Engine Tune-Up

Change: Model 180 c and modified valve timing gear have been added.

In general it is sufficient to carry out the checking and adjustment operations described in the procedures A–K below for gasoline engines and in the procedures A–G and M–P for fuel injection engines.

It is usually unnecessary to check the valve timing settings; this should only be done in special cases.

An accurate adjustment of the tappets is not possible when the engine is warm and should therefore never be undertaken. For this reason the tappet clearance data always refer to the cold engine.

If it should be necessary to begin adjustment operations with the engine at working temperature, procedures B etc. should be carried out first and, when the engine is cold, the tappet clearance should be adjusted and finally, after the engine has warmed up again, the idle should be adjusted. In the case of the injection engine for model 220 SE the control linkage can only be adjusted after the tappet clearance has been checked.

Operations should be carried out in the following order:

A. Tappet clearance adjustment
B. Compression measurement
C. Cleaning and testing of spark plugs
D. Measurement and adjustment of distributor contact gaps and angle of closure
E. Ignition setting
F. Checking camshaft adjustment
G. Measurement and adjustment of pressure of fuel feed pump
H. Measurement and adjustment of fuel level and injection amount of gasoline engines
I. Trouble-shooting hints on carburetor system
K. Adjustment of carburetor linkage and idle
L. Testing valve timing
M. Measurement of intake pipe vacuum
N. Exhaust gas test values
O. Engine testing on the roller test stand
P. Adjustment of gasoline injection pump in model 220 SE
Q. Checking gasoline injection system of model 220 SE
R. Trouble-shooting hints on gasoline injection system of model 220 SE
S. Adjustment of control linkage, idle adjustment, and readjustment of speed build-up of gasoline injection engine in model 220 SE

A. Tappet Clearance Adjustment

Tappet clearance should only be checked or adjusted with the engine cold!

On models 180a, 180b, 190 SL, 220a, 219, 220S, and 220 SE the tappet clearance is adjusted and checked as described for model 190, with the difference, however, that on model 220 SE not only the cylinder head cover, but also the air filter and the venturi control unit must be removed (see Job No. 01–4, Section A), and that the adjustment of the control linkage must always be checked after the tappet clearance has been checked and after previously removed parts have been reinstalled (see Workshop Manual Passenger Car Models starting August 1959, Job No. 00–16).

Tappet Clearance

Model	220 a	180 a, 180 b, 190, 190 SL	180 c 190 SL[1]	219, 220 S, 220 SE
Inlet	0.08	0.10	0.08	0.12
Exhaust	0.20	0.20	0.15	0.20

During adjustments be sure that the gage (tolerance feeler band) requires a **firm** pull. For setting tappet clearance use only the special Wrench Combination 000 589 11 07 or the short Wrench Combination 000 589 64 09. Using any other tool may prevent full tightening of the hexagon nut on the adjusting screw and the nut may come loose. Also, use of an unsuitable wrench may damage the hex nut during the tightening. Be sure to replace any damaged nuts.

[1] **On the new, further modified valve timing** (Fig. 01–4/20a) the tappet clearance is measured between the slide surface of the rocker arm the cam base circle of the camshaft.

If models 180 c and 190 SL with the new valve timing require a correction of their tappet clearance, adjustments are made by turning the upper portion of the ball pin at the hexagon portion (SW 14) with the adaptor 111 589 00 01 (1) and a torque wrench (0–6 mkg) (2) Fig. 01-3/1). Too small a tappet clearance is increased by screwing ball pin top down, too large a tappet clearance is decreased by screwing the ball pin top out. When turning the ball pin top (3) in its socket (1) the adjusting torque should be at least 1.5 mkg (Fig. 01–4/20a). If the adjusting torque is less, either the ball pin top (3) or the ball pin socket (1) or both parts should be replaced. If the tappet clearance is too small and the ball pin top cannot be further adjusted (turned down) by means of the hexagon SW 14 into the ball pin socket, a thinner thrust piece (7) may be inserted into valve spring retainer (9) (Fig. 01–4/20a). Normally, the thrust plates are 4.5 mm thick, they are also available 3.5 mm and 2.5 mm thick. Replacement of a thrust plate requires disassembly of the rocker arm (refer to Job. No. 05–1).

Valve Arrangement

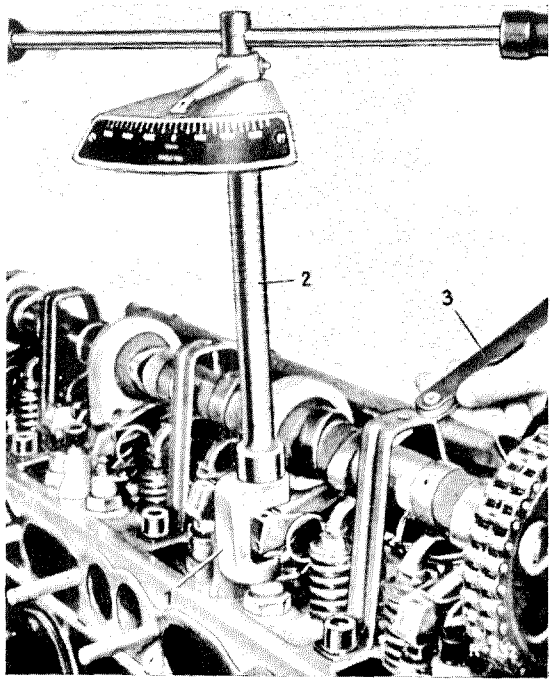


Fig. 01–3/1

1 Adaptor for adjustment of tappet clearance 111 589 00 01
2 Torque spanner
3 Gage with tolerance feeler band 0.08 mm and 0.15 mm

Note: The camshaft with Code No. 33 used in models 219 and 220 S with a compression ratio of $\varepsilon = 8.7:1$ is also available as a replacement for models 220 a, 219 and 220 S with a compression ratio of $\varepsilon = 7.6:1$. When using the camshaft with Code No. 33 for type 220 a inlet tappet clearance should also be set to 0.12 mm. When installing a camshaft with Code No. 33 sodium-filled exhaust valves should be included in the installation.

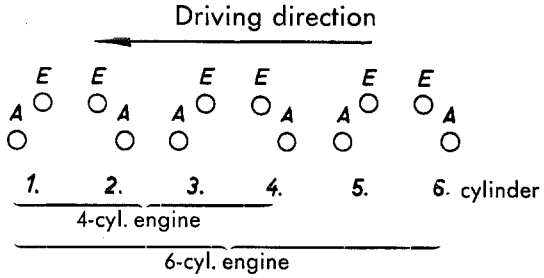


Fig. 01–3/2

B. Compression Measurement

The compression pressure should always be measured (by means of the Compression Recorder 000 589 18 21) **with the engine at working temperature and the throttle valves fully opened** (see Model 190 Workshop Manual).

The compression values are listed in the Table below. They apply only when Compression Recorder 000 589 18 21 is used. When judging the compression pressure, not so much importance should be attached to the absolute figure as to the equality of the figures for the individual cylinders. The figures obtained for the individual cylinders **must not vary by more than 1.5 atmospheres.**

Compression Ratio, Capacity of Compression Chamber, and Compression Pressure

Model	180 a 190 [1]	180 b	180 a [2] 180 b [2] 190	220 a [3] 219 [3] 220 S [3]	220 a 219 [4] 220 S [4]	219 [5] 220 S [5] 220 SE	190 SL [6]	190 SL [7]
Compression ratio ε Maximum permissible Normal Minimum permissible	 7.0:1 6.8:1 6.6:1	 7.25:1 7.0:1 6.8:1	 7.8:1 7.5:1 7.25:1	 7.1:1 6.8:1 6.5:1	 7.8:1 7.6:1 7.35:1	 9.0:1 8.7:1 8.4:1	 8.8:1 8.5:1 8.25:1	 9.2:1 8.8:1 8.45:1
Total capacity of compression chamber with cylinder head fitted (cc)	78.5—84.5	76—82	69.8—75.8	60.5—65.5	53.5—57.5	45.5—49.5	60.3—66.3	57.8—63.8
Capacity of compression chamber in cylinder head with valves fitted and spark plugs screwed in (cc)	70.3—71.3	68.5—69.5	62.3—63.3	50.0—51.0	44.3—45.5	36.4—37.4	51.7—53.7	49.3—51.3
Compression pressure in new engines (atmospheres)	7.5—8.0	7.5—8.0	8.0—8.5	7.5—3.0	8.0—8.5	9.0—10.0	9.0—9.5	9.0—10.0
Minimum compression pressure in used engines (atmospheres appr.)	6	6	7	6	7	8	8	8

[1]) Engine with lower compression as optional extra for Model 190 according to SA 10250.

