighten the cylinder head screws in the sequence shown in Fig. 01-4/1 with a torque of 9 mkp.

Note: After retightening the cylinder head screws the tappet clearance need not be checked again.

37. When the cylinder head cover has been reinstalled run the engine for a short time and check all oil, water and fuel line connections and the cylinder head cover for leaks.

38. **Retighten the cylinder head screws again and check the tappet clearance after the car has been driven for another 300—1000 km.**

Caution: There is a danger that the required second retightening of the cylinder head screws is omitted because very often the unscrewing torque is higher than the prescribed tightening torque with the result that in the first tightening phase the torque reading is above the prescribed tightening value. In order to ensure that the cylinder head gasket is actually compressed in accordance with the prescribed screw tightening torque the cylinder head screws should be retightened as follows:

In the proper sequence according to the tightening schedule slightly loosen each screw individually and then retighten to the prescribed torque. On no account should all screws be loosened one after the other and retightened afterwards (see Fig. 01-4/1).

The tappet clearance can be checked and readjusted either before or after tightening the cylinder head screws.

B. Cleaning, Checking and Preliminary Procedures

1. Clean cylinder head and crankcase seperating surface.

2. Check separating surface of cylinder head and crankcase for distortion and for scores, scratches, cracks and similar damage.

Maximum longitudinal departure must not exceed 0.1 mm and maximum lateral departure must not exceed 0.01 mm.

Cracks are not uncommon in particular on the first cylinder of the cylinder head (Fig. 01-4/3).

Cracks "a" which run from the bore of the pre-chambers to the center of the cylinder head and are no longer than 15 mm do not affect the proper functioning of the cylinder head, since they do not extend toward the water jacket. Cylinder heads with this type of crack should on no account be discarded, they are absolutely safe. The cylinder head need only be replaced if the cracks "a" are longer than 15 mm and when cracks "b", "c" and "d" are present which extend into the valve seat.

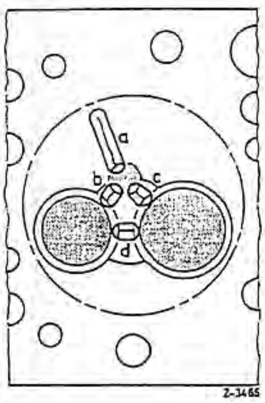

Fig. 01-4/3

a) Crack from the bore of the pre-chanber to the center of the cylinder head
b) Crack extending to exhaust valve seat
c) Crack extending to inlet valve seat
d) Crack across inlet and exhaust valve seats

3. Clean water passage openings in the cylinder head and the crankcase. Make sure that the water distribution pipes are firmly seated in the cylinder head; if necessary peen them or replace them.

4. Remove heavy oil carbon deposits on the piston head.

5. Retap the threads for the cylinder head screws in the crankcase with an M 12 × 1.75 tap. This applies in particular to older crankcases with heavily clogged threads. It is essential that the cylinder head screws should reach an adequate depth in the blind bores; if they do not the screw can be tightened with the prescribed torque but would not exert the pressure on the cylinder head gasket which corresponds to the tightening torque. The same problem arises when an oil pad builds up in the blind bore; to prevent this the thread should never be lubricated by putting oil in the blind bore. There is the additional danger that the crankcase may crack. Before placing the cylinder head in position make sure that the screws can be turned in to a sufficient depth.

6. Lightly coat the threads of the cylinder head screws with graphite oil. Inherent friction can only be prevented and the prescribed compression of the cylinder head gasket can only be achieved if the cylinder head screws turn easily.

Note: Before installing new cylinder head screws check their length.

7. Check the fitting pins in the crankcase for damage and if necessary drive in new fitting pins.

Cylinder Head Gaskets

Engines of the OM 621 series are no longer provided with a water passage opening in the crankcase and in the cylinder head for cylinder 1. On cylinder 4 the 15 mm water passage opening in the cylinder head has been reduced to 6 mm.

These engines require the new cylinder head gasket 621 016 12 20 (Fig. 01-4/5).

Since the crankcase and the cylinder heads were not modified at the same time engines with partly modified engine components where either the cylinder head or the crankcase is provided with a water passage opening should be equipped with gasket 621 016 14 20; on this gasket the cylinder 1 water passage opening is closed by a dished copper disk and at cylinder 4 the water passage opening has been reduced by a copper ring from 18 to 7 mm (Fig. 01-4/4). This gasket can also be used for previous engines with a water passage opening for cylinder 1 and a large water passage opening in the cylinder head for cylinder 4. Stocks of the old gasket 621 016 10 20 (Fig. 01-4/6) can be used up for Model 190 Dc.

Caution: The gasket shown in Fig. 01-4/5 should not be used for engines in which only some of the components have been modified since otherwise the circulating cooling water may deteriorate the gasket material.

The cylinder head gaskets to be used for the various crankcase and cylinder head versions are listed in a table below.

In this connection we should like to draw your attention again to the importance of retightening the cylinder head screws to the specified values.

For the first retightening stage after warming up the engine after the reinstallation of the cylinder head see Section A, Para 36. For the second retightening sequence after the car has travelled 300—1000 km see Section A, Para 38.

Cylinder Head Gaskets to Be Used for Specific Engine End Numbers

Model	Engine type	Install up to engine end no.	Install as from engine end no.
190 Dc 200 D	621 912 621 918	in all engines -10-022 258 -12-001 497	— —

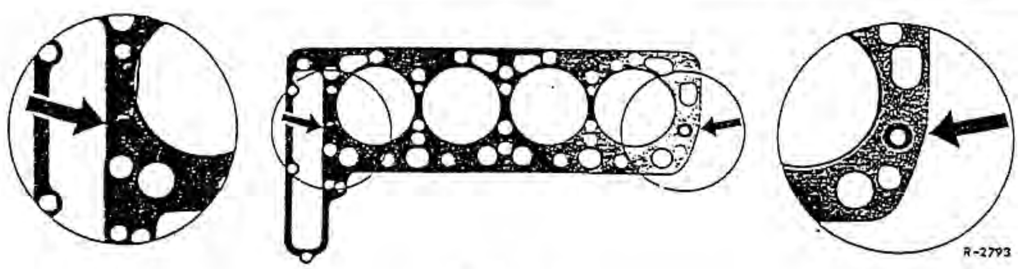

Fig. 01-4/4

Cylinder head gasket, Part No. 621 016 14 20

190 Dc 200 D	621 912 621 918	— —	— -10-022 259 -12-001 498

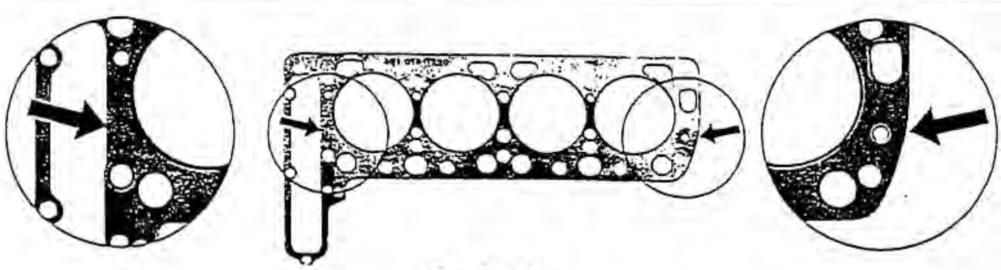

Fig. 01-4/5

Cylinder head gasket, Part No. 621 016 12 20

Stocks of gasket 621 016 10 20 can be used up on Model 190 Dc

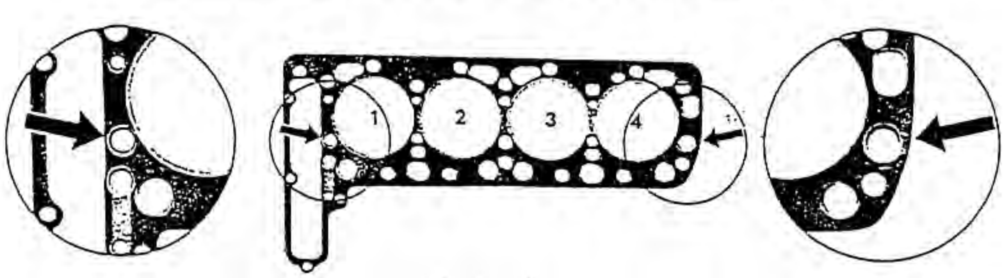

Fig. 01-4/6

Cylinder head gasket, Part No. 621 016 10 20

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

D. Disassembly and Reassembly according to Assessment and Jobs Required for Cylinder Head Replacement

12. For removal and installation of outside chain guide (7) see Job No. 05-18.

13. Removal and installation of intake pipe together with Venturi control unit and exhaust manifold as well as camshaft and bearing.

14. For removal and installation of injection nozzles, see Job No. 07-22.

15. For removal and installation of glow plugs and pre-chambers see Job No. 01-5.

16. Removal and installation of valves, tension sprocket and tension sprocket bearing together with the reversing sprocket.

17. Reconditioning of valves.

Removal and Installation of Pre-Chamber

Job No. 01-5

a) Remove injection nozzle holder assembly (see Job No. 07-22).

b) Remove glow plug

Unscrew milled nuts, remove cable, insulators and bus bars.

Then unscrew glow plug, using SW 20.9 mm offset Box Wrench (Part No. 000 589 17 03 00).

The glow plug must be removed because the heater coil projecting into the pre-chamber will be sheared off when the pre-chamber is pulled out (Fig. 01-5/3).

c) Remove pre-chamber

1. First of all unscrew the pre-chamber threaded ring (4), using spindle (1), sleeve (3) and socket-wrench head (5) (Fig. 01-5/1). These parts are used in the following way: Push sleeve (3) and spindle (1) together. Then screw the spindle into the threaded ring as far as possible and fit the sleeve into the groove of the threaded ring. With the hand, screw the hexagon nut (2) on the spindle to the point at which the flats of the nut are aligned with those of the sleeve and the socket wrench (5) can be slipped over the two hexagon contours.

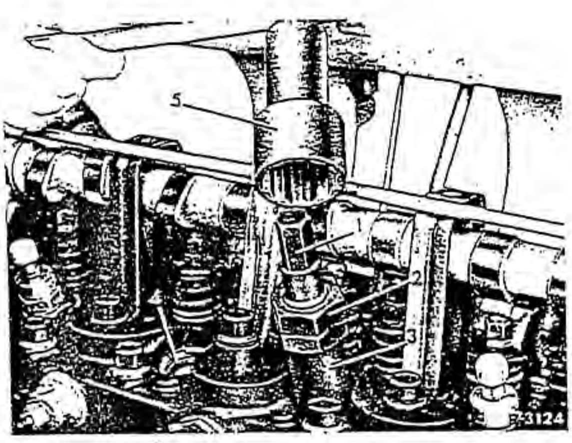

Fig. 01-5/1

1 Spindle, Part No. 636 589 01 63 00
2 Hexagon nut for pushing the sleeve against the threaded ring
3 Sleeve, Part No. 636 589 02 07 00
4 Threaded ring of pre-chamber
5 Socket-wrench head, Part No. 636 589 04 09 00

Now turn the sleeve with the box wrench and unscrew the threaded ring.

2. Use Puller, Part No. 401 589 12 33 00, to extract the pre-chamber. Here again, the procedure is to screw the spindle (1) in as far as possible — in this case into the pre-chamber. Then turn the prying bell (3) until the cutaway section is exactly opposite the groove in the cylinder head — and of course opposite the safety stop (4) of the pre-chamber. Now tighten up the hexagon nut (2) and extract the pre-chamber (Fig. 01-5/2).

Note: During the extraction process make sure that the prying bell is not turning when the hexagon nut is turned; otherwise the pre-chamber safety stop will be sheared off by the prying bell.

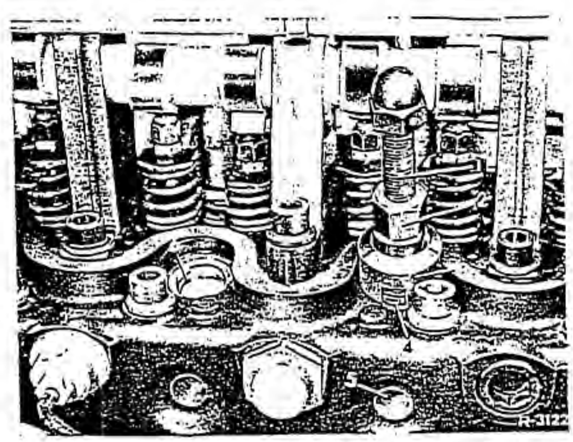

Fig. 01-5/2

1 Spindle
2 Hexagon nut
3 Prying bell
4 Safety stop of the pre-chamber
5 Glow-plug tapping
6 Threaded ring of pre-chamber

3. Take gasket (13) out of cylinder head (Fig. 01-5/3).

Note: If it is not intended to reinstall the pre-chamber at once the tappings should be covered so that no dirt gets into them.

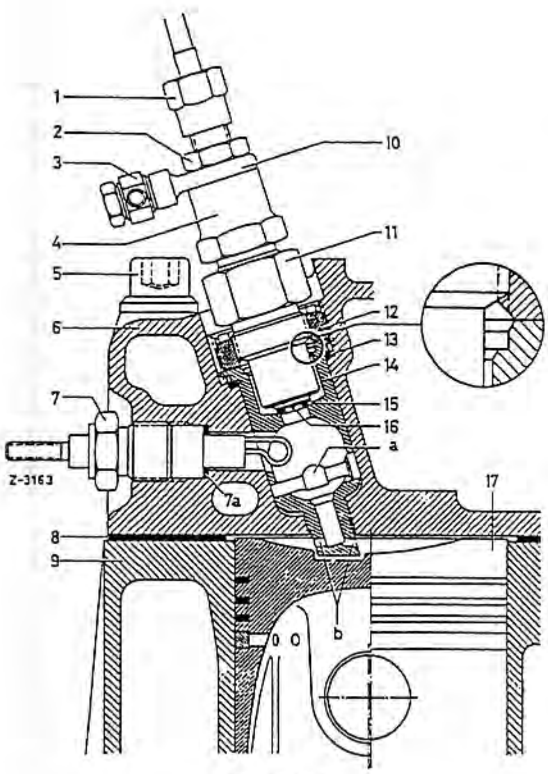

Fig. 01-5/3

1 Retaining nut of injection line
2 Hexagon nut
3 Fuel leak-off pipe
4 Nozzle holder
5 Cylinder head screw
6 Cylinder head
7 Glow plug
7a Seal
8 Cylinder head gasket
9 Crankcase
10 Through-piece
11 Retaining nut of nozzle holder
12 Threaded ring
13 Gasket
14 Pre-chamber
15 Seal
16 Nozzle needle
17 Piston
a Ball pin
b Exit bores of multi-hole burner

d) **Installation of Pre-Chamber**

4. If the same pre-chamber is to be reinstalled make sure that it is in good condition. The condition of the ball pin (a) in the pre-chamber gives a useful idea of the condition of the pre-chamber itself. The pin is in order if the ball is not scorched and the changeover radius between ball and pin is approx. 10 mm (Fig. 01-5/3).
If the burner is scorched, remove the intake manifold and the connecting hose from the vacuum pump to the intake manifold. If the inside walls are thickly covered with oil remove the diaphragm of the vacuum pump and check for cracks or other damage; if necessary, replace diaphragm (see Job No. 07-30).

5. Install a new gasket seal (13) in the cylinder head. Only the type of gasket originally made for this purpose in the specified thickness and shape must be used; this is because the distance of 5.7 ± 02 mm between pre-chamber and cylinder head is critical and must be adhered to.
The minimum distance between the front face of the pre-chamber and the piston-head recess = 1.35 mm (Fig. 01-5/3).

Note: If too much material has been milled off the cylinder head separating surface thicker gaskets (13) must be installed between the cylinder head and the pre-chamber.
The following gaskets are available for this job:

Thickness in mm	Part No.
1.9—2.1 (standard equipment)	636 017 01 19
2.2—2.4 (standard equipment)	636 017 02 19
2.5—2.7	636 017 03 19
2.8—3.0	636 017 04 19

A further point is that when thicker gaskets have been fitted, the throughway bore to the pre-chamber that accepts the glow plug is out of line. It must therefore always be rebored to line up with the main bore in the cylinder head and blown out clean with a compressed air line.

6. Insert pre-chamber in cylinder head.

7. Screw in threaded ring (4) with spindle (1) / sleeve (3) assembly and tigthen up to the specified tightening torque with the socket wrench (5) (Fig. 01-5/1 and Job No. 00-0).

e) **Installation of Glow Plug**

8. Install glow plug after having reamed — i. e. cleaned — the glow-plug canal and bore in the pre-chamber with the boundary-edged reamer, Part No. 636 509 03 53 00. Remember to fill grooves of the reamer with grease before doing this job.

An ordinary, commercially available, 11 mm reamer may also be used but if it is, the following should be taken into account:
To prevent damage to the ball pin in the prechamber, insert the reamer no more than appr. 55 mm. The safest way is to provide the reamer with a safety-stop, making use of a tightly-fixed rubber band or the like.

Note: After a time oil-carbon deposits form in the glow-plug canals and may ultimately lead to starting difficulties. To obviate these the glow-plug canals should not only be cleaned in the course of the regular inspection service but also when any appreciable cylinder-head repairs are carried out and whenever the glow plugs are being replaced.

9. If the glow-plug canals have been cleaned with the cylinder head in position turn the engine over a few times with the starter in order to blow any residual swarf and dirt out of the combustion chamber.

10. Lightly lubricate the thread of the glow plugs with graphite oil and screw them into the cylinder head, tightening up to the specified tightening torque (Job No. 00-0).

11. Connect the glow plugs to the bus bars. First of all put on the two outer bars with the larger connecting eyes that link plugs 1 to 2 and 3 to 4; then follow up with the union insulators and the bus bar linking the 2nd and 3rd glow plugs. The connecting cable is taken either to the 1st or 4th glow plug and the ground cable to the opposite side.

12. Make sure that the glow plugs are working properly (see also Job No. 15-31).

f) **Install nozzle-holder / injection-nozzle assembly** (see Job No. 07-22).

Crank Assembly – Group 03

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Removal and Installation of Counterweight and Vibration Damper on Crankshaft

Job No.
03-10

Modification: Section C included

A. Counterweight on the 4-Cylinder Models 190 c, 190 Dc, 200, 200 D

Removal:

1. If the counterweight has to be removed with the engine in the vehicle first remove the radiator (see Job No. 50-1). Release the tension of the fan belt and remove it.

2. Unscrew the stretch screw (8) together with washer (10) from the crankshaft. Remove vee-pulley (9) and counterweight (11) from the crankshaft, using Puller Part No. 112 589 07 33 00 (Fig. 03-10/1). Replacement of a damaged counterweight is impossible with the crankshaft installed. For replacement the crankshaft has to be removed and rebalanced together with the new counterweight.

Note: See section C for the proper procedures for fastening loose or sliding counterweights.

Installation:

3. Fit the counterweight (11) to the crankshaft (13) in such a way that the bores for the cylindrical pins (1) and (12) are aligned. Then drive home the two cylindrical pins (Fig. 03-10/1).

4. Fit on the vee-pulley (9) and tighten by means of the stretch screw (8) and the washer (10) (see Fig. 03-10/1). For tightening torque of stretch screw see Job No. 00-0.

5. Fit the vee-belts and tension them.

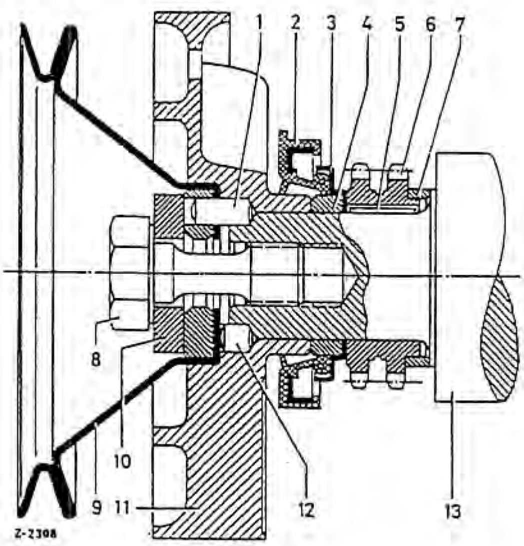

Fig. 03-10/1

1 Cylindrical pin 8h 8 × 16 DIN 7
2 Oil seal
3 Oil thrower
4 Spacer ring
5 Woodruff key
6 Crankshaft sprocket
7 Compensating ring
8 Stretch screw
(621 031 00 71 – length 53 mm)
9 Vee-pulley
10 Washer
11 Counterweight
12 Cylindrical pin 8h 8 × 8 DIN 7
13 Crankshaft

6. Install the radiator and fill in cooling water (see Job No. 50-1).

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

B. Vibration Damper and Counterweight on the 6-Cylinder Models 220 b to 250 SL

On Models 220 b to 250 SL a rubber vibration damper (1) has been installed between counterweight (12) and vee-pulley (2); the body of the damper and the hub are rubber-vulcanised and have been balanced as a unit.

Removal:

1. If the vibration damper or the counterweight has to be removed with the engine in the vehicle first remove the radiator (see Job No. 50-1). Release the tension of the fan belts and remove them.

2. Unscrew the three hexagon screws (5) and remove the vee-pulley (2) with the forced-on spacer ring (6) and the vibration damper (1) (Fig. 03-10/2).

3. Unscrew the stretch screw (4) with washer (3) from the crankshaft and pull the counterweight (12) off the crankshaft using Puller Part No. 112 589 07 33 00.

Note: See Section C for the proper procedures for fastening loose or sliding counterweights. When the counterweight is damaged the crankshaft must be removed and must be rebalanced together with the new counterweight. Replacement of a damaged vibration damper is possible because the vibration damper is balanced independently of the crankshaft.

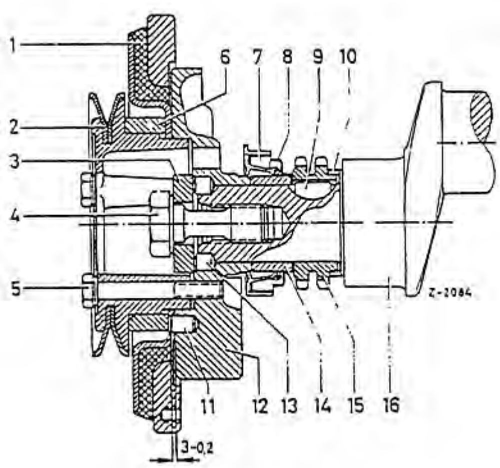

Fig. 03-10/2

1 Vibration damper
2 Vee-pulley
3 Washer
4 Stretch screw or 3 plate springs
5 Hexagon screw
6 Spacer ring
7 Oil seal
8 Oil thrower
9 Woodruff key
10 Compensating ring
11 Dowel pin 8h 8 × 12 DIN 7
12 Counterweight
13 Dowel pin 8 × 8 N 27 b
14 Spacer ring
15 Crankshaft sprocket
16 Crankshaft

Installation:

4. Fit the counterweight (12) to the crankshaft in such a way that the two bores for the dowel pins are aligned. Then drive in the two dowel pins (13) (Fig. 03-10/2).

5. Screw the stretch screw (4) with washer (3) to the crankshaft. For tightening torque of the stretch screw see Job No. 00-0.

6. Drive the dowel pin (11) into the counterweight (12) until it projects by no more than 3—0.2 mm.

7. Fit the vibration damper (1) to the pulley (2) and fit them together to the counterweight (12). The dowel pin (11) on the counterweight should project into the bore in the vibration damper. When the vibration damper is properly seated screw the vibration damper and the pulley to the counterweight by means of the three hexagon screws (5). For tightening torque of the hexagon screws see Job No. 00-0.

8. Fit the vee-belt and tension.

9. Install the radiator (see Job No. 50-1) and fill in the cooling water.

C. Refastening of Loose Counterweights on Crankshaft of Models 190 c to 250 SL

The procedures for fastening the counterweight on the crankshaft have been modified in a few details. The stretch screw is now installed together with 3 plate springs to increase initial tension. The force fit between crankshaft and counterweight was increased and the assembly procedure was modified so that the counterweight is installed on the crankshaft only once.

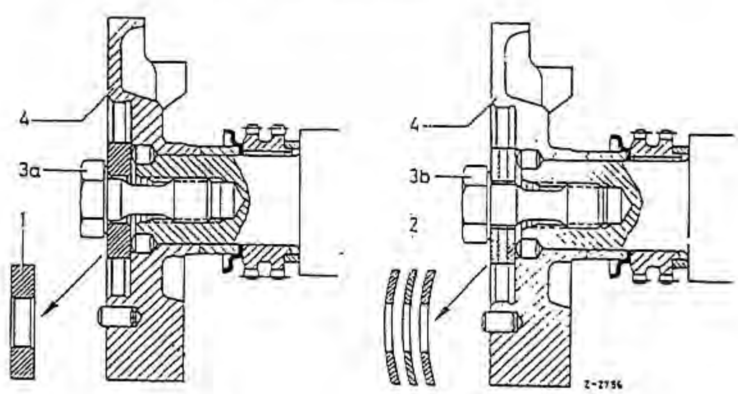

Fig. 03-10/3

1 Washer, previous version
2 3 plate springs, new version (127 993 00 26)
3a Stretch screw, previous version, length 53 mm
3b Stretch screw, new version, length 56 mm (127 031 00 71)
4 Counterweight

The following repair procedures have been evolved in order to make it possible to refasten a loose previous-version counterweight without having to replace the whole crankshaft; these procedures can be used provided that the play between crankshaft stub and counterweight hub does not exceed 0.16 mm.

1. Remove counterweight. To do this remove radiator, fan, vee-pulley and vibration damper, back out stretch screw and remove counterweight (see Sections A and B).

2. Clean front crankshaft stub and counterweight bore, use emery cloth if necessary. Measure crankshaft stub with a micrometer and counterweight bore with an internal micrometer and calculate the play.

3. Spray crankshaft stub with "Loctite Activator N" or with "Omnifit Activator" and wait until activator is completely dry (normally within 15—20 minutes, but check with instructions).

4. When activator has dried, select appropriate type of Loctite or Omnifit according to the play as determined above and apply a thin coat to both counterweight and crankshaft stub.

Play	Loctite Type	Omnifit Type
0.00—0.06	"Fügeteile" (green)	250 (red)
0.07—0.16	AVX (red)	250 (blue)

5. Slide the counterweight on the crankshaft making sure that the half bores of the counterweight are aligned with those of the crankshaft. (The dowel pin bore for the vibration damper should be in the TDC position. The relative position of crankshaft and counterweight is marked.) Now insert a 6—8 mm long tube with an outer diameter of appr. 8 mm in one of the dowel pin bores to prevent the counterweight from turning when the stretch screw is being tightened.

6. Screw in a new 56 mm stretch screw together with three plate springs and tighten with a torque of 21 + 1 mkp.

7. **Leave the Loctite or Omnifit to harden for a minimum of 24 hours.**

Note: Loctite and Omnifit require this minimum period to reach the final hardness required.

8. Bore the two dowel pin bores to

   $10\ \phi\ \begin{matrix}-0.044\\0.056\end{matrix}\ \text{mm}$

   using a three-lipped twist drill (DIN 343).

   Never use a standard twist drill since this will produce neither accurate bores nor the required surface quality.

Note: Since the distance between counterweight and front cross-member is only 21 cm, it is advisable to use an angular drilling machine for the purpose.

9. Measure depth of bore and length of dowel pin. Shorten new dowel pin, if necessary; there must be a minimum clearance of 0.3 mm between driven-in pins and counterweight face.

10. On 6-cylinder models:
    Drive in 2 new 8 mm dowel pins.

    On 4-cylinder models:
    Drive in one 8 mm and one 16 mm dowel pin.

Note: The dowel pin must always have the prescribed fit (see List of Parts required). On the 4-cylinder models always extend the vee-pulley bores to 10 mm since the 16 mm long dowel pin also serves to fix the vee-pulley.

11. Screw in a new stretch screw together with three plate springs and tighten with a torque of 21 + 1 mkp. Make sure that the plate springs are properly positioned: they must all be pushed on with the dished side pointing toward the screw head (Fig. 03-10/3).

12. Install vibration damper, vee-pulley, fan and radiator: see Sections A and B.

13. Run the engine and with the increase in speed check whether the engine runs without any abnormal vibrations and noises.

List of Parts Required:

Dowel pins	10 m 6 ϕ, length 8 mm, DIN 7, Part. No. 000007 010120
	10 m 6 ϕ, length 16 mm, DIN 7, Part. No. 000007 010101
Three-lipped twist drill ϕ	10 × 8 DIN 343
Loctite Activator Type N or	180 cc spray bottle
Omnifit Activator	180 cc spray bottle
Loctite Type "Fügeteile"	50 cc bottle green
Omnifit 250 red	50 cc bottle red
Loctite Type AVX or	50 cc bottle red
Omnifit 250 blue	50 cc bottle blue

These parts can be ordered from the Stuttgart-Untertuerkheim Spare Parts Department; or Loctite products also from Loctite-Technik Deutschland, Delo GmbH & Co. KG, 8 München 23, Bonner Platz 1, and Omnifit products from Omni-Technic GmbH, 8 München 54, Hanauer Strasse 30 a.

D. Vibration Damper on Models 300 SE, 300 SEb, 300 SEL

The vibration damper has been arranged on the front part of the crankshaft. It consists of a hub, two contact disks, two flywheel rings, two shear blocks, eight pressure springs, and a flywheel. The hub is fixed in position on the crankshaft by two dowel pins and the flywheel is fixed to the hub by two cylindrical pins (Fig. 03-10/4).

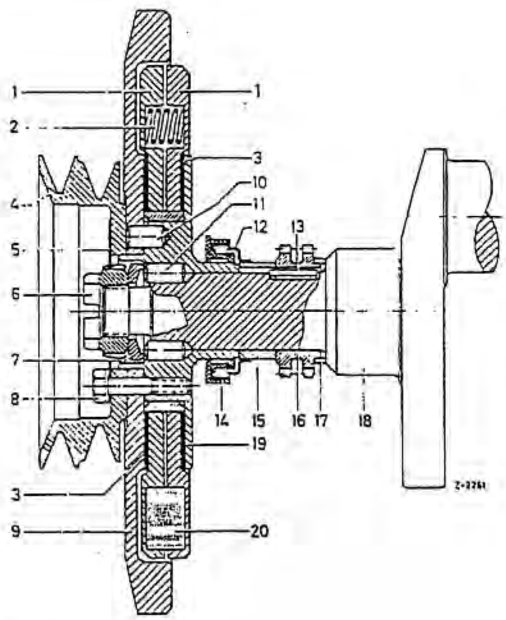

Fig. 03-10/4

1 Flywheel ring	11 Dowel pin
2 Pressure spring	12 Oil thrower
3 Contact disk	13 Feather key
4 Vee-pulley	14 Sealing ring
5 Locking plate	15 Spacer ring
6 Tightening nut	16 Crankshaft sprocket
7 Thrust plate	17 Compensating ring
8 Hexagon screw	18 Crankshaft
9 Flywheel	19 Hub with contact ring
10 Cylindrical pin	20 Shear block

Removal:

1. Remove the radiator (see Job No. 50-1). Remove the fan mounting bracket (see Job No. 20-3).

2. Clamp the vibration damper together by means of two Clamps Part No. 198 589 01 31 00 (Fig. 03-10/5). This is necessary in order to ensure that the hexagon screws are relieved when disassembling the vibration damper and that the vibration damper does not come apart.

3. Unscrew the four hexagon screws (8) and remove together with the locking plate and the vee-pulley (4) (Fig. 03-10/4).

4. Use Serrated Wrench Part No. 186 589 00 08 00 to unscrew the tightening nut (6) and remove the nut together with the thrust plate (7) and the vibration damper from the crankshaft.

Note: If the hub has to be removed use Puller Part No. 112 589 07 33 00 to pull the hub off the crankshaft.

5. Release the two clamps evenly and disasemble the vibration damper (Fig. 03-10/5).

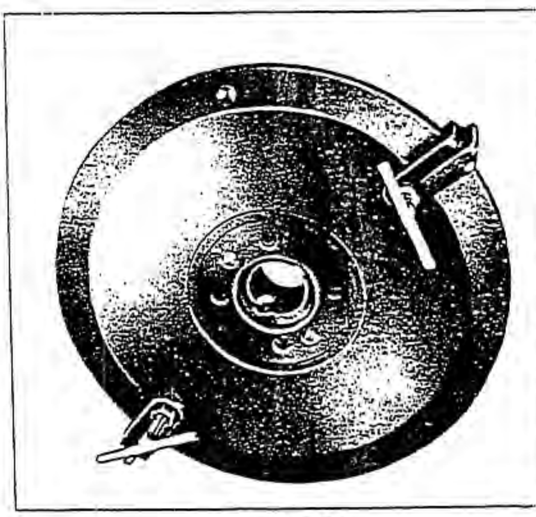

Fig. 03-10/5

6. Check all individual parts of the vibration damper (Fig. 03-10/6).

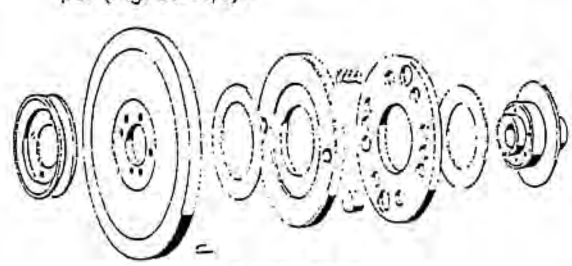

Fig. 03-10/6

Note: If the hub (19) or the flywheel (9) has to be replaced (Fig. 03-10/4) use Hub and Flywheel Part No. 189 030 09 08 which are properly balanced for repair work. In this repair version the hub is fixed in position in relation to the crankshaft with the two half bores and the flywheel is fixed in position in relation to the hub with the two bores.

Installation:

7. If the hub had been removed, drive a dowel pin (11) into one of the half bores of the hub (19) (Fig. 03-10/4). Lightly grease the shaft journal and the hub. Fit the hub to the crankshaft and install by means of Mounting Tool Part No. 186 589 12 61 00.

8. Check the second dowel pin hole and if necessary ream up. Fit the second dowel pin and drive in by means of a drift. Then drive the two cylindrical pins (10) into the hub.

Note: The hub can also be mounted together with the vibration damper.

9. Reassemble the vibration damper, making sure that the 8 pressure springs and the new shear blocks are properly seated in the holes (see Fig. 03-10/4). Then apply the two clamps and tension them evenly (Fig. 03-10/5).

Note: The contact disks (3) should be installed dry (Fig. 03-10/4).

10. Fit the rear contact disk (3) to the hub and slide the vibration damper on to the hub. The bores in the vibration damper must be aligned with the dowel pins in the hub.

11. Screw in the tightening nut (6) (Fig. 03-10/4) and tighten with the prescribed torque (see Job No. 00-0). Take care to ensure that the four bores in the locking plates (5) are aligned with the screw bores. Remove the two clamps.

12. Fit the pulley (4) to the flywheel (9). Install the locking plate (5) and attach the pulley to the hub by means of the four hexagon screws (8) with spring washers (Fig. 03-10/4). Tighten the four hexagon screws (8) with the prescribed torque (see Job No. 00-0).

13. After mounting the vibration damper check the friction torque which should be between 4.5 and 7 mkp. To do this attach a weight of 10 kg to a lever arm 600 mm long (Fig. 03-10/7).

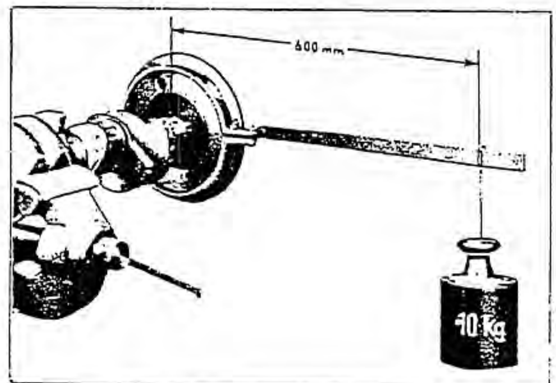

Fig. 03-10/7

14. Install the fan mounting bracket (see Job No. 20-3).
Install the radiator (see Job No. 50-1).

15. Run the engine, check the oil level in the automatic transmission, and if necessary top up.

Replacement of Front Oil Seal for Crankshaft

Job No.
03-12

Removal:

1. Remove counterweight (see Job No. 03-10).

2. Press out the oil seal (2) with a suitable tool. Take care to ensure that the crankcase oil-sump bore, the crankshaft stub and the oil thrower (3) are not damaged (see Fig. 03-10/1).

3. Remove spacer ring from the crankshaft stub (see Fig. 03-10/1).

Installation:

4. Round off the external edge of the bore between crankcase and oil sump with emery cloth.

5. Slide oil thrower and spacer ring onto the crankshaft stub (see Figs. 03-10/1 and 2).

6. Pack the space between the lips of the new oil seal with high melting point grease and lightly wipe the periphery with oil (see note following para. 8).

7. So as not to damage the lips of the oil seal, slide it onto the installing sleeve 111 589 17 61 00 and draw into the bore with the anti-fatigue/stretch screw for the counterweight. The collar half of the oil seal must fit snugly against the front face of the crankcase.

8. Fit counterweight (see Job No. 03-10).

Note: The front oil seal on the crankshaft, Part No. 180 031 06 81 (colour blue), has been replaced by a silicone oil seal, Part No. 108 031 00 81 (colour white/yellow), on the models listed below as from the stated engine end numbers. This seal is very elastic and therefore matches itself to the base bore exactly, thus providing a good seal.

Data

Model	Type of transmission	Engine end No.
230	mechanical	008 900
	automatic	002 580
230 S	mechanical	011 443
	automatic	004 756
230 SL	mechanical	012 284
	automatic	003 993
250 S, 250 SE, 250 SE/C, 250 SL	from beginning of manufacture of these models	

When repairs are being carried out, however it is not possible to fit the white/yellow sillicone oil seal with the engine installed, since when the oil seal is being installed the soft sealing material is pushed away at the edge of the base bore — so that it does not always provide a tight seal. When the front oil seal for the crankshaft is to be replaced, the newly-developed black oil seal with profiled periphery, Part No. 108 031 01 81 should be used.

This oil seal is less sensitive to the butt of the crankcase and oil sump base bore and to its edges. In addition, it may be employed instead of the white/yellow or blue oil seal and further for crankshaft with or without oil thrower. It may hence be used for repairing all 2.2, 2.3 and 2.5 litre engines (see table on next page).

The following table indicates how the various versions of oil seal may be used when repairs are being carried out.

Part. No.	Material (colour)	Model	Repair	Observations
180 031 06 81	Perbunan (blue)	220 b 220 Sb 220 SEb 220 SEb/C	With engine disassembled and with engine installed	Only with oil thrower and spacer sleeve Part No. 180 031 04 51 (16.25 mm)
108 031 00 81	silicone (white/yellow)	230 230 S 230 SL 250 S 250 SE 250 SE/C 250 SL	Only when engine is disassembled	Without oil thrower, but with wider spacer sleeve, Part No. 108 031 01 51 (16.9—17 mm)
108 031 01 81	polyacryl (black)	220 b/Sb/SEb 220 SEb/C 230 230 S 230 SL 250 S 250 SE 250 SE/C 250 SL	When engine is installed	With oil thrower and spacer sleeve, Part. No. 180 031 04 51 (16.25 mm), or without oil thrower but with wider spacer sleeve Part No. 108 031 01 51 (16.9—17 mm)

The oil seals obtainable as spare parts for all four-cylinder engines and engines for Models 300 SE, 300 SEb and 300 SEL may be used for disassembled and installed engines with or without oil thrower.

Engine Timing - Group 05

Revolution Counter - Group 06

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Engine Timing

General Data, Dimensions and Tolerances

Chain Tensioner

Model	Part No.	Dimension "a" (if removed from engine)
190 c, 200	121 050 06 11 *	57
190 D, 200 D	621 050 02 11	74
220 b, 220 Sb, 220 SEb, 230, 230 S, 230 SL, 250 S, 250 SE, 250 SL	180 050 07 11 *	51
300 SE, 300 SEb, 300 SEL	189 050 00 11 with three-hole flange and O-ring seal	37

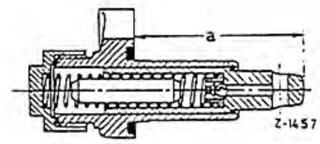

Fig. 05-0/6

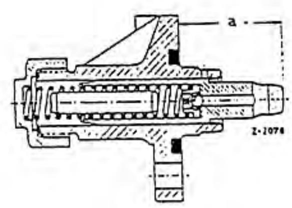

Fig. 05-0/7

Removal and Installation of Rocker Arm

Job No.
05-1

Note: The rocker arms for the inlet valves and the exhaust valves are identical.

Removal:

1. Press out the spring clamp (2) from the notch at the top of the rocker arm (3) and push the spring clamp outward over the ball cup of the rocker arm (see Fig. 05-1/1).

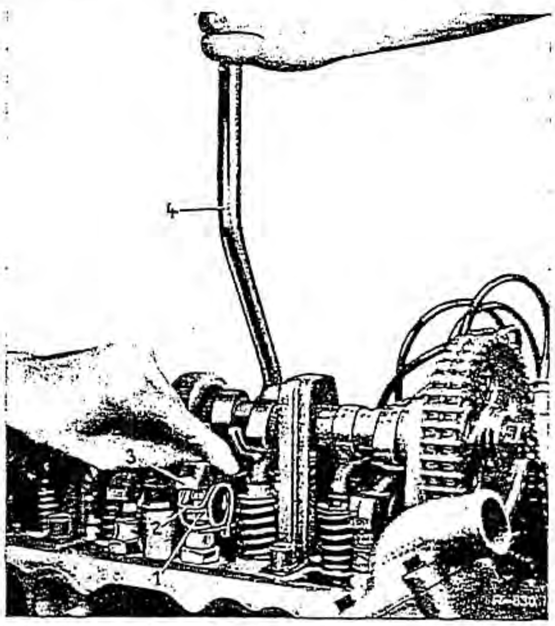

Fig. 05-1/1

1 Ball pin head
2 Spring clamp
3 Rocker arm
4 Special Tool 111 589 01 61

2. Apply Special Tool (4) 111 589 01 61 to the camshaft and to the valve spring retainer and push the valve downward to relieve the rocker arm (3) (Fig. 05-1/1).

3. Lift the rocker arm (3) out of the ball pin head (1) and remove it (Fig. 05-1/1).

Note: Before installation check the sliding surfaces and the ball cup of the rocker arm. Damaged rocker arms must be replaced.

Installation:

4. Apply Special Tool 111 589 01 61 to the camshaft and to the valve spring retainer and push the valve downward until the rocker arm with its ball cup can be placed on the ball pin head.

5. Position the rocker arm.

6. Push the spring clamp over the ball cup of the rocker arm until it engages in the notch of the rocker arm.

7. Check and if necessary adjust the tappet clearance (see Job No. 00-3).

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Job No.
05-2

Valve Stem Sealing System

Modification: Revised and supplemented

A. Replacing Valve Stem Sealing System with Cylinder Head Installed

Removal:

1. Remove rocker arm (see Job No. 05-1).

2. For removal of the valve stem sealing assemblies, the piston concerned should be in the ignition TDC position.

3. Support valve by connecting the cylinder leakage tester CLT-228 or one hose of the available compressed air supply to the spark plug bore (pressure in the compression chamber should be approx. 5 atm.).

4. Tap the valve spring retainer with a hammer so that the valve cone halves will come loose.

5. Use special tool to press the valve spring retainer downward far enough so that the valve cone halves (1) are free and can be lifted out with the aid of the magnetic lifting device (2) (Fig. 05-2/1).

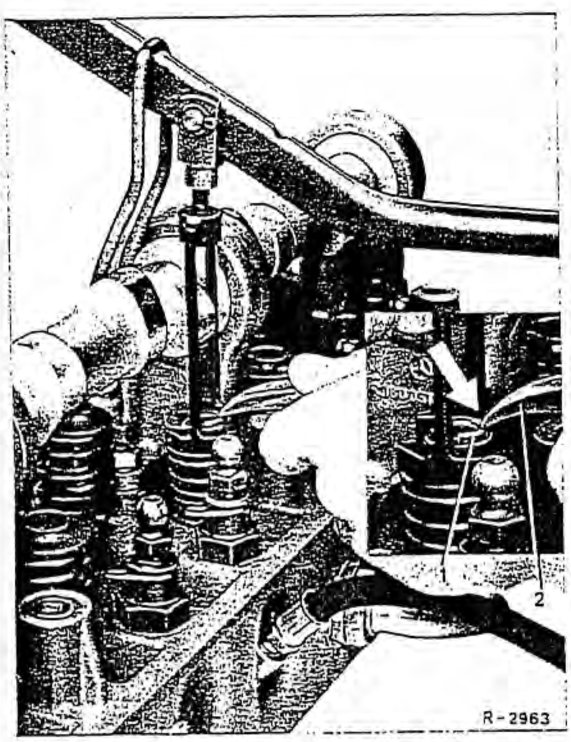


Fig. 05-2/1

1 Valve cone halve
2 Magnetic lifting device, Part No. 108 589 09 63 00

Note: On diesel engines unscrew cap nut and lock nut (Fig. 05-2/3) instead of valve cone halves.

6. Remove valve spring retainer, valve spring and valve spring seal as required (Figs. 05-2/3 to 13).

Note: Use the shop-made removal and installing tool (according to Fig. 05-2/14) for removing the valve seal so that no damage will occur to the valve guide.

Installation:

Installation of a new valve stem sealing ring is the reverse of the removal procedure; the following points should be carefully observed in the process:

a) The valve grooves for the valve cone halves must be free from burrs; valve spring retainers and valve cone halves must not be damaged by dents.

b) On the versions shown in Figs. 05-2/3, 7, 8, 10 and 13 always slide a plastic installation sleeve over the valve before installing the valve stem seal; the sleeve prevents damage from the groove.

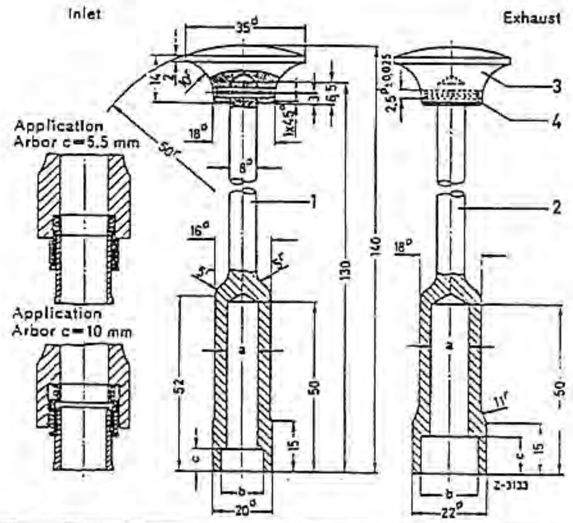
Plastic installation sleeves are available for
9 mm valve dia., Part No. 127 589 00 98 00,
10 mm valve dia., Part No. 110 589 00 98 00.

c) The shop-made installing arbor (Fig. 05-2/2) should be used for sliding the valve stem seal onto the valve guide.

d) The sealing-ring retainer (6) as shown in Figs. 05-2/5 and 11 must slide easily over the valve guide but without any clearance.

e) The sealing-ring retainer (3a) as shown in Figs. 05-2/4, 6 and 12 must not project more than 2 mm beyond the valve guide with the valve closed.

f) In installed condition, clearance between valve cone halves should be identical on both sides.



Dimension	Inlet all models 1st version	Inlet all models 2nd version	Exhaust 200, 230, SL 1st version	Exhaust 200, 230, SL 2nd version 230 S, 250 S, SE	Exhaust 200, 230, SL 3rd version 230 S, 250 S, SE, 2nd version 250 SL	Exhaust 300 SEb, SEL 600
a	9.2	9.2	10.2	11.2	11.2	12.2
b	13.3	14.7	14.2	14.2	16.5	15.5
c	5.5	10	5.5	5.5	10	5.5

Fig. 05-2/2

Assembly tools for valve stem seals

1, 2 Installation sleeve C 45, tempered
3 Knob
4 Cylindrical notched pin 2.5 × 16 DIN 1473

B. Valve Stem Sealing System Versions

a) Models 190 Dc, 200 D

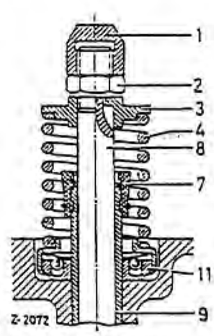


Fig. 05-2/3

Inlet and exhaust valve

1 Cap nut
2 Lock nut
3 Valve spring retainer
4 Valve spring
7 Valve stem seal
8 Valve
9 Valve guide
11 Valve rotator

The valve stem seal (7) as shown in Fig. 05-2/3 consists of a Teflon sealing ring which is carried in a rubber cap. A wire ring holds the rubber cap in the valve guide groove.

b) Model 190 c

with improved valve mechanism

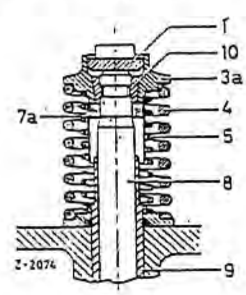


Fig. 05-2/4

Inlet and exhaust valve

1 Pressure piece
3a Valve spring retainer with sleeve (sealing-ring retainer)
4 Outer valve spring
5 Inner valve spring
7a Rubber sealing ring
8 Valve
9 Valve guide
10 Valve cone half

On the valve stem sealing system shown in Fig. 05-2/4 the sleeve, which is brazed to the valve spring retainer and which covers the valve guide, prevents oil spraying the valve stem. The rubber sealing ring (7a) prevents oil flowing down the valve stem into the combustion chamber.

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c) **Models 220 b, 220 Sb, 220 SEb**

with improved valve mechanism

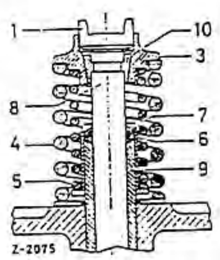


Fig. 05-2/5

Inlet valve

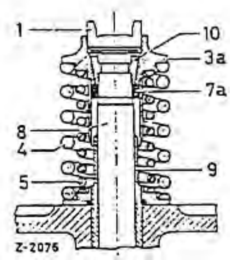


Fig. 05-2/6

Exhaust valve

1 Pressure piece
3 Valve spring retainer
3a Valve spring retainer with sleeve (sealing-ring retainer)
4 Outer valve spring
5 Inner valve spring
6 Sealing-ring retainer
7 Silicone sealing ring
7a Rubber sealing ring
8 Valve
9 Valve guide
10 Valve cone half

On the inlet valve the stem is sealed by a sealing-ring retainer (6) with a silicone sealing ring (7) which is pressed against the valve guide by the inner valve spring (5) (Fig. 05-2/5).
On the outlet valve the sleeve, which is brazed to the valve spring retainer (3a) and which covers the valve guide, prevents oil spraying the valve stem. The rubber sealing ring (7a) prevents oil flowing down the valve stem into the combustion chamber (Fig. 05-2/6).

Note: The first engines of Models 220 b and 220 Sb have the same valve stem sealing system for inlet and exhaust valves. The inlet valve sealing system as shown in Fig. 05-2/5 was installed in these models as from the following engine end numbers:

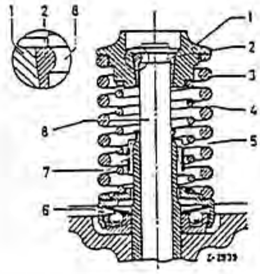
Model 220 b	without automatic clutch	00 21 62
	with automatic clutch	00 00 02
Model 220 Sb	without automatic clutch	00 40 90
	with automatic clutch	00 00 05

When repairs are carried out the present inlet valve stem sealing system can be installed subsequently without any difficulty: either replace the cylinder head or the valve guides.

d) **Models 200, 230, 230 S, 250 S, 250 SE, 250 SL**[1])

Fig. 05-2/7

Inlet and exhaust valve



1 Valve spring retainer
2 Valve cone half
3 Outer valve spring
4 Inner valve spring
5 Teflon sealing ring with clamping ring or annular spring and tightening strap
6 Valve rotator (Rotocap) (see also footnote 1)
7 Valve guide
8 Valve with annular groove for valve cone

1) The exhaust valves on Models 200, 230 (engine type 189 949) and 230 S, and the inlet valves on Models 230 (engine type 180 945) are provided with a thrust ring instead of the valve rotator (6).
Moreover, all valves in the engines of Models 250 S, 250 SE and 250 SL are equipped with valve rotators.

The valve stem is sealed by means of a Teflon sealing ring with clamping ring and tightening strap.

As a further improvement of the sealing system the exhaust valves, as from March 1967, have been provided with a valve guide with an annular groove and a beaded sealing ring (Fig. 05-2/8).

The important point in assembling the valve mechanism is to ensure that previous and present sealing rings and valve guides are properly matched: present version seals must not be used together with previous version valve guides and vice versa.

previous version | present version

Fig. 05-2/8

Exhaust valve sealing

000 053 07 58 manufactured by PC | 000 053 10 58 manufactured by Freudenberg

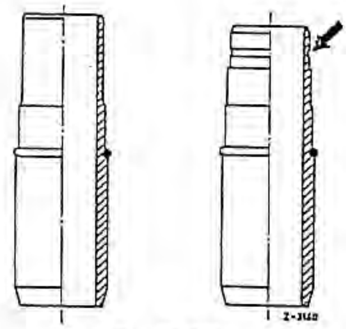


Fig. 05-2/9

Exhaust valve guide

108 050 00 24 | 108 050 05 24

Installation of improved valve sealing

Model	as from engine end no. with mechanical transmission	as from engine end no. with automatic transmission
200	043189	005765
230	006865	002408
230 S	023839	009342
250 S	026488	015531
250 SE	019856	016632
250 SL	000618	000466

e) Model 230 SL

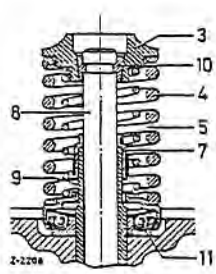


Fig. 05-2/10

Inlet and exhaust valve

3 Valve spring retainer
4 Outer valve spring
5 Inner valve spring
7 Teflon PC valve sealing ring with clamping ring and tightening strap
8 Valve
9 Valve guide
10 Valve cone half
11 Valve rotator (Rotocap) on inlet and exhaust valve

The valve stem sealing system is identical with the previous version described under d).

f) Model 300 SE

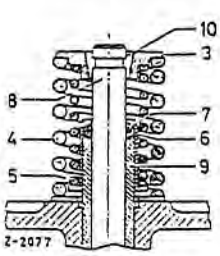


Fig. 05-2/11

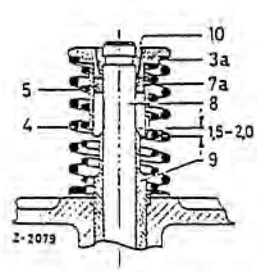
Inlet valve

3 Valve spring retainer
3a Valve spring retainer with sleeve (sealing-ring retainer)
4 Outer valve spring
5 Inner valve spring
6 Sealing-ring retainer

Fig. 05-2/12

Exhaust valve

7 Silicone sealing ring
7a Rubber sealing ring
8 Valve
9 Valve guide
10 Valve cone half



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The valve stem sealing system is in principle identical with the system described under c) (Figs. 05-2/5 and 05-2/6).

g) 300 SEb, 300 SEL

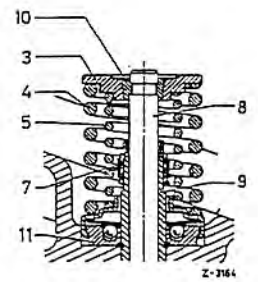


Fig. 05-2/13

Inlet and exhaust valve

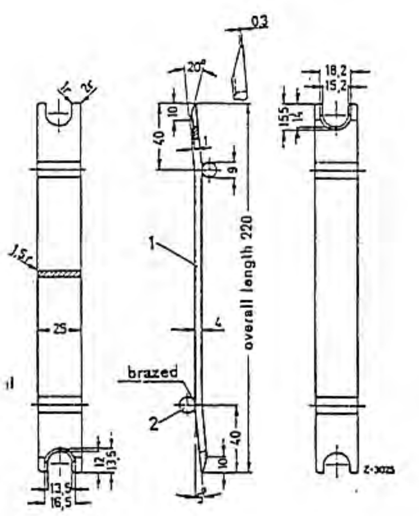
3 Valve spring retainer
4 Outer valve spring
5 Inner valve spring
7 Teflon PC valve sealing ring with clamping ring and tightening strap
8 Valve
9 Valve guide
10 Valve cone half
11 Valve rotator (Rotocap) on inlet and exhaust valve

The valve stem sealing system is in principle identical with the previous version described under d).

h) Removal Tool for PC Valve Sealing Ring

The sealing rings are removed with the tool shown in Fig. 05-2/14 which should be made in the shop.

Model
190 c
200
220 b
220 Sb
220 SEb
230
230 S
230 SL
250 S
250 SE
250 SL



Model
190 Dc
200 D
300 SE
300 SEb
300 SEL

Fig. 05-2/14

1 Removing lever, made of St. 37
2 Support roll, made of St. 37

Removal, Installation, and Bleeding of Chain Tensioner

Job No.
05-10

Modification: Revised

All engines are provided with a self-bleeding chain tensioner so that any air bubbles that may be produced can escape via a short longitudinal groove, with the result that the chain tensioner is always properly bled and chain noise is kept at a minimum. On the 1st version of the chain tensioner a flange seal was installed between cylinder head and chain tensioner. On later models a groove was cut into the chain tensioner housing and an O-ring installed as a seal between cylinder head and chain tensioner.

Removal:

1. In order to remove the chain tensioner, take off the cylinder head cover, drain part of the cooling water, and remove the thermostat housing. On gasoline injection engines also remove the control shaft between Venturi control unit and injection pump and on Model 300 SE also remove the guide pulley bracket.

2. Unscrew the fixing nuts of the chain tensioner and pull out the chain tensioner.

Note: Check the chain tensioner (see Job No. 05-11).

Installation:

3. Before installing the chain tensioner check the flange seal or, on recent chain tensioners, the O-ring. Heavily compressed or damaged flange seals and deformed or damaged O-rings should always be replaced. Chain tensioners with O-ring seals should never be provided with an additional flange seal.

Note: The oil case should always be empty when the chain tensioner is being installed since otherwise the housing may be strained when the nuts are being tightened.

4. Insert the chain tensioner in the cylinder head and evenly tighten the fixing nuts. On Model 300 SE tighten only the lower hexagon nut and install the guide pulley bracket.

Bleeding:

5. Fill the oil case in the cylinder head with engine oil. Use Bleeder Lever Part No. 187 589 02 63 00 or, if necessary, a screw driver to push the tension sprocket bearing as far as it will go (see Fig. 05-10/1). Slowly release the lever or the screw driver at the same time filling up the oil in order to ensure that the oil case is always full and the chain tensioner cannot suck in any air. Repeat this procedure until there are no longer any air bubbles on the chain tensioner. When the chain tensioner is properly bled there is no free travel and even at the beginning the tensioner can only be compressed with considerable force.

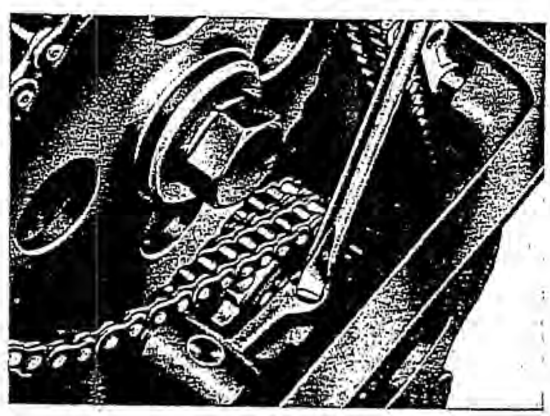


Fig. 05-10/1

6. Install the cylinder head cover. On gasoline injection engines also install the control shaft between the Venturi control unit and the injection pump and check the correlation (see Job No. 00-16/2, pages 00-16/4 to 16/8).

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<table><tr><td>Job No.</td></tr><tr><td>05-11</td></tr></table>

Checking of Chain Tensioner

Normally, a special testing appliance is required to check the accurate functioning of a chain tensioner. If no testing appliance is available a comparison between the defective chain tensioner and a new one will suffice. For this purpose the chain tensioner is removed, 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, evenly, 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 pressure pin (9) and the housing (4) must not be exchanged individually since both parts must be selected so as to match perfectly (see Fig. 05-11/1).

Disassembly:

1. Unscrew the cap nut (1); please remember that the pressure spring (3) presses against the cap nut (see Fig. 05-11/1).
2. Take the pressure spring (3), the pin (5), the ball retainer (6), the ball (8), and the pressure pin (9) out of the housing (4) (see Fig. 05-11/1).
3. Carefully clean all parts, check for wear and, if necessary, replace (for measurements and tolerances see Job No. 05-0, p. 05-0/4).

Reassembly:

4. Insert the pressure pin (9) in the housing (4). Put the ball (8) together with the ball retainer (6), the pin (5), and the pressure spring (3) in the pressure pin (9). Screw on the cap nut (1) together with the sealing ring (2) and tighten (see Fig. 05-11/1).
5. Fill the chain tensioner with oil, bleed, and check.

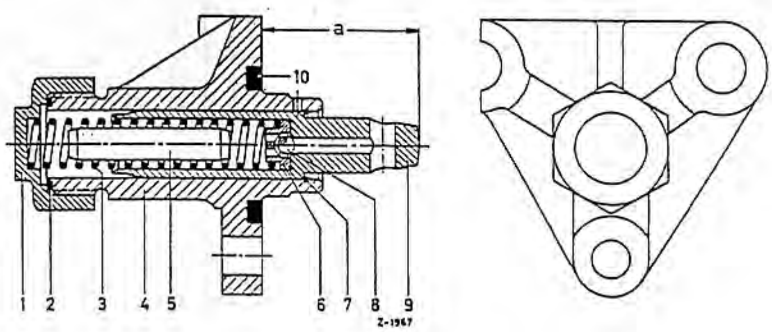

Fig. 05-11/1

1 Cap nut
2 Sealing ring
3 Pressure spring
4 Housing
5 Pin
6 Ball retainer
7 Snap ring
8 Ball
9 Pressure pin
10 O-ring

a = see Job No. 05-0

Removal and Installation of Twin Roller Chain

Job No.
05-15

If repairs should be necessary, a chain with a jointing link (spare link) can be installed as a substitute for the endless chain. This enables the chain to be replaced without disassembling the engine.

When the engine is being overhauled, however, an endless chain should always be fitted.

Removal:

1. Remove the cylinder head cover.

2. Remove the spark plugs in order to facilitate turning of the engine.

3. Remove the chain tensioner (see Job No. 05/10).

4. Remove rocker arm blocks.

Note: It is not absolutely necessary to remove the rocker arm blocks, but this procedure is advisable in order to prevent damage to the valves and the pistons if the roller chain should jump on the timing gear when the engine is being turned to install the chain.

5. In order to remove the old chain grind off the two chain rivets of one link and remove the link. Connect the new chain by means of a jointing link to the old chain and properly install the spring clip (locking clip) (see Fig. 05-15/1).

Note: Install the spring clip in such a way that it cannot be pushed off if it should jam anywhere.

Installation:

6. Put the old chain which is connected to the new chain on the timing gear, slowly turn the engine in the proper direction of rotation and feed in the new chain.

   Feed the chain to the timing gear in such a way that the camshaft is being turned at the same time and that the chain is being tensioned by the crankshaft in the direction of pull. Pull out the released end of the old chain evenly as the new chain is being fed in to ensure that the chain cannot jam.

Note: The crankshaft can be turned over by means of a box wrench SW 22 fitted to the shoulder screw for the pulley attachment. On the Model 300 SE it can be turned over via the bores on the outer diameter of the vibration damper flywheel.

7. Turn over the crankshaft until the jointing link with the spring clip can be fitted to the other end of the new chain.

8. Lock the new chain by means of the jointing link.

Caution!

Insert the jointing link (2) from front to rear. Insert the spring clip (1) with its closed end pointing in the direction of rotation (see Fig. 05-15/1).

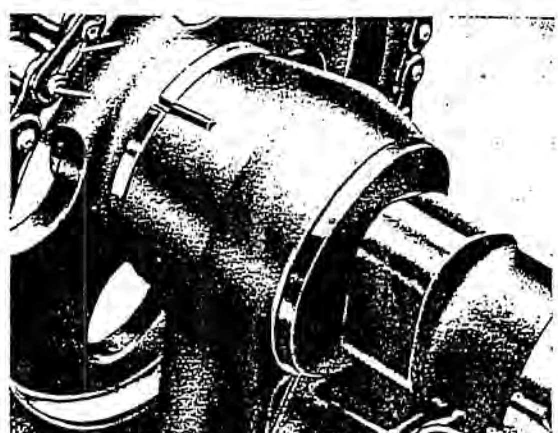

Fig. 05-15/1

1 Spring clip
2 Jointing link (spare link)

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9. Install the chain tensioner and bleed (see Job No. 05-1/10).

10. Install the rocker arm blocks and adjust the tappet clearance.

11. Check the adjustment of the crankshaft in relation to the camshaft.

    If the adjustment is incorrect the timing gear must be removed and the chain must be reset on the timing gear by the corresponding number of teeth.

12. Install the spark plugs and the cylinder head cover.
    On Models 220 SEb, 230 SL, and 300 SE also install the control shaft between the Venturi control unit and the injection pump and check the correlation (see Job No. 00-16, p. 00-16/4-18).

Chain Guides

Job No.
05-18

A. General Remarks

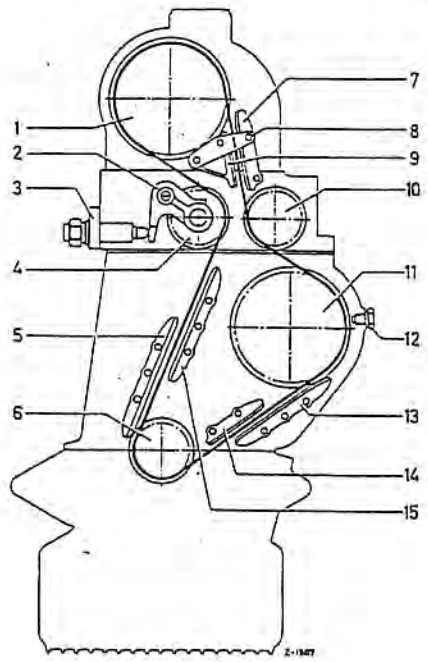

Fig. 05-18/1

1 Camshaft sprocket
2 Tension sprocket bearing c/w sprocket
3 Chain tensioner
4 Tension sprocket
5 Chain guide, outside (180 050 1416) ¹)
6 Crankshaft sprocket
7 Chain guide, outside (621 050 04 16)
8 Bracket for chain guide, inside
9 Chain guide, inside (621 050 05 16)
10 Reversing sprocket
11 Intermediate gear
12 Locking screw
13 Chain guide, outside (615 050 01 16) ¹)
14 Chain guide, inside (621 050 07 16) ¹)
15 Chain guide, inside (180 050 14 16) ¹)

¹) **New, Reinforced version**

On the 190 Dc and 200 D models with vacuum pump the chain guides (13) and (14) between crankshaft sprocket and injection timer are specially jeopardized. Chain guides (13) and (14) are subject to wear because of oscillation of the chain and the chain guide (13) may hence become bent and break.

A broken chain guide may be accompanied by secondary damage caused by the chain breaking and resulting in fracture of the camshaft.

For this reason, a reinforced chain guide (13), Part No. 180 050 14 16, is installed as standard instead of the earlier chain guide, Part No. 180 050 08 16, in the 200 D model as
from engine No. 621 918-10-106 047
and 621 918-12-007-144,
(Fig. 05-18/1). When repairs are necessary, however, the latest version with Part No. 615 050 01 16 should be installed for the chain guide (13).

Moreover, as from engine Nos. 621 918-10-122 680 and 621 918-12-008 048 **the reinforced and longer chain guide (14)**, Part **No. 621 050 07 16**, is installed instead of the previous chain guide, Part No. 621 050 04 16.

To prevent the aforementioned secondary damage, it is recommended exchanging the two chain guides (13) and (14) for the reinforced versions after approximately **37,500 miles**. On this occasion, if complaints have been received about chain noises the reinforced compression spring, Part No. 621 993 06 01, should be fitted in the chain tensioner.

When repairs are carried out, the **non-reinforced chain guides (5) and (15)**, Part No. 180 050 08 16, may also be replaced by **the reinforced version**, Part No. 180 050 14 16 (Fig. 05-18/1).

B. Replacement of Chain Guides (13) and (14) between Injection Timer and Crankshaft Sprocket

Removal:

1. Remove radiator (see Job No. 50-1).
2. Detach intake and pressure pipes from the vacuum pump.
3. Unscrew vacuum pump from the crankcase and remove together with gasket.
4. Remove fan and water pump Vee-pulley.
5. Unscrew the fixing screw for the counterweight on the crankshaft and remove counterweight. If this cannot be removed by hand, do **not pull off the counterweight**, but proceed as follows:

Make a disk with the dimensions shown in Fig. 05-18/2. This disk corresponds in thickness to the Vee-pulley.

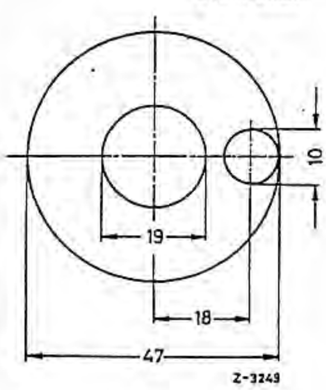

Fig. 05-18/2

Now screw in the fixing screw with the shop-made disk for rotating the crankshaft. Drill out the 8-mm bore in the counterweight to a diameter of 15 mm. To cancel out the unbalance produced, drill a hole with a diameter of 10 mm and a depth of 4 mm at the same distance from the axis of rotation but staggered by 180°.

6. Remove cylinder head cover and chain guides (7 and 9) (see Section C and Fig. 05-18/1).

7. Merely back off the camshaft sprocket fixing screw and unscrew Polystop nut from injection timer.

8. Rotate crankshaft in direction of rotation until the bored hole in the counterweight with a diameter of 15 mm coincides with the lower chain guide attaching bolt. **In this position,** mark the mesh of the chain on the chain and on the timing sprocket of the injection timer as well as the position of the injection timer with respect to the crankcase by using a punch. In addition, fix the meshing position of the chain on the camshaft sprocket by winding with wire and mark the position of the compensating washer on the camshaft with respect to the first camshaft bearing by using a punch.

Note: If the injection timer has to be disassembled it is advisable to mark the position of the segmental flange with timing gear with respect to the segmental plate with lifting cam by means of a punch.

9. Carefully unscrew the cap nut from chain tensioner; withdraw pressure bolt with compression spring from the chain tensioner housing together with ball cage, ball and straight dowel pin.

10. Unscrew fixing screw for the camshaft sprocket, pull off camshaft sprocket with chain and place both in the chain box. When pulling the camshaft sprocket pay attention to the compensating washer between camshaft and camshaft sprocket.

11. Unscrew locking screw (12) for the chain drive and withdraw upper bearing bolt of chain guide (13) with the extractor, Part. No. 115 589 07 33 00, (Fig. 05-18/1).

12. Between the intermediate gear (11) and the chain insert a strip of sheet metal or cardboard measuring approximately 200 × 70 mm and bent to follow the contour of the intermediate gear, in such a way that the chain is lifted off the teeth of the latter (Fig. 05-18/1).

13. Pull off injection timer. To do this, tap the drive shaft lightly with a Belzerit hammer so that the injection timer is released from the shaft. Remove strip of sheet metal or cardboard.

Caution! Do not rotate crankshaft and camshaft after removing the injection timer.

14. Remove bushing (7) for the injection timer and for the timing chain sprocket as well as the stop ring (3) from the intermediate gear shaft

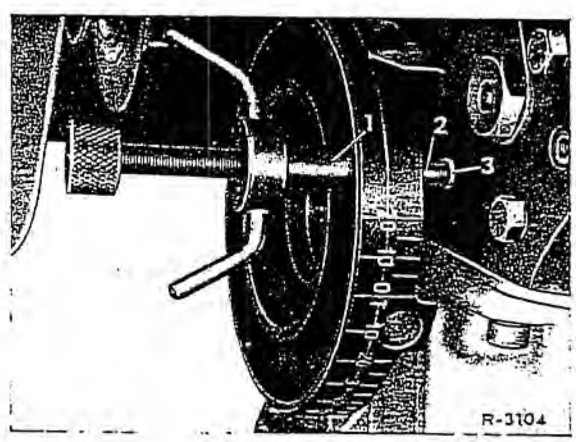

Fig. 05-18/3

1 Puller (115 589 07 33 00)
2 Threaded pin of puller
3 Lower bearing bolt of chain guide (14)

15. Pull lower bearing bolt of the chain guide (13) with the puller and remove chain guide (Fig. 05-18/1).

16. Pull lower bearing bolt of chain guide (14) (Figs. 05-18/1 and 18/3).

To do this, insert a 10 mm washer which has been filed to fit between the puller and the 15-mm bore in the counterweight (Fig. 05-18/3). The washer compensates for the curvature in the counterweight so that the puller seats properly.

17. Unscrew locking screw (2) together with upper bearing bolt for the chain guide (14), remove alignment indicator and chain guide (Fig. 05-18/4).

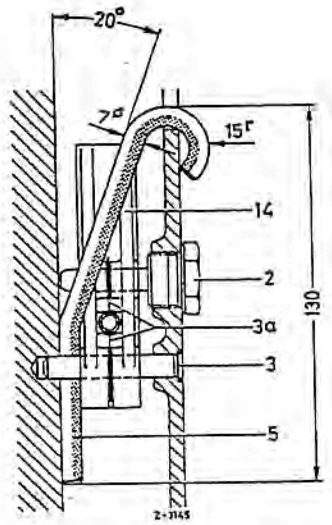

Fig. 05-18/4

2 Locking screw with upper bearing bolt for chain guide
3a Locking wire for bearing bolt
3 Lower bearing bolt for chain guide
5 Retaining bracket (shop-made)
14 Chain guide

Installation:

18. **Installation of chain guide (14), inside** (Fig. 05-18/1). Introduce upper bearing bolt (2) with locking screw and oil seal into the crankcase and the chain guide (Fig. 05-18/4). To prevent the chain guide from shifting toward the rear, insert a shop-made retaining bracket (5) between crankcase partition wall and chain guide and attach to the front crankcase wall. When tightening the locking screw (2), make sure that the locking wire of the chain guide snaps into the annular groove. Screw lower bearing bolt (3) onto an M 6 × 60 hexagon screw and coat outer end with sealing compound; then introduce through the 15-mm bore in the counterweight into the crankcase and the chain guide; tap in with the hexagon screw. The locking wire must also snap into position in the bearing bolt. Remove hexagon screw and retaining bracket.

19. **Installation of chain guide (13), outside.** Coat outer end of lower bearing bolt with sealing compound and introduce into crankcase and chain guide; insert retaining bracket (5) between chain guide and partition wall and tap in bearing bolt until the locking wire snaps into position in it. Remove retaining bracket (5).

20. Insert strip of sheet metal or cardboard (see para. 12) for introducing the injection timer; slide stop ring and bushing onto intermediate gear shaft and insert injection timer — paying attention to the marks made as described in para. 7. Remove strip of sheet metal or cardboard.

21. Slide camshaft sprocket with chain onto camshaft, paying attention to the compensating washer between camshaft and camshaft sprocket.

22. Check for coincidence of marks: camshaft sprocket vs. chain, first camshaft bearing vs. compensating washer and injection timer vs. chain; correct if necessary.

23. Fit a new oil seal to the locking screw (12) for the chain drive and screw in. Coat the outer end of the upper attaching bolt for the outside chain guide (13) with sealing compound and then tap into the crankcase and chain guide (Fig. 05-18/1).

24. Insert pressure bolt with compression spring, ball cage, ball and dowel pin into the chain tensioner housing and tighten cap nut. Fill oil case in cylinder head with oil and bleed chain tensioner.

Note: If chain noises are apparent, the stronger pressure spring, Part No. 621 993 06 01 may be fitted. It must further be checked whether the chain is properly tensioned by the tensioner. When the timing chain has stretched excessively, the pressure lever of the sprocket bearing is in contact with the oil retaining wall in the cylinder head (see Job No. 05-20).

25. Tighten the fixing screw for the camshaft sprocket. Tighten hexagon screw and Polystop nut for fixing the injection timer with a torque of 7 mkp.

26. Install Vee-pulley for the crankshaft and tighten fixing screw with a torque of 18 mkp.

Note: If the counterweight has been removed because of insufficient force-fit, properly secure counterweight again in accordance with Job No. 03-10, para. C.

27. Check beginning of delivery (see Job No. 00-8).

28. Further assembly is carried out in the reverse sequence to that followed for disassembly.

C. Replacement of Chain Guides (7) and (9) between Camshaft Sprocket and Reversing Sprocket

1. Unscrew hexagon screw from bracket of inside chain guide (9); remove bracket together with inside chain guide from outside chain guide (7) and from the cylinder head (Fig. 05-18/1).

2. Now withdraw lower bearing bolt of the outside chain guide (7) with the puller 115 589 07 33 00, holding the chain guide so that it cannot drop into the crankcase.
Installation is carried out in the reverse sequence; when tapping in the lower bearing bolt of the outside chain guide make sure that the locking wire snaps into the annular groove of the bearing bolt.

D. Replacement of Chain Guides (5) and (15) Between Tension Sprocket and Crankshaft Sprocket

1. Extract bearing bolts of chain guides with the puller 115 589 07 33 00.

2. When fitting, coat the ends of all bearing bolts with sealing compound over a length of about 1 cm. Then tap in until the locking wire on the chain guide snaps into the annular groove in the bearing bolt.

Chain Stretch and Chain Noises

Job No.
05-20

Type 190 Dc and 200 D

A. Chain Stretch

As a consequence of normal wear the twin silent chain (earlier roller chain) employed in the timing gear may stretch; this not only causes rattling noises, but also changes the start of delivery by the injection pump and shifts the timing. In the event of chain noises and changed timing of the beginning of delivery in the direction of retarded timing, the available adjustment reserve "a" of the chain tensioner must therefore also be measured. This is done by inserting a 2-mm thick gage, Part No. 621 589 02 23 00, from the front between the lever (2) of the sprocket bearing and the web (3) on the cylinder head (Fig. 05-20/1). If the gage can be introduced between lever and web, i. e. if the dimension is still larger than 2 mm, chain stretch is as yet relatively small; it is then sufficient to correct the beginning of delivery. (For correction of the beginning of delivery, see Job No. 00-8).

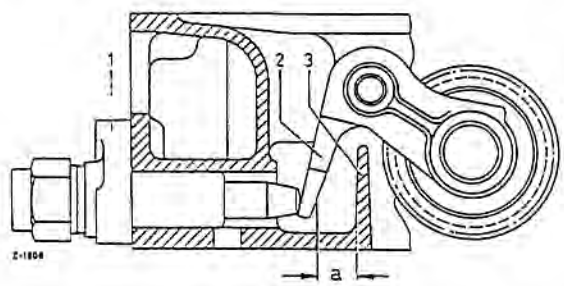

Fig. 05-20/1

1 Chain tensioner
2 Lever of sprocket bearing
3 (Web) oil pocket in cylinder head
a Available adjustment reserve

If the gage barely fits between lever (2) and web (3), chain stretch of about 6 mm and more has already occurred. Apart from the beginning of delivery, the timing must also be corrected first (see following section). A chain stretch of 1 mm is equivalent to a shift in the timing of 1° (crankshaft) in the direction of retard; chain stretch of 6 mm hence results in a shift in valve timing of 6° (crankshaft) in the direction of retard.

As a rough guide it can be assumed that a shift in the valve timing of 6° (crankshaft) reduces engine output by about 3 % and the engine torque by the same amount; a 10° (crankshaft) shift in valve timing causes a reduction of some 5 %.

If the gage cannot be introduced between lever and web, the chain should be replaced.

Correction of Valve Timing

Check timing and correct (see Job No. 00-9). Timing can be corrected by installing a Woodruff key offset to the right (viewed in forward direction).

If there is a pronounced shift of 6° and more in the timing, correction is absolutely imperative so as to prevent the valves from striking the piston crowns. For distance between valve and piston, see Job Nos. 00-9 and 00-0.

B. Chain Noises

General Remarks

Chain tensioner spring is fatigued; replace spring (Part No. of spring is 621 993 06 01). Chain stretch is excessive; increase available adjustment reserve or replace chain.

Chain Noises when Engine is idling

Sprocket bearing seized or pressure bolt in chain tensioner jammed; free up sprocket bearing and pressure bolt.

Intermittent Chain Noise

With a hot engine and fast driving on right-hand bends, intermittent chain noise may occur if the oil pocket has drained to such an extent that the chain tensioner entrains air and consequently becomes more flexible. Chain rattle disappears again in the course of time, since the air is gradually expelled.

Continuous Chain Noise

Chain guides are faulty, particularly the chain guides 13 and 14 between crankshaft sprocket and injection timer. See Job No. 05-18.

Revolution Counter Drive

Modification: revised

The engines of Models 220 SEb/C, 230 SL and 250 SL as well as those of Models 250 SE/C and 300 SE/C up to April 1966 are fitted with a revolution counter drive as standard equipment. As from the following chassis numbers the 250 SE/C and 300 SE/C engines have since been equipped with electronic revolution counters.

Model 250 SE/C as from chassis end No. 085 398
(with exception of 085 529, but also fitted in 085 361, 371, 373, 375, 377-382, 384-386, 388-390, 392-396).

Model 300 SE/C as from chassis end No. 009 291
(also fitted in 009 211, 232, 283, 285, 286, 287).

Drives for Mechanical Revolution Counter

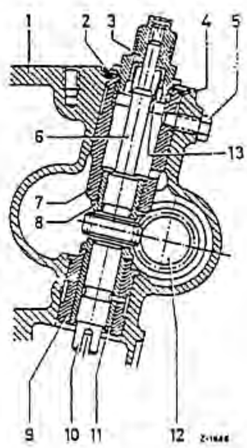

Fig. 06-1/1

Models 220 SEb and 250 SE Coupé and Convertible
230 SL and 250 SL

1 Crankcase
2 Cover disc
3 Connector for revolution counter drive
4 Rubber ring
5 Hexagon screw
6 Adaptor for revolution counter drive
7 Pressure piece
8 Bearing bushing
9 Bearing assembly
10 Helical gear
11 Bearing bushing
12 Idling gear shaft
13 Seal

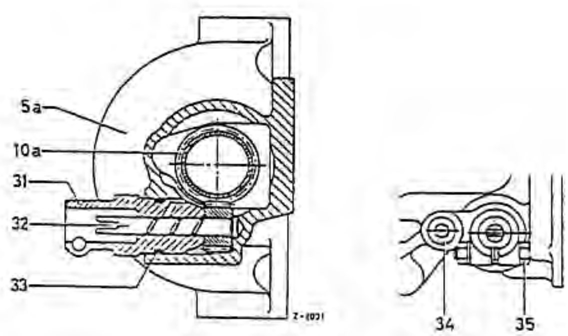

Fig. 06-1/2

Model 300 SE Coupé and Convertible

5a Drive housing
10a Connecting sleeve with helical gear for revolution counter drive
31 Revolution counter drive housing
32 Drive shaft with helical gear
33 Radial seal
34 Hexagon socket screw M 8 x 60
35 Hexagon screw M 6 x 30

For subsequent installation in the 220 SEb sedan model, use adaptor (6) and connector (3) (Fig. 06-1/1).

For subsequent installation in the 300 SE sedan, fit connecting sleeve (10a), the drive housing (5a) and the housing (31) together with drive shaft and helical gear (32) (Fig. 06-1/2).

Drive shafts, also see Job No. 18-6

For subsequent installation in Models 190 Dc and 200 D, fit the drive shaft together with revolution counter drive (10), Part No. 127 180 00 07, and the connector (3), Part No. 127 060 00 46 (see Fig. 06-1/1).

Carburetor and Injection System, Fuel Feed Pump Group 07

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Job No.
07-0

Gasoline and Diesel Injection Systems

General Data, Dimensions and Tolerances

Modification: Gasoline injection pump table supplemented, diesel injection pump and injection timer tables added

For Testing and Adjustment Data see Job No. 00-0

Gasoline Injection Pumps

Model	Transmission version	Engine type	Bosch designation DB Part No.	Remarks	Test values DAI Sheet date
220 SE	Mech. transmission	127.980	EP/ZEA 2 KL 75 R 1 000 074 28 01	Cam plate and cam lever have positive connection. Idle adjustment screw not adjustable from outside. One adjustment screw for total partial load range. (Replaced by R 3 pump)	2.2 a 7. 59
			EP/ZEA 2 KL 75 R 2 127 070 00 99	Cam plate and cam lever have non-positive connection. Idle adjustment screw adjustable from outside by means of spring-loaded idle control knob. Two adjustment screws for lower and upper partial load range. Replaced by R 3 pump.	
			EP/ZEA 2 KL 75 R 3 127 070 00 01	Differs from R 2 injection pump in insulating flanges fitted between thermostats and corrector assembly. Cut-off temperature for supplementary air and mixture enrichment during warm-up period by means of cooling water thermostat is between 65-68° C (on R 1 and R 2 injection pumps appr. 60° C). Inlet air thermostat with spring cup which limits adjustment by inlet air thermostat to 30 to 35° C.	2.2 b 12.59
220 SE Convertible and Coupé		127.983	EP/ZEA 2 KL 75 R 3 Z 127 070 02 01	Differs from R 3 injection pump in modified partial-load and full-load adjustment.	2.2 c 12.59
220 SEb	Mech. transmission	127.982 127.984	EP/ZEA 2KL 75 R 4 003 074 38 01	Differs from R 3 Z injection pump only in modified adjustment lever. Replaced by R 6 pump.	
			EP/ZEA 2 KL 75 R 6[1]) 003 074 68 01	Differs from R 4 injection pump in the adjustment lever which is suitable for top and bottom control linkage	
			EP/ZEB 2 KL 75 R 11 127 070 05 01	Two-cylinder injection pump with mechanical control. Replaced by R 14 pump.	2.2 f 6. 62
			EP/ZEB 2 KL 75 R 14 127 070 16 01	Differs from R 11 injection pump in modified pressure valves	2.2 g 5. 64
	Automatic transmission		EP/ZEA 2 KL 75 R 7 004 074 06 01	Differs from R 6 injection pump in better governing of warming-up air and steeper end of idle governing (increased idling speed)	2.2 d 8. 61
			EP/ZEB 2 KL 75 R 13 127 070 08 01	Differs from R 11 injection pump in steeper idle adjustment curve. Replaced by R 16 pump.	2.2 h 6. 62
			EP/ZEB 2 KL 75 R 16 127 070 17 01	Differs from R 13 injection pump in modified pressure valves	2.2 i 5. 64
230 SL	Mech. and automatic transmission	127.981	PES 6 KL 70/120 R 11 127 070 07 01	Six-cylinder injection pump with mechanical control via three-dimensional cam	2.3 a 7. 66

Model	Transmission version	Engine type	Bosch designation DB Part No.	Remarks	Test values DAI Sheet date
250 SE 250 SL	Mech. and automatic transmission	129.980 129.981 129.982	PES 6 KL 70 A 120 R 18 129 070 03 01	Differs from R 11 injection pump in longer pump housing, modified three-dimensional cam. Replaced by R 18 z pump.	2.5 a 7. 66
			PES 6 KL 70 A 120 R 18z 129 070 06 01	Differs from R 18 injection pump in ball pressure valves, no oil check valve and slightly richer adjustment.	
			PES 6 KL 70 A 120 R 18y 129 070 08 01	USA version (exhaust gas purification). Differs from R 18 z in stop magnet, modified three-dimensional cam and guide tube for full-load adjustment screw.	2.5 a 1 4. 68
300 SE 300 SE (long)	Automatic transmission	189.984 189.985	EP/ZEB 2 KL 75 R 12 003 074 99 01	Two-cylinder injection pump with mechanical control. Replaced by R 15 pump.	3.0 h 6. 62
			EP/ZEB 2 KL 75 R 15 189 070 00 01	Differs from R 12 injection pump in modified pressure valves	3.0 k 5. 64
	Mech. transmission		EP/ZEB 2 KL 75 R 17 189 070 01 01	Differs from R 12 injection pump by flatter idle adjustment curve. Replaced by R 18 pump	3.0 l 4. 63
			EP/ZEB 2 KL 75 R 18 189 070 02 01	Differs from R 17 injection pump in modified pressure valves.	
	Mech. and automatic transmission	189.986	PES 6 KL 70 A 120 R 12 189 070 03 01	Six-cylinder injection pump with mechanical control via three-dimensional cam	3.0 i 7. 66
		189.987	PES 6 KL 70 A 120 R 12 189 070 03 01	up to engine no. 189.987-10-000 480 or 189.987-12-000 871	
			PES 6 KL 70 A 120 R 19 189 070 05 01	as from engine no. 189.987-10-000 481 or 189.987-12-000 872	3.0 m 7. 66
300 SEb 300 SEL	Mech. and automatic transmission	189.989 189.988	PES 6 KL 70 A 120 R 19 189 070 05 01	Differs from R 12 injection pump in longer housing, modified return-line union, start mechanism. (cable harness) modified. Replaced by R 19 pump Part No. 189 070 07 01	
			PES 6 KL 70 A 120 R 19 189 070 07 01	Differs from R 19 injection pump, Part No. 189 070 05 01, in being without oil check valve and with ball pressure valves	

[1]) On Model 220 SEb the ZEA injection pump can be replaced by the ZEB injection pump in the case of engines with top control linkage (see Job No. 07-12).

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Diesel Injection Pumps

Model	Injection pump with governor and fuel feed pump DB Part No.	Injection pump Bosch designation	Governor Bosch designation[3])	Fuel feed pump Bosch designation	Control rod travel incl. compensating travel[1]) mm	Test values DAI Sheet Date[2])
Injection pumps with governor and fuel feed pump as standard equipment on all models intended for operation in altitudes up to 2000 metres above sea level						
190 Dc 200 D left-hand drive model	621 070 23 01	PES 4 M 50 C 320 RS 14	EP/MN 60 M 15 DR	FP/K 22 M 7	14.9—15	1.9 K 3. 1965
190 Dc 200 D right-hand drive model	621 070 24 01	PES 4 M 50 C 320 RS 14	EP/MN 60 M 16 DR			
Injection pumps with governor and fuel feed pumps as standard equipment on all models intended for operation in altitudes over 2000 metres above sea level						
190 Dc 200 D left-hand drive model	621 070 25 01	PES 4 M 50 C 320 RS 14z	EP/MN 60 M 15 DR	FP/K 22 M 7	14.9—15	1.9 K 3. 1965
190 Dc 200 D right-hand drive model	621 070 26 01	PES 4 M 50 C 320 RS 14z	EP/MN 60 M 16 DR			

Note: Max. engine speed must always be measured under no-load condition. If necessary, the control valve must be positioned accordingly. (Specified max. rpm ratings must under no circumstances be exceeded; see Job No. 00-0).

Max. permissible speeds (speedometer readings)		
Model	for 2nd gear	for 3rd gear
190 Dc, 200 D	58 km	91 Km

Instead of carrying out the no-load max. rpm measurement (end of governing) the beginning of governing can be checked at full load, or, in the case of motor vehicles, the max. permissible speed for the 2nd and 3rd gear can be checked by the speedometer reading, and corrected if necessary. See table above for max. permissible speed ratings. Higher speeds are not permissible for mechanical reasons and because of the danger of oil and dirt being dragged from the air cleaner (see Job No. 00-19, Section D).

[1]) The indicated control rod travel represents the control rod travel from the full load stop to the extreme stop position. With the aid of the specified control rod and compensating travel values, the injection pump can also be checked without the use of a test bench in case this is absolutely necessary.
Checking and adjusting the injection pump accurately, however, is only possible by using an injection test bench or by carbon monoxide analysis of the exhaust gases (see Job No. 00-19, Section E). Test Sheets for various pump types are available for workshops having an appropriate test bench. These Test Sheets are supplied on request by the Service Division. **The sheets always refer to the latest injection pump model; if replacement is necessary, install that model or a replacement pump of the same model.**

[2]) Only those test values and test sheets apply that carry this or a later date.

[3]) **On model 190 Dc the injection pump with governor 15 d or 16 d should only be installed when the engine is equipped with a flexibly-mounted intake pipe and a Venturi control unit with check valve.**
If an RS 14 injection pump with a 12 d governor is installed in these engines in an emergency, the end of governing will be advanced by appr. 300 rpm. Correct maximum rpm under no load by opening the control valve and if necessary by adding supporting rings to the control spring (see Job No. 00-19, Section C). If an RS 14 injection pump with a 7 d governor is installed, modify the governor by replacing the control spring or by installing control spring WSF 11 P 260 X, since the 7 d governor does not function properly in engines with flexibly-mounted intake pipe and the engine tends to produce smoke in the upper speed range. Check maximum rpm under no load and correct (see Job No. 00-19, Section C).

Carburetor

Job No.
07-2

1. Model 220 b

The engine of Model 220 b is equipped with two Solex down-draft carburetors, type 34 PJCB. The carburetor 34 PJCB has a suction canal diameter of 34 mm.
The starter mechanism, the idle system and the main carburetor system are the same as in the down-draft carburetor 32 PJCB (previously fitted to model 180a) except that in the mixing tube holder a polyamide ball has been fitted which prevents a flow-back of the fuel to the float-chamber and the stalling of the engine, when the brakes are applied hard.
The accelerating pump used for carburetor 34 PJCB is known as a "neutral" pump (Carburetor 32 PJCB has a mixture enriching pump). With the neutral accelerating pump it is possible for the engine under partial load and full load depending on the depression in the air horn, to draw additional fuel from the pump system by way of the injection tube (15) and the bore (17) without using the accelerating pump (Fig. 07-2/1).

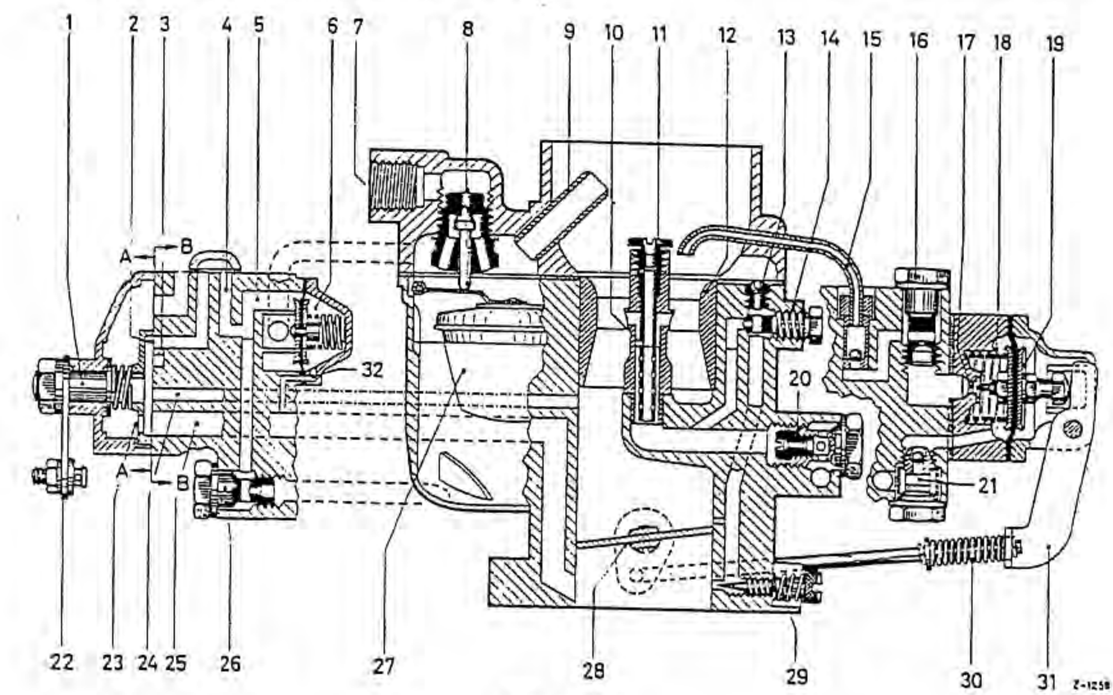


Fig. 07-2/1

Down-Draft Carburetor 34 PJCB
In Model 180 b without polyamide ball, as shown
In Model 220 b with polyamide ball in the mixing tube holder

1 Starter rotary slide valve
2 Graded intake bore in starter flange for fuel canal (4)
3 Graded intake bore in starter flange for fuel slot
4 Fuel canal to starter system
5 Air canal from starter air valve to fuel canal (4)
6 Starter air valve
7 Fuel-line connection in carburetor cover
8 Float needle valve
9 Vent tube for float chamber
10 Mixing tube holder with mixing tube
11 Air correction jet
12 Air horn
13 Idle air jet
14 Idle fuel jet
15 Injection tube
16 Pump jet
17 Bore
18 Diaphragm spring
19 Pump diaphragm
20 Main jet plug with main jet
21 Ball valve
22 Starter lever
23 Starter air bore in starter rotary slide valve
24 Additional air canal
25 Starter mixture canal
26 Starter fuel jet
27 Float
28 Throttle valve
27 Idle mixture adjustment screw
30 Connecting rod with compression spring
31 Pump arm
32 Vacuum canal for starter air valve

2. Model 220 Sb

The engine of Model 220 Sb is fitted with two Solex compound down-draft carburetors with the designation 34 PAJTA which have a suction canal diameter of 34 mm in the first stage. (Carburetor 32 PAJTA in Model 220 S has a suction canal diameter of 32 mm in the first stage). The starter mechanism and the idle system are the same as for compound down-draft carburetors 32 PAJTA.