[2]) Engine with higher compression for countries with altitudes above 2000 meters as optional extra for Models 180 a and 180 b according to SA 10331.

[3]) Engines with lower compression as optional extra for Models 220 a and 219 according to SA 10037, and Model 220 S according to SA 10187.

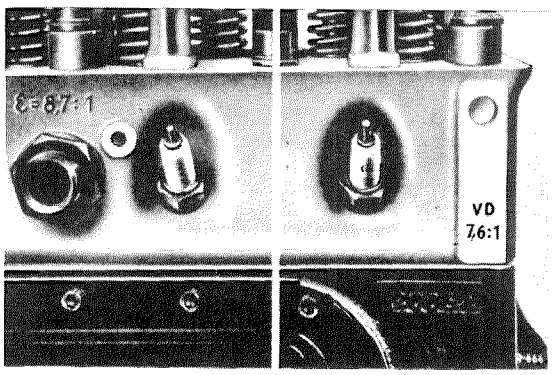
[4]) 1st Version on Model 219 up to engine end no. 75 04347, on Model 220 S up to engine end no. 75 09083.

[5]) 2nd Version on Model 219 with standard clutch as from engine end no. N 75 04348, with hydraulic automatic clutch as from engine end no. Z 75 00002, on Model 220 S with standard clutch as from engine end no. N 75 09084, with hydraulic automatic clutch as from engine end no. Z 75 00008.

[6]) 1st Version up to engine end no. 65 03803.

[7]) 2nd Version as from engine end no. 65 03804.

On previous Models the compression ratio was stamped on the left rear part of the cylinder head; on recent Models it is cast in the cylinder head on the left-hand side above the threaded union for the water pipe connection (Fig. 01-3/3).



Compression ratio markings on cylinder head
now previously

Fig. 01-3/3

C. Cleaning and Testing of Spark Plugs

For testing and cleaning the spark plugs and for the interpretation of spark plug appearance in Models 180 a, 180 b, 190 SL, 220 a, 219, 220 S, and 220 SE see the details given in the Model 190 Workshop Manual.

Approved Spark Plugs

The approved spark plugs are listed in our Service Bulletins and Spark Plug Tables and are also contained in our Workshop Tables.

Thread Length of Spark Plugs

The thread lengths differ on different types of spark plugs. It is necessary therefore to ensure that only spark plugs of the type approved for the individual engines are installed.

Wrong spark plugs may cause engine trouble and may even damage the engine.

The following list gives the thread length of the spark plugs for the various engines. The Table is based on thread length "H_2" (Fig. 01-3/4a).

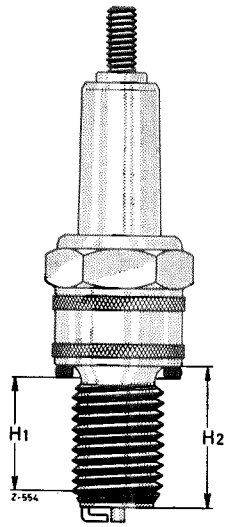


Fig. 01-3/4 a

H_1 = free thread length
H_2 = thread length (standard length)

Thread Length of Spark Plugs

Model	Thread length "H_2"
180 a, 180 b, 190, 220 a, 219, 220 S all with the exception of $\varepsilon = 8.7:1$	12
190 SL with $\varepsilon = 8.5:1$	18
190 SL with $\varepsilon = 8.8:1$	19 *)
219, 220 S with $\varepsilon = 8.7:1$	19 *)
220 SE	19

*) The cylinder heads for Models 190 SL ($\varepsilon = 8.8:1$) and 219, 220 S ($\varepsilon = 8.7:1$) formerly had a plug thread for spark plugs with a thread 18 mm long, and now have a plug thread for spark plugs with a 19 mm thread. To distinguish the two types, cylinder heads with a plug thread for 19 mm spark plugs are marked "19" beside the compression ratio marking.

On Champion spark plugs the beginning of the thread is **not** chamfered, so that the free thread length "H_1" is slightly longer than that of Bosch and Beru spark plugs. For this reason it is necessary to install a second sealing ring of a minimum thickness of 1 mm when Champion spark plugs are used. This is necessary, since otherwise part of the plug thread would project into the combustion chamber and may accumulate carbon deposits, which, under certain circumstances, may damage the thread in the cylinder head when the plugs are unscrewed.

Installation of Spark Plugs

Spark plugs should only be slackened and tightened by means of the Articulated Spark Plug Wrench 000581 00 67. Great care is necessary when this wrench is used to screw in the spark plugs, as a certain amount of experience is necessary to insert the spark plug correctly. In order to avoid damage to the plugs and to the thread in the cylinder head, Spark Plug Holder 198 580 00 65 should be used for screwing in the spark plugs (Fig. 01-3/4b).

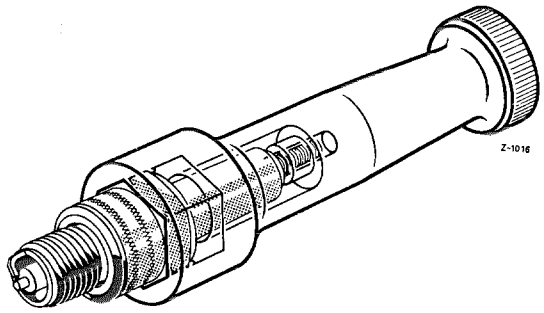


Fig. 01-3/4b

The Rubber Socket 000 581 00 86 pressed into the Articulated Spark Plug Wrench and the Socket 000 581 00 56 screwed into the Spark Plug Holder are replaceable.

D. Measurement and Adjustment of Distributor Contact Gaps and Angles of Closure

Measurement and adjustment on Models 180 a, 180 b, 190 SL, 220 a, 219, 220 S, and 220 SE are carried out in the same way as on Model 190. **We should like to point out again that whenever the angle of closure has been corrected, it is absolutely necessary to check whether the contact gap is still satisfactory.**

When the contact gaps have been adjusted, it is always necessary to check and if necessary to readjust the ignition setting.

Distributor Contact Gaps and Angles of Closure

Model	180 a, 180 b, 190, 190 b, 190 SL	220 a, 219, 220 S, 220 SE
Distributor contact gap (mm)	0.4—0.5	0.3—0.4
Angle of closure *)	50° ± 2°	36° ± 2°

*) When measuring the angle of closure please note that at higher engine speeds it may be lower by a maximum of 3°.

E. Ignition Setting

For the ignition setting in Models 180 a, 180 b, 190 SL, 220 a, 219, 220 S, and 220 SE see the details given in the Model 190 Workshop Manual.
Ignition adjustment should always be made by means of a flash stroboscope, and a timing light should only be used in exceptional circumstances.
The adjustment data are listed in the Table overleaf.