The accelerating pump is as before a so-called neutral pump, with which it is possible for the engine under partial load and full load, depending on the depression in the air horn, to draw additional fuel from the pump system without using the accelerating pump. In addition, however, the accelerating pump is fitted with a valve which at a throttle valve position of 65–70° is opened by the pin of the pump diaphragm. In this way, when the engine is under full load, additional fuel flows through the check valve (50), the open valve (47), the enriching jet (47a), and through a fuel canal, by-passing the main jet, directly into the mixing tube holder. In throttle valve positions above 65–70° the fuel air mixture is thus additionally enriched (Fig. 07-2/2).

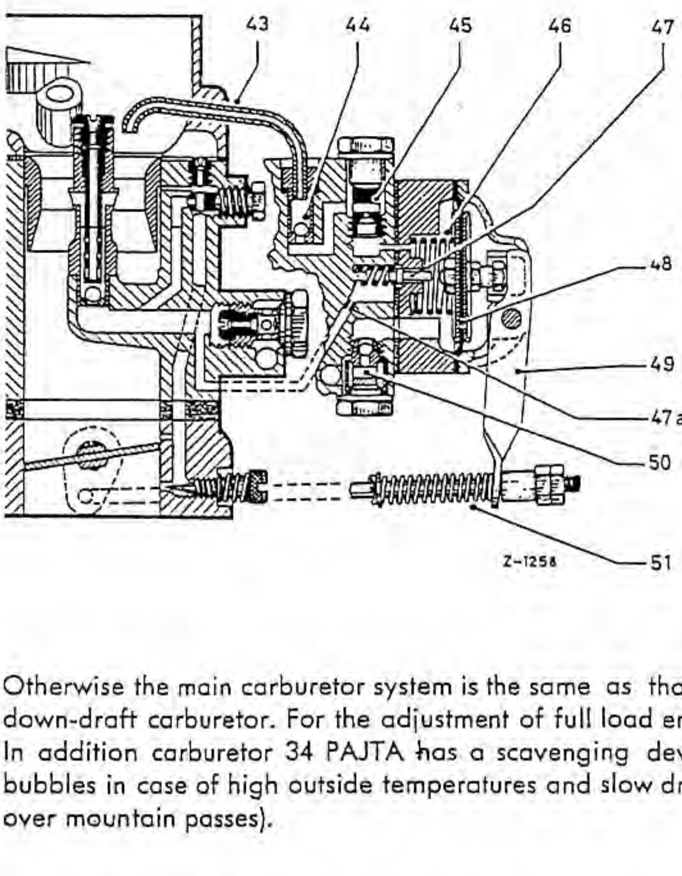


Fig. 07-2/2

43 Injection tube
44 Ball valve
45 Pump jet
46 Diaphragm spring
47 Valve
47a Enriching jet
48 Pump diaphragm
49 Pump arm
50 Ball valve
51 Connecting rod

Otherwise the main carburetor system is the same as that of the previous 32 PAJTA compound down-draft carburetor. For the adjustment of full load enrichment see Job No. 00-11.
In addition carburetor 34 PAJTA has a scavenging device to prevent the formation of vapor bubbles in case of high outside temperatures and slow driving (driving in a line of cars, and driving over mountain passes).

Description of the Scavenging Device

When idling and when the throttle valve is only slightly open, the engine needs very little fuel and consequently the fuel feed pump, because of the free wheel link in the pump arm, does not feed fuel to the carburetor with each stroke of the tappet. In these driving conditions only very little fuel flows through the whole fuel system and thus the danger of vapor bubble formation arises with high outside temperatures.

In order to reach a certain fuel circulation at low engine speeds and under light load, and in particular during idling, a fuel return valve (29) has been attached to the front carburetor, which is connected to the fuel tank by way of the fuel return pipe (30) (see Fig. 00-13/3).

The fuel return valve is operated mechanically by the spring-loaded head of the pump arm (25) of the accelerating pump (26), and the excess fuel runs back through the opened return valve (29) by way of the ring connector and the fuel return pipe (30) to the fuel tank (Fig. 00-13/2). Because of this circulation the fuel is cooled and the formation of vapor bubbles prevented.

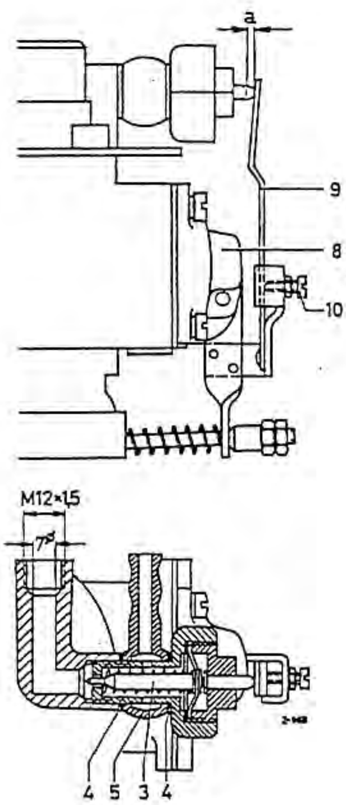


Fig. 07-2/3

Scavenging device on Models 220 b and 220 Sb

3 Valve pin
4 Fiber gasket
5 Ring connector
8 Accelerating pump
9 Spring-loaded pump arm head
10 Adjusting screw
a = 0.4—0.6 mm

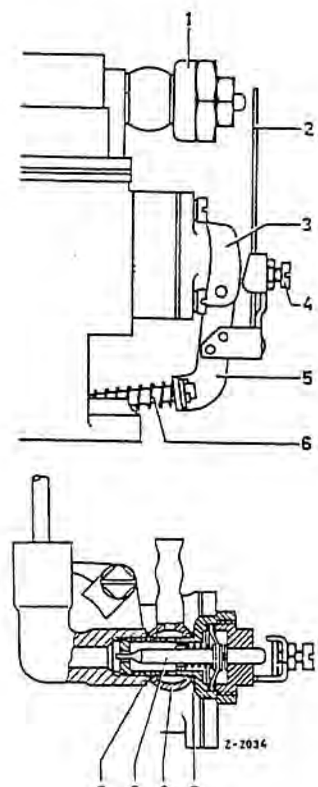


Fig. 07-2/4

Scavenging device on Model 190 c

1 Return valve
2 Spring-loaded the pump arm head
3 Accelerating pump
4 Adjusting screw
5 Pump arm
6 Connecting rod
7 Fiber gasket
8 Ring connector
9 Valve pin

In the idle position and when the throttle valve is only slightly open, the valve pin (3) of the return valve which is fitted with a sealing cone, is pressed outward by the compression spring so that the bore for the fuel flow remains open. When the throttle valves are opened further, the spring-loaded head of the pump arm (9), by overcoming the elastic force, presses the valve pin far enough in to close the bore to the passage of fuel and thus interrupts the scavenging process (Fig. 07-2/3).

Adjustment of the Fuel Return Valve

a) On Models 220 b and 220 Sb

Detach the spring-loaded push rod at the throttle valve lever of the front carburetor. Then back out the idle adjustment screw until the throttle valve of stage one is completely closed. Screw in the adjusting screw (10) on the pump arm until the return valve is completely closed. Then back out the adjusting screw until the valve pin of the return valve has covered the prescribed distance 'a' of 0.4–6.0 mm. Then lock the adjusting screw with the hexagon nut (Fig. 07-2/3).

Note: If the fuel return valve is not properly adjusted, and for this or for any other reason does not close properly, there is a shortage of fuel at higher engine speeds and the car can no longer reach its maximum speed.

b) On Model 190 c

On Model 190 c the scavenging device functions exactly the same way as on the six-cylinder models, the only exception being the adjustment of the fuel return valve. Since Model 190 c is provided with only one carburetor the return valve must close later in order to guarantee proper scavenging in the partial load range On Model 190 c the return valve closes a the end of the accelerating pump stroke.

The Fuel Return Valve should be adjusted as follows:

Push the accelerator linkage until the accelerating pump lever (5) is in its final position. Then turn in the adjusting screw (4) until the return valve (1) is completely closed (Fig. 07-2/4).

Job No.
07-3

Fuel Hose Model 190 c

The fuel hose between fuel feed pump and carburetor consists of a rubber hose with a braided fabric cover and has no screw joints. As a result, this fuel hose has a firm grip when it is under tensile stress. When removing the fuel hose it is therefore necessary to **press** it **off** by means of the washer (2). In no case must the fuel hose be pulled off, for this may force the pipe union out of the carburetor or the pump.

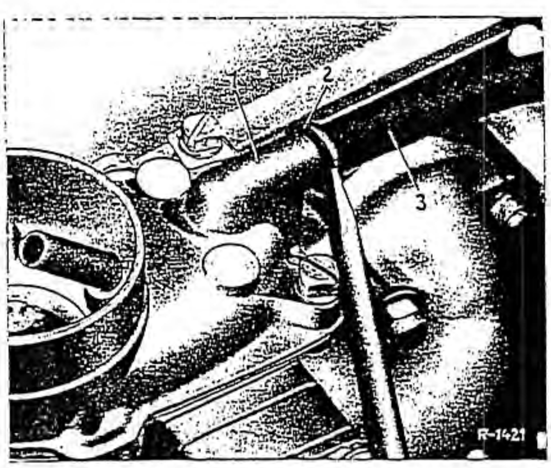


Fig. 07-3/1

1 Carburetor
2 Washer
3 Fuel hose

Fuel Injection System

Modification: Injection Pumps EP/ZEB 2 KL 75 R 11, R 12 and R 13 added

A. General

The fuel injection system works on the principle of intermittent intake pipe injection. In contrast to Model 300 d with intake pipe injection and Models 300 Sc and 300 SL with direct injection, in which injection control is vacuum operated, the injection system in Models 220 SE, 220 SEb and 300 SE is mechanically controlled. Furthermore, the injection pump (15) is not six-cylinder but a two-cylinder pump. The two pump elements of the injection pump, via two fuel distributor fittings (5), supply the six injection valves (19), which are located in the suction pipe (17) in front of the inlet valves. In the case of intake pipe injection, the injection fuel mixes partly in the suction canals of the cylinder head, partly inside the cylinders to form the combustible fuel-air mixture. Combustion is initiated by a standard ignition system (ignition coil, distributor and spark plugs).

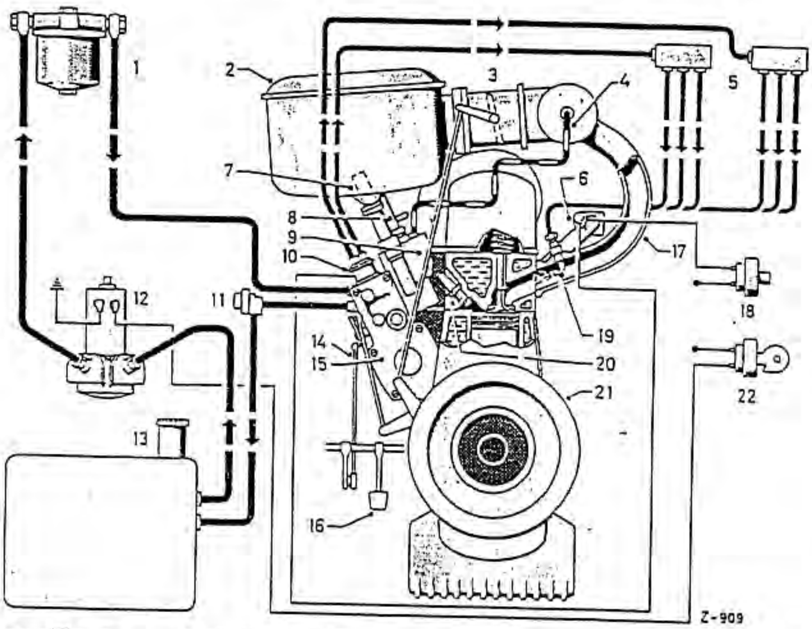


Fig. 07-10/1

Injection System in Model 220 SE with ZEA Injection Pump

1 Fine fuel filter
2 Air filter
3 Venturi control unit
4 Supplementary-air pipe
5 Fuel distributor fittings
6 Thermo switch for cold start magnet
7 Inlet air thermostat
8 Cooling water thermostat
9 Aneroid compensators
10 Cold start magnet
11 Damper unit in fuel return line
12 Fuel feed pump
13 Fuel tank
14 Control linkage
15 Injection pump
16 Accelerator pedal
17 Intake pipe
18 Starter push-button switch
19 Injection valve
20 Spark plug
21 Engine
22 Ignition switch (Model 220 SE)
Ignition starter switch (Model 220 SEb)
23 Damper unit in fuel feed line (also on Model 220 SE)
24 Relay
25 Time switch for cold start magnet (delay switch)
26 Thermo time switch for additional cold start mechanism
27 Relay
28 Solenoid starting valve
29 Atomizing jet

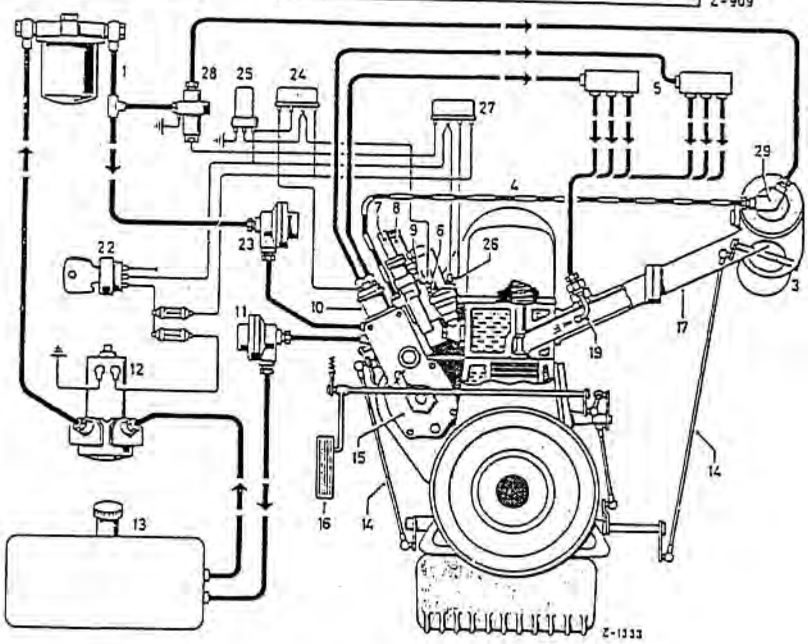


Fig. 07-10/2

Injection System in Model 220 SEb with ZEA Injection Pump

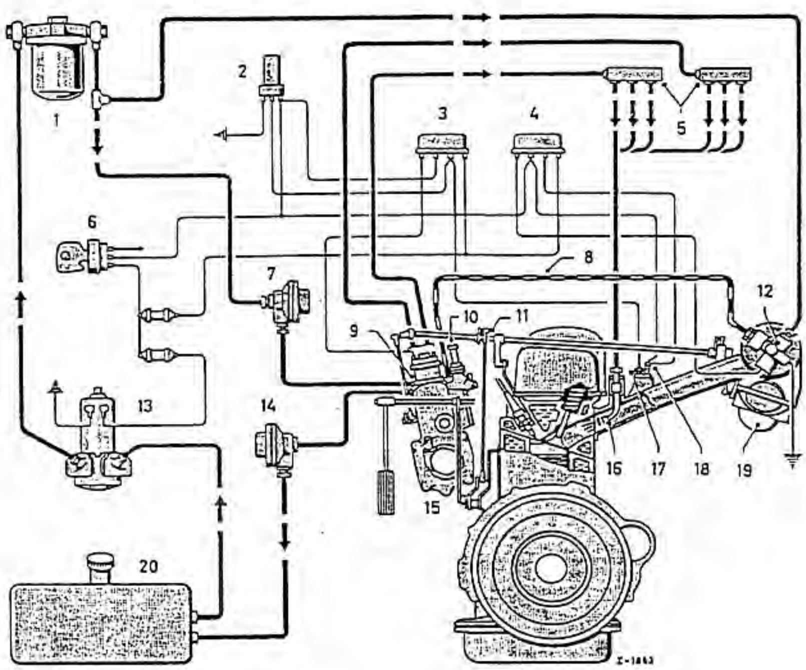


Fig. 07-10/3

Injection System in Model 300 SE with ZEB Injection Pump

1 Fine fuel filter
2 Time switch
3 Relay
4 Relay
5 Fuel distributor fittings
6 Ignition starter switch
7 Damper unit (feed line)
8 Supplementary air pipe
9 Cold start magnet
10 Cooling water thermostat
11 Control linkage
12 Solenoid starting valve with atomizing jet
13 Fuel feed pump
14 Damper unit (return line)
15 Injection pump
16 Injection valve
17 Thermo switch in cooling water circulation system
18 Thermo time switch in cooling water circulation system
19 Venturi control unit
20 Fuel tank

Control of Fuel Injection Amount

(see Figs. 07-10/1 to 3)

In order always and under all operating conditions to ensure the correct mixture for the engine – air-to-fuel ratio – the injection amount is controlled as follows:

1. Via the control linkage, the movements of the accelerator pedal are transmitted to the adjustment lever on the injection pump and simultaneously to the throttle valve in the venturi control unit. Thus fuel and air are positively controlled.

2. In accordance with the engine speed and the position of the adjustment lever, the centrifugal governor moves the fuel control rod of the injection pump.

3. When the engine is started cold, the fuel control rod is automatically moved to starting delivery by the automatic auxiliary start mechanism consisting of the cold start magnet on the injection pump and the thermo switch in the cooling water outlet connection.

   Additional enrichment in Models 220 SEb and 300 SE: at cooling water temperatures below + 5° C, additional fuel released by the solenoid starting valve is injected into the intake pipe by the atomizing jet. This process is controlled by the thermo time switch: the additional injection period increases with decreasing temperature to a maximum of 12 ± 3 seconds at –20° C.

4. When the engine in Models 220 SEb and 300 SE is started warm, the fuel control rod is moved to "starting delivery" for about 1 second by the time switch (delay switch) of the automatic auxiliary starting mechanism.

5. During the warming-up period of the engine after a cold start, the cooling water thermostat which is connected with the cooling water circulation system, decreases the amount of additional air and fuel supplied for the cold start.

6. In accordance with the air temperature, the fuel control rod of the ZEA Injection Pump is automatically adjusted by the inlet air thermostat.

7. In accordance with the prevailing atmospheric pressure, the fuel control rod is automatically adjusted by the aneroid compensators installed in the injection pump.

For Types and Distinguishing Features of the Injection Pumps see Job No. 07-0

B. Fuel Flow System

The electrically driven fuel feed pump (12), which continues to operate as long as the ignition is switched on, draws the fuel from the fuel tank (13) and forces it through the fine fuel filter (1) into the suction chamber of the injection pump (15) (Fig. 07-10/5).

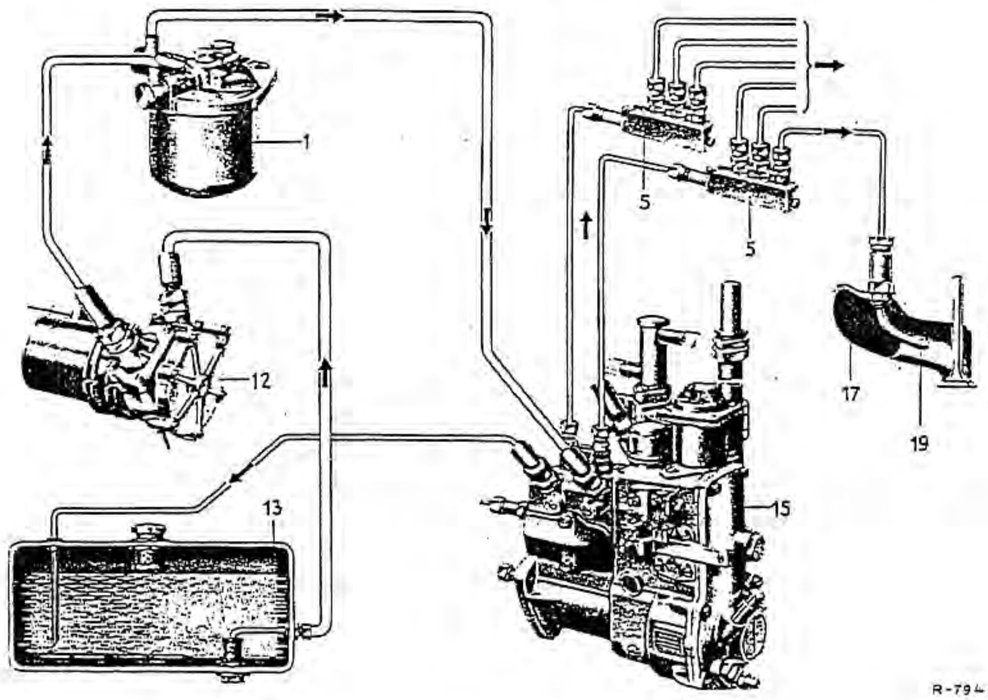


Fig. 07-10/5

1 Fine fuel filter
5 Fuel distributor fittings
12 Fuel feed pump
13 Fuel tank
15 Injection pump ZEA version
17 Intake pipe
19 Injection valves

Note: The position of the individual assemblies and parts as shown in Fig. 07-10/5 does not correspond to their arrangement in the car.

Independently of the engine speed the fuel feed pump always delivers the same amount of fuel. Delivery is many times the amount required by the engine at full load so that the fuel pipes and the suction chamber of the injection pump are subject to continuous scavenging action and the formation of vapor bubbles is prevented. The excess fuel flows back into the fuel tank trough the fuel return pipe.

In order to reduce the noise made by the fuel, damper units have been installed in the fuel feed pipe between the fine fuel filter and the injection pump and in the fuel return pipe directly behind the injection pump (see Fig. 07-10/25). The bore in the threaded union on the inlet side of the damper unit in the return pipe acts at the same time as a throttle. An overflow valve has not been installed in the pipe.

The plungers of the two pump elements in the injection pump force the fuel through the pressure valves into the fuel pressure pipes leading to the two fuel distributor fittings (5). From there the fuel passes to the injection valves (19) which inject the finely atomized fuel into the suction canals of the cylinder head, each distributor fitting supplying three cylinders simultaneously.

C. Design and Operation of the Injection System

a) Injection Pump

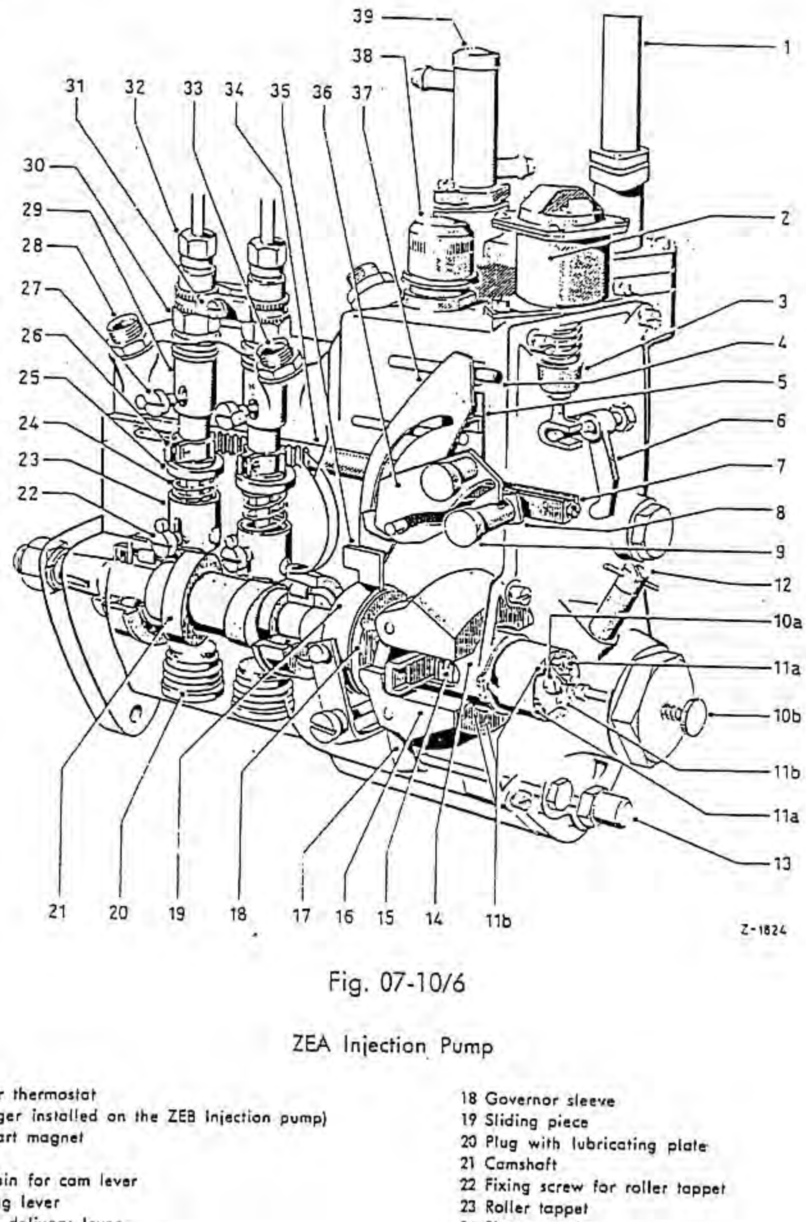
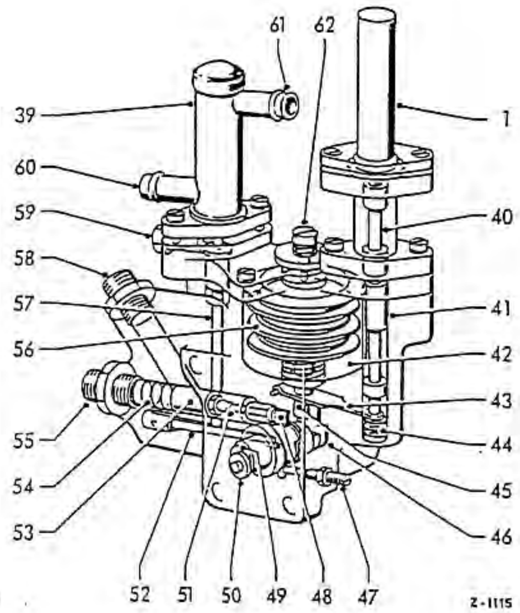


Fig. 07-10/6

ZEA Injection Pump

1 Inlet air thermostat
(no longer installed on the ZEB Injection pump)
2 Cold start magnet
3 Pin
4 Guide pin for cam lever
5 Reversing lever
6 Starting delivery lever
7 Fuel control rod head
8 Relay lever
9 Eccentric bushing
10a Idle adjustment screw
(black) up to appr. 1000 rpm
10b Spring-loaded idle control knob
11a Adjustment screw (black) for partial load or medium speed range of appr. 700 to appr. 4000 rpm
11b Adjustment screw (white) for partial load or too speed range as from appr. 2000 rpm
12 Dipstick
13 Governor sleeve stop screw
14 Joint
15 Governor springs
16 Flyweights
17 Supporting lever
18 Governor sleeve
19 Sliding piece
20 Plug with lubricating plate
21 Camshaft
22 Fixing screw for roller tappet
23 Roller tappet
24 Plunger spring
25 Control sleeve
26 Mobile toothed quadrant
27 Fixing screw for pump element
28 Fuel return pipe
29 Pump element
30 Pipe union
31 Clamping jaws
32 Pressure pipe
33 Fuel feed pipe
34 Fuel control rod
35 Drive lug
36 Cam plate
37 Cam lever
38 Air filter
39 Cooling water thermostat



1 Inlet air thermostat (no longer installed on the ZEB Injection Pump)
39 Cooling water thermostat
40 Pin
41 Guide bolt
42 Compensator basket
43 Lever
44 Spring
45 Bolt
46 Guide plate
47 Stop screw
48 Drive lug
49 Eccentric bushing
50 Eccentric shaft
51 Guide pin
52 Lever
53 Control slide valve
54 Spring
55 Supplementary-air inlet
56 Aneroid compensators
57 Guide bolt
58 Supplementary-air outlet
59 Stop bolt for cooling water thermostat
60 Cooling water inlet
61 Cooling water outlet
62 Stop screw for air inlet thermostat

Fig. 07-10/7

Corrector Assembly of ZEB Injection Pump

As described in section "A. General", Models 220 SE, 220 SEb and 300 SE have a two-cylinder pump with centrifugal governor instead of the six-cylinder pump with vacuum control hitherto used for our fuel injection engines. This pump injects the fuel not in the usual way separately for each cylinder at a certain fixed time, but injects finely atomized fuel into the intake pipe simultaneously for three cylinders at a time. This means that fuel is by no means always injected during the suction stroke with the inlet valve open, but injection takes place at various times although the time does not vary for any one cylinder. Since the camshaft of the injection pump turns at half the engine speed but has double cams, fuel is injected at every turn of the crankshaft. This means in fact that the fuel quantity for any one cylinder is injected in two equal parts. Independently of the position of the valves, fuel is continually injected into the intake pipe and together with the inlet air forms the fuel-air mixture.

Pump Element

Each pump element represents a single-acting constant-stroke plunger pump and consists of pump plunger (2) and pump cylinder (1) (Fig. 07-10/8). The two parts are given a lapped fit so that the plunger remains completely leak-proof even at low engine speeds and high pressures. This condition is brought about mainly by the oil contained in the cylinder and plunger trap groove (for details see "Oil lock in pump element").

A helix is cut into the top part of the plunger skirt; the edge thus produced is known as a helical control edge (3). In addition to this helical control edge the plunger has a vertical groove (4) and a horizontal groove (5).

The pump cylinder has an inlet bore (6) which connects the suction chamber in the pump housing with the pressure chamber in the pump cylinder. The pump cylinder is closed at the top by a spring-loaded pressure valve, to which the pressure pipe to the fuel distributor fitting is connected. (For details see "Pressure valve at pump element").

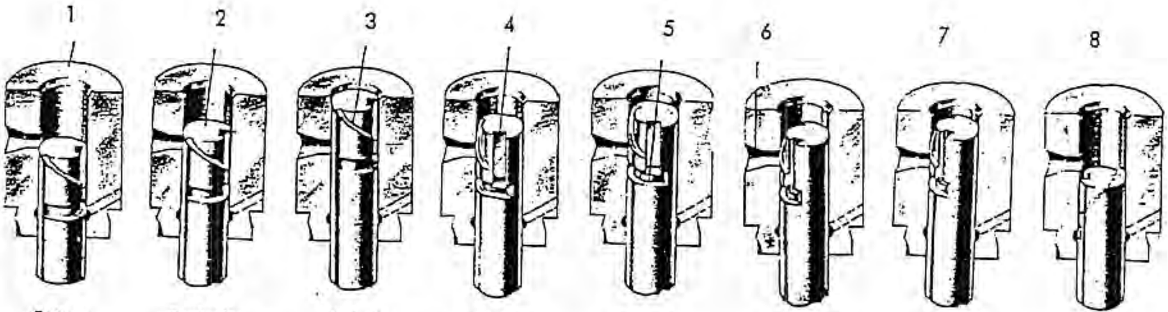


Fig. 07-10/8
Pump Element of the ZEA and ZEB Injection Pumps

The pump plunger is raised during the pressure stroke by the camshaft (21) via the roller tappet (23) and is pressed down during the suction stroke by the plunger spring (24) (see Fig. 07-10/6).

During the suction stroke, the plunger draws up fuel into the cylinder from the suction chamber through the inlet bore (6), and during the pressure stroke the fuel is forced into the pressure pipe through the pressure valve as soon as the helical control edge (3) has passed the inlet bore (beginning of delivery) (Fig. 07-10/8).

Delivery is finished as soon as the plunger, progressing upward, again opens up the inlet bore (6) by means of the horizontal groove (5) (end of delivery) for at that moment the pressure chamber above the plunger again communicates with the suction chamber via the vertical groove (4), the horizontal groove (5) and the inlet bore (6) and the fuel above the plunger is no longer under pressure.

By turning the plunger in the cylinder the delivery amount required at any given moment is adjusted by means of the helical control edge and the inlet bore as follows:

Delivery during the pressure stroke is progressively retarded the further the plunger is turned in the cylinder in a clockwise direction (seen from above), and vice versa. However, in the selected range, delivery always comes to an end at the same time, i. e. when the horizontal groove has passed the inlet bore. Each position of the pump plunger therefore corresponds to a certain definite delivery amount.

Note: It is important to remember that in the case of gasoline injection pumps the helical control edge is at the top whereas in the case of Diesel injection engines it is at the bottom of the plunger. For this reason the **end of delivery** is independent of the position of the plunger in gasoline injection pumps, whereas in Diesel injection pumps it is the **beginning of delivery.**

The pump plunger is turned by the fuel control rod (34) via the mobile toothed quadrant (26) of the control sleeve (25) (see Fig. 07-10/6). The lug (plunger vane) of the pump plunger engages in the longitudinal slot of the control sleeve (25) and turns automatically with the toothed quadrant when the fuel control rod is moved. If the injection amount is to be reduced, the fuel control rod must be pulled toward the right – in the direction "stop"; if the injection amount is to be enlarged, the fuel control rod is to be pushed toward the left, in the direction of "full load". In the "stop" position of the fuel control rod (extreme right, no delivery) the vertical groove (4) of the pump plunger is in front of the inlet bore (6) so that the fuel cannot be subjected to pressure (see Fig. 07-10/8).

Oil Lock in Pump Element

Each pump element has an oil lock (leakage seal) which prevents the flow of the fuel along the surface of the plunger to the pump drive where it would reduce the lubricating capacity of the oil. Since gasoline, which is here used as fuel, possesses inadequate lubricating properties, sealing of the pump elements is of particular importance.

The oil lock is formed by two circular grooves in each pump cylinder. The upper relief groove communicates with the suction chamber of the injection pump through the bore (2) (Fig. 07-10/9). The fuel leaking through between plunger and cylinder during the pressure stroke is reduced in pressure in this relief groove and flows back to the suction chamber through the bore. Oil from the engine lubrication circuit is forced into the groove (3) in the cylinder and the plunger under a pressure higher than the pressure of the fuel in the suction chamber of the injection pump. This oil blocks the way to the pump drive for any fuel that may have leaked through past the relief groove.

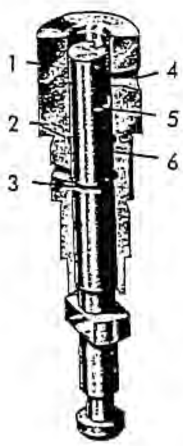


Fig. 07-10/9

Oil lock in pump element of ZEA and ZEB Injection Pumps

1 Pump cylinder
2 Relief bore with groove
3 Lock groove
4 Inlet bore
5 Horizontal groove
6 Pump plunger

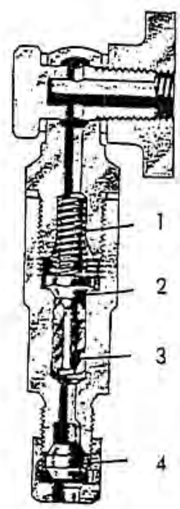


Fig. 07-10/10

Check valve in front of oil lock of ZEA and ZEB Injection Pumps

1 Valve spring
2 Valve seat
3 Valve
4 Seal

The check valve in front of the oil lock canal, which is screwed to the outside of the injection pump housing, prevents fuel from getting into the engine lubricating circuit when the oil pressure decreases (Fig. 07-10/10).

Pressure Valve in Pump Element

A pressure valve is fitted at the top of each of the two pump elements (Fig. 07-10/11). The stem of the valve (4) is carried in the valve holder and is loaded by the pressure spring (3) which is adjusted by means of the adjusting screw (1) and the shims (2). During the power stroke of the pump plunger the valve is lifted from its seat so that the fuel can flow into the pressure pipe, the amount being equal to that delivered by the plunger.

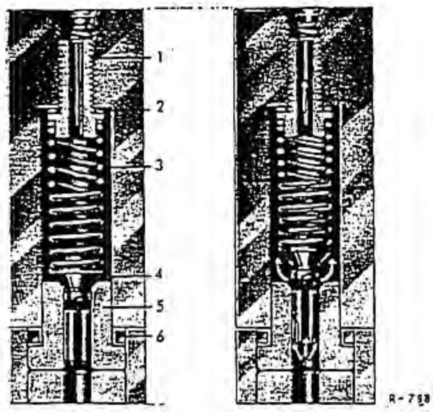


Fig 07-10/11

Pressure valve of ZEA and ZEB Injection Pumps

1 Adjusting screw
2 Shim
3 Valve spring
4 Valve
5 Valve holder with seat
6 Seal

When the delivery stroke ends, the valve immediately falls back on its seat because the pressure in the pump cylinder has by that time decreased considerably below the pressure prevailing in the pressure pipe and because the spring presses the valve on its seat.

The valve is designed as an adapting valve. The pressure spring, the position of the bores, and the clearance between valve stem and valve holder have been so designed that the maximum quantity of fuel supplied by the injection system at different engine speeds corresponds exactly to the actual fuel requirements of the engine. The correctly adjusted adapting valve ensures that the engine torque is as high as possible over the whole engine speed range.

b) Control Assembly (ZEA Injection Pump)

As was mentioned above, the injection amount delivered by the injection pump for Models 220 SE, 220 SEb and 300 SE is mechanically controlled. When the accelerator pedal is depressed, the fuel control rod of the injection pump is moved and at the same time the throttle valve in the venturi control unit is opened. For this purpose the adjustment lever (67) on the injection pump is connected to the throttle valve lever (65) on the venturi control unit via the push rod (68), the control lever (6) and the pull rod (70) (Fig. 07-10/12). The adjustment lever on the pump is operated by a push rod attached to the lever of the control shaft for the accelerator pedal. Thus fuel and air are positively controlled. Each position of the throttle valve in the venturi control unit corresponds to a certain definite position of the adjustment lever on the injection pump. This so-called "correlation" is not linear but progressive.

The movements of the adjustment lever are transmitted inside the injection pump to the fuel control rod (34) via the camplate (36) and the cam lever (37) which is controlled by the centrifugal governor and overrides the engine speed influence. The correcting devices (inlet air and cooling water thermostats and aneroid compensators) transmit their movements to a common eccentric which shifts the fulcrum of the reversing lever (5) located between the cam lever and the fuel control rod, and thus moves the fuel control too.

Modification: Automatic auxiliary start mechanism 2nd and 3rd version added

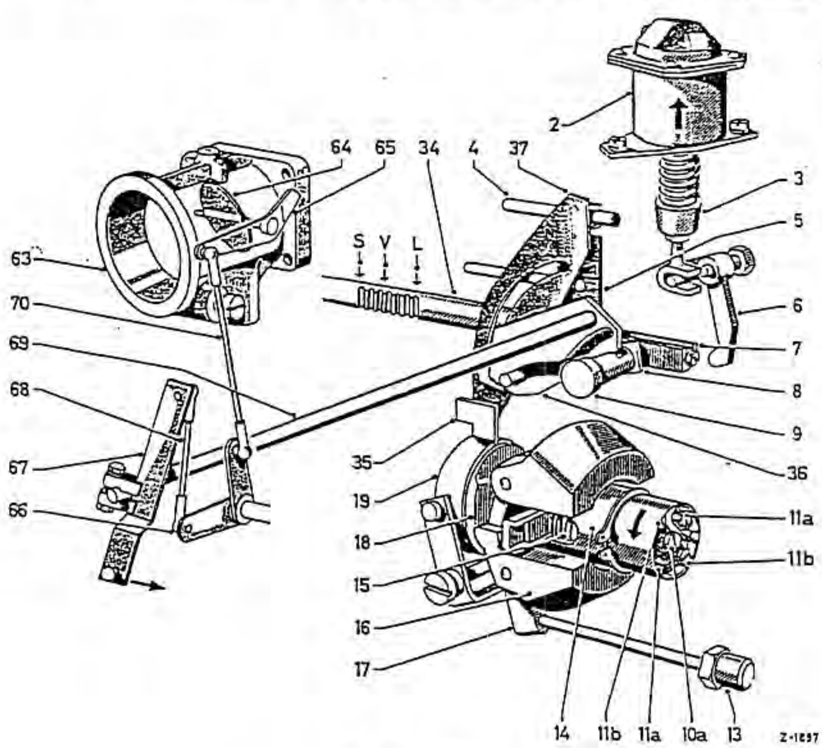


Fig. 07-10/12

Control Assembly of ZEA Injection Pumps

S = Starting position of fuel control rod
V = Full load position
L = Idle position
2 Cold start magnet
3 Pin
4 Guide pin from cam lever
5 Reversing lever
6 Starting delivery lever
7 Fuel control rod head
8 Relay lever
9 Eccentric axle
10a Idle adjustment screw (black) for up to appr. 1000 engine rpm
11a Adjusting screw (black) for partial load or medium speed range of appr. 700 to appr. 4000 engine rpm
11b Adjusting screw (white) for partial load or top speed range as from appr. 2000 engine rpm
13 Governor sleeve stop screw
14 Joint
15 Governor springs
16 Flyweights
17 Supporting lever
18 Governor sleeve
19 Sliding piece
34 Fuel control rod
35 Drive lug
36 Camshaft
37 Cam lever
63 Venturi control unit
64 Throttle valve
65 Throttle valve lever
66 Control lever
67 Adjustment lever
68 Push rod
69 Axle
70 Pull rod

In detail, the injection pump control assembly operates as follows:

The camshaft (36) is fastened on the axle (69) of the adjusment lever (67). The roller of the relay lever (8) slides in the slotted hole of the cam plate. On the opposite side of the relay lever (8) there is one pin which slides in the slotted hole of the cam lever (37). The lower end of the cam lever (37) is carried in a drive lug (35), whereas the pin of the cam lever (37) engages the top of the reversing lever (5). All movements of the pin are transmitted to the fuel control rod (34) by the reversing lever in the opposite direction.

When the accelerator pedal is depressed, the adjustment lever (67), the cam plate (36), and automatically also the relay lever (8) are turned upward by way of the adjustment lever (67) or the axle (69). In this way the uper end of the cam lever (37) and thus its pin are moved backward and the reversing lever (5) moves the fuel control rod (34) forward in the direction "rich".

With increasing engine speed the flyweights (16) move outward. Since the two flyweights (16) engage with their levers the recesses of the governor sleeve (18) the outward movement of the flyweights produces a backward movement of the sliding piece (19) and drive lug (35) and of the bottom end of the cam lever (37). Since the cam lever (37) now bears against the pin of the relay lever (8), the movement of the lower part of the cam lever (37) results in a movement in the opposite direction at the upper end, i. e. the fuel control rod is moved backward in the direction "lean".

In this way both movements, that of the accelerator pedal and that of the centrifugal governor, are transmitted to the cam lever (37), which then moves the fuel control rod (34) by way of the reversing lever (5).

In the full load position the pin of the relay lever (8) forms a common axis with the pin of the cam lever (37) so that in this position the influence of the centrifugal governor cannot become effective.

This mechanical control assembly simultaneously and positively controls both the throttle valve and the fuel control rod, i. e. air and fuel.

Furthermore, the centrifugal governor moves the fuel control rod to "stop" when the car overruns the engine so that no fuel is injected. The result is inoffensive exhaust gas and fuel economy. It is only below an engine speed of 1500 rpm that the governor automatically produces fuel injection even when the accelerator pedal is not operrated, thus preventing jerky running of the car at low speeds and ensuring even idling of the engine.

c) Automatic Auxiliary Start Mechanism (Start Mechanism)

When starting the engine the control rod of the injection pump is automatically moved to "starting delivery" or the starting valve on the intake pipe is actuated, depending on the start mechanism version installed. The various versions of the start mechanism are described in detail below.

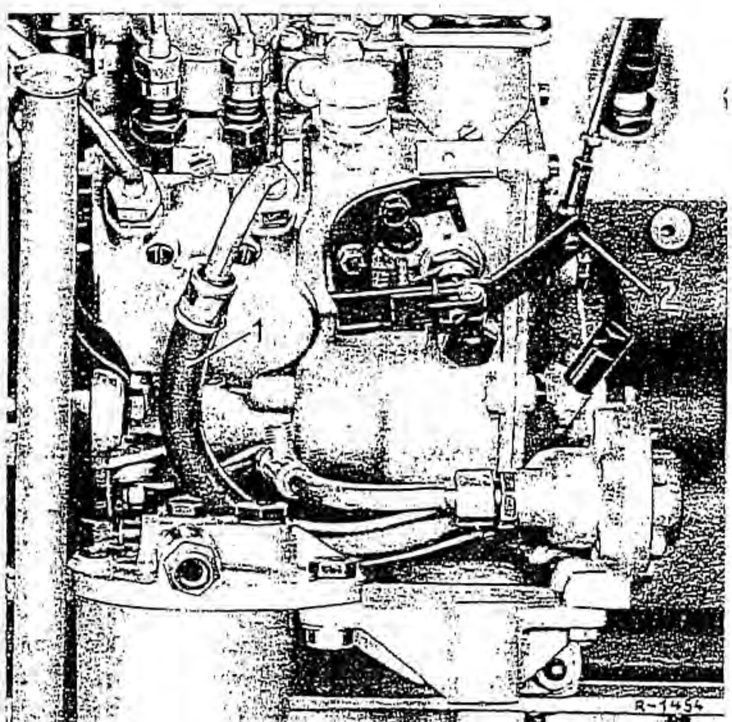


Fig. 07-10/13

Model 220 SEb with ZEB Injection pump

8 Start magnet
19 Thermo switch
20 Thermo time switch with terminals 'G' and 'W'

1st Version of the Start Mechanism on Models 220 SEb and 300 SE

Intake pipe version: Starting valve at the front

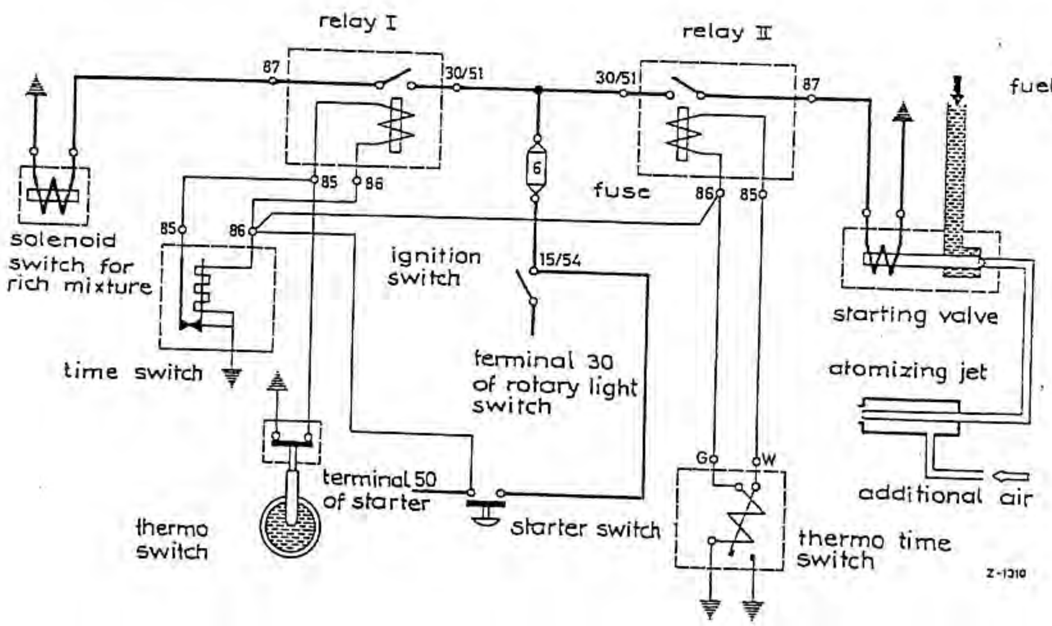


Fig. 07-10/14

Wiring diagram for automatic auxiliary start mechanism 1st version

Operation:

At cooling water temperatures **up to +45° C on Model 220 SEb** and **up to +35° C on Model 300 SE** the thermo switch and the circuit to relay I are closed and the start magnet of the injection pump is switched on during the whole starting period.

At cooling water temperatures **above +45° C on Model 220 SEb** and **above +35° C on Model 300 SE** the thermo switch is open and consequently the control line to relay I is interrupted. While the starter is being operated the time switch (delay switch) closes the circuit to relay I for **about 1 second** and thus operates the start magnet for 1 second.

At temperatures **below +5° C** both the thermo time switch and the relay II are closed and as a result fuel is injected into the intake pipe through the starting valve, in addition to the starting delivery of the injection pump. The injection period increases with decreasing temperature to a maximum of approx. 17 seconds at —20° C.

2nd Version of the Start Mechanism on Models 220 SEb and 300 SE

Intake pipe version: Starting valve at the front

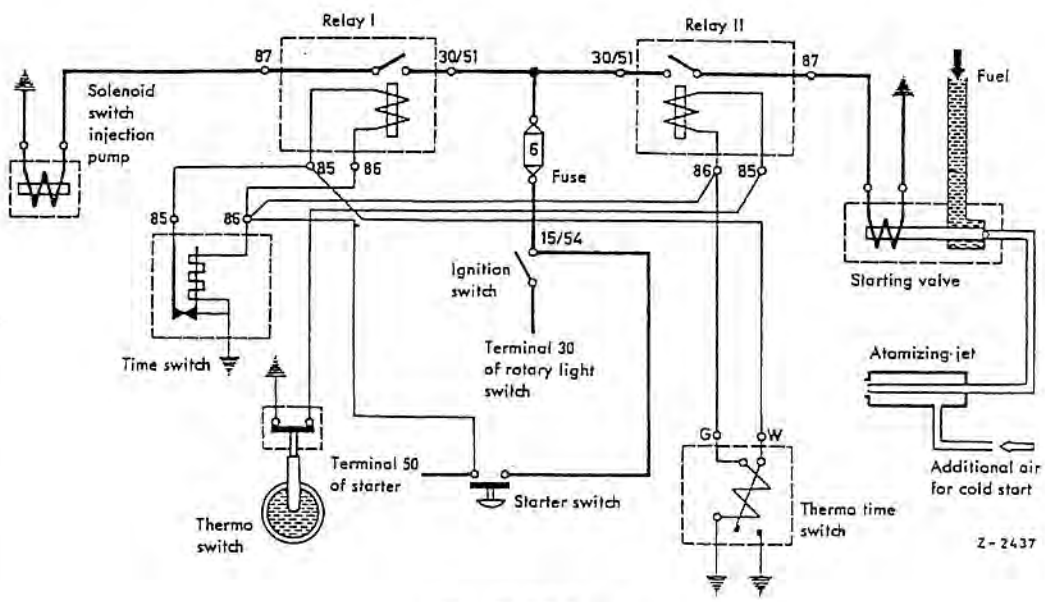


Fig. 07-10/14a

Wiring diagram for automatic auxiliary start mechanism 2nd version

In this version the function of the solenoid starting valve and the start magnet on the injection pump have been reversed by exchanging the lines on the thermo switch and the thermo time switch terminal W (see Fig. 07-10/14a).

This wiring system is intended to eliminate any possible over-enrichment during excessively long or repeated cold starts. As from beginning of March 1963 the start mechanism on Models 220 SEb and 300 SE with intake pipe version starting valve at the front have been wired accordingly.

Operation:

At cooling water temperatures **up to +45° C on Model 220 SEb** and **up to +35° C on Model 300 SE** the thermo switch and the circuit to relay II are closed and as a result fuel is injected into the intake pipe through the starting valve during the whole starting period.

At cooling water temperatures **above +5° C** the thermo time switch is open and consequently the control line to relay I is interrupted. While the starter is being operated the thime switch closes the circuit to realy I for **about 1 second** and thus operates the start magnet on the injection pump.

At cooling water temperatures **below +5° C** both the thermo time switch and the relay I are closed and as a result fuel is injected into the intake pipe through the starting valve, in addition to the starting delivery of the injection pump. The injection period increases with decreasing temperature to a maximum of approx. 17 seconds at —20° C.

3rd Version of the Start Mechanism on Models 220 SEb, 230 SL and 300 SE

Intake pipe version: Starting valve in center

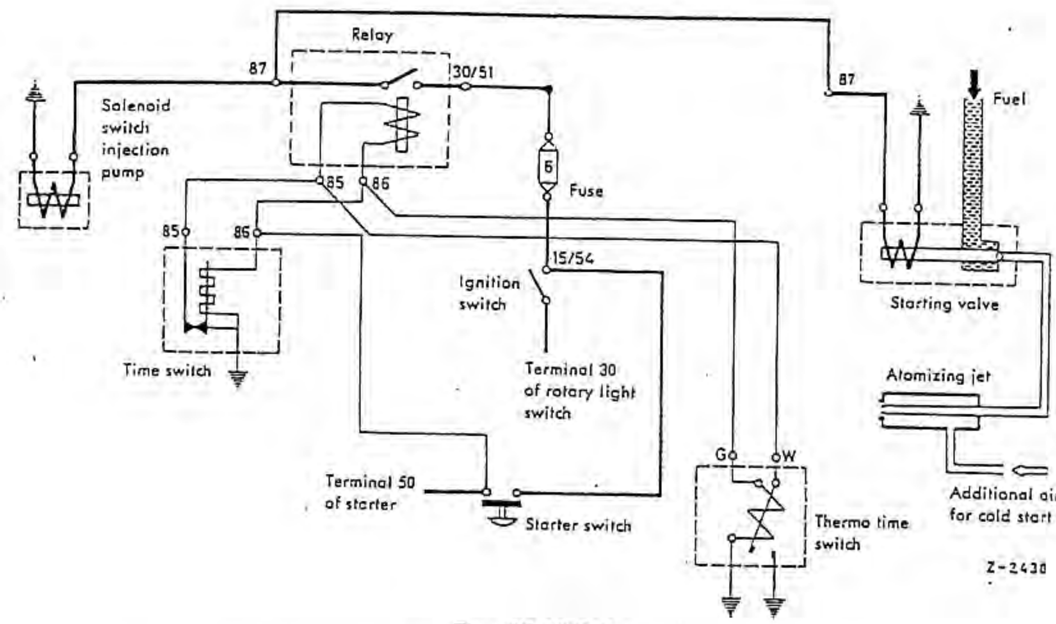


Fig. 07-10/14b

Wiring diagram for automatic auxiliary start mechanism 3rd version

In the 3rd version the thermo switch and relay II have been dispensed with. In addition, a new thermo time switch has been installed which operates at +35° C cooling water temperature as compared with +5° C in the previous version.

Operation:

At cooling water temperatures **up to +35° C** both the thermo time switch and the circuit to the relay are closed and as a result both the start magnet on the injection pump and the starting valve are operated during the whole starting period. The operating time increases with decreasing temperature and, at —20° C, is approx. 17 seconds.

At cooling water temperatures **above + 35° C** the thermo time switch is open and the control line to the relay interrupted. However, while the starter is being operated, the circuit is connected to the relay via the time switch for a period of **approx. 1 second**, and as a result both the start magnet on the injection pump and the starting valve are operated.

Note: On the first cars of Models 220 SEb and 230 SL with the starting valve in the center of the intake pipe the second version of the start mechanism was installed with thermo switch, relay II, and thermo time switch, for a cooling water temperature of + 5° C. If starting difficulties should occur in these cars, the start mechanism can be modified to correspond to the 3rd version described above. Modification requires the installation of a + 35° C thermo time switch, and the following additional operations: Detach the cable from the thermo switch, ream the cable socket up to 5 mm Ø, and connect it to the terminal W of the thermo time switch. The thermo switch is not removed, but is no longer operative.

d) Warming-up Mechanism (ZEA — and ZEB Injection Pump)

During the warming-up period the engine needs more air and more fuel in order to overcome the increased friction when the engine is cold. Enrichment is controlled by the cooling water thermostat (39) attached to the injection pump and connected to the cooling water circulation system (Fig. 07-10/15).

The cooling water controlled thermostat operates the eccentric bushing (49) via the guide bolt (57) and the lever (52). Via the driving lug (48) the bushing moves the control slide valve (53) which releases the supplementary air and at the same time shifts the fulcrum of the reversing lever so that the fuel control rod moves in the direction "rich". The supplementary air which the cold engine needs, particulary when idling, passes directly through the injection pump in the intake manifold.

Note: The supplementary air pipe from the air filter to the injection pump is calibrated by a Solex starter air jet size 5.0. If earlier cars of Model 220 SE still have air jet size 4.0 it should be replaced by an air jet size 5.0 or should be bored to 5 mm ϕ. Engines with additional cold start mechanism have no air jet.

With increasing temperature of the cooling water, air and fuel enrichment decreases continuously until it finally ceases completely at a cooling water temperature of appr. 60° C in the case of ZEA-R 1 and R 2 Injection Pumps and of 65—68° C in the case of ZEA-R 3, R 4, R 6 and R 7 Injection Pumps and ZEB Pumps R 11, R 12 und R 13. At that temperature the supplementary air pipe is closed completely by the control slide valve (53) and the fuel control rod is no longer moved by the cooling water thermostat.

Note: On some R 1 and R 2 ZEA Injection Pumps the guide bolt (57) was shortened by 0.4 mm as compared with its original length or an 0.4 mm shim was added between cooling water thermostat and housing cover of the correcting device in order to obtain greater enrichment during the warming-up period. On such pumps the enrichment cut-off temperature is nevertheless 65—68° C.

A defective cooling water thermostat can be fixed in the switched-off position corresponding to a cooling water temperature above 60° C or 68° C respectively by pressing the stop bolt (59) in and giving it half a turn to vthe right until it engages again (Fig. 07-10/15). The whole warming-up mechanism is then inoperative.

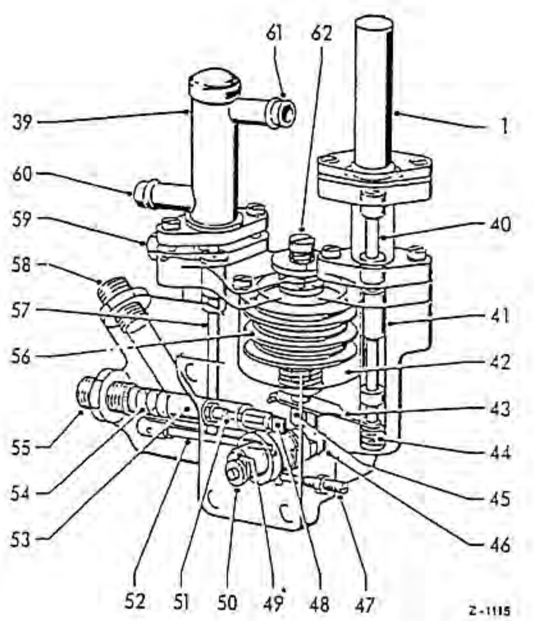


Fig. 07-10/15

Corrector Assembly of ZEA Injection Pumps

1 Inlet air thermostat (no longer installed on ZEB Injection Pump)
39 Cooling water thermostat
40 Pin
41 Guide bolt
42 Compensator basket
43 Lever
44 Spring
45 Bolt
46 Guide plate
47 Stop screw
48 Drive lug
49 Eccentric bushing
50 Eccentric shaft
51 Guide pin
52 Lever
53 Control slide valve
54 Spring
55 Supplementary-air inlet
56 Aneroid compensators
57 Guide bolt
58 Supplementary-air outlet
59 Stop bolt for cooling water thermostat
60 Cooling water inlet
61 Cooling water outlet
62 Stop screw for air inlet thermostat

e) **Inlet Air Thermostat** (installed on ZEB Injection Pump only)

With increasing air temperature the specific gravity of the inlet air and consequently the charge of the cylinders decreases. In order to obtain a constant fuel-to-air-ratio, the fuel quantitly injected must be decreased.

The inlet air thermostat (1) at the injection pump controls the injection amount in relation to the temperature of the inlet air (Fig. 07-10/15). On Model 220 SE the thermostat projects into the air filter.

With increasing air temperature the pin (40) and the gude bolt (41) depress the lever (43) on which the basket of the aneroid compensators (42) rests. Since a spring presses against a basket from above, it is also moved downward. The bolt (45) which is connected to the aneroid compensators, and passes freely through the lever (43) is attached to the guide plate (46), and moves the eccentric shaft (50) by way of the guide plate. The shaft shifts the fulcrum of the reversing lever and thus moves the fuel control rod in the direction "lean".

This control ensures correct composition of the fuel-air mixture independently of the air temperature.

Note: **When the inlet air thermostat is defective,** the compensators can be fixed in the position which corresponds to an inlet air temperature of 20° C by turning in the stop screw (62) as far as it will go (Fig. 07-10/15). The operation of the aneroid compensators is not affected by this.

In order to ensure that the thermostat does not make the mixture too lean when the external temperature is extremely high, the adjustment range is limited to 30—35° C on R 3, R 4, R 6 and R 7 Injection Pumps. A spring cup (44a) is installed to bring about this limitation (Fig. 07-10/17).

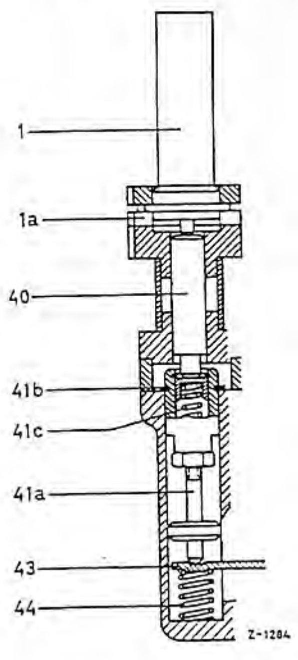


Fig. 07-10/16

Subsequently installed spring-loaded guide bolt on R 1 and R 2 Injection Pumps as well as on the R 3 Injection Pump (1st version)

1 Inlet air thermostat
1a Insulating flange
40 Pin
41a Spring-loaded guide bolt
43 Lever
44 Spring
41b Snap ring
41c Spring

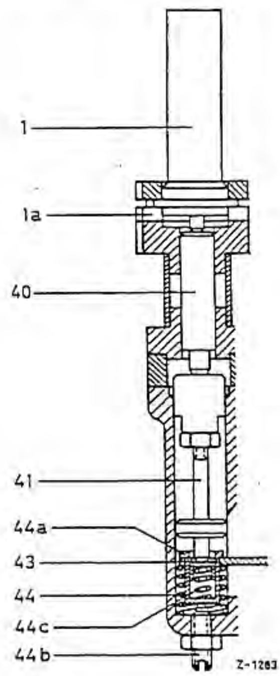


Fig. 07-10/17

Spring cup on R 4, R 6, R 7 Injection Pumps and on the R 3 Injection Pump (2nd version)

1 Inlet air thermostat
1a Insulating flange
40 Pin
41 Guide bolt
43 Lever
44 Spring
44a Spring cup
44b Adjusting screw
44c Spring

Note: The R 1 and R 2 Injection Pumps have no insulating flange (1a). On these pumps the pin (40) is correspondingly shorter (Fig. 07-10/16).

On the R 2 Injection Pumps and the R 3 Injection Pump without spring cap the guide bolt can be replaced subsequently by a spring-loaded guide bolt (41a) which also limits attenuation of the mixture to 30—35° C (Fig. 07-10/16). For details about the subsequent installation of a spring-loaded guide bolt see Job No. 00-16.

f) Aneroid Compensators (ZEA and ZEB Injection Pump)

With increasing altitude, the atmospheric pressure, i. e. the specific gravity of the inlet air, decreases.

In order to ensure a constant fuel-to-air ratio also under these conditions the injection amount must be reduced.

The aneroid compensators feel the specific gravity of the air in relation to the altitude and automatically reduce the fuel amount by expanding with increasing altitude.

Since the compensators are directly connected to the bolt (45) which passes freely through the lever (43) and is attached to the guide plate (46), the movement of the aneroid compensators is transmitted to the eccentric shaft (50) (Fig. 07-10/15). By way of the reversing lever the fuel control rod is moved in the direction "lean".

This automatic control of the injection amount in relation to atmospheric pressure ensures a correct composition of the fuel-air mixture at all altitudes.

Note: The aneroid compensators are evacuated and therefore do not react to temperature.

g) Venturi Control Unit

The venturi control unit, which is attached to the intake manifold, contains the throttle valve controlling the combustion air for the engine (Fig. 07-10/18).

By depressing the accelerator pedal the control lever (14) and the control shaft (6) are operated via the pull rod (15) (see Fig. 00-16/6). As a result, the pull rod (5), the throttle valve lever (1), and the throttle valve are actuated by the control lever (7a) and at the same time the adjustment lever of the injection pump via the control lever (7b) of the push rod (8).

Since the throttle valve must be completely closed in the idle position, the engine receives the necessary combustion air through the idle air canal in the venturi control unit. For adjusting the idle speed the cross section of the idle air canal can be changed by means of the idle air throttle (2). The threaded union (6) receives the vacuum line to the distributor. (Fig. 07-10/18).

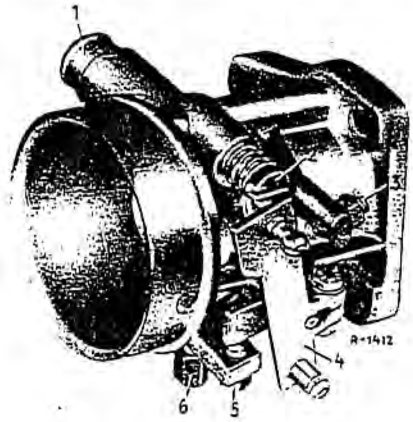


Fig. 07-10/18

Venturi control on Model 220 SEb

1 Connection for engine air vent line
2 Idle air throttle
3 Full load stop screw
4 Throttle valve lever
5 Idle stop screw
6 Vacuum line to distributor

Mercedes, Nachtrag 12 englisch

h) Fuel Distributor Fittings and Injection Valves with Support

The fuel delivered by the injection pump passes through the pressure pipes to the fuel distributor fittings (3) (Fig. 07-12/19). From these fittings it passes evenly distributed through the pressure pipes to the injection valves, the front distributor fitting supplying the injection valves for cylinders 1, 2, and 3, the rear distributor fitting supplying the injection valves for cylinders 4, 5, and 6.

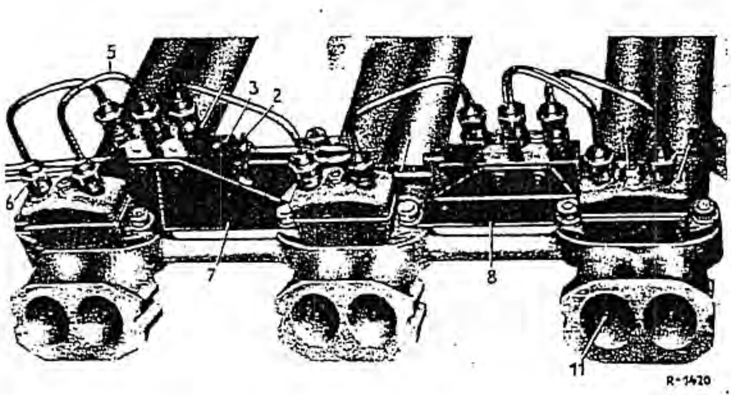


Fig. 07-10/19

Fuel distributor fittings and injection valves on Model 220 SEb

1 Pressure pipe connection
2 Locking plate
3 Fuel distributor fitting
4 Pressure pipe connection
5 Injection pipe
6 Cap nut
7 Support for front distributor fitting
8 Support for rear distributor fitting
9 Flange
10 Holder for the injection valves
11 Injection valve

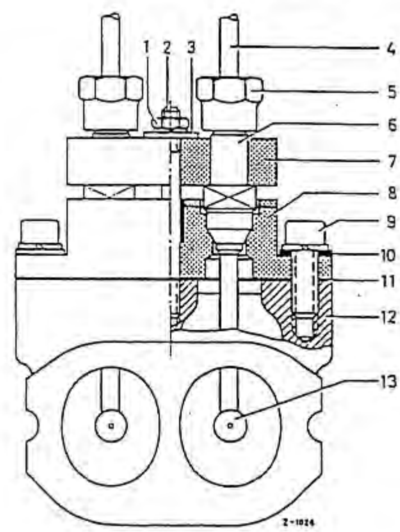


Fig. 07-10/20

1 Nut
2 Stud bolt
3 Washer
4 Injection pipe
5 Cap nut
6 Injection valve
7 Flange
8 Holder for the injection valves
9 Cheese head screw
10 Washer
11 Gasket
12 Intake pipe
13 Locking cap on injection valve

Each fuel distributor fitting (3) is attached to the intake pipe by a support (7 and 8) (Fig. 07-10/19).

The injection valves are so arranged in the intake pipe that in the installed condition the fuel outlet openings are almost flush with the flange faces of the intake pipe.

The holders (8) for the injection valves (6) are screwed to the intake pipe by means of cheese head screws, two injection valves being carried in a common holder. The injection valves themselves are held in the holder (8) by the flange (7).

Fuel Distributor Fitting

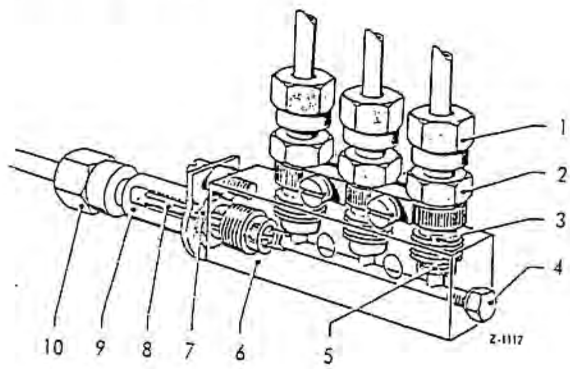


Fig. 07-10/21

1 Pressure pipe with cap nut to injection valve
2 Pressure pipe connection
3 Throttle
4 Screw plug
5 Strainer
6 Distributor fitting
7 Locking plate
8 Filter
9 Pressure pipe connection
10 Pressure pipe with cap nut from injection pump

A filter (8) is installed in the pressure pipe connection (9) for the pressure pipe (10) from the injection pump, whereas throttles (3) (capillary tubes with a 0.3 mm ⌀ bore) have been inserted in the pressure pipe connections (2) for the pressure pipes (1) to the injection valves. These throttles insure an even distribution of the fuel to the individual cylinders.

In addition, strainers (5) are installed in the pressure pipe connections (2) in front of the throttles (3). In the first version of the distributor fittings a strainer cartridge was installed behind the pressure pipe connection (9) in place of the strainer.

Injection Valve

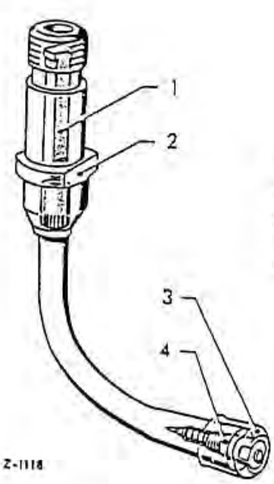


Fig. 07-10/22

1 Filter
2 Retainer
3 Locking cap
4 Valve insert

The filter (1) is located in the upper part of the retainer (2). The valve insert (4) is screwed into the front part of the retainer and is secured by the locking cap (3).

i) Fuel Feed Pump

The injection system of Models 220 SE, 220 SEb and 300 SE is provided with only one fuel feed pump which is an electrically driven vane-type pump (Fig. 07-10/23). It is fitted to the chassis base panel assembly to the left of the fuel tank.

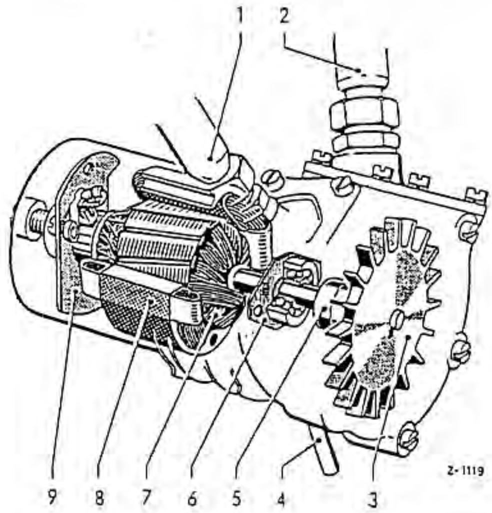


Fig. 07-10/23

1 Connection delivery side, with check valve
2 Connection suction side
3 Vane
4 Leak-off pipe
5 Slide ring seal
6 Mounting plate
7 Armature
8 Laminated pole
9 Brush holder plate

The pump is put in operation when the ignition is switched on. It continues to deliver fuel until the ignition is switched off again (see also Section B).

k) Fine Fuel Filter

A cellular paper filter is used as fine fuel filter, which on Model 220 SE is fastened to the wheel arch pan by a bracket, on Models 220 SEb and 300 SE to the left engine support (Fig. 07-10/24).

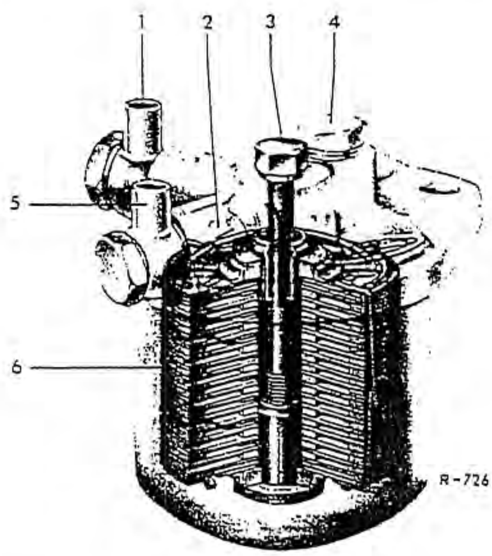


Fig. 07-10/24

Fine fuel filter on Model 220 SE

1 Fuel outlet
2 Vent screw
3 clamping bolt
4 Filter screw
5 Fuel inlet
6 Cellular filter element

Note: On Models 220 SEb and 300 SE the fine fuel filter is larger than on Model 220 SE.

The filter element is a cellular paper filter which ensures very satisfactory elimination of dirt and other impurities from the fuel. This is particularly important for injection engines since inadequate filtration of the fuel would result in premature wear of the injection pump elements. The result would be inaccurate metering of the injection amount which would be particularly noticeable at idling speed because of the small injection amounts required.

l) Damper Units

In order to reduce the noise made by the fuel, a damper unit has been installed in the fuel feed pipe between the fine fuel filter and the injection pump and in the fuel return pipe directly behind the injection pump (Fig. 07-10/25). The two damper units show the same design and the only difference is in their threaded unions (see Job No. 00-15, Section C, under "Damper Unit").

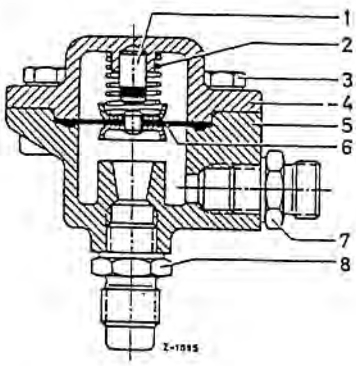


Fig. 07-10/25

1 Plug
2 Pressure spring
3 Hexagon screw with spring washer
4 Cover
5 Housing
6 Diaphragm
7 Threaded union with sealing ring (outlet)
8 Threaded union with sealing ring (inlet)

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Removal and Installation of Injection Pump

Job No.
07-12

Modification: Models 250 SE and 250 SL as well as Section B

A. Gasoline Injection Pump

Removal:

1. Remove the battery.

2. Drain off part of the cooling water. Unscrew the cooling water hoses (2) and (6) as well as the supplementary air line (3), oil line (17) and the fuel lines from the injection pump (Fig. 07-12/1 and 07-12/2).

3. Detach the control rod (7). Disconnect the cable from the cold start magnet.

4. Unscrew the fixing nuts (16) and on six-cylinder injection pumps unscrew the rear pump bracket and remove the injection pump toward the rear. Remove the coupling sleeve (Figs. 07-12/1 and 07-12/2).

5. If the drive lug on the camshaft of the injection pump has to be replaced the drive lug must be pulled off by means of Puller Part. No. 621 589 00 33. In order to loosen the nut on the camshaft, the drive lug must be held steady with Serrated Wrench Part No. 621 589 00 08. To make room for the puller, two adjacent cheese-head screws for fastening the flange to the injection pump must be screwed out (see Fig. 07-12/3). After having pulled off the drive lug, do not forget to screw the two screws in again.

Installation:

6. Set the crankshaft and the injection pump to installation position.

Models 220 SEb and 300 SE with two-cylinder injection pump.

Set the piston of the first cylinder to TDC (intersection dead center or ignition dead center) and turn the camshaft of the injection pump until the line mark on the camshaft is indexed with the line mark on the flange of the injection pump (Fig. 07-12/3).

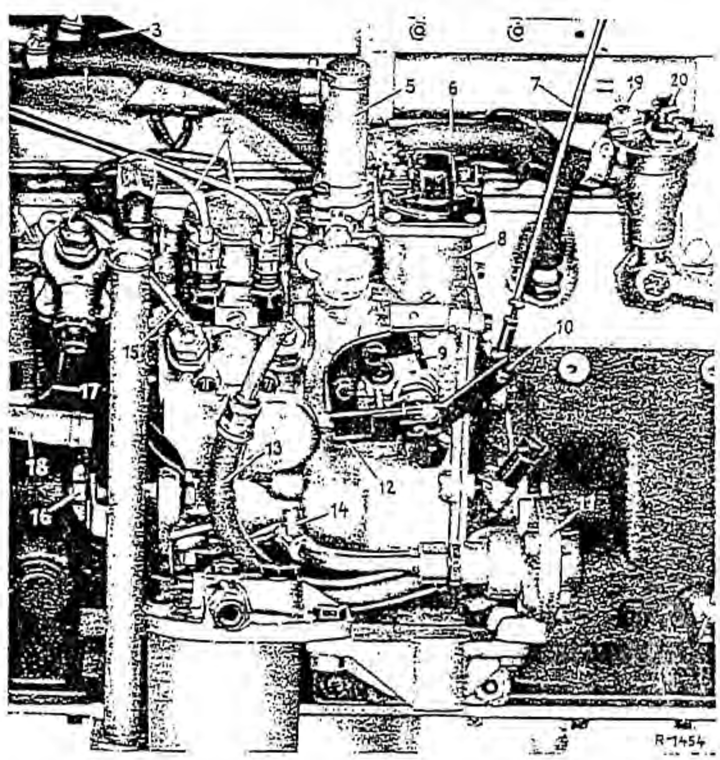

Fig. 07-12/1

Model 220 SEb with ZEB Injection Pump

1 Damper unit (return line)
2 Cooling water hose
3 Rubber hose for supplementary air line
4 Injection pipes
5 Cooling water thermostat
6 Cooling water hose
7 Push rod
8 Cold start magnet
9 Full-load stop
10 Adjustment lever
11 Damper unit (feed line)
12 Idle stop
13 Fuel hose (feed line)
14 Fuel line connection cold start valve
15 Fuel line (return line)
16 Hexagon nut
17 Oil line
18 Oil container for power steering
19 Thermo time switch
20 Thermo time switch

07-12/1

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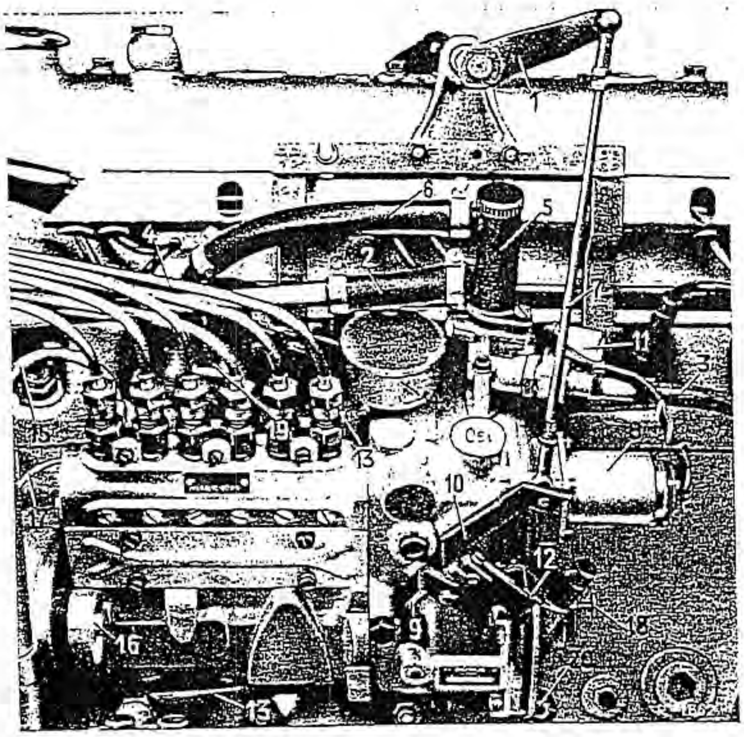


Fig. 07-12/2

Model 230 SL

1 Control lever
2 Cooling water hose
3 Supplementary air line
4 Injection pipes
5 Cooling water thermostat
6 Cooling water hose
7 Control rod
8 Cold start magnet
9 Full-load stop
10 Adjustment lever
11 Air cleaner
12 Idle stop
13 Fuel line (feed line)
14 Aneroid compensator
15 Fuel line (return line)
16 Hexagon screw
17 Oil line
18 Spring-loaded idle control knob
19 Housing for the thermostat switches
20 Hexagon screw

Models 230 SL, 250 SE, 250 SL, 300 SE, 300 SEb and 300 SEL with six cylinder injection pump

On the above-mentioned models with six-cylinder injection pump the injection pipes have been arranged in the reverse order as compared with our previous injection engines, i. e. the injection line from pump element 1 of the injection pump leads to injection valve 6 of the engine, the line from pump element 2 leads to injection valve 5, etc.

Caution: For this reason it is necessary to set the piston of **engine cylinder No. 6 to 20° ATDC of the suction stroke on Model 230 SL, 250 SE, 250 SL and at 60° on Model 300 SE, 300 SEb, 300 SEL** (1st cylinder 20° or 60° after ignition TDC). Then turn the camshaft of the injection pump until the line mark on the camshaft is indexed with the line mark on the flange of the injection pump.

7. Push the coupling sleeve onto the drive lug and install the injection pump. It is not necessary to check the end of the delivery stroke by means of container and overflow pipe. For this reason the attaching flange of the pump has no slotted holes for correcting the pump position.

8. Connect all lines.

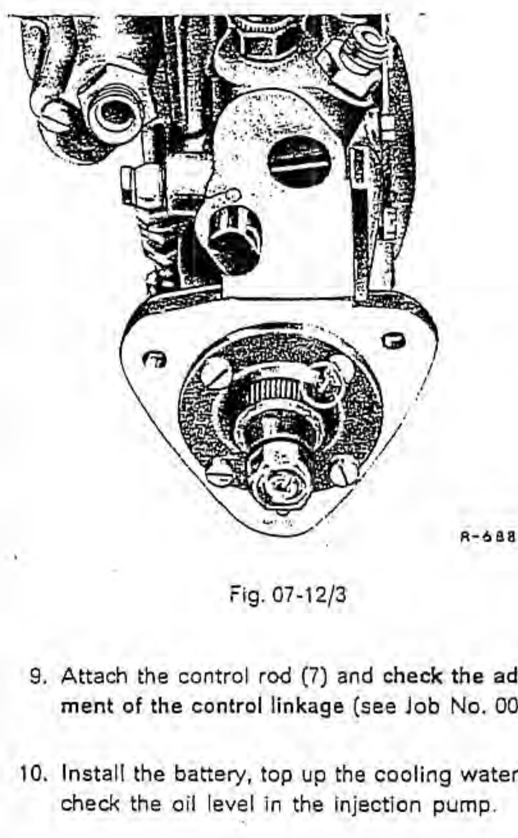


Fig. 07-12/3

9. Attach the control rod (7) and **check the adjustment of the control linkage (see Job No. 00-16).**

10. Install the battery, top up the cooling water and check the oil level in the injection pump.

11. Warm up the engine and check all lines for leaks; if necessary, tighten up, in particular oil line (17) to avoid loss of oil.

12. Adjust the idle (see Job No. 00-16).

Subsequent installation of ZEB injection pump in Model 220 SEb

On engines with top control linkage the ZEA Injection Pump can be replaced by the ZEB version with the following modifications:

a) Engine with undivided suction pipe

Shorten cooling water hose (6) and, if necessary, replace water hose (2).

Remove the spacer tube from the supplementary air line and fit the rubber hose (3) (Fig. 07-12/1).

b) Engine with divided suction pipe

Shorten cooling water hose (6) and replace water hose (2).

Change the supplementary air line from 10 mm to 12 mm outer diameter; to do this, adjust the rubber hose (3), saw off the line, clean it and solder a 12 mm OD pipe length to the supplementary air line (Fig. 07-12/1).

B. Diesel Injection Pump

Removal:

1. Screw out all injection lines, the vacuum line and all fuel lines connected to the injection pump. Plug the injection line and fuel hose unions of the injection pump.

2. Detach connecting rod for the auxiliary mechanical control as well as starting and stopping cable at the injection pump adjusting lever. Unscrew screw in the retaining angle (3) and remove coil spring with clamp (4) (Fig. 07-12/4).

3. Screw out hexagon nut at the bell-shaped support and fixing nuts at the front flange; then pull out the injection pump from the crankcase. Remove coupling sleeve from the injection pump drive collar or from the drive shaft.

Note: When replacing a drive collar, hold it steady with Special Wrench 621 589 00 08 00 in order to loosen hexagon nut, then pull off drive collar from the injection drive shaft using Puller 636 589 02 33 00. Clean shaft end and drive collar. Both cones must be flawlessly clean and absolutely free from grease.

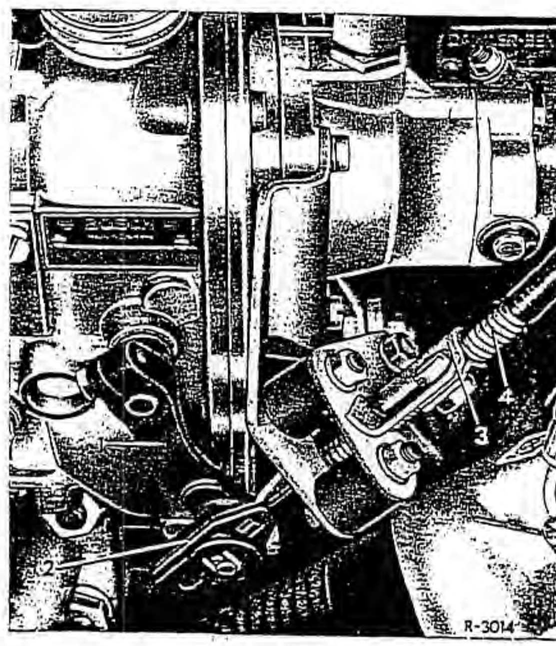


Fig. 07-12/4

1 Adjusting lever (starting and stopping cable lever)
2 Eyelet with rubber molding
3 Retaining angle
4 Coil spring

Observe markings when putting a new drive collar on (see arrows in Fig. 07-12/5).

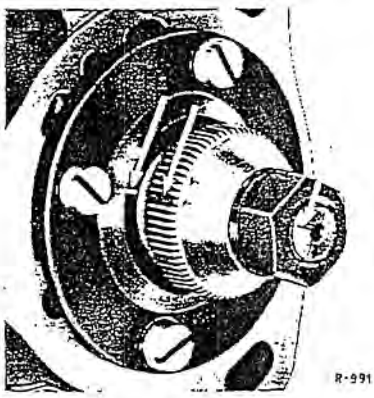


Fig. 07-12/5

Installation:

4. Turn crankshaft in the direction of rotation until the 47° **BTDC** mark of the graduated rim of the counterweight (1) coincides with the **alignment indicator** (2). (In Fig. 07-12/6, the crankshaft is shown in the position of 26° BTDC.) The piston of the first cylinder must be in its compression stroke during this process.

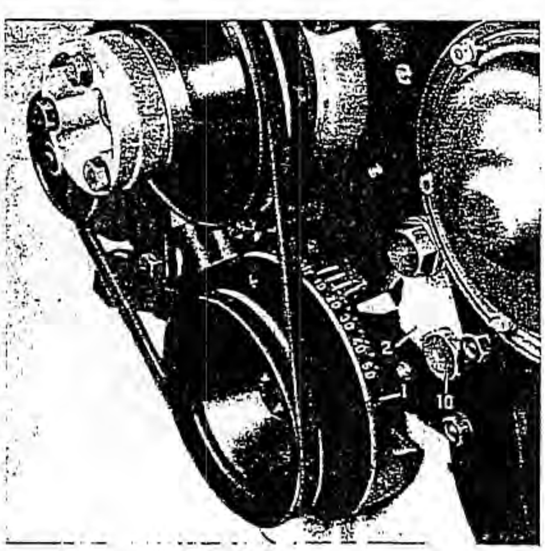


Fig. 07-12/6

(with the crankshaft at 26° BTDC)

1 Counterweight
2 Alignment indicator
10 Locking screw with bearing bolt for guide bar

5. Now determine whether the coupling sleeve can be easily slid onto the drive collar of the injection pump. If this is the case, slide coupling sleeve onto the drive shaft in the crankcase (Fig. 07-12/7).

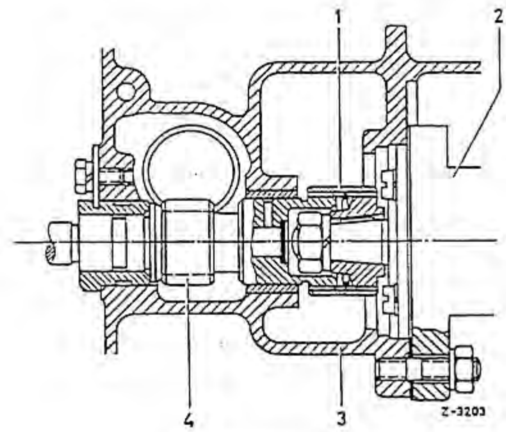


Fig. 07-12/7

1 Coupling sleeve
2 Injection pump
3 Crankcase
4 Idling gear shaft (drive shaft for injection pump and oil pump)

6. Remove plug from oil overflow pipe at rear end of the injection pump.

7. Set injection pump to start delivery position. This is done by turning the pump shaft until the drive collar tooth gap and the injection pump marking coincide (Fig. 07-12/5).

8. When applying light leftward oriented pressure to the drive collar (pressure is applied opposite to the direction of rotation), cam pressure action of the camshaft causes the drive collar to jump back by two teeth to the cam base circle. The **second tooth must then coincide with the marking** on the injection pump housing. Before inserting pump, double-check whether **the piston of the first cylinder** is in **compression stroke and whether the crankshaft is at** 47° **BTDC.**

Note: Because the drive collar jumps back by two teeth, crankshaft adjustment to 47° BTDC is necessary.

9. Apply grease to either side of new paper gasket and place paper gasket on crankcase.

Installation of Injection Pump:

10. Install injection pump in the coupling sleeve in such a way that the stud bolts are centrally positioned within the slotted holes. This way, fine alignment is possible by swiveling to either side.

Note: After swiveling or fine alignment of the injection pump, there must be a clearance of approx. 80 mm between crankcase and center of injection line union in order that the glow plugs can be removed.

11. Place washers in their position and slightly tighten the injection pump with two hexagon nuts.

12. Turn crankshaft further in the direction of rotation until the 26° BTDC mark coincides with the alignment indicator (2) (Fig. 07-12/6); the piston of the first cylinder must be in the compression stroke position.

Note: As a rule, crank engine only in its proper direction of rotation in order to ensure that the flyweights are not forced from their initial positions and that the chain is kept tensioned.

13. Screw out pipe union (1) of the first pump cylinder, then remove rubber sealing ring (2), coil spring (3), and pressure valve (5) with sealing ring (4) (Fig. 07-12/8).

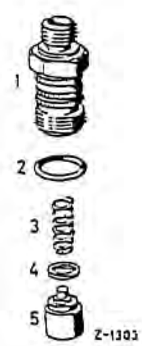


Fig. 07-12/8

1 Pipe union
2 Sealing ring (rubber)
3 Coil spring
4 Sealing ring
5 Pressure valve holder with pressure valve

Screw pipe union without parts (3 to 5) back in and screw on overflow pipe (5), Part No. 636 589 02 23 00 (Fig. 07-12/9).

14. In order to make sure that the adjusting lever (1) or the control rod, respectively, are positively positioned at full load, actuate adjusting lever (and thus control rod) in stop direction as far as possible and then release (Fig. 07-12/4). Repeat the process several times.

When checking the beginning of the effective stroke it is imperative that the control rod should be in the full load position since in the case of injection pumps with double control edge the beginning of the effective stroke will be constant only in this position. In this connection reference must be made again to our instruction to measure the beginning of the effective stroke according to the overflow method since the capillary tube method is less reliable.

15. Connect the fuel tank (7) to the injection pump, fill it with clean fuel and open the stop cock of the fuel tank (Fig. 07-12/9).

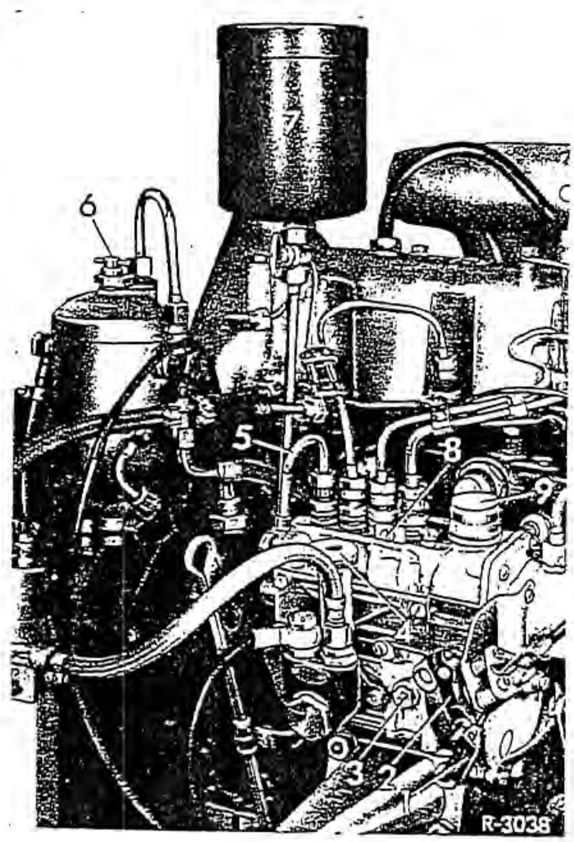


Fig. 07-12/9

1 Eye of the stopping and starting cable
2 Adjusting lever of injection pump
3 Oil level check screw of injection pump
4 Hand-operated fuel feed pump
5 Overflow pipe, Part No. 636 589 02 23 00, screwed to the injection line union of the 1st pump cylinder
6 Bleed screw on main fuel filter
7 Fuel tank, Part No. 000 589 05 23 00 with stop cock and pipeline, Part No. 621 589 01 90 00
8 Clamping jaws for securing two pipe unions
9 Breather filter and oil filler neck of injection pump

The fuel will now flow from the overflow pipe (5) (Fig. 07-12/10).

Note: For checking purposes the fuel tank (7) is not necessarily required. It is sufficient to connect the fuel feed line to the injection pump, to bleed the fuel system and then to back out the bleed screw (6) on the main fuel filter as for bleeding. The fuel reserve will be sufficient for one or two checks. Always refill the main fuel filter by means of the hand-operated fuel pump (4).

Adjustment of Beginning of Effective Stroke:

16. Correct the beginning of the effective stroke in relation to the crankshaft position by moving the injection pump in the appropriate direction.

Moving the injection pump toward the engine advances the beginning of the effective stroke, moving the pump away from the engine retards it.

The injection pump is at the beginning of the effective stroke in relation to the desired and set-crankshaft position when the fuel just begins to stop dripping from the overflow pipe. One more drop may follow after approx. 15-20 secs (Fig. 07-12/11).

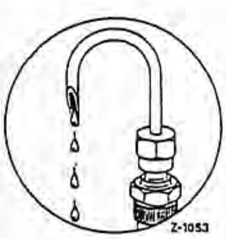


Fig. 07-12/10

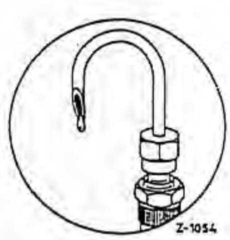


Fig. 07-12/11

17. Tighten the injection pump in this position by means of two hexagon nuts and check the adjustment again.
To repeat the check turn the crankshaft exactly two turns in the direction of rotation. Toward the end of the second turn move the crankshaft slowly until the fuel is on the point of no longer flowing or dripping from the overflow pipe. (One more drop may follow after approx. 15-20 secs).

In this position the pump plunger just covers the inlet bore in the pump cylinder, i. e. the plunger of the first cylinder of the injection pump is just at the beginning of its effective stroke.
If in addition the pointer again points to 26° BTDC, the beginning of the effective stroke of the injection pump has been properly set in relation to the crankshaft position (Fig. 07-12/6).

18. If this check should prove negative, readjust the beginning of the effective stroke (see para 16). Detach the injection pump from the attaching flange just enough for the pump to be moved.

19. When the adjustment is found to be correct firmly tighten all hexagon nuts attaching the pump to the flange.

20. Unscrew the fuel tank and the overflow pipe.

21. Unscrew the pipe union (1) and install the pressure valve (5), a new sealing ring (4), the coil spring (3) and an undamaged rubber sealing ring (2) (Fig. 07-12/8). Coat the thread of the pipe union with tallow, screw it in again and tighten with a **torque of 3.0 mkp.** To ensure a **proper** fit of the sealing ring **loosen** the pipe union and retighten it **with a torque of 3.0 mkp, loosen it again and finally tighten it with a torque of 3.0 + 0.5 mkp.**
Malfunction and faults may occur with both the pump and the engine if the tightening torque for the pipe union is either too high or too low. Absolute cleanliness is of paramount importance when the pressure valve is installed since dirt particles may produce engine trouble.

22. Install the clamping jaws (8) between the pipe unions **taking care to ensure that the tightening for the fixing screws does not exceed 0.9 mkp**; excessive tightening may distort the injection pump housing and produce leakage of the elements on the low and high pressure side (Fig. 07-12/9).

23. Connect injection pipes, vacuum pipes and all fuel hoses.

Use new sealing rings for all connections. Place the hoses in such a way that they are not under any tension and cannot rub against any part.

Tighten the injection pipes with a torque of no more than 2.5 mkp.

24. Bleed the fuel system.

25. Attach wire coil (4) together with clip to the retaining angle (3) and attach the starting and stopping cable to adjusting lever of the injection pump (Fig. 07-12/4).

26. Check the adjustment of the cable (see Job No. 00-10).

Note: When attaching the starting and stopping cable remember that there must be a clearance of approx. 2.0 mm between the adjusting lever pin of the injection pump and the rear part of the slotted eye when the glow starter and stop switch is in the drive position. Do not forget to check the bowden cable in the slotted eye for ease of movement after installation.

27. Check the adjustment of the additional mechanical control and if necessary correct the length of connecting rod (7) (Fig. 00-19/1). To do this attach connecting rod to lever (9), detach it from angle relay lever (6) and push it down until it rests against the idle stop. In this position, i. e. throttle valve in idling position and lever (9) of the injection pump governor resting against the idle stop, there should now be a clearance of appr. 1 mm between ball socket and ball head, i. e. to attach the connecting rod (7) to the ball socket of the angle relay lever (6) the rod must be raised appr. 1 mm. If the distance is larger or smaller than 1 mm the connecting rod must be either lengthened or shortened.

28. Run the engine for a short time, check the unions for leakage, turn the idle control knob over to the right and switch off the engine. If adjustment should prove difficult, i. e. if start and stop positions cannot be set satisfactorily, it is permissible slightly to reduce the starting delivery in favor of an accurate stop position.

29. Check and if necessary correct idling speed, maximum speed under no load and maximum speed under full load (see Job No. 00-19).

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Job No.
07-14

Adjustment of Injection Pump

Adjustment of Two-Cylinder Injection Pump for USA Cars

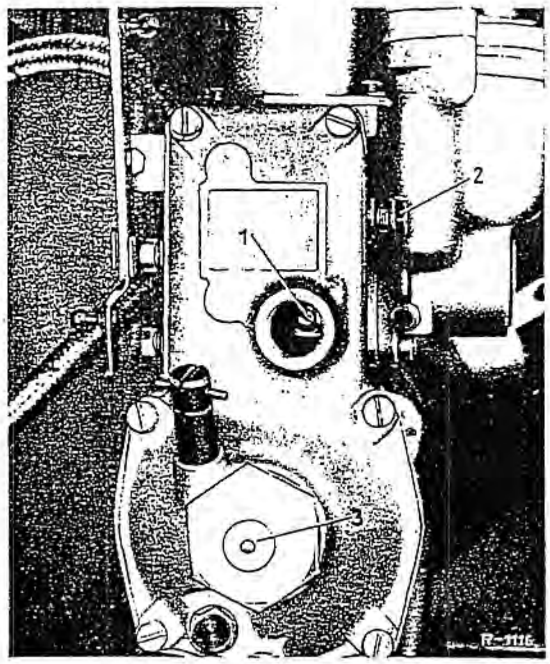


Fig. 07-14/1

1 Adjusting screw on control rod end with screw plug removed
2 Mounting screw for starter lever (backed out)
3 Spring-loaded idle control knob

Since April 5, 1962, all cars of Models 220 SEb and 300 SE supplied to the USA have been adjusted to the specifically lighter premium fuel in our Sindelfingen Works by moving the adjusting screw by 3 notches in the direction "rich".

In order to indicate this adjustment to US premium fuel, the screw plug in the rear control assembly cover has been replaced by a screw plug marked "USA".

This adjustment is not carried out on cars taken over by US clients at our works, and these cars have to be adjusted on arrival in the USA.

To do this remove the hexagon screw plug on the control assembly cover which is lead-sealed by the firm of Bosch, and back out the mounting screw (2) as far as it will go (Fig. 07-14/1).

Now turn the adjusting screw (1) 3 notches toward the left by means of a screw-driver. This increases the injection amount by approx. 1—1.5 mm^3/stroke.

Screw on both the mounting screw (2) and the screw plug. Then mark the screw plug "USA" and secure it by means of a DB or Bosch seal.

Note: If complaints are received about USA cars which are temporarily being driven in other countries with standard fuel the adjusting screw should not be touched; the difficulty can be removed by regulating the idle adjustment to provide for a leaner mixture (see page 00-16/6).

If complaints are received about irregular engine performance in the lower speed range on cars previously supplied to the USA, the injection pump can be adjusted accordingly.

Pumps which are repaired in US workshops and are not marked "USA" on the screw plug must be corrected on a test stand for driving with premium fuels after they have been repaired and tested in accordance with Bosch Test Sheets WPP 001/5 DAI 2,2 a to h).

New or exchange injection pumps supplied to the USA should be adjusted by authorized workshops before they are installed in the car and the screw plug should be marked "USA".

Injection Nozzles for Diesel Engines

Job No.
07-22

A. Testing and Evaluation of Injection Nozzles Installed in Pump

(See also Job. No. 00-23, Diesel Knock under Starting and Partial Load Conditions.)

When the engine shakes or runs unevenly or when suddenly a loud and persistent combustion noise ("diesel knock") is heard, or when there is an appreciable loss of power, these symptoms may be due to fouled and sticking metering needles or inadequate nozzle injection pressure, faulty pre-chamber ball-pin or a leaky vacuum system or leaky diaphragm. If the malfunction is due to one of these things the following checks and/or jobs should be carried out:

a) **Observation ot exhaust gases;** with the vehicle standing, accelerate the engine, for a moment or two, to full or partial revolution speed, keeping the exhaust gas pulsation under observation and noting the noise produced, the "motor-boat effect".

If the exhaust gives off intermittent clouds of black smoke this often means that one or more of the nozzles are not operating evenly. In the same way an increase in the injection rate may be due to a marked fall-off in the nozzle pressure or it may also be due to normal wear or a leaky vacuum system or pump diaphragm. The injection nozzles should be removed and tested and a leak test carried out on the vacuum system and governor of the injection pump (see Job No. 07-26).

If uneven noise ("motor-boat effect") should be heard at the exhaust, this means that one cylinder is either partly or completely out of action (see following para b), Running and Sound Test).

b) **Running and sound test;** there are two separate tests involved: The first is with the engine idling and the second with the engine running at increased idle speed; slacken the cap nuts of the individual injection pipes on the injection pump half a turn, one after the other, and retighten, at the same time paying attention to the running and the sound of the engine. If when a cap nut is slackened there is no change at all in the running and the sound of the engine this means that part of the trouble at least is a **defect in the corresponding nozzle** or inadequate sealing between the pipe union and the pressure valve holder (see Sections B and C, Job No. 07-23).
If when a cap nut is slackened the engine starts to run unevenly this means that the corresponding injection nozzle is in order.

When a complaint is made of so-called "diesel knock" the very first thing to ascertain is the particular operating condition in which this combustion noise appears — i. e. whether it is with the engine warmed up or cold, when starting up, when the idle speed is higher, under partial load or full load conditions, in what engine speed range or road speed range, as the case may be, and finally in what gear.

B. Removal and Installation of Nozzle Holder/Injection Nozzle Assembly

Removal:

1. Take off cap nut (7) retaining injection pipe (Fig. 07-22/1).

2. Unscrew hexagon nut (6) holding the through-way jointing piece (5) and the hollow bolt (3) that forms part of the union of the leak-off oil pipe (4) and anchors it in position.

After the four valve holders have been removed, disconnect and remove leak-off oil pipe at the T-piece (junction connecting leak-off oil pipe, overflow pipe and return pipe).

Note: Before unscrewing the hollow bolt (3) and taking off the leak-off oil pipe the hexagon nut (6) must be backed out; this will prevent the cap nut (2) or the nozzle holder (1) from coming loose in the event of a jammed nut. If it does come loose, however, the nozzle holder should be steadied with an SW 24 wrench.

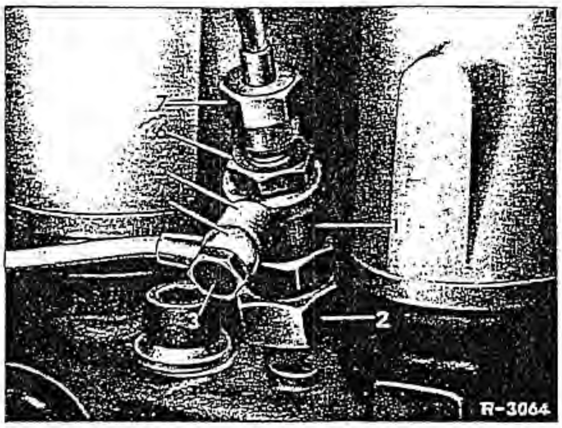


Fig. 07-22/1

1 Nozzle holder
2 Cap nut of nozzle holder assembly
3 Hollow bolt
4 Union head of leak-off oil pipe
5 Through-way jointing piece
6 Hexagon nut anchoring the through-way jointing piece
7 Cap nut anchoring the injection pipe

3. Use Socket-Wrench Head 000 589 61 09 00 to remove assembly consisting of cap nut (11), nozzle holder (4) and injection nozzle. Take out seal (15) (Fig. 07-22/2). Carry out visual inspection of pre-chamber. If all is in order tighten up threaded ring (4) to the specified tightening torque (see Fig. 01-5/1 and Job No. 00-0). To prevent dust or foreign bodies from entering the bore it should be kept covered until the assembly is reinstalled.

Note: Checking or adjustment of the nozzle aperture or injection pressure and examination of jet contour are described in Section C. Disassembly, cleaning and reassembly of the nozzle holder and/or the injection nozzle is described in Section D.

Installation:

4. Turn the engine over with the starter in order to expel any deposits there may be from the combustion chamber. A new seal (15) between nozzle and pre-chamber should always be fitted (Fig. 07-22/2). When this seal is fitted care must be taken to ensure that the cylindrical part fits perfectly into the bore of the pre-chamber and that the threaded ring (12) stands no more than 11 mm high.

5. Install assembly consisting of cap nut (2), nozzle holder (1) and injection nozzle in the pre-chamber and use Socket-Wrench Head 000 589 61 09 00 to tighten to 7-8 mkp (Fig. 07-22/1).

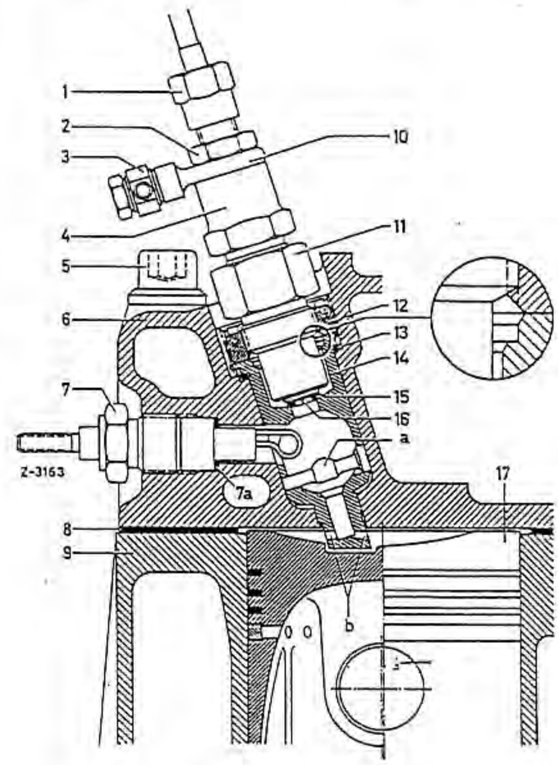


Fig. 07-22/2

1 Cap nut of injection pipe
2 Hexagon nut
3 Leak-off fuel pipe
4 Nozzle holder
5 Cylinder head screw
6 Cylinder head
7 Glow plug
7a Sealing ring
8 Cylinder head gasket
9 Crankcase
10 Through-way jointing piece
11 Cap nut of nozzle holder
12 Threaded ring
13 Sealing ring
14 Pre-chamber
15 Seal
16 Nozzle needle
17 Piston
a Ball pin
b Outlets of multi-hole burner

6. Install the through-way jointing piece (10) on the nozzle holder (4).

Note: The contact surfaces of the nozzle holder and the through-way jointing piece must be absolutely clean and plane-ground in order to ensure that the union seals perfectly. If necessary the sealing surfaces should be polished to final fit or the through-way jointing piece replaced.

7. Install hexagon nut (2), but do not tighten it as yet.

8. Tighten up the leak-off fuel pipe with the hollow bolt on the through-way jointing piece after having installed new seals on both sides.

9. Now tighten up the hexagon nut (2) to the specified tightening torque. **Under no circumstances must an attempt be made to cure a faulty union by excessive tightening.** Tightening to excess stretches the threaded union and renders the nozzle holder useless. If leakage develops it is always due to unsatisfactory sealing surfaces on the through-way jointing piece and the nozzle holder.

10. Connect up injection pipe by installing the cap nut (1) on the nozzle holder (for specified tightening torque see Job No. 00-0).

11. Run engine and check whether all unions are leak-proof.

C. Testing and Evaluation of Uncleaned, Cleaned, Reconditioned and New Injection Nozzles

(Bosch Throttle Nozzles DNO 151 and 1510)

Adjustment of Injection Pressure

The design features of throttle nozzles are such that evaluation of jet and nozzle chatter is conducted in virtue of "second-by-second" operation of the pump lever (speed of lever movement). If the specified number of down-strokes of the lever per second is not adhered to false evaluations can easily be made and nozzles are rejected when in actual fact they are still quite serviceable.
It is for this reason that the following testing instructions are given in some detail.

Nozzle Testing under Working Conditions

1. With the injection nozzle fitted in the nozzle holder connect up to the Bosch Nozzle Tester for Diesel Pumps (Order No. EFEP 60 F or EFEP 340) (Fig. 07-22/3).
   Only clean test oil or filtered diesel oil may be used for the test. **Under no circumstances allow the bare hand to get in the way of the jet.** The jetted fuel penetrates deeply into the flesh and destroys the tissue. Fuel that works its way into the blood may cause blood poisoning.

2. **Jet Test**

   When a test is made with short rapid partial strokes **(approx. 2 strokes per second)** the jet must be quite concentrated and cut off smartly between strokes. At the same time, however, a certain amount of common sense must be exercised in making an assessment. A few individual discrete drops or out-of-line, oblique-deltoid, spreading jets or slightly swollen jets have no effect on the combustion process within the engine.

   The jet and chatter test must be carried out with the pressure gage turned off.

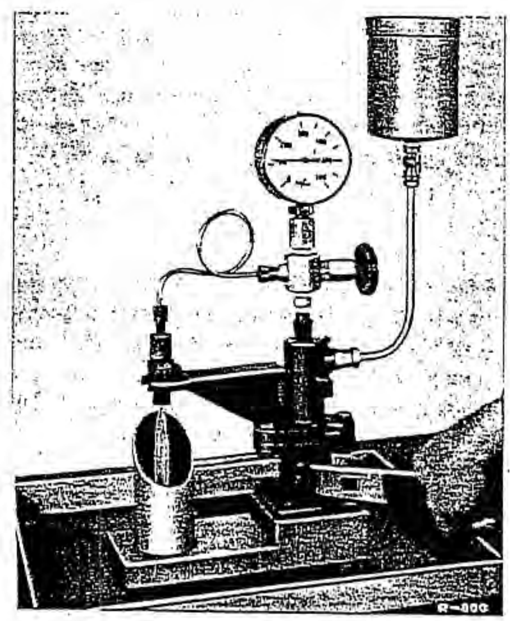


Fig. 07-22/3

3. **Chatter Test**

   Every nozzle accumulates carbon deposits along the floor of its canal, in the injection orifice and on the injection pin. In order to test whether a used nozzle is fit for further service the manual operation lever must be slowly pressed down to its full extent **(approx. 1 stroke per second)** when the nozzle should chatter at low sound-level but quite audibly. If there is only slight chatter or none at all the nozzle should be cleaned and if no improvement can be achieved by this it should be replaced.

If there is only slight chatter of a used nozzle and if it is of the narrow throttle aperture type (DNO SD 151), the nozzle is still serviceable but it may cause engine knocking at partial load. It is possible to restore nozzle chatter by cleaning and thus to eliminate engine knocking at partial load but this can only be a short-term remedy. It is advisable to install the slightly modified nozzle DNO SD 1510, Part No. 000 017 28 12, which produces an audible chatter even if carbon deposits have accumulated.

4. If the test procedures given in Paras. 2 or 3 yield no results the nozzle should be flushed through for 10 seconds, the process consisting of short, rapid full-length strokes of the manual lever at a rate of 2 to 3 strokes per second. The resultant jet should be concentrated and should emerge with a clearly audible high-pitched whine. If it does not, the nozzle may be strained, fouled up, damaged or excessively worn. It should then be cleaned (see Section D). If after cleaning its performance does not come up to standard it must be replaced.

When the conditions of Para. 4 have been fulfilled, all the procedures of Paras. 2 and 3 must be repeated. Flushing out rapidly with full-stroke movements may be enough to clean out gummed or slightly fouled nozzles and to improve the chatter and the jet contours.

5. If the performance fulfills the requirements of Paras. 2 and 3, check the opening or injection pressure of the injection nozzle and carry out a leakage test.

6. **Testing of Opening Pressure and Spray Pressure of Injection Nozzle**

Switch on the pressure gage, slowly depress the pump lever (1 stroke per second) and take the pressure at the moment of opening — i. e., at the beginning of injection; during this test the nozzle must be clearly heard to chatter (Fig. 07-22/3).

Caution: With the pressure gage on, advance the pressure very gently — and, above all, release it very gently so as to avoid possible damage to the gage.

New nozzles have an opening pressure of 115 atm. and used ones must have at least 100 atm. to remain serviceable. The difference in opening pressures with a given set of nozzles in an engine must not be more than 5 atm. The opening pressure is a function of the bearing tension of the compression spring and is adjusted by adding washers (15) (actually, machined steel disks) which are fitted at the top between the compression spring and the nozzle holder (Fig. 07-22/6).

These disks are available in a range of gages extending from 1.0 to 1.8 mm in 0.05 mm steps. Increasing the spring tension by 0.05 mm increases the opening pressure by approx. 3.0 atm. (See also Section D, para. 10, Installing Injection Nozzle in Nozzle Holder).

7. **Testing Injection Nozzles for Leaks**

Slowly depress the pump lever to the point at which the pressure gage pointer shows 20 atm. below the opening pressure set on the gage. If no drops form at the mouth of the nozzle, the nozzle is fluid-tight.

If there is a leakage that cannot be cured by careful cleaning of the seating surfaces of the nozzle casting and of the needle the nozzle must be replaced (see also Section D, Cleaning of Injection Nozzle, Para. 7, Note).

If the nozzle leaks at the screw fitting of the cap nut, no attempt must be made to effect a seal by excessive tightening. If the nozzle element (3) does not seal perfectly it can be lapped on both sides with lapping paste on a finishing plate (see Fig. 07-22/6) and the same applies to the end face of the nozzle holder (7). In fact it is often quite sufficient just to turn the nozzle element and retighten the cap nut — but then as laid down in the appropriate procedure.

If the performance fulfils the requirements of the tests specified in Paras. 2, 3, 6 and 7 the nozzle is serviceable and can be put back again.

Note: In cases of complaint and where claims are lodged in respect of either a warranty or negotiated replacement the guarantee certificate or tag should always show any nozzle defects that have been discovered; these might include: unsatisfactory jet contour, nozzle fails to chatter even when cleaned, nozzle is not fluid-tight and drips, carbon deposit on needle, needle strained, binding and fouled points on needle guide shaft etc. In order to avoid damage in transit when a number of nozzles are being sent back to the makers (without the nozzle holders), they must be individually packed in paper and on no account simply bundled together in a single package.

As from engine nos. 621.918-010-073 382 and 621.918-012-005 322 injection nozzle DNO SD 1510 (Part. No. 000 017 28 12) has become standard equipment. The previous injection nozzle DNO SD 151 (Part No. 000 017 25 12) should be used up; both nozzle versions can be used together in one engine.

D. Disassembly of Nozzle Holder, Cleaning of Injection Nozzle and Reassembly of Nozzle Holder

Disassembly of Nozzle Holder

When the nozzle holder is disassembled strict attention must be given to the matter of cleanliness, both of the shop and of the tools.

1. The nozzle holder must never be gripped in the vise without using the Special Jaws 636 589 01 31 00 to avoid the nozzle holder being damaged by the contact pressure (Fig. 07-22/4).

   If no special jaw attachment is available set up a suitable SW 24 mm socket wrench in the vise and nest the nozzle holder in it.

2. Use an SW 27 mm box spanner to remove cap nut (5) (Fig. 07-22/6).

   Take nozzle assembly (2) plus jet needle (1) out of the cap nut.

   Take nozzle element (3), thrust pin (4) and compression spring (6) out of the nozzle holder (7). In disassembling care must be taken to ensure that the nozzle assembly, the needle and the separate parts of the individual nozzle assembly units are not interchanged. The special washer (15) may remain in the nozzle holder while it is being cleaned.

Do not touch the lapped surfaces of the jet needle since this is liable to cause corrosion; **grasp it only at its thrust pin end** (see Fig. 07-22/11).

Cleaning of Injection Nozzles

The Bosch Cleaner EF 8486 B, Part No. 000 589 00 68 00, is used for cleaning already-used injection nozzles (Fig. 07-22/5). Under no circumstances may abrasive paper or scrapers or the like be used. The work of cleaning should only be carried out by specially trained personnel.

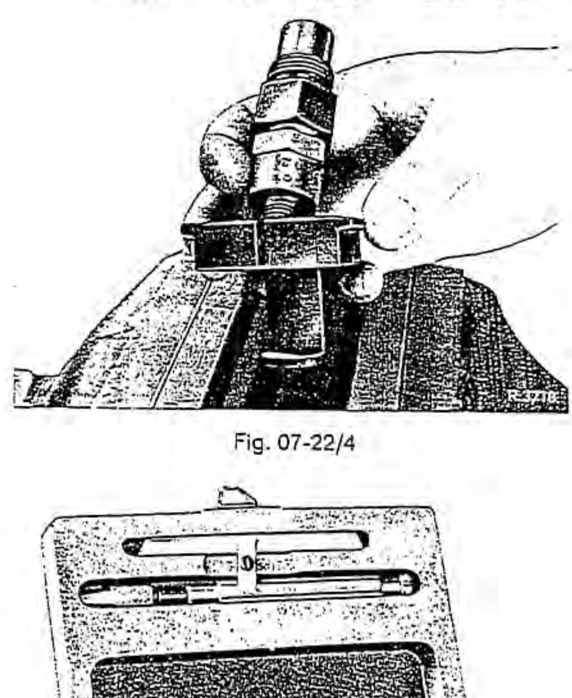


Fig. 07-22/4

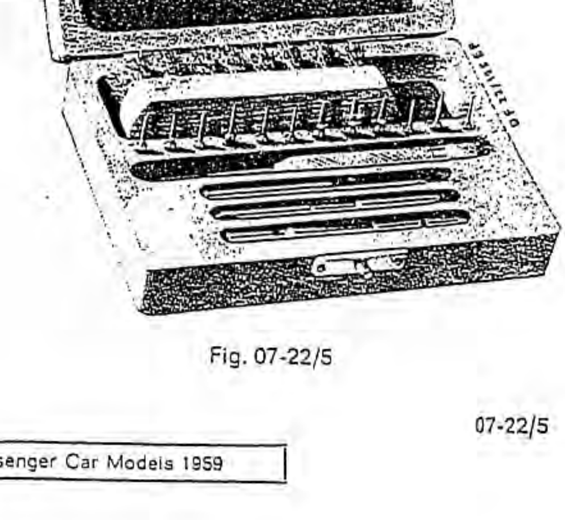


Fig. 07-22/5

3. Brush away combustion deposits on the outside of the face side of the nozzle assembly (2), (Fig. 07-22/6), mainly around the mouth of the nozzle (7), (Fig. 07-22/11), using a brass brush or, if no brass brush is available, clean or diesel fuel. If a Bosch Nozzle Cleaner is available, the following is the procedure:

Clean **pressure chamber** (19) of nozzle assembly with the annular groove scraper (Figs. 07-22/6 and 07-22/7).

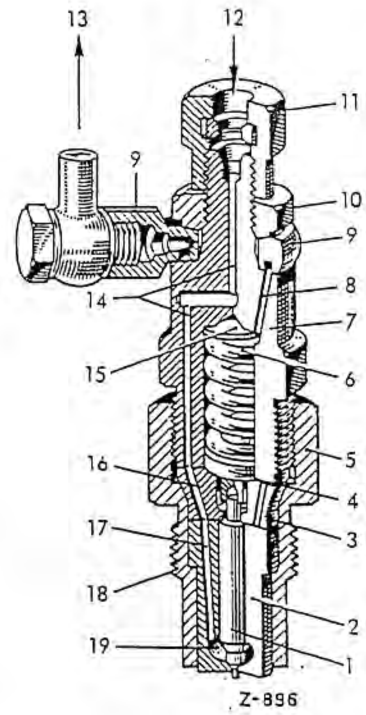


Fig. 07-22/6

Nozzle holder/injection nozzle assembly

1 Jet needle
2 Nozzle assembly
3 Nozzle element
4 Thrust pin
5 Cap nut for fixing injection nozzle
6 Compression spring
7 Nozzle holder
8 Drain hole in the nozzle holder
9 Through-way jointing piece with annular canal for leak-off oil union
10 Hexagon nut for fixing the through-way jointing piece
11 Cap nut for fixing the injection pipe
12 Fuel feed
13 Leak-off oil drain back to fuel tank
14 Pressure canal in the nozzle holder
15 Special washers for compression spring (machined steel disks)
16 Annular groove and feed bores in nozzle element
17 Annular groove and pressure canal in nozzle assembly
18 Mounting thread
19 Pressure chamber in nozzle assembly

the end face of the nozzle assembly on a flat piece of diesel-soaked hardwood with a groove in it, along which the protruding injection pin (8) can move. Under no circumstances must a hard object be brought into contact with the mouth of the nozzle.

4. Clean the interior of the nozzle assembly with a suitably-shaped piece of stick and **gasoline**

Clean the **seat of the jet needle** in the nozzle assembly with the cleaning tool (Fig. 07-22/8). This job should be done with particular care because the serviceability of the nozzle is to a large extent dependent upon the seating of the jet needle making a proper fit.

Undue pressure must always be avoided when the cleaning tool is being turned.

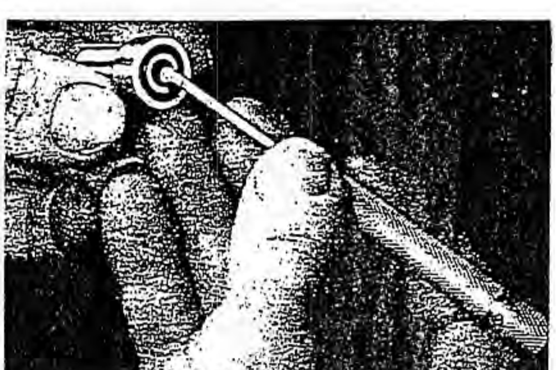


Fig. 07-22/7

Fig. 07-22/8

Clean the injection orifice in the mouth of the nozzle with the injection orifice cleaner. As can be seen from Fig. 07-22/9 not outward, but from the inside outward; this is so that the injection orifice cleaner can be properly guided without tilting.

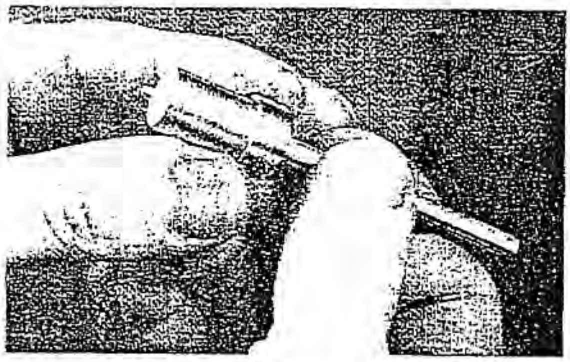


Fig. 07-22/9

5. Use an edged, diesel-soaked hardwood stick to clean the jet needle. If the profile of the jet needle is thickly covered with carbon deposit it can be fitted (by its thrust pin (13) end) in a suitable lathe-chuck or drill-chuck; the injection pin (8), throttle pin (9) and needle seating (10) should then be cleaned with an edged hardwood stick dipped in oil (Figs. 07-22/10 and 07-22/11).

Fig. 07-22/10

6. Visual Inspection

After cleaning, all nozzles that have been used should be visual-inspected.

a) Watch out for damaged or rough needle seating surfaces and worn or damaged injection pins.

b) Examine the nozzle assembly for scarring or carbon deposits on the seating surface (use Illuminating Magnifier EFAW 25 B) and make sure that the injection hole is not out-of-round. Defective nozzles should be replaced or obtained on an exchange basis from the supplier firm of Bosch.

7. Free-Sliding Test

For both used and new nozzles inspection should be followed by the free-sliding test.

Check that the jet needle moves easily in the nozzle assembly. Then immerse jet needle and nozzle assembly individually in filtered diesel fuel and install jet needle and nozzle assembly. Now pull the jet needle for approximately a third of its length out of the nozzle assembly and hold the latter vertical; the jet needle must now slide down by gravity until it settles on its seating surface (this is known as the falling test).

Turn the jet needle over and repeat the process. If despite careful cleaning it fails to fall down replace the nozzle.

Note: Temporary repairs may be effected in an emergency when it is not possible to lay hands on a replacement nozzle, but this should only be done under exceptional circumstances; use may be made of the Bosch Lapping Paste FT 26 V 2 to free up a jamming jet needle by lapping the shaft of the needle or to seal a leaky nozzle by lapping the seating surface of the jet needle and the nozzle assembly. The relapping process must be confined to the absolute minimum consistent with proper functioning of the nozzle. After lapping, the two parts must be thoroughly cleaned and rinsed.

Nozzles with damaged seating surfaces or too much needle play, as a result of being kept in operation for too long, should be replaced. (Excessive needle play causes abnormal leak-off oil losses and results in impaired engine performance.)

Nozzle needle and nozzle assembly are always a matched pair; they should always be replaced as pairs, and no jet needle should ever be mated to a nozzle assembly to which it is not already matched.

Installation of Injection Nozzle in Nozzle Holder

8. Before assembly give all the parts concerned a further rinsing in pure diesel fuel. Particular attention should be paid to the ground sealing surfaces of the nozzle holder, the nozzle element and the nozzle assembly, which must be scrupulously clean and undamaged.

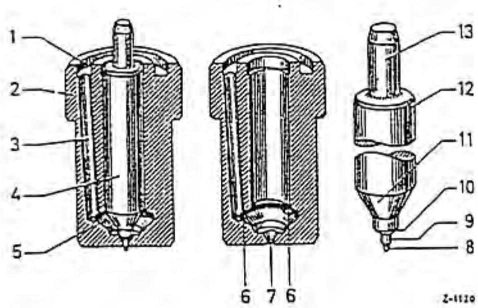


Fig. 07-22/11

1 Annular groove
2 Nozzle assembly
3 Intake bore
4 Jet needle
5 Pressure chamber
6 Mouth of intake bore in pressure chamber
7 Mouth of nozzle
8 Injection pin
9 Throttle pin
10 Needle seating surface
11 Thrust shoulder
12 Needle shaft
13 Thrust shank

New and reconditioned injection nozzles are treated with anti-corrosive grease at the supplier's factory. These nozzles must therefore be washed in clean gasoline and tested for ease of movement as described in Para. 7 above.

9. Then insert nozzle holder in Special Jaws 636 589 01 31 00 or in an SW 24 mm socket wrench (Fig. 07-22/4).

10. Fit special washer (15) in nozzle holder (7) if it had been previously removed; fit compression spring (6) and put thrust pin (4) on the compression spring with the shorter pin pointing toward the spring. Place nozzle element (3) with annular groove downward over the thrust pin (4) (Fig. 07-22/6).

11. Place nozzle assembly (2) plus jet needle (1) on nozzle element (3). Then install cap nut (5) on nozzle holder (7), by hand for the time being.

12. Now tighten up the cap nut with a torque of 7—8 mkp. (Excessive tightening of the cap nut may strain the nozzle assembly and cause binding or jamming of the jet needle.

13. **Check and adjust opening or spray pressure** (see Section C, Para. 6).

14. **Check injection nozzle for leakage** (see Section C, Para. 7).

15. **Carry out jet and chatter test** (see Section C, Paras. 2 and 3).

Venturi Control Units with Check Valve on Diesel Engine

Job No.
07-25

A. General Remarks

Up to engine No. 621.912-10-016 855 the engines for Model 190 Dc have different **venturi control units without check valve** and may only be installed together with the appropriate intake pipe and the matched governor of the injection pump as indicated by the following table.

Note: As a safety precaution, after installation of a venturi control unit the maximum rpm should be measured under no load and the control valve correspondingly adjusted if necessary. The prescribed maximum rpm figures should on no account be exceeded (see Job No. 00-19, Section C).

Venturi Control Units

Model	Venturi control unit Part No.	Observations
190 Dc	621 070 17 28 or 621 070 20 28 with solid shaft but without check valve	for installed small standard intake pipe 621 140 00 01 and injection pump PES 4 M 50 A 320 RS 14 with governor EP/MN 60 M 7 d or 8 d
	621 070 18 28 with solid shaft but without check valve (the venturi control unit differs from the one listed above merely in that it has different levers)	for installed ram intake pipe 621 140 02 01 and injection pump PES 4 M 50 A 320 RS 14 with governor EP/MN 60 M 12 d or 13 d
	621 070 22 28 with check valve	for installed ram intake pipe 621 140 02 01 or 621 140 05 01 and injection pump PES 4 M 50 A 320 RS 14 with governor EP/MN 60 M 15 d or 16 d
200 D	621 070 25 28 with check valve	for installed ram intake pipe 621 140 05 01 and injection pump PES 4 M 50 A 320 RS 14 with governor EP/MN 60 M 15 d or 16 d
	621 070 27 28 with check valve and automatic opening of check valve at full throttle to prevent check valve flutter and hence engine "stutter" (brief fall in engine speed)	

Venturi control units with check valve ensure that the engine is stopped immediately or can be stopped with the aid of the stop cable in the event of the engine's starting in the wrong sense of rotation because of faulty procedure.

The function of the check valve may be described as follows:

When the engine is running normally, the inlet air flow opens the check valve (Fig. 07-25/1). However, if the engine starts in the wrong sense of rotation, the check valve is closed by the dynamic pressure of the exhaust gases and the engine stops (Fig. 07-25/2).

If there are complaints, for example, about poor performance premature governing or because the engine does not attain maximum rpm, check the check valve for freedom of movement. It must open at once when the throttle is fully opened. To ensure the required freedom of movement, lubricate the bearing points of the check valve shaft with engine oil when service and maintenance jobs are being carried out.

If, on the other hand, the engine "snores" when governed, the check valve flutters because of ex-

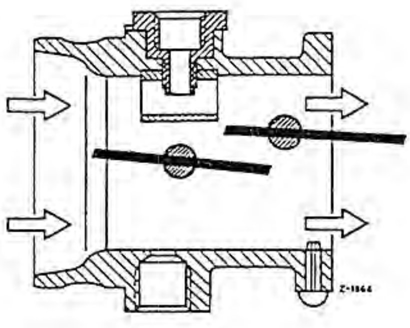


Fig. 07-25/1

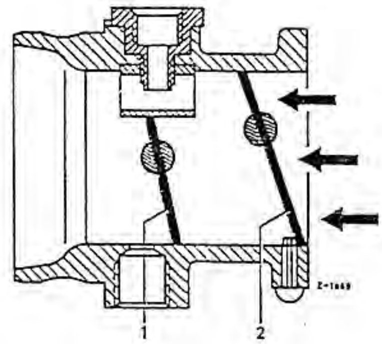


Fig. 07-25/2

Attitude of control and check valves when

engine running properly — engine running backward

1 Control valve
2 Check valve

cessive freedom of movement and can be braked more strongly by fitting a washer behind the pressure spring of the check valve shaft (see Fig. 07-25/3).

Subsequent installation of a venturi control unit with check valve

On Model 190 Dc
with 1st intake pipe version, Part No. 621 140 00 01

Install venturi control unit with check valve, Part No. 621 070 24 28. Run the engine and set the maximum rpm to 5,000 to 5,200 rpm under no load by adjusting the check valve.

with ram intake pipe

Install venturi control unit with check valve, Part No. 621 070 22 28. Up to engine No. 621.912-10-013 569 remove control spring, Part No. 000 074 42 93 (Bosch Order No. WSF 11 S 16x), and replace by the control spring, Part No. 000 074 45 93 (Bosch Order No. WSF 11 P 260x). Run the engine and set the maximum rpm to 5,000 to 5,200 rpm under no load by adjusting the check valve.

Note: The two control springs differ only in length. The unloaded spring 000 074 42 93 is 95 mm, the spring 000 074 45 93 102 mm ± 3 mm lang.

B. Checking and Reconditioning of Venturi Control Unit

Loose control valves and worn-out control valve shafts lead to jamming of the throttle linkage and, in certain circumstances, to uneven running of the engine.

The vacuum line connection and the attaching flange of the venturi control unit must be absolutely air-tight — because a leak in the vacuum system influences the injection control. The result would be retarded governing, increased fuel consumption and heavy exhaust smoke.

The control valve must therefore be checked to make sure that it is properly seated on the control valve shaft; at the same it should be ensured that the closed control valve is seated concentrically in the venturi control unit and does not bind. If there is heavy wear of the base bores for the control valve shaft, the venturi control unit must be replaced or the base bore re-bushed and reamed. A clearance of between 0.04 and 0.08 mm should be adhered to between the bore and control valve shaft. Also check the seating of the air jet and the auxiliary venturi pipe. Correct depth of thread engagement is important here (Fig. 07-25/4). The dimension b must be 4.5 ± 0.3 mm, dimension c of the air jet 5 mm. A change in the dimension b or in the diameter of the jet influences governing and results in incorrect adjustment values. Regarding checking the attaching flange on the venturi control unit: if necessary, smooth the sealing surface on a surface plate. After reconditioning, first set the full-load stop screw (1) so that in the full throttle position the control flap is not quite fully open by about 5° — it should not be fully open. This setting renders possible subsequent correction of the full-

load maximum speed and of the maximum rpm under no-laod conditions (Fig. 07-25/3).
The dimensions a, b and c, the venturi control unit housing, the control valve, the control valve shaft, the auxiliary venturi pipe and the air jet are identical for the engines for Models 190 Dc and 200 D. Merely the control valve lever and the stop lever for the check valve are different.

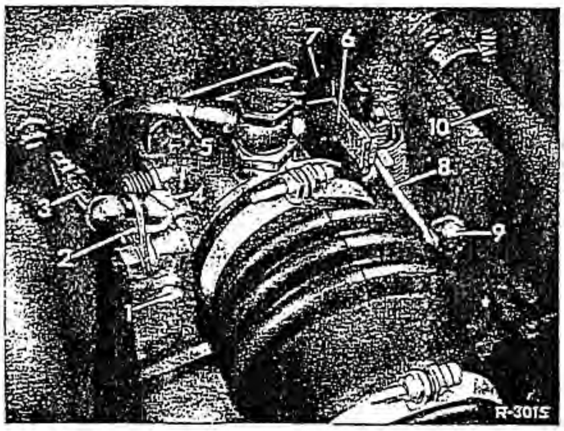


Fig. 07-25/3

Venturi control unit with control and check valves

1 Full-load stop screw
2 Control valve lever (front)
3 Connecting rod from control valve lever to angle lever for actuating butt bolt of injection pump
4 Idle stop screw
5 Vacuum line for injection pump
6 Check valve lever with stop for automatic opening and with rubber damping (check valve open in this position)
7 Lug on control valve lever (rear) for automatically opening check valve
8 Control valve lever (rear)
9 Connecting rod for reversing lever, push rod, control shaft, pedal lever, foot plate
10 Line to vacuum pump for power brake

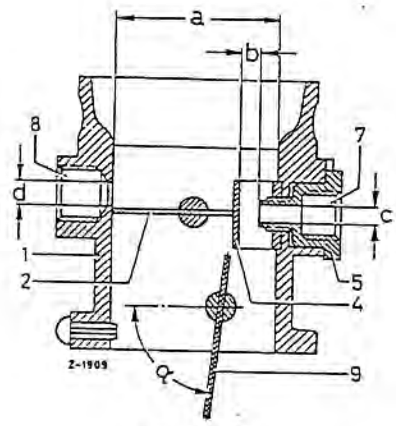


Fig. 07-25/4

Venturi control unit with check valve

1 Venturi control unit housing
2 Control valve
4 Auxiliary venturi pipe
5 Screw/air jet
7 Union for vacuum line
8 Union for vent line
9 Check valve
a 42 mm internal diameter of venturi control unit
b 4.5 + 0.3 mm (screwed to depth of)
c 5.0 mm (bore of air jet)
d 6.0 to 7.0 mm (see Note)
α The control dimension for position of check valve for Models 190 Dc and 200 D is 84° 30' ± 1°

Job No. 07-26

Pneumatic Governor of Diesel Injection Pump

With Pump Fitted in Engine

It is not possible to carry out accurate checking and adjustment of the governor unless the injection pump can be set up on a test stand. The following is a selection of jobs that can be carried out without a test stand and with the pump installed in the vehicle.
The conditions under which it becomes necessary to examine the governor are: impaired car performance, engine producing thick smoke, uneven running, hunting and bursts of acceleration while engine is idling, exceeding of the full-load maximum engine speed — in other words exceeding of the maximum speed allowed in the various gears on the level and of the maximum engine speed allowed under no-load conditions.

A. Testing Diaphragm, Governor Housing and Vacuum-Line Union for Leakage

1. With the engine running, brush soapy water over the intake manifold, vacuum line, fixing flange of Venturi control unit and governor housing; this will reveal leaky spots which should then be made leak-proof.

2. Detach starter and stop cable from control lever (2) of injection pump. Take off protector sleeve (3) above control rod. Unscrew vacuum line from vacuum union (1). Press control rod with control lever (2) hard over to STOP and close vacuum union (1) with one finger. Then release control lever and watch control rod (see Fig. 07-26/1).

   If both the diaphragm and the vacuum housing are in order the control rod is simply pushed forward a little by the control spring and is then held fast by the vacuum produced in the vacuum housing. If after moving a short distance the control rod does not stop, either the diaphragm or the vacuum housing is leaking. If the control rod stops, a certain amount of backlash can be felt when the control lever is actuated.

   If there is leakage the vacuum housing must be dismantled by taking out the four fixing screws, detaching the diaphragm stud from the control rod and taking out and examining the diaphragm for damage.
   If the diaphragm is brittle it must be replaced as a matter of course.

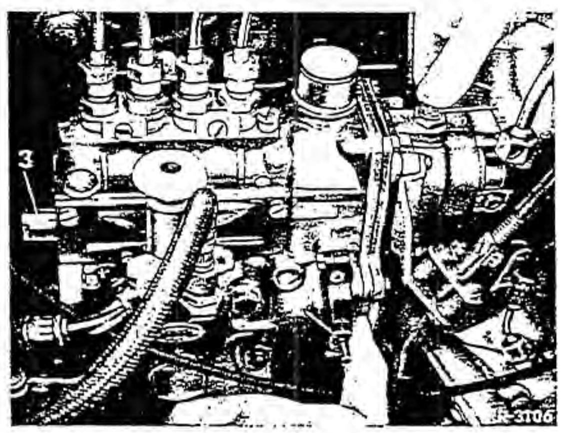


Fig. 07-26/1

1 Vacuum union
2 Control lever
3 Protector sleeve above the control rod

B. Replacement of Diaphragm in Governor Housing

Remove injection pump, replace diaphragm, set up injection pump on an injection pump test stand, check and/or rectify beginning of compensation and compensator travel.

It is also possible, however, to replace a diaphragm with the injection pump fitted to the engine, provided that the following instructions are observed:

1. When the diaphragm is being removed care must be taken to ensure that the parts 1 to 4 (compensator mechanism) inserted in the sleeve (5) do not fall out. If they should happen to fall out they must all be put back again in the proper order as shown in Fig. 07-26/2.
2. Use dial gage to measure the maximum compensator travel — i. e. the travel of the compensator pin on the old diaphragm (see Figs. 07-26/3 and 4).

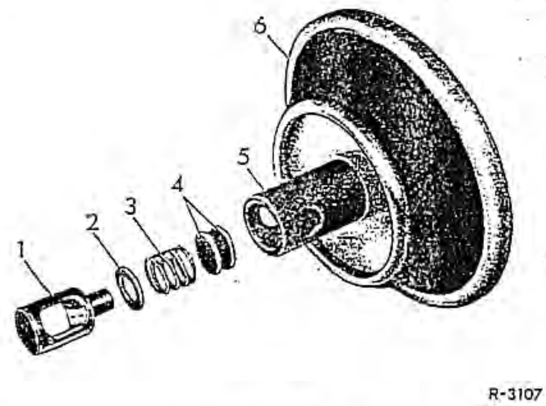


Fig. 07-26/2

1 Compensator pin
2 Shim for compensator spring
3 Compensator spring
4 Shims for compensator spring
5 Sleeve
6 Diaphragm

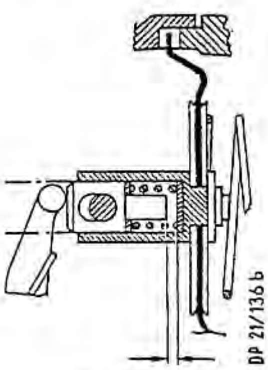


Fig. 07-26/3

a = max. compensator travel

The measurement is taken by putting a 6 mm pin (4) through the sleeve (2) of the diaphragm and through the compensator pin (5) and putting the diaphragm on a piece of tubing (3) which should have an external diameter of no more than 35 mm and an internal diameter of at least 22 mm and must be at least 10 mm long. Then set the stand of the dial gage in such a position that the prod (1) of the gage is placed in the middle of the compensator pin (5). Set dial gage to zero.

Now press down the prod (1) of the dial gage and read off the travel from the dial. The maximum compensator travel will vary according to the type of governor and may be anything from 1.1 to 2.7 mm.

Caution: If the prod is not placed in the middle of the compensator pin the latter may tilt; 2 or 3 separate measurements should therefore be taken (see Fig. 07-26/4).

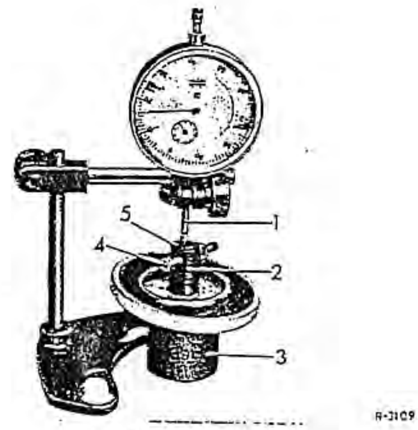


Fig. 07-26/4

1 Prod of dial gage
2 Sleeve of diaphragm
3 Piece of tubing
4 Pin, 6 mm Ø
5 Compensator pin

3. Take the compensator pin, the shim, the compensator spring and the compensator shims out of the old diaphragm and insert them in the new diaphragm.

4. Measure the maximum compensator travel of the new diaphragm with the dial gage (see Para. 2 and Fig. 07-26/4). If the difference between this and the old diaphragm is not greater than 0.06 mm the new diaphragm should be installed, together with the old control spring (13), that was matched to the compensator spring, and the backing ring (14) if one was fitted (see Fig. 07-26/5).
   If the difference in maximum compensator travel is greater, it should be offset by means of the shims (4), which are supplied by Bosch in the gages 0.2 mm, 0.3 mm, 0.5 mm and 1.0 mm (Fig. 07-26/2).

Note: It is only on the injection pump test stand that a proper test can be made to ascertain wheter compensation starts at the proper moment; in consequence the shim, which determines the initial tension of the compensator spring and thus the beginning of compensation, must under all circumstances be taken out of the old diaphragm for use in the new one. The same applies to the control spring (13) and the backing rings (14) which, in turn, are made to match the compensator spring (4) (see Fig. 07-26/5). Arbitrary alteration of the initial tension of either the compensator or the control spring results in incorrect adjustment values.

5. Measure maximum rotation speed under no-load conditions (at the end of the governing process) (see Job No. 00-19).

6. Run road tests to determine carbon monoxide in exhaust gases or to adjust smoke threshold (see Job No. 00-19, Sections E and F).

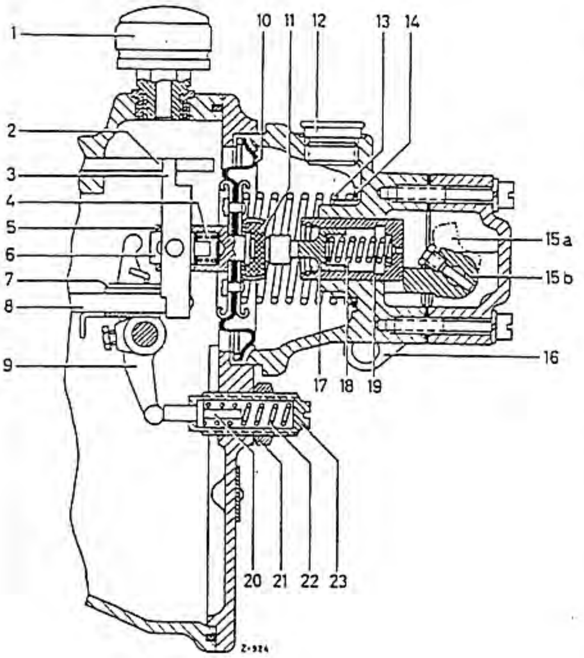


Fig. 07-26/5

System in idle position

1 Air cleaner
2 Guide rod
3 Guide lever
4 Compensator spring
5 Diaphragm sleeve
6 Compensator pin
7 Start-metering stop
8 Control rod
9 Double-link rocker
10 Diaphragm
11 Rubber buffer
12 Vacuum union to vacuum chamber
13 Control spring
14 Backing ring
15a Switch cam, full-load position
15b Switch cam, idle position
16 Lever for automatic auxiliary governor system
17 Stop stud (butt bolt)
18 Auxiliary spring
19 Butt bolt housing or spring housing, sliding
20 Stop stud for full-load stop
21 Setting nut
22 Spring
23 Full-load stop screw

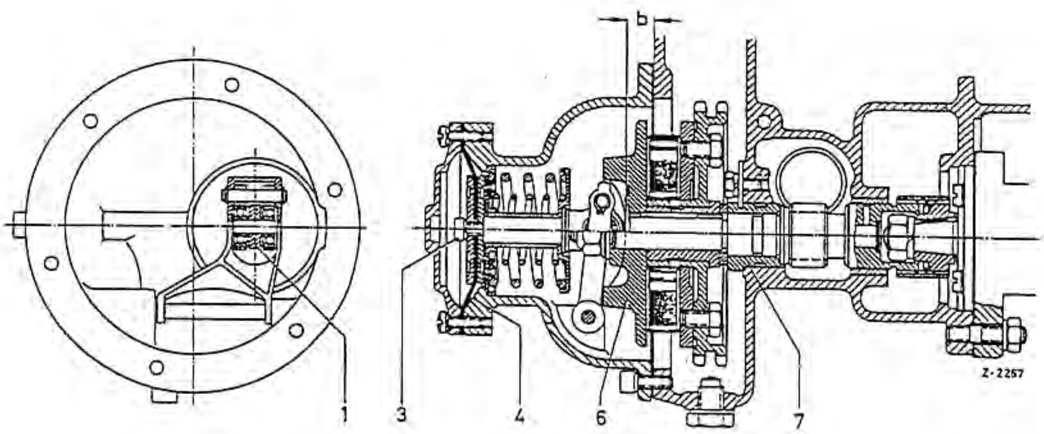
Vacuum Pump for Power Brake

Job. No.
07-30

Modification: Revised

A. General

As from chassis end number 099 642 diesel cars have been equipped with a vacuum pump for the power brake as a standard part. The vacuum pump is screwed to the front of the crankcase instead of the cover and is driven by the segmental flange with lifting cam (6) from the spray adjuster. The front bearing bushing with collar (7) receives the axial pressure of the vacuum pump.



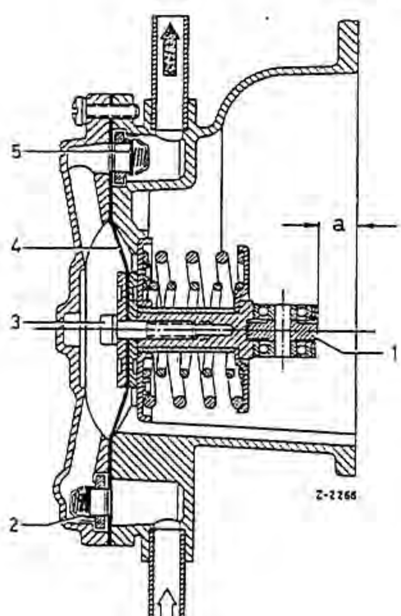


Fig. 07-30/1

1 Roller
2 Plate valve / suction side
3 Cylindrical screw
4 Diaphragm
5 Plate valve / pressure side
6 Segmental flange with lifting cam
7 Bearing bushing with collar

a) Dimension 11.7 — 12.1 mm
b) Dimension 12.92 — 13.8 mm

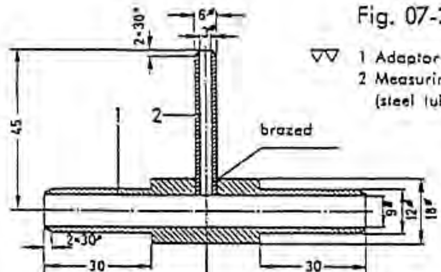


Fig. 07-30/2

1 Adaptor
2 Measuring connection (steel tube 6 × 1.5)

B. Checking of Vacuum Pump

If brake action is found to be unsatisfactory check the vacuum pump in the car. Install a shop-made adaptor (Fig. 07-30/2) for the vacuum gage (e. g. the SUN Tester) between vacuum pump and power brake.

At average engine speed and after approx. 10 seconds the vacuum gage should register 0.7 atm. below atmospheric pressure. If this value is not obtained, check the hoses for leaks and retighten the hose clips. There is also the possibility that the diaphragm or the plate valves of the vacuum pump are defective. A rapid decrease in the vacuum after the engine has been switched off suggests leaky plate valves. If the plate valves function properly, a rapid decrease in the vacuum is due to a defective tandem master cylinder or power brake (see Job No. 42-21, Section H).

C. Repair of Vacuum Pump

Parts for vacuum pump repair:

Rocker arm	Part No. 000 586 08 43
Diaphragm set	Part No. 000 586 00 43
Outer pressure spring	Part No. 000 435 15 84
Inner pressure spring	Part No. 000 435 16 84
Replacement vacuum pump	Part No. 000 435 02 01/80

Removal of Vacuum Pump and Cover

1. Detach the intake and delivery line from the vacuum pump and remove the vacuum pump.

2. Fasten the vacuum pump to the shop-made mounting plate (Fig. 07-30/3) and pretension the roller (1) (dimension "a" = 23.5 mm) by turning the thrust screw (Fig. 07-30/1).

3. Remove the locking device and the lead seal from the Philips screw and unscrew the pump cover. If the cover sticks to the housing, prise it off with a screwdriver.

Replacement of Plate Valves

4. Take out the plate valves (2) and (5) and install new valves.

Note: The two plate valves are interchangeable.

Replacement of Diaphragm

5. Unscrew the cylindrical screw (3) while holding the diaphragm disk steady by Pin Wrench 000 589 00 05 and remove the diaphragm disk together with the diaphragm (4).

Note: Before installation, carefully clean the diaphragm disk and the sealing surfaces on the cover and on the pump housing.

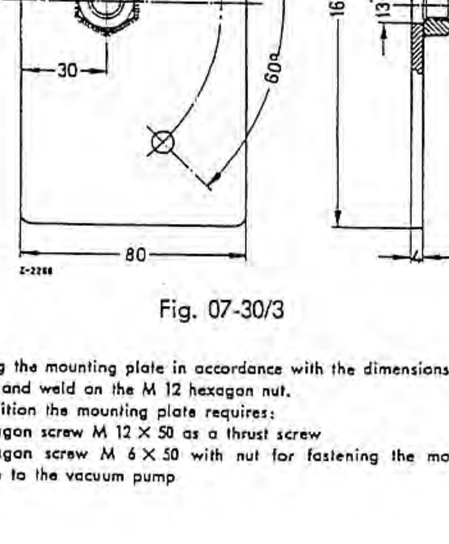


Fig. 07-30/3

Making the mounting plate in accordance with the dimensions given above and weld on the M 12 hexagon nut.
In addition the mounting plate requires:
1 Hexagon screw M 12 × 50 as a thrust screw
2 Hexagon screw M 6 × 50 with nut for fastening the mounting plate to the vacuum pump

6. During installation the raised (lettered) part of the diaphragm must point toward the screw head, and the corrugation in the diaphragm disk toward the diaphragm.

   Use trichloroethylene or a similar completely volatile solvent to free the thread of the cylindrical screw (3) (M 6 x 30 DIN 6912-8 G with flat head) and the internal thread of the diaphragm rod from oil and grease. Then coat the thread of the cylindrical screw with a "Loctite Type A" adhesive and screw in with a new sealing ring, holding the diaphragm disk steady by means of Pin Wrench 000 589 00 05. The cylindrical screw (3) should be tightened with a torque of 1 mkp.

Removal and Installation of Pressure Springs and Rocker Arm

7. Relieve the two pressure springs by turning out the thrust screw on the mounting plate and unscrew the mounting plate. Lift the rocker arm with roller and take out the two pressure springs.

8. Use pliers to press the rocker arm pivot pin through the threaded hole and remove the rocker arm. If the bearings are damaged replace the rocker arm together with bearing and pivot pin, Part No. 000 586 08 43.

9. Check the tension of the two pressure springs (see Table: Test Values of springs).

10. Install the spring retainer (I. D. 15 mm) in the pump housing and insert the two pressure springs with the rear spring retainer (I. D. 12 mm). Insert the diaphragm rod in the rear spring retainer, install the rocker arm and press in the pivot pin. Screw in the pivot pin locking screw together with a new seal. Then screw the vacuum pump to the mounting plate and pretension to the dimension "a" (23.5 mm) by means of the thrust screw, making sure that the springs are properly seated in the spring retainers.

Installation of Cover and Vacuum Pump

11. Screw down the pump cover. Thread the lead seal wire through the Philips screw and the locking screw, and seal.

12. Turn out the thrust screw on the mounting plate and unscrew the mounting plate.

13. Before installing the vacuum pump check the dimensions "a" and "b" (Fig. 07-30/1).

Note: The gasket between the crankcase and the vacuum pump is 0.2 mm thick.

Test Values of Springs

Spring version	Length under load			
	under prelim. load		under final load	
	mm	kp	mm	kp
Outer pressure spring 000 435 15 84	35	17	24	25
Inner pressure spring 000 435 16 84	35	12	24	23

Air Intake Silencer - Group 09

Intake and Exhaust Manifold - Group 14

Air Intake Silencer

Job. No.
09-1

Modification: Models 190 c and 300 SE and Oil Bath Filter (Addition)

A. General

Models 190 c, 220 b, 220 Sb, 220 SEb, and 300 SE have an air intake silencer as a standard part which takes the form of a dry air filter, which works with a paper filter element.

On Model 220 Sb two different versions of the intake scoop have been installed (see Figs. 09-1/1 and 09-1/2). This change in scoop design was made in order to avoid the occasional occurrence of uneven build-up. At the same time it was necessary to enlarge the 1st stage main jets and the enriching jets of the carburetors (see also Job No 00-0). The 2nd version intake scoop can be installed subsequently provided that the 1st stage main jets of the carburetors are changed in accordance with the Table given in Job No. 00-0. It is not necessary in these cases to install a larger enrichment jet.

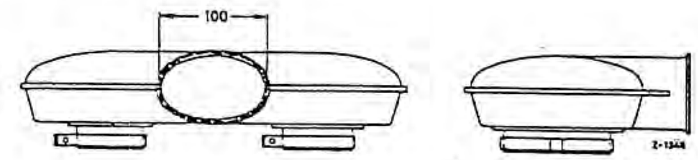


Fig. 09-1/1

Intake Scoop for Model 220 Sb 1st Version

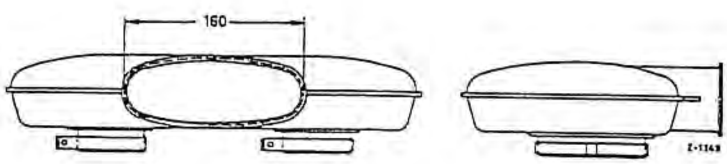


Fig. 09-1/2

Intake Scoop for Model 220 Sb 2nd Version

B. Removal and Installation

The following points require attention when the air intake silencer is removed and installed:

Models 220 b and 220 Sb

The retaining plate (11) for fixing the air intake silencer to the chassis base panel can be adjusted after loosening the hexagon screws (Fig. 09-1/4).

Models 220 SEb, 300 SE

When the air intake silencer is removed, the venturi control unit of the engine must be unscrewed. When the venturi control unit has been reinstalled it is necessary to check the adjustment of the control linkage (see Job No. 00-16).

C. Cleaning of Air Filter Element

I. Dry Air Filter

The air filter element should not be oiled or moistened.

Under normal road conditions (paved roads), the air filter element should be cleaned every 3000 km, and the filter element should be replaced after a mileage of 50 000 km.

If the car is driven on very dusty roads, the air filter element should be cleaned or replaced earlier, since a clogged air filter element reduces engine performance and increases fuel consumption.

The air filter element can be removed for cleaning or replacement without removing the air intake silencer.

1. On the air intake silencer upper part of Model 190 c detach the hose band on the carburetor (Fig. 09-1/3), on Models 220 b and 220 Sb remove the rubber cuff (3) (Fig. 09-1/4), and on Models 220 SEb and 300 SE pull off the air hose (6) (Fig. 09-1/5).

2. After loosening the snap catches, on Model 190 c after loosening the hexagon nut (5), remove the upper part of the air intake silencer and take out the air filter element.

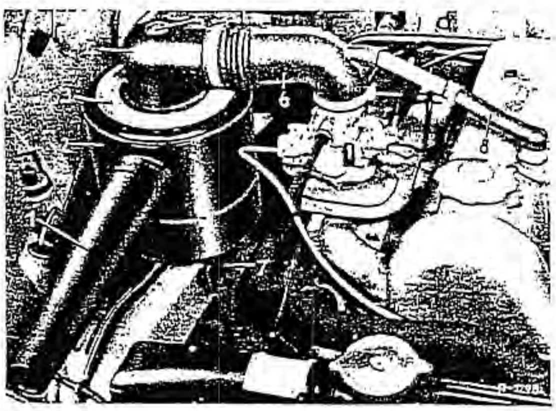


Fig. 09-1/3

Model 190 c

1 Air suction tube
2 Lower part of air intake silencer
3 Air filter element
4 Upper part of air intake silencer
5 Hexagon nut
6 Rubber bend
7 Retaining plate
8 Engine air-vent line

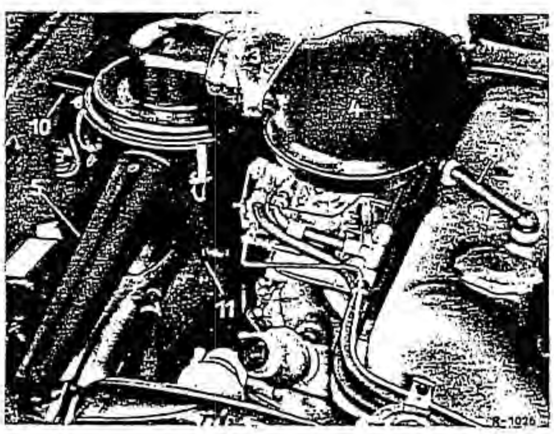


Fig. 09-1/4

Models 220 b and 220 Sb

1 Lower part of air intake silencer
2 Upper part of air intake silencer
3 Rubber cuff
4 Carburetor intake scoop
5 Air suction tube
6 Air hose
7 Venturi control unit
8 Position markings

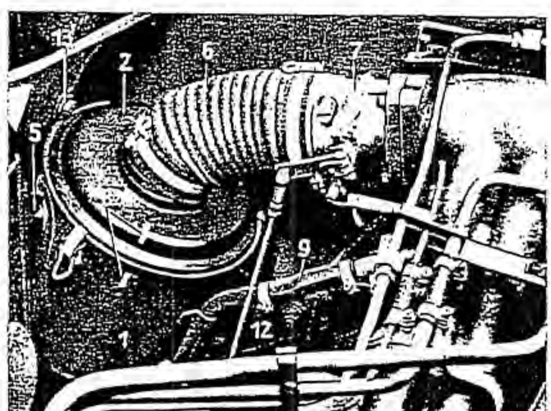


Fig. 09-1/5

Models 220 SEb and 300 SE

9 Connecting hose for engine air-vent line
10 Support bracket at wheel arch panel
11 Retaining plate for fixing the air intake silencer to the chassis base panel
12 Support bracket for fixing the air intake silencer to the wheel arch panel
13 Support bracket for fixing the air intake silencer to the cowl

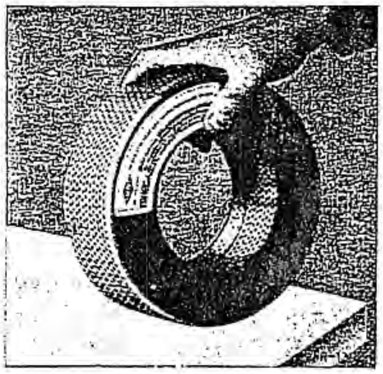


Fig. 09-1/6

Fig. 09-1/7

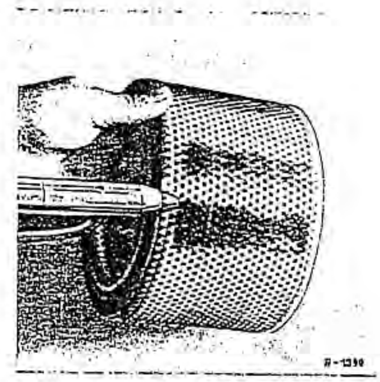


Fig. 09-1/8

3. Tap the air filter element carefully yet vigorously on a solid even surface (Fig. 09-1/6), then blow it out with compressed air (maximum pressure 5 atm) from the inside to the outside (Fig. 09-1/7), and then blow off the dirt on the outer cover of the element with the compressed-air gun held at an angle (Fig. 09-1/8).

Note: Dry air filter elements must under no circumstances be washed in a fluid or wetted with oil.

4. Clean the upper and lower parts of the air intake silencer from dust and condensation water. The best way is to use a gasoline-soaked rag.

Note: The air intake silencer must on no account be cleaned with cotton waste. When the air intake silencer is installed in the car any condensation water can best be removed through the bore in the lower part of the housing by means of a suitable syringe or a siphon.

5. Check and if necessary replace all rubber parts such as the sealing ring between the upper and lower parts of the air intake silencer, the rubber bend between the upper part and the Venturi control unit or the carburetor.

6. Install the air filter element. Install the upper part of the air intake silencer and fasten by simultaneously tightening two snap catches; on Model 190 c by tightening the hexagon nut (5). Care should be taken to ensure that the rubber sealing ring and the air outlet are properly positioned.

Note: On Model 220 SEb install the upper part in such a way that the two red line marks (8) are aligned (Fig. 09-1/5).

II. Oil Bath Air Filter

On this type of filter the inlet air flows into the fresh air chamber and through the inlet slot between element and housing to the oil bath chamber in which part of the dust is deposited. The remaining particles and the oil particles carried away by the air stream are deposited on

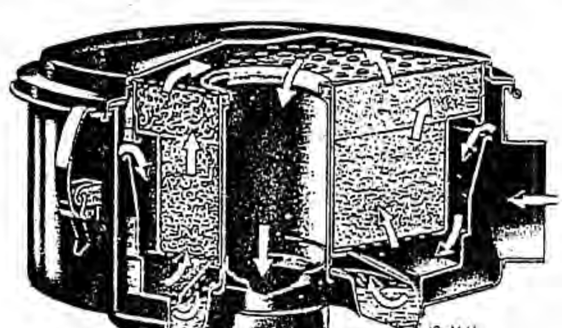


Fig. 09-1/9

the filter element which is wetted with oil by the air flow, and the surplus oil drips back into the oil bath (see Fig. 09-1/9).

The oil bath air filter can only work properly if in accordance with the prevailing amount of dust **it is cleaned in time** and **if it is supplied with fresh oil as specified.** "In time" means **as soon as the oil has become dark and viscous from the accumulated dirt.**

Wash the filter element thoroughly in Diesel fuel, kerosene or in an acid-free cleaning agent, centrifuge it, dry it or blow it out with compressed air.

Filters on which the filter element and the filter top form one integral part (Fig. 09-1/10), must be rinsed and blown out with compressed air from the top.

On no account must water or fluids containing alkali or acids be used for washing the element (the element will be destroyed for instance by P 3 or Tri).

Remove the old oil from the lower part of the filter completely and wash the part. The oil level in the oil bath chamber must be neither too **low** nor too **high; for that reason top up with fresh oil only to the mark "Normal-Ölstand" (Standard oil level)** (see arrow in Fig. 09-1/10). If the oil level is too low the filtering action is insufficient, and if the oil level is too high the air carries oil upward and through the filter element into the combustion chamber of the engine. Oil and dust form an abrasive compound which causes premature cylinder and piston wear.

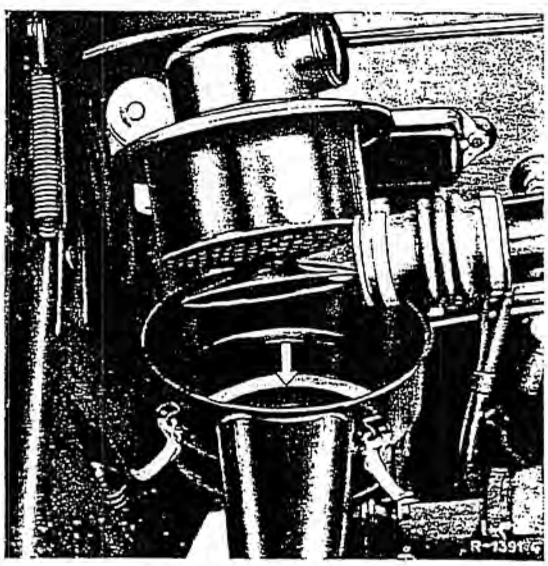


Fig. 09-1/10

The oil level must not be checked when the engine is warm but approximately one hour after switching off the engine. It is only then that the oil from the filter element has returned to the oil bath chamber. **Under normal circumstances the oil need not be topped up since the oil bath air filter does not lose oil if it is properly looked after.**

D. Inlet Air Pre-Heating an Models 220 b and 220 Sb

Recent cars of Models 220 b and 220 Sb have been equipped with an inlet air pre-heating system in order to prevent engine trouble resulting from speed build-up difficulties and icing of the jets of the carburetor.

On Model 190 c the inlet air pre-heating system can be installed as an optional extra.

The inlet air pre-heating system consists of a scoop (5) attached to the exhaust manifold; an air hose (4) connects the scoop to a pipe union with valve on the suction tube of the air intake silencer. The valve is controlled by a counterweight (3) on the valve shaft (2) and by the vacuum in the engine in such a way that at idling speed and in the partial load range the engine is supplied with warm air whereas in the full load range it is supplied with cold air (Fig. 09-1/11).

During the warmer season the inlet air pre-heating system must be switched off. To do this press the lever on the valve shaft (2) down and clamp it to the edge of the suction tube (Fig. 09-1/11).

If the inlet air pre-heating system is installed subsequently the lower part of the air intake silencer must be replaced, the scoop (5) must be screwed to the exhaust manifold and the scoop and the air intake silencer suction pipe must be connected by means of the air hose (4).

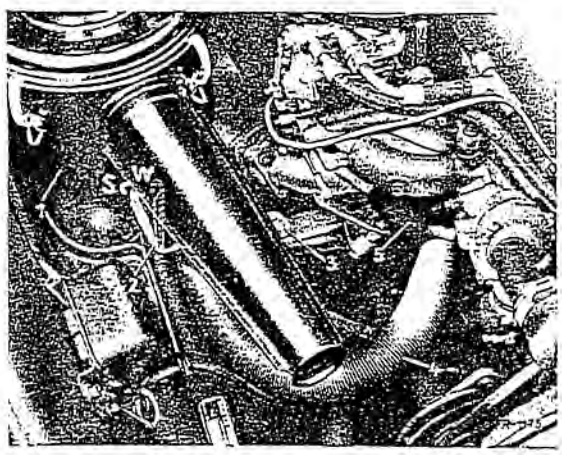


Fig. 09-1/11

Inlet air pre-heating system on Model 220 Sb

1 Lower part of air intake silencer
2 Valve shaft
3 Counterweight
4 Air hose
5 Scoop
6 W Winter position
S Summer position

Main Fuel Filter on Diesel Engine

Job No.
09-3

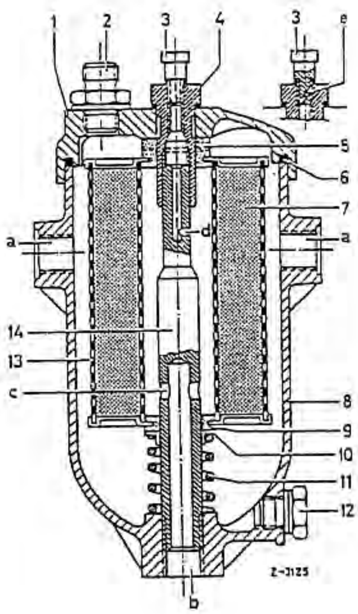


Fig. 09-3/1

1 Cover
2 Reducer screw
3 Bleed screw
4 Clamp nut
5 Rubber seal
7 Felt tube filter element
8 Housing
9 Seal
10 Spring retainer disk
11 Compression spring
12 Sludge drain plug
13 Felt tube carrier of perforated sheet
14 Clamping bolt
a Fuel feed to filter at one side, closed at other side. Connection for cross fitting (Caution! do not use hollow screw.)
b Outlet/fuel line to injection pump
c Drain bore
d Feed to bleed screw
e Fuel outlet when bleed screw opened

A. General

The main fuel filter removes the impurities from the fuel which are not retained by the coarse primary filter. This is necessary to protect the sensitive precision components of the injection pump and the nozzles against damage and premature wear. Trouble-free running of the engine depends to a large extent on proper filtration of the fuel.

In no circumstances should the engine be run without fuel filter element; very often extremely short periods of such operation suffice to make nozzles and injection pump completely unserviceable.

To relieve the load on the fuel filter element and lengthen its service life, clean fuel only should be filled into the tank.

A felt tube filter element is fitted as standard equipment. If there are complaints about engine knock, the **felt tube** filter element can be replaced by the square **felt pad** filter element, Part No. 000 477 54 15 (Bosch) or Part No. 000 477 10 15 (Knecht), (see Job No. 00-23).

In addition, in the case of filter elements with a felt ring as seal the filter cover can be machined as shown in Fig. 09-3/2 — so as to prevent the filter cover from resting on the seal surround and therefore ensure the correct sealing pressure between filter cover and seal (5) (Fig. 09-3/1).

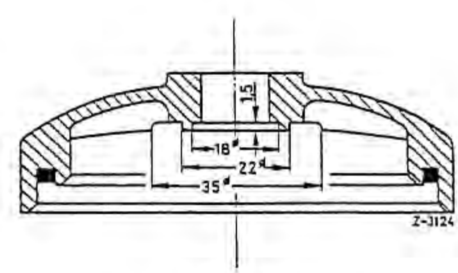


Fig. 09-3/2

The fuel to be cleaned flows through the feed union (a) into the filter housing, passes through the filter element (7) from the outside and reaches the inside (Fig. 09-3/1). **Some dirt retained by the filter element drops down due to vibration while the vehicle is running and collects at the bottom of the filter housing. To remove this dirt, unscrew the sludge drain plug (12) from time to time.**

The fuel in the feed space of the filter then flushes most of the sludge out of the housing. Residual sludge is then removed the next time the filter element is cleaned.

From inside the filter the cleaned fuel flows to the injection pump through the drain bore (c) in the clamping bolt and the feed line (b). The two seals (5) and (9) seal off the internal spaces of the filter element (7), the spring retainer disk (10) with compression spring (11) ensuring that a specific pressure is exerted on the seals. Opposite the fuel feed union (a) is fixed a cross fitting to which are attached a vent line from the filter, a flexible tube from the leak-off pipe, a flexible tube (oil return line) from the overflow valve on the injection pump and the return line to the fuel tank. The cross fitting is not connected internally to the filter; the filter housing merely supports it. The cross fitting is therefore fixed by a **standard hexagon screw. A hollow screw must not be used.**

Screwed into the highest point of the main fuel filter is reducer union (2) in which there is a throttle bore having a diameter of 1 mm. From the reducer union a vent line leads to the fuel return line. This vent line considerably raises the level of the fuel in the filter, so that even when the tank contains little fuel no trouble arises due to air being entrained.

If fuel noises occur in the lines, a damper unit, Part No. 189 070 05 68, may be installed in the fuel line between the overflow valve of the injection pump and the cross fitting of the main fuel filter.

Note: With the introduction of plastic fuel lines the fixing/cross piece on the fuel filter was dispensed with. At the same time, the main fuel filter was equipped with a hollow screw 615 090 00 69 with orifice plate and, more recently, with the hollow screw 615 990 02 63, which has a 1 mm throttle bore at the side, instead of the reducer union (2).

B. Cleaning Main Fuel Filter

When the filter is being cleaned, the following instructions and the sequence of operations must be adhered to.

1. The filter must be drained before the filter element is removed. First open the bleed screw (3), unscrew the sludge drain plug (12) and allow the filter to drain (Fig. 09-3/1).

2. Unscrew feed line (b) to injection pump. Only then release clamp nut (4), take off housing cover (1) and remove filter element.

3. Remove any sludge residue from filter housing and flush again.

4. **Cleaning filter element**

a) **Felt tube element**

To carry out preliminary cleaning: Close element at each end with suitable plugs. At this stage it is advisable to already use the Bosch cleaning tool EFEP 143 A needed for final cleaning (Fig. 09-3/3).

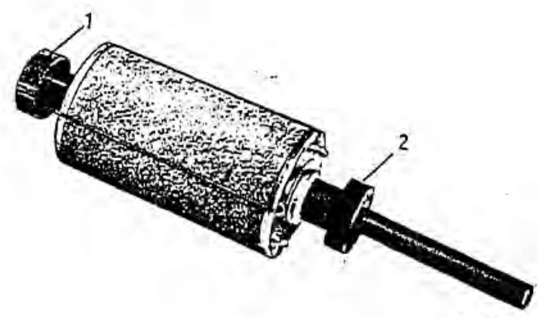


Fig. 09-3/3

1 Plug
2 Plug with tube connection

Brush down the felt tube with a soft, non-metallic brush in diesel fuel or kerosene, wash out and then rinse again in clean diesel fuel or kerosene. Make sure that the cleaning fluid **only passes through the felt** of the element before reaching the inside. If the cleaning tool EFEP 143 A is used, the tube should not dip into the fluid. As a precaution it should be nipped shut when the element is immersed. The maximum degree of cleaning by this method is 40-50 %.

To carry out final cleaning: This is done with the cleaning tool EFEP 143 A, with which felt tube elements can be cleaned very simply and thoroughly (degree of cleaning almost 100 %, i. e. flow rate as when filter element in new condition).

Connect tool to felt tube element and carry out preliminary cleaning as described earlier.

Immerse element in clean cleaning fluid and leave it to soak up fluid. Then remove from the fluid and energetically blow through the tube of the tool with compressed air or by mouth. Foam bubbles are formed on the outside of the felt tube. Wash these away. Soaking and blowing through should be repeated 4 or 5 times. **It is important that blowing through be carried out from the inside outward and not in the opposite direction.**

b) Felt pad element

The element is cleaned by washing out the individual felt pads in gasoline or diesel fuel. The element has to be disassembled for this purpose.

No brushes should be used for cleaning, since this would destroy the structure of the felt pads. Nor should the felt filter elements be cleaned too often, since frequent cleaning makes the felt prematurely hard and filtration therefore worse.

The felt pads should merely be squeezed well until the expelled fuel exhibits no more contamination. When reassembling the filter ensure that thick and thin pads are piled one on top of the other alternately. A thin metal plate is arranged at the top and bottom of the stack. Since the felt pads swell slightly when washed, they have to be compressed for reassembly so that the knurled nut can be fitted. **In no circumstances, however, should felt pads be omitted.**

5. Before re-installing the filter element, check that the clamping bolt (14) is firmly seated and that seals (5) and (9) are in good condition (see Fig. 09-3/1).

   Heavily compressed seals must be replaced.

   A swollen or heavily compressed, deformed rubber seal (6) in the housing cover must also be replaced. In addition, all aluminum sealing rings for the screwed connections must be replaced.

6. Attach feed line leading to injection pump to outlet (b) (see Fig. 09-3/1).

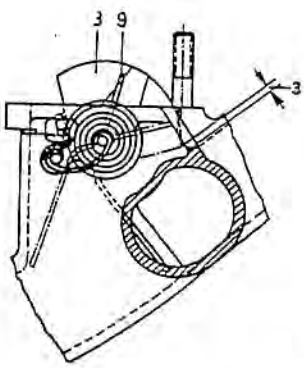
7. **Check whether compression spring (11) and spring retainer (10) are fitted;** only then insert cleaned filter element and fit housing cover. Now pump fuel into the filter housing with the hand operated fuel pump and bleed the fuel system (see Job No. 00-22.)

Intake and Exhaust Manifold

Job No.
14-3

Carefully examine the intake and exhaust manifold for cracks before re-installing them. In addition check the contact surfaces of the attaching flanges for displacement and distortion on a surface plate and, if necessary, recondition them. Cracked exhaust manifolds must always be replaced.

Replacement of the heating spiral, the damper spring and the heater valve and shaft is the same as in previous gasoline engines.



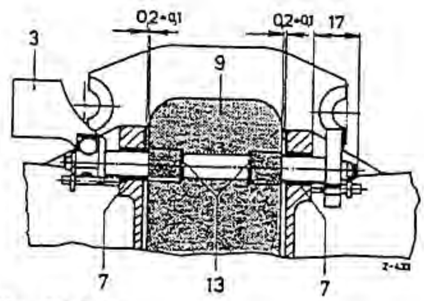


Fig. 14-3/1

3 Balancing weight
7 Bushing
9 Heater valve
13 Weld seam

Heater Valve Mounting

Dimensions in mm

Internal Ø of bushing	10.132 / 10.159
External Ø of bushing	13.039 / 13.028
Bore in exhaust manifold	13.000 / 13.018
Diameter of valve shaft	9.995 / 9.986

Engine Lubrication - Group 18

Engine Cooling Units - Group 20

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Oil Filter

Job No.
18-1

Modification: completely new

A. Main Flow Oil Filter

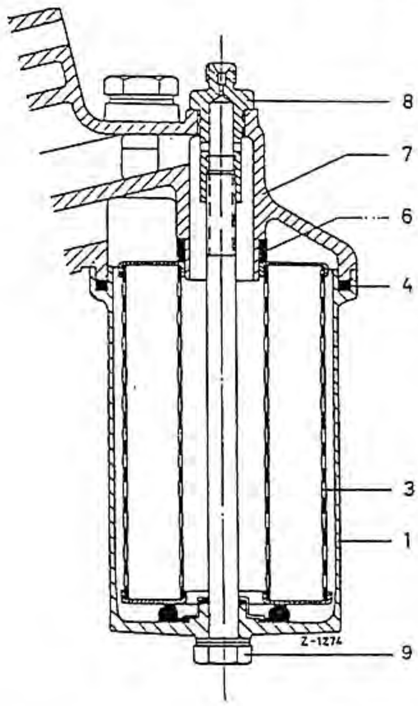


Fig. 18-1/1

1 Oil filter base
3 Paper filter element
4 Rubber filter element
6 Rubber sealing ring
7 Oil filter top
8 Threaded union
9 Hexagon fixing screw for oil filter base

Oil Change and Replacement Intervals for Paper Filter Element

Models 190 c, 220 b, 220 Sb, 220 SEb, 230 SL, 300 SE Oil filter version: **paper filter element only**

Oil change: at 300—1000 km, 5000 km and subsequently every 5000 km under normal running conditions

300—1000 km	5000 km	10 000 km	15 000 km	and so on
OC—P	OC	OC—P	OC	

Models 200, 230, 230 S, 250 S, 250 SE, 250 SL, 300 SEb, 300 SEL
Oil filter version: **paper filter element only**

Oil change: at 300—100, 10 000 km and subsequently every 10 000 km under normal running conditions

300—1000 km	10 000 km	20 000 km	30 000 km	and so on
OC—P	OC—P	OC—P	OC—P	

Key to symbols: OC = oil change
P = paper filter element

The Knecht designation for the paper filter element is EH 256/1 and the DB Part No. 000 184 43 25 (paper type 233).

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

When replacing the paper filter element (3) pay special attention to the sealing ring (4) in the oil filter base. For safety reasons always replace sealing ring after filter has been opened. When fitting the new sealing ring make sure that an air cushion is not formed in the groove of the oil filter base beneath the sealing ring. If an oil filter element shows an unusual amount of sludge, this is an indication that cooling water has mixed with the oil. The engine must be examined and the leak stopped.

Caution: oil filter elements for completely reconditioned engines

For the first 300 to 1000 km, completely reconditioned engines have to be equipped with a running-in filter element (fine pore paper element) Part No. 000 184 42 25 just like replacement engines or engines in new cars.

The filter for initial operation has finer pores than the normal filter element and therefore also removes even the smallest dirt particles which are inevitable when an engine is being assembled. To differentiate between the filters for initial operation, Part No. 000 184 42 25, and the standard filter element, Part No. 000 184 43 25, for the Gasoline engines (with the exception of model 600) the Part No. is hot stamped on one side of the filter and can be read any time after the filter has been wiped.

This running-in filter must be replaced by a standard oil filter element, Part No. 000 184 43 25, when the first oil change (service Schedule A) is carried out.

On model 600 and the diesel engines of Models 190 Dc and 200 D, which are equipped with a combined oil filter, the difference between the running-in filter and the standard filter elements is obvious. The running-in filter is a large paper filter element (main flow filter, Part No. 000 184 56 25 for Models 190 Dc and 600, Part No. 000 184 84 25 for Model 200 D) which should be replaced at the first oil change (to be carried out between 300 and 1000 km) by a small paper filter element (by-pass flow filter, Part No. 000 184 58 25 for Models 190 Dc and 600, and Part No. 000 184 85 25 for Model 200 D) and by the main flow filter element (disc-type element with Perlon mesh, Part No. 000 184 57 25).

The aforegoing also applies, of course, to engines which have been completely reconditioned with or without a shortblock.

B. Combined Main and By-pass Flow Oil Filter for Diesel Engine

a) Oil change and cleaning and replacement intervals for filter elements

Oil filter version: Paper filter element for the first 300 to 1000 km; afterwards main and by-pass flow element.

Oil change: at between 300 and 1000 km, at 2500 km, 5000 km and subsequently every 2500 km under normal running conditions.

Model	300—1000 km	2500 km	5000 km	7500 km	10 000 km	and so on
190 Dc	OC—M	OC	OC—M₁—P	OC	OC—M₁—P	

Model	300—1000 km	5000 km	10 000 km	15 000 km	20 000 km	and so on
200 D	OC—M	OC—M₁—P	OC—M₁—P	OC—M₁—P	OC—M₁—P	

Key to symbols: OC = oil change
M = replace paper filter element by main and by-pass flow elements
M_1 = clean main flow filter element
P = replace by-pass flow paper filter element

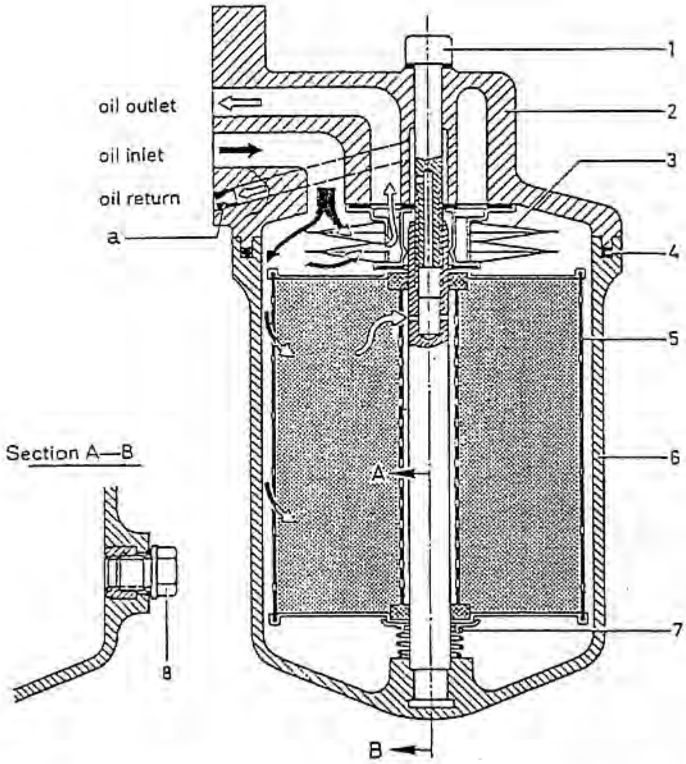


Fig. 18-1/2

Combined main and by-pass flow oil filter

1 Cylindrical screw for fixing oil filter base
2 Oil filter top
3 Main flow filter element (Part. No. 000 184 57 25)
4 Rubber sealing ring
5 By-pass flow filter element (Part No. 000 184 58 25)
6 Oil filter base
7 Compression spring with spring retainer
8 Oil drain plug
a Throttle bore

Caution! If oil pressure too low, check whether nozzle with throttle bore (a) is fitted.

Note: If the sulfur content of the diesel fuel exceeds 5 % or the running conditions are particularly arduous (pronounced short runs, dust-laden air etc.), **the oil must be changed at shorter intervals** (e. g. 2500 km). In all cases, however, the engine oil must be changed at least twice a year, i. e. in the spring and fall.

When fitting the oil filter base (6) pay special attention to the rubber sealing ring (4). For safety reasons always replace sealing ring after filter has been opened. When fitting the new sealing ring make sure that an air cushion is not formed in the groove of the oil filter base beneath the sealing ring (Fig. 18-1/2).

If an oil filter element shows an unusual amount of sludge, this is an indication that cooling water has mixed with the oil. The engine must be examined and the leak stopped.

b) General

The diesel engine is equipped with a combined main and by-pass flow oil filter. This is fixed at an angle to the crankcase by four hexagon socket screws.

The engine oil delivered by the oil pump passes through the inlet bore into the oil filter and most of it flows through the main flow filter element (disc-type with Perlon mesh) and via the outlet bore into the main oil passage in the crankcase to the lubrication points. A small proportion of the pressure oil returns to the oil pan via the return and throttle bores. In this way the engine oil is practically filtered twice — thus much improving filtration.

c) Removal, cleaning and installation of filter elements

Removal:

1. Engage reverse gear, turn steering fully to the right and release parking brake.

2. Unscrew oil drain plug (8) from the oil filter base, drain off oil. If drain plug is not easily accessible, back off cylindrical screw (1) slightly and rotate oil filter base in appropriate direction (see Fig. 18-1/2).

3. To remove oil filter base, unscrew cylindrical screw (1).

Use special wrench, Part No. 110 589 00 07 00, for this purpose (8 mm).

4. Remove oil filter base (6) and withdraw main flow filter element (3). Now withdraw oil filter base between tie-rod and front axle support (see Fig. 18-1/3). If there is not enough room, have an assistant pull the steering to the right until the oil filter base has been withdrawn. In addition, the engine may be raised slightly to facilitate withdrawal.

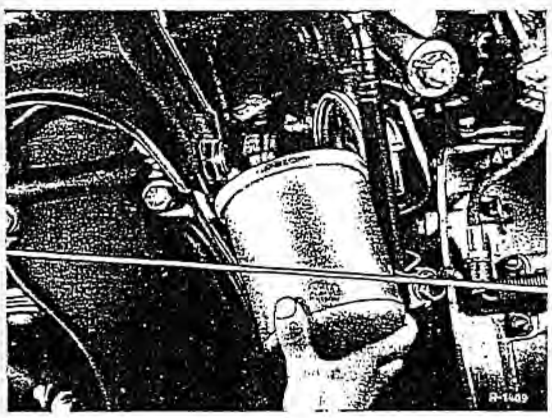


Fig. 18-1/3

5. Remove by-pass flow filter element (5) and compression spring (7) together with retainer.

Cleaning:

6. Wash oil filter base in gasoline. Check that the drilled cylindrical screw (1) and the return bore in the riser of the oil filter base are not blocked; if necessary blow out with compressed air (see Fig. 18-1/2).

7. Wash the cleanable main flow filter element in gasoline. **Make sure that no dirt gains access to the inside surfaces of the filter element.** This is prevented reliably if the top and bottom openings of the main flow filter element are closed with masking tongs (Fig. 18-1/5) or with two washers and a bolt. After removing the masking tongs or washers, lightly blow out the main flow filter element from the inside with compressed air (Fig. 18-1/4).

Caution! Too powerful a blast of compressed air may damage the plastic filter mesh.

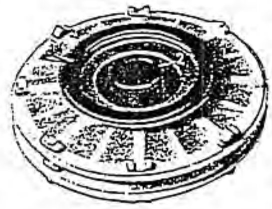


Fig. 18-1/4

Main flow filter element with integral sealing lips

1 Outer sealing lip
2 Inner sealing lip

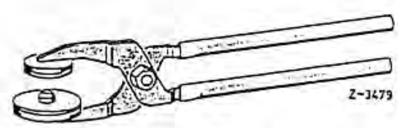


Fig. 18-1/5

Special tongs for cleaning oil filter 110 589 00 68 00

Installation:

8. Fit new sealing rings for oil drain plug (8) and cylindrical screw (1); insert oil drain plug and tighten.

9. Replace rubber ring (4) in oil filter base. When inserting the new sealing ring make sure that no air cushion is formed in the groove of the oil filter base beneath the sealing ring (Fig. 18-1/2).

Note: Use only approved sealing rings.
For safety reasons always replace sealing ring (4) after filter has been opened.

10. Insert compression spring with spring retainer (7) and new by-pass flow filter element in the oil filter base.

Caution! If the compression spring or the spring retainer are forgotten on installation, the sealing rings at the two faces of the by-pass flow filter element cannot perfom their function of sealing off the inside of the by-pass flow filter element (5) and of the main flow filter element (3). Oil then passes to the lubrication points without being cleaned first.

11. Introduce oil filter base between tie-rod and front axle support — in a similar way to that described under 4) for removal —, mount main flow filter element on the by-pass flow filter element with the large opening upward and fix the oil filter base to the filter top with the cylindrical screw (1); previously rotate oil filter base

so that the oil drain plug (8) points downward (see Fig. 18-1/2). The tightening torque for the cylindrical screw (1) is about $4.0^{-0.5}$ mkp. The special wrench, Part No. 110 589 00 07 00, can be used for tightening the cylindrical screw (1).

Important! In no circumstances may the cylindrical screw (1) be replaced by a standard hexagon screw. If a standard screw is employed the by-pass flow does not function. The correct cylindrical screw has a through bore (Fig. 18-1/2) for the by-pass flow.

12. If the oil filter has been removed without the engine oil being changed, top up with 1.0 liter of engine oil.

Note: the oil capacity of the combined oil filter is about 1 liter.

When the engine oil is changed **and** the oil filter serviced, fill with 5 liters of engine oil.

When the engine oil is changed **without** the oil filter being serviced, top up the engine with 4 liters of engine oil.

13. Run the engine, check filter and connections for leaks (oil loss), put gear shift in neutral and steering in straight-ahead position.

Note: In no circumstances should the engines be run without by-pass flow filter element, since the main flow filter element does not function then either.

If difficulty is experienced in obtaining the correct by-pass flow filter element abroad, the corresponding by-pass flow filter elements of Messrs. Fram (type C 4), Knecht (type ENC 305), Hengst type E110M, Purolator type T 110/312 or Mann and Hummel (type P 1145) with diameter of 110 mm and a length of 125^{-3} mm may be used.

d) Removal and installation of complete oil filter

Removal:

1. Detach pipe for oil pressure gage from oil filter.

2. Unscrew fixing screws for the oil filter top and remove filter.

Installation:

3. When installing filter replace gasket between filter housing top and crankcase.

   Tighten oil filter fixing screws and attach pipe for oil pressure gage.