Ignition Setting

Model	Compression ratio ε	Distributor Bosch designation	Basic setting and stroboscope value at starter speed	Stroboscope values at engine speed (rpm)					
				800	800	1500	3000	4500	4500
				Automatic vacuum control					
				with	without	without	without	without	with
180 a [4] 190	6.8:1	VJU 4 BR 14 VJU 4 BR 22 VJUR 4 BR 27	8° ± 1° BTDC	15°—23° 12°—19°	26°—32° 12°—19°	27°—33°	32°—39°	41°—47°	49°—59°
180 b [4]	7.0:1	VJUR 4 BR 28	4° ± 1° BTDC	0°—10°	0°—10°	18°—25°	37°—43°	46°—52°	52°—62°
220 a 219	6.8:1 7.6:1	VJU 6 BR 24 VJUR 6 BR 24 VJUR 6 BR 38	5° ± 1° BTDC	10°—19°	10°—19°	23°—30°	28°—34°	34°—41°	42°—53° [1]
219	8.7:1	VJUR 6 BR 38	1° ± 1° ATDC	4°—13°	4°—13°	17°—24°	22°—28°	28°—35°	36°—47° [1]
220 S	6.8:1 7.6:1	VJUR 6 BR 24 VJUR 6 BR 38	8° ± 1° BTDC	13°—22°	13°—22°	26°—33°	31°—37°	37°—44°	45°—56° [1]
220 S	8.7:1	VJU 6 BR 38	2° ± 1° BTDC	7°—16°	7°—16°	20°—27°	25°—31°	31°—38°	39°—50° [1]
220 SE	8.7:1	VJUR 6 BR 32	2° ± 1° BTDC [2]	0°—6°	0°—6°	13°—19°	24°—28°	28° [3]	36°—40°
190 SL	8.5:1 8.8:1	VJUR 4 BR 11 VJ 4 BR 12	1° ± 1° BTDC	—	—	—	35°—41°	—	—
		VJ 4 BR 11 VJR 4 BR 24	9° ± 1° BTDC	—	—	—	35°—41°	—	—

[1] In the case of the 2nd version distributor VJUR 6 BR 38 the vacuum control is 10±2° on the crankshaft, as compared with 20±2° on distributors VJUR 6 BR 38, 1st version, VJUR 6 BR 24, and VJU 6 BR 24. The values given in the above Table apply to distributor VJUR 6 BR 38, 2nd version; the corresponding values for the 1st version and for the two distributors VJUR 6 BR 24 and VJU 6 BR 24 are 10° higher (e. g. 52°—63° instead of 42°—53°).

[2] The basic setting only applies to the assembly setting. For the final ignition setting see the values given for a speed of n = 4500 rpm without automatic vacuum control.

[3] In the case of distributor VJUR 6 BR 32 T, whose centrifugal governor advance curve is near the upper limit of the tolerance range, the centrifugal governor control already starts at a speed of n = 650 rpm. For this reason the ignition setting with a distributor VJUR 6 BR 32 T should also be checked at idling speed. At this speed the ignition setting must not be earlier than 4° BTDC. If the value is smaller, ignition can be retarded up to 26° BTDC at a speed of n = 4500 rpm.

If in exceptional cases a fuel with an octane rating lower than 96—99 ROZ (F—1) has to be used, ignition must be retarded in order to adapt it to the octane number of the fuel used. This setting should be carried out only within certain limits set out below.

Fuel with ROZ	Stroboscope value at n = 4500 rpm
93	26° BTDC
90	22° BTDC
88	20° BTDC

Ignition should be retarded at the distributor bearing by means of the hand lever. Adjustment by one graduation changes the ignition by 2° on the crankshaft. As soon as premium gasoline is being used, the hand lever should be moved back to its full advance position (28° BTDC at n = 4500 rpm).

If in engines which have run for a considerable time, the ignition is found to have moved in the "advance" direction, check the end play of the idling gear shaft, which should be 0.05—0.12 mm. If the end play exceeds 0.20 mm, the wear parts must be replaced.

[4] Ignition setting on Models 180 a and 180 b with a compression ratio ε = 7.5:1 for countries with altitudes above 2000 meters: 8° BTDC.

Note: The distributor named last with each model indicates the present standard design.
On model 190 SL the distributors VJ 4 BR 12, VJ 4 BR 11 and VJR 4 BR 24 have no vacuum control. Though the distributor VJUR 4 BR 11 is provided with a vacuum box, it is not connected. Compared with the two other distributors the VJ 4 BR 11 and VJR 4 BR 24 have a different movement curve. Therefore, care must be taken, that the various distributors are not mixed up when the ignition is adjusted.

Measurement of Ignition Vacuum Control

If the initial operation of the vacuum control and the amount of the vacuum should ever require an inspection, the following table shows the required values. However, the vacuum at the distributor should not be confused with the vacuum at the testing connection of the intake pipe. For this reason a Tee-piece should be inserted on the distributor when measuring the vacuum.

Initial Operation of Vacuum Control and Amount of Vacuum

Model	Distributor	Begins to operate at Engine Speed without Load rpm	Vacuum at Distributor mm Hg
180 a, 190	VJU 4 BR 14 VJU 4 BR 22 VJUR 4 BR 27	1000–1200	90–120
180 b, 180 c	VJUR 4 BR 28	1000–1200	90–130
200 a, 219	VJU 6 BR 24 VJUR 6 BR 24	1400–1600	90–120
219	VJUR 6 BR 38	1400–1600[1])	90–160
220 S	VJUR 6 BR 24	1800–2000	90–120
	VJUR 6 BR 38	1800–2000	90–160
220 SE	VJUR 6 BR 32	800–1000	90–140

[1]) For carburetors with by-pass bores (as from Nr. 3908566) vacuum control at engine speed n = 2500–3500 rpm

F. Checking Camshaft Adjustment

The camshaft adjustment for models 180 a, 180 b, 180 c, 190 SL, 220 a, 219, 220 S and 220 SE is tested in the same workshop way as described in the manual for model 190.

Contrary to the above and contrary to the more recent models the earlier 220a and the early 190 SL models have no marks at the front of the counterweight on the crankshaft. On these engines the graduation on the flywheel should be used, which is exposed at bottom of clutch housing after removing cover plate.

G. Measurement and Adjustment of Pressure of Fuel Feed Pump

I. Models 180 a, 180 b, 180 c, 190 SL, 220 a, 219 and 220 S

The fuel feed pump, the location of the pump on the engine, its drive, as well as measuring and adjusting of delivery pressure, are the same as for Model 190.

Note: When reassembling the pump make sure that prior to tightening the upper part of the pump the diaphragm spring is pre-stressed up to stop by means of hand lever, because otherwise the diaphragm will either tear or warp during operation.

Test Values of Fuel Feed Pump

Delivery Pressure		Vacuum at Suction Side
At Starter Speed	At Idling Speed	
0.12–0.16 atm.	0.15–0.20 atm.	0.28–0.38 atm.

II. Model 220 SE

For description and test procedure of electric fuel feed pump refer to Workshop Manual Passenger Car Models starting August 1959, Job. No. 00–15.

H. Measurement and Adjustment of Fuel Level and Injection Amount in Carburetor Engines

Fuel Level and Injection Amount

Model	180 a	180 b	180 c	190 SL	220 a, 219	220 S
Fuel Level mm	16–20	16–18	16–18	*)	13–15	19–21
Injection quantity cm^3/stroke	0.9–1.2	1.0–1.2	0.7–1.0	0.4–0.6	1.3–1.5	1.1–1.3

*) Distance from separating surface of carburetor cover with gasket to upper edge of vertical float wall: For die-cast carburetors 37–38 mm, for sand-cast carburetors 39–40 mm.

Note: The injection amounts named in the table for models 220 a and 219 refer to the total injected by both injection tubes.

After measuring the injection amount, check whether injection tubes are aligned in such a manner that the injection jet hits the edge of the closed throttle valve, if this is not the case, speed build-up faults may result.