4. If the oil filter has been removed without the engine oil being changed, top up with about 0.5 liters of engine oil.

5. Run the engine. Check filter and connections for leaks (oil loss).

Drive for Oil Pump, Distributor and Injection Pump

Job No.
18-6

Modification: Models from August 1965 added

Models 190 c, 200, 220 b, 220 Sb, 230, 230 S and 250 S

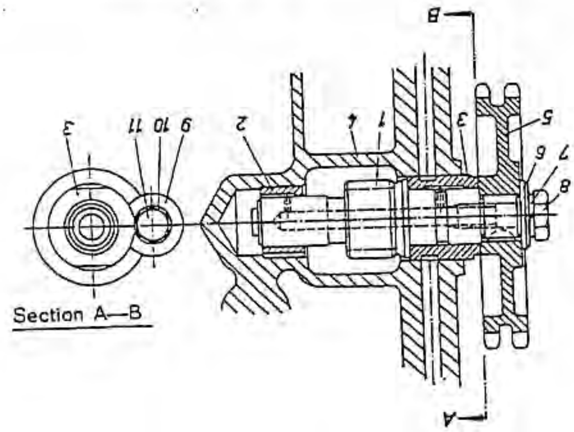


Fig. 18-6/1

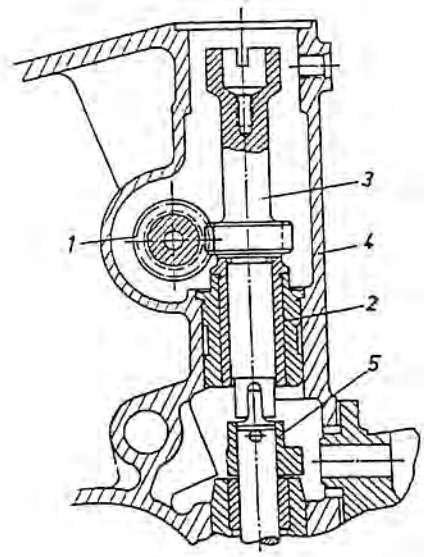


Fig. 18-6/2

Drive for oil pump and distributor

1 Idling gear shaft
2 Rear bearing bushing
3 Front bearing bushing
4 Crankcase
5 Idling gear
6 Washer
7 Lock washer
8 Hexagon screw
9 Retaining disk
10 Lock washer
11 Hexagon screw

1 Idling gear shaft
2 Bearing with bushing
3 Helical gear shaft or drive shaft for oil pump and distributor
4 Crankcase
5 Oil pump drive shaft with cams for fuel pump

Models 220 SEb, 220 SEb/C, 230 SL, 250 SE, 250 SE/C and 250 SL

The idling gear (24) with a shorter hub and a stop ring (42) is fitted in the engines of the Models 220 SEb and 230 SL. On Model 220 SEb the stop ring was fixed to the idling gear (24) with the grooved pin (41) for a time (see Fig. 18-6/3).

No stop ring was fitted in the engines for Model 220 SEb.

When repairs are being carried out, however, only the idling gear with the shorter hub and the additional stop ring (42) may be fitted between idling gear and front bearing bushing.

If the idling gear (24) has to be removed, first move piston of 1st cylinder to ignition TDC. Then remove chain tensioner, camshaft sprocket, diverter sprocket, distributor (1), distributor bearing (8) and upper pivot pin for bottom left guide rail. After backing off the hexagon nut (21) remove lock washer (22), shim (23), drive sleeve (18), front Woodruff key and spacing collar (19). Now back off the lock screw for the chain drive a few turns and remove idling gear (24) and stop ring (42) from idling gear shaft (Fig. 18-6/3).

Note: Before the idling gear shaft is removed, the chain case below the idling gear must be plugged with a clean cloth to prevent the stop ring (42) from falling into the crankcase.

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

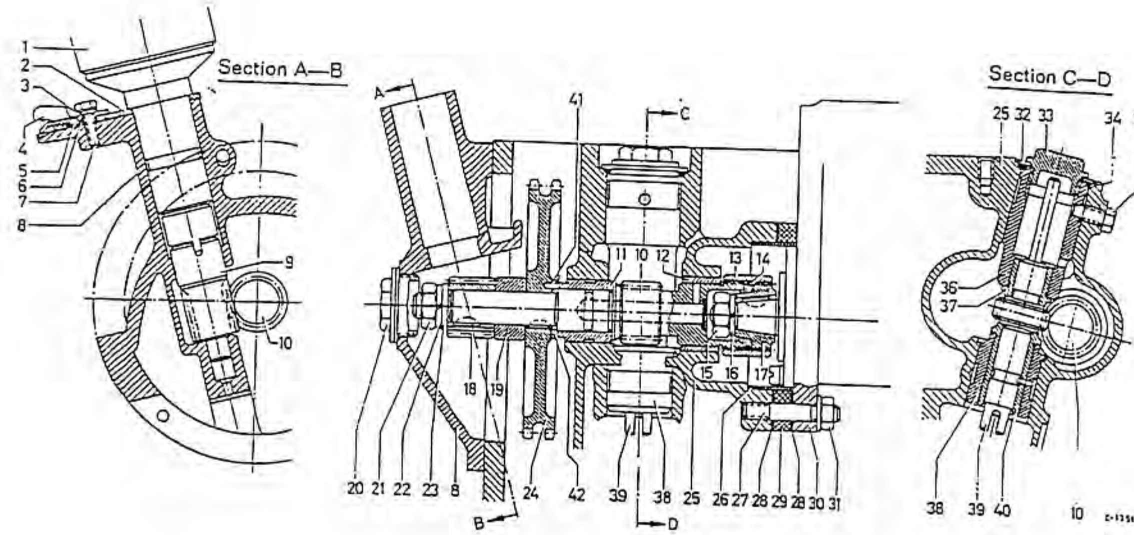


Fig. 18-6/3

Drive for distributor, injection pump and oil pump

1 Distributor
2 Timing lever
3 Spring washer
4 Hand lever
5 Cylindrical pin
6 Eccentric disk
7 Hexagon screw
8 Distributor bearing
9 Helical gear or drive shaft for distributor
10 Idling gear shaft or drive shaft for injection pump
11 Front bearing bushing
12 Rear bearing bushing
13 Coupling sleeve
14 Snap ring
15 Hexagon nut
16 Lock washer
17 Follower
18 Drive sleeve
19 Spacing collar
20 Screw plug with seal
21 Hexagon nut
22 Lock washer
23 Shim
24 Idling gear
25 Crankcase
26 Bearing sleeve
27 Stud bolt
28 Sealing flange
29 Insulating flange
30 Injection pump
31 Hexagon nut with washer
32 Cover plate
33 Screw plug
34 Rubber ring
35 Hexagon screw
36 Pressure piece
37 Bearing bushing
38 Bearing body
39 Helical gear or drive shaft for oil pump and revolution counter
40 Bearing bushing
41 Grooved pin
42 Stop ring

For revolution counter drive see Job No. 06-1

Caution! To improve the wearing properties and surface finish the drive and idling gear shafts for oil pump, distributor and injection pump on the models below are bath nitrided. These shafts do not differ in design from the shafts previously installed. To differentiate them from the previous patterns the bath nitrided shafts have a turned slot 1 mm wide (refer to Figs. 18-6/4 to 8).

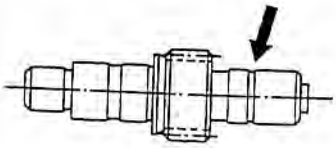


Fig. 18-6/4

Idling gear shaft 180 050 04 06
Models 190 c, 200, 220 b, 220 Sb, 230, 230 S and 250 S

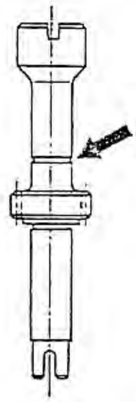


Fig. 18-6/5

Drive shaft 180 158 06 12 for oil pump and distributor
Models 190 c, 200, 220 b, 220 Sb, 230, 230 S and 250 S

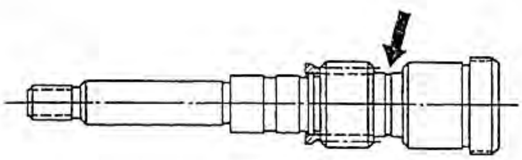


Fig. 18-6/6

Idling gear shaft 621 050 03 06
Models 220 SEb sedan, 220 SEb/C, 230 SL, 250 SE, 250 SE/C and 250 SL

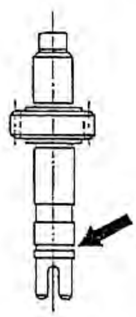


Fig. 18-6/7

Drive shaft 621 180 03 04 for oil pump
Models 220 SEb, 250 SE sedan and 250 SE/C (129'980)

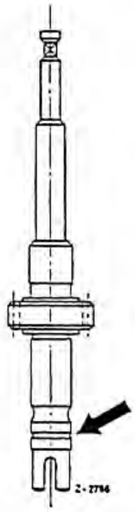


Fig. 18-6/8

Drive shaft 127 180 03 07 for oil pump
Models 220 SEb/C, 230 SL, 250 SE/C (129 981) and 250 SL

The tightening torque for the hexagon or polystop nut on the idling gear shaft with turned slot is 5+0,5 mkp.

When repairs are carried out, the bath-nitrided shafts can be installed in the Models listed in the table which are still provided with the previous-version shafts.

Model	Part No. of set
190 c, 200, 220 b, 220 Sb, 230, 230 S, 250 S	180 050 05 06
220 SEb sedan, 250 SE, 250 SE/C (129 980)	621 050 04 06
220 SEb/C, 230 SL, 250 SE/C (129 981), 250 SL	621 050 05 06

Shafts should be replaced in sets only. If only one of the previous pattern of shafts is replaced by a new one, the different wearing properties cause further damage after a short mileage.

Models 300 SE, 300 SEb, 300 SEL

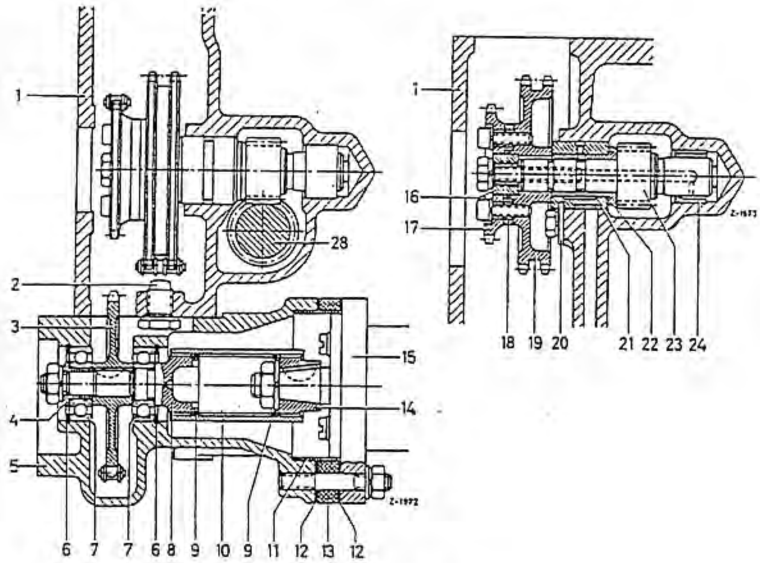


Fig. 18-6/9

Drive for injection pump

1 Crankcase
2 Locking screw (for sprocket)
3 Sprocket
4 Bushing
5 Gear housing
6 Lock ring
7 Grooved ball bearing
8 Drive shaft for injection pump
9 Snap ring
10 Coupling sleeve for injection pump drive
11 Bearing sleeve
12 Sealing flange
13 Insulating flange
14 Follower
15 Injection pump
16 Locating sleeve
17 Sprocket
18 Shim
19 Idling gear
20 Washer
21 Bearing bushing (for idling gear, front)
22 Bushing (on idling gear shaft)
23 Idling gear shaft for driving oil pump and injection pump
24 Bearing bushing (for idling gear shaft, rear)
28 Drive shaft for oil pump and distributor

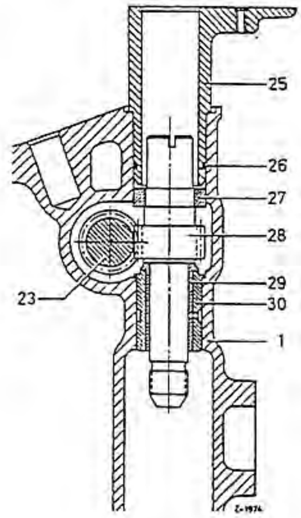


Fig. 18-6/10

Drive for oil pump and distributor

1 Crankcase
23 Idling gear shaft
25 Distributor bearing
26 Seal
27 Oil deflector ring (on drive shaft)
28 Drive shaft for oil pump and distributor
29 Bearing bushing for drive shaft
30 Bearing housing for drive shaft

On Model 300 SE the injection pump is driven by a single roller chain via the sprockets (3) and (17); the idling gear shaft (23) with idling gear (19) is driven by a twin roller chain (Fig. 18-6/9).

For revolution counter drive see Job No. 06-01.

Models 190 Dc, 200 D

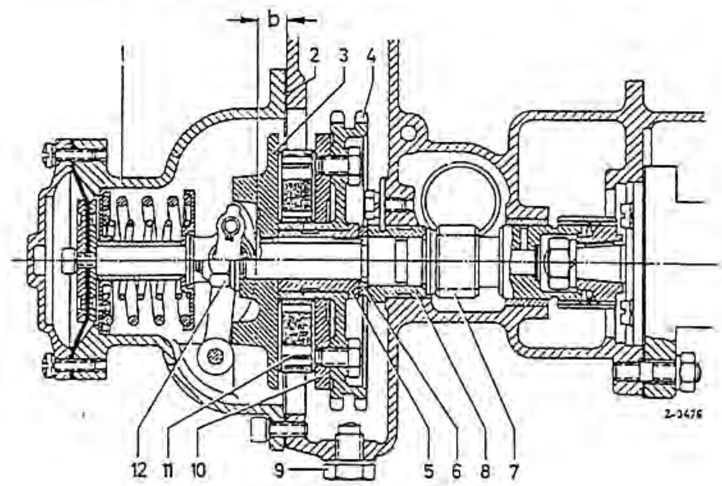


Fig. 18-6/11

Drive for injection pump, injection timer, vacuum pump and oil pump

1 Vacuum pump
2 Gasket
3 Segmental flange with cam profile
4 Sprocket (idling gear of chain drive and drive gear for injection timer, idling gear shaft, injection pump and oil pump)
5 Bushing for sprocket
6 Stop ring
7 Idling gear and drive shaft, injection and oil pump (621 050 02 06)
8 Bearing bushing
9 Lock screw
10 Segmental plate
11 Governor weights (split)
12 Self-locking nut (Polystop)

Dimension "b" = 12.92 – 13.8 mm

Removal and installation of drive shaft for oil pump

Removal:

1. Back off screw plug (1) about 2 turns, unscrew hexagon screw with spigot (11) and by inserting a screwdriver between the screw plug and the cover disk, and push out the pressure piece (5) upward (see Fig. 18-6/12).

Note: Pressure piece (5) may also be extracted by means of a modified screw plug (1). Take a second screw plug AM 26 x 1.5 DIN 7604, drill through the middle and tap with an M 8 thread. Into this thread screw a sufficiently long M 8 hexagon screw. After unscrewing the first screw plug (1) insert the modified screw plug and extract the pressure piece by screwing in the M 8 hexagon screw.

2. Extract helical gear/drive shaft (8) for oil pump (see Fig. 18-6/12).

3. Completely unscrew screw plug (1) from the pressure piece (5) and remove cover disk (2) and the rubber ring (3) (see Fig. 18-6/12).

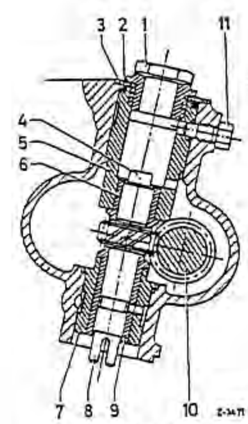


Fig. 18-6/12

Drive for oil pump

1 Screw plug
2 Cover disk
3 Rubber ring
4 Cylindrical screw
5 Pressure piece
6 Bearing bushing
7 Bearing housing
8 Helical gear (drive shaft, 621 180 02 04, for oil pump)
9 Bearing bushing
10 Idling gear shaft (drive shaft for injection pump and for the helical gear/drive shaft for oil pump)
11 Hexagon screw with spigot

Checking:

4. Check helical gear/drive shaft (8) and bearing bushes (6) and (9) for wear and replace if necessary (see Fig. 18-6/12).

Installation:

5. Fit helical gear/drive shaft (8) and pressure piece (5) and tighten by means of hexagon screw with spigot (11).

Check end play (0.1—0.25 mm) of helical gear (8) (see Fig. 18-6/12).

Note: If end play is too small or excessive, remove pressure piece (5) again. If end play is too small, turn the face of bearing bushing (6) by a suitable amount on a lathe and install pressure piece (5) again. If play is excessive, press the bearing bushing (6) out of the pressure piece and correct end play of the helical gear (8) by inserting the appropriate washers between bearing bushing (6) and pressure piece (5). Press bearing bushing with washer into the pressure piece and tighten the hexagon screw with spigot. Check end play of helical gear again (see Fig. 18-6/12).

6. Place rubber ring (3) and cover disk (2) in position and tighten screw plug (1) (see Fig. 18-6/12).

Removal and Installation of Water Pump

Job No.
20-1

Model 300 SE

Removal:

1. Drain the cooling water and collect the water if additives are present.

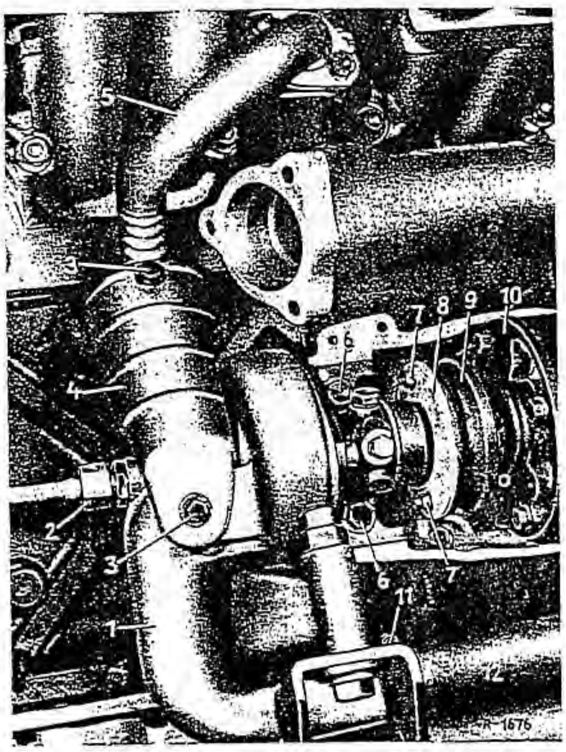


Fig. 20-1/1

1 Water pump
2 Cooling water line
3 Hexagon screw with cover plate
4 Cover plate
5 By-pass line
6 Hexagon screw on bearing housing
7 Hexagon nut with corrugated washer
8 Coupling flange water pump
9 Coupling flange generator
10 Generator
11 Hose strap
12 Rubber hose

2. Pull off the rubber hose (12) between water pump and radiator (Fig. 20-1/1).
3. Disconnect the cooling water line (2) to the injection pump thermostat at the water pump.
4. Remove the cover plate (4) and disconnect the by-pass line (5) from the water pump.
5. Detach the hose clip between water pump and crankcase and remove the clip and the two clip halves.
6. Unscrew the two hexagon nuts (7) on the water pump coupling flange (8).
7. Unscrew the two hexagon screws (6) fastening the bearing housing of the water pump to the generator bed and move the water pump out of the coupling flange of the generator.
8. Remove the rubber seal between water pump and crankcase and check whether it is still serviceable.

Note: Hardened or compressed rubber seals should always be replaced since they may cause leaks on reassembly.

Installation:

9. When the unit is being reassembled the seal between crankcase and water pump is fitted to the cone of the water pump.
The installation of the water pump is the reverse of the removal procedure.

Job No.
20-3

Removal and Installation of Fan Mounting Bracket

Removal:

1. Remove the radiator (see Job No. 50-1).

2. Loosen the three hexagon nuts (8) and (10) on the fan mounting bracket (9), loosen the lock nut on the tensioning screw (6), back out the tensioning screw and remove the V-belt.

3. Remove hexagon nuts (8) and (10) and remove the fan mounting bracket together with retaining plate (7).

Installation:

4. Attach the fan mounting bracket (9) and retaining plate (7) putting hexagon nuts (8) and (10) in position without tightening them.

5. Put on the V-belt and tension it by means of the tensioning screw (6). The V-belt is properly tensioned when it can be depressed under moderate thumb pressure approx. 5–10 mm.

6. Tighten the lock nut on the tensioning screw (6) and the hexagon nuts (8) and (10) on the fan mounting bracket.

7. Install the radiator (see Job No. 50-1).

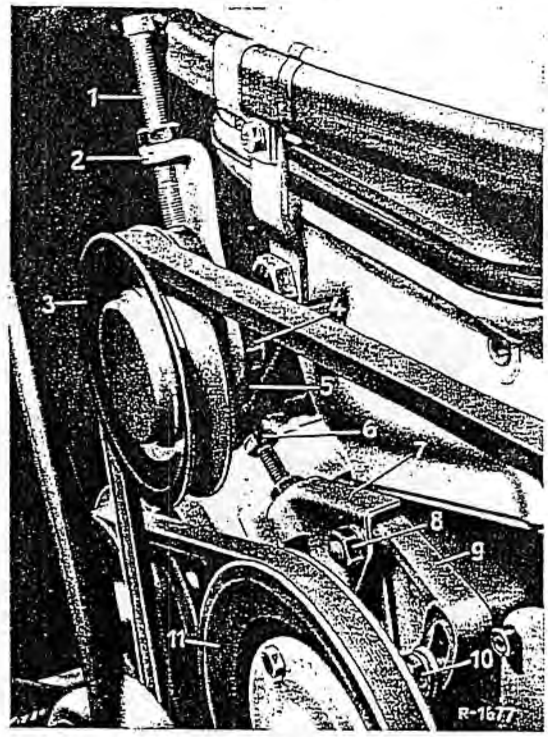


Fig. 20-3/1

1 Hexagon screw (tensioning screw)
2 Tension bracket
3 V-belt pulley
4 Hexagon nut with lock washer
5 Bracket
6 Hexagon screw (tensioning screw)
7 Retaining plate
8 Hexagon nut with lock washer
9 Fan mounting bracket
10 Hexagon nut with lock washer and washer
11 V-belt pulley

Repair of Fan Mounting Bracket

Job No.
20-5

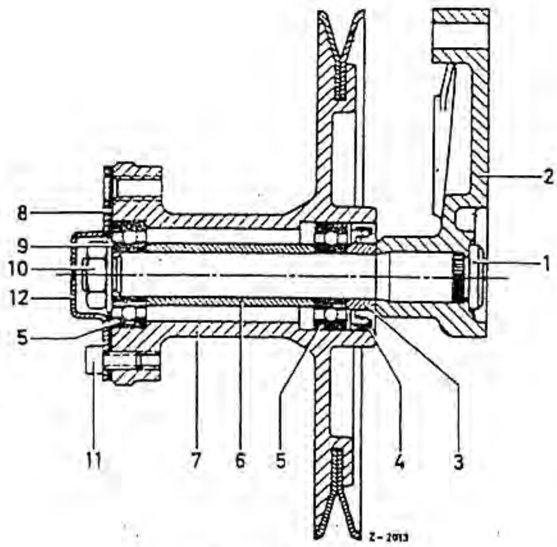


Fig. 20-5/1

1 Fan axle
2 Mounting bracket
3 Spacer ring
4 Seal
5 Annular grooved bearing
6 Spacer tube
7 Hub with pulley
8 Gasket
9 Spring washer
10 Hexagon nut
11 Hexagon socket screw
12 Cover cap

Disassembly

1. Unscrew the fan from the hub.

2. Unscrew the hexagon socket screws (11) from the hub and remove the cover cap (12) together with gasket (8).

3. Unscrew the hexagon nut (10) from the fan axle (1) and remove together with spring washer (9).

4. Drive the mounting bracket (2) together with the fan axle (1) out of the hub (7) toward the rear.

5. In the case of sand-cast pulleys unscrew the pulley from the hub. In the case of the die-cast version the pulley is cast integral with the hub.

6. Use a suitable drift to tap the annular grooved bearing (5) and the seal (4) out of the hub and remove the spacer tube (6) from the hub.

7. Clean all parts. Check the annular grooved bearings, the spacer ring (3), and the pulley for wear. Worn spacer rings should be pressed or turned off the fan axle.

   The seal (4) and the gasket (8) should always be replaced.

Reassembly:

8. Press the annular grooved bearing (5) and the seal (4) into the hub (7) with a suitable drift, making sure that the seal is absolutely flush with the front face of the hub.

9. If necessary, press a new spacer ring (3) onto the fan axle (1). Lightly grease the spacer ring on the contact surface of the seal.

10. Press the fan axle (1) together with the mounting bracket (2) into the hub (7). Put 24 cm^3 Hypoid Oil SAE 90 into the hub and slide the spacer tube (6) over the fan axle.

11. Press the front annular grooved bearing (5) into the hub.

12. Put on the spring washer (9), screw on the hexagon nut (10) and tighten.

13. Fit a new gasket (8); screw the cover cap (12) and fan to the hub. On the sand-cast version fit the pulley to the hub.

Job No.
20-6

Cooling Water Thermostat

Modification: Model 300 SE and winter cooling water thermostat added

On Models 190 c, 220 b, 220 Sb and 220 SEb the cooling water thermostat consists of a cast light-metal housing which is screwed directly to the cylinder head with a gasket, and a thermostat element (6) (wax thermostat). On Model 300 SE the housing of the cooling water thermostat is combined with the cooling water outlet connection. The cooling water thermostat operates with a by-pass control. At cooling water temperatures below 78–79° C the cooling water from the cylinder head flows through the open by-pass valve and the by-pass line directly into the water pump (see Fig. 20-6/1). At a cooling water temperature of 78–79° C the wax thermostat element by opening the main valve starts to open the flow to the radiator and at the same time to close the by-pass line. When the main valve is fully opened, the cooling water flows from the cylinder head via the cooling water thermostat or through the open main valve to the radiator and only then to the water pump. At this stage the by-pass line is completely closed (see Fig. 20-6/2).

When reassembling the cooling water thermostat, care sould be taken to ensure that the four hexagon socket screws (3) are not tightened before the cover (4), and in particular the cover recess, is properly seated in the cooling water thermostat so that the sealing ring (2) is under uniform pressure.

Cooling Water Thermostat with Wax Thermostat Element and By-Pass Control

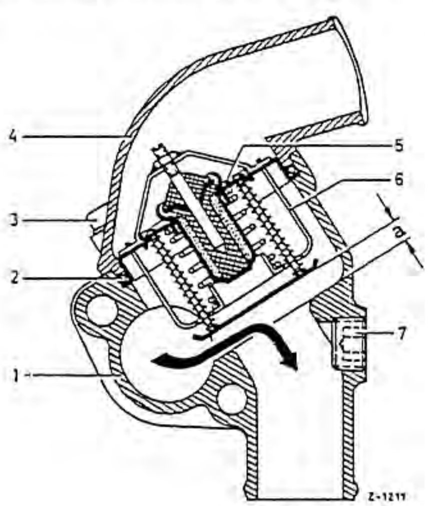


Fig. 20-6/1

Main valve closed — By-pass valve fully open
Stroke "a" = 6—6.5 mm from 0 to appr. 74—78° C

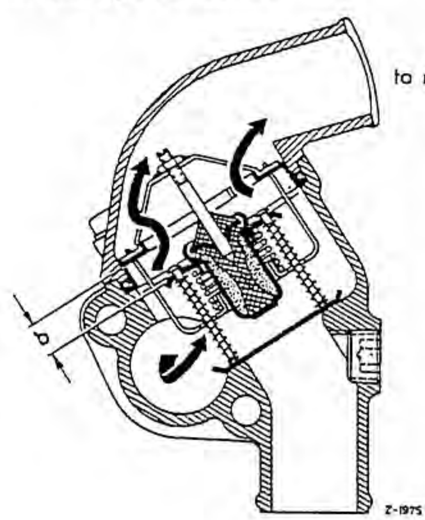


Fig. 20-6/2

Main valve open — By-pass valve closed
Stroke "b" = 8—9 mm at appr. 91—94° C

1 Cooling water thermostat
2 Sealing ring
3 Hexagon socket screw
4 Cover
5 Corrugation
6 Cooling water thermostat element
7 Plug

Note: To reach the optimum temperature more quickly in winter and thus to improve the performance of the heating system, a cooling water thermostat element can be installed which begins to open at a temperature of 87° C.

This winter thermostat can be obtained from our Replacement Part Division at Untertürkheim; it should be removed from the vehicle in spring to prevent overheating the engine during the summer.

Viscosity Fan Clutch on the Models 250 S and 250 SE

Job No.
20-9

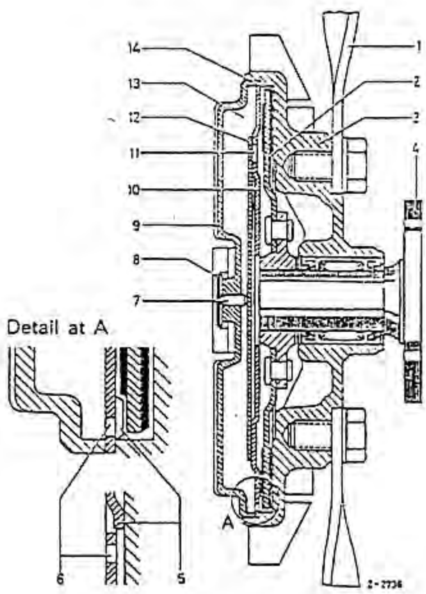


Fig. 20-9/1

1 Fan
2 Drive plate (primary part)
3 Clutch body (secondary part)
4 Drive shaft with flange
5 Oil control
6 Oil return bore
7 Thrust pin
8 Bimetallic strip
9 Cover (secondary part)
10 Separating shim
11 Inlet port
12 Valve lever
13 Reservoir
14 Working space

A. General Description

Like the electromagnetic and hydraulic fan clutches the viscosity fan clutch offers the advantage of no extra power being needed for the fan when the fan is not running. In almost all operating conditions more engine power is available for driving the car, since the fan runs only in extreme conditions such as when the car is negotiating mountain passes or driving in a line of traffic in warm weather. In addition, fan noise is reduced. Moreover, the engine warms up better and more quickly.

The viscosity fan clutch is a self-contained maintenance-free unit which cannot be disassembled. It consists of the primary and secondary parts. The secondary part is the clutch body proper (3) to which the fan is fixed by 4 screws. The primary part is the drive plate (2), which is rigidly connected to the drive shaft (4). The drive plate rotates in the secondary part, i.e. in the working space formed by the clutch body (3) and the cover (9). At each side of the drive plate is a narrow air gap. When the fan or clutch is actuated the silicone oil (torque transmission medium) is in this working space. The silicone oil with which the viscosity fan clutch is filled is a fluid whose viscosity remains largely constant, i.e. the viscosity is insensitive to temperature fluctuations. Since there is no mechanical connection between primary and secondary parts, the torque is transmitted only by the viscous silicone oil. The oil is never, of course, able to produce a rigid connection between the driving and driven parts of the clutch with the arrangement provided. The fan speed will therefore always be less than the input speed, even if all the oil is in the working space. The temperature-dependent control for the clutch is fitted to the cover (9). It consists of the separating shim (10) with inlet port (11), the valve lever (12) fixed to these, the stepped oil control (5), the thrust pin (7) and the bimetallic strip (8).

The cover (9) with the separating shim (10) and valve lever (12) form the oil reservoir (13). This reservoir is connected to the working space by 2 bores: by the inlet bore in the separating shim for the flow of oil from the reservoir to the working space and by the oil return bore (16) in the separating shim preceding the stepped oil control (5) for the return flow from the working space. The fan speed is simply controlled by metering the flow of silicone oil. Metering is temperature-dependent, which is why the bimetallic strip is used as temperature sensor. Since the temperature of the cooling air behind the radiator core depends on engine temperature, the cooling air temperature is used as a control criterion.

The curvature of the bimetallic strip acts directly on the valve lever position via the thrust pin; when the bimetallic strip is cold and straight the valve is closed; when it is hot and curved, the valve is open.

The stepped oil control (5) near the return bore (6) in the separating shim in conjunction with the speed differential between primary and secondary parts produces a dynamic pressure which collects the oil and forces it into the reservoir. The oil is in circulating flow from the working space through the stepped oil control and return bore to the reservoir and then back into the working space via the valve lever and inlet bore. Circulation is maintained in this way so long as the drive plate rotates. The oil must of necessity collect in the reservoir when the valve lever is closed by the cold bimetallic strip. If the gap at both sides of the drive plate is largely free from silicone oil, the clutch idles. This minimum fan speed is about 25 % of the input speed or the speed of the drive plate. This means that there is always an air flow available for cooling exhaust manifold, injection pump, fuel pump, generator etc. When the bimetallic strip has been sufficiently heated by the air exhausted from the radiator, the thrust pin and valve lever open the inlet bore and the working space fills with silicone oil. The fan speed increases to a maximum when the valve is fully open. Any intermediate speed required can hence be attained to match the actual air temperature. If the primary speed rises above about 3,000 rpm and the fan is fully actuated, the clutch acts as a torque-limited control, i.e. the fan speed does not increase further, but remains constant over a wide engine speed range.

B. Checking Viscosity Fan Clutch in Vehicle

When the engine is started from cold the fan will initially run at higher speed until the oil has flowed back into the reservoir from the working space (about 1 to 3 minutes). The fan clutch will then cut out and the fan speed will fall to its minimum, i.e. to about 25—30% of input speed.

If the engine is run for a short period and switched off while still cold it will be noticed that the fan can then be rotated by hand with relatively little force. The clutch is fully disengaged. Full engagement of the clutch is obtained when the air coming from the radiator reaches a temperature of at least about 62° C.

It is not possible to repair the clutch. A faulty clutch should be removed and a replacement clutch fitted.

C. Transport and Storage

Viscosity fan clutches must be transported in the vertical position and stored in the same way. Fluctuations in atmospheric pressure and temperature may, if the clutches are not stored in this way, lead to slight quantities of oil escaping from the bearing or thrust pin beneath the bimetallic strip. When the fan clutch is in operation and the fan shaft in the horizontal attitude, the oil only partially fills the lower half of the clutch — without reaching the bearing seals or the thrust pin.

D. Instructions for Removal of Fan Clutch

To remove the fan clutch, evenly unscrew the hexagon shoulder screws SW 10 (3) which fix the fan clutch to the water pump; remove clutch complete with fan and hub ring (5) and then unscrew fan from clutch.

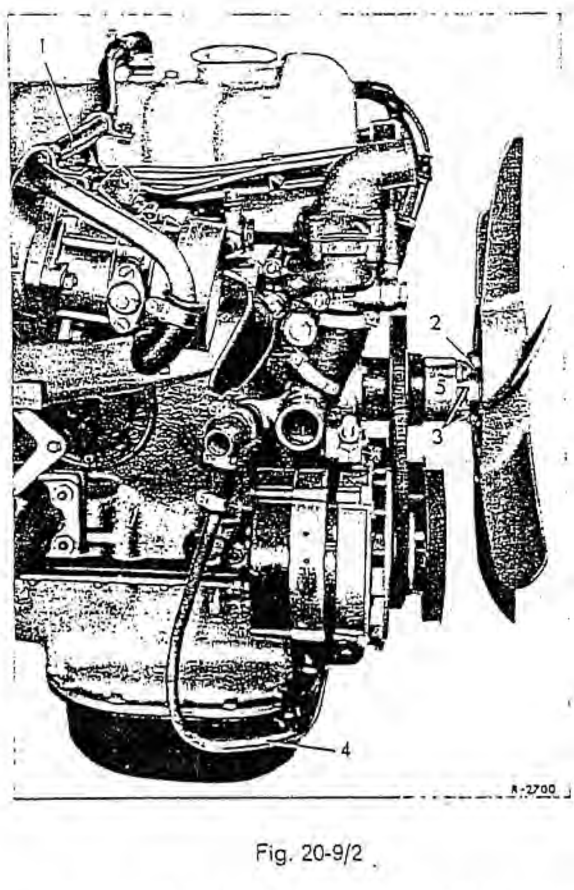


Fig. 20-9/2

1 Crankcase vent from cylinder head to venturi control unit
2 Hexagon screw for fan
3 Hexagon shoulder screw SW 10 for fixing viscosity fan clutch to the water pump
4 Coolant line from oil-water heat-exchanger
5 Hub ring

Electromagnetic Fan Clutch on Model 300 SE

Job No.
20-10

Modification: Note to Para. 7 added.

Cars of Model 300 SE have been provided with an electromagnetic fan clutch as a standard part as from engine numbers 189 984-10-000 132, 189 985-10-000 167, 189 984-12-003 652, 189 985-12-000 666. The clutch is controlled via a thermo switch which is located in the cooling water drain outlet. The fan clutch requires no maintenance.

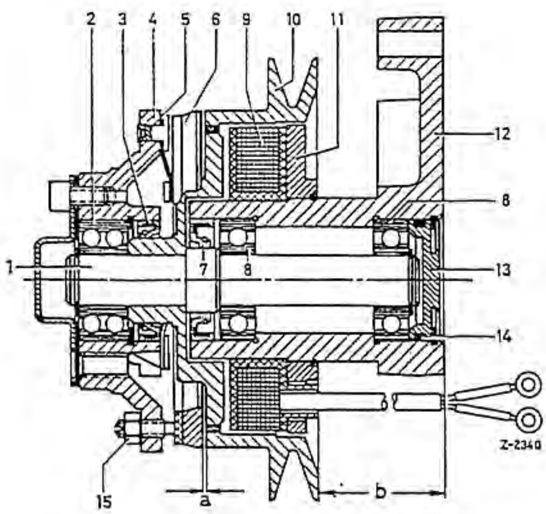


Fig. 20-10/1

Electromagnetic fan clutch

1 Fan shaft
2 Angular contact bearing
3 Radial sealing ring
4 Fan hub
5 Leaf spring
6 Clutch ring with insulating disk
7 Radial sealing ring
8 Grooved ball bearing
9 Coil frame with winding
10 Pulley
11 Magnetic disk
12 Fan bracket
13 Cover cap
14 O-ring
15 Adjustment srews with hexagon nut
a = Adjustment play 0.4-0.1 mm
b = Dimension from pulley to contact surface of fan bracket

A. General

The electromagnetic fan clutch has the special advantage that the fan requires no extra power while it is switched off. As a result the fan is only in operation in extreme cases, e. g. when driving in mountainous country or in a line of cars during the hot season, and engine output is increased. An additional advantage is that fan noises are reduced and that the engine warms up more readily.

At a cooling water temperature of 92—96° C the circuit to the magnetic clutch coil is closed via the thermo switch. It may happen, however, that after fast driving followed by slow driving in a line of cars the engine heats more quickly and the thermo switch begins to operate with a certain delay. The cooling water temperature may rise to approx. 105° C without, however, damaging the motor in any way. Inductivity causes the clutch ring which is connected to the fan hub by the riveted leaf spring to be lifted and this operates the fan. When the cooling water temperature decreases to 87—83° C the thermo switch breaks contact and the fan rotates automatically, i. e. it is driven by the air stream.

B. Repair of Fan Clutch

Disassembly:

1. Unscrew the cover cap from the fan hub and remove together with the gasket. Drain the oil from the fan hub.

2. Remove the front retainer ring from the fan shaft (1). Pull the fan hub (4) together with the clutch ring (6) and the insulating disk off the fan shaft by means of Puller Part No. 112 589 07 33 00 (Fig. 20-10/1). Before pulling off the fan hub remove the pressure piece from the puller.

3. Remove the retainer ring from the fan bracket (12) and take out the cover cap (13). Drain the oil from the fan bracket.

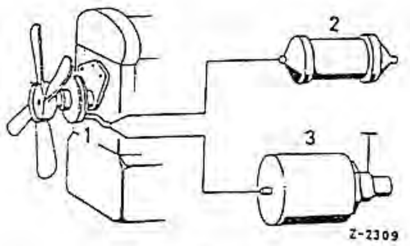


Fig. 20-10/2

Wiring diagram

1 Electromagnetic fan clutch
2 Fuse 3
3 Thermo switch

4. Remove the rear retainer ring together with the shims from the fan shaft (1) and drive out the pulley together with the fan shaft from the fan brackets by means of a suitable drift. (The pulley was shrunk on the fan shaft at a temperature of 300° C.)

Note: On the previous version remove the retainer ring from the fan shaft (1), drive the fan shaft forward by approx. 30 mm and pull off the rear grooved ball bearing (8). Drive the fan shaft back and remove the center retaining ring from the fan shaft (1) and drive the pulley together with the fan shaft out of the fan bracket by means of a suitable drift.

5. Drive the radial sealing ring (7) and the front grooved ball bearing (8) out of the fan bracket (12).

6. Drive the angular contact bearing (2) out of the fan hub (4), remove the retainer ring and drive out the radial sealing ring (3). If the coil frame (9) should be defective, replace the fan bracket together with the magnetic disk and the coil frame. As a matter of principle always replace all bearings, the two radial sealing rings (3) and (7), the O-ring (14) in the cover cap (13) and the gasket on the cover cap.

Reassembly:

7. Reassembly is the reverse of the disassembly procedure (Fig. 20-10/1).
   Adjust the play "a" $= 0.4^{-0.1}$ mm between the pulley and the clutch ring by means of the adjustment screw and the hexagon nut (15).

Note: As from December 1964 the adjustment screw (15) was dispensed with and the leaf springs (5) were modified in such a way that the play (a) need no longer be adjusted.
Before installing the rear retainer ring eliminate any axial play of the fan shaft by means of shims and then install the rear retainer ring.

On the previous version do not install the center retainer ring on the fan shaft (1) on the rear grooved ball bearing (8) and insert instead a shim 40—0.1×35×0.8 mm in the fan bracket before pressing in the front grooved ball bearing (8).

8. When reassembling the fan clutch fill the bracket with 10 cc of oil and the fan hub with 5 cc of oil. Oil grade: AFT as for the automatic transmission.

C. Trouble Shooting Hints

If complaints are received about premature vee-belt damage (wear) or if the vee-belt should jump off the pulley, check the alignment of the pulley on the fan clutch. The dimension "b" between the pulley and the contact surface of the fan bracket may be up to 43 mm and a dimension of 41.7 mm is still permissible. If the dimension is less than 41.7 mm replace the electromagnetic fan clutch.

If the temperature gage in the instrument cluster should register a temperature rise above 96° C, or in exeptional cases with thermo switch delays of over 105° C cooling water temperature, the cause may be either an insufficiently tensioned or a broken veebelt. It is also possible that the thermo. switch is defective. Check the thermo switch by running the engine up to a cooling water temperature of 100° C. At this temperature the thermo switch must have closed the circuit and the fan must rotate or if the engine is not working it should not be possible to turn the fan by hand. If with the engine stationary it is possible to turn the fan by hand the thermo switch must be replaced unless there is a failure in the electrical wiring. Check the function of the magnetic clutch at a cooling water temperature below 92° C by short-circuiting. The switching noise should be heard and if the fan clutch is in proper working condition, the fan should be rotating. Another cause may be excessive play "a" between clutch ring (6) and pulley (10) (see Fig. 6). The play should be 0.4—1.0 mm.

Hydraulic Fan Clutch on model 300 SE

Job No.
20-12

The Model 300 SE passenger cars with air conditioning system are equipped with a hydraulic fan clutch and a thermostatically controlled regulating valve (Fig. 20-12/1).

If overheating of the engine occurs (cooling water temperature above 95° C) and the cause is unknown, also check for proper functioning of fan clutch and regulating valve (1). The check is carried out by measuring the forces produced at the fan blade under various operating conditions, a spring balance being used for this purpose.

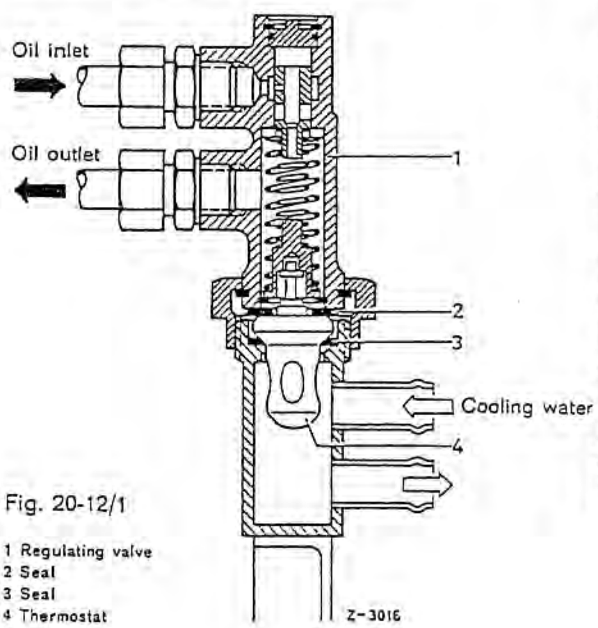


Fig. 20-12/1

1 Regulating valve
2 Seal
3 Seal
4 Thermostat

Checking fan clutch:

1. Place a rubber ring round the end of a fan blade and position spring balance at right angles to the fan blade in the plane of the fan (Fig. 20-12/2).

2. Run engine at test speed and compare measured values with figures in Table below.

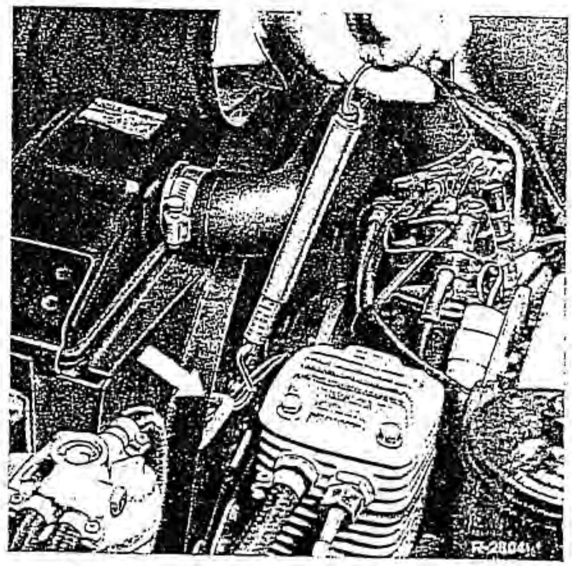


Fig. 20-12/2

Engine speed rpm	Cooling water temperature °C	Effective lever arm on fan mm	Load on spring balance[1]) kp
3,000	102	230	min. 3.5
	91—93		1.00—2.95
	below 70		min. 0.2

[1]) If larger forces than stated are acting, cooling is influenced favourably.

Daimler-Benz, Nachtrag 40, englisch, Kurzfassung

Fig. 20-12/3

1 Regulating valve
2 Sealing ring (189 997 01 40)
3 Thermostat
4 Sealing ring (007 603 01 61 02)
5 Cooling water line

If the values are not attained:

3. Remove regulating valve (1) (Fig. 20-12/3).

Note: When replacing the regulating valve or thermostat, the seals (2) and (4) must always be replaced. If this is not done there is a danger that the old seals may no longer seal properly and engine oil consequently get into the cooling water system.

4. Establish what version of regulating valve is fitted (see marks listed in Table below).

a) **Regulating valves of the type mentioned under No. 1 in the table must not be used again;** they should be replaced by a regulating valve of the type listed under Nos. 2 or 3 with reinforced compression spring.

b) If a No. 2 or 3 regulating valve is fitted, replace it by one of the same type.

Regulating valve No.	Part No.	Note	Marking
1	100 993 28 01		
2	100 200 00 31	Reinforced spring	White dot
3	100 200 01 31	Reinforced spring	2 White dots

When installing a No. 3 regulating valve, unless this type was fitted previously simultaneously install the new hydraulic oil line, Part No. 100 180 11 27.

Note: Regulating valves Nos. 2 and 3 function in the same manner; the No. 3 version has an M 16 x 1.5 thread on the upper union, the lower union thread being M 14 x 1.5 as previously. This difference is merely intended to ensure proper connection.

5. If the new regulating valve does not cure the trouble, replace the thermostat (3). (Do not forget new seals — see para. 3, Note.)

Engine Suspension

Groups 22/24

Job No.

Job No.
22/24-0

Engine Suspension

General Data, Dimensions, and Tolerances

Modification: Tables supplemented

Front rubber mountings

Model	left Part No.	left Cast-in Part No.	right Part No.	right Cast-in Part No.
190 c 190 Dc	121 220 04 30 121 220 05 30 [1]	121 223 04 12 180 223 10 12 [1]	121 220 04 30 121 220 05 30 [1]	121 223 04 12 180 223 10 12 [1]
220 b 220 Sb 220 SEb	180 220 05 30 180 220 09 30 [1]	180 223 09 12 180 223 11 12 [1]	180 220 06 30 180 220 10 30 [1]	180 223 10 12 180 223 12 12 [1]
230 SL	127 220 03 30 127 220 04 30 [1]	180 223 10 12 180 223 12 12 [1]	127 220 03 30 127 220 04 30 [1]	180 223 10 12 127 223 12 12 [1]
300 SE	180 220 06 30	180 223 10 12	112 220 00 30	112 223 00 12

Rear rubber mountings

Model	Part No.	Cast-in Part No.
190 c	121 224 00 12 180 223 02 12 [1] 120 223 04 12 [2][3] 120 223 06 12 [2][3]	121 224 00 12 180 223 02 12 [1] 120 223 04 12 [2][3] 120 223 06 12 [2][3]
190 Dc	120 223 04 12 [3] 120 223 06 12 [3] 180 223 02 12 [1]	120 223 04 12 [3] 120 223 06 12 [3] 180 223 02 12 [1]
220 b, 220 Sb 220 SEb, 230 SL	120 223 04 12 [3] 120 223 06 12 [3]	120 223 04 12 [3] 120 223 06 12 [3]
300 SE	112 242 00 13	112 242 00 13

Adjustment of limit stop

	front dimension "a"	front	rear dimension "a"	rear
190 c, 190 Dc	14	fig. 22-1/1	10,5	fig. 24-1/2
220 b, 220 Sb 220 SEb Sedan and Coupé 300 SE Sedan and Coupé	1,5	fig. 22-1/2		
220 SEb Convertible 300 SE Convertible			33,5	fig. 24-1/3
230 SL	2 [4]		21	fig. 24-1/4

[1]) Optional for bad road conditions
[2]) With automatic transmission
[3]) Optional
[4]) Under a load of 120 kg on the rubber mounting

Removal and Installation of Front Rubber Mounting of Engine Suspension

Job No.
22-1

Modification: Adjustment of Limit Stop on Model 230 SL added

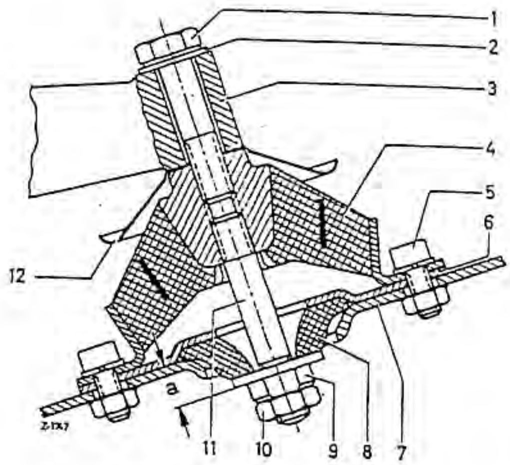


Fig. 22-1/1

Models 190 c, 190 Dc

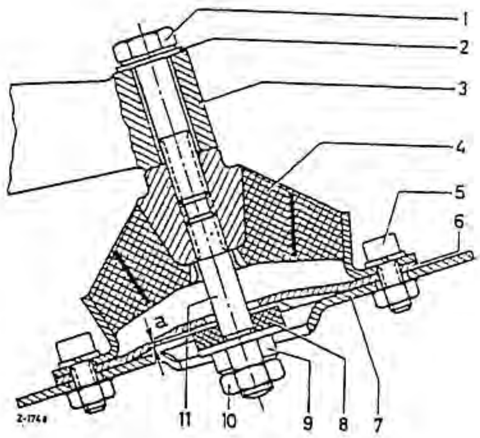


Fig. 22-1/2

Models 220 b, 220 Sb, 220 SEb, 300 SE

1 Hexagon screw
2 Spring washer
3 Engine support
4 Rubber mounting
5 Hexagon socket screw
6 Stop plate
7 Front axle support
8 Rubber spacer
9 Collar nut
10 Hexagon nut
11 Stud bolt
12 Cover disk

Removal:

1. Unscrew the hexagon screw (1) from the rubber mounting (4), holding the core in the rubber mounting steady with an SW 22 wrench.

2. Unscrew the two hexagon socket screws (5) by which the rubber mounting is fixed to the front axle support (7).

3. Use the jack to lift the engine till the weight is taken off the rubber mounting and it can be taken out.

   On Models 190 c and 190 Dc remove the cover disk (12) Fig. 22-1/1).

Note: Place a suitable pad between the jack and the oil pan.

4. Remove the limit stop from the rubber mounting after having unscrewed the hexagon nut (10) and the collar nut (9). Remove the rubber spacer (8) and the stop plate (6).

Note: The first version on Models 220 b, 220 Sb and 220 SEb had a castle nut and cotter pin instead of the hexagon nut and the collar nut.

Installation:

5. Install the limit stop in the rubber mounting.

Models 190 c, 190 Dc

Install the stop plate (6) and the rubber spacer (8). Screw on the collar nut (9) until the distance "a" is obtained. Measure the distance "a" with a depth gage between the collar nut (9) and the stop plate (6) (Fig. 22-1/1 and Job No. 22/24-0). Lock the collar nut (9) by means of the hexagon nut (10).

Models 200 b, 220 Sb, 220 SEb, 300 SE

Install the stop plate (6) and the rubber spacer (8). Adjust the distance "a" between the rubber spacer (8) and the stop plate (6) by means of the collar nut (9). To do this screw the collar nut down as far as it will go and back it out 1 turn (Fig. 22-1/2 and Job No. 22/24-0). Lock the collar nut (9) by means of the hexagon nut (10).

On the 1st version rubber mountings screw on the castle nut until the distance "a" is obtained and the nut can be locked by the cotter pin.

Model 230 SL

Intall the stop plate (6) and the rubber spacer (8). Screw the collar nut (9) down as far as it will go. Compress the rubber mountings in a press until there is a sufficient distance between the stop plate (6) and the rubber spacer (8). Then screw in the collar nut **two turns** and lock by means of the hexagon nut (10) (Fig. 22-1/2).

Note: This load on the rubber mounting is necessary in order to prevent torsional stress and damage to the rubber spacer when the collar nut is being turned.

6. Fasten the rubber mounting to the front axle support by means of the hexagon socket screws.

   On Models 190 c and 190 Dc remove the cover disk (12) (Fig. 22-1/1).

Note: On the six-cylinder engines, with the exception of Model 230 SL, the left and right rubber mountings are different.

7. Lower the engine and install and tighten the hexagon screw (1) with spring washer holding the core in the rubber mounting steady with an SW 22 open wrench.

Removal and Installation of Rear Rubber Mounting of Engine Suspension

Job No.
24-1

Modification: Adjustment of Limit Stop on Model 230 SL with Figure added

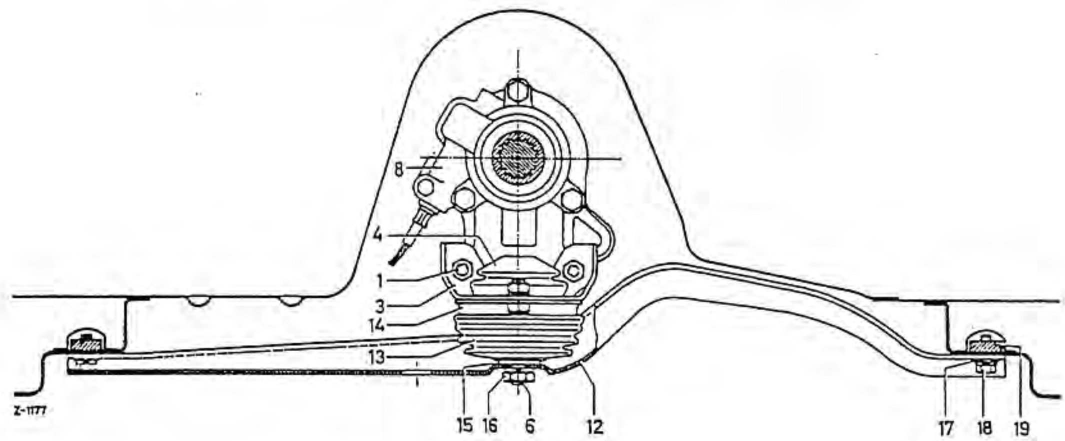


Fig. 24-1/1

1 Hexagon nut
3 Rear engine support
4 Bellows
6 Hexagon screw
8 Transmission case rear cover
12 Support
13 Bellows
14 Rubber mounting
15 Sheet-metal cover
16 Hexagon nut
17 Washer
18 Hexagon screw
19 Nut

Removal:

1. Unscrew the hexagon nut (16) or (19) (Fig. 24-1/2 or /3, /4).

2. Lift the engine at the rear part of the oil pan until the rubber mounting (14) is free from tension.

Note: To prevent the oil pan from being damaged, a suitable piece of wood must be placed between the oil pan and the jack.

3. Mark the position of the support in relation to the chassis base panel (Fig. 26-1/4).

4. Detach the center brake cable at the brake lever, and remove from the cable guide of the front axle support and the support.

5. Unscrew the support (12) from the chassis base panel (Figs. 24-1/1 or /3, /4).

6. Remove the sheet-metal cover (15) and the bellows (13) from the rubber mounting (14). Then remove the bellows (4) and unscrew the hexagon lock nut (6) (Figs. 24-1/2 or 24-1/3, /4). On Models 220 SEb and 300 SE Convertible and Model 230 SL unscrew first the hexagon nut (16) or (20).

7. Screw off the rubber mounting from the engine support.

Installation:

8. Attach the rubber mounting (14) to the engine support (3), and put on the bellows (13) and the sheet-metal cover (15) (Figs. 24-1/2 and 24-1/3, /4).

   On Models 220 SEb and 300 SE Convertible and Model 230 SL adjust the limit stop. To do this screw in the hexagon screw (6) until dimension "a" is reached (Fig. 24-1/3 or /4 and Job No. 22/24-0). Then lock the screw (6) with the lock nut (16 or 20). Put on the bellows (4) and push on the spacer ring (17).

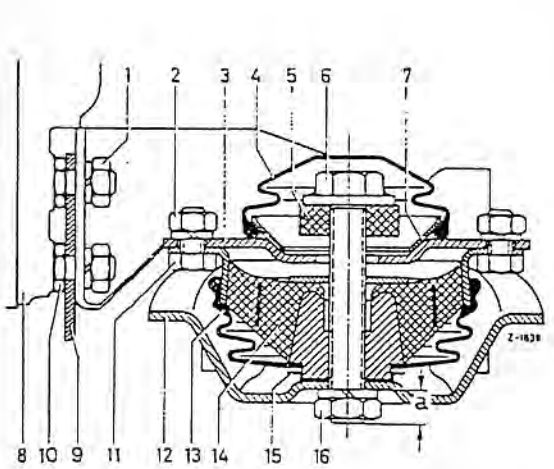


Fig. 24-1/2

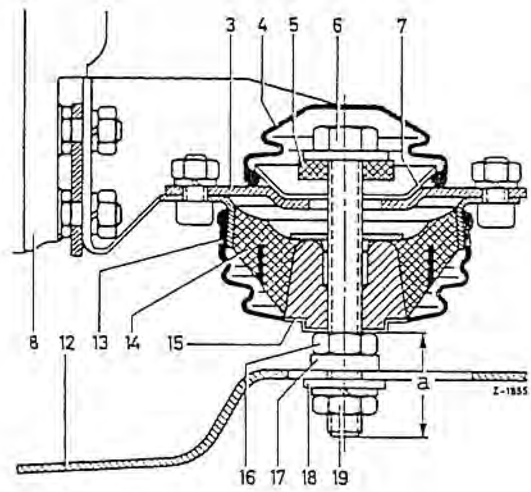


Fig. 24-1/3

Models 220 SEb Convertible, 300 SE Convertible

1 Hexagon nut
2 Hexagon nut
3 Engine support
4 Bellows
5 Rubber spacer
6 Hexagon screw
7 Bracket for bellows
8 Transmission case rear cover
9 Attachment plate
10 Collar screw
11 Hexagon screw
12 Support
13 Bellows
14 Rubber mounting
15 Sheet-metal cover
16 Hexagon nut
17 Spacer ring
18 Washer
19 Hexagon nut

9. Fasten the support (12) to the chassis base panel, noting carefully the position marked on the chassis base panel and on the engine support.

10. Lower the engine. On Models 220 SEb and 300 SE Convertible and on Model 230 SL install the washer (18) and the lock washer, then tighten the hexagon nut (19) (Fig. 24-1/3 or 24-1/4).

11. In order to adjust the limit stop on Sedans and Coupés properly screw in the hexagon screw (6) until the distance "a" is obtained. Measure the distance "a" with a depth gage between the hexagon screw (6) and the support (12) (Fig. 24-1/2 and Job No. 22/24-0). Then install the spring washer and screw on the hexagon nut (16). When tightening the hexagon nut make sure that the hexagon screw (6) does not turn. When the limit stop is adjusted correctly, the beveled edge of the hexagon screw (6) projects beyond the hexagon nut (16) appr. 1 mm (Fig. 24-1/2).

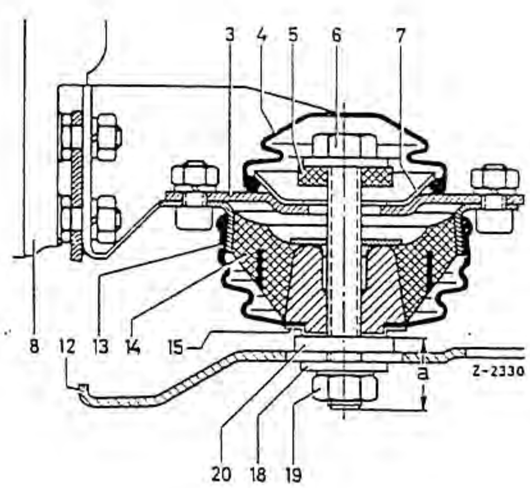


Fig. 24-1/4

Model 230 SL

12. Install the bellows (4) on the rear engine suspension (Fig. 24-1/2).

13. Attach the hand brake cable to the brake lever.

14. Adjust the hand brake.

Clutch Group 25

Clutch

General Data, Dimensions and Tolerances

Modification: Revised and New Models Added

A. Mechanical Clutch

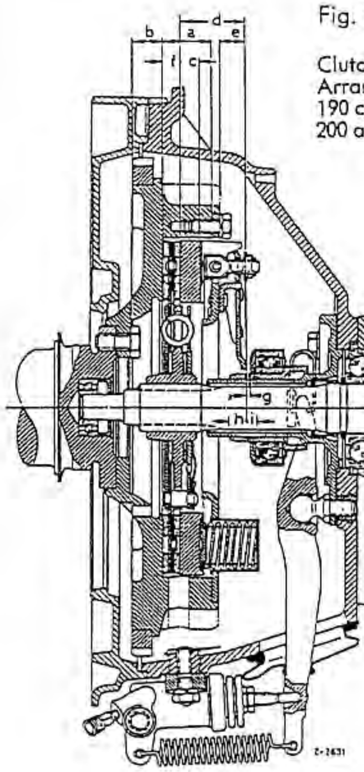


Fig. 25-0/1

Clutch Arrangement 190 c, 190 Dc, 200 and 200 D

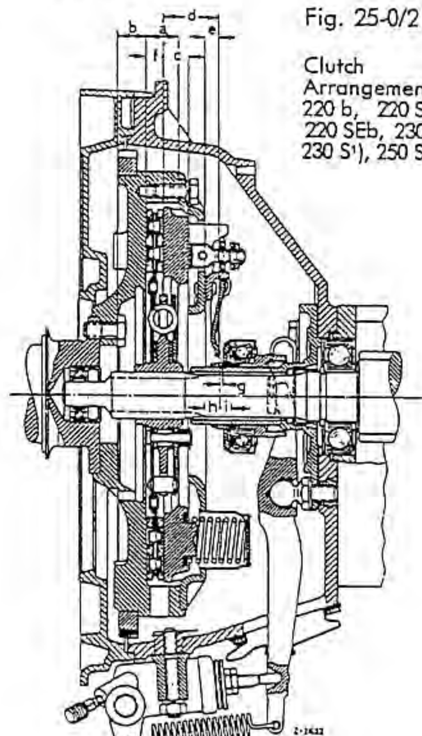


Fig. 25-0/2

Clutch Arrangement 220 b, 220 Sb, 220 SEb, 230 SL¹), 230¹), 230 S¹), 250 S¹) and 250 SE¹)

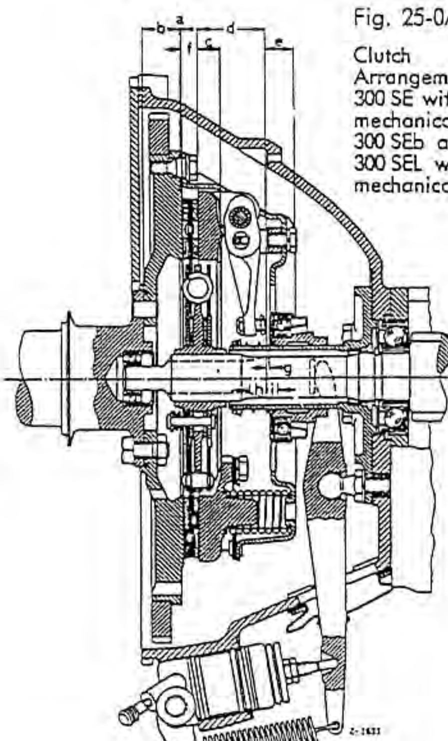


Fig. 25-0/3

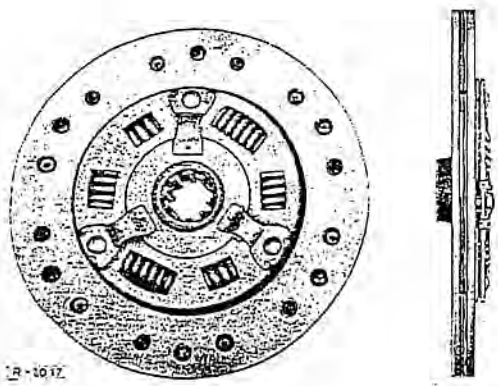
Clutch Arrangement 300 SE with mechanical transmission 300 SEb and 300 SEL with mechanical transmission

Legends of Figs. 25-0/1 to 0/3

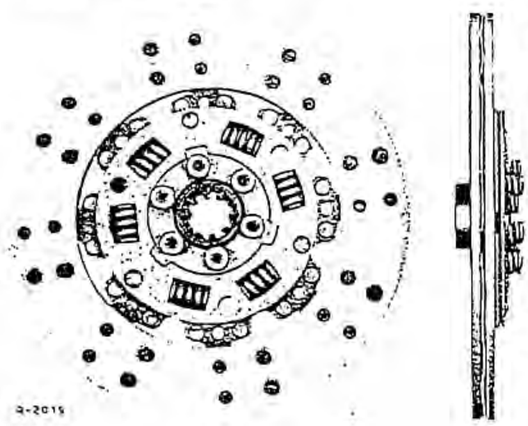
a = Clearance between clutch face and clutch clamping face on the flywheel (see also Fig. 25-1/2)
b = Clearance between clutch face and flywheel attaching flange (see also Fig. 25-1/2)
c = Thickness of clutch pressure plate
d = Adjusting dimension for clutch assembly
e = Control dimension between cover plate and release levers for new driven plate
f = Thickness of new driven plate compressed
g = Free play between throw-out bearing and release levers (clutch free play)
h = Throw-out travel
i = Travel of release levers because of driven plate wear

¹) The clutches of these models are provided with a sheet-metal ring over the spring cups for better engine speed adaptability.

Driven Plate

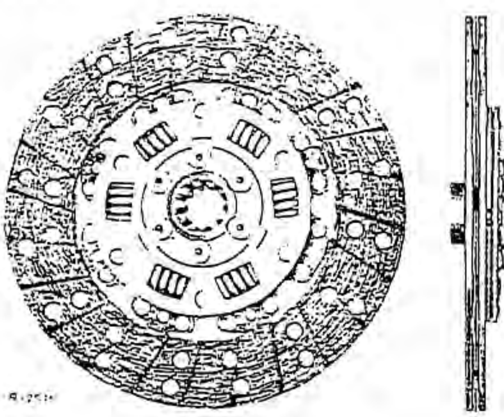


Models 190 c, 190 Dc, 200 and 200 D



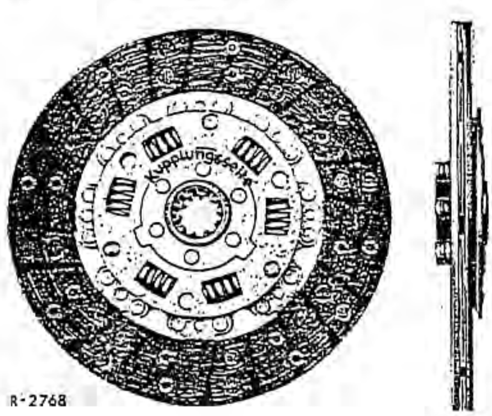
Models 220 b, 220 Sb and 220 SEb

with single spring-loaded facing



Models 220 b, 220 Sb, 220 SEb and 230 SL

with double spring-loaded facing

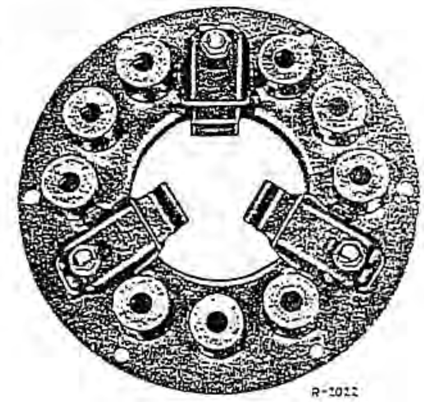


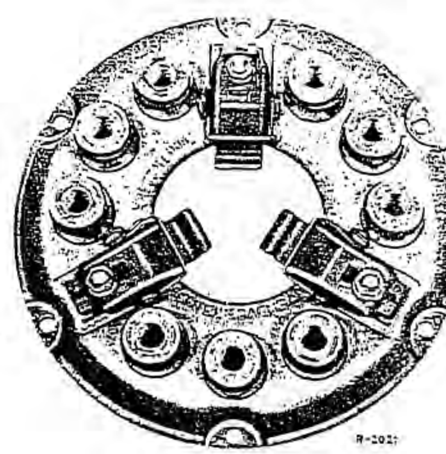
R-2768

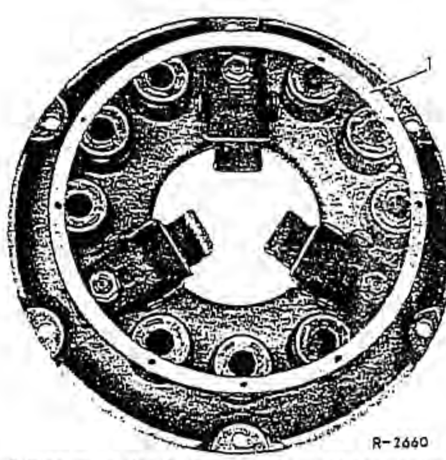
Models 230, 230 S, 250 S, 250 SE and 230 SL

with double spring-loaded facing

Pressure Plate



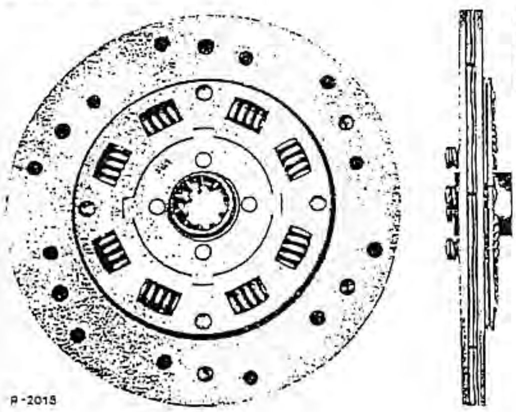




R-2660

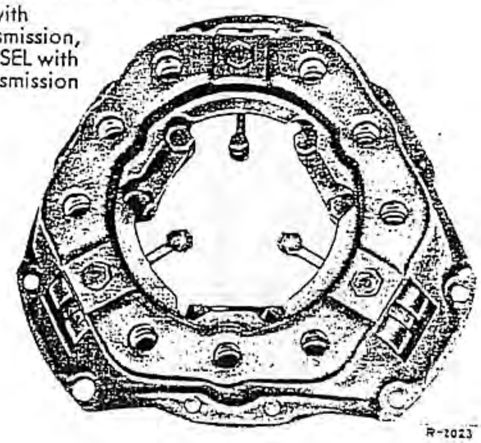
1 Sheet-metal ring for better engine speed adaptability

Driven Plate



Pressure Plate

Models 300 SE with mechanical transmission, 300 SEb and 300 SEL with mechanical transmission



Clutch Pressure Plate

Model	190 c, 190 Dc 200, 200 D	220 b, 220 Sb, 220 SEb Sedan	220 SEb/C	230 230 S 230 SL 250 S 250 SE	300 SE[6]) 300 SEb 300 SEL[6])
Fichtel & Sachs Designation	KS 200 KV[3])	TK 228 KX[4])			HB 18 Sph
Part No.	180 250 07 04	000 250 27 04[4])	000 250 29 04	000 250 68 04[5])	189 250 01 04
Control dimension "e" between cover plate and the release levers with new driven plate installed mm	17.5 ± 0.2	7.0 ± 0.2			18 ± 0.2
Resulting adjusting dimension of worn-out driven plate mm	24.5	14			11
Adjusting dimension "d" for clutch assembly mm	41.4	36.8			42.5
Travel "i" of release levers because of permissible wear of driven plate mm	7				
Throw-out travel "h" of release levers mm max.	10				10.6
Free play "g" between throw-out bearing and release levers (clutch free play) mm	2				
Maximum permissible difference between the release levers[1]) mm	0.3				
Thickness "c" of pressure plate (Fig. 25-0/1) mm	15	16.5			14.5
Regrind dimension of the pressure plate[2]) mm max.	1				
Maximum permissible unbalance of the pressure plate cmg	20	15			
Contact pressure kg	475	540 ± 25			620
Clutch springs: Number	9				
Clutch springs: Part No.	000 252 16 20	000 252 18 20			000 252 23 20
Clutch springs: Color code	colorless and gold	yellow and gold			light blue and gold
Clutch springs: External diameter mm	29	28.6			27.4
Clutch springs: Wire gage	4	4.1			4.2
Clutch springs: Free length mm	50	55.1			58.5
Clutch springs: Length under load mm	32.4	37.2			39.5
Clutch springs: Load kg	53 + 6	61.5 ± 2.5			69 ± 3.5

[1]) Press down the release levers several times before measuring.
[2]) If the reduction in thickness exceeds 0.5 mm, ground shims corresponding in thickness to the total amount of material removed should be placed between the clutch springs and the cups to restore the total spring presssure.
[3]) New Fichtel & Sachs designation, previously KS 12 KV.
[4]) 2nd version. On the 1st version the Fichtel & Sachs designation was TK 228 KV and the Part No. 128 250 02 04.
[5]) On Model 230 SL — 2nd version; 1st version was 000 250 29 04.
[6]) With mechanical transmission.

Driven Plate

Model	190 c, 190 Dc, 200, 200 D	220 b, 220 Sb, 220 SEb	230, 230 S, 230 SL, 250 S, 250 SE	300 SE[5]) 300 SEb 300 SEL[5])
Fichtel & Sachs designation	200 SZP	228 SD[2])		225 SZ
Part No.	000 250 45 03[1])	000 250 87 03[3])	001 250 11 03[4])	000 250 77 03[6])
Thickness of the driven plate "f" — released mm	10.3 ÷ 0.3	10.3 + 0.4		10.6 ÷ 0.4
Thickness of the driven plate "f" — compressed mm	9.1 ÷ 0.3	$9.1^{+0.4}_{-0.1}$		$9.3^{+0.4}_{-0.1}$
Thickness of facing mm	3.5	3.8		3.5
Permissible wear of facing thickness on either side mm	1			
Permissible unbalance cmg	5			
Permissible run-out mm	0.5[7])			
Permissible radial play on the drive shaft mm	0.04 ± 0.01			
Torsion damper — Free motion torque, traction side mkg	17.3	20		30
Torsion damper — Stop angle degrees	8°30'	5°		4°
Torsion damper — Friction torque mkg	0.6 — 0.9	1.4 — 1.7		0.9 — 1.2

Throw-Out Bearing

Model		190 c to 230 SL	300 SE[9])
Internal diameter of the throw-out bearing	mm	39.988 / 40.000	49.988 / 50.000
External diameter of the throw-out bearing	mm	40.006 / 39.995	50.006 / 49.995
Oversize (+) or play (—) of the throw-out bearing on the throw-out unit	mm	— 0.005 to + 0.018	
Internal diameter of the throw-out unit	mm	35.600 / 35.639	40.100 / 40.139
External diameter of the transmission case front cover	mm	35.500 / 35.438	40.000 / 39.938
Clearance between throw-out unit and neck at transmission case front cover	mm	0.1 — 0.2	

[1]) 2nd version, 1st version was 000 250 41 03.
[2]) On 220 models 3rd version, 2nd version was 228 SBL, 1st version was K 16 CBL.
[3]) On 220 models 5th version, 4th version was 000 250 72 03, 3rd version was 000 250 55 03, 2nd version was 000 250 43 03, 1st version was 128 250 00 03.
[4]) On model 230 SL 3rd version, 2nd version was 000 250 87 03, 1st version was 000 250 72 03.
[5]) With mechanical transmission.
[6]) 2nd version, 1st version was 000 250 65 03.
[7]) For handling of driven plate see Job No. 25-1.
[8]) The throw-out unit must be hypercooled before the throw-out bearing is pressed on.
[9]) With mechanical transmission.

Removal and Installation of Mechanical Clutch

Job No.
25-1

Modification: Revised and New Models Added

Removal:

1. Remove the transmission case (see Job No. 26-1).

2. Place the hold-down clamps 111 589 06 61 – or 186 589 01 61 for the 300 SE models with mechanical transmission – under the clutch release levers (Fig. 25-1/1).

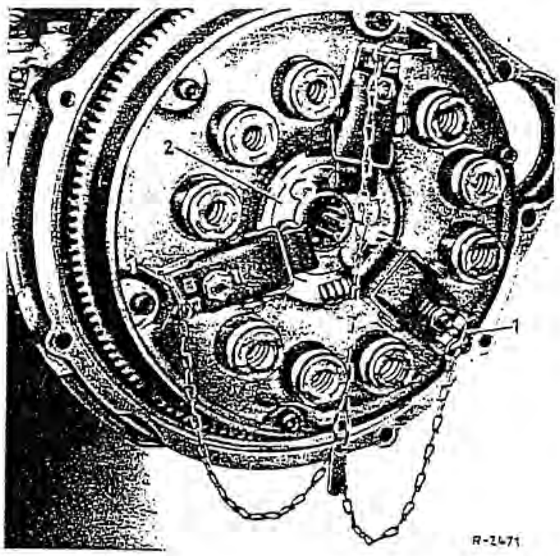


Fig. 25-1/1

1 Hold-down clamps
2 Driven plate

Note: If the clutch pressure plate is not to be disassembled, the hold-down clamps remain in position until the clutch is reinstalled. New and replacement clutches are supplied under tension by wire clamps.

3. Loosen the clutch fixing screws (hexagon socket screws) crosswise and evenly. Then remove the clutch together with the driven plate.

Caution: All **driven plates,** whether new or removed from the clutch must be **stored** and **handled** with the **greatest care** in order to prevent distortion of the facing rim.

Checking:

4. Check the clutch face of the flywheel and the clutch pressure plate for heat cracks and scores. If necessary, regrind or re-turn.

Note: When the friction surface "A" of the flywheel is reconditioned always refinish the surface "B" in order to reestablish the distance "a" and to maintain the prescribed contact pressure. The friction surface of the flywheel can be reconditioned until the lower limit of the dimension "b" is reached (Fig. 25-1/2).

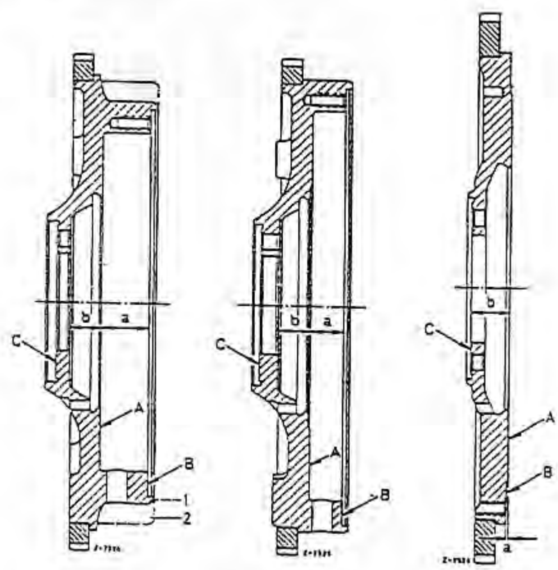


Fig. 25-1/2

1 = 190 c, 200 2 = 190 Dc, 200 D	220 b, 220 Sb, 220 SEb 230 SL 230, 230 S, 250 S, 250 SE	300 SE with mechanical transmission 300 SEb 300 SEL with mechanical transmission

5. Check whether the driven plate slides freely on the drive shaft.

Note: Carefully remove any rust or resinous deposits from the splineways of the drive shaft and from the hub of the driven plate. After cleaning the splineways should be given a **thin** coat of a suitable lubricant, e. g. Kenlube M-621.

6. Check the radial play of the driven plate on the drive shaft. For dimensions see Page 25-0/2.

7. Always check the driven plate for run-out and if necessary readjust it (Fig. 25-1/3). For maximum permissible run-out see Job No. 25-0.

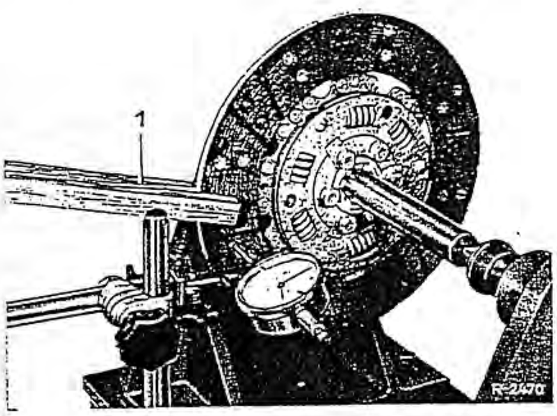


Fig. 25-1/3

1 Turning fork (wooden)

8. Check the annular grooved bearing between transmission drive shaft and crankshaft for ease of movement and lightly grease it.

Installation:

9. Center the driven plate (2) in the annular grooved bearing with Centering Arbor 136 589 00 61 (1) (Fig. 25-1/7).

Caution: The driven plate should be installed in such a way that the six small pressure springs of the friction damping system (three leaf springs on the 4-cylinder models) point **toward the rear, i. e. toward the transmission.** The arrangement is different on the 300 SE models with mechanical transmission: the four pressure springs of the friction damping system must point **toward the flywheel.**

On the **new driven plate** Part No. 001 250 11 03 for Models 230, 230 S, 230 SL, 250 S, and 250 SE the **friction damping springs** are also arranged **on the flywheel side** (Fig. 25-1/4). To ensure correct installation, the new driven plate is stamped "Kupplungsseite" on the side facing the clutch (see Page 25-0/1b).

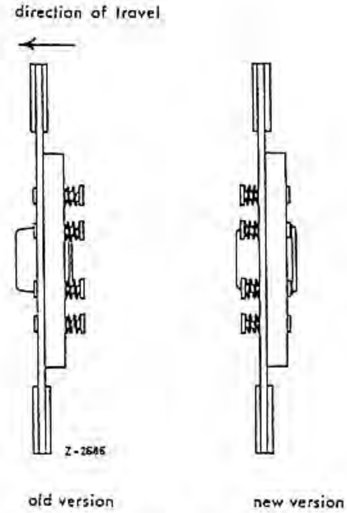


Fig. 25-1/4

10. Fit the clutch pressure plate and screw it down (Fig. 25-1/7).

Note: In order to prevent any clutch squeaking it is advisable to apply a **thin** brush coat of a suitable lubricant, e. g. Kenlube M-621, to the parts marked with an arrow in Fig. 25-1/5, in particular to the guide lugs (1) and their openings in the cover plate.

During this process the clutch should be compressed several times in a press.

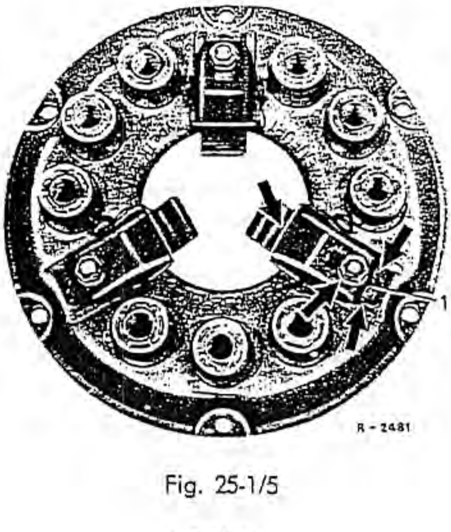


Fig. 25-1/5

1 Guide lug

Important: The clutch must not be forced into place; it must fit properly into the flywheel recess and must make even contact allround. The fixing screws should therefore be tightened crosswise and evenly.
On Model 300 SE two of the six fixing screws are fitted screws. Care must be taken to ensure that the fitted screws are inserted in the two larger holes of the clutch (see arrows in Fig. 25-1/6) and that these bores are aligned with the center bores in the flywheel when the clutch is being installed.

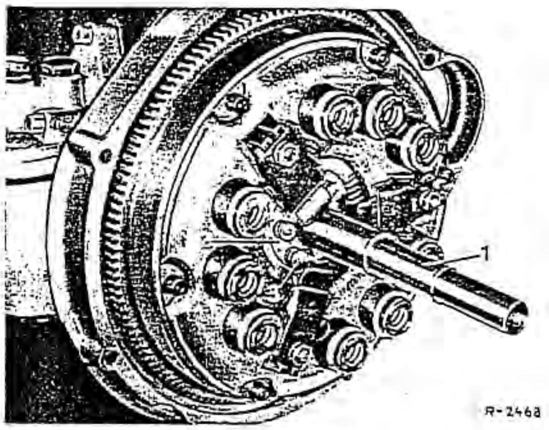


Fig. 25-1/7

1 Centering arbor
2 Driven plate
3 Pressure spring of friction damping system

11. After installation remove the centering arbor and the hold-down clamps.

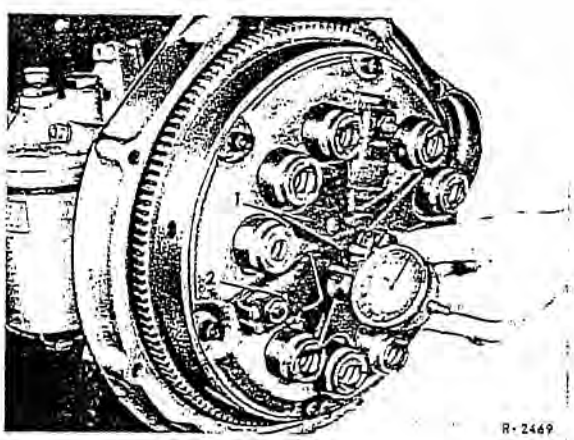


Fig. 25-1/8

1 Checking gage 110 589 01 21 00 with dial gage
2 Release lever

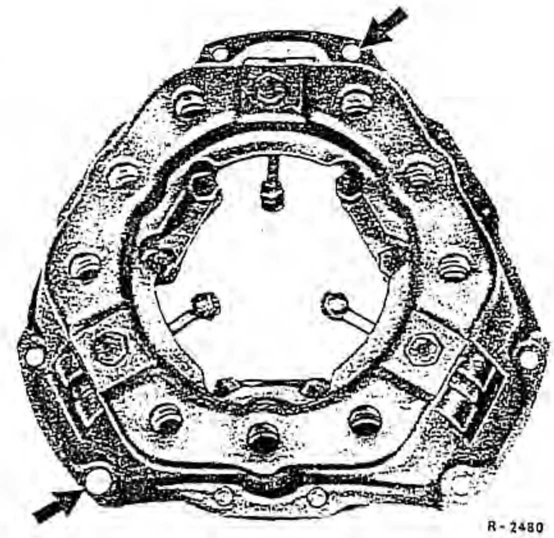


Fig. 25-1/6

12. Use Checking Gage 110 589 01 21 00 or a depth gage to check the adjusting dimension between release lever and cover plate (Fig. 25–1/8).
For dimensions see Job No. 25-0/1c.

Note: The adjusting dimension can only be measured with the pressure plate installed i. e. pretensioned. Depress the release levers (3) several times before measuring. It is important that the distance from the cover plate should be identical for all three release levers (for dimensions see Job No. 25-0). Any excessive deviation between the release levers will produce a grabbing tendency of the clutch and the uneven pressure of the throw-out bearing will produce clutch noise and the bearing will become unserviceable.

13. Install the transmission (see Job No. 26–1).

14. Adjust clutch free play (see Job No. 29–6).

Performance Test:

With the engine running shift into reverse and check clutch performance and driven plate arresting period.

It must be borne in mind that at idling speed and with the transmission oil at operating temperature a fully serviceable driven plate needs 3 to 5 seconds after declutching before it comes to rest. It follows that grating noises will be produced if the reverse gear is engaged too fast.

Job No.
25-4

Clutch Throw-Out Bearing

In February 1964, the previous clutch throw-out bearings were replaced by a new design. The change was made as follows:

On Model	190 c	as from chassis end no.	081 441
	190 Dc		128 634
	220 b		056 243
	220 Sb		122 526
	220 SEb Sedan		058 618
	220 SEb/c		058 599
	230 SL		002 500

All new models whose production started in August 1965, have been provided with the new clutch throw-out bearings.

Cars of Model 300 SE with mechanical transmission (before August 1965) were not equipped with the new throw-out bearing but can subsequently (e. g. when repairs are necessary) be provided with the complete unit as installed in Models 300 SEb or 300 SEL with mechanical transmission.

Figures 25-4/1 and 4/2 show respectively the previous and the present version of the throw-out bearings and throw-out units.

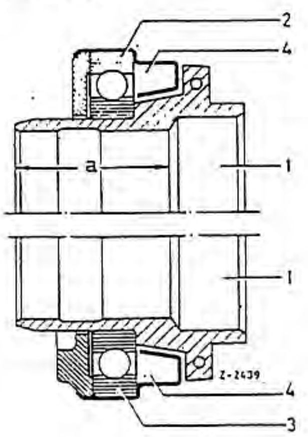


Fig. 25-4/1

Previous version

1 Throw-out unit
2 Throw-out bearing four-cylinder models
3 Throw-out bearing six-cylinder models
4 Circular chamber for grease cake
a = Supporting length of guide sleeve = 31.5 mm

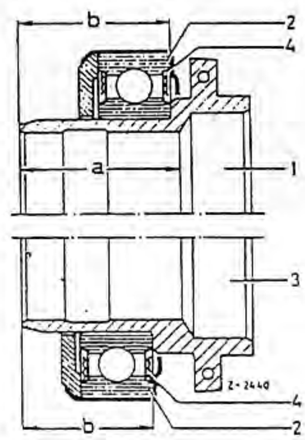


Fig. 25-4/2

Present version

1 Throw-out unit four-cylinder models
2 Throw-out bearing
3 Throw-out unit six-cylinder models
4 Positive seal
a Supporting length of guide sleeve = 33.5 mm
b = Length of bearing sleeve
for four-cylinder models = 31.5 mm
for six-cylinder models = 27 mm

In the case of the "previous" version the throw-out unit was the same for the four-cylinder and six-cylinder models but the throw-out bearings were different (Fig. 25-4/1).

In the case of the "present" version there is a difference in the throw-out units and the throw-out bearings are the same (Fig. 25-4/2).

In order to improve axial guidance the inside length of the guide sleeve of the present throw-out unit was increased by 2 mm. (compare dimension "a" in Figs. 25-4/1 and 2).

The "previous" bearings were lubricated by a grease cake; the "present-version" bearings are filled with silicone grease and are protected against grease losses by two positive seals, whose function is particularly important when the bearings are hot.

Caution: Neither bearing version requires any maintenance and should under no circumstances be washed out.

Wherever a transmission is to be cleaned with solvents, the throw-out bearings must be removed beforehand.

Replacing the Throw-Out Bearing

Job No.
25-5

Removal:

1. Remove the transmission (see Job No. 26-1).

2. Press the spring clips (2) out of the throw-out fork (4) toward the rear and pull them out upward (Fig. 25-5/1).

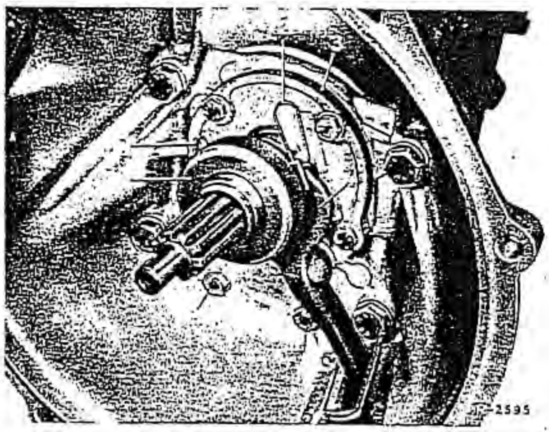


Fig. 25-5/1

1 Throw-out unit and bearing
2 Spring clip
3 Transmission case front cover
4 Throw-out fork

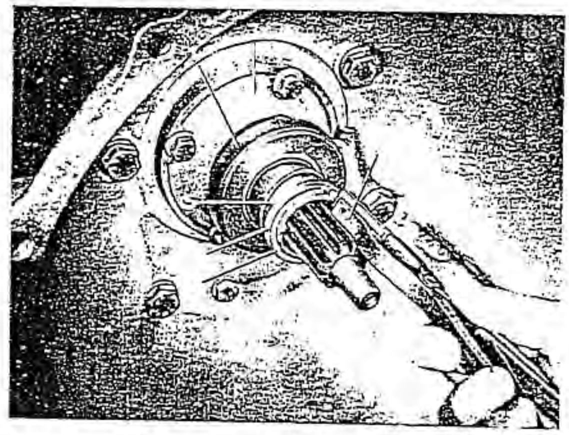


Fig. 25-5/2

1 Throw-out unit with bearing
3 Transmission case front cover
5 Return spring
6 Spring retainer
7 Snap ring
8 Snap ring pliers

On the 300 SE cars with mechanical transmission remove the snap ring (7) by means of snap ring pliers (8). Remove the spring retainer (6) and the return spring (5) (Fig. 25-5/2).

3. Remove the throw-out unit (1) together with the throw-out bearing from the neck of the transmission case front cover (3).

4. To remove the bearing place the throw-out unit on the shop-made removing arbor (Fig. 25-5/3).

5. Grip the throw-out bearing and knock the removing arbor with the throw-out unit against a hard surface (Fig. 25-5/4).

Note: If the inner ring of the bearing should stick on the throw-out unit, it must be pulled off with a suitable puller or as an emergency measure be cut up.

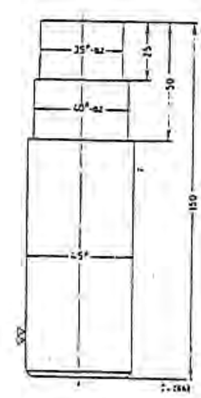


Fig. 25-5/3

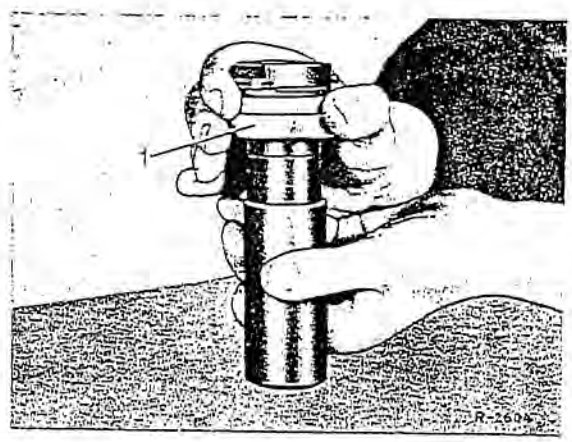


Fig. 25-5/4

1 Throw-out bearing

Installation:

Important: The "new" throw-out unit and the "new" throw-out bearing can only be installed together to replace the previous parts.