I. Measurement and Adjustment of Fuel Level

a) **Models 180 a, 180 b, 180 c, 220 a and 219**
For the downdraft carburetor of models 180 a and 180 b, 180 c, and the double-downdraft carburetor for models 220 a and 219 measuring and adjustment procedures are substantially the same as for the compound downdraft carburetor of model 190. The fuel level is measured as usual on the wall which faces the suction canal (Fig. 01–3/5).

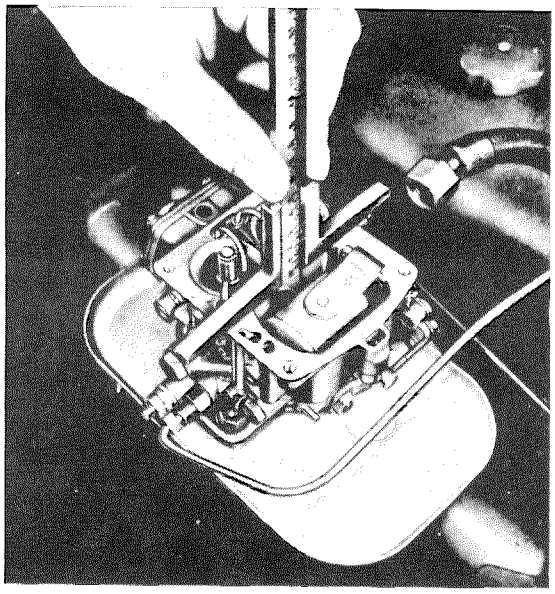


Fig. 01-3/5

For correcting the fuel level in downdraft carburetors, copper sealing rings are available for the float needle valve in the following thicknesses:

Part No. 000 997 81 40
0.5 mm thick

Part No. 000 997 28 40
1.0 mm thick (standard)

Part No. 000 997 82 40
1.5 mm thick

Part No. 000 997 83 40
2.0 mm thick

The fuel level can thus be corrected quite simply. An alteration of 0.5 mm in the thickness of the sealing ring is equivalent to an alteration in fuel level of appr. 1 mm.

b) **Model 220 S**

In the case of the compound downdraft carburetor for Model 220 S the fuel level measuring procedure is exactly the same as in the case of the compound downdraft carburetor for Model 190.

c) **Model 190 SL**

In the case of the cross-draft compound carburetor for Model 190 SL a different method is used to measure the fuel level. When the carburetor cover is removed, the float is removed with it. This means that instead of the float level, the position of the float in relation to the carburetor cover has to be measured (Fig. 01-3/8).

To do this, disconnect the fuel line, the support of the fuel overflow line at the hot-start mechanism, and the hose connections at the carburetor covers. Then unscrew the four fixing screws from the carburetor covers and carefully remove the carburetor covers, taking care not to bend the float arms (Figs. 01-3/6 and 01-3/7).

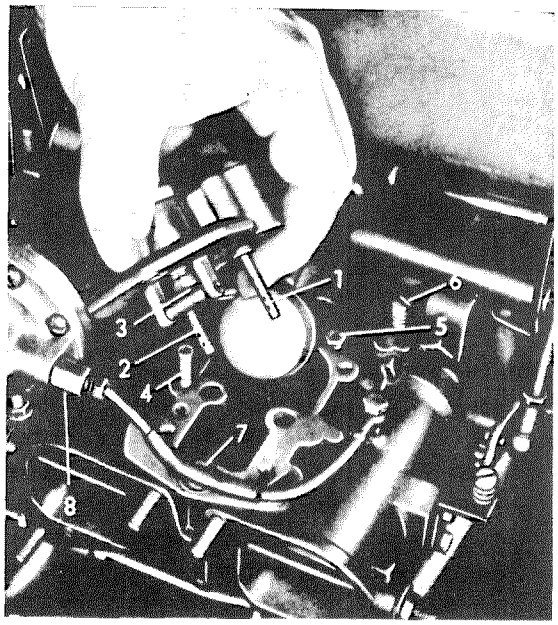


Fig. 01-3/6

Die-cast carburetor

1 Mixing tube of Stage 1
2 Mixing tube of Stage 2
3 Float needle valve
4 Mixture outlet tube
5 Idle fuel jet of Stage 1
6 Idle mixture adjustment screw of Stage 1
7 Pump jet with injection tube
8 Ball valve (delay valve) on the vacuum side

Note: On sand-cast carburetors the fuel overflow line is connected to the carburetor covers by means of a cap nut.
To check the float adjustment, measure the position of the float in relation to the separating surface of the carburetor cover. The distance "h" from the separating surface (with gasket) to the upper edge of the vertical float wall should be:

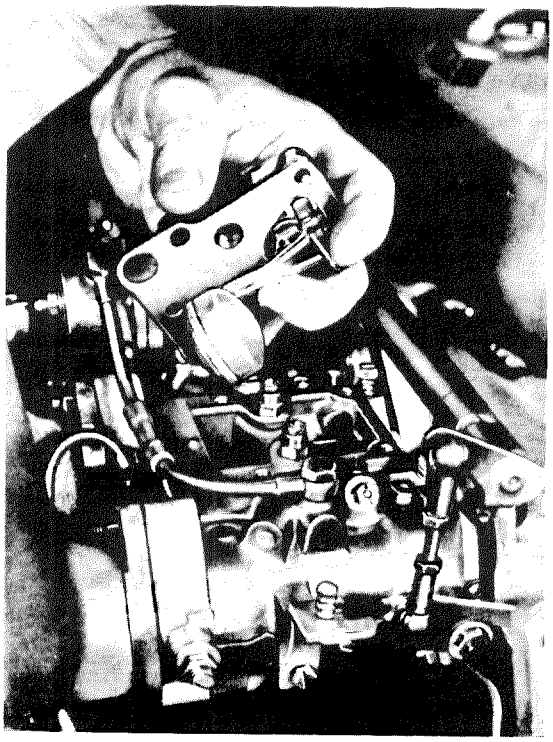


Fig. 01-3/7
Sand-cast carburetor

h = 37–38 mm for die-cast carburetors
h = 39–40 mm for sand-cast carburetors
(Fig. 01-3/8).

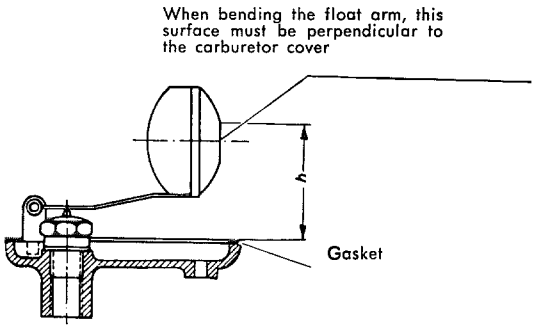


Fig. 01-3/8

II. Measurement and Adjustment of Injection Amount

Note: To measure the injection amount of the accelerating pump, use measuring tubes that have been bent to the correct shape. **On no account must the injection tubes of the carburetors be used** for this purpose, since there is a danger that the tubes will leak in the holder. The gaskets for the holder of the injection tubes should always be replaced.

It is advisable always to measure the fuel amount produced by five strokes in order to achieve the required degree of accuracy.

a) **Models 180 a, 180 b, 220 a, and 219**

In the case of the downdraft carburetor for Models 180 a and 180 b and the double downdraft carburetor for Models 220 a and 219 measuring and adjustment procedures are basically the same as in the case of the compound downdraft carburetor for Model 190.

Unlike other carburetor models, the connecting rod to the accelerating pump in the downdraft carburetor for Models 180 a and 180 b is provided with three cotter-pin holes instead of an adjusting nut. The adjustment can be slightly changed by adding washers between the pump arm and the cotter pin (see also Job No. 07-0, Sections E and F).
When measuring the injection amount on the double downdraft carburetor for Models 220 a and 219 the two injection tubes must be considered as a unit (Fig. 01-3/9a).