Under no circumstances can a "new" throw-out bearing be installed with a throw-out unit of the previous version. The dimensional differences would make it practically impossible to adjust the clutch free play properly.

A throw-out bearing of the "previous" version will immediately become unserviceable if it is pressed on a "new" throw-out unit.

6. Give the neck on the throw-out unit a thin coat of a graphite lubricant.

7. Carefully press on the throw-out bearing.

Caution: Both the "previous" and the "present" versions of the throw-out bearing do not require any maintenance and should under no circumstances be washed out.

Note: Because of the oversize of the throw-out unit in relation to the throw-out bearing it is advisable to hypercool the throw-out unit before the bearing is pressed on. When cooling facilities are available the bearing neck need not be lubricated.

8. Fill the annular groove in the throw-out unit with Kenlube M 621 and give the sliding surfaces of the throw-out unit a thin coat of the same lubricant.

9. Apply a thin coat of a suitable graphite lubricant to the mounting tube of the transmission case front cover.

10. Push the throw-out unit on the mounting tube of the transmission case front cover and attach it to the throw-out (4) by means of the spring clips (2) (Fig. 25-5/1).

    On 300 SE Model cars reinstall the return spring (5), the spring retainer (6) and the snap ring (7) after the throw-out unit has been introduced into the throw-out fork (Fig. 25-5/2).

11. Reinstall the transmission (see Job No. 26-1).

Hydraulic Automatic Daimler-Benz Clutch

Job No.
25-10

I. Introduction

The hydraulically-operated automatic clutch is designed to relieve the driver of the task of operating the clutch when starting off and when changing gear, and to make this process automatic. Cars which are equipped with the hydraulically-operated automatic clutch have therefore no clutch pedal.

In order to provide a comprehensive survey, this chapter incorporates all modifications necessary for the various models.

The hydraulically-operated clutch consists of four main assemblies:

a) The hydraulic start-off coupling
b) The conventional mechanical clutch
c) The servo assembly for operating the mechanical clutch
d) The control element which operates the servo assembly.

The vehicle is moved from a standing start by means of the hydraulic start-off coupling. The hydraulic coupling is so designed that the engine can idle with the gear lever engaged and its characteristics also enable the vehicle to get off the mark very smoothly. The method of operation and characteristics of the hydraulic coupling are already known from the automatic transmission, but they are here repeated in detail in Section II, "Description of the Hydraulic Automatic Clutch".

The disconnection of engine and rear axle which is necessary when changing gear, is accomplished by means of a conventional mechanical clutch, with the difference that it is no longer operated via a clutch pedal but instead, is controlled by a servo assembly. The shift lever is the same in external appearance as hitherto and the gear positions are also unaltered. When the shift lever is touched, an electrical contact is made which operates the servo assembly via a control valve. This connects the vacuum side of the servo piston with the engine intake manifold while the high-pressure side is still subject to atmospheric pressure. The pressure differential furnishes the operative force necessary to throw out the mechanical clutch so promptly that the gearshift can be carried out in the normal way.

A free-wheel unit has also been incorporated in the hydraulically-operated clutch and this unit locks automatically whenever the car is overrunning the engine. Thus when the car is overrunning the engine, the engine and the rear axle are rigidly locked together. This arrangement enables the braking torque of the engine to be fully utilized right up to the moment when the vehicle comes to a halt, and at the same time, it enables the engine to be started quickly when the vehicle is being towed or pushed. Furthermore, it serves as a gradient lock, that is to say, when the car is placed in 1st gear on a downward slope or in reverse gear on an upward slope, it supplements the action of the hand brake to prevent the car rolling.

II. Description of Hydraulic Automatic Clutch

A. The Hydraulic Coupling

The simplest way of explaining the method of operation of a hydraulic coupling is to perform an experiment, using two ordinary electric fans. For this purpose, two electric fans are arranged facing each other (Fig. 25-10/1).

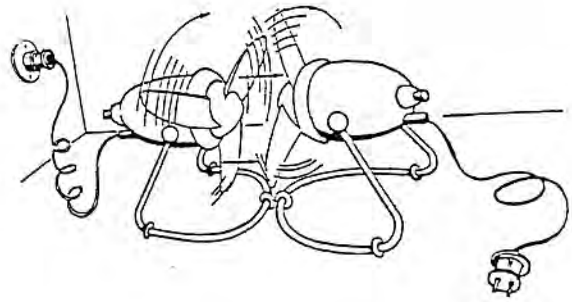


Fig. 25-10/1

When one of the fans is switched on, there is a stream of air which strikes the blades of the second fan and compels it to turn in the same direction of rotation. Power is thus being transferred from the first fan to the second and air is serving as the transfer medium.

A hydraulic coupling works on the same principle, but with the difference that

a) instead of air, a special oil is used as a transfer medium and

b) instead of the blades of the fan, turbine wheels are used.

The turbine wheels, the so-called members in the case of the hydraulic coupling, are arranged with the least possible clearance distance between them, in order to avoid losses (Fig. 25-10/2).

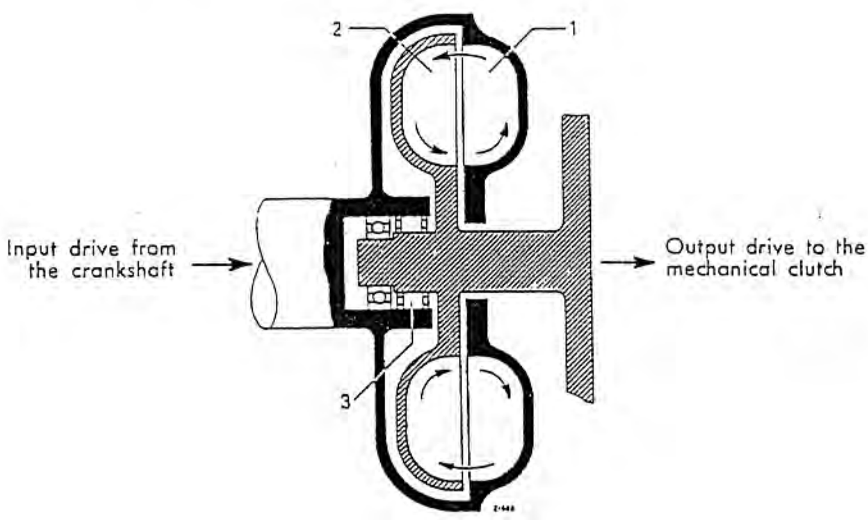


Fig. 25-10/2

1 Primary member
2 Secondary member
3 Free-wheel

The driving member (1), the so-called primary member, is welded to the clutch end plate. The driven member (2), the so-called secondary member, is mounted on a ball bearing.

The clutch end plate is bolted to the flywheel of the engine; this means that the primary member is permanently locked to the crankshaft of the engine. The secondary member, however, is connected via the mechanical clutch to the transmission and thus to the rear axle. The constructional form of the two members is shown in Fig. 25-10/3 in which the primary member (1), the secondary member (2) and the clutch end plate (3) are illustrated.

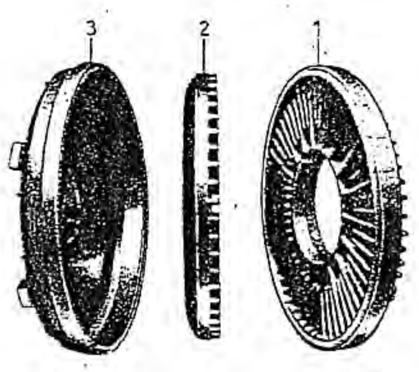


Fig. 25-10/3

1 Primary member
2 Secondary member
3 Clutch end plate

When the engine is started, the clutch end plate turns and this causes the primary member to turn at the speed of the engine. This rotary movement makes the oil in the hydraulic coupling turn in the same direction of rotation, due to the vanes of the primary member. This rotary movement causes the oil to be forced outward, due to the centrifugal force which is now operating, so that it leaves the vanes of the primary member at the outer part and strikes the vanes of the secondary member. The secondary member thus begins to turn in the same direction of rotation as the primary member. The oil is now directed from the outer part to the inner part of the secondary member where it emerges and is received by the inlet at the inner part of the primary member. There is thus a circulation of the oil between primary and secondary members (see arrows in Fig. 25-10/2). Power transmission between the primary and the secondary members is thus effected by the oil because the mass of the oil in the primary member is being accelerated and in the secondary member, it is being braked.

The overall motion of the oil thus forms a kind of spiral which may be regarded as describing a circular path around the rotary axis of the hydraulic coupling since on the one hand the oil is being carried round in the direction of rotation of the engine and on the other hand, there is a circulation of oil between primary and secondary members.

The hydraulic coupling enables a stepless change of speed to take place, that is to say, the secondary member is at first stationary when the car starts off – with the gear engaged – and then it gradually starts to turn and increases its speed until it is revolving at almost the same speed as the primary member. There will, however, always be a slight difference in speed between the primary and the secondary members. This difference is referred to as slip and is approximately 2 %. Since the efficiency of the coupling is expressed in terms of the relationship between the speed of the output drive n_2 and that of the input drive, n_1, it can be seen that the efficiency is approximately 98 % when travelling at even speed on the level.

Between the flange shaft of the secondary member and the clutch end plate, the free-wheel unit (3) is located. This unit locks in the direction opposite to the direction of rotation of the engine (see Fig. 25-10/2). Thus when the car is overrunning the engine, it causes the rear axle to be rigidly locked to the engine so that the braking torque of the engine can be fully utilized right up to the moment when the vehicle comes to a halt.

In place of the clamping plate free-wheel unit (9) (see Fig. 25-10/5) a screw-type free-wheel unit (9) has now been installed (Fig. 25-10/4).

Sealing of the hydraulic coupling on the mechanical clutch side is done by means of a specially constructed axial seal. The graphite ring (10) is pressed hard against the sealing surface of the flange shaft of the secondary member by means of a thrust ring on which pressure is exerted by the spring (12) (Fig. 25-10/4). The seal between the thrust ring and the threaded ring which is screwed into the clutch end plate, takes the form of a metal bellows which connects the two parts and acts as a cushion.

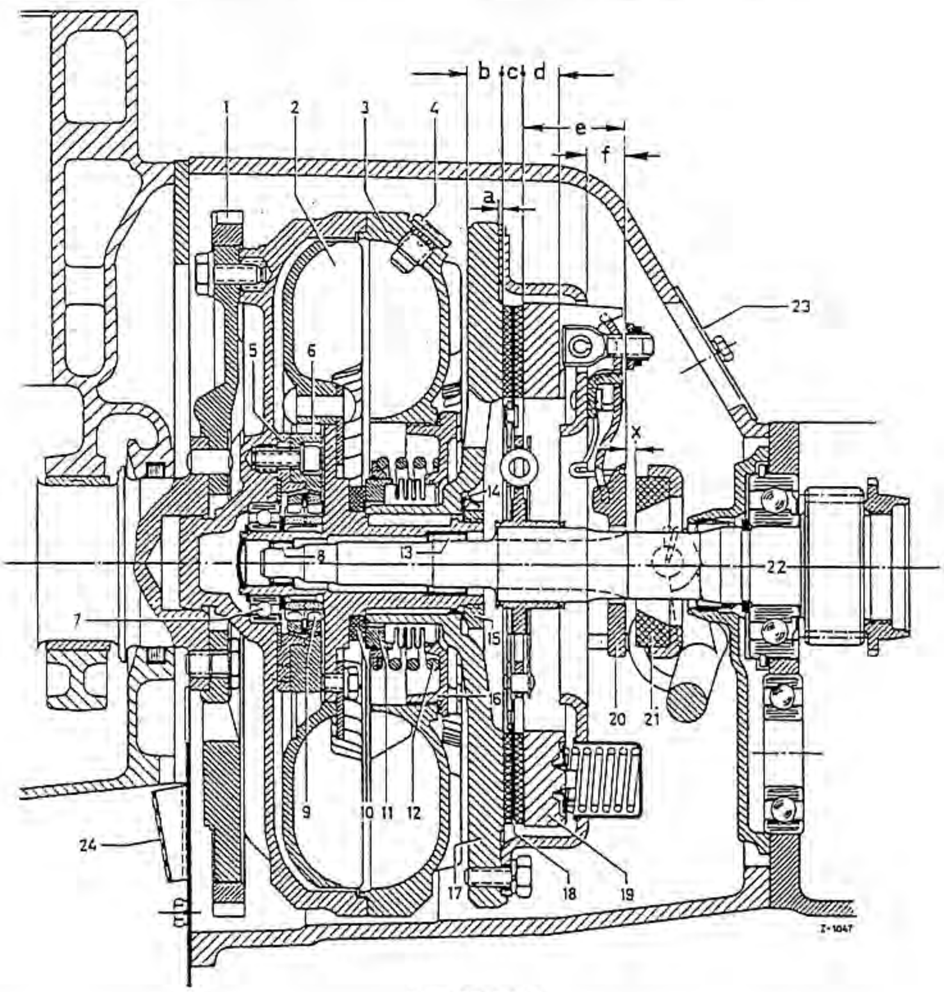


Fig. 25-10/4

2nd version of the hydraulic automatic clutch with screw-type free-wheel unit

1 Flywheel with starter ring gear
2 Secondary member
3 Primary member
4 Screw plug
5 Outer ring left
6 Outer ring right
7 Annular grooved bearing
8 Needle bearing
9 Screw-type free-wheel unit
10 Graphite sealing ring
11 Thrust ring
12 Pressure spring
13 Needle bearing
14 Locking plate
15 Grooved nut
16 Threaded ring and axial seal
17 Drive plate
18 Driven plate
19 Contact plate of clutch pressure plate
20 Thrust ring
21 Throw-out bearing with graphite ring
22 Drive shaft
23 Cover plate for cooling air inlet
24 Cover plate for cooling air inlet (1st version)

a = Clearance between clutch face and clamping face for the clutch pressure plate
b = Thickness of drive plate
c = Thickness of driven plate
d = Thickness of pressure plate
e = Adjusting dimension of the release levers between the clutch face and the contact ring
f = Adjusting dimension between the cover plate and the contact ring
x = Clutch free play

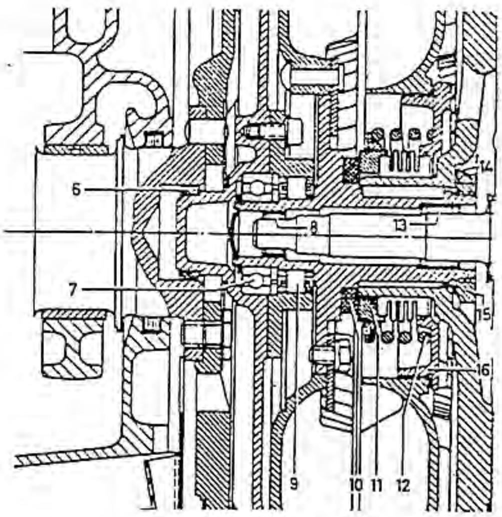


Fig. 25-10/5

1st version of hydraulic-automatic clutch with clamping plate free-wheel unit

6 Centering ring
7 Annular grooved bearing
8 Needle bearing
9 Clamping plate free-wheel unit
10 Graphite sealing ring
11 Thrust ring
12 Pressure spring
13 Needle bearing
14 Locking plate
15 Grooved nut
16 Threaded ring and axial seal

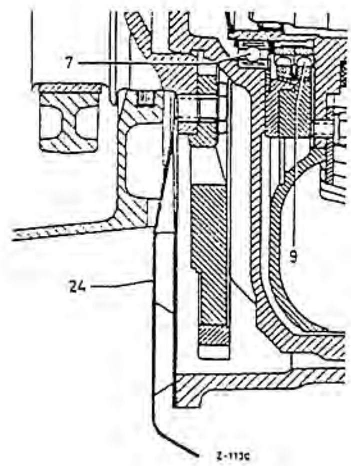


Fig. 25-10/6

2nd version of cover plate for cooling air inlet

7 Annular grooved bearing
9 Screw-type free-wheel unit
24 Cover plate for cooling air inlet

B. The Mechanical Clutch

The mechanical clutch consists of the drive plate (17), the driven plate (18) and the actual clutch with contact plate (19) (see Fig. 25-10/4). The drive plate (17) is bolted to the flange shaft of the secondary member with a grooved nut; a Woodruff key is installed between the flange shaft and the drive plate.

The drive shaft of the transmission is mounted on two needle bearings in the flange shaft of the secondary member. When the mechanical clutch is thrown in, therefore, the secondary member is rigidly locked to the drive shaft of the transmission.

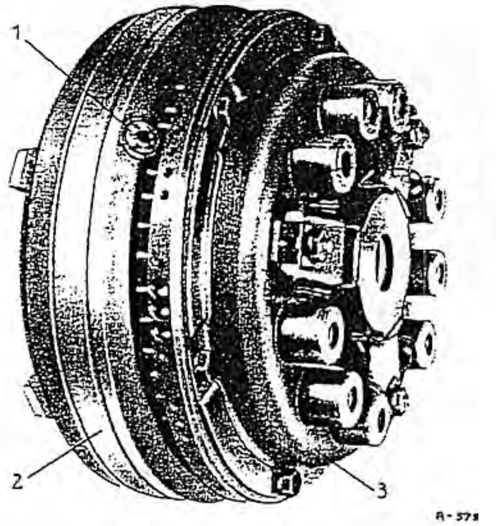


Fig. 25-10/7

The picture shows clutch KFX 12

1 Screw plug
2 Hydraulic coupling
3 Mechanical clutch

C. The Clutch Housing

The clutch housing is fastened in the normal way to the jointing plate or direct to the crankcase. The heat developed in the hydraulic coupling, particularly under load when considerable slip is present, is dissipated by means of cooling air. For this reason, apertures for the inlet and outlet of the air have been made in the clutch housing and they are covered by perforated metal covers. The cooling air enters through the cover plates (23) and (24), and the exhaust air emerges through a cover plate situated on the left at the bottom of the clutch housing (see Fig. 25-10/4).

In models 219, 220 S, and 220 SE the clutch housing is centered in relation to the crankcase by means of dowel pins. In models 220 b, 220 Sb, and 220 SEb the clutch housing is centered in the jointing flange by means of a cylindrical centering device (see Job No. 01-2).

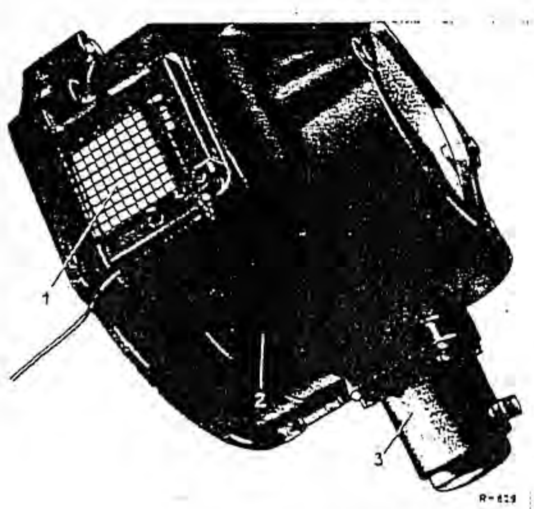


Fig. 25-10/8

1 Cover plate with temperature switch
2 Cover plate
3 Clutch brake

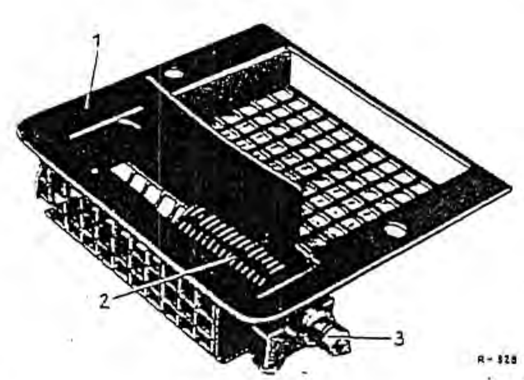


Fig. 25-10/9

1 Cover plate
2 Temperature switch
3 Cable connection

In recent production models a temperature switch has been installed in the cover plate for the cooling air outlet. As soon as the emerging cooling air has reached a temperature of appr. 100° C (corresponding to an oil temperature of appr. 180° C in the hydraulic clutch), the switch is making contact and gives the driver an optical signal to shift down. The optical signal is switched off the moment the temperature of the emerging cooling air falls below appr. 100° C (Fig. 25-10/9).

With the exception of Model 220 SE the throw-out shaft in the clutch housing is operated from the left, seen in the direction of travel. Since in Model 220 SE the servo assembly, for reasons of space, has been arranged on the right side of the engine, the throw-out shaft is operated from the right.

In models with fuel injection engine an additional electrical clutch brake is attached to the clutch housing for the adjustment of the clutch brake in Model 220 SE see Job No. 25-10, Section VI, G).

D. The Servo Assembly

The mechanical clutch is operated via the pull rod by means of the servo assembly. The servo assembly is attached to the left of the crankcase (Fig. 25-10/10) except in the case of Model 220 SE, in which it is attached to the right side of the intake manifold. In the case of Model 220 SE the servo assembly is connected to the throw-out lever of the throw-out shaft via a relay lever which is fastened to the intake manifold by a bracket (Fig. 25-10/11). In order to reduce the contact noise of the diaphragm disk, rubber buffers have for some time been installed in the servo assembly.

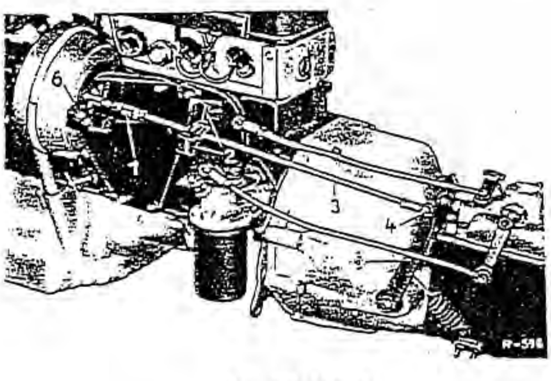


Fig. 25-10/10

Arrangement in Models 219 and 220 S

1 Turnbuckle
2 Adjusting clamps
3 Pull rod
4 Connector head
5 Throw-out lever
6 Limit switch

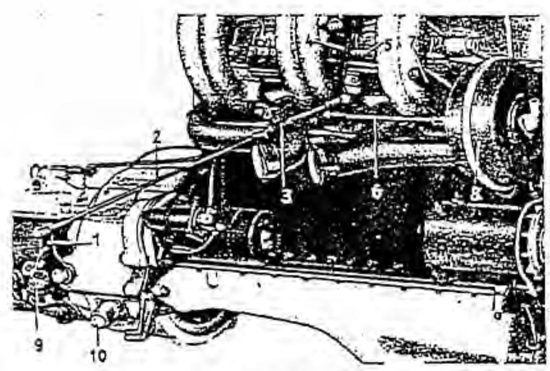


Fig. 25-10/11

Arrangement in Model 220 SE

1 Throw-out lever
2 Long pull rod
3 Turnbuckle
4 Relay lever
5 Spring for clutch brake switch
6 Short pull rod
7 Bracket for servo assembly
8 Servo assembly
9 Spring on throw-out lever
10 Clutch brake

The servo assembly incorporates a limit switch (6) (Fig. 25-10/10), which brakes the circuit to the relay of the solenoid in the control element when the mechanical clutch is engaged. In the first version the length of the pin of the limit switch is a = 27 mm, in the second version a = 10.5 mm (Fig. 25-10/12). The second version limit switch may only be installed together with a control element Part No. 000 250 02 60.

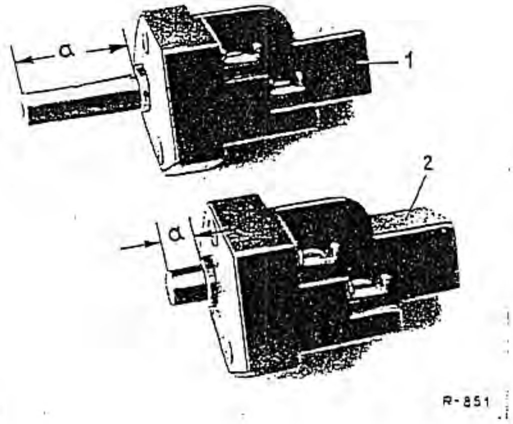


Fig. 25-10/12

1 Limit switch (1st version)
2 Limit switch (2nd version)
a = pin length

E. Control Element

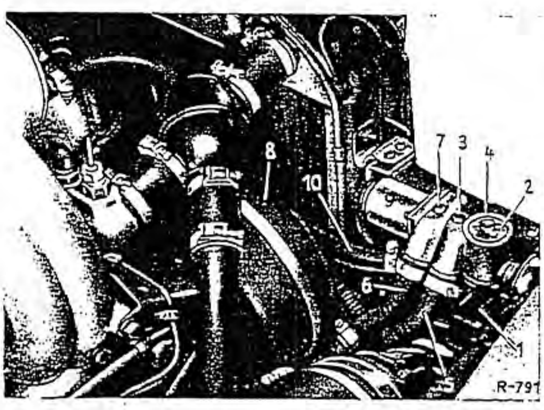


Fig. 25-10/13

Arrangement in Model 220 SE

1 Relay
2 Threaded ring
3 Screw plug
4 Adjusting screw and lock nut
5 Hose to servo assembly
6 Hose to vacuum supply reservoir
7 Screw plug
8 Servo assembly
9 Control element
10 Vacuum tube from intake manifold

Control element St V 12 HF/12 V Part No. 000 250 01 60
installed in Models 219, 220 S

Control element St V 12 HF/12 V Part No. 000 250 02 60
installed in Model 220 SE

Control element St V 14 HF/12 V Part No. 000 250 03 60
installed in Models 220 b, 220 Sb, 220 SEb.

Control element St V 14 HF/12 V has larger cross-sections which make the response of the mechanical clutch even quicker. The action of the control element is influenced additionally by an electric switch contact at the rear axle (see Fig. 25-10/28) via the relay (1) (see Fig. 25-10/13 and Fig. 25-10/31).

F. Clutch Brake in Models with Fuel Injection Engine

In models with fuel injection engine an automatic brake is installed which absorbs the gear-shift shock. This supplementary device is necessary because the engagement shock is fiercer on account of the larger mechanical clutch. The clutch brake (3) is attached to the clutch housing (5) (Fig. 25-10/14).

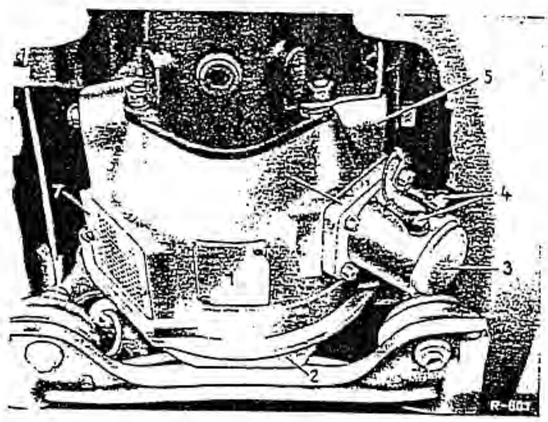


Fig. 25-10/14

Arrangement in Model 220 SE

1 Cover plate
2 Cover plate for cooling air inlet
3 Clutch brake
4 Cable connection at clutch brake
5 Clutch housing
6 Jointing flange
7 Cover plate for cooling air outlet

Fig. 25-10/15 shows the circuit diagram for the control of the clutch brake in Model 220 SE. As soon as the shift lever is touched, the mechanical clutch is thrown out, the relay lever connecting the long and the short push rod from the servo assembly to the throw-out lever moves forward. The contact pin of the switch, which is fastened to the cooling water drain outlet by means of a bracket, closes the circuit when the clutch is thrown out, the electro-magnet of the clutch brake is energized and its core, to which the piston with the brake lining is attached, brakes the drive plate of the mechanical clutch (see Fig. 25-10/35).

As soon as the shift lever is released, the relay lever returns to its initial position, the switch breaks the circuit, and the clutch brake releases the drive plate. In order to ensure that the clutch brake operates only when the vehicle is stationary or creeping, an additional switch contact has been installed in the speedometer, which breaks the circuit at a speed above appr. 8 km/h.

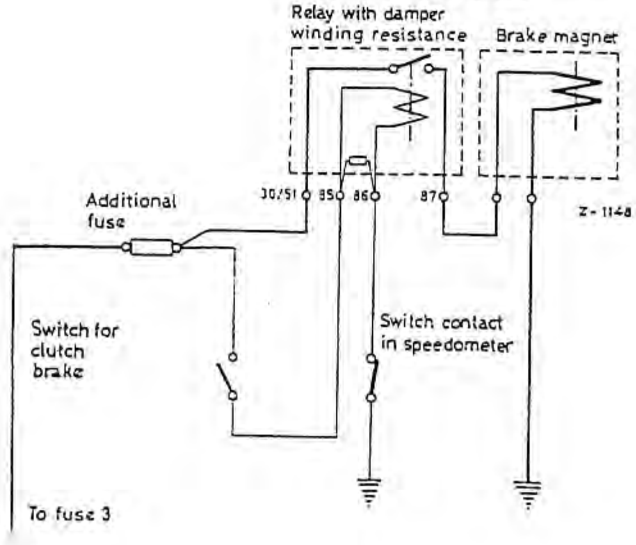


Fig. 25-10/15

Circuit diagram of clutch brake in Model 220 SE

Fig. 25-10/15 a shows the circuit diagram for the control of the clutch brake in Model 220 SEb. As soon as the shift lever is touched, the clutch brake is energized via the relay and brakes the drive plate. When the shift lever is released, the current supply to the clutch brake is interrupted. Above a speed of appr. 8 km/h the eddy current switch on the transmission case rear cover breaks the ground circuit to the clutch brake so that the brake can only operate up to this particular speed.

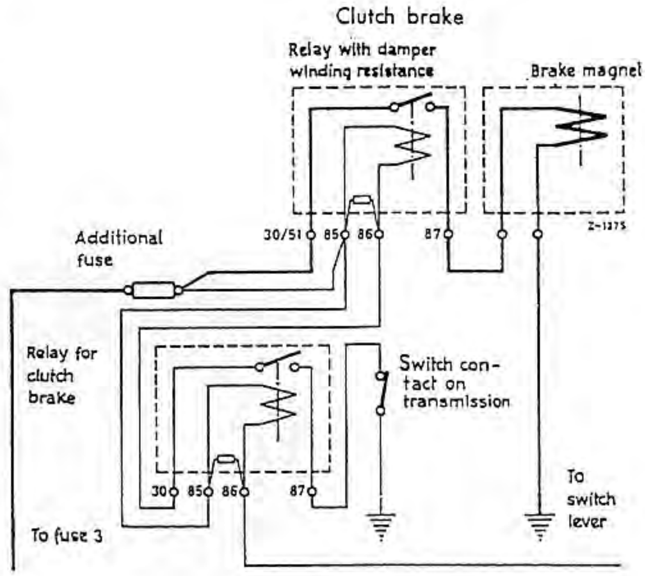


Fig. 25-10/15 a

Circuit diagram of the clutch brake in Model 220 SEb

G. Idle Increase Device in Models with Fuel Injection Engine

The automatic device for increasing the idle speed in models with fuel injection engine increases the idle speed by 40-60 r.p.m. when a gear is engaged. In this way a decrease in the idle speed is prevented, although the hydraulic clutch already transmits a slight torque. When the shift lever is touched, not only the control element but also the pressure magnet is energized. The push rod, which has a stroke of 5 mm, presses against the control linkage, so that the throttle valve opens appr. 2°. The engine is supplied with additional air and fuel and consequently the idle speed increases. When a gear is engaged, the double cam, which is situated on the relay shaft lever, presses in the pin of the switch and thus closes the circuit to the magnet, since the circuit via the shift lever contact is again interrupted when the shift lever is released. This device serves to increase the idle speed during the actual gear shift. When the gear has been engaged the idle speed is actually 40–60 r.p.m. higher. (For adjustment of the switches see Job No. 25-10, Section VI, F).

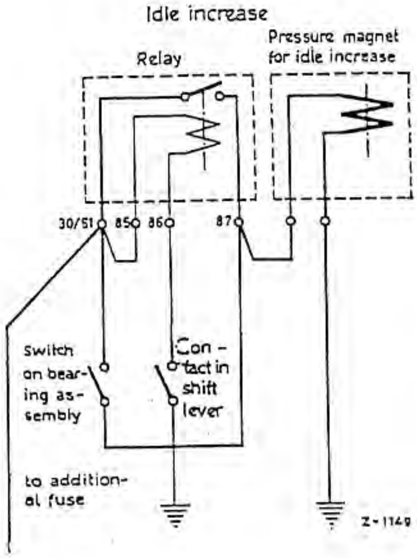


Fig. 25-10/16

Circuit diagram of automatic idle increase device

III. The Working of the Hydraulic Automatic Clutch

When the engine is running, and particularly when it is idling with the throttle valve (3) only slightly opened, a considerable vacuum prevails in the engine intake manifold. This vacuum is transmitted via the vacuum line (4), the check valve (17) and the vacuum line (5) to the supply reservoir (H) (Fig. 25-10/17).

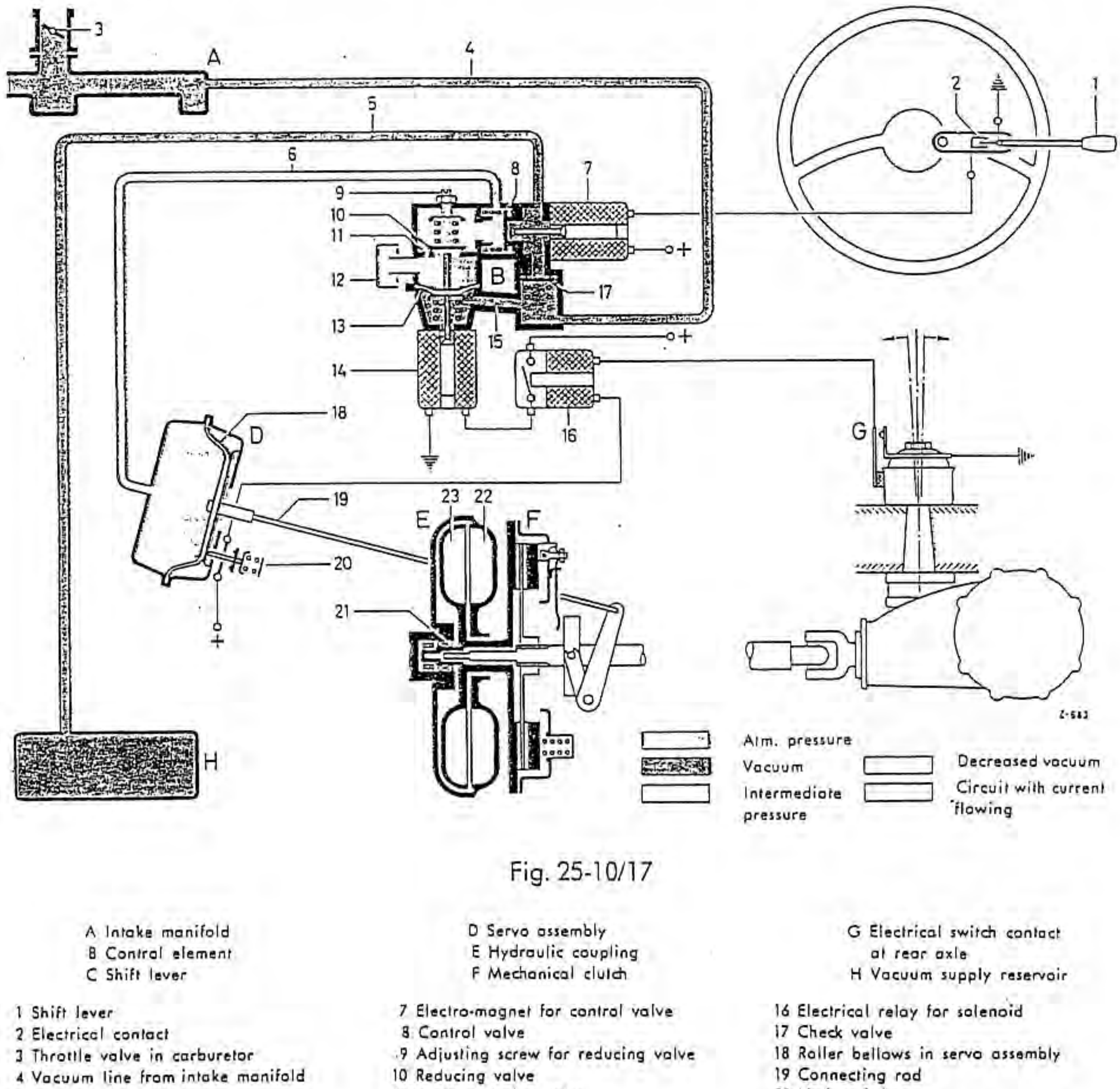


Fig. 25-10/17

A Intake manifold
B Control element
C Shift lever

D Servo assembly
E Hydraulic coupling
F Mechanical clutch

G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intake manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly

7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal

16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

The check valve (17) prevents the vacuum in the supply reservoir (H) from being dissipated when the depression in the intake manifold is decreased when the throttle is opened or when the engine is stopped. The vacuum valve and the unions must be leak-proof so that the vacuum supply in the reservoir remains effective at least overnight.

The atmosperic pressure is able to reach the vacuum side of the servo assembly via the air cleaner (12), the jet (11) and the line (6) so that the pressure springs of the mechanical clutch press the contact plate onto the driven plate and thus onto the drive plate, that is to say, the mechanical clutch is thrown in.

As soon as the shift lever (1) is touched, the electrical contact (2) is closed and the electro-magnet (7) of the control element is energized. This causes the valve (8) to be thrust open so that the vacuum side of the servo assembly is connected to the intake manifold and / or the vacuum reservoir (Fig. 25-10/18).

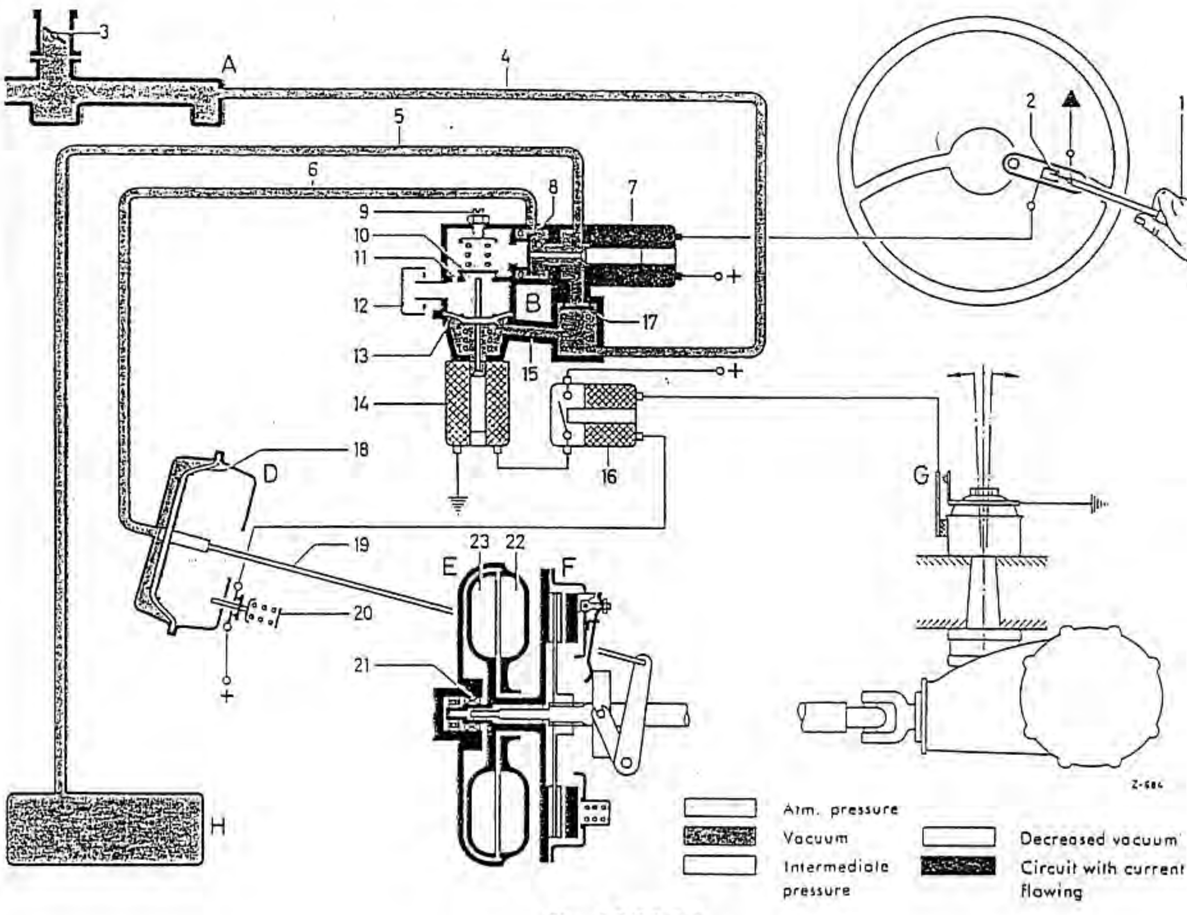


Fig. 25-10/18

A Intake manifold
B Control element
C Shift lever

D Servo assembly
E Hydraulic coupling
F Mechanical clutch

G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intokte manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly

7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal

16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

At the same time the valve (8) closes the canal to the reducing valve (10). The difference in pressure between the atmospheric pressure and the vacuum causes the diaphragm (18) of the servo assembly (D) to be drawn to the left and the mechanical clutch (F) is thrown out via the connecting rod (19). The mechanical clutch is thus released simply by touching the shift lever and the release is therefore effected before every gear shift. The process of throwing out the clutch is so rapid that a smart gear shift can be effected.

Engaging of the clutch after the gearshift operation commences immediately the shift lever is released. As soon as the driver's hand lets go of the shift lever, the current supply to the electro-magnet (7) is interrupted and thus the control valve (8) of the servo assembly (D) is cut off from the intake manifold of the engine and / or from the vacuum supply reservoir (Fig. 25-10/19). The canal to the reducing valve is once more opened up.

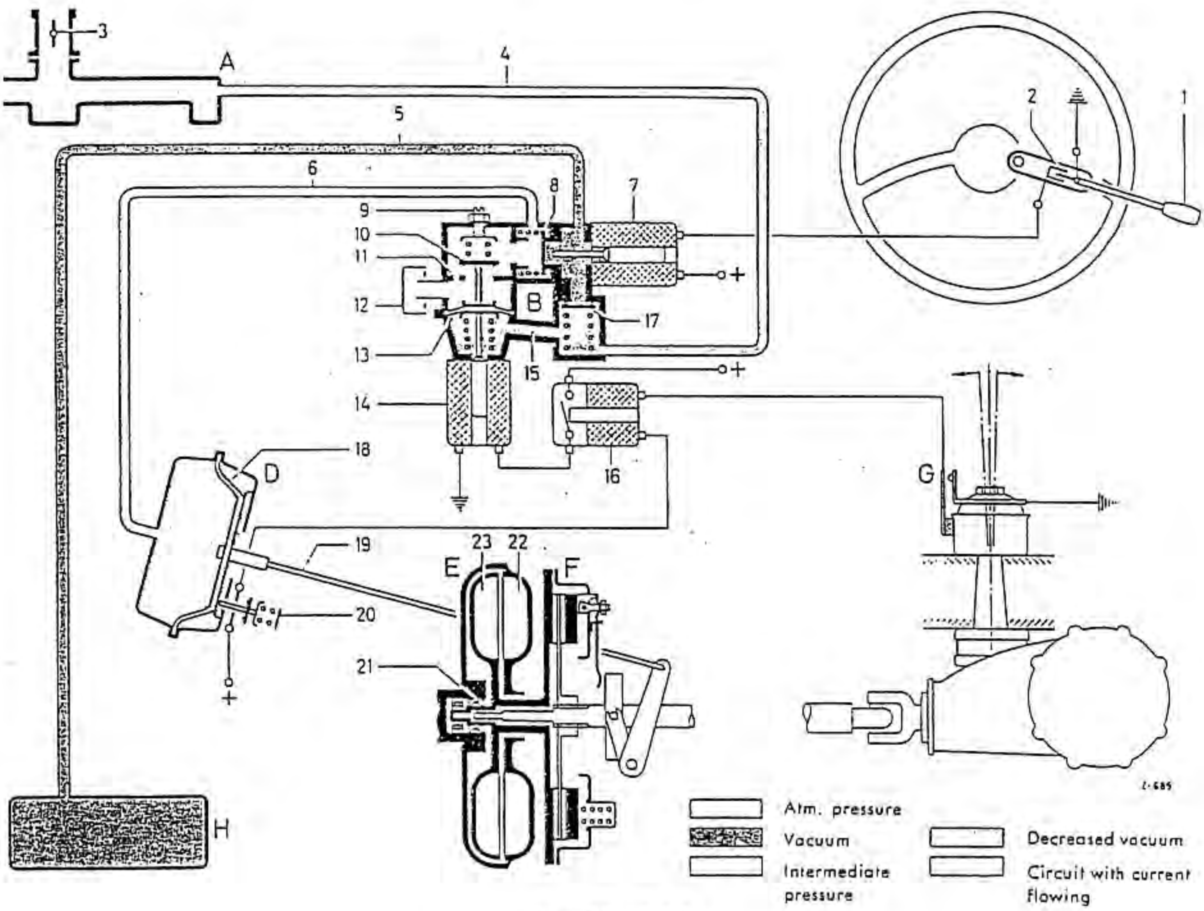


Fig. 25-10/19

A Intake manifold
B Control element
C Shift lever

D Servo assembly
E Hydraulic coupling
F Mechanical clutch

G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intake manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly

7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal

16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

The breakdown of the vacuum in the servo assembly and the simultaneous increase of torque transmitted by the mechanical clutch, takes place in two phases. In the first phase the vacuum is dispersed very quickly until the mechanical clutch begins to grip, because now the reducing valve (10) opens. With the closing of the control valve (8) the remaining vacuum in the servo assembly produces a suction effect on the reducing valve (10) so that the atmospheric pressure entering via the air cleaner (12) can force it open.

As soon as the vacuum has decreased to a certain value, the spring-loaded reducing valve closes once again. The second phase now begins. The dispersal of the vacuum takes place gradually by virtue of the small jet (11) so that the mechanical clutch engages slowly and smoothly. The timing of the second phase and therefore the sharpness of the braking action resulting from the downshift, can be varied by means of the adjusting screw (9). Screwing the adjusting screw in advances the timing of the second phase and softens the action of the clutch. If the adjusting screw is backed out, the timing is retarded and the clutch action is therefore fiercer. A further device is now necessary in order to accelerate the engagement of the clutch. This is necessary when the accelerator is depressed immediately after the gearshift since the clutch would slip under these conditions because it is not yet completely engaged. The fast engagement of the clutch necessary in this case is brough about by the spring-loaded diaphragm (13). One side of the diaphragm is connected via the air cleaner (12) direct to the external atmosphere and the other side is connected via the canal (15) to the intake manifold of the engine. When the throttle valve is closed and there is a considerable vacuum at the intake manifold, the atmospheric pressure, overcoming the spring pressure, presses the diaphragm down.

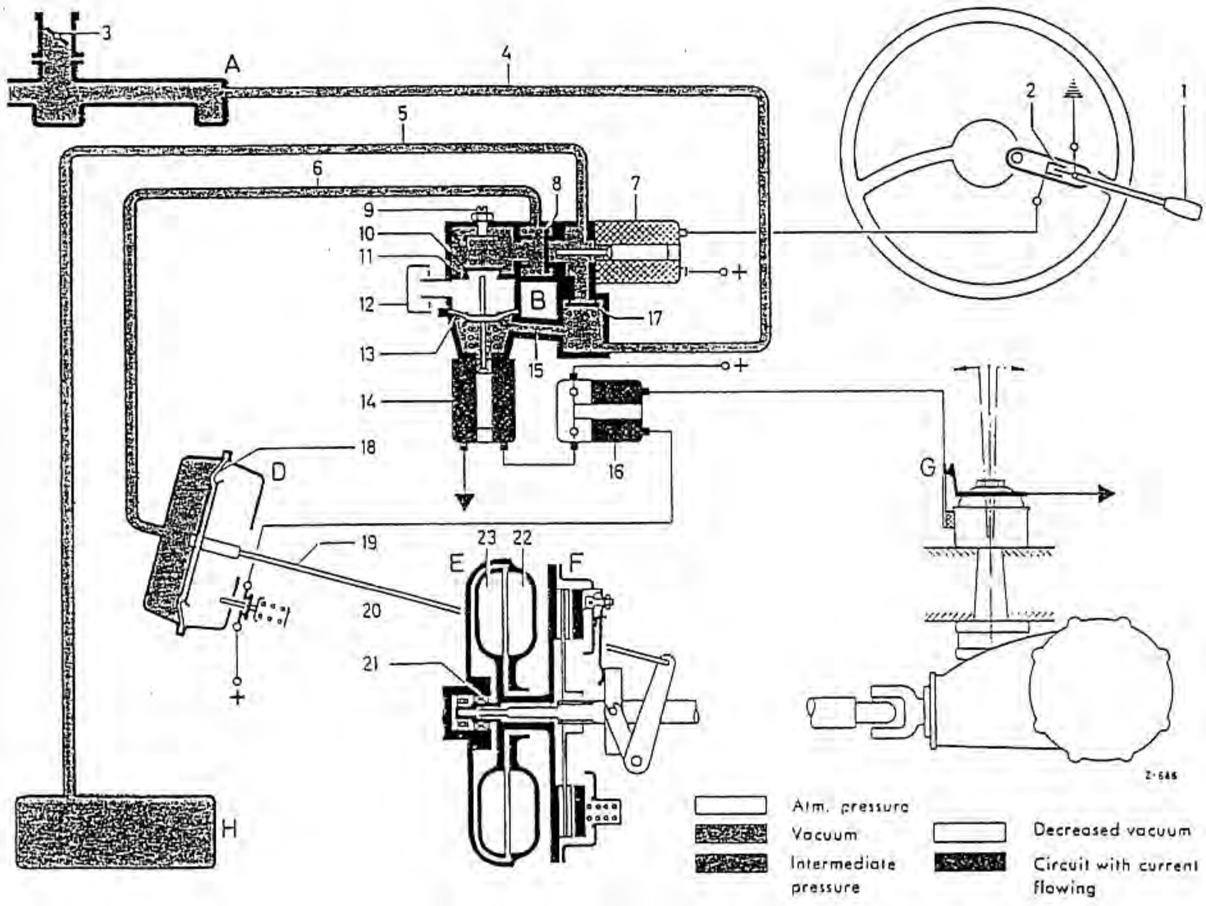


Fig. 25-10/20

A Intake manifold
B Control element
C Shift lever

D Servo assembly
E Hydraulic coupling
F Mechanical clutch

G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intake manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly

7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal

16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

When the accelerator is depressed, that is, when the throttle valve is opened, the vacuum in the intake manifold decreases. This decrease in vacuum enables the spring once more to press the diaphragm upward and oppose the action of the reducing valve (10) and force it open via the pin connected to the diaphragm. The vacuum in the servo assembly can therefore be very quickly dispersed via the opened reducing valve (10) and the rate of dispersal actually increases, the more the accelerator is depressed (see Fig. 25-10/19).

The interplay of reducing valve and spring-loaded diaphragm thus effects a rapid or gradual engagement of the mechanical clutch according to the driving requirements.

In order to effect a further improvement of the downshift, an additional electrical switch contact (G) is fitted at the rear axle. This electrical contact can detect, from the attitude of the rear axle, whether the car is pulling or is overrunning the engine. This is possible by virtue of the fact that when the car is pulling, the suspension bolt of the rear axle is inclined toward the rear, due to the reaction torque, while when the car is overrunning the engine, the suspension bolt moves forward and makes contact at the switch (Fig. 25-10/20).

As soon as the rear axle switch is making contact, the solenoid (14) is energized via the relay (16). The solenoid (14) then exerts a magnetic pull upon the spring-loaded diaphragm (13) and thus prevents any opening of the reducing valve (10) even when the accelerator is suddenly depressed, for as long as the car is overrunning the engine. This means that the engagement of the clutch proceeds gradually. As soon as the acceleration of the vehicle takes effect and the suspension bolt of the rear axle moves toward the rear, the contact of the rear axle switch opens and the current supply to the solenoid (14) is cut off. The spring loaded diaphragm (13) can now move upward and can force open the reducing valve (10) so that a faster clutch engagement can take place. In order to prevent the solenoid (14) from being energized each time, when during normal driving the car is oscillating between the two sets of conditions, a limit switch (20) is fitted to the servo assembly and this switch breaks the circuit when the clutch is engaged.

With its continuously progressive (stepless) change of speed, the hydraulic coupling (E) gives a very smooth start-off and a controlled drive, particularly when driving in a line of cars and in city traffic. It is impossible for the engine to stall when the gear is engaged.

IV. Hints on Operating the Gears and on Driving

A. General

Gear shifting is done with the shift lever alone and the lever is handled in the normal way. The gear positions of the shift lever are the same as hitherto.

B. Starting the Engine

The engine should only be started when the shift lever is in the neutral position. It is not advisable to start the engine when the gear is engaged since this causes the car to jerk forward immediately. But if this should have to be done on occasion, the foot brake should be applied firmly enough to arrest the motion of the car.

If it is difficult to disengage a gear which has been engaged in a parked vehicle as a precaution against rolling, work the starter shortly and at the same time disengage the gear and depress the brake pedal vigorously.

After the engine has started, depress the accelerator two or three times and then release it immediately, so that the high vacuum can form which is necessary to operate the hydraulic automatic clutch.

Note: At very low temperatures and at high altitudes (e. g. in mountainous regions) difficulties in engaging the gears may sometimes arise on account of an insufficient vacuum when the choke control is pulled out. Contrary to our usual instructions, the engine should in such a case be warmed up witch the car stationary until the idle is quite normal. Then, as is described above, depress the accelerator several times, always releasing it immediately so that a high vacuum can form.

C. Start-off

The car can be driven from a standstill in 2nd gear when on the level, but when it is standing on a hill, the 1st gear must be used. Although it is possible to start-off in 3rd or in 4th gear (which of course reduces the accerelation considerably), a practice must not be made of this since it would overheat the hydraulic coupling. **The accelerator must not be depressed when the gear is being engaged since this causes the car to jerk forward.** Moreover, the left foot should be used to apply the brake in order to avoid the inevitable slight shock when engagement takes place. Starting off on a hill is extremely easy. The left foot is used to operate the brake, the right foot to operate the accelerator pedal and the foot brake is then gradually released.

D. Driving Hints

When driving, gear-shifting should be done in the usual way. The hydraulic coupling shows to the best advantage in city traffic and when driving in a line of cars since the movement of the car can always be kept under smooth control. The common practice of driving with the right hand resting on the shift lever should be avoided since this immediately releases the mechanical clutch via the electrical contact in the shift lever.

When climbing hills, particularly with the accelerator pedal fully depressed, the downshift must be made in good time. **The minimum speed for downshift in the various gears marked on the speedometer in models 219 and 220 S must be strictly observed since otherwise the hydraulic clutch may be overheated. Be sure, therefore, to shift down on hills in good time.**

As soon as the optical signal on the steering column jacket or the instrument panel lights up, it is imperative to shift down.

When stopping on a hill, for example, when travelling in a line of cars, the car must not be held with the accelerator, since this may cause overheating of the hydraulic coupling. Instead, the hand brake or foot brake should be used. If the car is held up in traffic for any length of time, the shift lever must be put in neutral.

In order to ensure a smooth start-off, the accelerator should be depressed about $1^1/_2$ seconds after the gear has been engaged. For this reason it is advisable to engage first or second gear at intersections before traffic lights change or even to leave them engaged, so that for starting off the accelerator pedal can be depressed right away. In the stationary vehicle with the engine running the gear can safely remain engaged for a period of appr. 10 minutes; in that case do not jiggle the accelerator pedal and do not run the engine at an increased speed since the hydraulic-automatic clutch would be heated up excessively. When shifting down to the next lower gear it is advisable slightly to depress the accelerator pedal to facilitate shock-free gear shifting. Sudden acceleration shortly after or even during gear shifting should be avoided under all circumstances.

It is common knowledge that when the engine is cold, a richer fuel mixture is required, this enriched mixture being obtained by pulling the start choke. When driving with engine and automatic clutch cold, the start choke should therefore be put in the position "Warm-up" – choke control pulled half-way out – until the idle is quite normal. This is done in order to avoid stalling of the engine when the gear is engaged and when the car is standing still.

E. Parking

In order to be able to maneuver the car slowly when parking, it is advisable to keep the engine running at an increased engine speed, adjusted to the requirements of the moment, using the right foot on the accelerator pedal. By exerting the various pressures required with the left foot on the brake pedal, the car can be moved inch by inch. **Do not jiggle the accelerator pedal.**

When not actually engaging 1st or 2nd gear for start-off or parking, the **right** foot should always be used for braking. This avoids the danger of confusion between the pedals when driving a car not fitted with the hydraulically-operated automatic clutch.

F. Leaving the Car Unattended

When leaving the car unattended, the hand brake should be firmly applied. If the car is standing on a hill, it should be put in gear as an extra precaution against rolling.

When standing on a down-grade, engage first gear,
when standing on an up-grade, engage reverse gear.

G. Emergency Starting

If for any reason the engine cannot be started with the starter, the car can be towed in the usual way or can be allowed to run down a hill in 3rd gear. The 3rd gear must, however, be engaged before moving the car since in most cases the shift lever has already been touched and the reservoir vacuum supply dispersed so that the mechanical clutch no longer releases.

When towing, it is absolutely essential to use a tow-rope which is sufficiently long in order to avoid the danger of the towed vehicle overtaking and colliding with the rear of the towing vehicle after the engine has started.

V. Service Instructions

A. Safety Precautions

As in the case of cars fitted with automatic transmission, special safety precautions have to be observed in cars with a hydraulic automatic clutch in order to avoid accidents. Whenever servicing or repair work is being done, the rear wheels must be chocked in both directions and the hand brake applied in order to avoid any accidental movement of the vehicle.

B. Checking the Oil Level

The oil level in the hydraulic clutch must be checked by measuring the stall speed. The hydraulic clutch can only function properly if it has sufficient oil. The stall speed is that speed which the engine reaches under full load conditions with the secondary member stationary. For this test a commercially available electric revolution counter is connected. Then the fourth gear is engaged and the accelerator fully depressed, with the handbrake on and the footbrake applied. If the oil level is correct and the engine is in good condition, the stall speed must be

in models with carburetor engine $n = 1600—1800$ r.p.m.
in models with injection engine $n = 1750—1950$ r.p.m.

If the stall speed is higher, there is insufficient oil in the hydraulic coupling or the mechanical clutch is slipping. If the stall speed is appreciably lower, this indicates that the engine is not delivering its full power. Before carrying out this test, therefore, the engine must be warmed up to normal working temperature or the full engine power will not be available.

Note: Owing to the fact that the secondary member is held stationary, the whole of the energy transmitted to the hydraulic coupling from the engine is converted into heat. Thus, to avoid damage which may be caused by overheating, the engine must not be allowed to run for longer than 3 seconds at full load when making this test.

At high altitudes, the normal stall speed will not be reached because of the reduced engine efficiency. To obtain truly representative data at such altitudes, the correct stall speed should be ascertained by testing several vehicles known to be in good condition. The data obtained on these tests can then be used as a standard in all cases.

If an electric revolution counter is not available, the oil level check must be made by opening one of the two screw plugs on the hydraulic coupling. Turn back the strip of carpet at the transmission tunnel and take out the cover plug at the right on the clutch housing (Fig. 25-10/21).

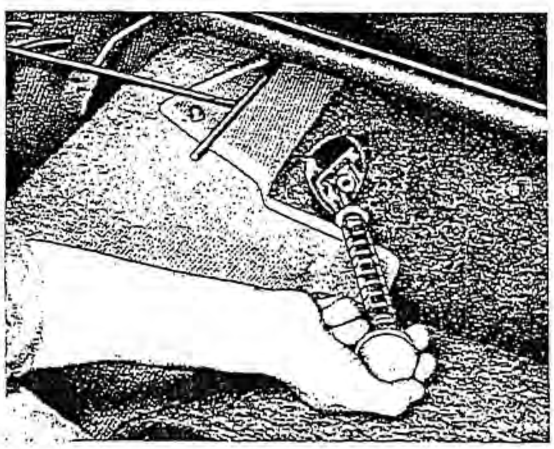


Fig. 25-10/21

Now use an SW 22 box wrench at the vibration damper collar screw at the front to turn the engine until one of the two screw plugs of the hydraulic coupling appears opposite the hole in the clutch housing. The mark stamped on the hydraulic coupling at the side of the screw plug must correspond with the mark stamped on the clutch housing. In the case of the first Hydrak-equipped cars where no marks have been stamped at these points, the hydraulic coupling must be so turned that the filler hole is just beyond the lower edge of the aperture in the clutch housing. Use a hexagon socket wrench SW 6 to loosen the screw plug, and remove it by means of **Installation Tool** 180 589 18 07. (A setting blow facilitates the loosening of the screw plugs).

Note: A dip-stick is not fitted.

Allow the coupling to cool down for approx. 10 minutes before opening the screw plug. Since the oil in the hydraulic clutch expands when the clutch is hot, the clutch when it contains hot oil must be turned slightly upward by way of compensation in such a way that the marker lines on the clutch housing point through the center of the screw plug bore. The screw plug should first be unscrewed a few turns to allow the overpressure in the coupling to escape gradually and only when the pressure is equalized, should the screw plug be completely removed. **When unscrewing the plug, take care that it does not fall into the clutch housing since otherwise the hydraulic coupling will have to be removed;** for this reason the screw plug should only be removed and installed with Installation Tool 180 589 18 07.

The two hydraulic clutch screw plugs M 12 × 1.5 DIN 908 (hexagon socket screws) have been replaced by new screw plugs Part No. 180 997 05 30. The new screw plugs have a 5 mm neck which is intended to facilitate the installation of the screw plugs. In order to avoid damage to the thread of the screw plug, the primary member has been provided with a heli-coil insert.

The aluminium sealing rings for the screw plug should always be replaced. The plug should be tightened with a torque of 3–3.5 mkg, and it should not be tightened any further since the sealing ring would be pushed aside and would no longer provide a satisfactory seal. Use an Oil Gun 000 589 00 72 or another suitable gun to fill up with oil to the brim in the position specified.

Note: When leaving our factory the hydraulic clutch is filled with blue-colored automatic transmission fluid so that in the case of oil loss the origin of the oil can be ascertained without any doubt. For topping up uncolored automatic transmission fluid type A can be used which has been tested and approved by our organisation.

Further details about make and type are given in the approved list in the operation instructions or in the latest edition of the booklet "Specifications and Instructions for the application of fuels, lubricants, coolants and brake fluids."

Oil changes are not specified for the hydraulic coupling. The oil level is merely checked and the coupling topped up if necessary. In general there should be no oil loss. If topping-up shows that considerable oil loss has taken place, the hydraulic coupling is leaking. In this case the axial seal should be checked. The filling capacity is 1.5 liters and the total internal volume of the hydraulic coupling approx. 1.9 liters. **Do not overfill.**

C. Cleaning of the Cooling Air Cover Plates

For cooling the hydraulic coupling, openings have been made in the clutch housing for air inlet and air outlet. Cover plates in the form of grilles are fitted to prevent the entry of foreign bodies.

After every 6,000 km these cover plates must be carefully cleaned.

The cooling air cover plate which is fitted to the top of the clutch housing, cannot be unscrewed with the transmission installed in the vehicle; it must therefore be cleaned from underneath or through the aperture in the transmission tunnel, using a clean rag for the purpose.

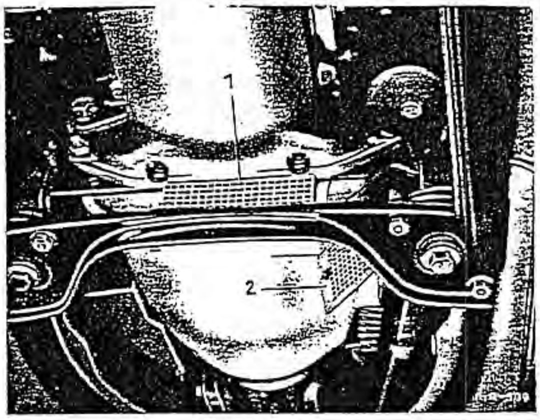


Fig. 25-10/22

As installed in Model 220 S

1 Cover plate for air inlet, 1st version
2 Cover plate for air outlet

In addition, it is essential for the oil film to be removed from the engine. The engine must therefore be thoroughly cleaned. This is necessary because of the danger of the cooling air carrying with it oil particles as it enters through the cover plate and depositing these on the clutch plate faces, which would cause the mechanical clutch to slip. Particular care must be taken to ensure that the corners between the crankcase and the jointing plate are clean.

VI. Adjustment and Checking

A. Adjusting the Free Play of the Mechanical Clutch

The free play of the mechanical clutch measured at the pull rod should be

in Models 219 and 220 S	= 10–12 mm
in Models 220 b, 220 Sb, 220 SE, and 220 SEb	= 6– 8 mm

The free play is adjusted by means of a turnbuckle on the pull rod (Fig. 25-10/23 and Fig. 25-10/24).

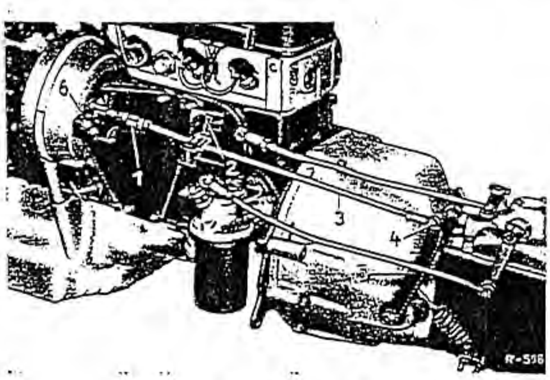


Fig. 25-10/23

As installed in Models 219 and 220 S

1 Turnbuckle
2 Adjusting Clamps 180 589 12 23 for adjusting the free play
3 Pull rod
4 Connector head
5 Throw-out lever
6 Limit switch

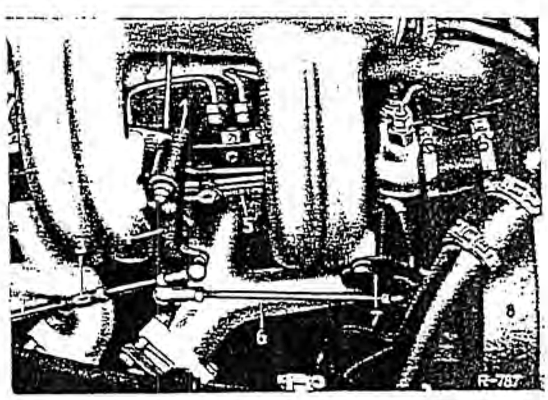


Fig. 25-10/24

As installed in Model 220 SE

1 Bearing for relay lever
2 Long pull rod
3 Turnbuckle
4 Relay lever
5 Spring for clutch brake switch
6 Short pull rod
7 Bracket for Servo assembly
8 Servo assembly

In Model 220 SE the adjustment should only be made on the long pull rod. In addition care must be taken to ensure that the relay lever does not foul the intake manifold whether the clutch is engaged or not. After the free play has been adjusted the electrical switch for the clutch brake at the cooling water drain outlet must be adjusted (see Job No. 25-10, Section VI, G). In Model 220 SEb this operation is not necessary since the brake magnet is controlled exclusively by the shift lever.

B. Control Element

a) Regulation of the Engagement Flexibility of the Clutch

The engagement flexibility of the mechanical clutch can be altered by means of the adjusting screw (2) (Fig. 25-10/25

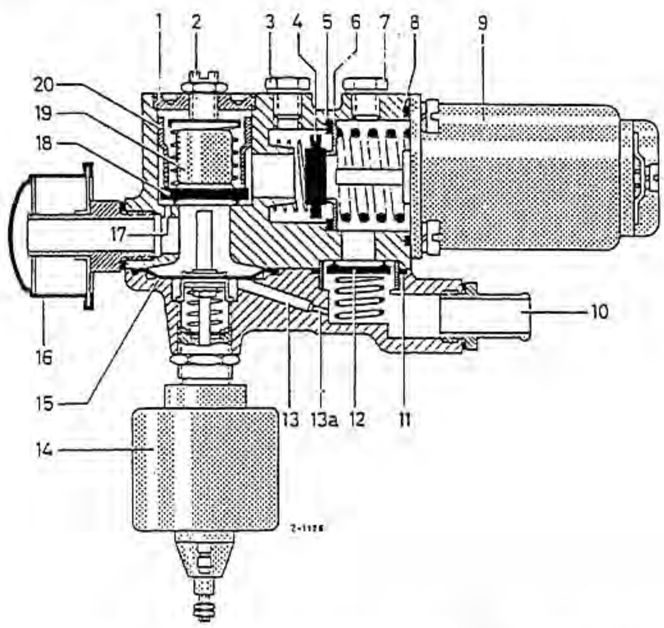


Fig. 25-10/25

1 Threaded ring
2 Adjusting screw with lock nut
3 Screw plug
4 Control valve
5 Rubber washer
6 Valve head
7 Screw plug
8 Rubber washer
9 Electro-magnet for control valve
10 Vacuum union for intake manifold
11 Rubber washer
12 Check valve
13 Vacuum canal
13a Throttle in vacuum canal
14 Solenoid for spring-loaded diaphragm
15 Spring-loaded diaphragm
16 Air cleaner
17 Jet in reducing valve
18 Reducing valve
19 Damper weight
20 Damper sleeve

By means of the adjusting screw (2), the fierceness of the braking shift (downshift with car over-running engine) and also the fierceness of the gearshift shock when the 1 st or 2nd gear is engaged, can be modified. Screwing the adjusting screw in makes the braking shift and the gearshift shock smoother and screwing it out makes them fiercer. As a rule, a half-turn is enough.

Note: The adjustment can be made during a test run. **The accelerator must not be depressed during the downshift because the rear axle switch contact must not be allowed to affect the shift. The simplest way is to disconnect the electric cable at the solenoid (14).**

No alterations must be made to the spring-loaded diaphragm (15). An accurate adjustment is only possible on a test stand.

The cross-section of the vacuum canal (13) has for some time now been decreased by a throttle passage (13a) in order to prevent excessive vibration of the spring-loaded diaphragm (15) and the resulting rattle of the damper weight (19).

Note: It has been found in practice that clutch engagement becomes smoother after the car has been run for a comparatively short time. This is due to the fact that the reducing valve (18) requires some time to produce a complete seal. For this reason, the brake downshift should be checked as described above after a mileage of appr. 500 km when the car is serviced for the first time; if necessary correct the clutch engagement by screwing out the adjusting screw (2) (Fig. 25-10/25).

b) Testing and Adjustment of Control Element

The control element can be tested and adjusted by means of a special device which uses the engine as a vacuum producer. The adjustment values are the same for the two control elements.

Vent	= 0.50 atm vacuum
Stop point	= 0.12 atm vacuum

The reducing valve should reduce to a vacuum of 0.10 atm in 5 to 10 seconds.

c) Removal and Cleaning of Reducing Valve

If the downshifts are irregular, that is to say if they are sometimes good and sometimes bad, the cause is usually dirt or a small foreign body at the reducing valve.

Remove the valve, using Socket Wrench 180 589 15 07 to unscrew the threaded ring at the top of the control element (Fig. 25-10/26

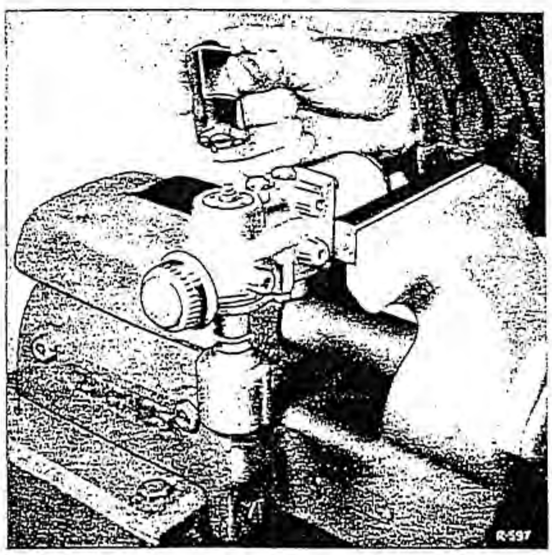


Fig. 25-10/26

Note: If this job is done with the control element installed, the control element must be steadied by a second mechanic because the threaded ring is put in with sealing compound and is therefore difficult to slacken.

After unscrewing the threaded ring, the pressure spring (6), the damper sleeve (4), the damper weight (5) and the valve head (7) can be taken out (Fig. 25-10/27).

Before re-installing, all traces of dirt must be removed with the greatest of care. This also applies to the housing. The thread of the threaded ring must be thinly coated with Teroson Fluid sealing compound.

Note: Use sealing compound sparingly in order to avoid it penetrating into the housing.
The remaining parts of the control element should not be unscrewed since otherwise it will be necessary to readjust the whole assembly on the stand.

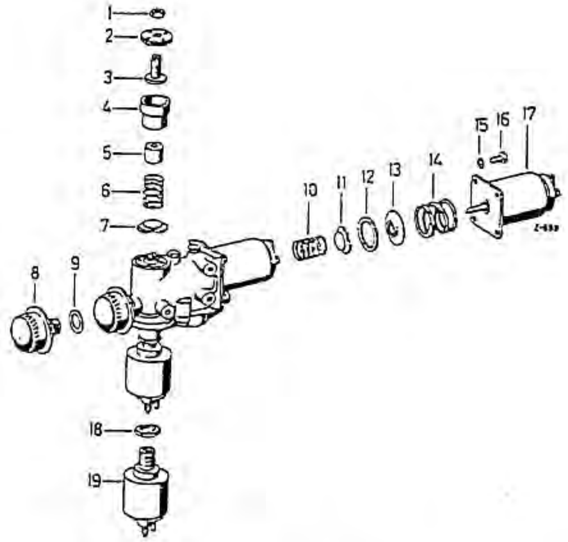


Fig. 25-10/27

1 Hexagon nut
2 Threaded ring
3 Adjusting screw
4 Damper sleeve
5 Damper weight
6 Pressure spring
7 Valve head
8 Air cleaner
9 Sealing ring
10 Pressure spring
11 Valve head
12 Sealing ring
13 Valve head
14 Pressure spring
15 Lock washer
16 Slotted screw
17 Electro-magnet of control valve
18 Hexagon nut
19 Solenoid of spring-loaded diaphragm

C. Adjustment of Electrical Switch Contact at the Rear Axle

The electrical switch contact at the rear axle is adjusted with the aid of a testing light. After removing the cover plate (1) in the trunk compartment, a testing light (5) with an adequate length of cable is connected to the positive terminal of the battery and to the switch connection marked with a + (Fig. 25-10/28).

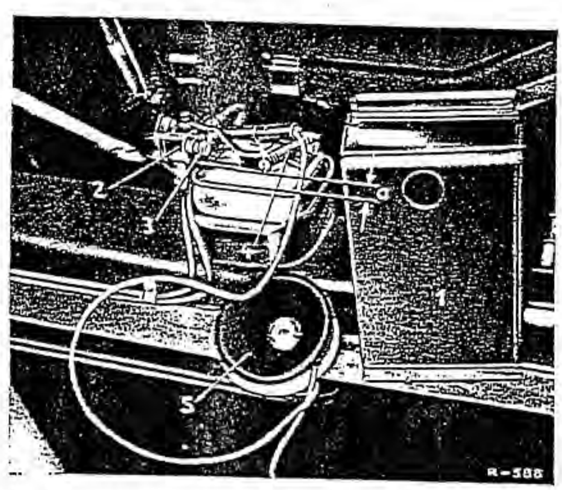


Fig. 25-10/28

As installed in Models 219 and 220 S

1 Cover plate
2 Electrical switch contact
3 Adjusting screw
4 Pressure pin with tension spring
5 Testing light
a = approx. 15 mm

The car must be placed on a level floor, the hand brake released, the shift lever put in neutral and the adjustment then made by turning the adjusting screw (3) so that the testing light just begins to light up. While this is being done, no one other than the mechanic himself must touch or put any weight on the car since this would result in false adjustment.

Backing out the adjusting screw causes fiercer shifts and screwing it in causes smoother shifts. When the adjustment is being made, care must be taken to ensure that the adjusting screw is not screwed in too far since this might cause the clutch to slip on full-accelerator upshifts owing to the engagement taking place too slowly.

In order to ensure that the rear axle movements are more directly transmitted to the switch, the lever length of the switch has been changed from 72 to 20 mm (see Fig. 25-10/29). This new switch can be installed subsequently in Models 219 and 220 S together with a new tension disk for the rear axle mounting.

The electrical switch contact must be fitted to the housing of the rear axle suspension in such a way that the distance 'a' between the clamping ring and the switch contact is approx. 15 mm (see Fig. 25-10/28). This distance must be strictly maintained because it decreases when the car is jacked up at the rear axle or when the car is fully loaded.

Note: The adjusting screw in the 2nd version switch must be screwed in 1/2 to 3/4 of a turn after the switch has been adjusted by means of the testing light.

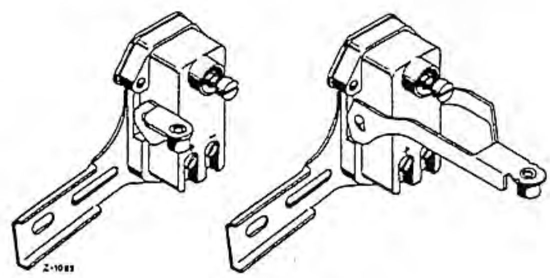


Fig. 25-10/29

D. Adjustment of Electrical Contact at Shift Lever

The electrical contact at the shift lever is also adjusted with the aid of a testing light. The testing light is connected with one cable to the positive terminal of the battery and the other to the black cable of the electro-magnet for the control valve. After slackening the lock nut (8), screw in the cover cap (2) to the point where the two contacts (3) and (6) touch, that is to say, the point where the testing light just lights up (Fig. 25-10/30).

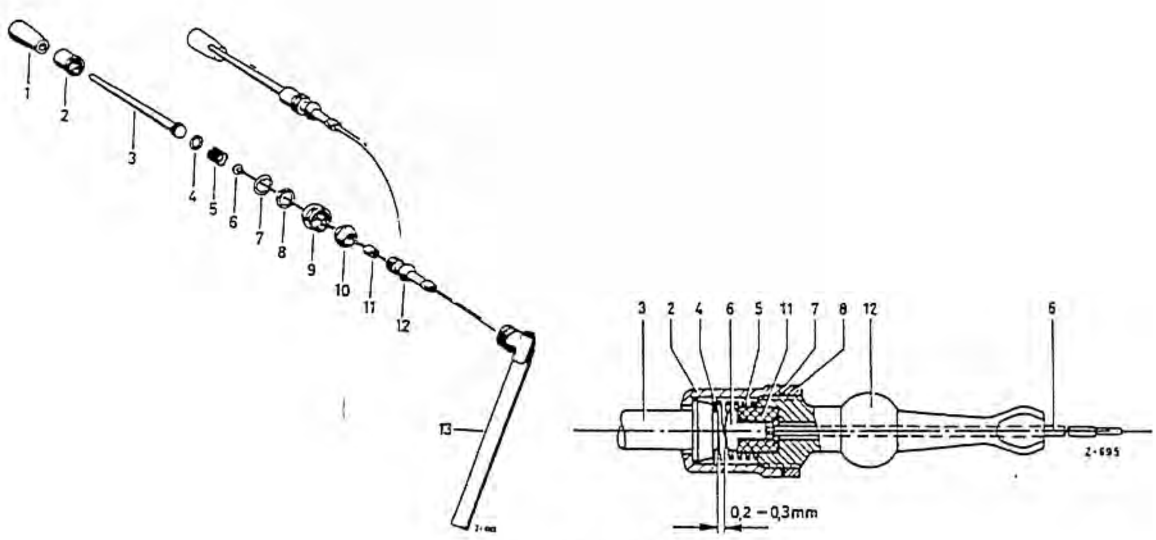


Fig. 25-10/30

1 Knob of shift lever
2 Cover cap
3 Shift lever with contact plate
4 Backing washer
5 Pressure spring
6 Contact plate with cable plate
7 Locking plate
8 Octagon nut
9 Cover cap
10 Rubber pad (cushion)
11 Bushing
12 Selector finger
13 Shift tube

From this position, unscrew the cover cap $^{1}/_{5}$ of a turn and this gives the specified contact distance of 0.2–0.3 mm.

After adjusting, tighten up and lock the lock nut (8); when this is done, care must be taken to ensure that the adjustment is not altered.

If there is unsatisfactory contact between the contact plate (6) in the selector finger (12) and the counter contact in the shift lever (3), unscrew the cover cap (2), remove the shift lever (paying attention to the pressure spring (5) and the washer (4)) and smooth down the end piece of the electric cable and the contact of the shift lever by means of abrasive cloth. If necessary remove the remains of soldering rosin from the center bore at the end piece. Then insert the pressure spring and washer, tighten the shift lever with the cover cap, and adjust the contact distance.

E. Checking the System for Leakage

The whole servo assembly must be completely airtight. Special attention should therefore be given to the airtightness of the unions and the lines. The airtightness of the check valve (12) can also be checked with the assembly installed in the vehicle, provided that the vacuum line and the supply reservoir are airtight. A test take-off point (7) has been fitted to the control element for this purpose (see Fig. 25-10/25).

Note: The front test take-off point (3) is fitted for the purpose of adjusting the spring-loaded diaphragm (15). This adjustment can only be carried out on a test stand.

In Model 220 SE the first control valves have no test take-off points.

After unscrewing the rear screw plug, a suitable pressure gage should be connected and after the engine has been allowed to run for a short time, the vacuum existing at the take-off point is read off (Fig. 25-10/31).

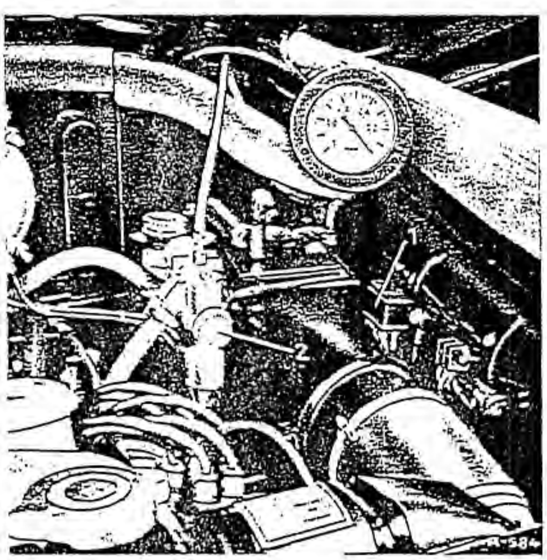


Fig. 25-10/31

1 Relay for the solenoid of the spring-loaded diaphragm
2 Control element

The supply reservoir should hold its vacuum for at least 5 hours so that without starting the engine the mechanical clutch is thrown out by touching the shift lever even after the vehicle has been standing for a long time.

F. Adjustment of Idle

a) Adjustment of Idle

The idle should be adjusted with the engine at normal working temperature and the shift lever in neutral

in Models with carburetor engine to n = 750–800 r.p.m.
in Models with injection engine to n = 700–800 r.p.m.

The adjustment of the idle must be done very carefully because if the idle speed is too high the shift surge and the tendency of the car to creep become too marked. If the idle speed is too low the engine in models with carburetor engine may stall when a gear is engaged.

In models with carburetor engine the idle decreases somewhat when a gear is engaged, due to the slight torque which the hydraulic clutch is already transmitting. In models with injection engine the idle is automatically increased when the gear is engaged.

b) Adjustment of the Pressure Magnet and Switch for Increasing the Idle Speed on Models with Injection Engine.

In Fig. 25-10/16 the operation of the automatic idle increase device is shown in a circuit diagram.

1) Pressure Magnet

The pressure magnet is attached to the crankcase by means of the control lever bearing.

The disk screwed onto the pressure pin presses against the control lever as soon as the circuit is closed.

Before adjusting the idle, measure the idle by means of a revolution counter with and without a gear engaged. If the setting has to be corrected screw the disk on the pressure pin either in or out and afterward lock it by means of the lock nut.

2) Switch

The switch (4) is mounted on the bearing assembly (1) of the steering column gear shift. When the shift lever is in neutral the contact pin of the switch must be in the middle between the two cams (5) on the relay lever (3).

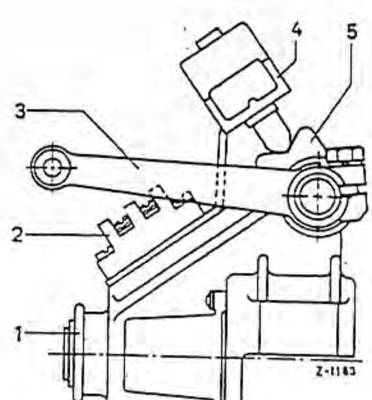


Fig. 25-10/32

1 Bearing assembly of steering column gear shift
2 Cable connector
3 Relay lever
4 Switch
5 Cam

G. Brake Clutch

a) Adjustment of Brake Period of Clutch Brake in Model 220 SE

The brake action of the clutch brake must begin as soon as the shift lever is touched, i. e. at the moment the disengagement process starts; it must continue while the gear is being engaged, and must stop shortly before the engagement process is finished. In fact, the brake action should stop when the mechanical clutch is in a position to hold the secondary member of the hydraulic clutch. As soon as the gear shift is finished the brake must definitely have released the drive plate. To ensure this the braking period of the clutch brake must be adjusted as described below by means of Adjusting Device 127 589 02 23 (Graduated disk and counter). In Model 220 SEb this adjustment is not necessary since the brake magnet is controlled exclusively by the shift lever.

1. Press the graduated disk (4) onto the relay lever (2) in such a way that it rests against the shoulder on the connector head (Fig. 25-10/33).

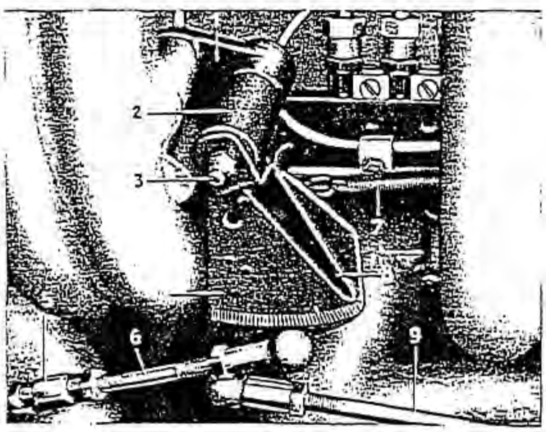


Fig. 25-10/33

1 Bearing for relay lever
2 Relay lever
3 Pinion rim grease fitting
4 Graduated disk
5 Turnbuckle
6 Long pull rod
7 Spring for the switch of the clutch brake
8 Pointer
9 Short pull rod

2. Unscrew the pinion rim grease fitting (3) from the bearing (1) of the relay lever and lightly fasten the pointer (8) to the bearing by means of the pinion rim grease fitting (Fig. 25-10/33).

3. Push either the long or the short pull rod forward in the direction of travel until the graphite ring of the throw-out bearing rests against the thrust ring of the mechanical clutch, i. e. until the clearance 'x' has been taken up. At this point a resistance is clearly noticeable (see Fig. 25-10/4).

4. In this position put the counter to the zero mark on the graduated disk, tighten the pinion rim grease fitting, and detach the long pull rod.

5. Connect the testing light to the switch and to ground.

6. Now move the relay lever forward until the counter points to 11° on the graduated disk. In this position of the relay lever the switch for the clutch brake must make contact, i. e. the testing light must light up.

Note: For the adjustment of the switch the bracket on the cooling water drain outlet has been provided with a slot.

7. If the clutch brake engages too early, move the bracket carrying the switch (1) forward in the direction of travel. If the clutch brake engages too late, move the switch bracket toward the rear (Fig. 25-10/35).

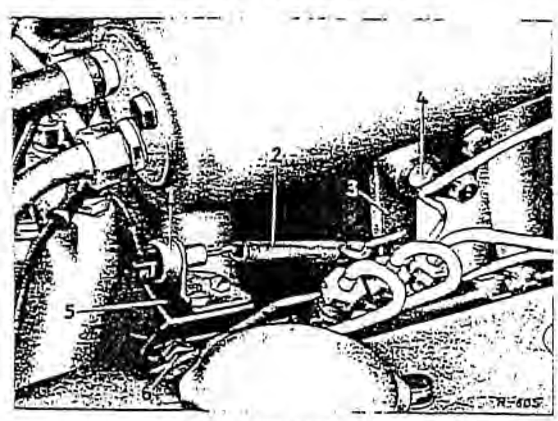


Fig. 25-10/35

1 Switch
2 Spring
3 Relay lever
4 Bearing for relay lever
5 Bracket
6 Hexagon screw

8. Remove the graduated disk and the pointer, screw on the pinion rim grease fitting, and attach the long pull rod.

b) Checking Clutch Brake Operation

Remove the lower center cover from the clutch housing. Run the engine and actuate the mechanical clutch by touching the shift lever. While this is being done an assistant should watch the drive plate which must be stationary when the clutch is engaged since the drive plate is held by the clutch brake. As soon as the shift lever is released, the drive plate together with the hydraulic clutch must rotate again. If during this process the drive plate fails to stop turning, this may be due to the following causes:

Cause	Remedies
Electro-magnet of clutch brake defective	Check fuse in additional fuse box, and if the electrical system is in order, replace clutch brake
Automatic adjustment of clutch brake out of order	Replace clutch brake
Brake lining oiled up or worn out	Replace piston with brake lining
Idle speed too high	Adjust idle speed as specified

c) Adjusting Switch Contact in Speedometer in Model 220 SE

Connect the testing light to the relay terminal 30/51 and terminal 86. Drive the car and at a speed of appr. 8 km/h touch the shift lever. Above this speed the testing light should no longer light up, i. e. the switch contact in the speedometer interrupts the ground circuit to the relay and makes the clutch brake inoperative .

d) Checking Eddy Current Switch in Model 220 SEb

Connect the testing light to terminal 87 of the relay and to the positive terminal of the battery. At a speed of appr. 8 km/h the testing light must go out since the ground circuit to terminal 87 of the relay is interrupted .

VII. Trouble-Shooting Hints

Cause	Remedies
Acceleration unsatisfactory in all Gears, Engine races	
Insufficient oil in hydraulic coupling Driven plate of mechanical clutch oiled up	Check stall speed, fill up with oil as specified Replace driven plate
Mechanical Clutch slips too long after Shift	
a) With car overrunning engine Adjusting screw of reducing valve screwed in too far	Adjust control element (see Job No. 25-10, Section VI, B)
b) With accelerator fully depressed Adjusting-screw of electrical switch contact at rear axle screwed in too far	Adjust rear axle switch (see Job No. 25-10, Section VI, C)
c) With accelerator partly depressed Spring-loaded diaphragm incorrectly adjusted	Replace control element
Braking Downshift too fierce	
Adjusting screw of reducing valve unscrewed too far	Adjust control element (see Job No. 25-10, Section VI, B)
Downshift too fierce when accelerating	
Adjusting screw of electrical switch contact at rear axle unscrewed too far	Adjust rear axle switch (see Job No. 25-10, Section VI, C)
Electrical switch contact at rear axle defective	Replace the switch contact
Limit switch at servo assembly jammed in "off" position or defective	Free up or replace switch
Braking Downshift sometimes smooth, sometimes fierce	
Reducing valve fouled or foreign body at valve head	Remove reducing valve (see Job No. 25-10, Section VI, B)
Mechanical Clutch slips on sudden Acceleration or on Hills	
Driven plate of mechanical clutch oiled-up	Replace driven plate **Note:** Do not wash out in gasoline. If a trichloro-ethylene bath is available an attempt may be made to clean the linings. **Remove the cause of oiling-up, checking engine, hydraulic coupling and transmission**

Cause	Remedies
Pull-rod at servo assembly incorrectly adjusted	Adjust as specified (see Job No. 25-10, Section VI, A)
Driven Plate fails to stop turning at Idle Speed	
Hub of driven plate jammed in splineway of transmission drive shaft	Free up; if necessary, install new driven plate
Considerable run-out at driven plate, linings distorted or broken	Replace driven plate
Needle bearing in hydraulic automatic clutch defective	Replace hydraulic automatic clutch
Mechanical Clutch fails to disengage during Shift	
Pull-rod at servo assembly incorrectly adjusted	Adjust as specified
Leakage in the hose lines or in the supply reservoir	Repair leak
Roller bellows in servo assembly defective	Replace servo assembly
Needle bearing in hydraulic automatic clutch defective	Replace hydraulic automatic clutch
Mechanical Clutch fails to disengage during Shifts	
Break in circuit	Trace and repair. Check fuse!
Break in hose lines or considerable leakage in hose lines or supply reservoir	Repair leaks
Roller bellows in servo assembly defective	Replace servo assembly
Contact surfaces in electrical switch contact of shift lever burnt or fouled	Clean contact surfaces
Electro-magnet of control valve defective	Replace electro-magnet
Mechanical Clutch fails to engage after Shift	
Contact at shift lever sticking	Free up contact at shift lever

Removal and Installation of Hydraulic-Automatic Clutch with Transmission

Job No.
25-15

A. Models 219, 220 S, 220 SE

Removal:

1. Disconnect the ground cable at the negative terminal of the battery.

2. Disconnect the two reversing light switch cables at the cable connector (5) (Fig. 25-. 15/1).

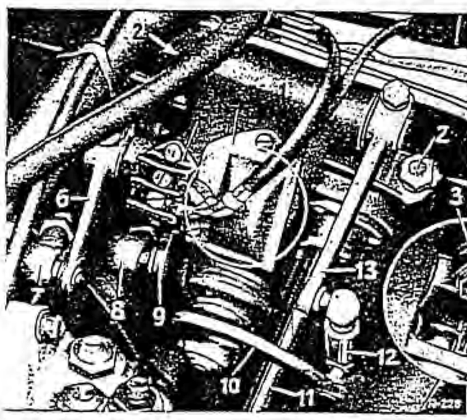


Fig. 25-15/1

1 Bearing
2 Hexagon screw
3 Selector lever at shift tube
4 Dust cover
5 Cable connector
6 Selector lever
7 Selector rod ball-cup connector
8 Shift rod ball-cup connector
9 Relay shaft lever
10 Lever at shift tube
11 Steering tube
12 Spring-loaded ball-cup connector
13 Relay lever

3. Detach the selector rod and the shift rod (7) and (8) (see Fig. 25-1/1). To do this, remove the spring clips (4) from the ball-cup connectors and press the rods off the ball-studs (Fig. 25-15/2).

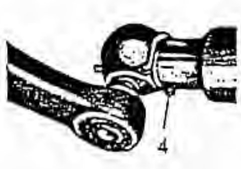


Fig. 25-15/2
4 Spring clip

4. Unscrew and remove the upper screw for fixing the starter and the two upper screws at the clutch housing, working from the engine compartment side.

Note: The upper left screw which also fastens the bracket for the cable to the reversing light switch, and the upper right screw on the clutch housing are hexagon screws. The other attaching screws for the clutch housing are hexagon socket screws. In a large number of cars only hexagon socket screws were used since there was not enough space for hexagon screws because of the shape of the clutch housing. If repairs are carried out the left upper hexagon socket screw should be replaced by a hexagon screw M 10 × 70. In this case a washer must be added between the

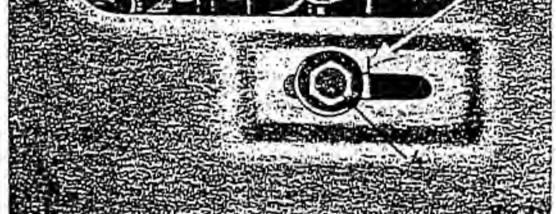


Fig. 25-15/3

1 Front universal joint pinion rim grease fitting
2 Pinion rim grease fitting for annular grooved ball bearing
3 Threaded bore for cover plate fixing screw
4 Fixing screw for bearing bracket
5 Position marking of bearing bracket on chassis base panel

clutch housing and the bracket for the cable to the reversing light switch. In certain difficult cases it may be advisable to reduce the hexagon head of the M 10 × 70 screw from SW 17 mm to SW 14 mm.

5. Take off the cover plate for the propeller shaft intermediate bearing. Then unscrew the two hexagon screws for fixing the intermediate bearing (Fig. 25-15/3).

6. Disconnect the propeller shaft at the transmission. To do this, unscrew and remove the three fitted bolts holding the shaft plate to the transmission flange, paying attention to the washers between the shaft plate and the flange (see Fig. 25-15/11).

7. Disconnect the flexible speedometer drive shaft at the transmission, unscrewing the hexagon screw at the rear transmission housing cover and pulling out the drive shaft.

8. Detach the pull-rod for actuating the mechanical clutch at the clutch throw-out lever (see Fig. 25-10/10 and 25-10/11).

Note: Before detaching the pull rod remove the spring clip on the connector head. On later models the spring clip has no longer been installed.

9. Unscrew the two cover plates on the clutch housing – one at the bottom at the front of the housing (1) and the other on the left side of the housing (2) (Fig. 25-15/4).

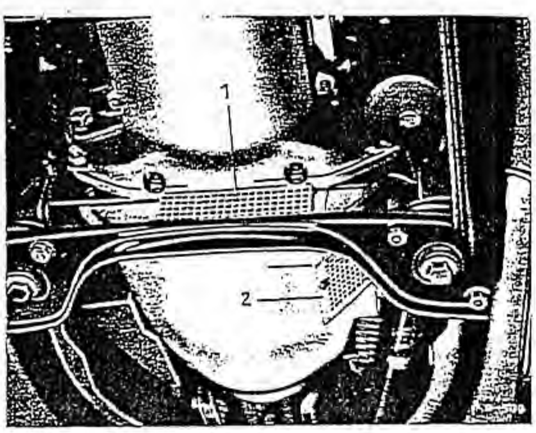


Fig. 25-15/4

1 Cover plate, air inlet
2 Cover plate, air outlet

Note: In Model 220 SE disconnect the cable from the temperature switch.

10. In Model 220 SE disconnect the two electrical cables from the clutch brake (3) and remove the brake from the clutch housing (5) (Fig. 25-15/5).

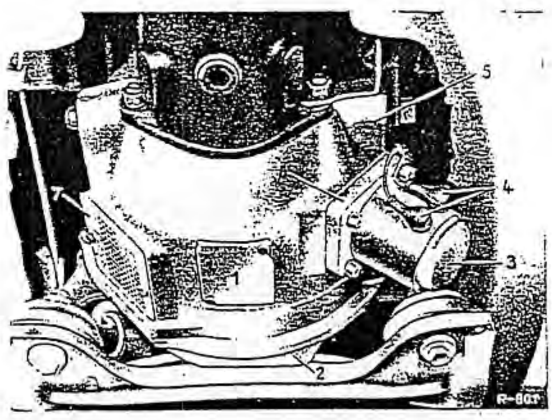


Fig. 25-15/5

1 Cover plate
2 Cover plate, cooling air inlet
3 Clutch brake
4 Cable connection at clutch brake
5 Clutch housing
6 Jointing flange
7 Cover plate, cooling air outlet

11. Unscrew the six hexagon screws for fixing the hydraulic automatic clutch assembly to the flywheel and remove them. To do this, the crankshaft should be turned each time to the position giving easy access to the screw-heads (Fig. 25-15/6).

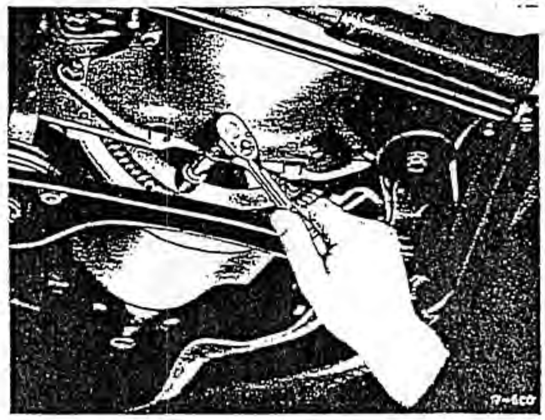


Fig. 25-15/6

12. Fit Retaining Bracket (1) 180 589 04 61 to the clutch housing (Fig. 15/7).

Note: It is absolutely necessary to fit the retaining bracket to the clutch housing when removing or installing the hydraulic-automatic clutch in order to prevent the clutch unit from slipping out of its position on the drive shaft.

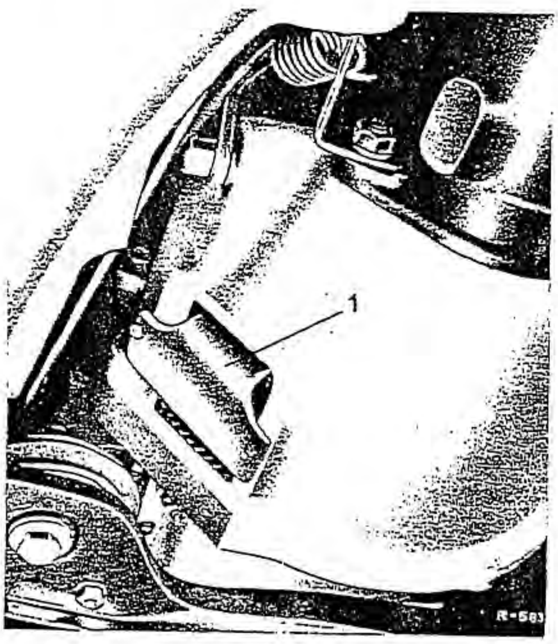


Fig. 25-15/7

1 Retaining Bracket 180 589 04 61

13. Unscrew the two hexagon screws for fixing the bracket to the support for the exhaust pipe suspension.

14. Take out the lower hexagon socket screw for fixing the starter and also the three remaining hexagon socket screws at the clutch housing and remove, together with the support for the exhaust pipe suspension.

15. Pull the transmission backward a little and carefully lower it.

16. Detach Retaining Bracket 180 589 04 61 from the clutch housing and pull out the clutch assembly.

Note: If during removal of the clutch assembly the centering ring (6) of the hydraulic clutch is left in the crankshaft, it must be carefully pressed out. If the hydraulic clutch is replaced, care must be taken to ensure that the centering ring is left in the hydraulic clutch. On late models the centering ring is no longer installed (see Fig. 25-10/5).

Journal ⌀ without centering ring 35 mm

Journal ⌀ with centering ring 31 mm

External ⌀ of centering ring 35 mm

17. Clean the outside of the transmission and the clutch housing. The cover plates for the clutch housing must be free of dirt.

Note: If a new clutch housing or a replacement engine is to be installed, pay attention to the dowel pin at the upper left side of the crankcase. The dowel pin has been increased from 8 to 12 mm. For repairs a shouldered dowel pin is available under Part No. 180 991 03 62.

18. Check the graphite ring (3) of the clutch throw-out bearing to see whether it is still serviceable (Figs. 25-15/8).

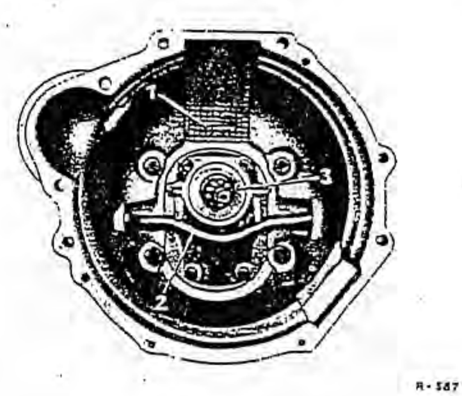


Fig. 25-15/8

1 Cover plate, air inlet, top
2 Throw-out fork
3 Graphite ring (throw-out bearing)

Fig. 25-15/9

Installation:

19. Lightly grease the transmission drive shaft and then put in the assembled clutch unit, turning the unit slightly and finally so positioning it that one of the recesses (short cooling ribs), which lies centrally between two of the threaded bores, points vertically downward (arrows in Fig. 25-15/9) Then screw Retaining Bracket 1805890461 onto the clutch housing. When dealing with the first design of the hydraulic automatic clutch push the centering ring onto the bearing journal.

Note: It is advisable to make provisional markings with chalk or another suitable material on the hydraulic clutch and at the side opening of the clutch housing so that when the transmission has been installed the correct position of the hydraulic clutch to the flywheel can easily be checked.

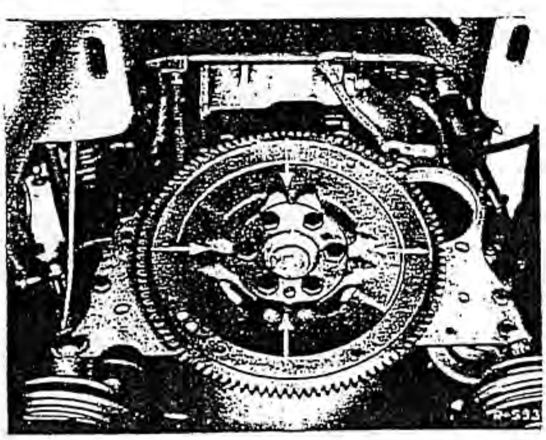


Fig. 25-15/10

20. Turn the flywheel on the crankshaft to the point where two of the humps which lie between two of the threaded bores, point vertically downward (arrows in Fig. 25-15/10).

Note: It is important to pay attention to the correct positioning of flywheel and clutch unit since otherwise there is a danger that when the transmission is put into the housing, the humps on the flywheel will press against the cooling ribs of the hydraulic coupling and the clutch end plate will be distorted.

21. Slide in the transmission with the clutch unit, taking care that the selector rod and the shift rod are not bent and that the cable for the reversing light switch and the ground lead at the starter are not jammed.

22. Screw in the screws for fixing the clutch housing to the engine and also the starter fixing screws and tighten them up.
Do not forget the washer for the upper left hexagon screw.

Note: When placing the screws in position, do not forget the ground cable and the ground lead at the starter and the exhaust pipe suspension support. Also make sure that the jointing flange for the starter is properly positioned.

23. Check that the flywheel and the hydraulic coupling are in the correct position, turning the clutch unit to the position where the screw holes in the flywheel are exactly opposite the threaded holes in the hydraulic coupling.
Screw in the six hexagon screws with lock washers and tighten them up evenly, turning the crankshaft a little further round each time (see Fig. 25-15/6).

After tightening the screws, check once again whether the hydraulic coupling is correctly positioned with respect to the flywheel.

24. Remove the retaining bracket from the clutch housing. Attach the front cover plate and in Models 219 and 220 S screw on the left cover plate.

Note: Instead of the perforated cover plate (24) (see Fig. 25-10/4) use the new cover plate (24) (see Fig. 25-10/6) Part No. 180 250 07 56 in which the air enters from below.

25. Press the propeller shaft forward and connect it, not forgetting the rubber seal (3) (Fig. 25-15/11).

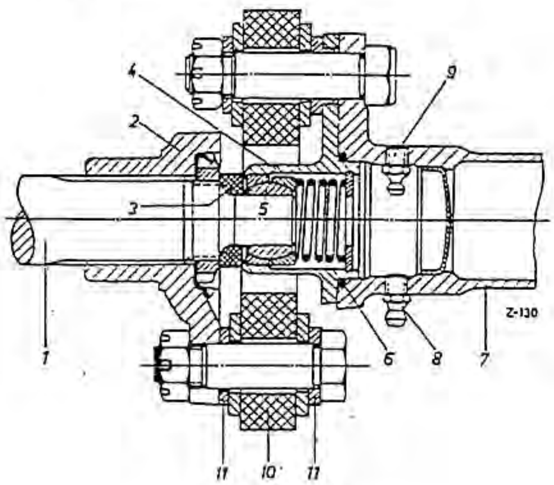


Fig. 25-15/11

1 Transmission main shaft
2 Three-way flange on the main shaft
3 Seal
4 Centering cross
5 Centering ball
6 Sealing ring
7 Propeller shaft
8 Pinion rim grease fitting
9 Relief grease fitting
10 Shaft plate
11 Washer

26. If a new shaft plate is to be installed, care must be taken to ensure that the double-links of the shaft plate are under tensile strength in the direction of rotation of the engine.
In order to assist differentiation, a small shoulder (a) has been made on the outside of the first hole of each double-link. The shoulder must always point in the direction of the transmission (Fig. 25-15/12).

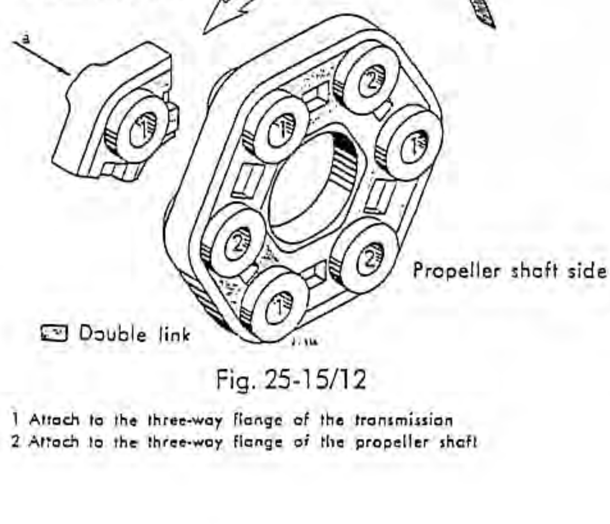


Fig. 25-15/12

1 Attach to the three-way flange of the transmission
2 Attach to the three-way flange of the propeller shaft

27. Slide the speedometer drive shaft into the rear transmission housing cover and tighten up the clamping screw.

28. Attach the pull-rod for actuating the clutch to the throw-out lever.

29. Install the intermediate bearing of the propeller shaft so that it is not under stress (see Fig. 25-15/3).

30. Attach the selector rod and the shift rod and fix the spring clips to the ball-cup connectors (see Fig. 25-15/1).

31. Connect the two cables for the reversing light switch at the cable connector (see Fig. 25-15/1).

32. Connect the ground cable to the battery.

33. Check the adjustment of the free play of the pull-rod for the clutch-actuating mechanism (see Job No. 25-10, Section VI, A).

34. In Model 220 SE attach the clutch brake to the clutch housing in such a way that the electric connections point toward the rear.

Note: If a new hydraulic clutch or a new clutch brake has been installed the adjustment of the clutch brake must be checked (see Job No. 25-10, Section VI, G).

35. Connect the two electric cables to the electro-magnet.

36. Check whether the brake lining fouls the drive plate. To do this turn the mechanical clutch by means of a screw driver through the left opening on the clutch housing. Then attach the left cover plate and connect the cable to the temperature switch.

37. Check the operation of the clutch brake (see Job No. 25-10, Section VI, G).

38. Check the adjustment of the steering-wheel gear shift and if necessary, re-adjust.

Note: Checking must be done with the engine running since the vacuum available for actuating the mechanical clutch with the engine stopped will only serve for at the most two shifts.

B. Models 220 b, 220 Sb, and 220 SEb

The removal and installation operations for the transmission are essentially the same as on cars with a mechanical clutch (see Job No. 26-1).

The operations necessary to remove the hydraulic automatic clutch from the flywheel and to reinstall it are the same as described in Section A.

Mechanical Transmission – Group 26

Removal and Installation of Transmission

Job No.
26-1

Removal:

1. Disconnect the ground cable from the battery.

2. Press the selector rod (1) and the shift rod (2) off the ball stud of the selector lever (6) and the relay lever (4) of the steering column shift mechanism.

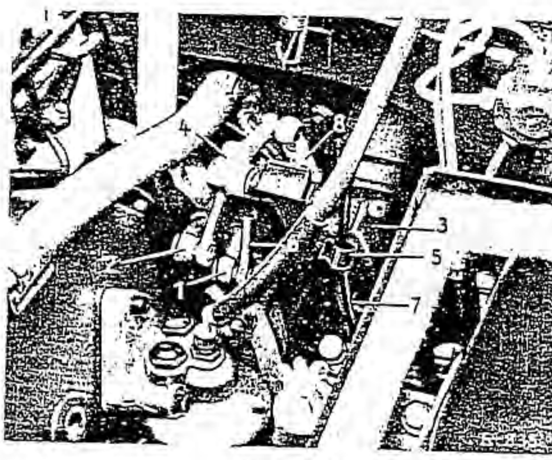


Fig. 26-1/1

1 Selector rod
2 Shift rod
3 Cover
4 Relay lever
5 Fixing clip
6 Selector lever
7 Flexible speedometer drive
8 Spring-loaded ball connector

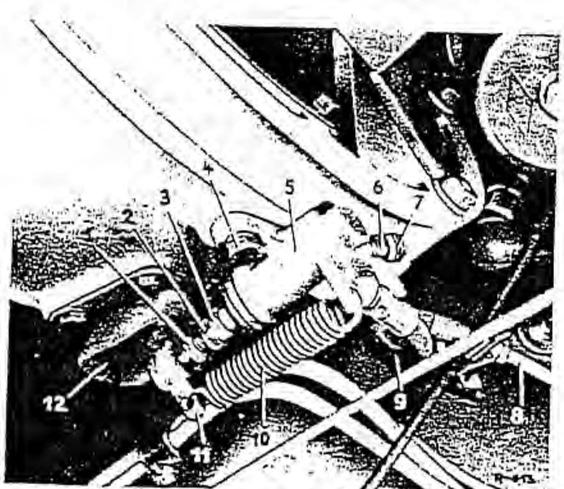


Fig. 26-1/2

1 Push rod
2 Hexagon nut
3 Pressure pin
4 Hexagon screw
5 Extraction cylinder
6 Bleed screw
7 Rubber cover cap
8 Line
9 Hose
10 Return spring
11 Throw-out fork
12 Cuff

3. Unscrew the extraction cylinder (5) for the clutch actuating mechanism at the clutch housing and remove the push rod (1) (Fig. 26-1/2).

4. Unscrew the exhaust pipe bracket on the mounting plate (9), loosen the clamping screw and turn the bracket (4) downward.

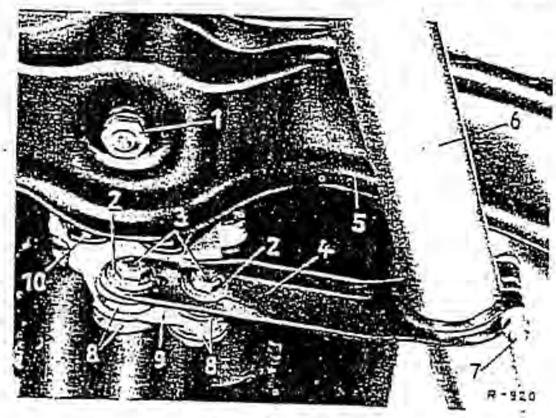


Fig. 26-1/3

1 Hexagon nut
2 Washer
3 Hexagon screw
4 Bracket
5 Support
6 Exhaust pipe
7 Hexagon screw (clamping screw)
8 Rubber washer
9 Mounting plate
10 Engine support

5. Mark the position of the rear support (12) in relation to the chassis base panel and remove the support from the chassis base panel. Loosen the center hand brake cable at the brake lever and remove from the cable guides of the front axle support and of the support. Then raise the engine a little at the back part of the oil pan until pressure is removed from the rubber mounting (14). Unscrew the hexagon nut (16) and the four hexagon screws (18) and remove the support (Figs. 26-1/4 and 26-1/8).

Note: To avoid damaging the oil pan a suitable piece of wood must be placed between the jack and the oil pan.

6. Unscrew the engine support (3) with the rubber mounting (14) at the transmission case rear cover (8) and remove it together with the mounting plate (9) (see Fig. 26-1/8).

Note: To avoid damaging the oil pan a suitable piece of wood must be placed between the jack and the oil pan.

7. Unscrew the engine support (3) with the rubber mounting (14) at the transmission case rear cover (8) and remove it together with the mounting plate (9) (see Fig. 26-1/8).

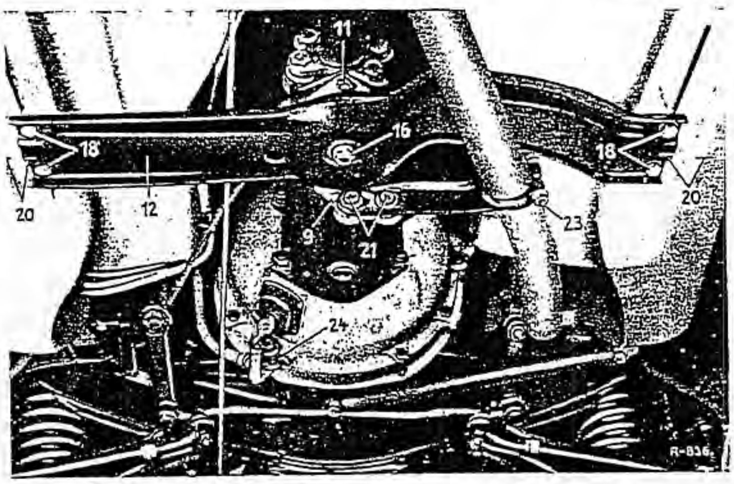


Fig. 26-1/4

9 Mounting plate
11 Rubber mounting
12 Rear bracket
16 Hexagon nut
18 Hexagon screw
20 Position markings
21 Hexagon screw
23 Hexagon screw
24 Extraction cylinder

8. Disconnect the propeller shaft (9) at the transmission; the shaft plate (11) remains attached to the transmission (Fig. 26-1/5).

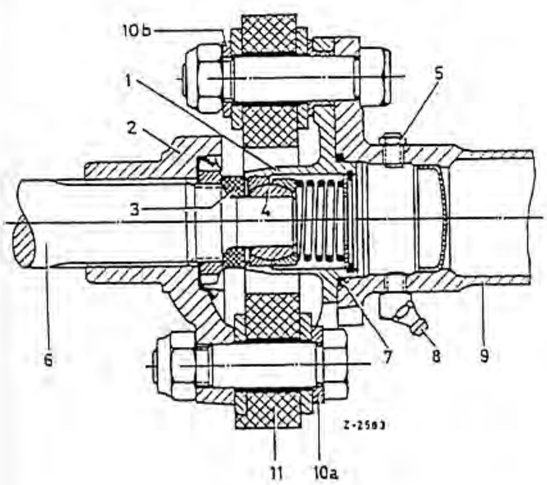


Fig. 26-1/5

1 Center cross
2 Three-way flange on the transmission main shaft
3 Rubber sealing ring
4 Locating ball
5 Relief valve
6 Transmission main shaft
7 Rubber sealing ring
8 Piston rim grease fitting
9 Front propeller shaft
10a Washer
10b Washer
11 Shaft plate

9. Mark the position of the propeller shaft intermediate bearing on the chassis base panel, and then remove the two mounting screws for the propeller shaft intermediate bearing and push the propeller shaft back as far as possible, paying attention to the center cross (1) (Fig. 26-1/5).

Note: The propeller shafts of the new models as from August 1965 are no longer provided with a slip coupling. Instead the front part (1) of the two-unit propeller shaft of Models 200 D, 230, 230 S, 250 S, 250 SE, 300 SEb and 300 SEL has been provided with clamp nut (3) (see Fig. 26-1/7) and the intermediate shaft (4) of the three-unit propeller shaft on Model 200 and on the ambulance cars Models 200 D and 230 has been provided with two clamp nuts (3a and 3b) (see Fig. 26-1/8).

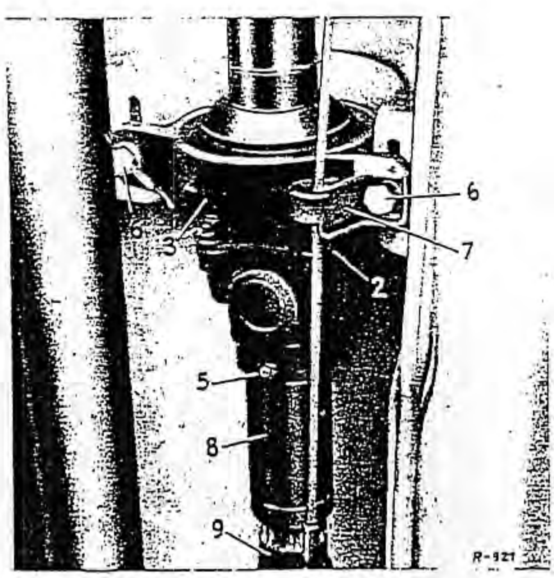


Fig. 26-1/6

2 Joint flange of front propeller shaft
3 Bearing bracket
5 Grease nipple for slip coupling
6 Hexagon screws for fastening the bearing bracket to the chassis base panel
7 Ca. e bracket
8 Sl.p coupling with universal joint of rear propeller shaft
9 Rear propeller shaft

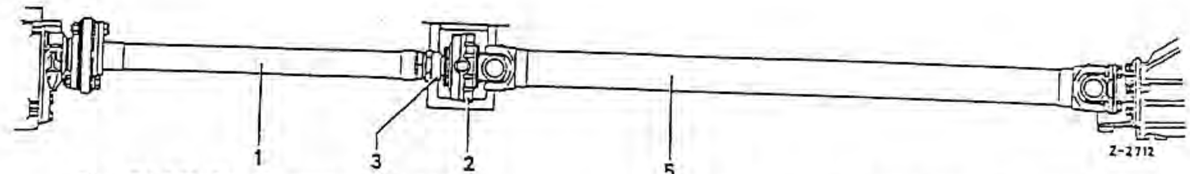
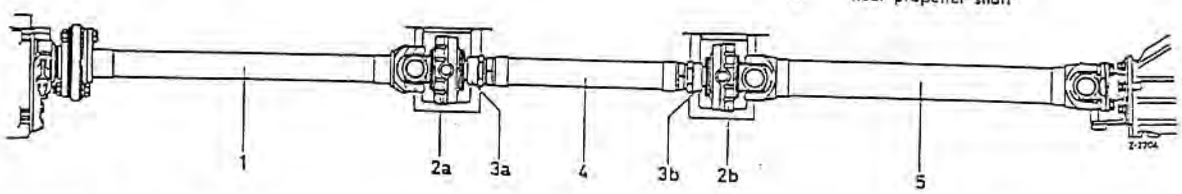


Fig. 26-1/7 2-unit propeller shaft

1 Front propeller shaft
2 Intermediate bearing
3 Clamp nut
5 Rear propeller shaft

Fig. 26-1/8 3-unit propeller shaft

1 Front propeller shaft
2a, 2b Intermediate bearing
3a, 3b Clamp nut
4 Intermediate bearing
5 Rear propeller shaft



When the transmission is being replaced these propeller shafts must be disconnected also at the rear axle, and after slackening the one or two intermediate bearings the whole assembly must be slightly pushed toward the rear.

10. Remove the sealing ring (3) from the transmission main shaft (6) (Fig. 26-1/5).

11. Disconnect the flexible speedometer drive at the transmission.

12. Unscrew the hexagon screws with which the clutch housing is attached to the intermediate flange.

13. Pull the transmission back and remove downward. For this purpose the transmission must be turned to the right, so that the recess on the clutch housing for the neck of the starter does not knock against the propeller shaft housing.

Important: In order to prevent damage to the driven plate the transmission should be moved backward **in a horizontal position** until the drive shaft is definitely disengaged from the hub of the driven plate. Under no circumstances must the transmission be lowered the moment it has been pulled out of the cylindrical centering device, or on Model 300 SE out of the dowel pins.

Note: It is advisable to remove and check the clutch at the same time (see Job No. 25-1).

If the transmission is to be cleaned the clutch throw-out bearing should always be removed beforehand.

The thrust bearing does not require any maintenance and becomes completely unserviceable if it is washed. It should be kept in a clean place until it is reinstalled.

Installation:

14. Give the journal and splines of the drive shaft a thin coat of grease. Install the transmission taking care to ensure that the selector and shift rods are in a forward position close to the clutch housing.

Note: The clutch housing with the flanged-on transmission on the 4 and 6 cylinder models is centered in relation to the engine by means of the cylindrical centering device on the clutch housing and intermediate flange.

The only exception are the 300 SE Models on which the transmission is centered in relation to the engine by two conical dowel pins. (See also "Important Instructions for Transmission Replacement on 300 SE Models at the end of this Job No.).

15. Screw the clutch housing with the transmission to the intermediate flange, at the same time screwing the ground cable of the battery to the hexagon screw behind the oil filter, and the ground cable from the engine to the body to the upper fixing screw of the starter. On the 300 SE Models the two conical dowel pins should be driven home by light hammer taps before the screws are finally tightened.

Note: The two long hexagon screws with which the starter too is fastened, must be tightened evenly, otherwise one of the fixing eyes of the starter may break off.

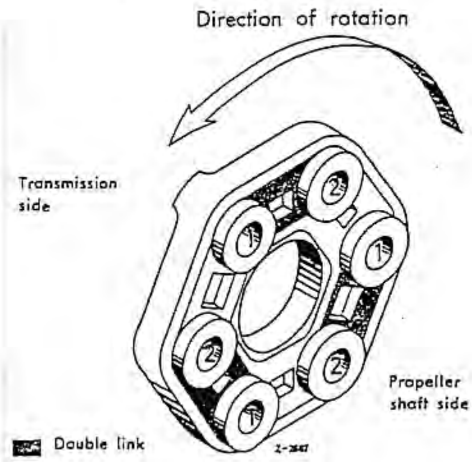


Fig. 26-1/9

16. Place the sealing (3) on the main shaft, push the propeller shaft forward and lightly screw the propeller shaft intermediate bearing to the chassis base panel.

17. Firmly screw the propeller shaft to the shaft plate paying attention to the center cross (1) (Fig. 26-1/5).

Note: The shaft plate must be installed in such a way that the double links are under tensile stress (see Fig. 26-1/9).

18. Then attach the propeller shaft intermediate bearing without forcing, noting the position marked during removal (see Fig. 26-1/6).

Note: The propeller shaft intermediate bearing should only be firmly tightened after the propeller shaft has been flanged to the transmission shaft plate.

Caution: On all new models as from August 1965 connect the two or three-unit propeller shaft to the rear axle. Make the fixing screws on the intermediate bearing finger-tight.
On the two-unit propeller shaft slacken the clamp nut (3) on the front shaft (1) and on the three-unit shaft slacken the front clamp unit (3a) on the intermediate shaft (4), using SW 41 und SW 46 wrenches respectively (see Figs. 26-1/7 and 8).
In this condition roll the car to and fro several times, then retighten the clamp nuts with a torque of approx. 20 mkg. and screw down the intermediate bearings without forcing (Figs. 26-1/7 and 26-1/8).

19. Connect the flexible speedometer drive to the transmission. Fasten the mounting plate (9) and the engine support (3) with the rubber mounting to the transmission case rear cover (8) (see Figs. 26-1/4 and 26-1/10).

20. Fasten the support (12) or the tunnel cover plate to the rubber mounting (14) (Fig. 26-1/10).

21. Screw the support (12) or the tunnel cover plate to the chassis base panel but do not tighten the hexagon screws (18). In this connection note the position marked (20). Now jack the car down and tighten the hexagon screws for fastening the support (see Fig. 26-1/4). On Model 230 SL the 16 screws can be tightened right away.

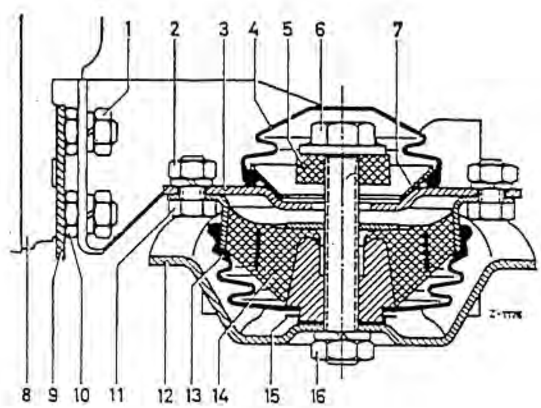


Fig. 26-1/10

1 Hexagon nut	9 Mounting plate
2 Hexagon nut	10 Hexagon collar screw
3 Engine support	11 Hexagon screw
4 Bellows	12 Support
5 Rubber pad	13 Bellows
6 Hexagon screw	14 Rubber mounting
7 Bellows bracket	15 Sheet-metal plate
8 Transmission case rear cover	16 Hexagon nut

22. Check the adjustment of the rear rubber mounting and if necessary readjust (see Job No. 24-1).

23. Fasten the exhaust pipe bracket (4) to the mounting plate (9) and tighten the clamping screw (7) (Fig. 26-1/3).

24. Fasten the extraction cylinder to the clutch housing.

25. Attach the return spring.

26. Adjust the clutch (see Job No. 29-6).

27. Pass the hand brake cable through the cable guides of the support and of the front axle support and fasten to the brake lever. Then adjust the hand brake.

28. Attach the selector rod and the shift rod to the ball studs of the steering column gear shift mechanism and adjust the gear shift mechanism (see Job No. 26-3).

29. Attach the ground cable to the battery.

30. Check the oil level in the transmission and if necessary correct.

Particularities of Floor-Mounted Gear Shift System

Para. 2.

Remove the two push rods (8) on top of the transmission case cover. Slacken the clamping screw (3) on the yoke end (2) and pull the shift tube (4) from the splines of the yoke end toward the rear (Fig. 26-1/11).

Para. 27.

Install and attach the two push rods (8) to the threaded bolts on top of the transmission case cover (Fig. 26-1/11). Insert the shift tube (4) in the splines of the yoke end and adjust the gear shift mechanism (see Job No. 26-3).

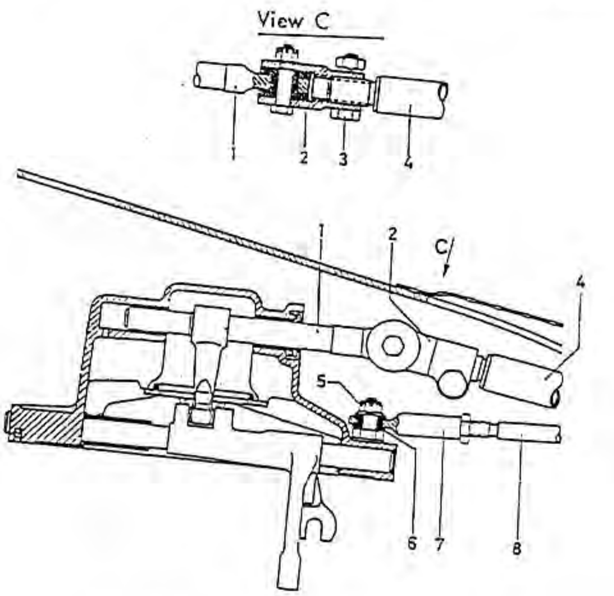


Fig. 26-1/11

1 Shifting shaft
2 Yoke end
3 Hexagon screw
4 Shift tube
5 Castle nut
6 Bushing
7 End piece
8 Push rod

Important Instructions for Transmission Replacement on 300 SE Models

In contrast to Models 190, 220 and 200, 230 and 250 with cylindrical centering device, the clutch housing of the 300 SE Models is still provided with dowel pins for centering as on the older models. During assembly in our factory the clutch housings are individually centered in relation to the engine, i. e. to the crankshaft, and are fixed in position by means of conical dowel pins. The engine number is then marked on the clutch housing between the two top fixing lugs. This individual procedure is necessary in order to achieve the accurate adjustment required for the DB automatic transmission. For reasons of production the cars with mechanical transmission are also equipped with these conical dowel pins.

As a result the clutch housing must never be detached from the engine when repair or replacement jobs are carried out no matter whether the car is equipped with a mechanical or an automatic transmission.

To prevent the danger of gears, in particular the 4th gear, slipping out, a new transmission is always combined with the clutch housing of the engine, even though new transmissions are always supplied together with a new clutch housing as in the case of the 190 and 220 Models. The new clutch should be disconnected, attached to the old transmission removed from the car and returned to the factory.
If the engine has to be replaced, the new engine is supplied together with a clutch housing which must be attached to the transmission installed in the car.

If, however, the clutch housing has to be replaced the new housing must be properly centered in relation to the engine.

Since on the present version mechanical transmission the clutch housing is installed between the transmission case front cover and the transmission case, the following jobs must be carried out whenever a transmission or an engine is replaced:

a) Proper positioning of drive shaft
b) Proper positioning of countershaft
c) Assembly of transmission and clutch housing.

If the clutch housing has to be replaced the following additional procedure is necessary:
d) Centering of the clutch housing in relation to the engine, i. e. to the crankshaft.

a) Proper Positioning of Drive Shaft

1. Remove old sealing compound from the jointing surface (transmission side) of the clutch housing associated with the engine.

2. Unscrew the clutch housing from the new transmission and carefully clean the front jointing surface of the transmission case.

3. Check the clearance between the upper edge of the snap ring on the grooved ball bearing and the recess in the clutch housing.

   Use a depth micrometer to measure the depth of the recess (Fig. 26-1/10a) and the distance between the front face of the snap ring on the grooved ball bearing and the jointing surface of the transmission case (Fig. 26-1/11a).

   When the distance is being measured the snap ring must lie snugly against the transmission case jointing surface and the space ring.

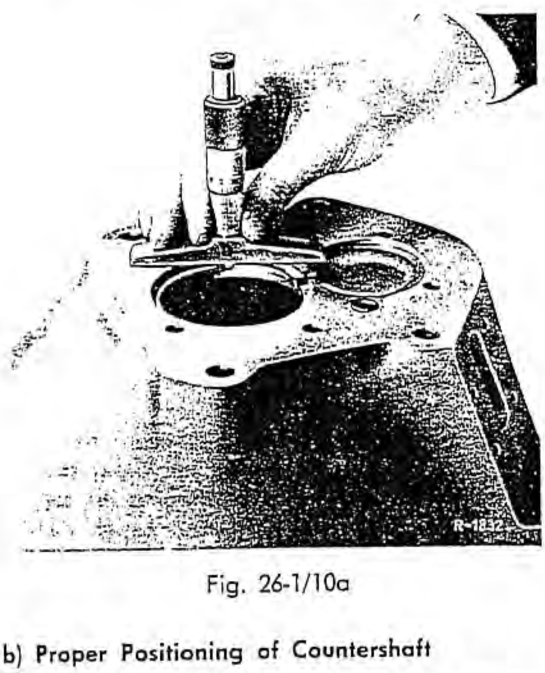


Fig. 26-1/10a

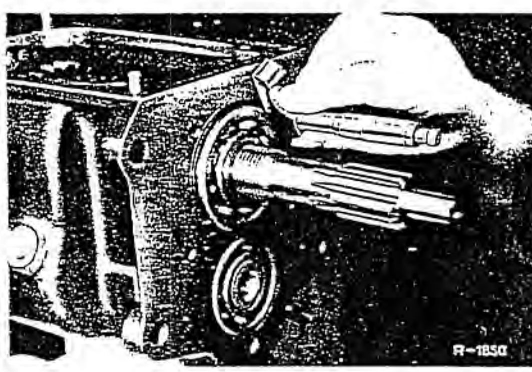


Fig. 26-1/11a

The clearance between grooved ball bearing and recess should be 0–0.10 mm. If the clearance is larger it can be reduced to the proper proportions by adding shims which are available in the following thicknesses:

0.1 mm, Part No. 136 262 06 52
0.2 mm, Part No. 136 262 07 52
0.3 mm, Part No. 136 262 08 52

b) Proper Positioning of Countershaft

Always measure the end play of the countershaft.

1. Push the countershaft back as far as it will go by light blows on its front part.

2. Use a depth micrometer to measure the distance between the face of the grooved ball bearing and the transmission case jointing surface.

3. Measure the depth of the lower recess in the clutch housing (see Fig. 26-1/12).

   The countershaft should have an end play of 0.10–0.15 mm. If a comparison between the two measurements proves that the play exceeds this limit it can be reduced to the proper proportion by inserting shim 120 263 17 52 in the clutch housing recess.

If no play or a play far below 0.10 mm. should be found the transmission case rear cover must be removed and the countershaft must be properly positioned in the rear bearing by removing the shim. If this procedure becomes necessary, first attach the clutch housing to the transmission (see Section C).

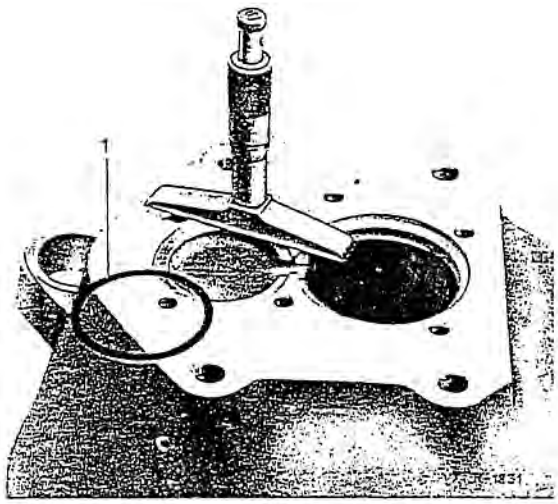


Fig. 26-1/12

1 Shim 120 263 37 52 gage 0.05 mm

Caution: Before loosening the grooved nut on the three-way flange remove the transmission case top cover and install Retaining Fixture 136 589 38 61 in the small gear section of the 1st and 2nd gear in such a way that the low gears are pushed toward the synchronising unit: this will prevent the key in the keyway of the stop ring from becoming dislodged (see Fig. 26-1/13).

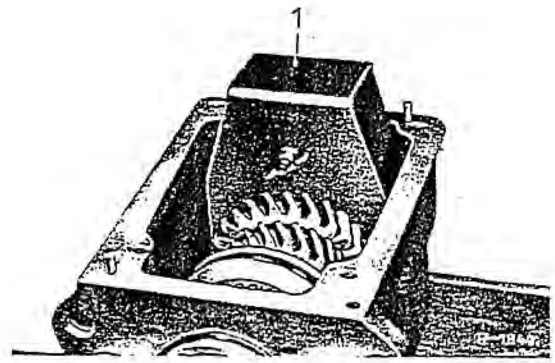


Fig. 26-1/13

1 Retaining Fixture 136 589 38 61

4. Then remove the transmission case rear cover and by light blows drive the countershaft forward again as far as it will go.

5. Remove all sealing compound and the old paper gasket from the jointing surface.

6. Proper positioning is achieved as described above, the only difference being that the thickness of the new paper gasket must be taken into account when measuring the transmission case rear cover.

Caution: In order to avoid the complications involved in removing the transmission case rear cover, the clutch housing has been changed as follows:

The recess depth for the front countershaft bearing in the clutch housing was increased from 2.0 + 0.2 mm. This 0.5 mm increase was compensated again by a 0.5 mm. shim Part No. 120 263 16 52 in order to retain the previous position of the countershaft. As before the countershaft is positioned during assembly in relation to the transmission case rear cover. However, if the clutch housing has to be replaced, the countershaft can now be repositioned with shims from the front side if the end play is too small.

c) Assembly of Transmission and Clutch Housing

1. Give the cleaned jointing surfaces of the clutch housing and the transmission case a thin but even sealing compound coat.

2. Slightly grease the previously selected shims and insert them in the recesses of the clutch housing and install the housing in the transmission case by fitting the recesses over the projecting grooved ball bearings.

3. Stick a new paper gasket to the transmission case front cover with grease and carefully slide the cover over the drive shaft into the recess in the clutch housing.

4. Liberally coat the threads of the 4 M 8 fixing screws for the transmission case front cover and of the 2 M 8 fixing screws arranged below it, and both faces of the associated corrugated washers with sealing compound, screw in and tighten.

Caution: The hexagon fixing screws come in three different lengths. The 30 mm. hexagon screw should go in the flatter fixing lug of the transmission case cover near the ball stud. The ball stud is also threaded and counts as a fifth fixing screw for the transmission case front cover.

5. Then screw in the 4 outer M 12 fixing screws.

d) Centering the Clutch Housing

The clutch housing can only be accurately centered when the engine has been removed from the car.

1. Unscrew the mechanical clutch from the flywheel.

2. Clean the flywheel and install a magnetic dial gage holder between the flywheel fixing screws (see Fig. 26-1/14).

3. Use 4 screws to attach the new clutch housing in such a way that it can still be shifted by light hammer blows.

4. Install a dial gage stand with Puppitast gage attached on the holder projecting through the top bearing bore in the clutch housing and align it in accordance with the internal diameter of the bore (see Fig. 26-1/15).

Note: When aligning the Puppitast gage remember its small range and adjust it to about the middle of this range to avoid the danger of forcing it beyond its range. A standard dial gage would not fit into the space available.

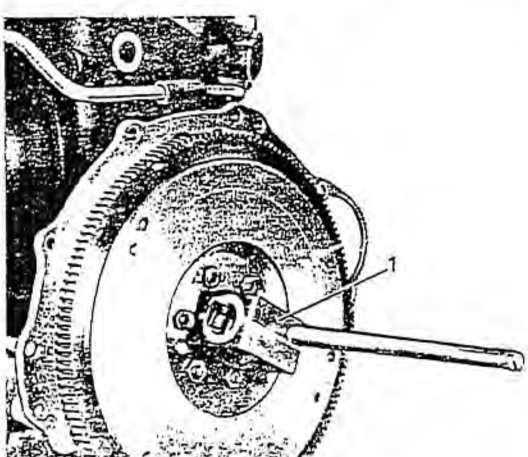


Fig. 26-1/14

1 Magnetic holder

5. Slowly turn the engine by hand and align the clutch housing by light hammer blows according to gage variations (see Fig. 26-1/15). Maximum permissible misalignment 0.05 mm.

Note: When the dial gage rotates the feeler must be lifted before it reaches the oil compensation groove.

6. Firmly tigthen the 4 fixing screws and bore the fitting holes to 12 mm ⌀.

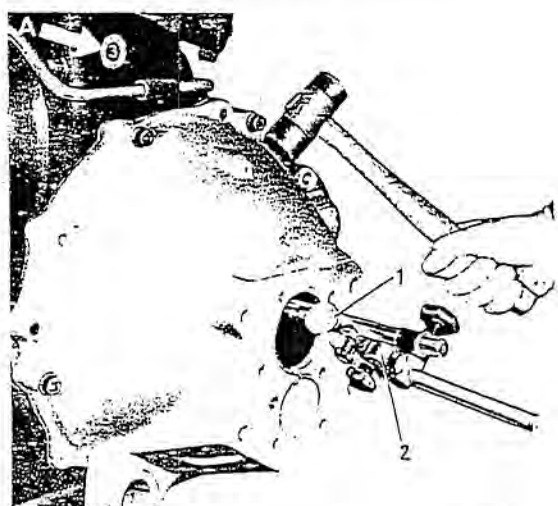


Fig. 26-1/15

A Punched in remaining misalignment in "hundredth of a millimeter"
B Engine number punched in
1 Puppitast
2 Dial gage stand

7. Ream up the bores with a conical 1:20 reamer.

8. Punch in the engine number between the two top fixing lugs of the clutch housing and punch in the remaining permissible misalignment in the white circle at the rear of the crankcase (see Fig. 26-1/15).

Adjustment of Gear Shift Mechanism

Job No.
26-3

Modification: Revised and supplemented

A. Adjustment of Steering Column Gear Shift Mechanism

1. Check the shift lever and the shift tube for freedom of movement.

Note: The shift lever should return automatically to the initial position when it is pulled up to the reverse stop.

2. Put the shift lever at the steering wheel in neutral, loosen the clamp screw (5) at the selector lever (6), pull the selector lever forward in the direction of travel. Pull the relay lever (4) forward by its lower leg. This engages the fourth gear (Figs. 26-11/1 and 2).

3. Remove the rubber sleeve on the shift lever from the recess of the steering column jacket. Now get an assistant to pull the shift lever on the steering wheel upward until there is a distance of about 2 mm between the shift tube collar and the recess in the steering column jacket.

4. Retighten the clamping screw (5) on the selector lever at the bearing assembly, pressing the selector lever toward the bearing assembley so that the spring washer (33) is pretensioned (Figs. 26-11/1 and 2).

5. Use the shift lever at the steering wheel to engage the various gears. All gears must be easy to shift. Always declutch when shifting the individual gears. When shifting into reverse, the mechanical resistance must be evident.

Note: If this is not the case, the reverse gear stop in the transmission case top cover must be checked and if necessary a new arresting spring must be installed.

6. Check the position of the shift lever at the steering wheel. In 2nd and 4th gear, the deviation of the lever from horizontal should be "a" (Fig. 26-3/1).

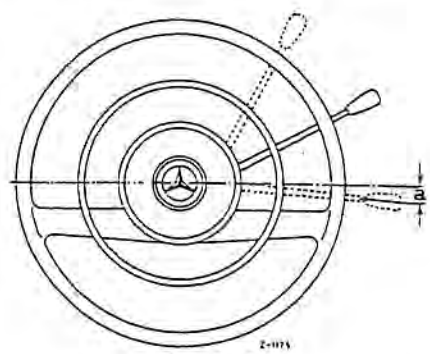


Fig. 26-3/1

a = deviation of the shift lever from horizontal in 2nd and 4th gear
a = approx. 15 mm

7. If there is any considerable deviation check the position of the lever in relation to the shift lever, the position of the shift lever on the transmission case top cover, and the length of the shift rod (Figs. 26-11/1 and 2).

Note: Small deviations can be corrected by shortening or lengthening the shift rod.
When changing gears the shift lever must have sufficient play in the recess of the steering column jacket.

B. Adjustment of Floor-Mounted Gear Shift System

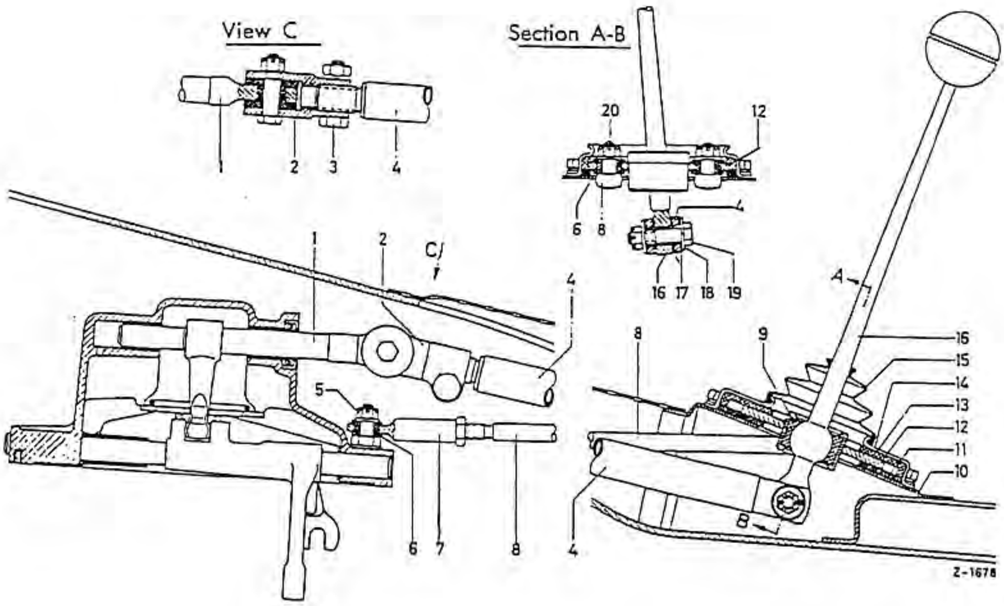
1. Move the shifting shaft (1) against the reverse gear stop and engage 2nd gear by pushing in the shifting shaft (1) (Fig. 26-3/2).

2. Move the shift lever (16) to the 1st-2nd gear shifting plane (see right-hand sketch in Fig. 26-3/3) and insert the shift tube (4) in the serrations of the yoke end (2) (Fig. 26-3/2).

Note: The serrations on the shift tube (4) should project into the yoke end at least 15 mm. (Fig. 26-3/2, View C).

3. Tighten the clamping screw (3) in the yoke end.

4. Check the gear shift mechanism by shifting through all gears to make sure that they can be engaged easily. Under no circumstances must the shift lever knock against the shift lever bearing since there could be a danger that the gear will slip out.



2nd Version

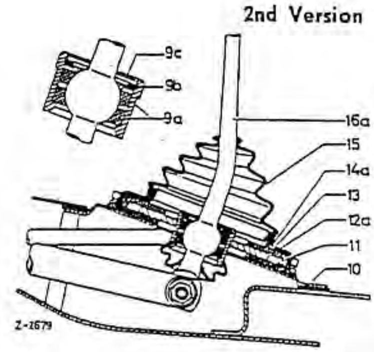


Fig. 26-3/2

1 Shifting shaft
2 Yoke end
3 Hexagon screw
4 Shift tube
5 Castle nut
6 Bushing
7 End piece
8 Push rod
9 Ball socket (vulcollan)
9a Split ball socket
9b Internal circlip
9c Corrugated washer
10 Transmission tunnel
11 Lower bearing cover
12 Shift lever bearing
12a Shift lever bearing, new version
13 Upper bearing cover
14 Cover plate 1st version, sheet metal
14a Cover plate 2nd version, vulcollan
15 Cuff
16 Shift lever
17 Bushing
18 Washer
19 Hexagon screw
20 Castle nut

When the shift lever is properly adjusted the shift positions will be as shown in Fig. 26-3/3.

If the shift lever knocks against the shift lever bearing (12) when a gear is being engaged, the length of the two push rods (8) should be adjusted (Fig. 26-3/2). To do this remove the push rods from the lug of the transmission case cover and turn the end pieces (7) until the bolts of the push rods (8) in the shift lever bearing (12) are situated in the center of the cover plate (14). The important point is that the two end pieces should always be adjusted by the same amount.

Caution!

As from November 1965 all cars with floor-mounted gear shift system are provided with a shift lever bent forward by 55 mm. in the direction of travel; the new design increases elbow room. There is no change in the lever positions in the direction of travel (see sketch on the right). At right angles to the direction of travel the lever positions have been shifted forward by approx. 55 mm. (see sketch on the left) compared with the previous version (see sketch in the middle) (Fig. 26-3/3).

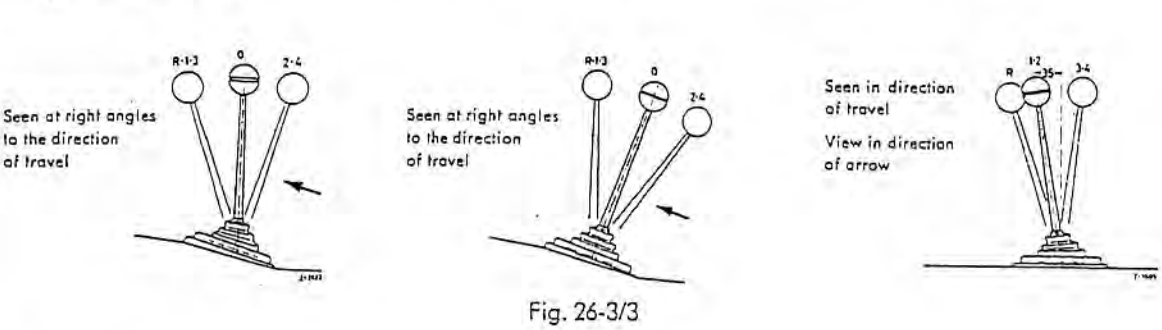


Fig. 26-3/3

Steering Wheel Shift System

Job No.
26-11

Modification: Revised and supplemented

A. General

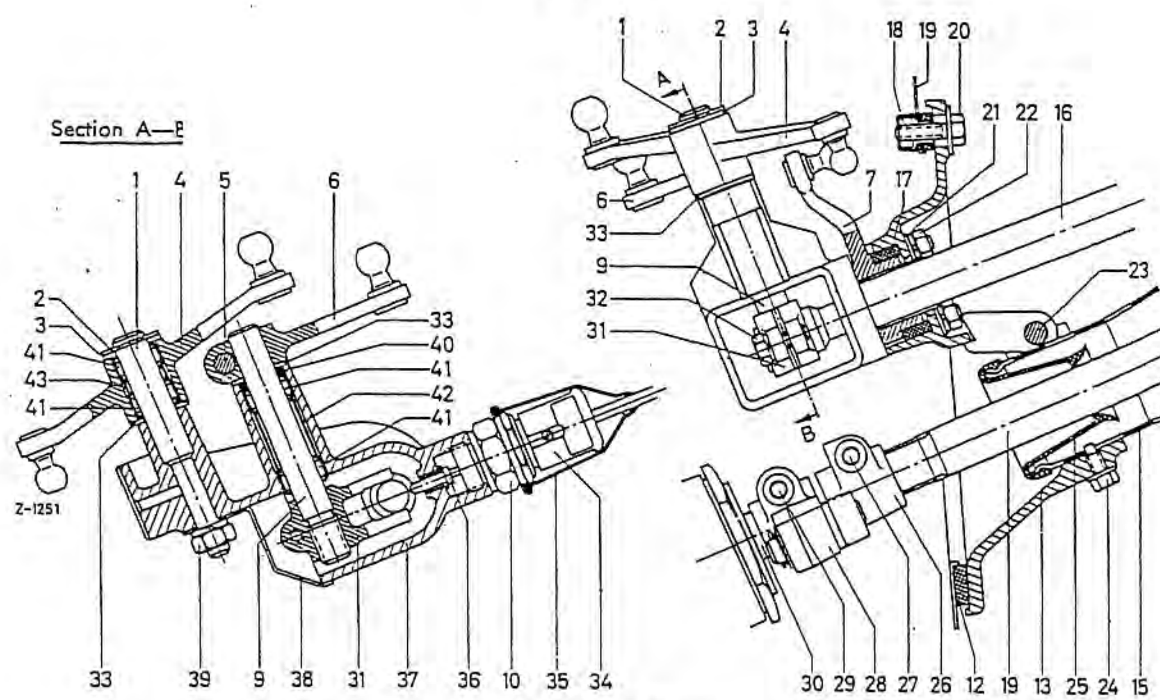


Fig. 26-11/1 **1st Version**

1 Relay lever shaft
2 Snap ring
3 Washer
4 Relay lever
5 Hexagon screw (clamping screw)
6 Selector lever
7 Lever on shift tube
9 Selector shaft
10 Reversing light switch
12 Rubber gasket
13 Cover plate
15 Steering column jacket
16 Shift tube
17 Vulkollan bushing
18 Cage nut
19 Steering tube
20 Hexagon screw with washer
21 Washer
22 Hexagon nut with lock washer
23 Hexagon screw (clamping screw)
24 Stud screw with lock washer
25 Rubber sleeve
26 Upper flange
27 Hexagon socket screw
28 Lower flange (clamping screw)
29 Hexagon socket screw (clamping screw)
30 Steering worm
31 Selector lever on shift tube
32 Hexagon screw (clamping screw)
33 Spring washer
34 Plug connection
35 Protective cap
36 Pressure pin
37 Bearing assembly
38 Cover
39 Hexagon nut with lock washer
40 Sealing ring
41 Needle bearing
42 Spacer sleeve
43 Spacer sleeve

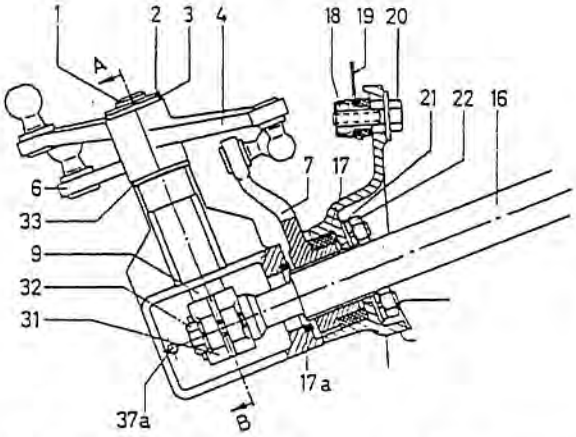


Fig. 26-11/2 **2nd Version**

1 Relay lever shaft
2 Snap ring
3 Washer
4 Relay lever
6 Selector lever
7 Lever on shift tube
9 Selector shaft
16 Shift tube
17 Vulkollan bushing
17a Spacer ring
18 Cage nut
19 Front panel
20 Hexagon screw with washer
21 Washer
22 Hexagon nut with lock washer
31 Selector lever on shift tube
32 Hexagon screw (clamping screw)
33 Spring washer
37a Water outlet bore

On the 3rd version the reversing light switch (10) is not required.

In order to improve gear shifting, individual parts of the steering wheel shift mechanism were changed as follows:

1. Bearing Assembly

If there is any misalignment between the front panel and the steering column jacket support on the instrument panel, the shift tube may in some cases show a tendency to jam. To counteract this tendency, a spacer ring (17a) was incorporated in the 2nd version bearing assembly. This spacer ring, which is slightly elastic, prevents the lever (7) from fouling the bearing assembly (Fig. 26-11/2).

In this connection the Vulkollan bushing (17) was made wider in order to prevent the lever (7) from fouling the cover plate. Furthermore, a water outlet bore (37a) with a 5 mm dia. was drilled into the 2nd version bearing assembly at its lowest point. This hole can also be subsequently drilled into the 1st version bearing assembly (Fig. 26-11/2).

Note: Water accumulating in the bearing assembly may cause corrosion and will make gear shifting difficult in very cold weather because of the formation of ice.

2. Lever on Shift Tube

The double bevel on the serrations of the lever (7) was increased in order to ensure that the lever cannot foul the lower part of the splines of the shift tube (16) (Fig. 26-11/2).

3. Spring-Loaded Ball Connector

The spring-loaded ball connector has been replaced by a rigid connecting rod. The rigid connecting rod can also be installed subsequently in place of the spring-loaded ball connector (for adjusting dimensions see (Fig. 26-11/3).

4. Actuation of Reversing Light Switch

The pressure pin (36) has been increased in length (for length see Job No. 26-0) and the recess in the end section of the shift tube has also been increased (Fig. 26-11/1) in order to ensure instant response of the reversing light switch.

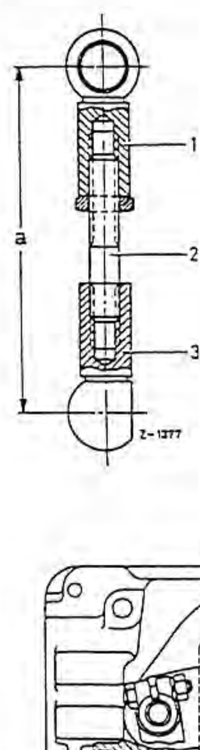


Fig. 26-11/3

1 Ball connector
2 Stud bolt
3 Ball connector
a = Adjusting dimension = 67 mm

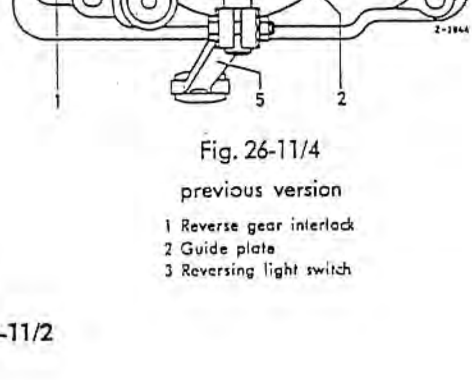


Fig. 26-11/4

previous version

1 Reverse gear interlock
2 Guide plate
3 Reversing light switch

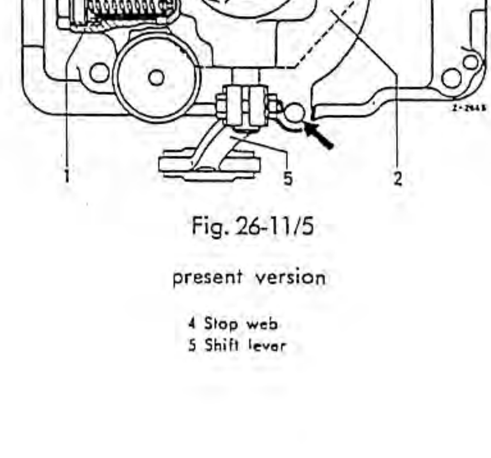


Fig. 26-11/5

present version

4 Stop web
5 Shift lever

In April 1962 the reversing light switch (3) was shifted from the bearing assembly to the transmission case top cover. This change was made

on model	190 c	as from chassis end no.	017 049
	190 Dc		023 538
	220 b		034 565
	220 Sb		073 730
	220 SEb		028 560

As a result the guide plate (2) in the transmission case had to be modified (see large arrows in Figs. 26-11/4 and 5).

At the same time the transmission case top cover was provided with two additional fixing holes and is now fastened with 6 screws (see small arrows in Fig. 26-11/5). The additional eye for the center fixing hole on the left-hand side of the transmission case top cover made it necessary to install a bent shift lever (5) (Fig. 26-11/5).

B. Checking of Grear Shift Mechanism

Stiffness and binding of the steering wheel shift system may be due to the following causes:

1. The shift tube (16) touches the steering column jacket passage or the felt in the steering column jacket and the leve (7) cannot move freely in the bearing of the 1st version bearing assembly (see Fig. 26-11/1). In this case loosen the cover plate (13) on the cowl and correct any misalignment by shifting the position of the cover plate. It is advisable at the same time to loosen the tightening strap (6) for the steering column jacket in order to ensure that the steering column jacket can be fastened to the cowl and to the tightening strap without forcing (see Fig. 26-12/4).
2. If the selector lever (31) binds in the recess of the shift tube (16), the selector lever must be removed and should be checked in order to make sure that it can move freely in the end section of the shift tube (Fig. 26-11/1). The selector lever must have a slight amount of radial and end play. If necessary, the claws of the selector lever can to some extent be bent apart or can be ground down.
3. If there is a certain amount of stiffness of the ball sockets of the selector rod (1) and the shift rod (2) on the ball heads of the relay lever and the selector lever (see Fig. 26-12/2), press off the ball sockets and lightly grease them. If this is not sufficient to remove the stiffness of the ball sockets, the condition can be improved by using a pair of pliers on the ball sockets.
4. If there is too much friction between the rubber cover (22) and the shift tube (16) (see Fig. 26-15/1), rub talc on the rubber cover or install the modified rubber cover Part No. 111 268 0197.
5. It is possible that the bearing assembly has worked loose because of strained or dislodged stud bolts. If this is the case replace the whole bearing assembly.

   When tightening the 4 fixing nuts never exceed a tightening torque of 0.6 mkg.

Job No.
26-12

Removal and Installation of Bearing Assembly

Modification: Rigid connecting rod (Fig. 26-12/6) added

Removal:

1. Detach the shift rod (2) and the selector rod (1) at the relay lever (4) and the selector lever (6) (Fig. 26-12/2).

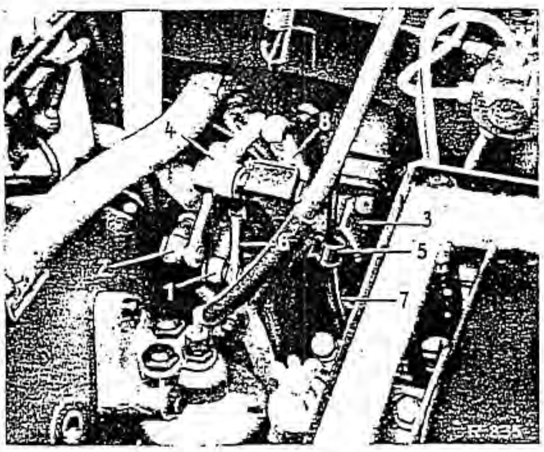


Fig. 26-12/2

1 Selector rod	5 Clip
2 Shift rod	6 Selector lever
3 Cover	7 Flexible speedometer drive
4 Relay lever	8 Spring-loaded ball connector

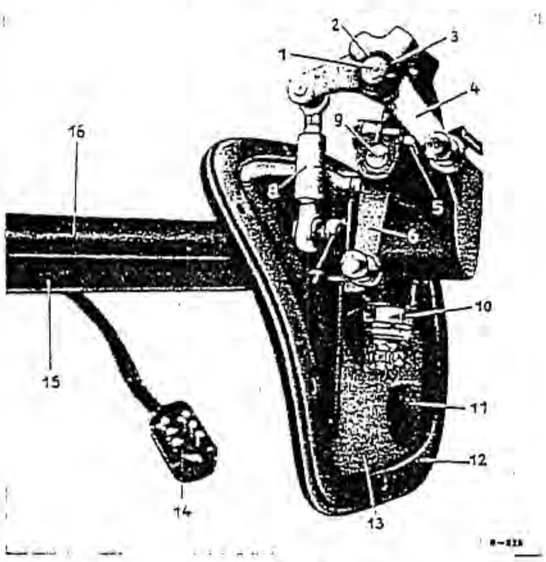


Fig. 26-12/3

1 Shaft	9 Selector shaft
2 Snap ring	10 Reversing light switch
3 Spring washer	11 Rubber grommet
4 Relay lever	12 Rubber gasket
5 Hexagon nut	13 Cover plate
6 Selector lever	14 Plug connection
7 Lever on shift tube	15 Steering column jacket
8 Spring-loaded ball connector	16 Shift tube

2. Remove the flexible speedometer drive from the fixing clip (5) of the cover (3). Unscrew the hexagon nut and remove the cover from the bearing assembly (Fig. 26-12/2).

3. Take the locking clamp from the ball sockets of the spring-loaded ball connector (8) and then pull off and remove the spring-loaded ball connector from the ball head of the relay lever (4) and the lever (7) (Fig. 26-12/3).

4. Unscrew the reversing light switch (10) from the bearing assembly (37) and take out the pressure pin (36) (Fig. 26-12/1).

Note: On cars supplied after April 1962 this procedure is not required since the reversing light switch is installed in the transmission case top cover.

5. Loosen the hexagon screw (32) in the selector lever (31), push the selector lever (6) with the selector shaft (9) to the right toward the center of the car, and remove the selector lever (31) upward (Fig. 26-12/).

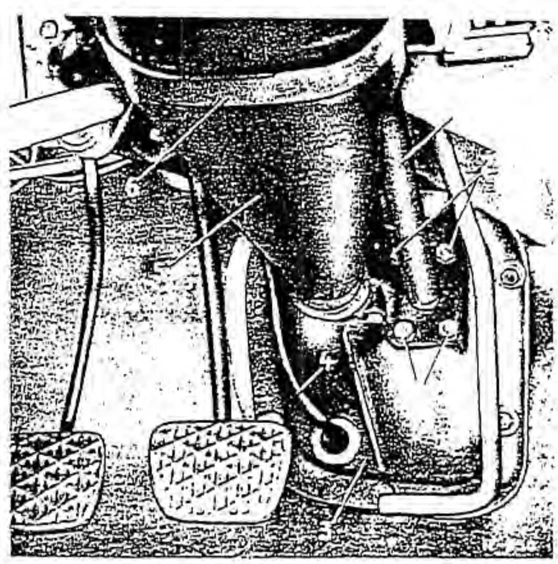


Fig 26-12/4

1 Shift tube	4 Cable for reversing light switch
2 Hexagon nuts for attaching the bearing assembly of the steering wheel shift system	5 Steering column jacket
3 Cover plate	6 Tightening strap for steering column jacket

6. Take out the rubber mat and unscrew the four hexagon screws (2) (Fig. 26-12/4).

7. Remove the bearing assembly. Then remove the lever (7) from the splines of the shift tube (16) (see Fig. 26-12/3).

8. Check the polyamide bushing (2) in the spring-loaded ball connector (Fig. 26-12/5). To do this compress the ball connector as far as the stop and let it go again. If a metallic noise can be heard at one of the stops, the polyamide bushing is damaged and the ball connector must be replaced.

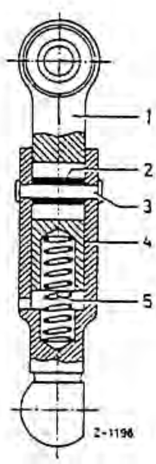


Fig. 26-12/5

1 Spring-loaded ball connector
2 Polyamide bushing
3 Cylindrical pin
4 Spring-loaded ball connector (outer part)
5 Pressure spring

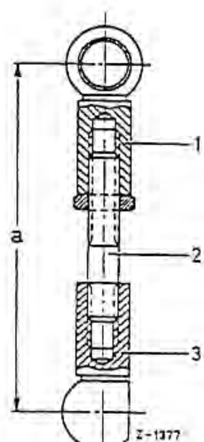


Fig. 26-12/6

1 Ball connector
2 Stud bolt
3 Ball connector
a = Adjusting dimension = 67 m

Note: The spring-loaded ball connector has been replaced by a rigid connecting rod. The rigid connecting rod can also be installed subsequently in place of the spring-loaded ball connector. Adhere strictly to the dimension "a" of the rigid connecting rod (Fig. 26-12/6).

9. Check the seat of the relay lever (4). The spring washer (33) installed between the relay lever (4) and the bearing assembly (37) must have sufficient initial tension (Fig. 26-12/1).

10. Check the radial play of the selector lever shaft (9) in the bearing assembly (37) and of the relay lever (4) on the shaft (1).

11. Check the end play of the selector lever (31) in the shift tube (16) (for dimensions see Job No. 26-0), since excessive play may make gear shifting difficult.

12. Push the lever (7) onto the splines of the shift tube (16). The lever must be easy to shift in the axial direction and must not bind.

13. Check the radial play of the lever (7) in the Vulkollan bushing (17). If the play is excessive, replace the bushing in the cover plate (13). (Fig. 26-12/1).

Installation:

14. Grease the splines of the shift tube (16) and the Vulkollan bushing (17) (Fig. 26-12/1).

15. Put the shift lever at the steering wheel in the horizontal position.

16. Slide the lever (7) onto the shift tube (16) in such a way that the collar of the lever points upward.

Note: The lever must be slid onto the splines of the shift tube in such a way that the shift lever cannot foul the steering column jacket. The movement of the lever must be limited by its contact with the recess of the cover plate.

17. Attach the bearing assembly (37) to the cover plate (13) of the steering column jacket (15) (Fig. 26-12/1).

18. Install the spring washer (33) on the selector shaft (9) and lightly grease the shaft.

19. Install the selector lever (31) in the shift tube (16) and insert the selector shaft in the serrations of the claw, and tighten the hexagon screw (32).

Note: The hexagon screw in the selector lever (31) must point in the direction of travel.

20. Fit the cover (38) to the bearing assembly (37) and fasten it by means of the hexagon nut (39) (Fig. 26-12/1).

21. Attach the flexible speedometer drive in the fastening clip.

22. Press the spring-loaded ball connector (8) or a rigid connecting rod on the ball heads of the relay lever (4) and the lever (7) and install the locking clamp (Fig. 26-12/3). Adhere strictly to the dimension "a" of the connecting rod.

23. Insert the pressure pin (36) in the bearing assembly (37) and screw in the reversing light switch (10). Plug in the plug connection (34) for the reversing light switch (Fig. 26-12/1).

Note: For cars supplied after April 1962 this procedure is not required.

24. Grease the ball heads of the shift lever and selector lever and press them onto the shift and selector rods.

25. Adjust the gear shift mechanism (see Job No. 26-3).

Removal and Installation of Shift Tube

Job No.
26-15

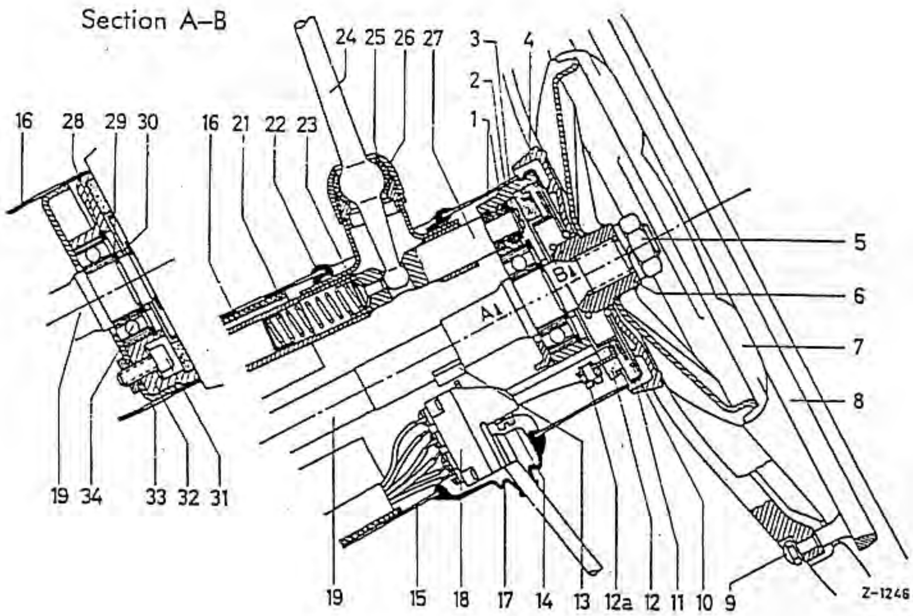


Fig. 26-15/1

1 Vulkollan ring
2 Washer
3 Snap ring
4 Horn ring, lower part
5 Hexagon nut
6 Steering wheel
7 Trademark plate
8 Horn ring, upper part
9 Cap nut
10 Annular spring
11 Retainer
12 Contact ring
12a Cheese-head screw
13 Canceling cam at the steering tube
14 Cheese-head screw
15 Steering column jacket
16 Shift tube
17 Rubber cover
18 Flash signal switch
19 Steering tube
21 Pressure spring
22 Rubber cover for shift tube
23 Spring seat pin
24 Shift lever
25 Ball socket for shift lever
26 Cover cap
27 Guide pin
28 Snap ring for annular grooved bearing
29 Snap ring for steering tube
30 Pressure spring
31 Hexagon socket screw with lock washer
32 Mounting plate
33 Steering column jacket base
34 Annular grooved bearing

Removal:

1. Remove the steering tube .

2. Remove the bearing assembly (see Job No. 26-12).

3. Take the contact ring (12) out of the steering column jacket (Fig. 26-15/2).

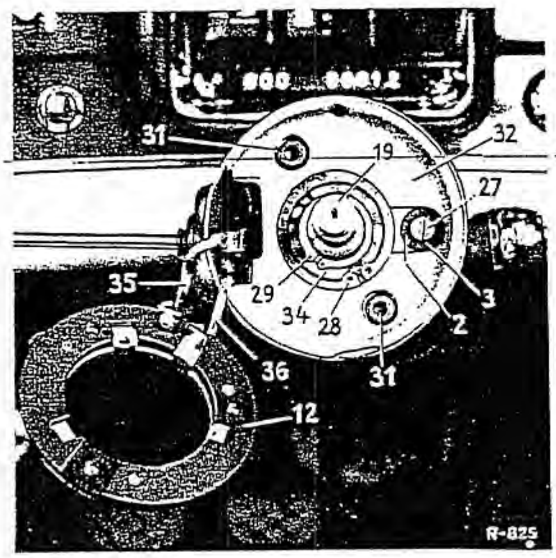


Fig. 26-15/2

2 Washer
3 Snap ring
12 Contact ring for actuating the horns
19 Steering tube
27 Shift tube guide pin
28 Snap ring for annular grooved bearing
29 Snap ring for steering tube
31 Hexagon socket screw for mounting plate
32 Mounting plate
34 Annular grooved bearing for steering tube
35 Cable
36 Cable

4. Take the rubber cover (22) out of the steering column jacket. Unscrew the cover cap (26), using Wrench 187 589 01 01 and remove the shift lever (24) together with the ball socket (25) (Fig. 26-15/1).

5. Turn the guide pin (27) 180°, and remove the snap ring (3) and the washer (2) (Fig. 26-15/2).

6. Press the guide pin (27) down until it can be taken out of the bore of the mounting plate (32).

7. Unscrew the two hexagon socket screws (31) from the mounting plate (32) and take the mounting plate out of the steering column jacket (Fig. 26-15/2).

8. Remove the pressure spring (21) from the shift tube (16) (Fig. 26-15/1).

9. Remove the two Vulkollan guide rings (1) from the mounting plate (32) (Fig. 26-15/1).

10. Remove the shift tube (16) upward out of the steering column jacket (Fig. 26-15/1).

Installation:

11. Insert the shift tube (16) into the steering column jacket from above (Fig. 26-15/1).

12. Lightly grease the pressure spring (21) and insert it in the shift tube.

13. Install two new guide rings (1) in the mounting plate (32) and install the mounting plate in the steering column jacket.

14. Insert the spring seat pin (23) in the guide pin (27) and insert the guide pin in the shift tube (16) (Fig. 26-15/1).

15. Use a screw driver to press the guide pin downward and insert it in the bore of the mounting plate.

16. Turn the guide pin in the mounting plate so that the bore which is **not** spot-faced points toward the shift lever (24). Put on the washer (2) and insert the snap ring (3) in the groove of the guide pin. Then turn the guide pin 180° so that the spot-faced bore points toward the shift lever.

17. Put a new Vulkollan ball socket (25) on the shift lever (24).

18. Insert the shift lever (24) in the guide pin (27) and screw on the cover cap (26) by means of Special Wrench 187 589 01 01.

19. Insert the contact ring (12) in the mounting plate (32) in such a way that the guide lug engages in the recess of the mounting plate (Fig. 26-15/2).

20. Install the rubber cover (22) in the steering column jacket (15) (Fig. 26-15/1).

21. Install the steering tube .

22. Install the bearing assembly (see Job No. 26-12).

Removal and Installation of Floor-Mounted Gear-Shift System

Job Nr.
26-25

Modification: 2nd version shift lever bearing added

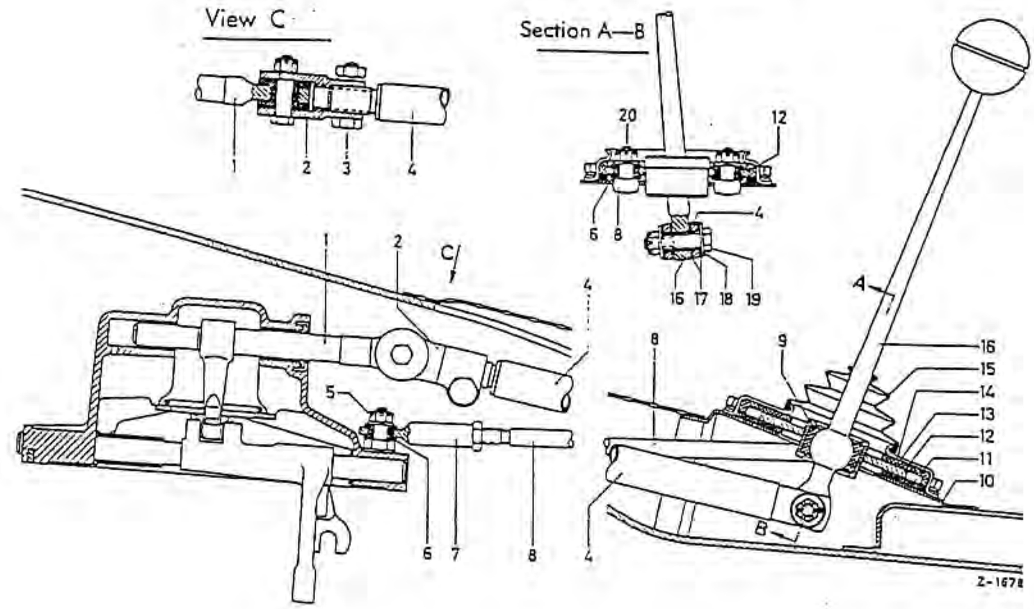
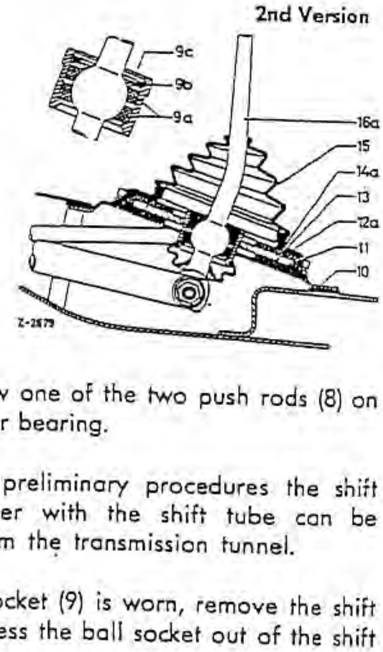


Fig. 26-25/1

2nd Version



1 Shifting shaft
2 Yoke end
3 Hexagon screw
4 Shift tube
5 Castle nut
6 Bushing
7 End piece
8 Push rod
9 Ball socket
9a Split ball socket
9b Internal circlip
9c Corrugated washer
10 Transmission tunnel
11 Lower bearing cover
12 Shift lever bearing
12a Shift lever bearing new version
12a Shift lever bearing new version
13 Upper bearing cover
14 Cover plate 1st version, sheet metal
14a Cover plate 2nd version, vulcollan
15 Cuff
16 Shift lever
17 Bushing
18 Washer
19 Hexagon screw
20 Castle nut

Removal:

1. Remove the two push rods (8) on top of the transmission case cover (Fig. 26-25/1).

2. Loosen the clamping screw (3) on the yoke end (2) and pull the shift tube (4) from the splines in the yoke end toward the rear (see View C in Fig. 26-25/1).

3. Remove the shelf between the front seats and remove the carpet on the transmission tunnel.

4. Unscrew the cover plate (14) on the shift lever bearing and pull out the shift lever as far as possible.

5. Now unscrew one of the two push rods (8) on the shift lever bearing.

   After these preliminary procedures the shift lever together with the shift tube can be removed from the transmission tunnel.

6. If the ball socket (9) is worn, remove the shift lever and press the ball socket out of the shift lever bearing.

Note: The shift lever bearing (12) and the ball socket (9) have been modified (see Fig. 26-25/1). In the new shift lever bearing 12a the top and bottom internal collars have been replaced by a top internal circlip and a spring washer. The ball socket has been split (9a).

This modification greatly facilitates replacement of the ball socket.

Installation:

Installation of the gear shift lever is the reverse of the removal procedures with the necessary modifications.

7. Grease the outside of a new ball socket before installation and the inside after installation. The new split ball sockets (9a) can be pressed into the bearing (12) by hand and only need internal greasing.

Important: The ball sockets should only be lubricated with vaseline or grease.

Under no circumstances should oil be used for lubrication.

Oil lubrication causes binding of the shift mechanism.

8. The shift tube (4) is inserted in the yoke end (2) when the shift mechanism is being adjusted, for which see Job No. 26-3.

Automatic DB Transmission

Group 27

Job No.
~~27–0~~

Automatic DB-Transmission

General Data, Dimensions and Limits

Terminal Voltage

On double acting solenoid	min. 10.8 Volt
On solenoid for kickdown	min. 10.8 Volt

Modulating Pressure

Modulating Pressure	kg/cm²
Basic pressure Maximum pressure Kickdown modulating pressure	0.9+0.1 2.9 4.6—0.2

Shift Points*

Gear shift mechanism			1st/2nd Gear		2nd/3rd Gear		3rd/4th Gear		Maximum speed in the various gears in km/h
			upshift	downshift	upshift	downshift	upshift	downshift	
selector lever position	gas pedal position	Governor Model[1]	Speeds in km/h at shift point						
4	partial throttle	I	—	—	28	23	40	30	
		II	—	—	28 B	23 G	40 C	30 H	
		III	—	—	25	18	40	30	
		IV	—	—	25	18	45	30	
	full throttle	I	18[2]	—	48	23	76	30	
		II	18[2] A	—	40 C	23 G	85 E	30 H	
		III	18[2]	—	40	18	100	30	
		IV	18[2]	—	45	18	120	30	
	kickdown	I	28	10–12	48	30	76	66	
		II	28 B	10–12 F	54 D	30 H	85 E	75 J	
		III	25	10–12	58	30	100	85	
		IV	25	10–12	75	30	120	105	
3	partial throttle	I	—	—	28	23	—	—	
		II	—	—	28 B	23 E	—	—	
		III	—	—	25	18	—	—	
		IV	—	—	25	18	—	—	
	full throttle	I	18[2]	—	48	23	—	—	86
		II	18[2] A	—	54 C	23 E	—	—	86
		III	18[2]	—	58	18	—	—	115
		IV	18[2]	—	75	18	—	—	130
	kickdown	I	28	10–12	48	38	—	—	
		II	28 B	10–12 D	54 C	44 F	—	—	
		III	25	10–12	58	46	—	—	
		IV	25	10–12	75	64	—	—	
2	partial throttle	I	15	10	—	—	—	—	
		II	15 A	10 C	—	—	—	—	
		III	15	10	—	—	—	—	
		IV	15	10	—	—	—	—	
	full throttle	I	15	10	—	—	—	—	55
		II	15 B	10 C	—	—	—	—	55
		III	40	10	—	—	—	—	70
		IV	45	10	—	—	—	—	80
	kickdown	I	28	23	—	—	—	—	
		II	28 B	23 D	—	—	—	—	
		III	40	30	—	—	—	—	
		IV	45	30	—	—	—	—	

Note: All values are approximate. The letters A, B, C etc. opposite the speed values refer to the diagrams in Job No. 27–1.

[1]) Governor Model I: Installed in transmission of Model 190 Dc, 1st version
Governor Model II: Installed in transmission of Model 190 Dc, 2nd version
Governor Model III: Installed in transmission of Models 190 c, 220 b, Sb, SEb, 300 SE with 160 HP engine and transmission versions 1 and ST
Governor Model IV: Installed in transmission of Models 230 SL, 300 SE with 170 HP engine and standard transmission (at rear axle ratio 3.92:1 speeds are lower by approx. 4 %).

[2]) Does not apply unless 1st gear was engaged by kickdown.

Adjustment Data

	Fig. No.	Adjusting Value
Play "a" between starter locking switch and cam disk	27–4/1	1 ± 0.3
* Longitudinal adjustment "b" of spring-loaded connecting rod	27–4/8	298 ± 1
* Switch-off speed of idling switch (max.)	–	1,600 r.p.m.
* Adjustment of modulating pressure control with graduated disk on Diesel engine cars Full throttle value Basic adjustment value (beginning of pressure rise)	 27–4/7 27–4/7	 39°–0.5° 41°–0.5°

Screws and Tightening Torques

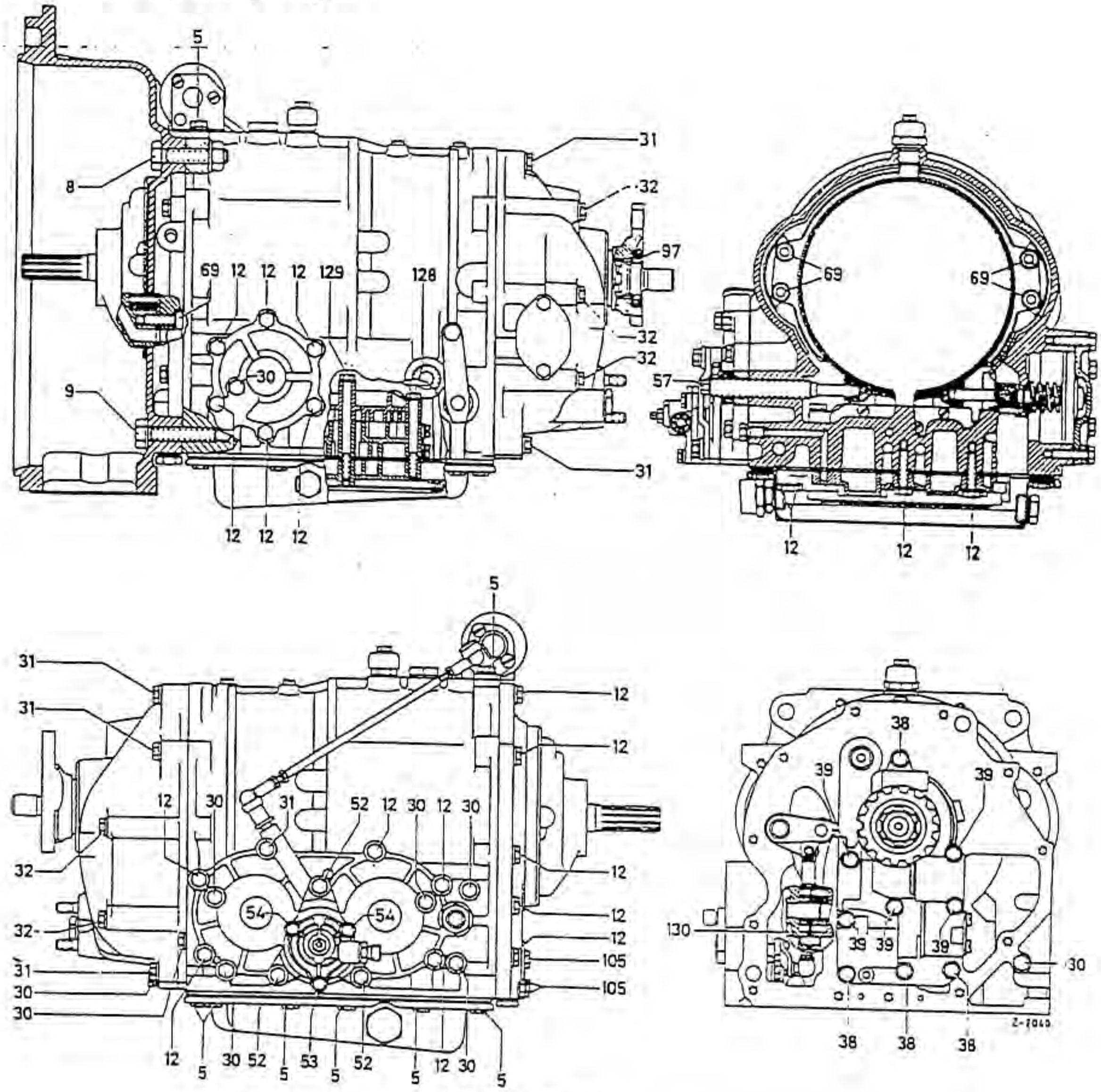


Fig. 27–0/1

Item	Screw Designation	Dim.	Tightening Torque mkg	Item	Screw Designation	Dim.	Tightening Torque mkg
5	Hex screw Oil pan	M 7×20	0.8	69	Hex socket screw	M 8×25	2
	Others	M 7×20	1.3	97	Slot screw for propellor shaft flange	–	8
8	Hex screw with nut	M 12×55	6				
9	Hex screw	M 12×55	5	105	Hex screw	M 7×35	1.3
12	Hex screw	M 7×30	1.3	128	Hex screw	M 6×60	0.8
30	Oil pressure test plug	–	–	129	Hex screw	M 6×75	0.8
31	Hex screw	M 7×40	1.3	130	Hex socket screw	M 6×50	1
32	Hex screw	M 7×80	1.3				
38	Hex screw	M 6×22	0.8		Drive disk: (Fluid coupling)		
39	Hex screw	M 6×65	0.8				
52	Hex screw	M 7×55	1.3	–	Hex socket screw All models except 300 SE	M 8×15	3
53	Hex screw	M 5×40	0.7				
54	Hex screw	M 5×15	0.7	–	Hex screw Model 300 SE only	M 8×15	3
57	Adjusting screw for B 3	–	0.5				

Automatic DB Transmission

Job No.
27–1

A. Operation

a) General Remarks

The Automatic DB Transmission is a fully automatic 4-speed transmission which eliminates conventional clutching and shifting. Under normal circumstances the transmission changes up and down through the gears in accordance with the speed and the gas pedal position. After setting the desired "driving position" all the driver does is accelerate or brake.

A special characteristic of the Automatic DB Transmission is that the driver can intervene at any time and change to manual shifting depending on driving conditions or the driver's disposition. Below the steering wheel on the steering column or on the transmission tunnel the former gear shift lever has been replaced by a so-called selector lever by means of which, according to prevailing driving conditions (direction and road condition) six different functional ranges of the automatic transmission can be selected. The position of the selector lever is transmitted to a selector lever position indicator mounted on the instrument panel or it is visible on the gear shifting gate on the transmission tunnel so that the driver is always informed about the selected functional range.

b) Functional Ranges

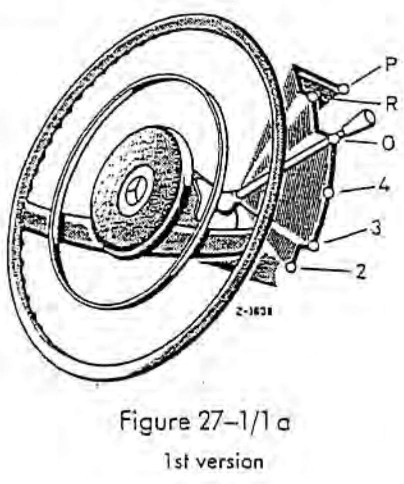


Figure 27–1/1 a

1st version

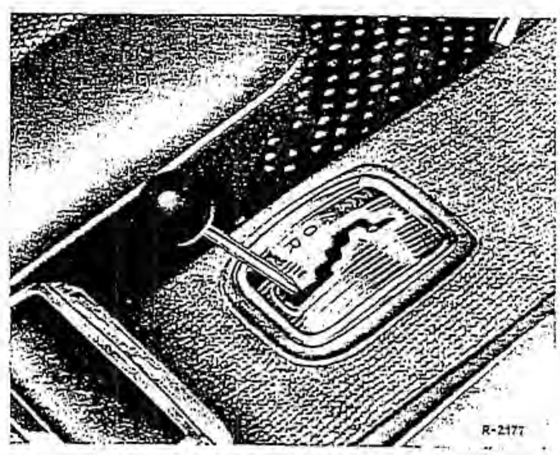


Figure 27–1/2

Floor-mounted selector lever

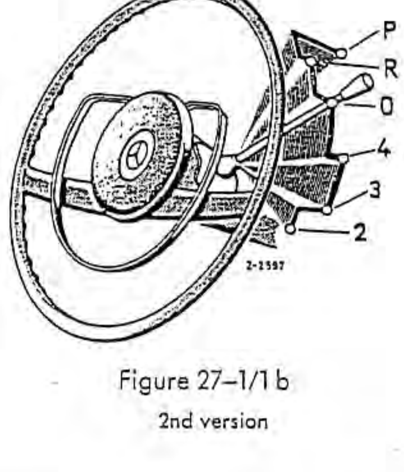


Figure 27–1/1 b

2nd version

P = Parking and starting position
R = Reverse
0 = Idling and starting position
4 = Normal driving
3 = Driving on average grades and slopes
2 = Driving on steep mountain passes, in convoy with repeated starting and with a trailer in the mountains.

Figure 27–1/1 c

For forward driving, where the actual automatic operation occurs, there are 3 selector lever positions (4, 3 and 2) available. The numerals 4, 3 and 2 indicate up to which gear the transmission will change up in each case. The other three selector lever positions, idling (0), reverse (R) and parking (P) are gear positions which are independent of the automatic system. The selector lever is easily moved to the various positions; but it must be raised to pass a notch when "P" or "R" or "2" are selected, also to shift from "P" into another position (Fig. 27–1/1). In the case of the 2nd version the selector lever must also be raised for a shift from position "4" to position "0" (Fig. 27–1/1 b).