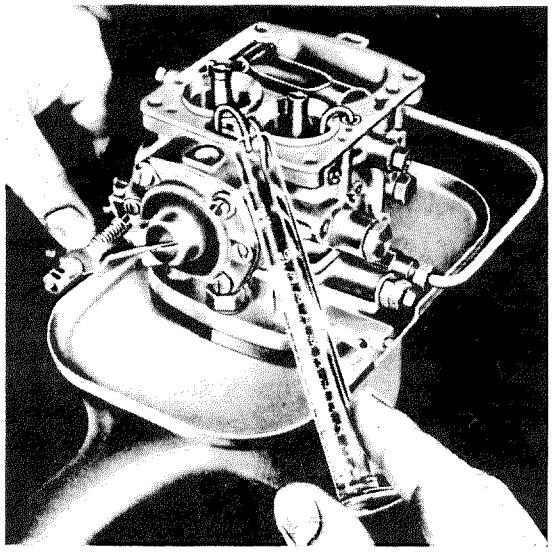


Fig. 01-3/9a

The injection amounts given in the Table always refer to the two injection tubes together.

When the injection amount has been adjusted, the two injection tubes must be so positioned that the injection jet is directed toward the edge of the closed throttle valve. If there are any doubts, check the height of the injection tube for the 1st version carburetor for Model 180 a and of the injection tubes of the double downdraft carburetor for Models 220 a and 219. Measure the distance "a" from the separating surface of the carburetor housing to the lower end of the injection tube (Fig. 01-3/9b).

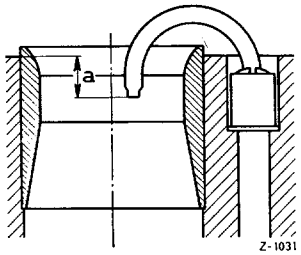


Fig. 01-3/9b
a = 9.0 ± 1.0 mm for Model 180 a
a = 5.0 ± 1.0 mm for Models 220 a and 219

b) **Model 220 S**

In the case of the compound carburetor for Model 220 S the procedures for measuring and adjusting the injection amount are exactly the same as in the case of the compound carburetor for Model 190.

c) **Model 190 SL**

On Model 190 SL the measuring procedure is different for die-cast carburetors and sand-cast carburetors.

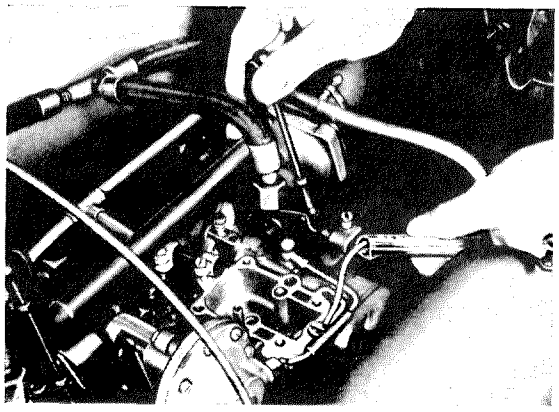


Fig. 01-3/10

Measurement on a die-cast front carburetor

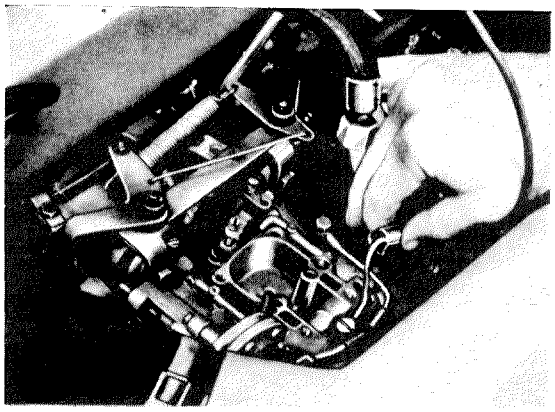


Fig. 01-3/11

Measurement on a die-cast rear carburetor

On the die-cast carburetors the carburetor covers are removed and the injection tubes are replaced by two Measuring Tubes 000 589 51 21 (Figs. 01-3/10 and 01-3/11).

If it is necessary to correct the injection amount, it is advisable to remove the air suction tube, which makes it much easier to adjust the connecting rods on the accelerating pumps, particularly on the rear carburetor.

Note: In order to ensure that during future measuring operations the choke control need not be disconnected when the air suction tube is removed, it is advisable to cut a slot as shown in Fig. 01-3/12a into the fixing eye for the choke control sleeve. If that is done, the air suction tube can be removed by simply loosening the clamping screw for the control sleeve.

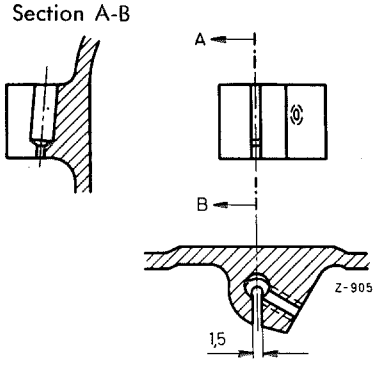


Fig. 01-3/12a

In the case of sand-cast carburetors, the air suction tube and the choke valve housings

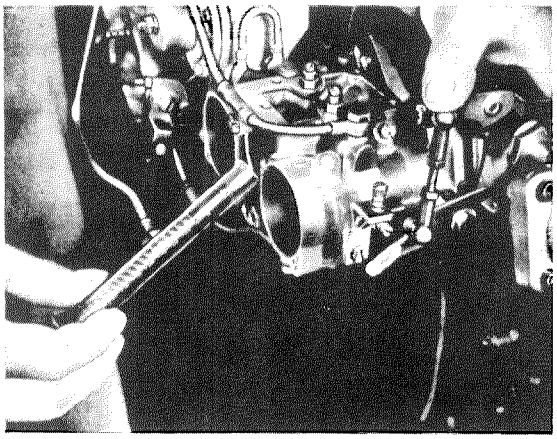


Fig. 01-3/12b

Measurement on a sand-cast front carburetor

must be removed. Then unscrew the injection tubes and install them upside down (Fig. 01-3/12b).

When screwing the choke valve housings and the air suction tube to sand-cast carburetors, make sure that the gaskets are absolutely flat and are not damaged during the operation. It is advisable to glue them to the flange surfaces with grease. Damaged gaskets should always be replaced.

The cylinder head screws used to fasten the choke valve housings must be well tightened to ensure that they cannot work loose.

III. Checking the Beginning of Enrichment via the Pump System on Carburetors for Model 180 a

1. Disconnect the push rod (10) from the angle lever of the carburetor linkage (Fig. 01-3/13a). Back out the idle adjustment screw (7) at the throttle valve lever until the throttle valve is completely closed.

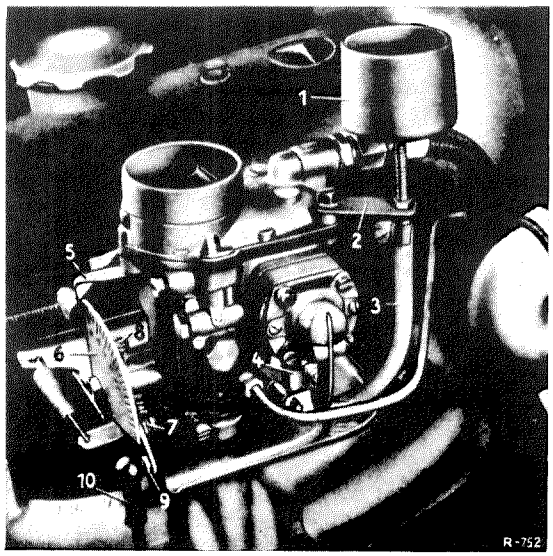


Fig. 01-3/13a

1 Container with outlet pipe
2 Holder
3 Hose length
4 Pipe union
5 Metal pointer
6 Graduated disk
7 Idle adjustment screw
8 Aperture limiting screw
9 Throttle valve lever
10 Push rod

2. Clamp a metal pointer (5) into position by means of the rear square screw for fastening the carburetor cover.

3. Fasten a suitable graduated disk (6) to the throttle valve shaft by means of an M 8 × 1 hexagon nut and adjust it so that, **when the throttle valve is completely closed,** the pointer points to 0° on the graduated disk.

4. Screw out the ball valve on the lower part of the carburetor housing and replace it by a pipe union (4) consisting of a pierced ball valve and a soldered pipe length.

5. Fasten a suitable small container (1) to the carburetor cover; the container must have an outlet pipe and a holder. Then connect the container to the pipe connection by means of a suitable hose length (3) and fill up with fuel.

Note: The outlet pipe of the container must not be too short, since otherwise the head will be insufficient to provide the necessary fuel flow.
The hose length must be of fuel-resistant material.

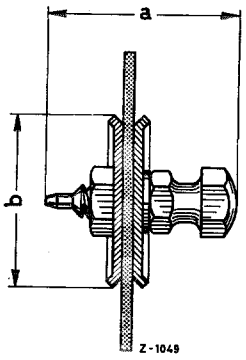


Fig. 01-3/13b

6. The enrichment delivery point differs according to the design of the pump diaphragm (see Table). The type of diaphragm used in any given carburetor can only be determined by removing the diaphragm.

   In addition, check the position of the cotter pins in the connecting rod.

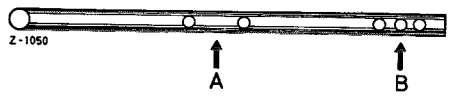


Fig. 01-3/13c

Enrichment Delivery Point

Pump diaphragm	Bolt length "a"	19	20.5	
	Plate dia. "b"	16	16	22
Enrichment delivery point		55°—60°	40°—44°	36°—40°
Cotter pin "A"		right pin hole	left pin hole	
Cotter pin „B"		center pin hole		
Washer between pump arm and cotter pin "B"		—	1 mm	—

7. Now move the throttle valve lever a few times. In order to check the enrichment delivery point, slowly open the throttle valve until fuel emerges from the injection tube. This is the enrichment delivery point.

   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 there is a constant dripping of fuel from the injection tube, the ball valve in the accelerating pump is leaking. In that case remove and clean the valve after detaching the accelerating pump.

   If fuel enrichment delivery occurs too early, the pin of the pump diaphragm can be slightly shortened. If the delivery point is far beyond the specified value, the pump diaphragm must be replaced.

I. Trouble-Shooting Hints on Carburetor System

Engine trouble is often ascribed to the carburetor system although it may very well be due to other causes.

Before beginning any work on the carburetor system, the following points should be checked:

The spark plugs (electrode gaps – the appearance of the plugs may also give useful hints), the distributor (appearance and gap of distributor contacts – distributor rotor – distributor plate), the ignition cable harness and ignition lead plugs, the ignition setting, the tappet clearance, the compression pressure, the air filter, and the fuel pre-filter (dirt), the fuel line connections and the fuel pre-filter (leaks), and the fuel feed pump pressure.

Also check all parts supplied with interference suppressors, in particular the distributor rotor, the ignition lead plugs, and the spark plugs; the easiest way of checking these parts is to replace them by non-suppressed parts.

If carburetor faults develop during running, these are usually caused by dirt, gum deposits, dried-up or faulty seals and gaskets. In such cases it will usually suffice to thoroughly clean the float chamber, all jets, valves, injection tubes, bores, and canals, to blow them out with compressed air and to replace defective seals and gaskets. When this has been done, the carburetor will usually be in perfect working order. If normal cleaning fails to remove the faults, it is advisable to disassemble the carburetor completely and to clean and examine all parts. It is often impossible to determine with certainty the exact cause of a fault without checking all parts, since the same fault can have various causes. To assist in trouble-shooting, some possible faults and their causes are listed below.

Cause	Remedy
Engine difficult to start when cold	
Models 180 a, 180 b, 220 a, 219, and 220 S	
Starter fuel jet blocked	Clean starter fuel jet
Air leakage caused by loose starter housing	Check start mechanism
Control cable for start mechanism wrongly connected	Check adjustment of control cable (see Job No. 30-6).
Model 190 SL	
Choke valve not closing	Check adjustment of start mechanism (see Job No. 07-0, IV. Compound cross-draft carburetor for Model 190 SL, Section C)
Failure of throttle valves of Stage 1 to open	Check functioning of throttle valves
Choke valve sticking	Free up
Throttle valves of Stage 2 not closing completely	Check adjustment of throttle valves and, if necessary, readjust (see Job No. 01-3, Section K)

Cause	Remedy
Engine uneven after cold start	
Models 180 a, 180 b, 220 a, 219, and 220 S Failure of starter air valve to open, and in consequence, start mixture too rich	Check starter air valve, blow out vacuum canal and, if necessary, replace sealing ring
Model 220 S Mechanical throttle valve of Stage 2 not closing	Free up
Model 190 SL Wrong adjustment of clearance between the relay lever and the throttle valve lever of Stage 1 on the rear carburetor	Adjust clearance after having adjusted the idle (see Job. No. 01-3, Section K)
Engine difficult to start when hot	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S Fuel level too high	Correct fuel level, clean or, if necessary, replace float needle valve, replace sealing ring, correct pressure of fuel feed pump
Model 190 SL Hot-start mechanism sticking	Free up hot-start mechanism, if necessary, replace return spring
Bowden cable of hot-start mechanism catching or wrongly adjusted	Free up Bowden cable or readjust
Fuel retained in suction canal of Stage 1 and 2	Check fuel suction pipe of Stage 2 and fuel outlet pipe of Stage 1
Poor idling **Note:** The idle can only be adjusted when the engine is at normal working temperature.	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S	
Idle fuel jet, idle air jet, or idle air suction pipes blocked	Clean jets
Idle canal or by-pass bores blocked	Clean canal and bores
Suction canals fouled	Clean suction canals
Fuel level incorrect	Adjust fuel level
Excessive delivery pressure of fuel feed pump	Correct fuel feed pump delivery pressure
Float needle valve leaking	Replace float needle valve or sealing ring
Idle mixture adjustment screw damaged or broken	Replace idle mixture adjustment screw

Cause	Remedy
Mixing tube holder loose	Carefully solder guide of mixing tube holder and press into position
Throttle valve shaft worn	Replace throttle valve parts together with parts or replace carburetor
Injection tube dripping	Set fuel level to lowest permissible value
Leaks in insulation flange, carburetor flange, intake pipe flange, in the vacuum system of the Power Brake, or in the pneumatic ignition control	Test joints for leaks by smearing with soap and stop the leaks
Models 220 S and 190 SL	
Uneven adjustment of carburetor linkage	Carry out basic adjustment of carburetor linkage (see Job No. 01-3, Section K)
Model 190 SL	
Throttle valves of Stage 2 not closing completely	Check automatic return adjustment of Stage 2 and, if necessary, readjust (see Job No. 01-3, Section K)
Idle mixture adjustment screws of Stage 2 not closed	Close idle mixture adjustment screws

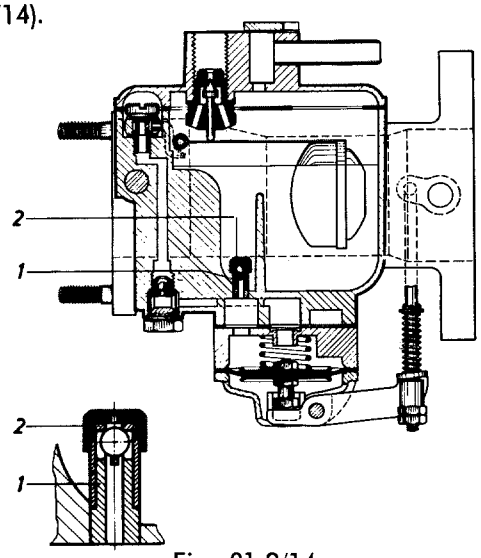
Models 180 a, 180 b, 220 a, 219, and 220 S