Corresponding to the four gear steps for forward driving the entire driving speed range is subdivided into four individual ranges. Within each one of these individual ranges two of the four forward speeds are available, with the exception of the 4th range, in which only 4th gear is available.

In the 1st speed range 1st and 2nd gear are available.

In the 2nd speed range 2nd and 3rd gear are available.

In the 3rd speed range 3rd and 4th gear are available.

In the 4th speed range only the 4th gear is available.

The lower of the two gears in each speed range may be maintained up to its upper range limit on full throttle or kickdown; changing up to the higher of the two gears is already effected earlier when returning from full throttle or kickdown to reduced throttle.

Changing down into the lower one of the two available gears within each speed range is only possible under kickdown.

Basically the pedal position and the shift moment are related as follows:

Opening throttle = late changing-up = heavy acceleration.
Closing throttle = early changing-up = weak acceleration.

Selector lever in position "P" = Parking and starting position

In this position the output shaft of the transmission is locked against a stop in the gear box which in turn blocks the rear axle to prevent unintentional rolling-off of the vehicle. This rolling-off protection is required because a hydraulic clutch has no mechanical connection between engine and rear axle.

Shift selector lever to position "P" only when the vehicle is stopped. When parking be sure to pull the hand brake

The selector lever may be shifted to position "P" with the engine running or stopped. To protect the gears a hydraulic interlock is provided which inactivates any unintentional shifting of the selector lever into position "P" from speeds of approx. 10 km/h (6 miles/h) upwards while driving in forward direction.

The engine may be started with the selector lever in the above position.

Selector lever in position "R" = Reverse

Place selector lever into position "R" only when the vehicle is stopped. For safety reasons a hydraulic interlock will interfere during forward driving from a speed of approx. 10 km/h (6 miles/h) upwards and will make shifting into reverse impossible.

Selector lever in position "0" = Idling and starting position

In this selector lever position there is no positive connection between engine and rear axle. The vehicle can be moved freely (for example, for towing) when the brakes are released.

Do not place selector lever in position "0" at speeds above 30 miles/h (50 km/h)

Similar to selector lever position "P" the engine can be started, while in lever position R, 4, 3 and 2 the electric circuit of the starting motor is interrupted by a starter locking switch.

Selector lever in position "4" = Normal driving

In this selector lever position all 4 forward speeds are automatically successively shifted. In almost all driving conditions position "4" provides optimal driving conditions and is therefore normally used for all drives in the country and in the city. Contrary to the stepless operation of a hydraulic clutch the automatic transmission operates as acted upon by the various control elements such as shift sleeve housing, pressure modulator and pressure step regulator, whose operation depends on the vehicle speed and the position of the accelerator pedal.

By means of the gas pedal the driver is therefore able to influence the moment when shifting should take place. The more he steps on the gas the later will the transmission shift up into the next higher gear. If he releases the gas pedal while the gears run, for example, still in third, the transmission will change up to fourth.

The gas pedal may be moved beyond its full throttle position, which is identified by a pressure point, into an additional kickdown position. In this kickdown position changing-up to the next following gear takes place only at the limit or maximum speed of the respective gear; vice-versa for faster acceleration, shifting-down may be accomplished during normal driving by moving the gas pedal to kickdown position.

Selector lever position "4"

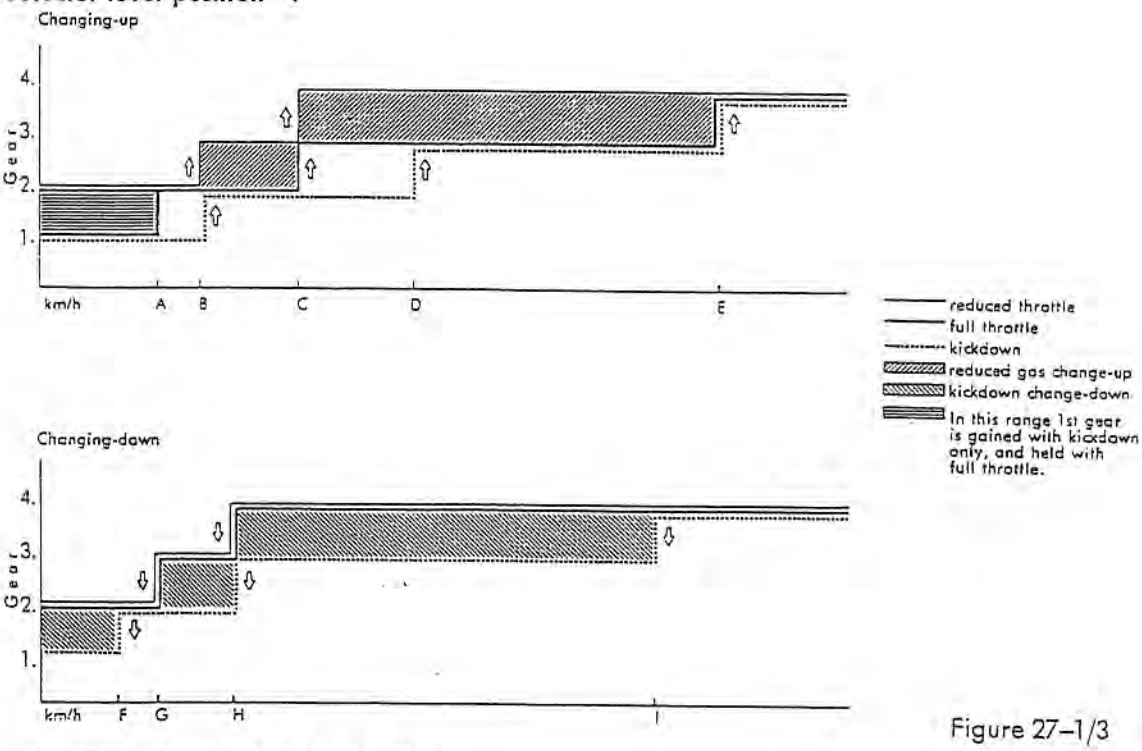


Figure 27–1/3

For speed values see Table Job No. 27–0.

Changing-up

with reduced throttle

If with the vehicle stopped the selector lever is shifted to position "4", the transmission will be in 2nd gear. In reduced throttle position changing-up from 2 to 3 takes place at the earliest at "B" at the latest at "C", changing-up from 3 to 4 at the earliest at "C", at the latest at "E". Please note that the term reduced throttle means the range between idling and full throttle.

at full throttle
Full throttle also starts in 2nd gear. Changing-up from 2 to 3 takes place at "C", changing-up from 3 to 4 at "E".

at kickdown
Kickdown position of the gas pedal permits energetic acceleration because the transmission changes down to 1st gear when starting or below "F". Following this change-down operation at kickdown first gear may be held while applying full throttle.

Changing-up from 1 to 2 takes place at full throttle at "A" and at kickdown at "B", changing-up from 2 to 3 at kickdown at "D", and changing-up from 3 to 4 at full throttle and kickdown at "E". This shows that at kickdown position the 2nd gear may be run up higher than at reduced or full throttle (except with transmission type 1 in which full throttle and kickdown have the same effect).

Changing-down
To prevent shift fluctuations from low into high and vice-versa the hydraulic gear-changing system is set up in such a manner that changing-down takes place at lower speed than changing-up.

at reduced throttle.
Changing-down from 4 to 3 takes place at "H", changing-down from 3 to 2 at "G". Changing-down from 2 to 1 is impossible at reduced throttle.

at full throttle
Changing-down from 4 to 3 at "H",
changing-down from 3 to 2 at "G",
changing-down from 2 to 1 is also impossible at full throttle.

at kickdown
Changing-down from 4 to 3 takes place below "J", changing-down from 3 to 2 below "H" and changing-down from 2 to 1 below "F".

Selector lever in position "3" = Driving on average grades and slopes
Selector lever position "3"

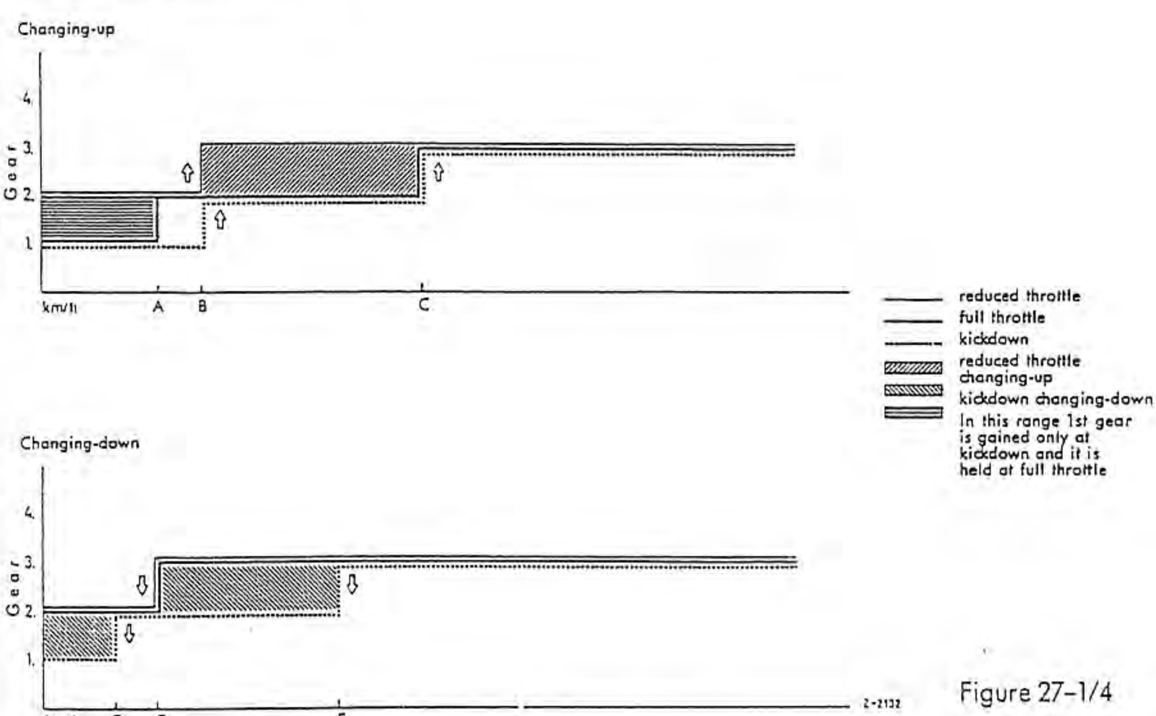


Figure 27–1/4

For speed values see Table Job No. 27–0.

In this selector lever position 4th gear is no longer available. The 3rd gear may therefore be used as braking gear. In this selector lever position "3" starting takes place in 2nd gear at reduced throttle and full throttle.

The speed limit of 2nd gear at full throttle has been raised to "C". Changing-down from 3 to 2 at kickdown takes place below "F". For the rest the operational effect is similar to selector lever position "4". To prevent overrevving of the engine 3rd gear in this selector lever position should be held only up to the permissible maximum speed (see Table in Job No. 27–0). Therefore, the selector lever should be shifted from position "3" to position "4" at this speed at the latest.

Corresponding to this restriction, engine brake engagement by shifting the selector lever from position "4" to "3" should be effected only at speeds below the permissible maximum speed (see Job No. 27–0).

Selector lever in position "2" = Driving on steep mountain passes, in convoy with repeated starting, and with trailer in the mountains

Selector lever position "2"

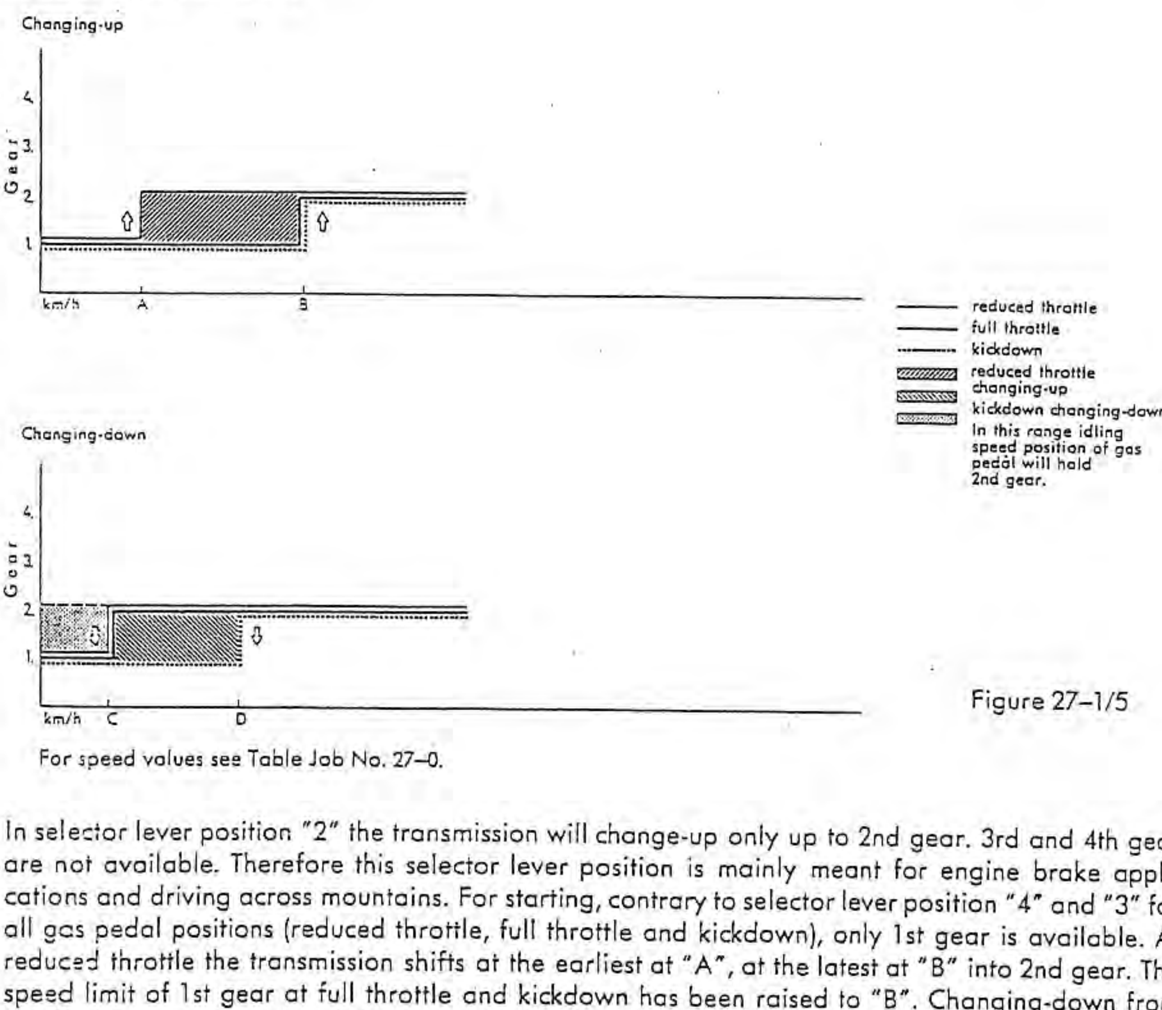


Figure 27–1/5

For speed values see Table Job No. 27–0.

In selector lever position "2" the transmission will change-up only up to 2nd gear. 3rd and 4th gear are not available. Therefore this selector lever position is mainly meant for engine brake applications and driving across mountains. For starting, contrary to selector lever position "4" and "3" for all gas pedal positions (reduced throttle, full throttle and kickdown), only 1st gear is available. At reduced throttle the transmission shifts at the earliest at "A", at the latest at "B" into 2nd gear. The speed limit of 1st gear at full throttle and kickdown has been raised to "B". Changing-down from 2 to 1 takes place at reduced throttle and full throttle at "C", at kickdown below "D". But the transmission does not change-down to 1st gear when the vehicle is coasting to a stop or is braked at idling position of gas pedal.

To prevent overrevving of the engine the permissible maximum speed must not be exceeded in position "2". Engine brake engagement from position "3" or "4" to position "2" should be attempted only when the speed is below the maximum prescribed for position "2" (see Table in Job No. 27–0).

c) **Driving Instructions**

During normal driving conditions both in the country and in city traffic the selector lever should be shifted to position "4". When shifting the selector lever from position "0" or "P" into one of the driving positions the foot brake should be operated because a slight cutting-in bump is unavoidable. This cutting-in bump depends on the speed of the idling gear. **Therefore, when shifting the selector lever into a driving position, never operate the gas pedal; likewise with gear engaged and brake actuated, don't play around with gas pedal.**

During city driving be sure that the brake is actuated when short stops (at traffic lights and road crossings) are the rule and when the selector lever is left in driving position (vehicle creep).

For slow manoeuvring while parking the engine is suitably held to a speed suiting the occasion by stepping on the gas pedal with the right foot, while inching the vehicle along by more or less heavy braking with the left foot.

If the vehicle is stuck in soft ground periodic to and fro movements of the selector lever between position "R" and one of the forward driving positions will rock the car into solid footing. Accelerate slightly for this purpose.

d) **Emergency Start of Vehicle (Towing of Vehicle)**

If for some reason or other the engine cannot be started with the starting motor start as is customary in such a case by having the vehicle towed or by coasting down a slope. For this purpose shift selector lever first to position "0", then switch on the ignition and at a driving speed of approx. 19 miles/h shift selector lever to position "3" or "4". While shifting the selector lever from position "0" to position "3" or "4" the gas pedal should be at reduced throttle.

If the engine is not operated by the rear wheels after engaging a gear, the indication is that the secondary pump cannot yet meet the oil requirements of the transmission. Take selector lever **immediately** back to position "0" and then once again to position "4" or "3" after another minute of towing.

If the vehicle is towed be sure to use a long towing rope and shift selector lever immediately to position "0" the moment the engine is starting up, in order to prevent hitting the towing vehicle.

e) **Towing of Vehicle**

If the vehicle must be towed for some reason or other shift selector lever into position "0". **Towing speed should not be less than 12 miles/h and should not exceed 31 miles/h. If the towing distance is long, if towing can only be done at a "crawling" speed, or if the transmission itself is damaged make sure that the universal shaft is disconnected at the rear axle.**

Maintenance work

Job No.
27–2

Change: Table on oil capacities added

With the engine running, work must only be carried out with the selector lever in position "P" and the handbrake firmly pulled.

During oil level checks and when refilling oil, most careful cleanliness must be adhered to; even the most minute impurity (for instance, fluff) may lead to trouble.

A. Oil level check

Too little oil, as well as too much oil will impair the perfect function of the transmission. Therefore check the oil level **regularly** with the transmission oil dipstick stored in engine compartment.

Check oil level with the engine running, handbrake pulled, selector lever in position "P", with the **vehicle standing on level ground** and **transmission at operating temperature** (approx. 80° C cooling water temperature). Prior to checking, let engine run approx. 1–2 minutes at idling, to permit the hydraulic clutch to fill up.

Measuring:

Pull out oil dipstick, wipe off with a rag free of fuzz (leather, if possible), dip in completely for measuring, pull out again and read off oil level.

Correct oil level:

With the transmission at operating temperature, the correct oil level must be **between the upper and lower dipstick mark.** Too much oil is filled in if the oil level is above the upper mark, too little oil if the oil level is below the lower mark.

Use only specified automatic transmission fluids.

Special instructions:

Fill in lacking oil quantity through a funnel with fine screen **into pipe for oil dipstick** while the engine is running. (We recommend our funnel 111589046300.) Use as reference value: Distance between the upper and lower dipstick mark corresponds to approx. 0.5 ltr. transmission oil.

Watch out for most careful cleanliness.

Due to heat expansion of transmission housing and transmission oil, check oil level only while the transmission is warm. A completely **cooled-down transmission** will indicate an **oil level below the lower dipstick mark** even if it contains the correct oil capacity.

With too **low oil level, air is sucked in** by the oil pump which is clearly audible. The **oil develops foam** which will lead to a **faulty result** when checking the oil level. Shut off engine until oil is de-foamed (approx. 2 minutes), top up with oil and check oil level.

Be sure to drain excessive transmission oil or suck off, because otherwise the transmission gear set has to overcome unnecessary resistance. The temperature rises unpermissibly until the foamy oil is ejected to the breather. The **transmission would be damaged** after **longer operation.**
Sprayer 112589037200 for flushing the oil cooler is suitable for sucking off too much transmission oil when provided with a hose.

When after filling in oil the upper dipstick mark is reached, operate foot brake, set selector lever into positions R–0–4–0–R (leave in each position for a few seconds) and set again to position "P", so that the work pistons of the servo members are coated with oil. Then check oil level again and correct, if required.

B. Oil Change

Observe the following requirements when changing oil: Vehicle on level ground, transmission in hot running condition, engine stopped.

First remove oil drain plug at bottom of transmission and drain oil (Fig. 27–2/1).

Fig. 27–2/1

Then remove cover at bottom of clutch housing by removing the screws and rotate fluid coupling until drain plug (1) is visible (Fig. 27–2/2). Remove drain plug.

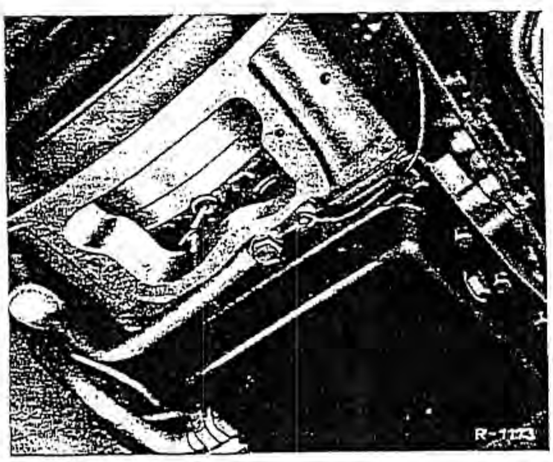


Fig. 27–2/2

1 Fluid coupling drain plug

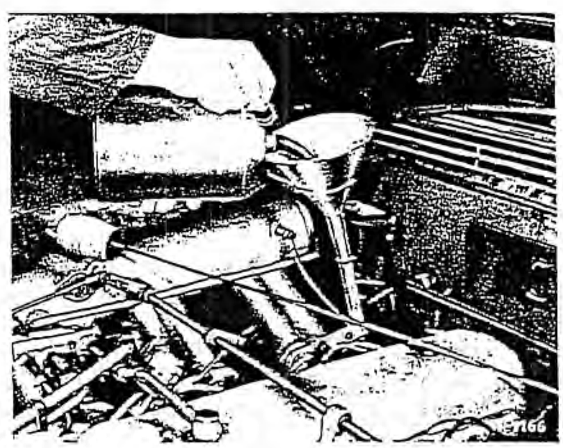


Fig. 27–2/3

When no more oil runs out of transmission and fluid coupling replace both drain plugs and install clutch housing cover.

Use new sealing rings when inserting drain plugs.

Fluid coupling: Seal ring A 12 x 18 DIN 7603 Al 99 F 8
Oil pan: Seal ring A 14 x 18 DIN 7603 Al 99 F 8

Oil capacities

Vehicle models	Oil capacities in liters		Remarks
	for new installations	for oil changes	
190 c, 190 Dc 200, 200 D, 230	4 1/2	3 1/2	without oil cooler
220 b, Sb, SEb 230 S, 230 SL 250 S, 250 SE	4 3/4	3 3/4	with oil cooler
300 SE, 300 SEb, 300 SEL	5 3/4	4 3/4	

At first, fill in a larger quantity of one of the automatic transmission fluids specified by us (refer to specifications for fuels, lubricants and coolants) through the hole for the dipstick while the engine is stopped (all models except model 300 SE: approx. 3 liters, model 300 SE: approx. 4 liters). Start engine and let run at idling in selector lever position "P". Subsequently fill in approx. 3/4 liter of oil slowly (Fig. 27–2/3). Then check oil level with warm oil at operating temperature.

Directly after filling-in, the oil level with correct oil quantity is approx. at the lower dipstick mark. (With warm oil, the oil level reaches the upper mark.)

We recommend to drive at partial throttle after oil changes for about 660 ft. and to check the oil level again. It should be at the lower mark. (Cold transmission oil.)

C. Maintenance instructions

The routine customer service work and oil change intervals are listed in the table below:

Work	After the first 500 km at Chart A	Regulary every	
		5,000 km [1]	20,000 km at Chart E
Oil level check	×	×	—
Retightening bolts on oil pan of transmission (for tightening torque refer to job No. 27–0)	×	—	—
Checking shift and kickdown linkage adjustment (refer to job No. 27–4)	×	—	×
Oil change	—	—	× [2]

[1] and prior to every major long-distance trip and at each engine oil check.

[2] however, at the latest after one year.

Removing and installing the transmission

Job No.
27–3

Change: Deviations of installation work on new models added (marked with)*

A. General

Due to its slightly higher weight, the automatic transmission can only be removed and installed by means of a pit lift or lifting jack which must be provided with a special attachment (Fig. 27–3/1).

This attachment is required to obtain a perfect, untilting support for the transmission. The upper plate of the attachment is resiliently held on the base plate by springs so that the transmission can be moved for convenient removal and installation.

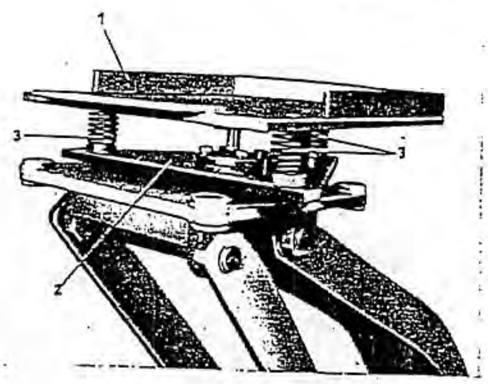


Fig. 27–3/1

1 Support plate 2 Base plate 3 Compression springs

The attachment BE 11 857 can be mounted on any suitable transmission or car lifting jack with slight changes. If it is not supplied as shop equipment by the company, the drawing No. BE 11 857 for making the attachment at your end can be submitted by the dept. Zentral-Planung/Einrichtungen Niederlassungen.

If the special attachments for automatic transmissions are available abroad by the leading companies of the American accessories industry, these can be used after respective changes.

Jack vehicle up at front and rear for pulling out the transmission towards the front or laterally by means of the car or transmission lifting jack. (On model 300 SE, pull out knob for valve unit of air suspension completely.) The dimension from the ground to bottom edge of lifting jack support must be 63–65 cm in this case.

*The following paragraphs describe the removal and installation of the automatic transmission on model 220 SEb. The installation work is carried out in the same way on all other models. However, observe the following differences: Model 300 SE has a larger hydraulic clutch and housing, as well as no flywheel on engine. At the place of the flywheel, a carrier plate of sheet metal is mounted which is attached on the hydraulic clutch by **6 hexagon bolts.**

*On models 200 and 200 D, the hydraulic clutch is mounted by means of 3 times 2 hexagon bolts on the flywheel. There is no trunnion screw on the hydraulic clutch so that there is no definite alignment between flywheel and clutch.
Models 190 c, 190 Dc, 200, 200 D and 230 have no oil cooler.

***Remove radiator prior to replacing a damaged automatic transmission (job No. 50–1). – Flush transmission oil cooler in bottom water box thoroughly with sprayer 112 589 03 72 00, using wash gasoline or kerosene. While replacing the transmission, place oil cooler in vertical position to permit draining and drying up until it is re-installed. (Does not apply for models 190 c, 190 Dc, 200, 200 D, 230.)**

The hydraulic clutch cannot be flushed with standard workshop equipment and must therefore be replaced when the transmission is damaged.

In addition, carefully clean all hydraulic lines which can be re-used for the new automatic transmission.

B. Removal and Installation

Removal:

1. Disconnect minus cable from battery.
2. Drain transmission oil. For the purpose, screw off oil drain plug on oil pan of transmission and on hydraulic clutch (Fig. 27–3/2 and 3).

   Use clean vessel only!
   (Refer also to job No. 27–2, section B.)

Fig. 27–3/2

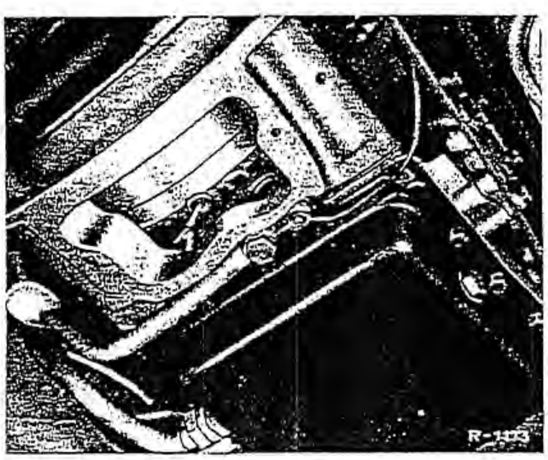


Fig. 27–3/3
1 Clutch oil drain plug

3. Separate feed line (1) and return line (2) for oil cooler from connecting lines (4) (Fig.) 27–3/4).

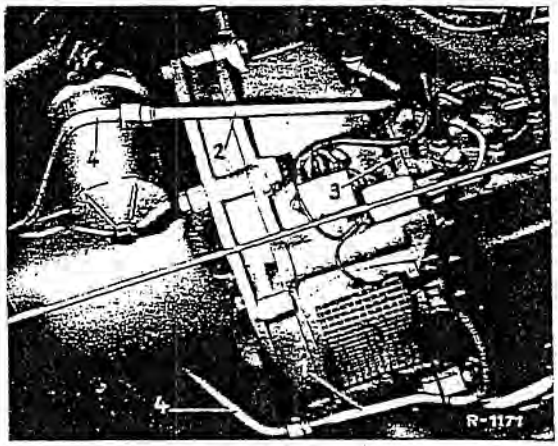


Fig. 27–3/4
1 Feed line to oil cooler
2 Return line from oil cooler
3 Front transmission housing cover
4 Connecting line

4. Remove guard plate (1) for modulating pressure transmitter (Fig. 27–3/5).

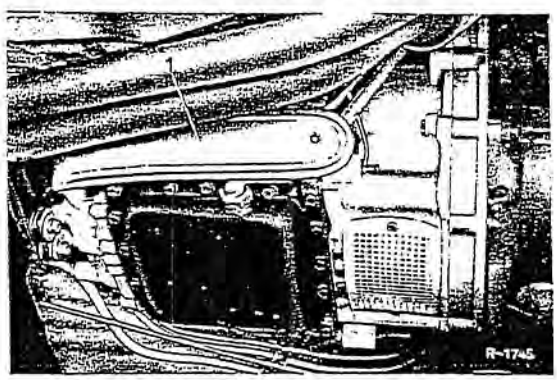


Fig. 27–3/5
1 Guard plate

5. Unscrew underpressure line (1) from modulating pressure transmitter and oil filler pipe (2) from oil pan (Fig. 27–3/6).

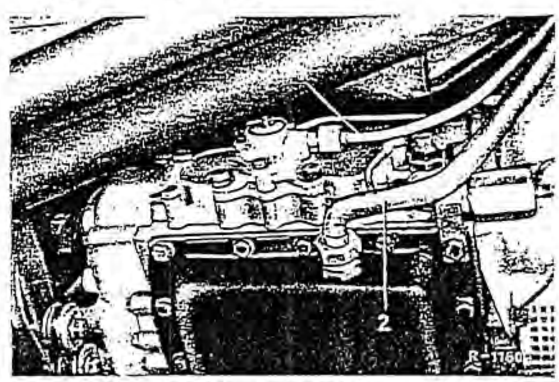


Fig. 27–3/6
1 Underpressure line 2 Oil filler pipe

6. Disconnect hand brake cable from brake lever and pull out of ducts.

7. Remove guard plate (3) for junction block (4). Unscrew electric lines from cable connection, disconnect electric line (1) from oil pressure switch (2) (Fig. 27–3/7).

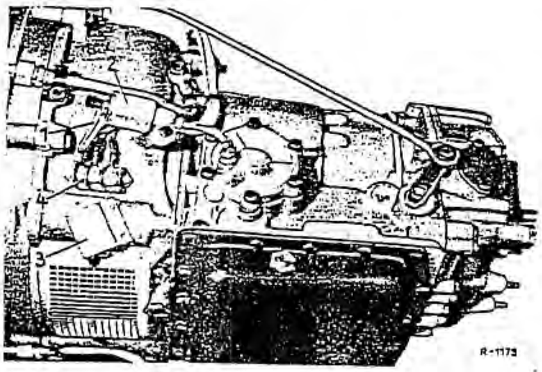


Fig. 27–3/7

1 Electric line
2 Oil pressure switch
3 Guard plate
4 Junction block

Fig. 27–3/7 shows the 2nd type of oil pressure switch arrangement and wiring. All other illustrations show the 1st type.

8. Disconnect speedometer cable (3) from transmission (Fig. 27–3/8).

9. To disconnect selector rod (4) on transmission, place selector lever in position "2" (Fig. 27–3/8).

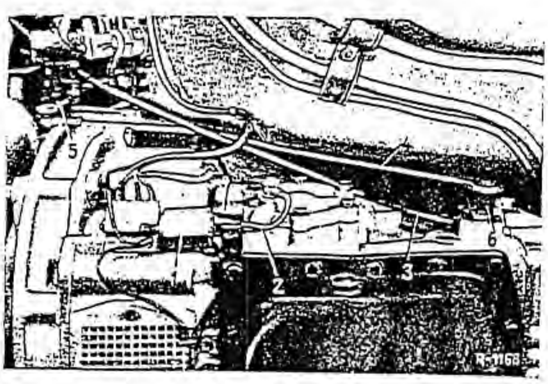


Fig. 27–3/8

1 Oil pressure switch
2 Pressure line
3 Speedometer cable
4 Selector rod
5 Intermediate lever
6 Range selector lever

Remove wire lock on ball socket and remove selector rod from intermediate lever (5). Then press off selector rod from range selector lever by means of a screw driver (Fig. 27–3/9).

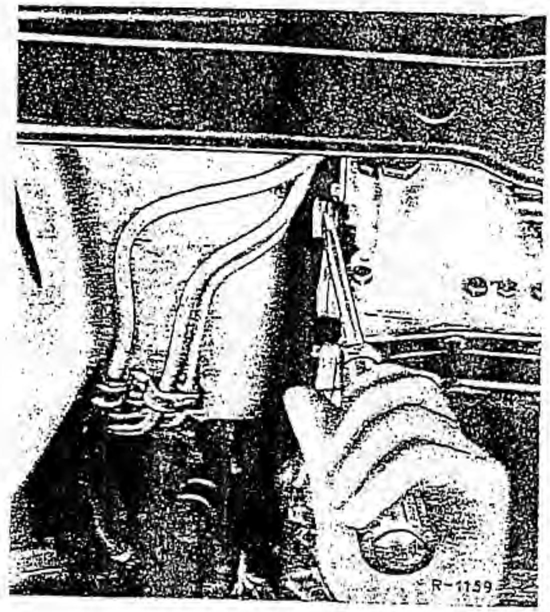


Fig. 27–3/9

10. Remove bracket for front exhaust pipe (1). Remove rubber bearings (2) from rear engine support (3). Remove rear engine support (3) (Fig. 27–3/10).

Prior to removal of the rear engine support, the engine must be supported at oil pan. Place suitable piece of wood between engine oil pan and front axle carrier (Fig. 27–3/11).

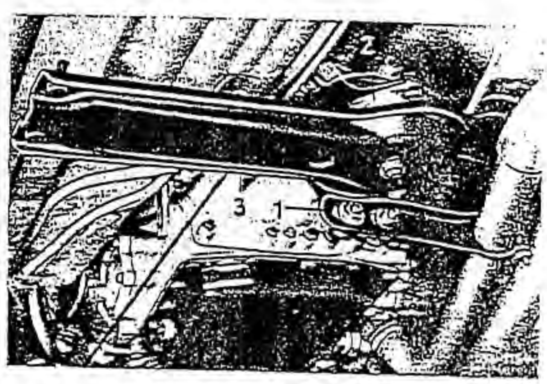


Fig. 27–3/10

1 Bracket for front exhaust pipe
2 Rubber bearing
3 Rear engine support

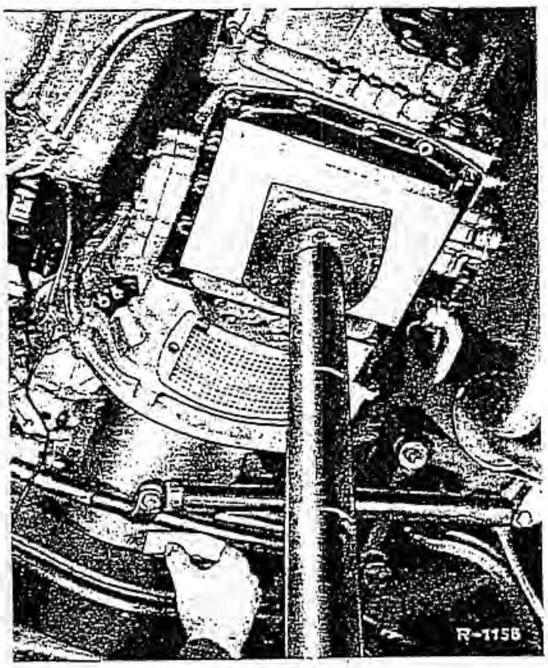


Fig. 27–3/11

11. Remove engine support from rear transmission cover. Disconnect propellor shaft. Loosen and slide back propellor shaft intermediate bearing support.

12. Remove cover plates from transmission housing. Separate fluid coupling from drive plate or flywheel. For this purpose, unscrew 4 allen head screws on all models except 300 SE, and 6 hexagonal bolts on model 300 SE (Fig. 27–3/12).

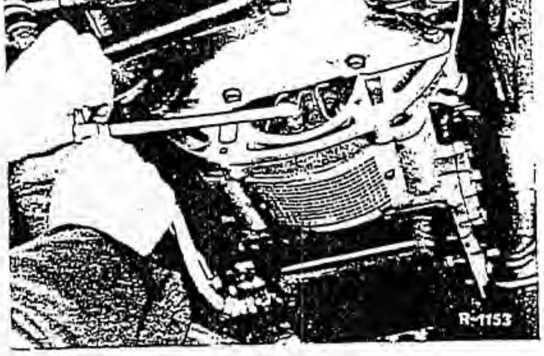


Fig. 27–3/12

13. Remove starter motor attaching bolts.

Note: The top attaching bolt for starting motor may be loosened from inside car through opening in floor pan (Fig. 27–3/13).

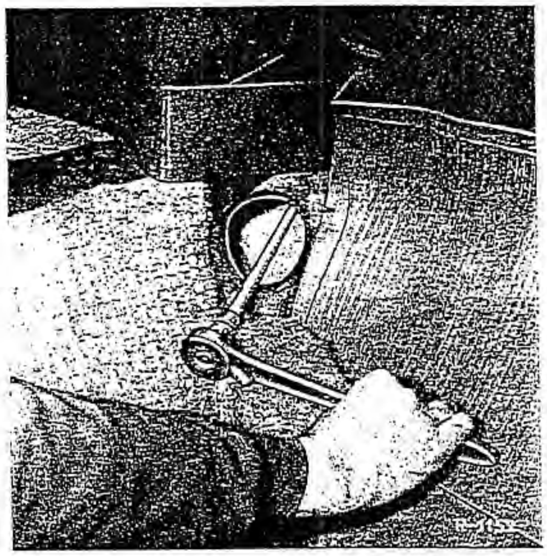


Fig. 27–3/13

14. Remove upper fastening bolts on clutch housing.

Note: Remove fastening bolt at right-hand end from inside vehicle (Fig. 27–3/13). The fastening bolt at left-hand end can be removed only from below car by means of an extended flexible joint wrench.

15. Place vehicle on supporting jacks (Fig. 27–3/14).

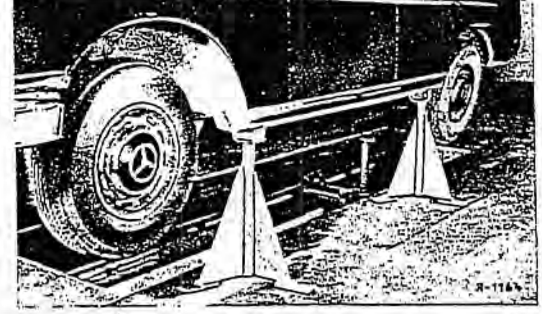


Fig. 27–3/14

16. Cover pit. Slide car jack with transmission supporting top under the vehicle in such a manner that the transmission is supported at oil pan (Fig. 27–3/15).

17. Remove bottom fastening bolts on clutch housing (Fig. 27–3/15).

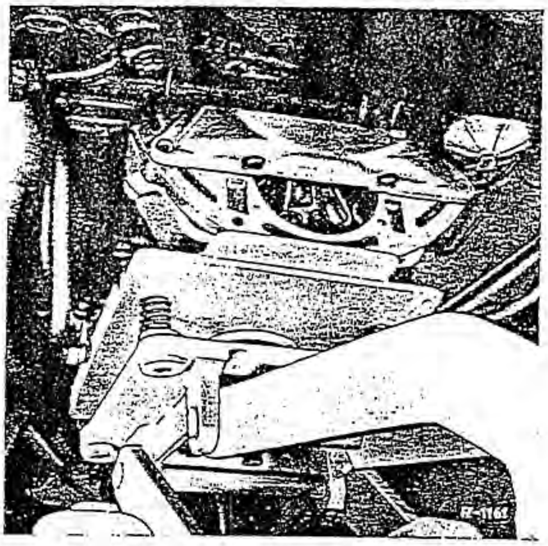


Fig. 27–3/15

18. Push transmission with fluid coupling toward rear axle so that the bearing pin of the fluid coupling no longer touches the intermediate flange during the lowering.

19. Carefully lower car jack and transmission and fluid coupling. Pull jack out toward front (Fig. 27–3/16).

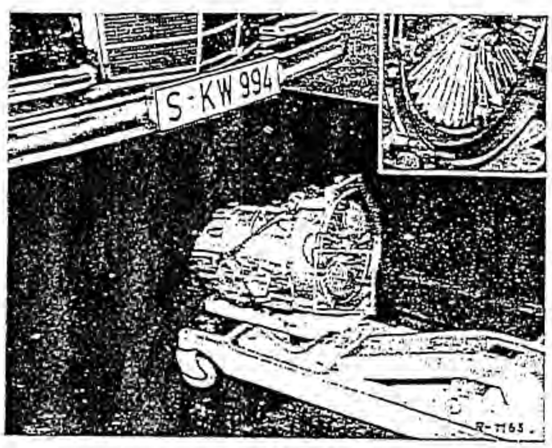


Fig. 27–3/16

20. Remove fluid coupling. For this purpose, screw two M 8 holding bolts into primary rotor. Support transmission vertically and carefully pull out coupling upwardly (Fig. 27–3/17).

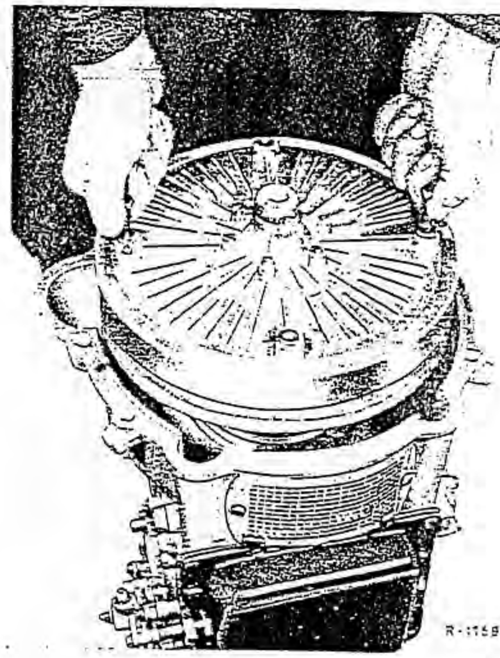


Fig. 27–3/17

Installation:

21. Install fluid coupling. For this purpose, screw two M 8 holding bolts into clutch. Set transmission in vertical position and carefully place clutch on drive shaft (Fig. 27–3/17).

    Prior to installation, observe position of pump gear of primary pump. The drive fingers on the hollow shaft (1) should have the same position of engagement as the pump gear. Move clutch slightly during installation in order to insert drive shaft splines into secondary member of fluid coupling (Fig. 27–3/18).

    Also make sure that during installation of the clutch the sealing lip of radial sealing ring in the primary pump housing is not damaged. The properly assembled clutch will touch the clutch housing with its cooling fins (sliding noises during turning). With transmission installed the clutch is supported and can no longer slide on the clutch housing.

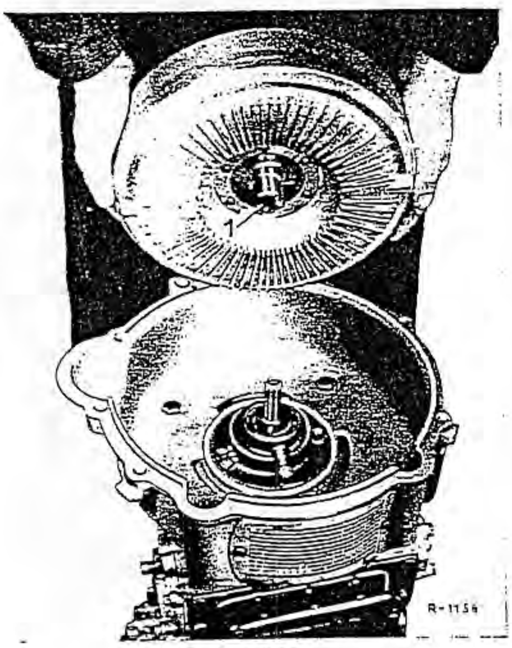


Fig. 27–3/18

1 Hollow shaft

22. Place transmission on car jack. Rotate coupling in such a manner that locating screw points downward (refer to arrow in Fig. 27–3/16).

23. Rotate engine until hole (1) in carrier plate (2) for locating screw of coupling is at bottom (Fig. 27–3/19).

Fig. 27–3/19

1 Hole for locating screw
2 Carrier plate
3 Bearing for coupling

24. Move transmission into place and raise by means of car jack to the point where the lower screw holes of clutch housing align with holes in intermediate flange and locating screw in coupling is in front of carrier plate hole. Push transmission forward until clutch housing abuts fully (Fig. 27–3/20).

Note: Do not use force; check whether locating screw is located in guide.

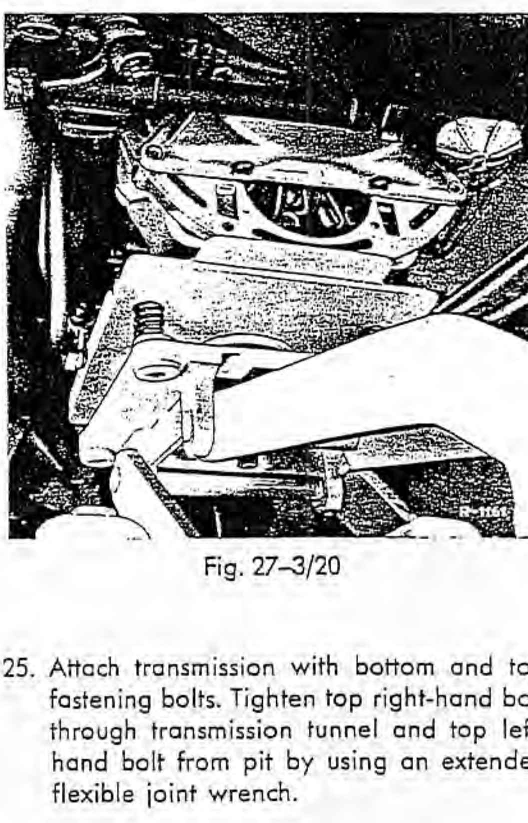


Fig. 27–3/20

25. Attach transmission with bottom and top fastening bolts. Tighten top right-hand bolt through transmission tunnel and top left-hand bolt from pit by using an extended flexible joint wrench.

Note: Car jack may be let down only when engine is supported at oil pan (refer to item 10).

26. Insert allen head screws or hexagon screws with corrugated lock washers into primary rotor of coupling and tighten with torque specified in Job No. 27–0 (Fig. 27–3/21). Assemble cover plates for clutch housing.

27. Remount starting motor.

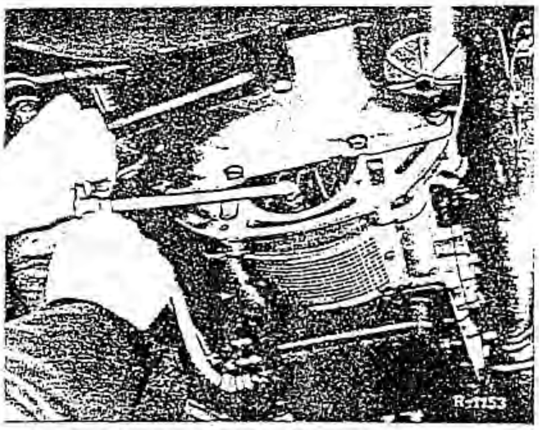


Fig. 27–3/21

28. Reconnect propellor shaft. Fasten engine support to rear gear housing cover and install bracket for front exhaust pipe and rear engine support.

29. Raise transmission slightly with pit lift or car jack and remove wooden block supporting engine (Fig. 27–3/22).

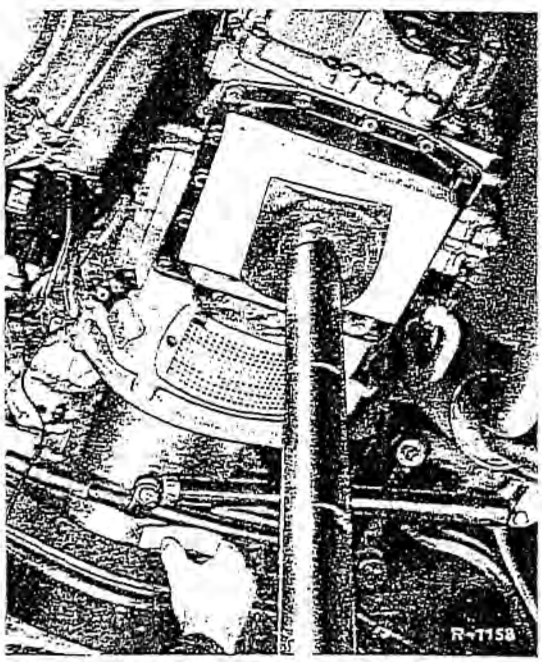


Fig. 27–3/22

30. Attach rubber support to rear engine support.

31. Take vehicle from jacks.

32. Reinstall selector rod. For this purpose, place shift lever (6) and selector lever in position "0". Press selector rod (4) by means of suitable screwdriver to bearing pin of shift lever (6) (Fig. 27–3/23 and 24). Adjust selector rod lengthwise until ball cup is aligned with ball head on intermediate lever (5) (Fig. 27–3/24). Attach selector rod to intermediate lever and install wire lock. Tighten counter nut.

Note: The smaller diameter of plastic bearing in selector rod should always be at transmission end.

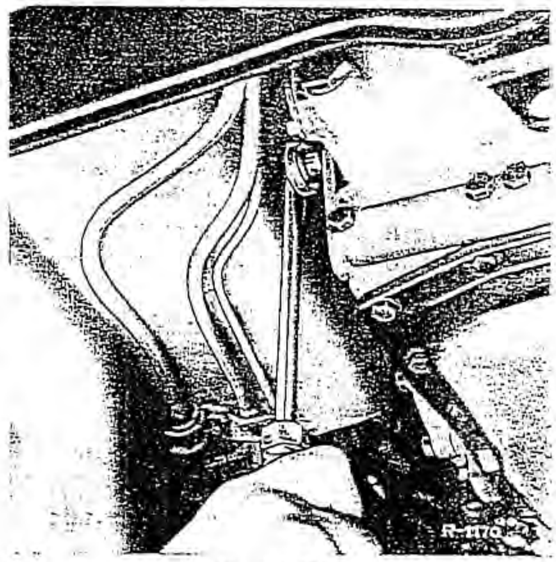


Fig. 27–3/23

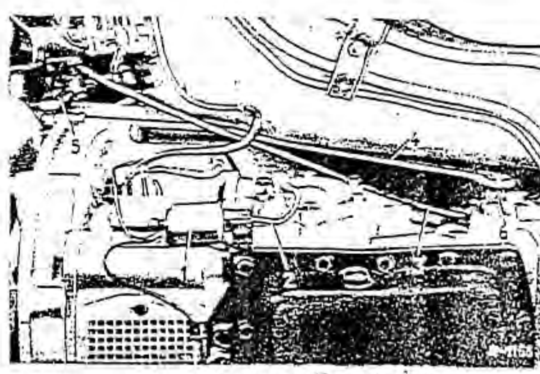


Fig. 27–3/24

1 Oil pressure switch
2 Pressure line
3 Speedometer cable
4 Selector rod
5 Intermediate lever
6 Shift lever

33. For completion of transmission assembly proceed in reverse through the disassembly steps, items 1 to 8.

C. Preparing Replacement Transmissions for Installation

Transmissions as supplied (without clutch housing, lines, etc.) cannot be installed immediately, but require preparation prior to assembly. The parts required for this purpose (Fig. 27—3/25 and 26) are disassembled from the transmission about to be replaced. The pipe lines and oil pressure switches are then carefully cleaned or flushed and dried (do not use compressed air for cleaning oil pressure switch). The are then attached to the exchange transmission. Be sure to use new aluminum sealing rings when fitting pipe lines.

Attention: The double-acting solenoid (12) has been tested and set to its various positions on the transmission test bench. For this reason, the attachment should definitely not be loosened, for example, when inserting the connecting cable of the oil pressure switch (8). If required, the clutch housing (1) should be removed again.

Sequence of preparation:

1. Connecting cable (8) and clutch housing (1).
2. Oil pressure switch (5) with oil pressure lines (6).
3. Oil cooler lines (2) and (9).
4. Retaining clip (4).
5. Cable adaptor (10). (Attach cover plate only after installation of transmission.)

Note: Oil pressure switches (5) with connecting cable (8) are present only in transmissions used for vehicles with injection engines.

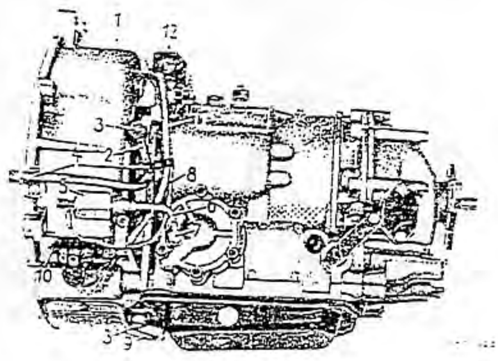


Fig. 27–3/25

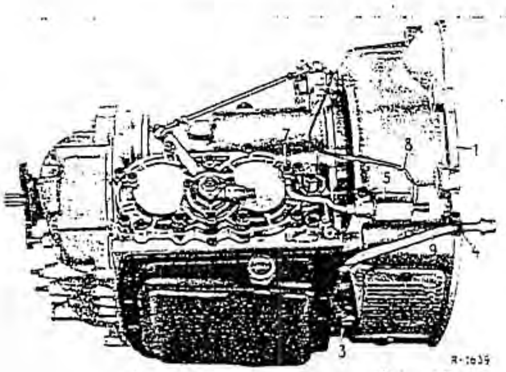


Fig. 27–3/26

1 Clutch housing
2 Return line from oil cooler
3 Hollow screw C 6 DIN 7623
Sealing ring A 12 x 16 DIN 7603 Al 99 F 8
(2 each per hollow screw)
4 Holding clip
5 Oil pressure switch
Sealing ring A 12 x 16 DIN 7603 Al 99 F 8
6 Oil pressure line
7 Hollow screw 112 990 02 63
Sealing ring A 8 x 12 DIN 7603 Al 99 F 8
(2 each per hollow screw)
8 Connecting cable (oil pressure switch)
9 Feed line to oil cooler
10 Cable adapter [1] with cover plate
11 Cable set (double-acting solenoid)
12 Double-acting solenoid

[1] Connections:
Front (small screw): kickdown (grounding wire)
center: lift end (grounding line)
rear (large screw): positive wire

Adjusting Work

Job No.
27–4

Change: Adjustment of additional lever with Fig. 27-4/1 added.

Caution: All adjusting work on the automatic transmission, which is listed in the following, must only be carried out when the front and rear axle is loaded by the vehicle's own weight; that is, the vehicle must stand on its wheels and should not be raised by supporting chocks, lifting jacks, etc.

a) Adjusting the shift rod and starter lock switch (steering wheel shift)

Remove shift rod (7), set range selector lever (8) on transmission and selector lever to "0". Push shift rod (7) by a screwdriver on bearing pin of range selector lever (8). Adjust shift rod so that ball socket coincides with ball head on intermediate lever (3). Suspend shift rod on intermediate lever and lock by a wire lock. Tighten counter nut (Fig. 27–4/1).

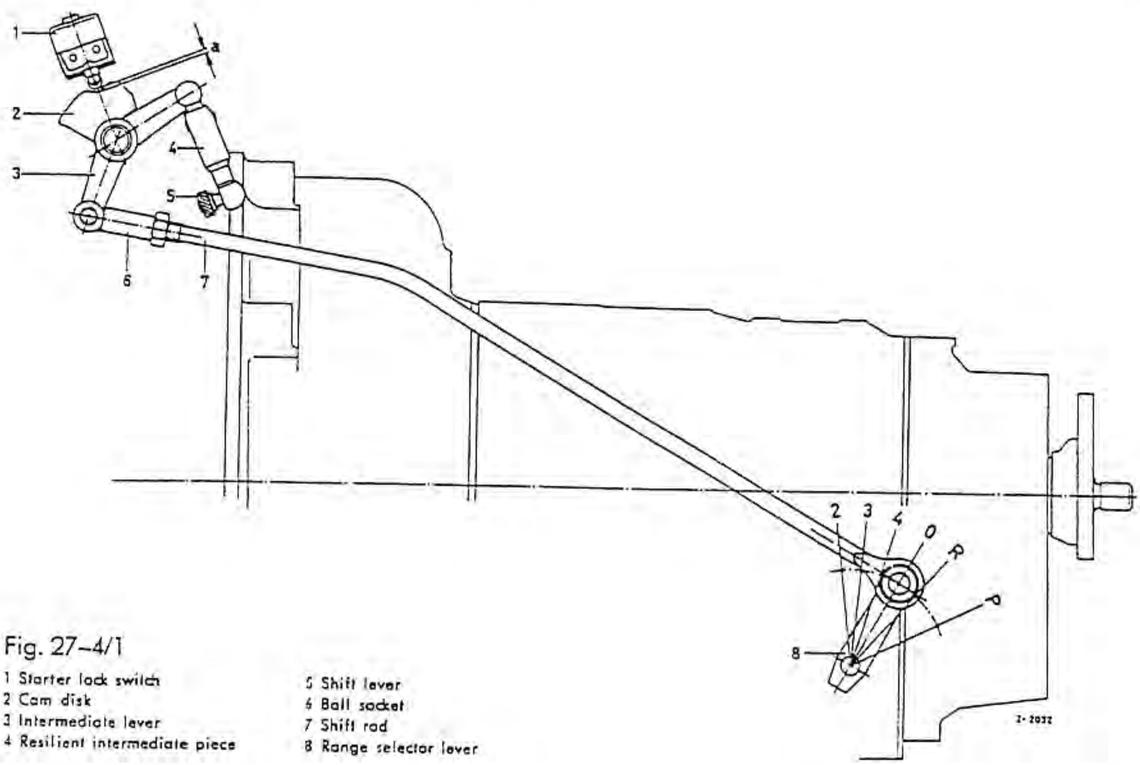


Fig. 27–4/1
1 Starter lock switch
2 Cam disk
3 Intermediate lever
4 Resilient intermediate piece
5 Shift lever
6 Ball socket
7 Shift rod
8 Range selector lever

The shift plunger of starter lock switch (1) should—with a clearance of "a"—always engage one recess of the cam disk (2) in the respective selector lever positions "0" and "P" so that the action of the starter lock is eliminated (Fig. 27–4/1). For dimension "a" refer to job No. 27–0.

Set selector lever to "0". Loosen fastening plate with starter lock switch so far that horizontal shifting is possible. (The fastening plate is provided with an oblong hole and is laterally adjustable, but not in height.) For setting the shift plunger of lock switch which is not visible from above, to center of recess on cam disk, hold a cylinder inspection lamp with mirror behind switch. After adjusting the lock switch, retighten the fastening plate firmly.

Check: Starter should operate in selector lever positions "0" and "P" and must be locked in driving positions (R, 4, 3, 2).

Caution: Operate brake when checking.

b) Adjusting the shift rod, starter lock switch and reversing light switch (center shift)

Remove shift rod (4). Set range selector lever (6) and selector lever (1) to "0", in doing so make sure that between "0" stop of sleeve and selector lever a play of approx. 1 mm exists. Loosen fastening bolts for additional lever so far that the adjusting mark on its upper oblong hole is aligned with the center line of range selector lever (Fig. 27–4/1 b), tighten fastening bolts. The additional lever on model 230 SL is so adjusted that the center lines of both levers are aligned (Fig. 27–4/1 a). Press shift rod (4) on bearing pin on additional lever (5). Adjust adjusting lug (3) so that it coincides with the bearing pin on selector lever bottom section (2). Fine adjustment is possible on the two oblong holes of additional lever (5), if required. Press shift rod on selector lever bottom section (2) (Fig. 27–4/1 a).

The cable pulls (7) which operate the starter lock and reversing light switch, must be so adjusted that starting of the engine is only possible in selector lever positions "0" and "P". The starter must be locked in all other positions. In addition, the reversing lights should light up in selector lever position "R". If required, adjust on adjusting stop (8) (Fig. 27–4/1 a).

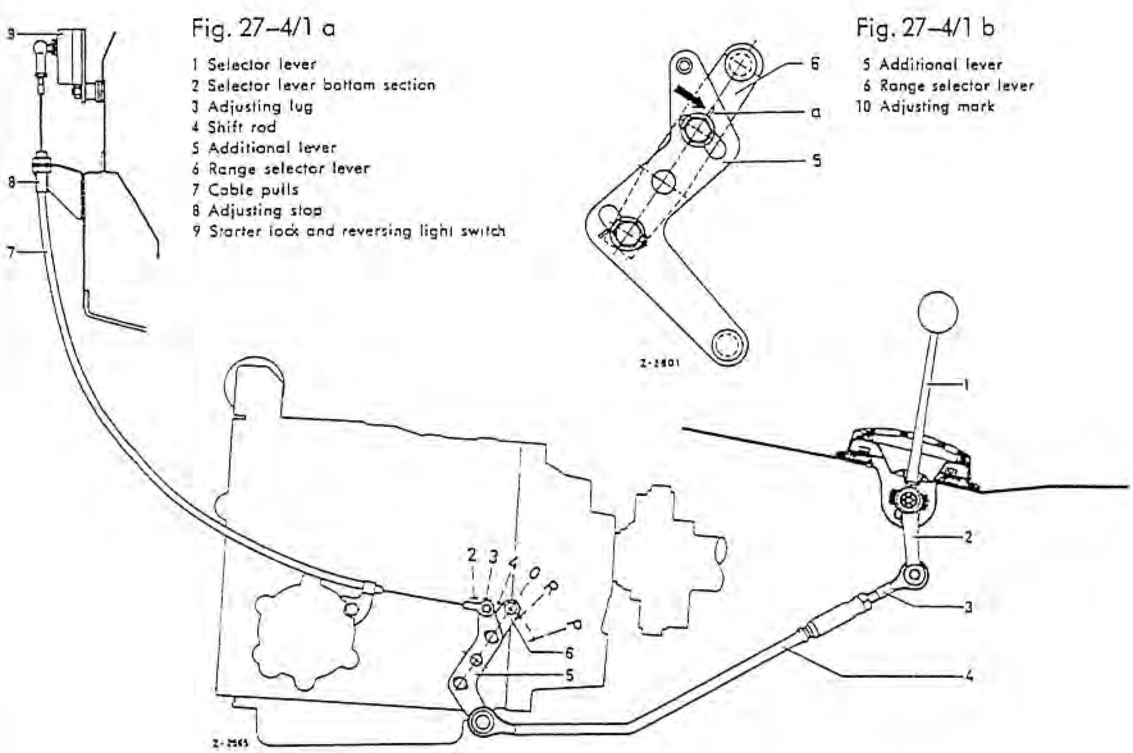


Fig. 27–4/1 a

1 Selector lever
2 Selector lever bottom section
3 Adjusting lug
4 Shift rod
5 Additional lever
6 Range selector lever
7 Cable pulls
8 Adjusting stop
9 Starter lock and reversing light switch

Fig. 27–4/1 b

5 Additional lever
6 Range selector lever
10 Adjusting mark

c) Adjusting the selector lever indication (steering wheel shift)

The selector lever indication is set in selector lever position "0". Cable pulls (3) from shift tube to selector lever indication can be set in length by the knurled nut (4) on selector lever indication (Fig. 27–4/2). For the purpose, loosen counternut (5) and retighten after the adjustment.

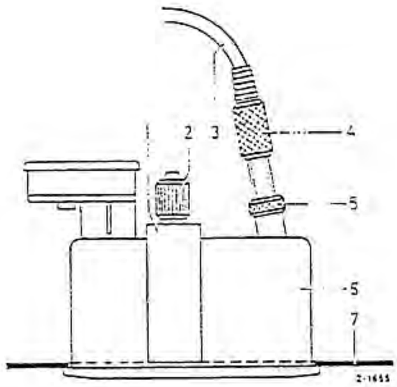


Fig. 27–4/2

1 Clamp
2 Clamp nut
3 Bowden cable
4 Knurled nut
5 Lock nut
6 Housing
7 Instrument panel

d) Adjustment of Kickdown Switch

Screw kickdown switch (4) out of cover plate (2), of the steering column jacket in the direction of the engine compartment, after loosening lock nut (3) (Fig. 27–4/4). Check gas pedal and linkage for easy operation and adjust, if required. The gas pedal should return easily to idling position from both reduced throttle and full throttle.

Screw kickdown switch into the cover plate of the steering column jacket to the point where the throttle valve lever (1) is located approx. $^3/_{16}$" from the full load stop screw (2) (Fig. 27–4/3) while the gas pedal rests against the kickdown switch (position B). When the gas pedal is depressed to kickdown (position C), there should still be a play of approx. $^3/_{64}$" between throttle valve lever and full load stop on the venturi control unit housing. The adjusting lever of the injection pump, on the other hand, should rest against the full load stop (only for cars with injection engines).

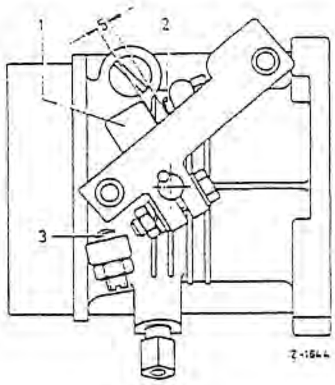
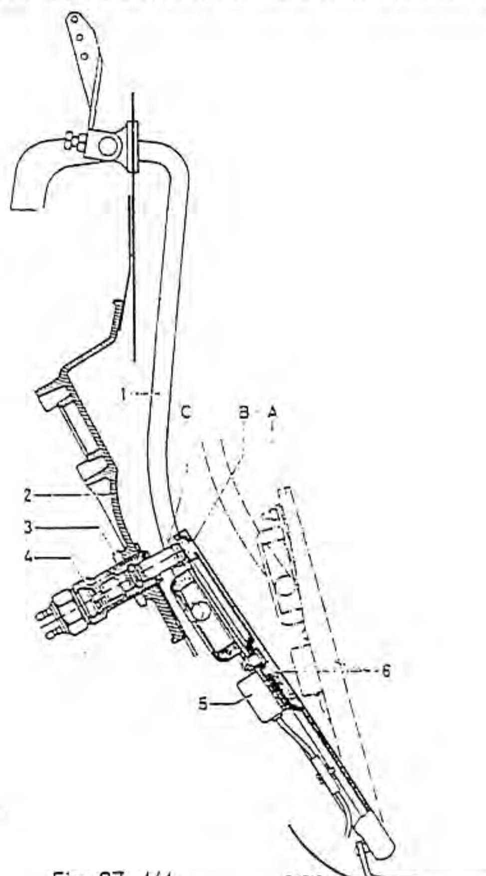
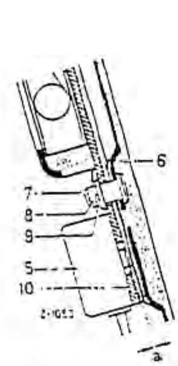


Fig. 27–4/3

1 Throttle valve lever
2 Full load stop
3 Idling load stop





1 Control lever
2 Cover plate
3 Lock nut
4 Kickdown switch
5 Idling switch
6 Foot plate
7 Compensating washer
8 Bolt
9 Cotter pin
10 Plate

A Idling position
B Full throttle position
C Kickdown position

a = .0039 to .0196 " (0.1–0.5 mm)

Fig. 27–4/4

Fig. 27–4/5

e) Adjustment of Kickdown Linkage

When kickdown shifting fails, the kickdown linkage should be checked for proper functioning and the modulating pressure should be checked.

Testing of Kickdown Linkage

For this purpose, operate gas pedal, with ignition switched on and engine stopped, as follows:

With gas pedal not operated (idling position), linkage moves toward the rear.

Gas pedal slightly down (partial to full throttle position), linkage moves to central position.

Gas pedal fully down (kickdown position), linkage moves forward.

If the double-acting solenoid will not move the kickdown linkage into these three positions, there is either an electrical failure (insufficient terminal voltage, short circuit, etc.) or the operating shaft (1) for the modulating pressure control in the brake band piston cover or the modulating pressure control (4) itself is jammed (Fig. 27–4/6).

Measuring of Kickdown Modulating Pressure

For this purpose, connect pressure gauge (84 p.s.i. capacity min.) to test connection (5) (Fig. 27–4/6), disconnect vacuum line from modulating pressure control and run engine at idling speed.

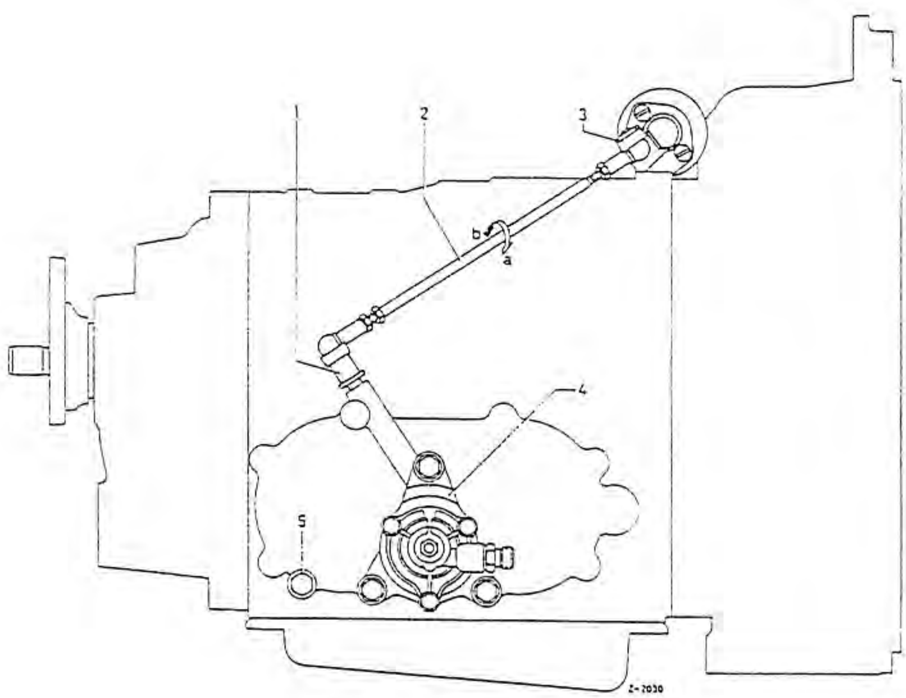


Fig. 27–4/6

1 Operating shaft
2 Linkage
3 Angle lever
4 Modulating pressure control
5 Measuring connection for modulating pressure

Move gas pedal down slightly with right foot while simultaneously operating the kickdown switch with tip of left foot. Read kickdown modulating pressure on pressure gage (for value refer to Job No. 27–0).

Check idle, full throttle and kickdown modulating pressure. If the idle modulating pressure is not reached, the operating lever of the modulating pressure transmitter will not return to its zero position. If required free up the joint of the control rod. **The basic adjustment screw (10) has been set in our works; under no circumstances should its setting be altered (Fig. 27–4/8).**

Adjustment of Control Rod

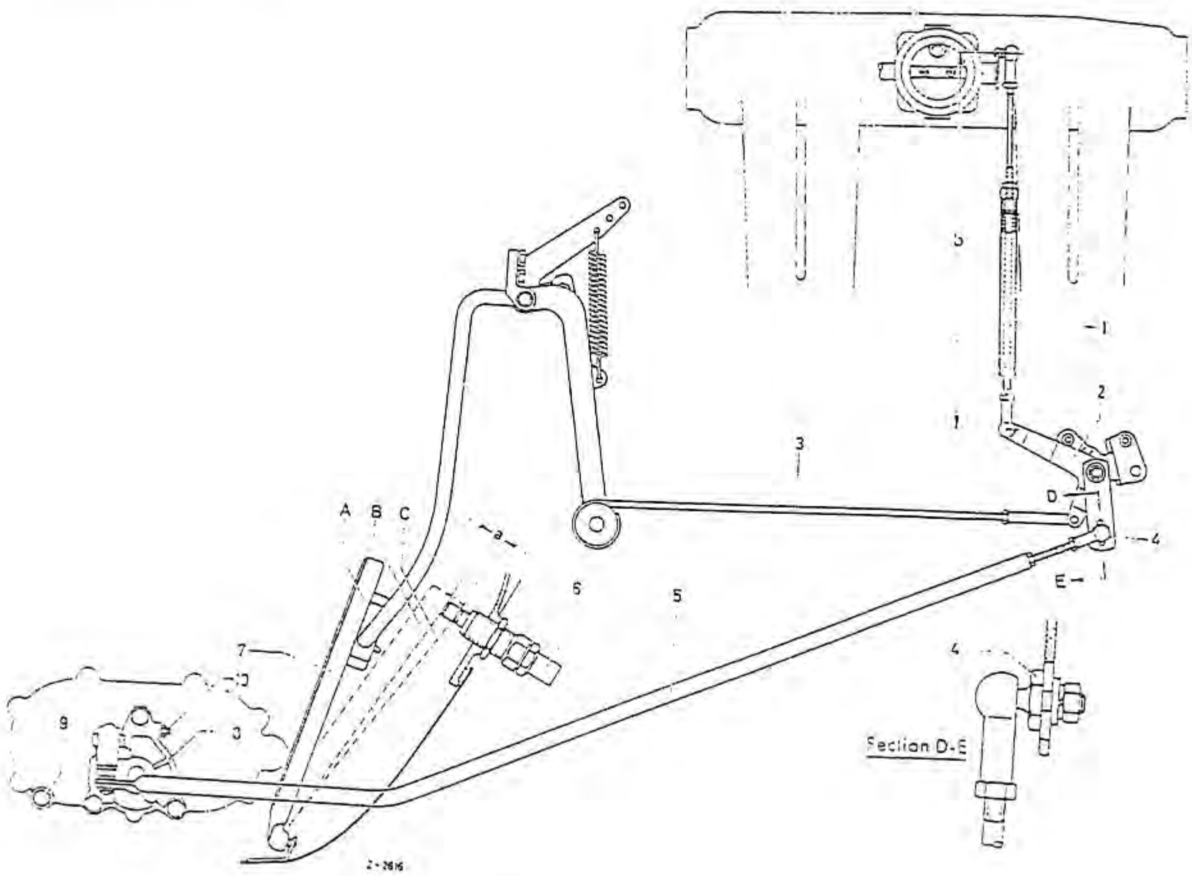


Fig. 27–4/8

1 Spring-loaded connecting rod
2 Angle lever
3 Push rod
4 Ball head
5 Control rod
6 Spring-loaded stop (kickdown change-down)
7 Accelerator pedal
8 Modulating pressure transmitter
9 Test connection for modulating pressure
10 Basic adjustment screw

Positions of accelerator pedal
A Idling B Full throttle C Kickdown
a Kickdown travel
b Non-extended length of connecting rod

If the ball cup of the control rod (5) cannot be pressed on the ball head (4) without forcing, the length of the control rod must be adjusted by means of the threaded member between ball cup and rod. If the throttle valve opens when the ball cup is being pressed on, the rod must be shortened. If the operating lever of the modulating pressure transmitter is lifted off its zero stop, the rod must be lengthened.

If the angular travel at the full throttle point or the full throttle modulating pressure is excessive, the ball head (4) must be shifted upward in its slot; if the angular travel or the full throttle modulating pressure is insufficient the ball head must be shifted downward (Fig. 27–4/8).

Basic Adjustment

A replacement modulating pressure transmitter needs adjustment.

The following tools are required:

Modulating pressure gage and graduated disk.

Turn the control knob of the idle adjustment cable fully to the left (increased idle speed).

Connect modulating pressure gage, attach graduated disk with pointer, detach spring-loaded connecting rod (1) at its lower ball head (Fig. 27–4/8) and run the engine. Detach the control rod (5), shorten it by approx. 5 mm, and reattach. Depress the accelerator pedal (7) to the point where it can be seen on the pressure gage of jumping up to the kickdown pressure. At exactly this moment set the pointer of the graduated disk to the basic adjustment value (see Job No. 27–0).

Shut off the engine, release the accelerator pedal (7), and detach the control rod (5). Let the operating lever of the modulating pressure transmitter rest against the basic adjustment screw (10) (Fig. 27–4/8). Turn the basic adjustment screw until the pointer points to the zero mark on the graduated disk (Fig. 27–4/7).

Attach the spring-loaded connecting rod (1) and adjust the control rod (see above).

Diagnosis Guide

Job No.
27–7

This list makes no claim for completeness and attention should also be paid to combinations of the individual conditions named here.

Prior to any corrections, be sure to complete the basic checkup (refer to gear test Job No. 27–8).

A. Troubles during Operation and when Shifting Manually

Cons. No.	Trouble	Cause
1	Starting Motor cannot be operated	1. Starting motor faulty 2. Selector lever indication is wrong 3. Starter locking switch makes no contact
2	Car begins to move when starter is operated	1. Faulty linkage adjustment 2. Short circuit in starter locking switch
3	Heavy starting jolt	Idling speed of engine too high
4	Engine stalls when driving range is selected	1. Idling speed of engine faulty 2. Engine speed fluctuates (only in vehicles with injection engines): a) Solenoid defective b) Oil pressure earthing switch defective c) Cables or their joints defective or loose d) Fuse blown
5	Excessive creeping of car	Idling speed of engine too high (in vehicles with injection engines: Constant speed solenoid set too high)
6	No power transmission in selector lever position "R", all forward ranges in order	1. Brake band B 3 wrongly adjusted 2. Brake band B 3 or lining mechanically destroyed 3. Clutch K 3 or disk linings mechanically destroyed or burned 4. Too low or no operating pressure a) Shift sleeve 30 stuck b) Round cord ring on plug pipe stuck or damaged c) Lip sealing ring on brake band piston B 3 or clutch piston K 3 damaged

Cons. No.	Trouble	Cause
7	No power transmission in selector lever position "R", in forward positions up to approx. 9 miles/h bad power transmission (slip), particularly when warm. Above 9 miles/h transmission behaves normal. Parking lock cannot be engaged with the engine running	Check valve of secondary pump (15) defective (pressure of primary pump escapes over secondary pump duct)
8	No power transmission in all driving positions (weak forward creeping in all selector lever positions except "P")	Too little or no operating pressure 1. Primary pump out of order
	or shift members engage only at higher engine speeds (approx. 3,000 r.p.m.)	2. Main pressure control sleeve (11) stuck (pressure buildup with increasing engine speed)
9	No return shifting from kickdown	Kickdown modulating pressure too low 1. Double-acting solenoid attains no kickdown position a) Kickdown switch badly adjusted or defective b) Cables or their joints defective or loose c) Fuse blown d) Double-acting solenoid defective 2. Kickdown linkage disconnected, worn or broken 3. Floor mat insufficiently cut out
10	Brake shifting impossible	One or more shift sleeves stuck (sleeves 1, 2, 10, 18, 19, 20, 25, 26)
11	No brake shifting 4,000 ft. above sea level	Double-acting solenoid will not attain lifting position
12	Parking lock is not locking	1. Gear shifting gate on shifting linkage is not accurately adjusted, loose or bent 2. Shifting linkage is not accurately adjusted 3. Secondary pump duct is under oil pressure 4. Interlocking sleeve for parking lock stuck 5. Resilient linkage of parking lock mechanism not accurately adjusted
13	Hydraulic interlock for "R" and "P" ineffective above 9 miles/h	1. Secondary pump supplies no or insufficient oil pressure 2. Sleeve 30 or interlocking sleeve for parking lock stuck
14	Engine will not start when the vehicle is towed	1. Engine defective 2. Sleeve 9 or 11 stuck 3. Insufficient oil pressure

B. Trouble during Automatic Shifting

Cons. No.	Trouble	Cause
1	General shifting trouble, such as: 1. Engine races with driving range selected 2. Irregular shifting 3. Heavily retarded brake shifting, particularly in cold transmission	Generally, the cause is contamination (check by removing oil pan) **Note:** If there are excessive chips or shavings, burned abrasive dust and other foreign bodies, completely disassemble and clean transmission and repair, if required. If the oil pan is clean (individual aluminium chips are unimportant), replacing or repairing the sleeve shift box is sufficient to repair the trouble
2	Engine races in 3rd and 4th gear	Clutch K 1 inoperative 1. Mechanical destruction 2. Insufficient or no operating pressure (sleeve 27 is open)
3	Engine races in 2nd and 4th gear	Clutch K 2 inoperative 1. Mechanical destruction 2. Insufficient or no operating pressure a) Round cord ring on plug pipe stuck or damaged b) Sleeve 28 is open
4	Engine races in 1st and 2nd gear	Brake band B 1 inoperative 1. Mechanical destruction of brake band or lining 2. Brake band does not grip because oil pressure remains at lift end a) Thrust bearing does not close b) Slot ring in sleeve shift box leaks c) Lifting sleeve 18/19 stuck **Note:** re 2a and b Brake shiftings are possible and small torques are transmitted, but engine races at increased throttle because the brake band piston lift end receives pressure over lifting sleeve 18/19 3. Brake band shift end receives insufficient oil pressure a) Quick-action valve in brake band piston is open b) Piston ring heavily leaky
5	Engine races in 1st and 3rd gear	Brake band B 2 inoperative 1. Mechanical destruction of brake band or lining 2. Brake band does not grip because oil pressure remains at lift end a) Thrust bearing will not close b) Slot ring in sleeve shift box leaks c) Lifting sleeve 20 stuck (continued next page)

Cons. No.	Trouble	Cause
5	Engine races in 1st and 3rd gear. (continued)	**Note:** re 2a and b Brake shiftings are possible and small torques are transmitted, but engine races at increased throttle because the brake band piston lift end receives pressure over lifting sleeve 20 3. Brake band shift end receives insufficient oil pressure a) Quick-action valve in brake band piston is open b) Piston ring heavily leaky
6	Engine races when throttle is increasingly opened (all driving ranges)	Modulating pressure too low 1. Double-acting solenoid remains in lifting position (lifting switch makes erroneously contact or has a short circuit) 2. Modulating pressure control sleeve 25 3. Diaphragm portion of modulating pressure transmitter stuck
7	Transmission does not shift beyond 2nd gear	1. Sleeve 7 stuck 2. Control sleeve O 1 is open (no stepped pressure)
8	Transmission does not engage beyond 2nd gear and tachometer does not indicate	1. Regulating pump is not driven 2. Worm gear drive of regulator defective
9	Transmission will not change to 4th gear in selector lever position 4	1. Stepped pressure too low 2. Sleeve 16 stuck 3. Ball valve between regulating pump and secondary pump leaks
10	Upshifts occur independent of gas pedal position (except kickdown) always at full throttle shift points	1. Underpressure line loose or clogged 2. Modulating pressure control sleeve 25 stuck
11	Upshifts occur independent of gas pedal position always at kickdown shift points. Starting always in 1st gear	Constant kickdown modulating pressure 1. Double-acting solenoid remains in kickdown position, electric connections may be interchanged: Cable from constant speed solenoid connected to kickdown 2. Modulating pressure control sleeve 25 stuck 3. Sleeve in modulating pressure transmitter stuck

C. Noises

Cons. No.	Trouble	Cause
1	Chattering, rattling noise with running engine while driving and standing still	1. Primary pump sucks air (oil level too low) 2. Oil strainer soiled
2	Whining noise rising with increasing engine speed	Primary pump loud
3	Whining noise in 4th gear at 48 to 67 miles/h	Angle drive (regulator drive) loud
4	Grunting noise at idling speed	Sleeve vibrations (unimportant flaw, will cause no trouble). Replace shift sleeve housing bottom portion
5	2nd gear loud	Front planet gear set loud
6	Transmission in 3rd gear loud	Rear planet gear set loud

D. Miscellaneous

Cons. No.	Trouble	Cause
1	Badly colored and badly smelling gear oil during oil level checkup	Shift members (mainly disk clutches) burned and destroyed. Generally a secondary damage; the primary damage is often excessively low modulating pressure in full throttle and kickdown ranges, stuck shift sleeves, and the like
2	Heavy exhaust fumes	Diaphragm in modulating pressure transmitter is leaky or destroyed, gear oil reaches intake tube (close underpressure line immediately!)
3	"Creeping" oil losses	1. Diaphragm in modulating pressure transmitter leaks, gear oil reaches intake tube 2. Other leaks

Gear Test

Job No.
27–8

Use the specified test methods to check the normal functions of the automatic DB transmission. Judging its performance and gear trouble, if any, requires obviously some experience in handling automatic transmissions. Where such experience is missing, it will be of advantage to use another automatic DB transmission in good running order for comparison. If malfunctions show up during the test the trouble can be determined by referring to the chapter "Diagnosis Guide" (see Job. No. 27–7).

A. Basic Inspection

Prior to the test be sure to check the oil level (see Job No. 27–2), the idling speed of the engine (refer to Job No. 00–13 and 00–16), proper adjustment of shift rod (refer to Job No. 27–4) of the regulating or gas linkage (refer to Job No. 00–13 and 00–16), the kickdown and lifting switch (refer to Job No. 27–4) and, if installed, the function of the constant speed solenoid.

B. Tests during the Trial Run

Below follows an example for testing the shifting procedure of a model 220 Sb/SEb, partially under the influence of the gas pedal and the selector lever and according to a specified program. (In this connection we refer to chapter "Operation" (Job No. 27–1/A) whose contents are assumed to be known.)

1. Shifting through all gears at reduced throttle.

   Take selector lever position "4" and accelerate slowly at considerably reduced throttle. The transmission is in 2nd gear.
   Shifting up occurs:
   at approx. 16 miles/h from 2nd into 3rd gear,
   at approx. 25 miles/h from 3rd into 4th gear.

2. Shifting down with kickdown.

   Accelerate car to 37 miles/h while holding gas pedal in position, then employ kickdown. The transmission will shift down into 3rd gear.

3. Shifting up at full throttle.

   Return gas pedal to "full throttle" and accelerate. Shifting up will take place at 62 miles/h from 3rd into 4th gear.

4. Brake shifts (gas pedal in idling position).

   Brake car to approx. 50 miles/h and put selector lever into position "3" (downshift into 3rd gear, duration up to beginning of shift: approx 1 sec. max.) Following a deceleration to approx. 31 miles per hour raise selector lever lightly and place in position "2" (downshift into 2nd gear, duration up to beginning of shift: approx. 2 sec. max.). Downshift take place at an increase of engine speed with a distinct braking action on the vehicle.

5. Acceleration with kickdown.

   At a driving speed of approx. 16 miles/h place selector lever again in position "3" or "4", the transmission will shift to 3rd gear. Employ kickdown and hold in kickdown position. The transmission will shift down into 2nd gear for acceleration, at 36 miles/h the transmission will shift up into 3rd gear.

6. Testing the parking lock and reverse gear interlock.

   At a speed of approx. 16 miles/h place selector lever into position "R" and "P" and return into one of the forward positions. In positions "R" and "P" the car should roll freely as if the transmission were in "0" position. Brake vehicle until it stops.

7. Start up with kickdown and accelerate at full throttle.
   Use kickdown in selector lever position "4" and hold at kickdown position. The car will start up in 1st gear and will shift up into 2nd at approx. 16 miles/h.
   Return gas pedal to full throttle and wait at 25 miles/h for the upshift from 2nd into 3rd gear. Brake vehicle until it stops.

8. Starting up in selector lever position "2".
   Use selector lever position "2" and start up at considerably reduced throttle. The car will start up in 1st gear and will upshift into 2nd gear at approx. 9 miles/h.
   Brake down to approx. 5 miles/h; acceleration should result into a shiftdown into 1st gear. Wait for upshift into 2nd gear, then brake car until it stops. The transmission remains in 2nd gear.

9. Reversing.
   Test transmission in reverse gear. Place selector lever into position "R", accelerate car quickly for a short moment and brake again.

Upshifts should occur at **reduced throttle** in such a manner that they will be noticed only when paying attention. At **full throttle** and **kickdown** the shifting gears can be clearly heard, but the new gear step should engage smoothly and the energetic pull of the engine should be maintained. A sudden increase in engine speed during upshift, for example, indicates a slipping servo member (brake band or clutch) and a check should be made (refer to "Diagnosis Guide", Job No. 27–7).

The automatic **downshifts with the throttle closed** occur at very low speeds and can be noticed only by paying particular attention (speed increase of engine). Downshifts under **kickdown**, on the other hand, are noticed by the increase in speed and a clearly felt shifting impact. **Reduced throttle and full throttle do not** initiate a **downshift.** The exception is at selector lever position "2", where at speeds below 6 miles/h acceleration will result in a downshift into 1st gear.

Downshifts with the selector lever are either downshifts under gas (for example on a hill) or brake shifts without gas (for example on a downslope or during decelerations). Downshifts under gas require only fractions of a second for changing gear, while brake shifts without gas require from 1 to 2 seconds.

Make sure that during the test, and particularly under load, there is no excessive shifting. During the shifting operations the servo members develop much heat and dispersion takes some time. A **suggested value is: One shifting operation under load at intervals of 15 seconds max.**

C. Measuring Instruments and their Connections

Each hydraulic unit of the automatic transmission has a special measuring connection for testing the oil pressure (refer to Figure 27–8/3 to 7) so that with the aid of an oil pressure gauge and the pertinent connection the respective oil pressure can be measured. The pressure gauge is suitably connected in such a manner that during the test run the readings can be observed from the driver's seat.

It will be of particular advantage to use an instrument combination having two oil pressure gauges and seven control lights attached to the instrument panel of the car (see Figure 27–8/1 and 2).

The above equipment permits excellent observation of the various shifting operations, the operation of the individual shifting members among each other, alert positions, the two most important pressures (modulating pressure and stepped pressure) and the function of the lifting switch.

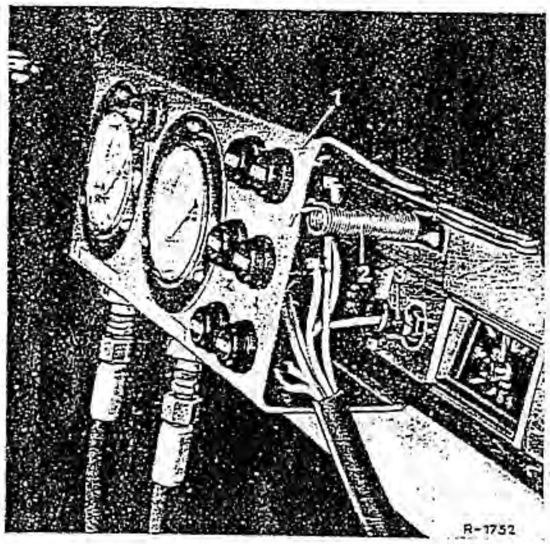


Figure 27–8/1

1 Instrument combination
2 Holding spring
3 Electric plug

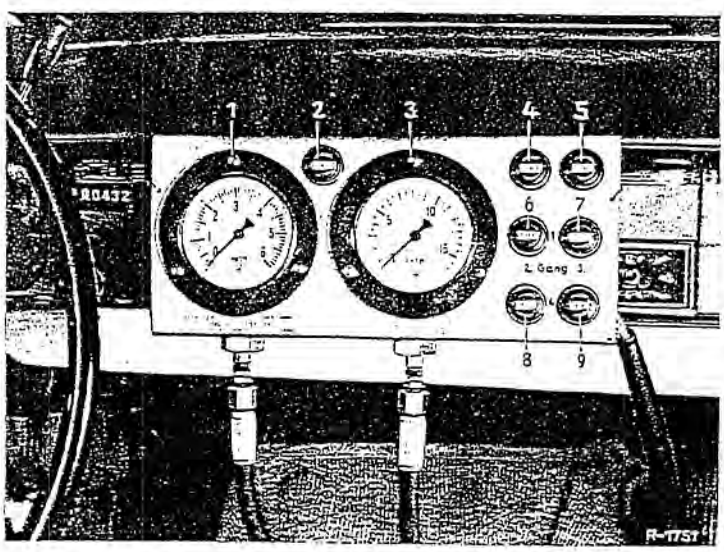


Figure 27–8/2

1 Modulating pressure gauge
2 A = Lifting switch
3 Stepped pressure gauge
4 A B 2 = Lifting pressure B 1
5 A B 2 = Lifting pressure B 2
6 S B 1 = Shifting pressure B 1
7 S B 2 = Shifting pressure B 2
8 K 2 = Shifting pressure K 2
9 K 1 = Shifting pressure K 1

Connection of Test Equipment

The pressure gauges are connected to their measuring joints together with their pressure hoses and adaptors as usual, while the connection of the six control lights shown at the right of the instrument are connected over single-core cables to one oil pressure switch each (sensitivity: 14.2 psi), similar to the connections of the constant-speed control system in cars with injection engines (see Figure 27–8/3). The control lamp for the lifting switch is connected to the central screw of the cable sleeve on the clutch housing (refer to Figure 27–3/25).

If a car is equipped with a constant-speed control system, cable "SB 1" is additionally connected to the already installed oil pressure switch. The connecting cable from the oil pressure switch B 1 to the oil pressure switch B 3 is removed from the latter and directly connected to the main cable.

The eyelets of the oil pressure switches cannot always be directly connected to their pertinent measuring points but occasionally require an adaptor for better accessibility or for reduction (AB 1, K 1, lube pressure, primary pump. The latter two only when required).

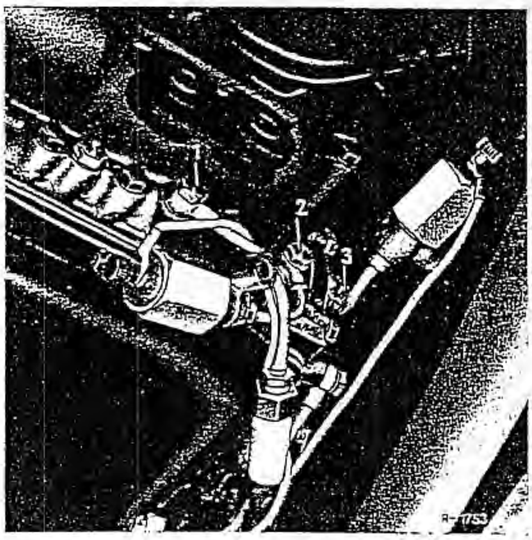


Figure 27–8/3

1 Hydraulic connection stepped pressure
2 Electric connection AB 2
3 Electric connection SB 2

Measuring joints on transmission:

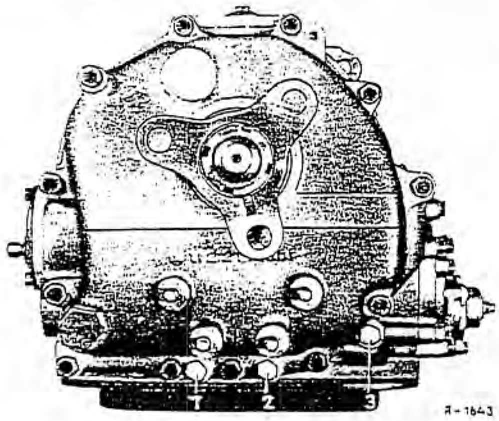


Figure 27–8/4

1 Secondary pump
2 Stepped pressure
3 Lifting pressure B 2

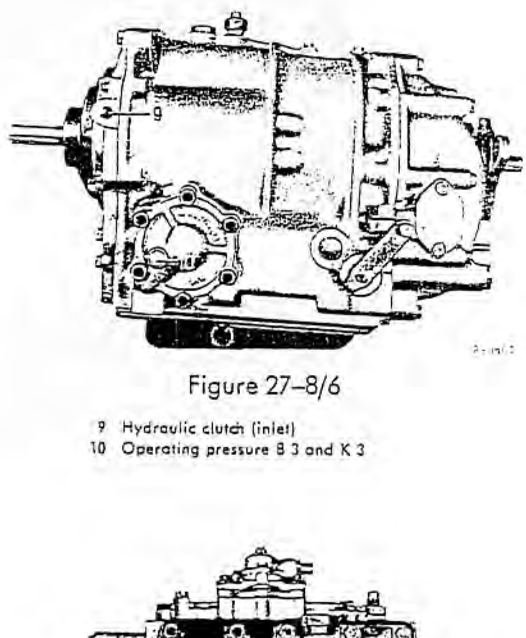


Figure 27–8/6

9 Hydraulic clutch (inlet)
10 Operating pressure B 3 and K 3

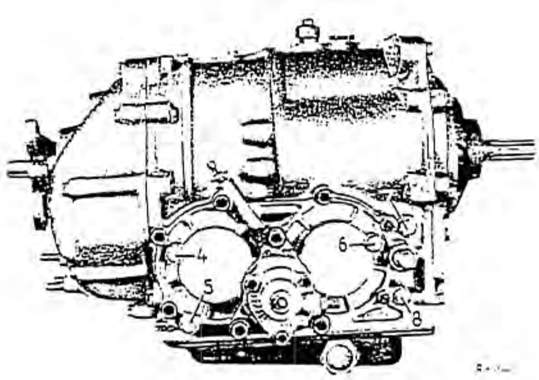


Figure 27–8/5

4 Shift pressure B 2
5 Modulating pressure
6 Shift pressure B 2
7 Lifting pressure B 1
8 Operating pressure K 2

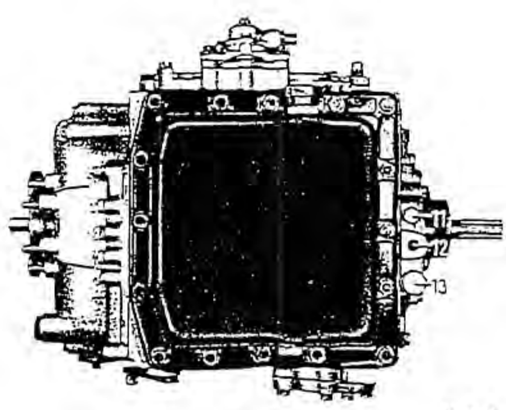


Figure 27–8/7

11 Operating pressure K 1
12 Lubricating pressure
13 Primary pump

D. Rated Pressures in dependence of given Driving Conditions

a) Modulating Pressure

Prior to testing all pressures measure the modulating pressure with the engine running, the hand brake pulled and the selector lever in position "P" and adjust, if required. The work requires a precision oil pressure gauge (accurate up to 0.7 psi, scale limit 84 psi, or the test instrument named under C). Accurate adjustment of the modulating pressure will automatically result in the required operating pressures.