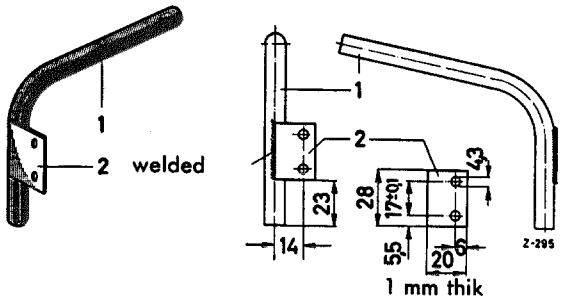
Note: If in countries with particularly high air temperatures the engine shows a tendency to stop at idling speed, the ball valve screwed into the lower part of the accelerating pump can be replaced by a spring-loaded ball valve (DB Part No. 000 070 02 46, Solex No. ZK 3508). In the spring-loaded valve the spring raises the ball a little from its seat in the "at rest" position, so that, as the pressure in the fuel chamber of the accelerating pump gradually increases, the fuel can flow back into the float chamber. When the outside temperature is low, however, and the car is gradually accelerated, a slight unevenness may occur as a result.

Idle too fast	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S	
Return spring for corburetor linkage too weak	Increase tension of return spring
Throttle valve shaft sticking	Check throttle valve shaft for ease of movement
Model 220 S	
Mechanical throttle valve of Stage 2 sticking	Check throttle valve shaft and relay lever

Note: The mechanical throttle valve of Stage 2 must close completely in the idle position. If the throttle valve is not completely closed, a greatly increased idle speed results; in this case the idle will not react to an adjustment of the idle mixture adjustment screw.

Cause	Remedy
Model 190 SL Throttle valves of Stage 2 not closing	Check the automatic return mechanism of Stage 2 and, if necessary, readjust (see Job No. 01-3, Section K)
Note: If the idle speed should be higher than usual when the accelerator pedal is released quickly, this may be due to worn throttle valves. In such cases the carburetors should be replaced.	
Idle too low	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S Wrong adjustment of idle adjustment screw	Adjust idle by means of the idle adjustment screw to the prescribed idle speed
Pressure spring of idle adjustment screw too weak	Replace pressure spring or increase spring tension by inserting a washer
Carburetor floods	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S	
Float needle valve leaking	Replace float needle valve and sealing ring
Faulty float needle valve sealing ring	Replace sealing ring
Uneven speed build-up	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S	
By-pass bores blocked	Clean bores
Injection tube holder gasket leaking	Tighten injection tube or replace gasket
Injection tube blocked	Replace injection tube
Injection amount wrongly adjusted	Correct injection amount
Ball valve of accelerating pump leaking	Replace ball valve
Pump jet blocked	Clean pump jet
Pump diaphragm faulty	Replace pump diaphragm
Model 190 SL Fuel suction pipe of Stage 2 or fuel outlet pipe of Stage 1 blocked	Check or clean pipes

Cause	Remedy
Bad idle adjustment	Check idle adjustment Make sure that in the idle position the throttle valves of Stage 2 are completely closed (see Job No. 01-3, Section K)
Idle fuel jets size 55 not yet installed	Replace in both Stages idle fuel jets size 50 by jets size 55 (possible also on sand-cast carburetors) Idle fuel jets size 55 are standard equipment as from Engine End No. 65 01365
Mixing tube no. 43 of Stage 1 not yet installed in die-cast carburetors and fuel line to accelerating pump not yet calibrated	In order to improve speed build-up, mixing tube no. 42 was replaced by mixing tube no. 43 of Stage 1 in die-cast carburetors as from Engine End No. 55 01823. At the same time the fuel line to the accelerating pump was calibrated to 0.5 mm. On engines from Engine End No. 55 00709 (where die-cast carburetors were first installed) up to Engine End No. 55 01822 mixing tube no. 43, Part No. 000 071 09 49, can be subsequently installed in Stage 1. This mixing tube no. 43 should only be installed subsequently together with the calibrated sleeve Part No. 000 071 03 40. In order to subsequently calibrate the fuel line to the accelerating pump, the calibrated sleeve (2) is installed on the ball valve (1) in the float chamber and is carefully pressed into position. Care should be taken to ensure that the ball valve pressed into the carburetor housing is not displaced and that the sleeve is not damaged. If the sleeve should be too tight, the internal diameter should be modified accordingly (Fig. 01-3/14).  Fig. 01-3/14 1 Ball valve for fuel admission 2 Calibrated sleeve

Cause	Remedy
	Note: Carburetors in which the fuel flow to the accelerating pump is calibrated (as from Engine End No. 55 01823) have no calibrated sleeve. In this design calibration takes place by way of the ball valve.
Lack of response of the engine at full load and engine speeds between n = 3000 and 4000 RPM	
Model 190 SL Fuel overflow line compressed at bends (only in die-cast carburetors)	Replace fuel overflow line **Note:** The line has a cross-section of 10× 1.0 mm. It must have an inside diameter of 8 mm along the whole length of the line. It is necessary therefore to ensure that the line is not bent out of shape. If it should be found that the inside diameter is smaller on bends, the line must be replaced. The full cross-section of the line must be available everywhere, since the compensating air for the main carburetion system passes through this line to the two carburetors (see also Job Nos. 07-0 and 01-4, Section A).
Connecting hose between fuel overflow line and pipe at the air scoop bracket compressed or pipe loose or twisted in the fixing clip	Realign fuel overflow line. If necessary, replace connecting hose **Note:** The pipe must be firmly attached to the air scoop bracket. The distance between the lower end of the pipe and the drain funnel must be appr. 10 mm. Make sure that this distance is maintained. Instructions for fastening and arranging the pipe apply to both die-cast and sand-cast carburetors. On recent cars the pipe is no longer fastened to the air scoop bracket by a pipe clip, but by a retaining plate welded to the pipe. This new retaining plate can also be subsequently welded to the pipe (Fig. 01-3/15).  Fig. 01-3/15 1 Pipe 2 Retaining plate

Cause	Remedy
Throttle valves of Stage 2 opening too quickly	Resin deposits on the ball valves (delay valves) on the vacuum side of the vacuum box. Clean or replace ball valves **Note: As from Engine End No. 65 04119 spring-loaded ball valves, Part No. 000 070 02 46, have been installed. These spring-loaded valves improve the build-up between Stage 1 and Stage 2, since the spring lightly presses the ball against the valve seat.**
Throttle valves of Stage 2 opening too slowly.	Check diaphragm and vacuum line for leakage Check ease of movement of the lever linkage and of the throttle valve shaft of Stage 2 **Checking of throttle valves of Stage 2:** The throttle valves of Stage 2 should open under the influence of the vacuum boxes at a speed of appr. n = 3500 rpm under full load. Their function can only be accurately checked on a test stand or during a road test with the engine hood removed. The opening of the throttle valves can be seen from the weights of the throttle valve levers. In general it will be sufficient to make a function check with the car stationary. To do this, cover the air intake pipe on the air intake silencer for a short time and accelerate with the other hand. The throttle valves of Stage 2 must open during this operation. **This should be done very carefully, since there is a danger that without load the engine may race when Stage 2 is fully open.**
Throttle valves of Stage 2 sticking	Check throttle valves **Note:** If there is any obstruction when the throttle valves are actuated, the cause in the case of older engines may be a fouling of the throttle valves of the rubber flanges between carburetor and intake pipe. If this should be the case, the carburetors must be removed and the rubber flanges must be replaced by flanges with an inside diameter of 49 mm. When repairs are carried out, the old flanges with an inside diameter of 46 mm should always be replaced by the new version flanges (see Job No. 01-4, Section A).