Measuring

Disconnect underpressure line from modulating pressure transmitter and attach pressure gauge to the joint provided for this purpose. Keep engine running.

Gas pedal in idling position (lifting switch operated):
basic pressure

Reduced throttle up to full throttle (tap gas pedal only lightly):
maximum pressure

Kickdown (tap gas pedal lightly with right foot and operate kickdown with left foot):
kickdown modulating pressure

Check diaphragm in modulating pressure transmitter with underpressure line connected and fuse No. 3 temporarily removed:

From an underpressure of 10 psi:
modulating pressure = basic pressure.

For values see Job No. 27–0.

Adjusting

The basic pressure cannot be adjusted. If it is outside the specified limits the spring of the control sleeve modulating pressure does not meet the permissible values or the control sleeve modulating pressure or the control sleeve operating pressure is stuck.

To adjust the **maximum pressure** remove seal at adjusting screw of modulating pressure transmitter. Loosen counter nut and regulate pressure by means of adjusting screw. Turning clockwise: Increased pressure, turning counter-clockwise: reduced pressure. One revolution corresponds to a change in pressure of approx. 2.1 psi.

Reattach seal on adjusting screw after adjusting pressure.

If there is insufficient pressure increase from maximum to kickdown modulating pressure check **adjustment of linkage and input voltage on double-acting solenoid** (for linkage adjustment on transmission refer to Job No. 27–4).

b) Stepped Pressure

The stepped pressure is generated by the regulating pump and is changed to the required value by the centrifugal governor by means of centrifugal and safety valves.

Automatic changing-up and down as well as shifting back from kickdown are determined by the stepped pressure, that is, the jump of the stepped pressure to its next higher value results at reduced throttle in an upshift into the next higher gear, which means that changing back from kickdown is no longer possible when the maximum stepped pressure has been attained (also refer to Job. No. 27–1).

If there is no stepped pressure or the various pressure steps indicate deviating values (see Job No. 27–0), remove bearing cap with governor after removing the rear gear box cover.

Note: The transmission itself need not be removed, but a bolt should be screwed into the rear gear box wall to keep the gear sets from falling apart.

The stepped pressure can be adjusted by adding washers (see Job No. 27–0).

c) Operating Pressures (Successive Shifting of all Shift Steps)

The operating pressures cannot be adjusted, they come up automatically at the various operating conditions.

The relative tables (see Job No. 27–0) contain all the pressures required for perfect functioning of the hydraulic controls of the automatic transmission. They refer to the test instrument named under C. Suitable arrangement of the lights at the right of the test instrument indicates for each gear step a typical "signal code", that is, the lighting up of respective lamps indicates the gear step employed at the moment. **If an individual operating pressure requires measuring, use the stepped pressure gauge.**

Note for using the tables:

A numeral on the table means:

1. Oil pressure of the respective hydraulic member when connecting pressure gauge.
2. Lighting up of the respective signal lamp when electrically connected.

Pedals

Group 29

Control System

Group 30

Job No.
29-0

Pedals

General Data, Dimensions, and Tolerances

Modification: Two-Circuit Brake, Models 230 SL and 300 SE with Mechanical Transmission added

Supply Cylinder and Extraction Cylinder

Model	Version	Supply Cylinder		
		Stroke mm	Nominal diameter in inches	Nominal diameter in mm
190 c, 190 Dc	1st and 2nd	34		
220 b, 220 Sb, 220 SEb	1st	30	3/4"	19.05
220 b, 220 Sb, 220 SEb	2nd	34		
220 b, 220 Sb, 220 SEb	3rd			
230 SL	—	34	15/16"	23.81
300 SE[1])	—			
Model		**Extraction Cylinder**		
190 c, 190 Dc, 220 b, 220 Sb, 220 SEb	1st	minimum 21[2])	13/16"	20.64
190 c, 190 Dc	2nd	minimum 23[2])		
230 SL (1st vers.), 220 b, 220 Sb, 220 SEb	2nd		1"	25.4
300 SE[1])	—	minimum 18[2])	1 1/8"	28.57

[1]) With mechanical transmission

[2]) If the clearance between piston rod and piston of the supply cylinder and the specified clutch pedal travel is adjusted correctly, this minimum stroke on the extraction cylinder must be obtained when the clutch pedal is pressed down.

Adjusting Dimension (continued on next page)

Model	190 c, 190 Dc, 220 b 220 Sb, 220 SEb, 300 SE	190 c, 190 Dc, 220 b, 220 Sb, 220 SEb, 230 SL, 300 SE
Brake system	Single-circuit brake	Two-circuit brake
Free play of the push rod of the extraction cylinder up to the contact of the throw-out bearing with the throw-out forks of the clutch pressure plate	4[1])	
Clearance "a" between piston and piston rod of the supply cylinder (see Fig. 29-6/1)	0.1—0.2[1])	
Clearance "a" between piston and piston rod of the master cylinder (see Fig. 42-3/1)	0.5—0.7	—
Free play of brake pedal	approx. 4—5	no play[2])

[1]) On Model 300 SE with mechanical transmission.

[2]) On models with power-brakes T 51/100 and T 51/200 there is no play.

Adjusting Dimensions (continued)

Model	Brake system	Control dimension "b" (see Fig. 29-2/1) Brake pedal	Control dimension "b" (see Fig. 29-2/1) Clutch pedal	Pedal travel "d" to the cowl (see Fig. 29-2/1) Brake pedal	Pedal travel "d" to the cowl (see Fig. 29-2/1) Clutch pedal	Adjusting dimension "c" (see Fig. 29-2/1)
190 c, 190 Dc	Single-circuit brake	48,5	44.5	approx. 168	approx. 163	67 + 1
190 c, 190 Dc	Two-circuit brake	63.5	—	approx. 152	approx. 163	67 + 1
220 b, 220 Sb, 220 SEb 1st version	Single-circuit brake	45.5	41.5	approx. 152	approx. 147	61 + 1
220 b, 220 Sb, 220 SEb 2nd version	Single-circuit brake	45.5	44.5	approx. 152	approx. 163	
220 b, 220 Sb, 220 SEb, 230 SL, 300 SE	Two-circuit brake	63.5	—	approx. 152	approx. 163[1]	67 + 1[1]
300 SE	Single-circuit brake	45.5	44.5[1]	approx. 152	approx. 163[1]	61 + 1[1]

[1]) Model 300 SE with mechanical transmission

Piston Rod, Push Rod, and Pressure Pin

Model		220 b, 220 Sb, 220 SEb 1st version	220 b, 220 Sb, 220 SEb 2nd version	190 c, 190 Dc, 300 SE[1]) 1st version and 220 b, 220 Sb, 220 SEb, 3rd version	230 SL and 190 c, 190 Dc, 300 SE[1]) 2nd version 220 b, 220 Sb, 220 SEb, 4th version
Piston rod	Part No.	111 290 09 39		111 290 16 39	110 290 18 39
	Length "L" (Fig. 29-3/4)	46		56	100
Push rod	Part No.	111 295 05 33	111 295 07 33		
	Length	49	43		
Pressure pin	Part No.	000 295 00 74	000 295 01 74	000 295 03 74	
	Length	38	45	53	

[1]) Model 300 SE with mechanical transmission.

Removal and Installation of Support together with the Pedals

Job No.
29-1

Modification: Pedal system with Inside Supply Cylinder added

A. Pedal System with Outside Supply Cylinder

Removal:

1. Take off the cover below the instrument panel.
2. Unscrew the bearing bracket (21) for the ratchet from the support (Fig. 29-1/1).

Note: In the case of models that are equipped with a hand-brake warning light take the plug out of the switch.

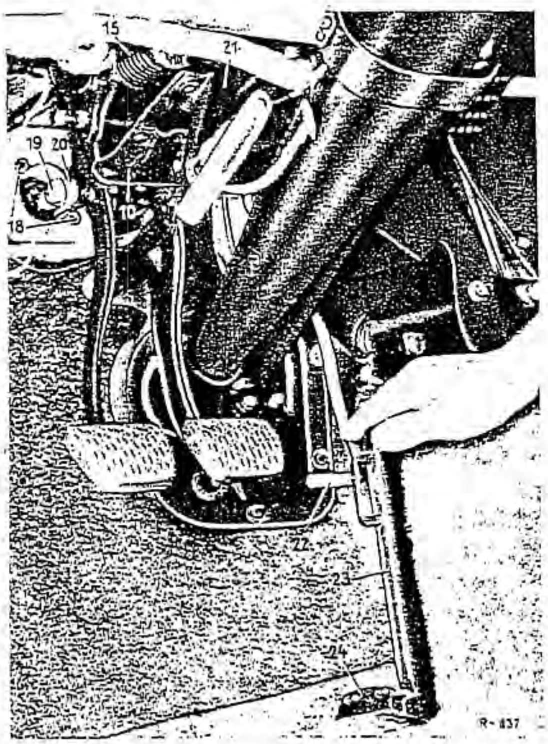


Fig. 29-1/1

10 Stop
15 Pressure spring (dead center spring)
18 Hexagon screw
19 Adjusting screw
20 Piston rod
21 Bearing bracket for ratchet
22 Adjustment lever
23 Foot plate
24 Bracket with ball heads

3. Unscrew the wing nut fastening the instrument cluster, and pull out the instrument cluster a little way. It is not necessary to disconnect the cables at the instrument cluster.
4. Unscrew the two hexagon nuts (1) and remove together with washer (2) (Fig. 29-1/2).

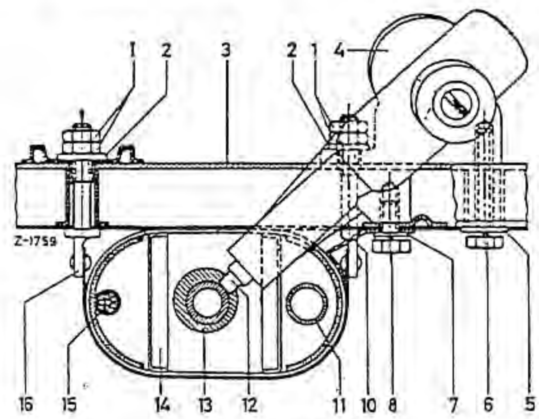


Fig. 29-1/2

1 Hexagon nuts for tightening strap
2 Washer
3 Cross member
4 Steering lock
5 Washer
6 Hexagon screw with lock washer
7 Washer
8 Hexagon screw with lock washer
10 Bracket on steering column jacket for attachment of steering lock
11 Shift tube
12 Lock bolt of the steering lock
13 Lock ring on steering tube
14 Steering column jacket
15 Wiring harness for flash signal switch and signal horns
16 Tightening strap

5. Unscrew the hexagon nuts of the two hexagon screws with which the support and the brake master cylinder are fastened to the intermediate flange and the cowl.
6. Remove the support together with the pedals paying attention to the shims (20) which are installed between the cross member (18) and the support (7) (Fig. 29-1/3).

Installation:

7. Fasten the support together with the pedals to the cowl and the cross member. Make sure that the piston rods for the supply cylinder and the brake master cylinder properly engage the pistons of the cylinders.
8. Measure the travel "d" of the brake pedal from the released position to the contact of the pedal with the cowl. The travel specified in Job No. 29-0 must be obtained.

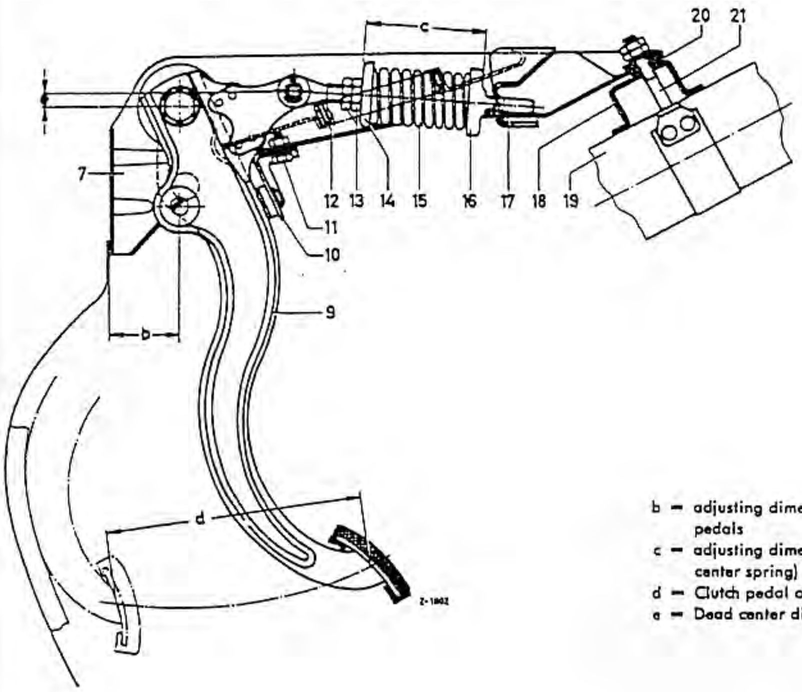


Fig. 29-1/3

7 Support for pedals
9 Clutch pedal
10 Bracket and stop
11 Hexagon screw
12 Return spring for brake pedal
13 Hexagon nut
14 Spring retainer
15 Pressure spring (dead center spring)
16 Spring retainer
17 Push rod
18 Cross member
19 Steering column jacket
20 Shim
21 Tightening strap

b = adjusting dimension of clutch and brake pedals
c = adjusting dimension of pressure spring (dead center spring)
d = Clutch pedal or brake pedal travel
e = Dead center dimension

If this is not the case disconnect the support again and put a shim 111 589 00 75 (20) between cross member (18) and support (7).

Note: The brake pedal travel from release position to contact with the cowl has been carefully fitted into the overall design and must be adjusted with the utmost care. The dimensions given in Job No. 29-0 must be considered an absolute minimum.

The best method of measuring the brake pedal travel is to use a tape to determine the distance between brake pedal plate center and lower edge of signal horn ring. Then back out a bleed screw and depress the brake pedal until it rests against the cowl. Brake travel is the difference between these two measurements. Close the bleed screw before releasing the brake pedal.

9. Check and adjust the clearance "a" between the piston rod on the clutch pedal and the piston of the supply cylinder (see Job No. 29-6, Section A).

10. Check and adjust the clearance "a" between the piston rod at the brake pedal and the piston of the brake master cylinder (see Job No. 42-20, Section B).

B. Pedal System with Inside Supply Cylinder

Removal:

1. Remove the cover below the instrument panel.

2. On Model 230 SL remove the revolution counter (see Job No. 54-11, Section B).

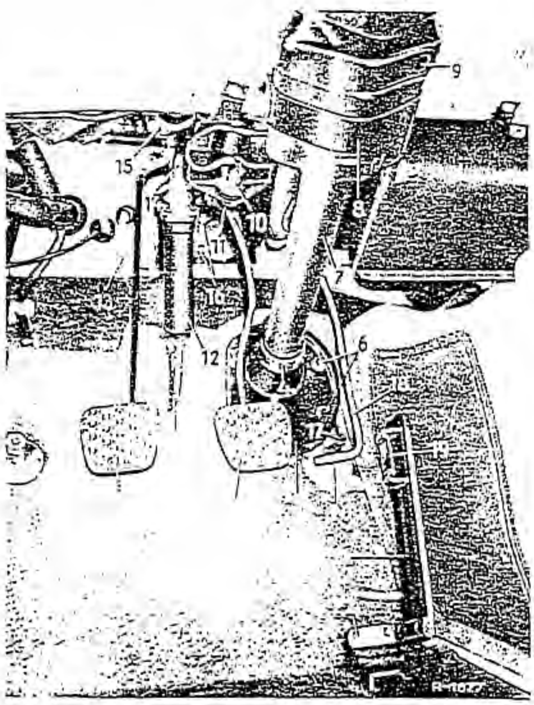


Fig. 29-1/4

Arrangement on Model 230 SL

1 Clutch pedal
2 Brake pedal
3 Cover plate
4 Pipe clip
5 Line to extraction cylinder
6 Hexagon screw with washer
7 Steering column jacket
8 Tightening strap
9 Opening for slotted screw
10 Mechanical stop light switch
11 Stop ring for brake pedal
12 Supply cylinder
13 Line from reservoir to supply cylinder
14 Piston rod
15 Pressure spring (dead center spring)
16 Hexagon screw with lock washer and hexagon nut
17 Stop screw
18 Pedal lever
19 Plastic plate
20 Hexagon nut
21 Foot plate
22 Bracket with ball heads

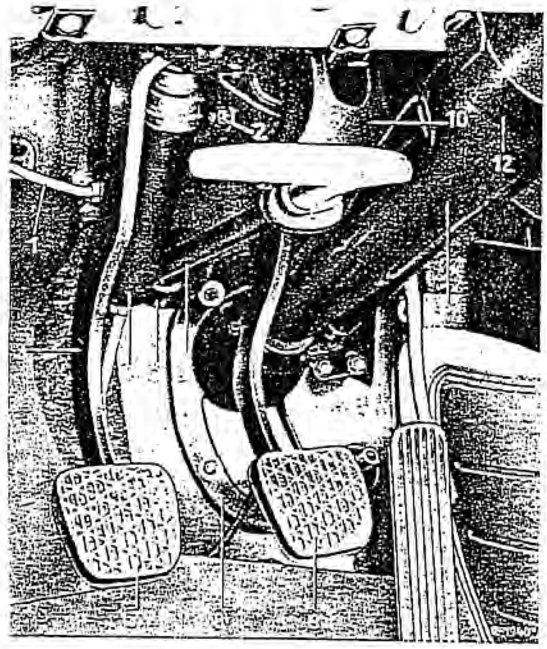


Fig. 29-1/5

Arrangement on Models 190 c, 190 Dc, 220 b, 220 Sb, 220 SEb

1 Line from reservoir to supply cylinder
2 Adjusting screw with hexagon nut and lock washer
3 Clutch pedal
4 Supply cylinder
5 Rubber sleeve
6 Guide tube for ratchet
7 Pedal plate on clutch pedal
8 Cover plate
9 Brake pedal
10 Bearing bracket for guide tube
11 Steering column jacket
12 Tightening strap

3. Pump the brake fluid from the reservoir of the supply cylinder via the opened bleed screw of the extraction cylinder.

4. Detach from the supply cylinder (12) both the line (13) from the reservoir and the line (5) to the extraction cylinder (Fig. 29-1/4).

5. On models with pistol-grip hand brakes unscrew the bearing bracket (10) for the ratchet from the pedal support (Fig. 29-1/5).

6. Unscrew the two hexagon nuts (1) which fasten the pedal support to the cross member (3) and remove together with the washer (2) (Figs. 29-1/2 and 6).

Note: On Model 230 SL the hexagon nuts are accessible through the opening for the revolution counter in the instrument panel.

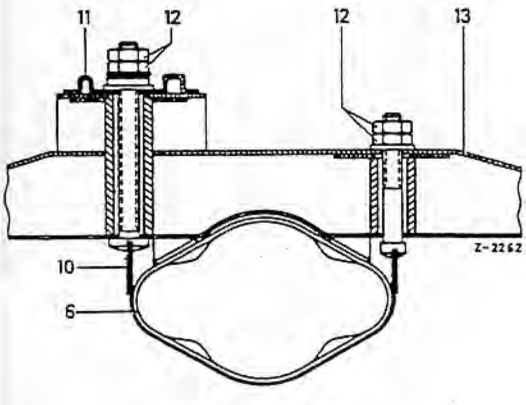


Fig. 29-1/6

Arrangement on Model 230 SL

6 Steering column jacket
10 Tightening strap
11 Pedal support
12 Hexagon nut
13 Cross member

7. Unscrew the hexagon nut from the adjusting screw (3a) and remove the adjusting screw from the brake pedal (T3) in order to detach the piston rod (2) of the power brake from the brake pedal (Fig. 29-1/7).

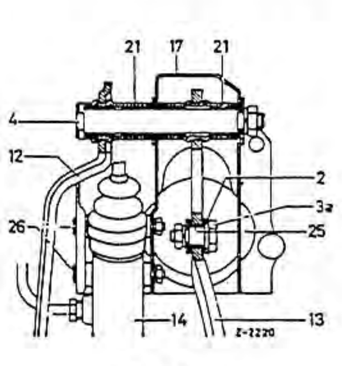


Fig. 29-1/7

Arrangement on Models
190 c, 190 Dc, 220 b, 220 Sb, 220 SEb

2 Piston rod of power brake
3a Adjusting screw with hexagon nut and lock washer
4 Pivot pin with hexagon nut and lock washer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
17 Pedal support
21 Bushings in the pedals
25 Bushings in the brakes
26 Hexagon screw with hexagon nut and lock washer

Note: On Model 230 SL this operation is not required, since the force exerted on the brake pedal is transferred to the power brake via the push rod and the relay lever in the bearing bracket.

8. Unscrew the hexagon nuts with which the power brake with the tandem master cylinder and the pedals are attached to the cowl.

9. Remove the support together with the pedals, paying attention to the shims installed between the support (7) and the cross member (8) (Fig. 29-1/3).

Installation:

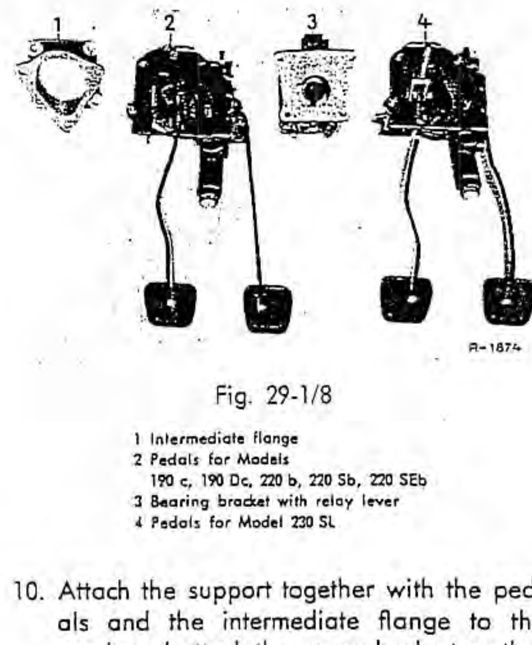


Fig. 29-1/8

1 Intermediate flange
2 Pedals for Models 190 c, 190 Dc, 220 b, 220 Sb, 220 SEb
3 Bearing bracket with relay lever
4 Pedals for Model 230 SL

10. Attach the support together with the pedals and the intermediate flange to the cowl, and attach the power brake together with the tandem master cylinder to the cowl.

Note: Before installing the pedals on Model 230 SL make sure that the rubber sleeve (17) is seated properly. The rubber sleeve partly covers the push rod (16) and seals the passenger compartment off from the engine compartment (Fig. 29-1/9).

11. On all cars on which the piston rod of the power brake is attached directly to the brake pedal, use the adjusting screw to attach the piston rod to the brake pedal, but do not yet tighten the hexagon nut.

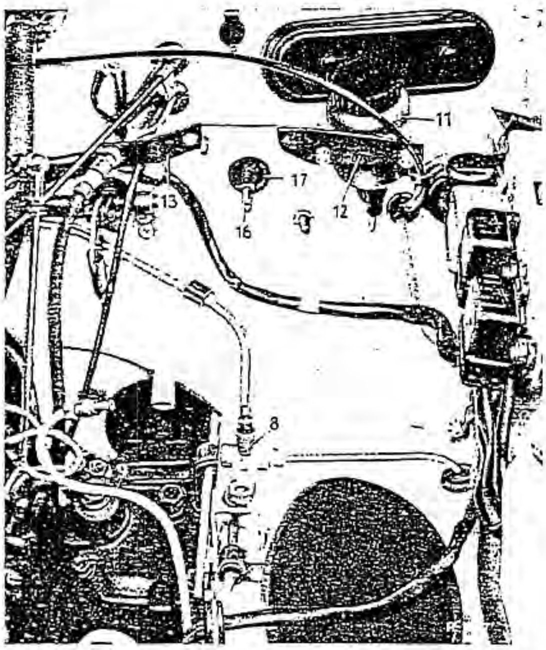


Fig. 29-1/9

8 Distributor fitting
9 Brake line
11 Reservoir for supply cylinder
12 Reservoir bracket
13 Bracket for oil pressure gage line
16 Push rod on brake pedal
17 Rubber sleeve

12. Fasten the pedal support to the cross member and measure the travel "d" of the brake pedal between the off-position and the point where it rests against the cowl. The prescribed travel given in Job No. 29-0 must be obtained. If this is not the case, detach the pedal support again and install a Shim 111 589 00 75 (20) between the cross member (18) and the pedal support (7) (Fig. 29-1/3).

Note: It is imperative that the prescribed brake pedal travel from off-position to cowl contact should be obtained. Measurements should never be below those given in Job No. 29-0.

The most convenient way of measuring the brake pedal travel is to use a tape measure to measure the distance from center brake pedal plate to lower edge of signal horn ring. Then open a bleed screw and depress the brake pedal until it rests against the cowl. The difference between these two dimensions is the brake pedal travel. Before releasing the brake pedal, screw down the bleed screw.

13. Check and adjust the clearance "a" between the piston rod on the clutch pedal and the piston of the supply cylinder (see Job No. 29-6, Section A).

14. Use the adjusting screw (2), or on Model 230 SL adjusting screw (3a) in order to set the maximum brake pedal travel (see Job No. 42-20 and Figs. 29-1/5 and 42-20/3).

15. On all models with pistol-type hand brake attach the bearing bracket for the ratchet to the support and check the adjustment of the hand brake (see Job No. 42-20).

16. Attach the feed line from the reservoir, and the pressure line to the extraction cylinder, to the supply cylinder and bleed the hydraulic system (see Job No. 29-5).

17. On Model 230 SL install the revolution counter (see Job No. 54-11).

18. Install the cover under the instrument panel.

Job No.
29-2

Removal and Installation of Pedals from the Support

Modification: Para 9 modified, Sections B and C added

A. Pedal System with Outside Supply Cylinder

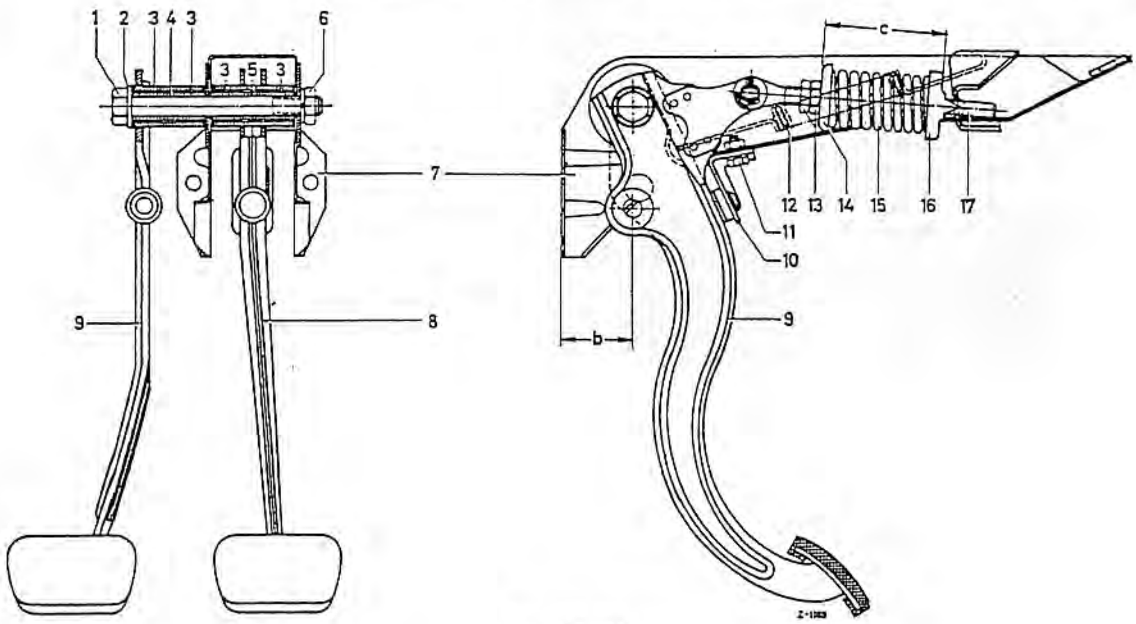


Fig. 29-2/1

1 Hexagon screw
2 Washer
3 Bushing
4 Bearing sleeve
5 Bearing sleeve
6 Hexagon nut
7 Support
8 Brake pedal
9 Clutch pedal
10 Bracket and stop
11 Hexagon screw
12 Return spring for brake pedal
13 Hexagon nut
14 Spring retainer
15 Pressure spring (dead center spring)
16 Spring retainer
17 Push rod

Removal:

1. Back out the hexagon nuts (13) in order to release the pressure spring (15) (dead center spring) (Fig. 29-2/1).

2. Pull the cotter pin out of the collar bolt (24) and remove the collar bolt from the clutch pedal (9). Then remove the push rod (17) together with the spring retainers (14) and (16) and the pressure spring (15) (Fig. 29-2/2).

3. Detach the return spring (12) at the brake pedal (Figs. 29-2/1 and 29-2/2).

4. Unscrew the hexagon nut of the adjusting screws (19) and (25) at the brake and the clutch pedal and remove the two adjusting screws together with the piston rods (Fig. 29-2/2).

5. Unscrew the hexagon nut (6), remove the lock washer and tap out the hexagon screw (1) (Fig. 29-2/1).

Checking:

6. Check the sleeves (4) and (5) and the bushings (3) in the pedals for wear. If necessary, press the bushings out of the pedals. Press in new bushings and ream them up to the prescribed diameter.

7. Check the polyamide bushings in the piston rods for wear and if necessary replace them.

Installation:

8. When reinstalling the sleeves and bushings, lightly coat them with Molykote paste.

9. Check the position of the pedals in the support (7). To do this, put a ruler against the face of the support and measure the distance 'b' from the face of the support to the center of the fulcrum and to the center of the adjusting screw bore. The prescribed distance is adjusted by moving the stop (10) (Fig. 29-2/1).

Note: The dimension "b" for the brake and clutch pedals differs on the 1st and 2nd versions of the pedal system. The travel of the pedals (d) after installation depends on the proper adjustment of this dimension. In addition, dimension "b" also determines the dead center dimension "e" of the clutch pedal (Fig. 29-1/3).

10. Adjust the pressure spring (15) (dead center spring) to the dimension 'c'. Lock the adjusting nut (13) by means of the lock nut (Fig. 29-2/1).

11. Screw the piston rod (23) actuating the brake master cylinder to the brake pedal (8) by means of the adjusting screw (25), but do not yet tighten the hexagon nut (Fig. 29-2/2).

12. Screw the piston rod actuating the supply cylinder to the clutch pedal (9) by means of the adjusting screw (20), but do not tighten the hexagon nut.

Note: Before installation, the collar of the adjusting screws should be lightly coated with Molykote paste.

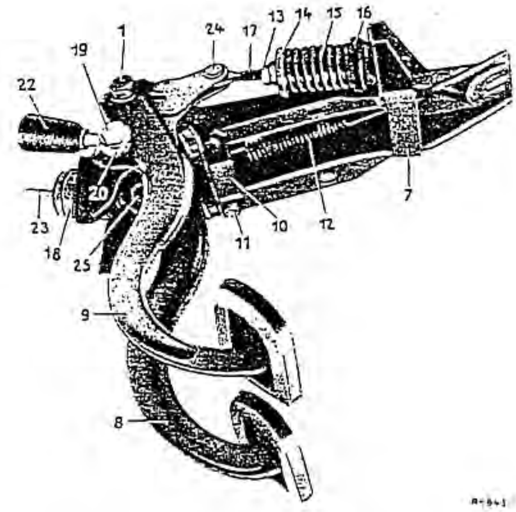


Fig. 29-2/2

1 Hexagon screw
7 Support
8 Brake pedal
9 Clutch pedal
10 Bracket and stop
11 Hexagon screw
12 Return spring for brake pedal
13 Hexagon nut
14 Spring retainer
15 Pressure spring (dead center spring)
16 Spring retainer
17 Push rod
18 Protective cap
19 Adjusting screw
20 Piston rod for supply cylinder
22 Protective cap
23 Piston rod for brake master cylinder
24 Collar bolt
25 Adjusting screw

B. Pedal System with Inside Supply Cylinder

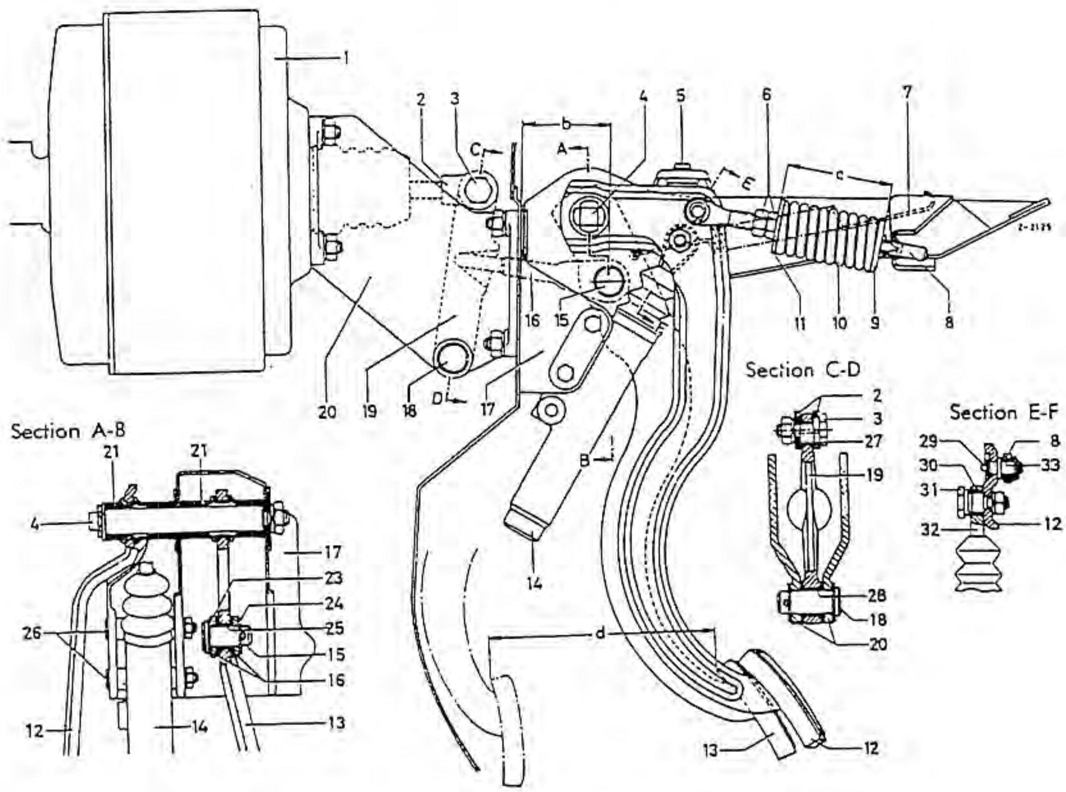


Fig. 29-2/3

Arrangement on Model 230 SL

b = Control dimension for brake pedal
c = Adjusting dimension for pressure spring (dead center spring)
d = Travel of the brake pedal until it rests on the cowl

1 Power brake T 51/200
2 Piston rod of power brake
3 Adjusting screw with lock washer and hexagon nut on the relay lever
4 Pivot pin
5 Rubber stop for clutch pedal
6 Hexagon nut
7 Return spring for brake pedal
8 Push rod for pressure spring
9 Spring retainer
10 Pressure spring (dead center spring)
11 Spring retainer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
15 Collar bolt
16 Push rod for intermediate lever
17 Support for pedals
18 Collar bolt with washer and cotter pin
19 Intermediate lever
20 Bearing bracket
21 Bushing for brake and clutch pedal
23 Spring washer
24 Washer
25 Bushing in the brake pedal for collar bolt
26 Hexagon screw with lock washer and hexagon nut
27 Bushing in the intermediate lever for adjusting screw
28 Bushing in the intermediate lever for collar bolt
29 Pivot pin for push rod
30 Bushing in the piston rod
31 Adjusting screw with lock washer and hexagon nut on the clutch pedal
32 Piston rod
33 Bushing in the push rod

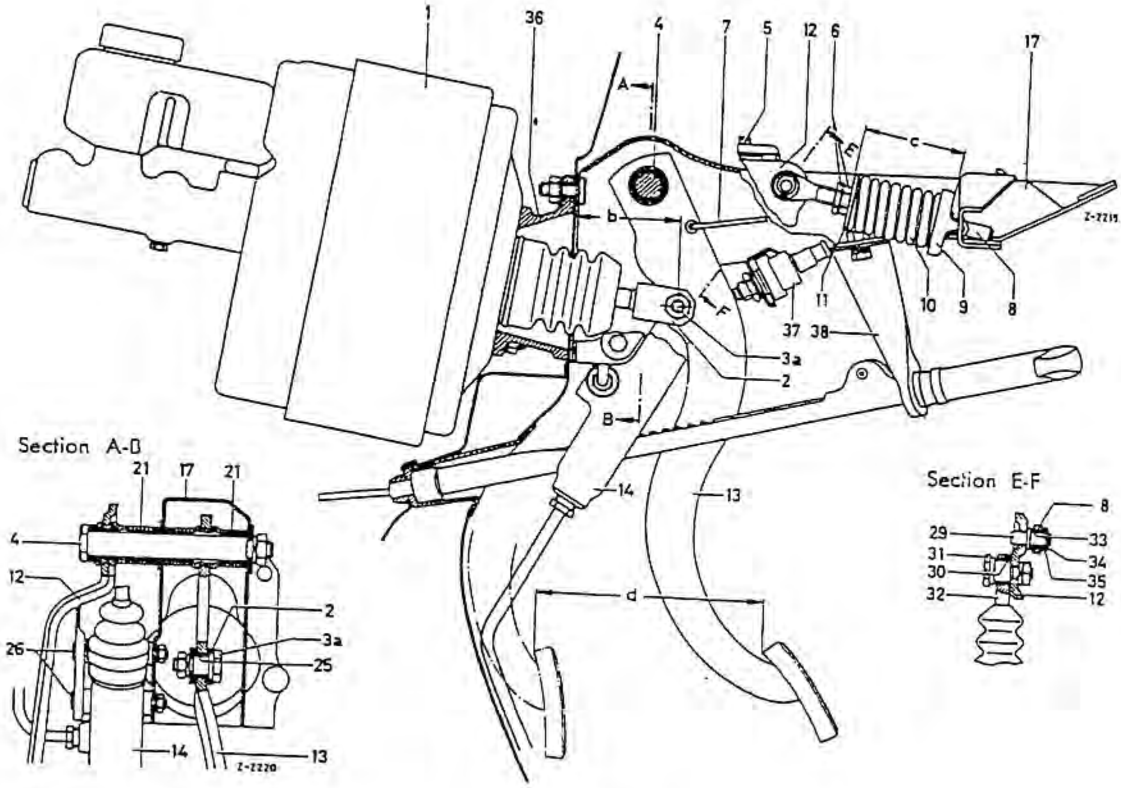


Fig. 29-2/4

Arrangement on Models 190 c, 190 Dc, 220 b, 220 Sb, 220SEb

b – Control dimension for brake pedal
c – Adjusting dimension for pressure spring (dead center spring)
d – Travel of the brake pedal until it rests on the cowl

1 Power brake T 51
2 Piston rod of power brake
3a Adjusting screw with lock washer and hexagon nut on brake pedal
4 Pivot pin
5 Rubber stop for clutch pedal
6 Hexagon nut
7 Return spring for brake pedal
8 Push rod for pressure spring
9 Spring retainer
10 Pressure spring
11 Spring retainer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
17 Pedal support
21 Bushings for brake and clutch pedal
25 Bushings in the brake pedal
26 Hexagon screw with lock washer and hexagon nut
29 Pivot pin for push rod
30 Bushing in the piston rod
31 Adjusting screw with lock washer and hexagon nut on clutch pedal
32 Piston rod
33 Bushing in the push rod
34 Snap ring
35 Washer
36 Intermediate flange
37 Mechanical stop light switch
38 Bracket for ratchet

Removal:

1. Unscrew the supply cylinder (14) from the pedal support (17) (Figs. 29-2/3 and 2/4 and Job No. 29-3).

2. Unscrew the hexagon nut from the adjusting screw (31) and remove the adjusting screw together with the piston rod (32) from the clutch pedal (12) (Figs. 29-2/3 and 2/4).

3. Completely back out the hexagon nuts (6) and depress the clutch pedal to release the pressure spring (10) (dead center spring) (Fig. 29-2/3).

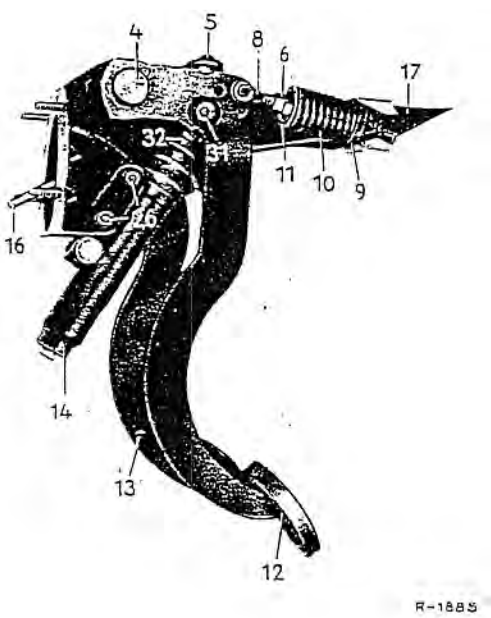


Fig. 29-2/5

4 Pivot pin
5 Rubber stop for clutch pedal
6 Hexagon nut
8 Push rod for pressure spring
9 Spring retainer
10 Pressure spring (dead center spring)
11 Spring retainer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
16 Push rod for relay lever
17 Pedal support
26 Hexagon screw with lock washer and hexagon nut
31 Adjusting screw with lock washer and hexagon nut
32 Piston rod

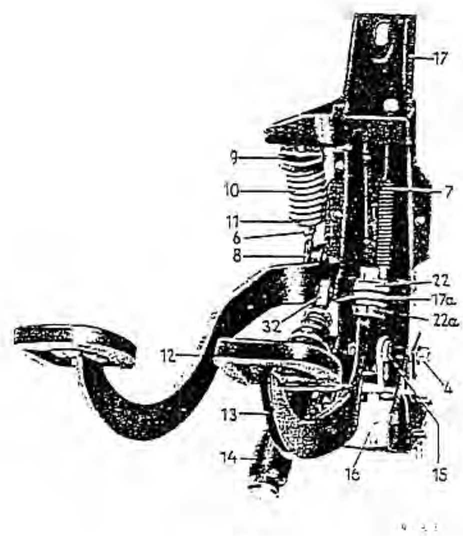


Fig. 29-2/6

6 Hexagon nut
7 Return spring for brake pedal
8 Push rod for pressure spring
9 Spring retainer
10 Pressure spring (dead center spring)
11 Spring retainer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
15 Collar bolt
16 Push rod for relay lever (only on Model 230 SL)
17 Pedal support
17a Bracket for stop light switch
22 Mechanical stop light switch
22a Stop ring (only on Model 230 SL)
32 Piston rod

4. Remove the snap ring (34) from the pivot pin (29) together with the washer (35). Then take off the push rod (8) together with the spring retainers (9) and (11) and the pressure spring (10) (Fig. 29-2/4).

5. Detach the return spring (7) from the brake pedal (13) (Fig. 29-2/3).

6. Unscrew the hexagon nut from the pivot pin (4), press the pivot pin out of the pedal support (17) and remove both pedals from the support (Fig. 29-2/3).

7. Unscrew the stop light switch (3) from the bracket (2) (Fig. 29-2/7).

8. On Model 230 SL pull the cotter pin out of the collar bolt (15) and remove the collar bolt together with push rod (16) and washers from the brake pedal (Fig. 29-2/4).

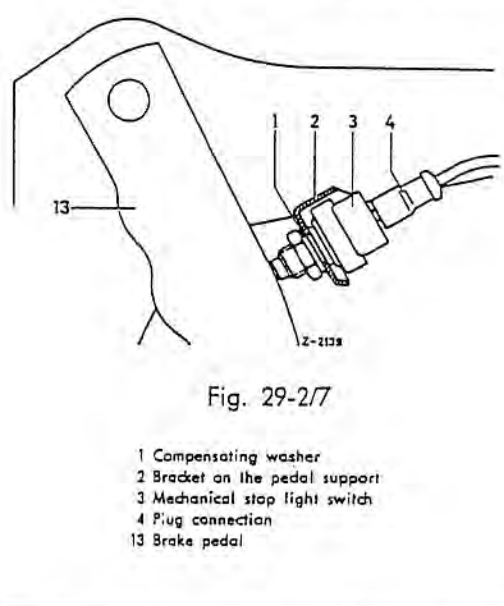


Fig. 29-2/7

1 Compensating washer
2 Bracket on the pedal support
3 Mechanical stop light switch
4 Plug connection
13 Brake pedal

Checking:

9. Check the bushings in the pedals for wear. If necessary, press the bushings out of the pedals, press in new bushings, and ream them to the prescribed dimension (see Job No. 29-0).

10. Check the bushings (25) in the brake pedal (13), the bushing (30) in the piston rod (32), the bushing (33) of the push rod (8), and the bushing in the spring retainer (9) for signs of wear and, if necessary, replace. After pressing in the bushings, ream them to the prescribed dimension (see Job No. 29-0 and Figs. 29-2/3 and 4).

Installation:

13. Before installation lightly rub all contact surfaces with Molycote paste and install the pedals in the support. Attach the return spring to the brake pedal and the support.

14. Install the pressure spring (10) (dead center spring) and adjust to the dimension "c" (see Job No. 29-0 and Fig. 29-2/3).

15. Attach the piston rod (32) for actuating the supply cylinder to the clutch pedal (12) (Figs. 29-2/3 and 4).

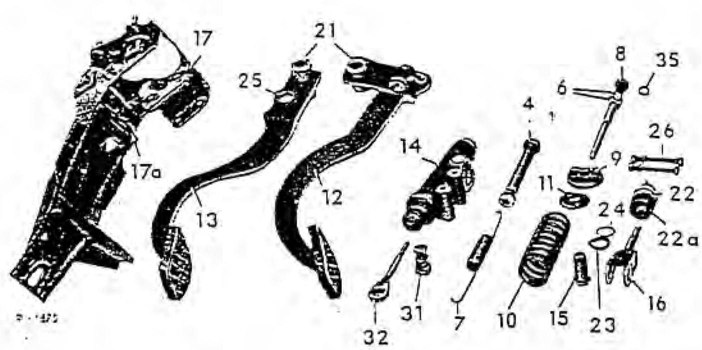


Fig. 29-2/8

4 Pivot pin with lock washer and hexagon nut
6 Hexagon nut
7 Return spring for brake pedal
8 Push rod for pressure spring
9 Spring retainer
10 Pressure spring (dead center spring)
11 Spring retainer
12 Clutch pedal
13 Brake pedal
14 Supply cylinder
15 Collar Bolt (only on Model 230 SL)
16 Push rod for relay lever (only on Model 230 S'.)
17 Pedal support
17a Bracket for mechanical stop light switch
21 Bushing
22 Mechanical stop light switch
22a Stop ring (only on Model 230 SL)
23 Spring washer
24 Washer
25 Bushing
26 Hexagon screw with lock washer and hexagon nut
31 Adjusting screw with lock washer and hexagon nut
32 Piston rod
35 Washer

11. Check the rubber stop (5) for the clutch pedal (12) on the support (17) (Figs. 29-2/3 and 2/4).

12. Check whether the stop light switch functions properly.

Note: The mechanical stop light switch (3) is the stop for the brake pedal (Fig. 29-2/7).

16. On Model 230 SL attach the push rod (16) to the brake pedal (13) (Fig. 29-2/3).

Note: The spring washer (23) must be placed on the collar bolt before the bolt is being installed. The washer (24) should be on the cotter pin hole side (Fig. 29-2/3).

17. Attach the supply cylinder (4) to the support (17) and adjust the clearance between the piston and the piston rod (see Job No. 29-6 and Fig. 29-2/3).

18. Attach the stop light switch to the support.

Note: The stop light switch for Model 230 SL has a stop ring above the threaded part and this stop ring serves as a stop for the brake pedal. The stop is necessary, since on this model the push rod attached to the brake pedal is not fastened to the relay lever. Furthermore the stop light switch on Model 230 SL is held in position by a lock plate.

C. Removal and Installation of Relay Lever from the Bearing Bracket on Model 230 SL

Removal:

1. Remove the power brake with the tandem master cylinder (see Job No. 42-16).

2. Unscrew the hexagon nuts which fasten the bearing bracket together with the pedals to the cowl and remove the bearing bracket.

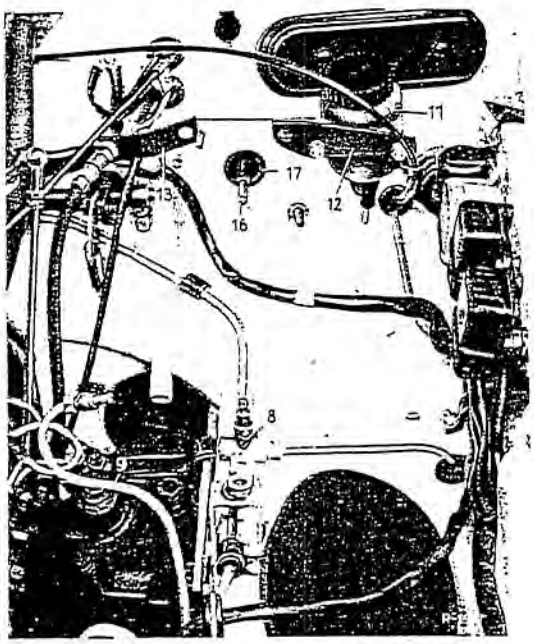


Fig. 29-2/9

8 Distributor fitting
9 Brake line
11 Reservoir for supply cylinder
12 Bracket for reservoir
13 Bracket for oil pressure gage line
16 Push rod on brake pedal
17 Rubber sleeve

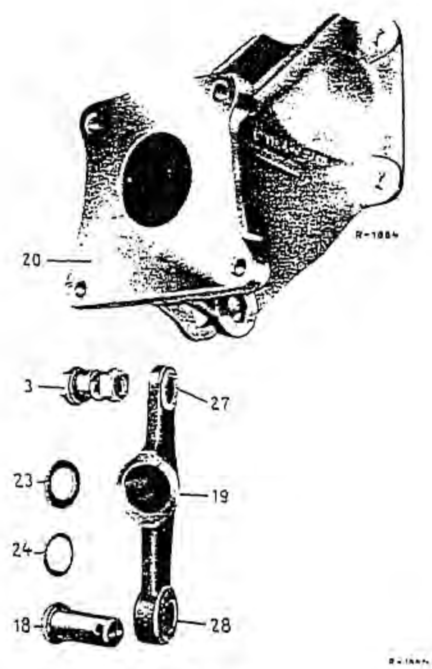


Fig. 29-2/10

3 Adjusting screw with hexagon nut and lock washer
18 Collar bolt
19 Relay lever
20 Bearing bracket
23 Spring washer
24 Washer
27 Bushing
28 Bushing

3. Pull the cotter pin out of the collar bolt (18) and remove the collar bolt together with the washers (23) and (24), and the relay lever (19) (Fig. 29-2/10).

4. Check the bushings (27) and (28) in the relay lever (19) and, if necessary, replace and ream to the prescribed dimension (see Job No. 29-0 and Fig. 29-2/10).

Installation:

5. Lightly coat the collar bolt with Molykote paste Type G and install the lever in the bearing bracket.

Note: The spring washer is placed between the head of the collar bolt and the bearing bracket.

6. Put on the washer (24) and secure the collar bolt by means of the cotter pin (Fig. 29-2/10).

7. Install the bearing bracket and attach the power brake together with the tandem master cylinder to the bearing bracket.

8. Adjust the brake pedal travel and the contact point of the mechanical stop light switch (see Job No. 42-20).

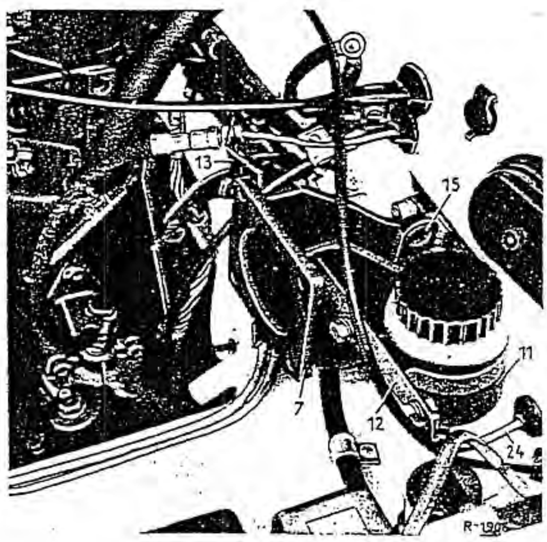


Fig. 29-2/11

7 Bearing bracket
11 Reservoir for supply cylinder
12 Bracket for reservoir
13 Bracket for oil pressure gage line
15 Relay lever
24 Line from reservoir to supply cylinder

Supply Cylinder

Modification: Supply Cylinder for Models 190 c and 190 Dc (Addition)

A. General

The construction of the supply cylinder with its fluid reservoir is similar to that of a brake master cylinder. Since the hydraulic clutch actuating mechanism does not require any residual pressure, the supply cylinders have no check valve.

1st Version Supply Cylinder for Models 220 b, 220 Sb and 220 SEb Sedan

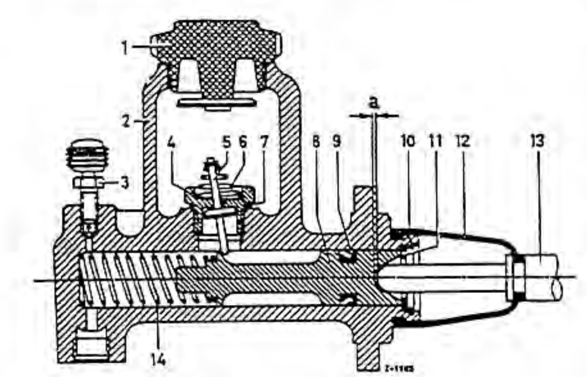


Fig. 29-3/1

1 Screw cap
2 Fluid reservoir
3 Bleed screw
4 Tilting valve
5 Pin in tilting valve
6 Spring of tilting valve
7 Sealing ring
8 Piston
9 Grooved cup
10 Snap ring
11 Stop washer
12 Protective cap
13 Piston rod (46 mm long)
14 Pressure spring
a = Clearance between piston and piston rod

The 1st version of the supply cylinder is provided with a tilting valve (4) and has no compensating port. The piston (8) has a grooved cup (9) (Fig. 29-3/1).

The length L of the piston rod is 46 mm (Fig. 29-3/5).

2nd Version Supply Cylinder for Models 220 b, 220 Sb and 220 SEb Sedan

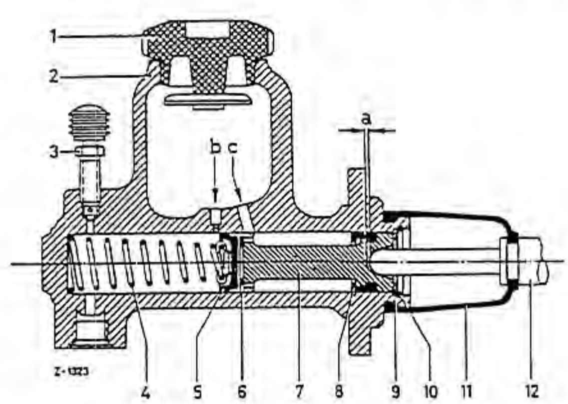


Fig. 29-3/2

1 Screw cap
2 Fluid reservoir
3 Bleed screw
4 Pressure spring
5 Primary cup
6 Piston cup washer
7 Piston
8 Secondary cup
9 Stop washer
10 Snap ring
11 Protective cap
12 Piston rod (46 mm long)
a = Clearance between piston and piston rod
b = Compensating port
c = Connecting port

Like the brake master cylinder the 2nd version of the supply cylinder contains a compensating port (b) and a connecting port (c). When the clutch pedal is released, the primary cup must not cover the compensating port, which would prevent the brake fluid from returning to the fluid reservoir when it heats up and expands. The primary cup (5) and the secondary cup (8) are on the piston and there is a piston cup washer (6) between the piston and the primary cup (Fig. 29-3/2).

The length L of the piston rod in this supply cylinder is also 46 mm (Fig. 29-3/5).

3rd Version Supply Cylinder for Models 220 b, 220 Sb and 220 SEb Sedan

1st Version Supply Cylinder for Model 220 SEb Coupé B

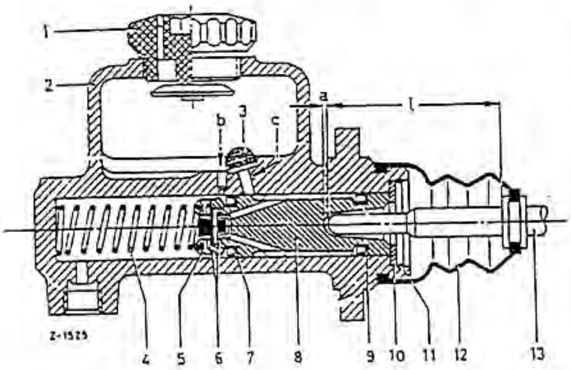


Fig. 29-3/3

1 Screw cap
2 Fluid reservoir
3 Screen
4 Pressure spring
5 Cap
6 Valve
7 Primary cup
8 Piston
9 Secondary cup
10 Stop washer
11 Snap ring
12 Protective cap (bellows-type)
13 Piston rod (56 mm long)
a = Clearance between piston and piston rod
b = Compensating port
c = Connecting port
L = Length of piston rod

The construction of this supply cylinder is similar to that of the 2nd version except that the piston (8) is provided with a valve (6). When the clutch pedal returns quickly to its release position, this valve ensures that the space in front of the piston is quickly refilled with brake fluid so that no air can enter the hydraulic system via the extraction cylinder (Fig. 29-3/3).

The length L of the piston rod is 56 mm (Fig. 29-3/5).

Note: Recent models of this supply cylinder are also provided with a bleed screw.

1st Version Supply Cylinder for Models 190 c and 190 Dc

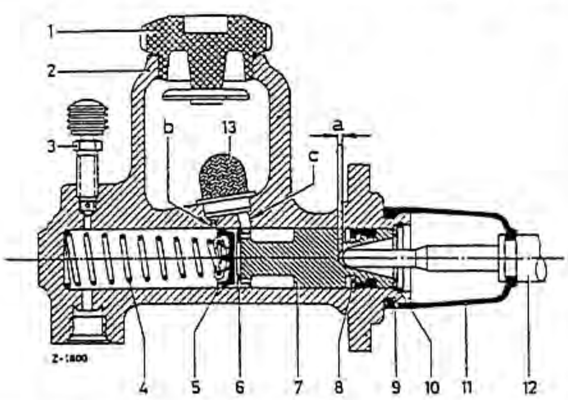


Fig. 29-3/4

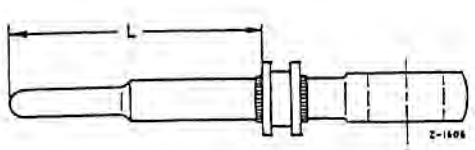
1 Screw cap
2 Fluid reservoir
3 Bleed screw
4 Pressure spring
5 Primary cup
6 Piston cup washer
7 Piston
8 Secondary cup
9 Stop washer
10 Snap ring
11 Protective cap
12 Piston rod (56 mm long)
13 Screen
a = Clearance between piston and piston rod
b = Compensating port
c = Connecting port

The supply cylinder is similar to that of the 2nd version for Models 220 b, 220 Sb and 220 SEb Sedan. Only the piston (7) and the piston rod (12) have been modified (Fig. 29-3/5).

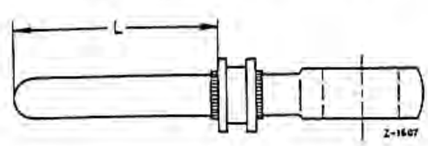
The length L of the piston rod is 56 mm (Fig. 29-3/5).

Piston Rod

Fig. 29-3/5



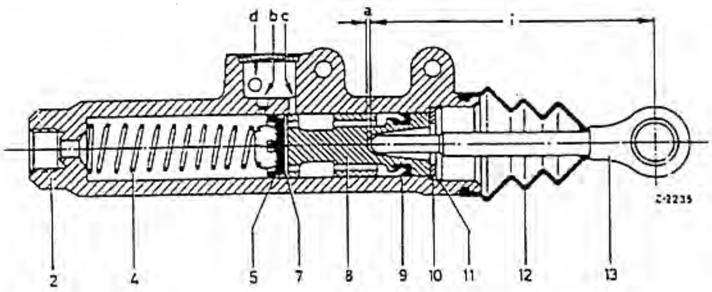
Piston rod for supply cylinder
2nd version
L = 56 mm



Piston rod for supply cylinder
1st version
L = 46 m

Inside Supply Cylinder for Models 190 c and 190 Dc

Fig. 29-3/6

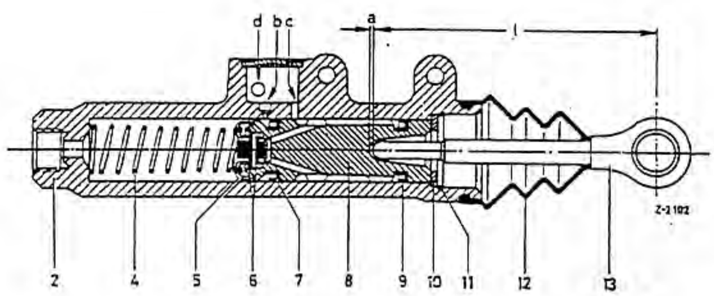


2 Housing
4 Pressure spring
5 Primary cup
7 Piston cup washer
8 Piston
9 Secondary cup
10 Stop washer
11 Snap ring
12 Protective cap
13 Piston rod
a = Clearance between piston and piston rod
b = Compensating port
c = Connecting port
d = Intake port from reservoir
l = Length of piston rod

The design of the supply cylinder is the same as the 2nd version supply cylinder (see Fig. 29-3/2). Since the supply cylinder is attached to the pedal support, the reservoir was arranged separately. The length "L" of the piston rod is 100 mm.

Inside Supply Cylinder for Models 220 b, 220 Sb, 220 SEb, and 230 SL

Fig. 29-3/7



2 Housing
4 Pressure spring
5 Cap
6 Valve
7 Primary cup
8 Piston
9 Secondary cup
10 Stop washer
11 Snap ring
12 Protective cap
13 Piston rod
a = Clearance between piston and piston rod
b = Compensating port
c = Connecting port
d = Intake port from reservoir
l = Length of piston rod

The design of the supply cylinder is the same as the 3rd version supply cylinder (Fig. 29-3/3). Since the supply cylinder is attached to the pedal support, the reservoir was arranged separately. The length "L" of the piston rod is 100 mm.

B. Removal and Installation of Outside Supply Cylinder

Removal:

1. After removing the battery, pump the brake fluid from the fluid reservoir of the supply cylinder via the bleed screw (6) of the extraction cylinder (5) (Fig. 29-4/4).

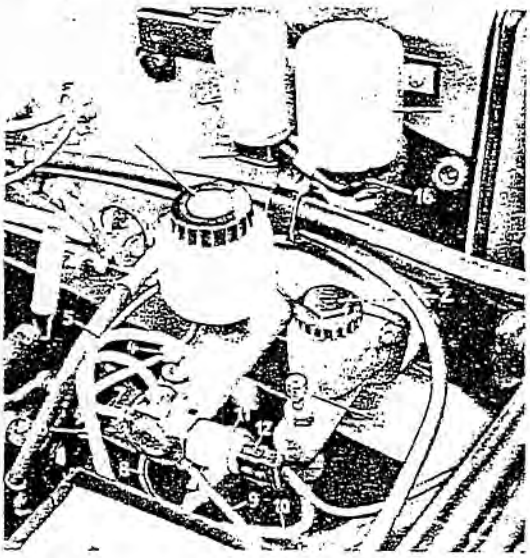


Fig. 29-3/8

1 Screw cap of brake master cylinder
2 Screw cap of supply cylinder
3 Bleed screw of supply cylinder
4 Bleed screw of brake master cylinder
5 Brake line
6 Brake line
7 Brake line
8 Brake line
9 Brake line
10 Line from supply cylinder to extraction cylinder
11 Stop light switch
12 Plug connection
13 Flash direction signal
14 Plug connection
15 Upper beam flash signal
16 Plug connection

2. Detach the line (10) at the supply cylinder and unscrew the supply cylinder from the intermediate flange and the cowl (Fig. 29-3/8).

Note: To prevent dirt from entering the system close the opening in the supply cylinder with a dummy plug and close the line with a rubber cap.

Installation:

3. When reinstalling the supply cylinder please note that the piston rod for the 3rd version is shouldered and measures 56 mm up to the collar whereas the piston rod for the 1st and 2nd version supply cylinders is cylindrical and measures 46 mm up to the collar (see Fig. 29-3/4).

4. Check and adjust the clearance between the piston rod and the piston of the supply cylinder (see Job No. 29-6).

5. Check and adjust the free play of the push rod of the extraction cylinder until the throw-out bearing rests against the release levers of the pressure plate (see Job No. 29-6).

6. Bleed the hydraulic system and check for leaks.

C. Removal and Installation of Inside Supply Cylinder

Removal:

1. Pump the brake fluid out of the reservoir of the supply cylinder via the bleed screw (6) of the extraction cylinder (5) (Fig. 29-4/4).

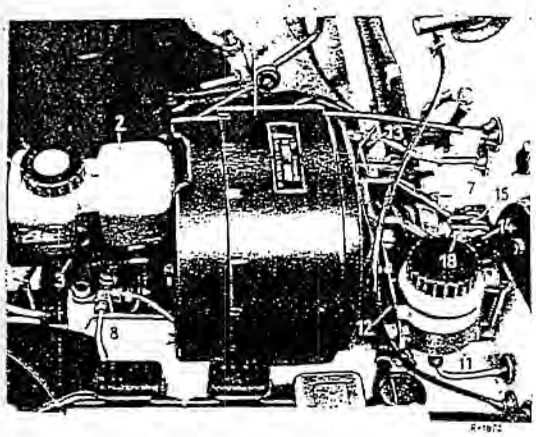


Fig. 29-3/9

1 Power brake
2 Reservoir of tandem master cylinder
3 Tandem master cylinder
7 Bearing bracket
8 Distributor fitting
9 Brake line to rear wheel brake
11 Reservoir for supply cylinder
12 Reservoir bracket
13 Bracket for oil pressure gage line
14 Adjusting screw with lock washer and hexagon nut
15 Relay lever
18 Piston rod of power brake

2. Detach the connecting line (13) from the reservoir on the supply cylinder (12). Also detach the line (5) to the extraction cylinder (Fig. 29-3/10).

3. Unscrew the supply cylinder (12) from the pedal support (Fig. 29-3/10).

Note: To prevent dirt from entering the system, close the opening in the supply cylinder with a dummy plug and close the line with a rubber cap.

Installation:

4. Fasten the supply cylinder to the pedal support.

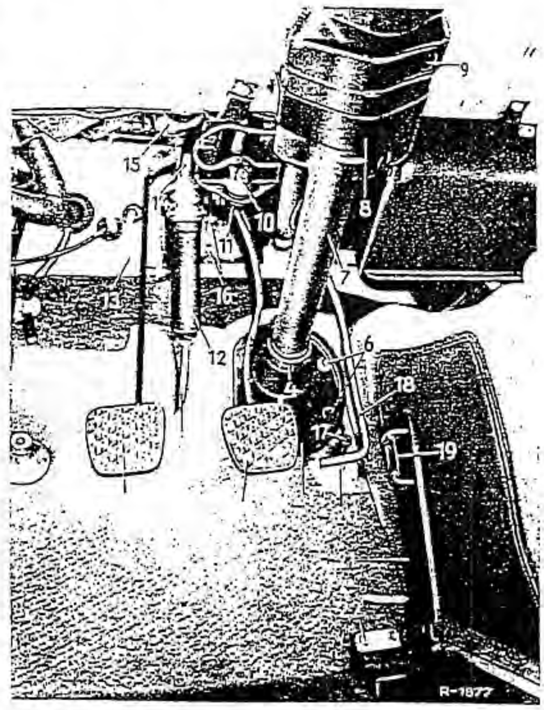


Fig. 29-3/10

1 Clutch pedal
2 Brake pedal
3 Cover plate
4 Pipe clip
5 Line to extraction cylinder
6 Hexagon screw with lock washer and washer
7 Steering column jacket
8 Tightening strap
9 Opening in steering column jacket for clamp ring
10 Mechanical stop light switch
11 Stop ring
12 Supply cylinder
13 Line from reservoir
14 Piston rod
15 Pressure spring (dead center spring)
16 Hexagon screw with lock washer
17 Stop screw
18 Control lever
19 Plastic plate
20 Hexagon nut
21 Foot brake
22 Bracket

5. Attach the connecting line from the reservoir and the line for the extraction cylinder to the supply cylinder.

6. Check and adjust the clearance between the piston rod and the piston of the supply cylinder (see Job No. 29-6).

7. Check and adjust the free play of the push rod of the extraction cylinder until the throw-out bearing rests against the release levers of the pressure plate (see Job No. 29-6).

8. Bleed the hydraulic system and check for leaks.

Removal and Installation of Extraction Cylinder

Modification: Model 300 SE added

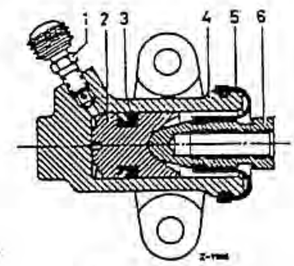


Fig. 29-4/1
1st Version

1 Bleed screw
2 Piston
3 Grooved cup
4 Housing
5 Protective cap (roll-type)
6 Pressure pin (length 38 mm)

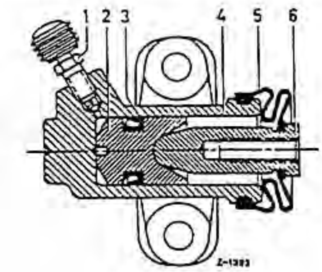


Fig. 29-4/2
2nd Version

1 Bleed screw
2 Piston
3 Grooved cup
4 Housing
5 Protective cap (bellows-type)
6 Pressure pin (length 45 mm)

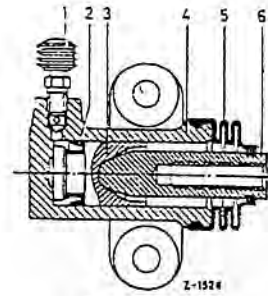


Fig. 29-4/3
3rd Version

1 Bleed screw
2 Grooved cup
3 Piston
4 Housing
5 Protective cap (bellows-type)
6 Pressure pin (length 53 mm)

When removing and installing the extraction cylinder please give attention to the following points:

1. Originally the extraction cylinder was fastened to the clutch housing (2) by means of hexagon screws (1) (Fig. 29-4/7). If on cars of this type the thread in the clutch housing has been damaged, Heli-Coil threaded adapters M 8 × 12 can be inserted instead. On new models the extraction cylinder is fastened to the clutch housing by means of two stud bolts (1) (Fig. 29-4/8).

Note: On Model 300 SE with mechanical transmission the extraction cylinder is attached to the clutch housing by means of a snap ring (13). The noses of the snap ring, which are under slight tension, must point towards the clutch housing when installed (Fig. 29-4/9).

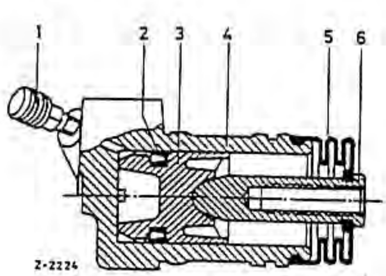


Fig. 29-4/4

1 Bleed screw
2 Grooved cup
3 Piston
4 Housing
5 Protective cap (bellows-type)
6 Pressure pin

2. Check the protective cap (5) of the extraction cylinder. Damaged protective caps must be replaced. Instead of the roll-type protective cap only bellows-type caps should be installed (Figs. 29-4/1 and 29-4/2).

Note: a) If on a 1st version extraction cylinder the roll-type protective cap (3) is replaced by a bellows-type protective cap (3), it is necessary at the same time to install the longer pressure pin (7) and the shorter push rod (5). (Figs. 29-4/7 and 29-4/8).

b) A small number of cars were supplied with the 2nd version extraction cylinder and the long push rod. **It is imperative that on these cars the shorter push rod should be installed subsequently.** The hexagon nut SW 12 for adjusting the push rod has been replaced in the 2nd version by a parallel flat SW 6.

c) The shorter push rod (5) must also be installed in the 3rd version extraction cylinder (Fig. 29-4/7).

3. After installing the extraction cylinder bleed the hydraulic system, adjust the clutch pedal free play, and check the hydraulic system for leaks.

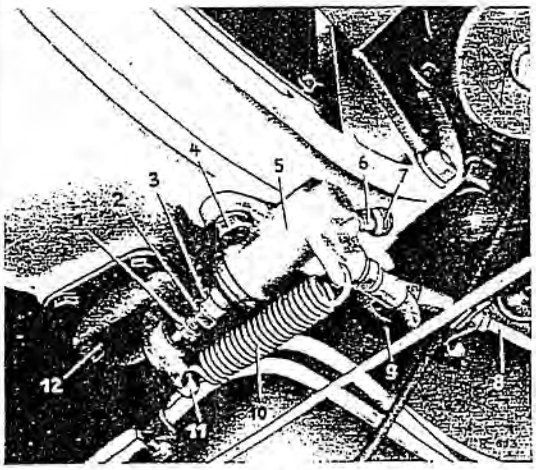


Fig. 29-4/5
1st Version

1 Push rod
2 Hexagon nut
3 Pressure pin
4 Hexagon screw
5 Extraction cylinder
6 Bleed screw
7 Protective cap
8 Line
9 Hose
10 Return spring
11 Throw-out fork
12 Cuff

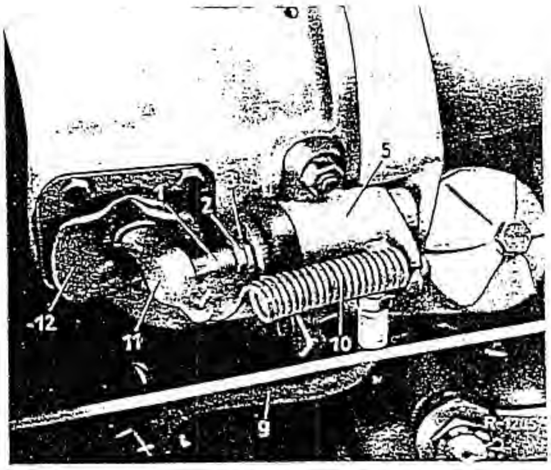


Fig. 29-4/6
2nd Version

1 Push rod
2 Hexagon nut
3 Pressure pin
5 Extraction cylinder
9 Hose
10 Return spring
11 Throw-out fork
12 Cuff

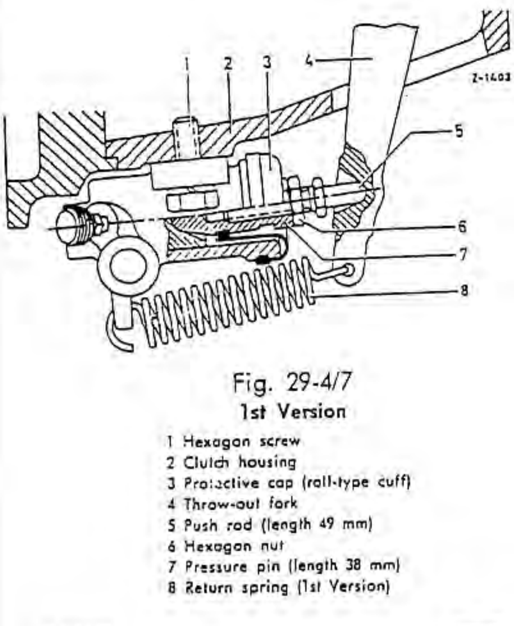


Fig. 29-4/7
1st Version

1 Hexagon screw
2 Clutch housing
3 Protective cap (roll-type cuff)
4 Throw-out fork
5 Push rod (length 49 mm)
6 Hexagon nut
7 Pressure pin (length 38 mm)
8 Return spring (1st Version)

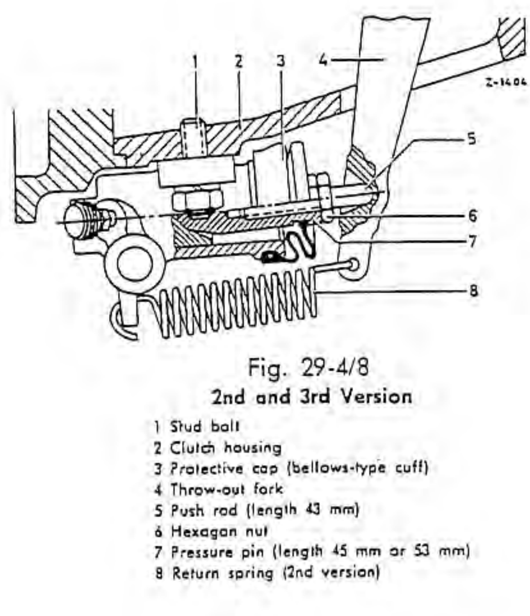


Fig. 29-4/8
2nd and 3rd Version

1 Stud bolt
2 Clutch housing
3 Protective cap (bellows-type cuff)
4 Throw-out fork
5 Push rod (length 43 mm)
6 Hexagon nut
7 Pressure pin (length 45 mm or 53 mm)
8 Return spring (2nd version)

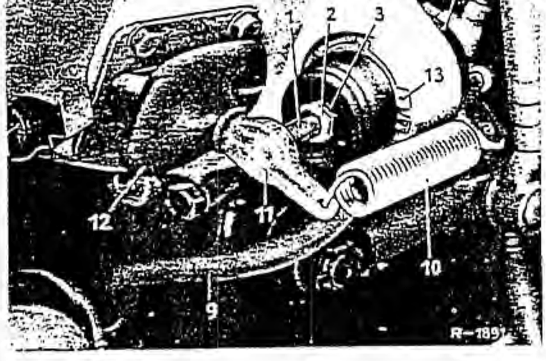


Fig. 29-4/9

Arrangement on Model 300 SE with mechanical transmission

1 Push rod
2 Hexagon nut
3 Pressure pin
5 Extraction cylinder
9 Hose
10 Return spring
11 Throw-out fork
12 Cuff
13 Snap ring

Important: When installing a new extraction cylinder make sure that the flange of the cylinder rests properly against the clutch housing (2); however the extraction cylinder housing must not touch the clutch housing or the intermediate flange at any point (Fig. 29-4/7). The minimum distance between the extraction cylinder and the clutch housing or the intermediate flange should be 1 mm. This distance can easily be checked by means of an approx. 1 mm. thick cardboard strip. If the distance is found to be smaller than 1 mm. the clutch housing and the intermediate flange must be reconditioned. If the extraction cylinder bears against the clutch housing or the intermediate flange the result after a short time will be stiffness in the clutch actuating mechanism and failure of the extraction cylinder itself.

Job No.
29-5

Bleeding of the Hydraulic System of the Clutch Actuating Mechanism

Modification: Note to Para 2 added

1. Unscrew the screw cap (2) of the reservoir and if necessary fill up with brake fluid.

2. First bleed the supply cylinder by means of the bleed screw (3) (Fig. 29-5/1) and then the extraction cylinder by means of the bleed screw (6) (Fig. 29-5/2).

Note: On cars with inside supply cylinder please note the following points:
Cars of Models 190 c and 190 Dc can only be bled from below by means of a bleeding device and via the opened bleed screw on the extraction cylinder.
When a bleeding device is used, the pressure should not exceed 0.5 atm since a higher pressure might force off the hose plug connection on the reservoir and the scattered brake fluid would damage the paint.
When the bleeding device is used to bleed from above, the clutch pedal should be completely depressed since otherwise the air between the primary and secondary cup in the supply cylinder might not be removed completely.
The supply cylinder need not be bled since it is not provided with a bleed screw.
When the system is bled without the use of a bleeding device, the bleed screw on the extraction cylinder must be closed before the clutch pedal is released in order to avoid the shuttling of an air pad in the lines.

3. Bleed the system until the brake fluid in the glass container is free from air bubbles. Then close the bleed screws again, taking care to ensure that the clutch pedal is fully depressed and is held in this position.

4. Check the fluid level in the reservoir and if necessary top up.

Note: Make sure that the vent bore in the screw cap of the supply cylinder is not obstructed.

5. Then depress the clutch pedal several times, always releasing the pedal with a jerk.

6. Check the whole system for leaks.

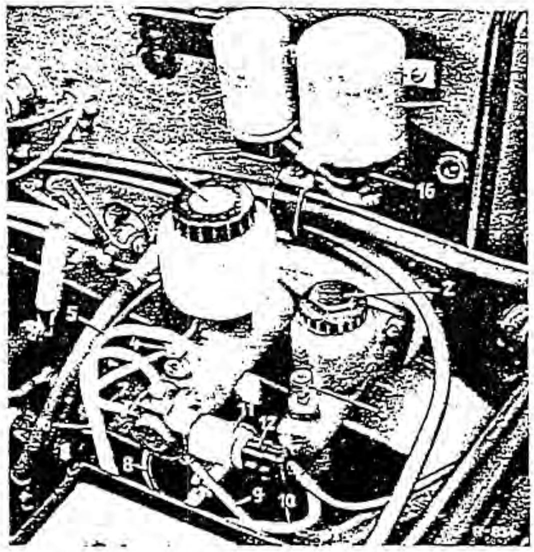


Fig. 29-5/1

1 Screw cap (master cylinder)
2 Screw cap (supply cylinder)
3 Bleed screw
4 Bleed screw
5 Brake line
6 Brake line
7 Brake line
8 Brake line
9 Brake line
10 Line
11 Stop light switch
12 Plug connection
13 Flash signal mechanism
14 Plug connection
15 Upper beam flash mechanism
16 Plug connection

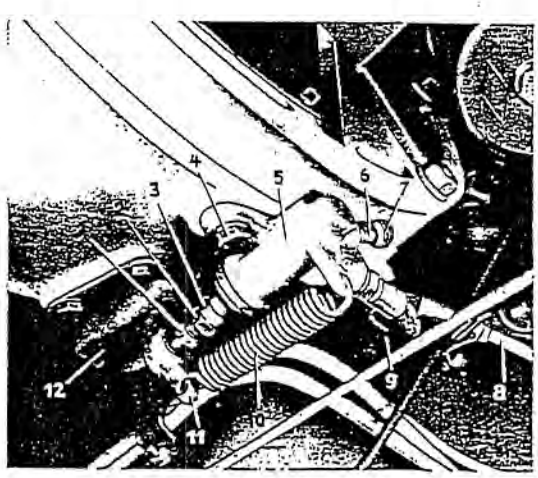


Fig. 29-5/2

1 Push rod
2 Hexagon nut
3 Pressure pin
4 Hexagon screw
5 Extraction cylinder
6 Bleed screw
7 Protective cap
8 Line
9 Hose
10 Return spring
11 Throw-out fork
12 Cuff

Adjustment of the Hydraulic Clutch Actuating Mechanism

Job No.
29-6

Modification: Inside Supply Cylinder added

In the case of the hydraulic clutch actuating mechanism, the clearance between the piston rod and the piston of the supply cylinder and also the free play between the push rod of the extraction cylinder and the throw-out bearing at the release levers of the clutch must be checked and adjusted.

A. Adjusting the Clearance of the Piston Rod at the Supply Cylinder

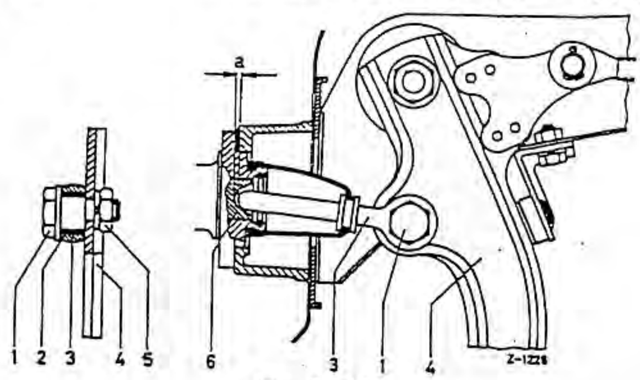


Fig. 29-6/1
Outside supply cylinder

1 Adjusting screw
2 Bushing in piston rod
3 Piston rod
a = clearance between piston and piston rod
4 Clutch pedal
5 Hexagon nut
6 Piston

1. Loosen the hexagon nut (5) of the adjusting screw (1). Then turn the adjusting screw until the piston rod (3) has the clearance "a". 0.2-0.5 mm in relation to the piston (6) of the supply cylinder. This clearance cannot be measured, it must be adjusted by touch.

Note: The head of the adjusting screw is provided with a line marking in the direction of maximum eccentricity. When adjusting the screw make sure that **on cars with outside supply cylinder** this line marking points in the direction of the pivot pin for the pedals, and that **on cars with inside supply cylinder** it points toward the rear.

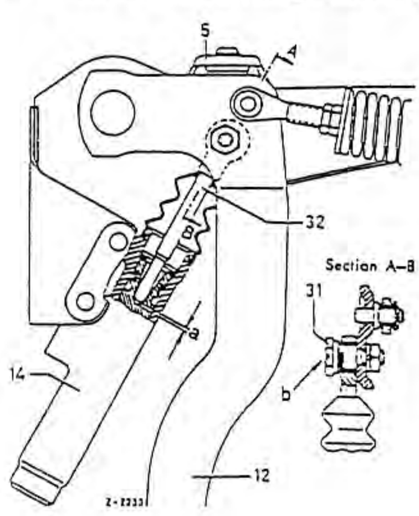


Fig. 29-6/2

5 Rubber stop for clutch pedal
12 Clutch pedal
14 Supply cylinder
31 Adjusting screw with hexagon nut and lock washer
32 Piston rod
a = Clearance between piston and piston rod
b = Line marking

2. If the clearance "a" is not maintained, the primary cup may cover the compensating port in the supply cylinder, which would make compensation of brake fluid between fluid reservoir and hydraulic system impossible (see Job No. 29-0).

B. Adjusting the Free Play of the Push Rod at the Extraction Cylinder

1. Detach the return spring (10) from the throw-out fork (11) and the extraction cylinder (5).

2. Push the throw-out fork back until the throw-out bearing rests against the release levers.

3. Check the clearance between the throw-out fork and the extraction cylinder push rod in this position of the individual units and if necessary correct by adjusting the push rod (1). To do this loosen the hexagon nut (2) and adjust the push rod to the correct length (for dimensions see Job No. 29-0).

4. Attach the return spring to the extraction cylinder and the throw-out fork.

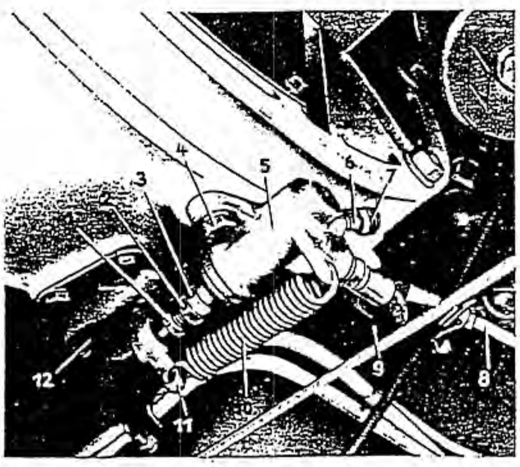


Fig. 29-6/3

Extraction cylinder 1st version

1 Push rod
2 Hexagon nut
3 Pressure pin
4 Hexagon screw
5 Extraction cylinder
6 Bleed screw
7 Protective cap
8 Line from supply cylinder
9 Pressure hose
10 Return spring
11 Throw-out fork
12 Cuff

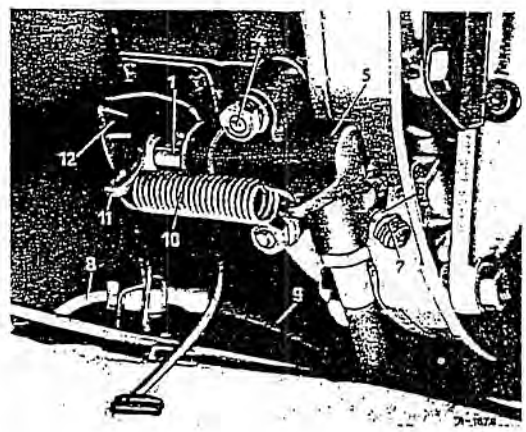


Fig. 29-6/4

Extraction cylinder 2nd version

1 Push rod
4 Stud screw
5 Extraction cylinder
6 Bleed screw
7 Protective cap
8 Line from supply cylinder
9 Pressure hose
10 Return spring
11 Throw-out fork
12 Cuff

If the adjustment range of the kickdown switch is not sufficient, turn the turnbuckle (2) on the control rod (1) (Fig. 30-3/1).

2. Depress the accelerator pedal to the kick-down position (position C). In this position there should be a clearance of about 1 mm between the throttle valve lever and the full load stop on the venturi control unit.

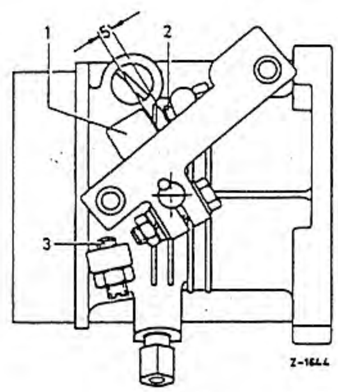


Fig. 30-3/2

1 Throttle valve lever
2 Full load stop
3 Idle stop

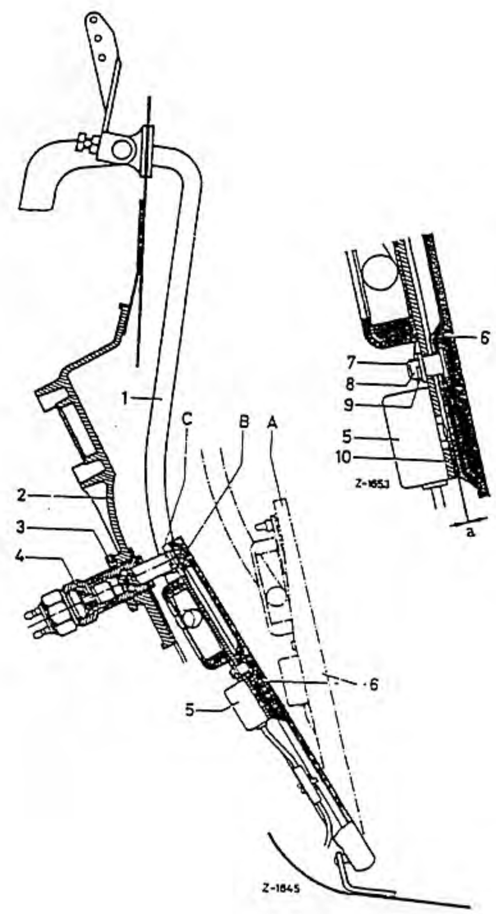


Fig. 30-3/3

1 Adjustment lever
2 Cover plate
3 Lock nut
4 Kickdown switch
5 Lifting switch (Idle switch)
6 Foot plate
7 Compensating washer
8 Bolt
9 Cotter pin
10 Plate
A Idle position
B Full load position
C Kickdown position

Adjustment of Accelerator Pedal

Job No.
30-3

Modification: Models 190 c, 190 Dc and 300 SE (added)

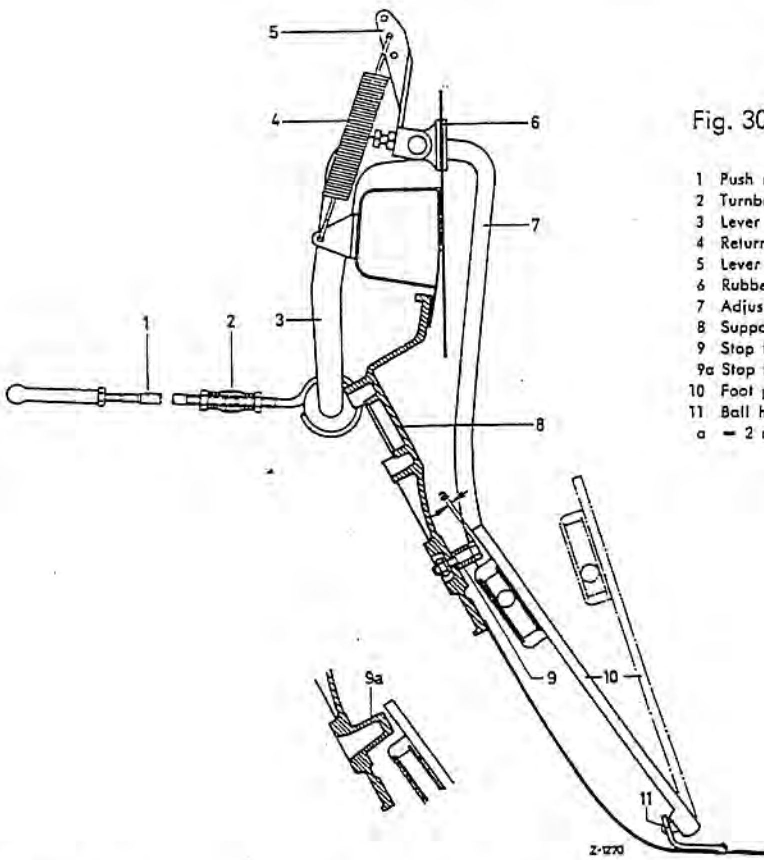


Fig. 30-3/1

1 Push rod
2 Turnbuckle
3 Lever on control shaft
4 Return spring
5 Lever for return spring
6 Rubber grommet
7 Adjustment lever
8 Support plate for steering column jacket
9 Stop for foot plate (1st version)
9a Stop for foot plate (2nd version)
10 Foot plate
11 Ball head bracket
a = 2 mm

Models 190 c, 190 Dc, 220 b, 220 Sb, 220 SEb with Mechanical Transmission

1. Insert a gage 2 mm thick between the foot plate (10) and the stop (9 or 9a). Use a suitable fixture to fix the foot plate in the full-load position (Fig. 30-3/1).
2. Adjust the length of the push rod (1) by means of the turnbuckle (2) in such a way that the throttle valve levers of the carburetors or the throttle valve lever of the venturi control unit rest against the full-load stop.
3. Lock the turnbuckle in its position by means of the hexagon nuts.
4. Return the foot plate to idle position and remove the gage.
5. Depress the accelerator pedal. If the adjustment is correct, the stop (9 or 9a) must be noticeable when the pedal is depressed beyond the full-load position.

Models 300 SE, 220 SEb, with Automatic Transmission

1. Depress the foot plate (6) until it bears against the kickdown switch (4) (position B, Fig. 30-3/3). In this position there must be 5 mm clearance between the throttle valve lever (1) and the full load stop (2) on the venturi control unit (Fig. 30-3/2). If necessary adjust the kickdown switch (4) after loosening the lock nut (3) by turning it in or out in the cover plate (2) in the steering column jacket (Fig. 30-3/3).