Cause	Remedy
High fuel consumption	
Models 180 a, 180 b, 190 SL, 220 a, 219, and 220 S	
Leaking float needle valve	Clean or replace float needle valve
Faulty float needle valve sealing ring	Replace sealing ring
Fuel level too high	Adjust fuel level
Fuel pump delivery pressure excessive	Adjust delivery pressure
Carburetor jets, valves, etc. loose or leaking	Tighten jets and valves and, if necessary, replace sealing rings
Idle air jet or air correction jets blocked	Clean jets
Carburetor cover loose	Tighten carburetor cover, check gasket
Mixing tubes blocked	Clean mixing tubes (including side bores)
Cable of starter rotary slide valve wrongly adjusted	Check cable and adjust correctly (see Job No. 30-6)
Starter rotary slide valve leaking	Check starter rotary slide valve for leaks and, if necessary, reface sliding surfaces
Model 220 S	
Connecting rod of the two start mechanisms bent	Check connecting rod and straighten or replace

Note: In the case of compound downdraft carburetors a leaking starter rotary slide valve or a slide valve which is not quite closed can be detected by examining the vacuum valve of Stage 2.

If the starter rotary slide valve is leak-proof or if it is closed, the vacuum valve is completely closed when the engine is idling.

Check by pressing on the counterweight of the vacuum valve.

If the starter rotary slide valve is leaking or is in operation, the vacuum valve is raised at idling speed, since the engine receives the start mixture via Stage 2. When making this check, however, the mechanical throttle valve of Stage 2 must be completely closed, since otherwise the vacuum valve will be raised by the air flowing via Stage 2.

Model 190 SL	
Start mechanism jammed or cable wrongly adjusted	See under "Engine difficult to start when cold"
Line to mixture outlet tube loose or leaking on die-cast carburetors	Tighten line, replace sealing rings
Fuel suction pipe loose or leaking	Tighten pipe, replace sealing rings

K. Adjustment of Carburetor Linkage and Idle

Before adjusting the carburetor linkage it is advisable first to check the attachment of the intake pipe, the exhaust manifold, the carburetor flange, the throttle valve lever, and the control lever, and to apply grease to the ball joints of the linkage. Any excessive end play at the control and angle levers or at the control shaft on Model 190 SL should be removed by inserting suitable shims.

I. Models 180 a, 180 b, 220 a, and 219

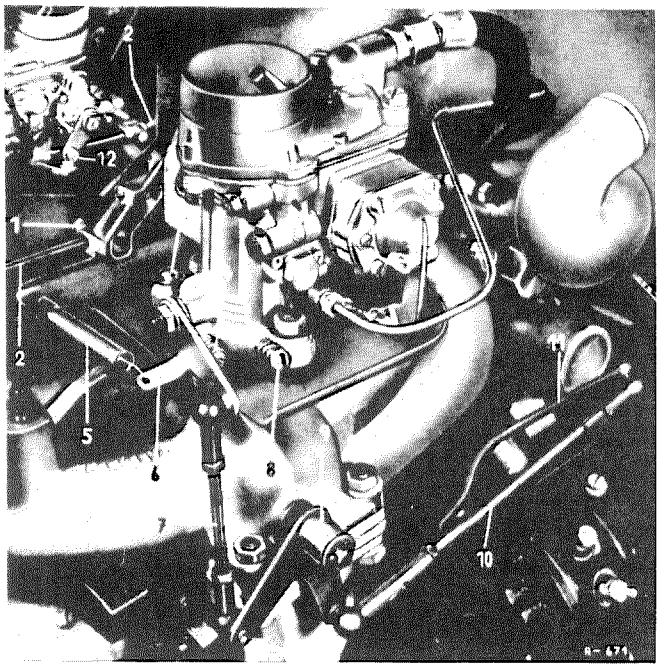


Fig. 01-3/16

1 Clamping screw for choke control sleeve
2 Choke control
3 Aperture limiting screw
4 Idle adjustment screw
5 Return spring
6 Throttle valve lever
7 Push rod
8 Idle mixture adjustment screw
9 Relay lever
10 Push rod
11 Double lever
12 Clamping screw for choke control

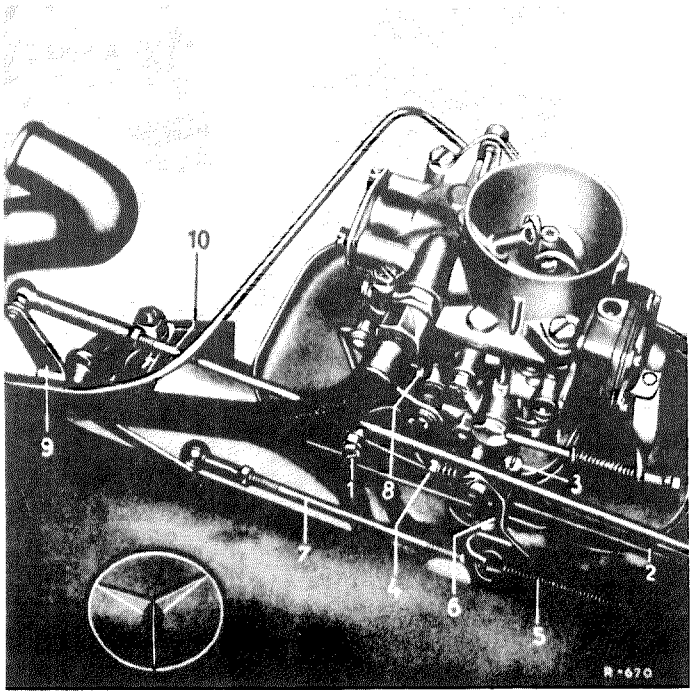


Fig. 01-3/17

1 Clamping screw for choke control
2 Choke control
3 Aperture limiting screw
4 Idle adjustment screw
5 Return spring
6 Throttle valve lever
7 Pull rod
8 Idle mixture adjustment screw
9 Relay lever
10 Pull rod

a) **Adjustment of Carburetor Linkage**

1. Check the throttle valve shaft for freedom of movement. To do this, detach the pull or push rod (7) at the throttle valve lever (6) and, if necessary, detach the return spring (5) (Figs. 01-3/16 and 01-3/17).

2. Turn out the idle adjustment screw (4) on the throttle valve lever until the throttle valve or in the case of double downdraft carburetors the throttle valves, are completely closed. Then turn in the idle adjustment screw until the throttle valve lever is on the point of moving. From this position the screw should be turned in one turn.

3. Press the throttle valve lever as far as the full load stop and check whether the aperture limiting screw (3) is resting against the full load stop of the carburetor housing.

4. Attach the pull or push rod (7) and the return spring (5) to the throttle valve lever. Again check the throttle valve position, actuating the carburetor linkage by depressing the accelerator pedal from inside the car (see also Job No. 30-3).

b) **Adjustment of Idle**

1. In order to adjust the idle on Models 180 a and 180 b, turn the idle mixture adjustment screw (8) right in and back it out by exactly two turns. On Models 220 a and 219 also turn in the two idle mixture adjustment screws completely and back them out by exactly one turn.

2. After warming up the engine to normal working temperature (cooling water temperature at least 70° C), adjust the idle by means of the idle adjustment screw (4) to 700–750 rpm on Models 180 a and 180 b and to 700–800 rpm on Models 220 a and 219. Use a revolution counter for this adjustment.

3. Adjust the idle mixture adjustment screw by slowly turning it in or out, so that

   a) the engine turns smoothly and

   b) the highest possible idle engine speed is obtained.

Note: On double downdraft carburetors the two idle mixture adjustment screws should be adjusted evenly.

4. Then readjust the idle speed by means of the idle adjustment screw (4) once more to a speed of 700–750 rpm on Models 180 a and 180 b and to 700–800 rpm on Models 220 a and 219.

5. By making a further slight correction with the idle mixture adjustment screw check whether the idle can be further improved. If necessary, again adjust the idle speed with the idle adjustment screw.

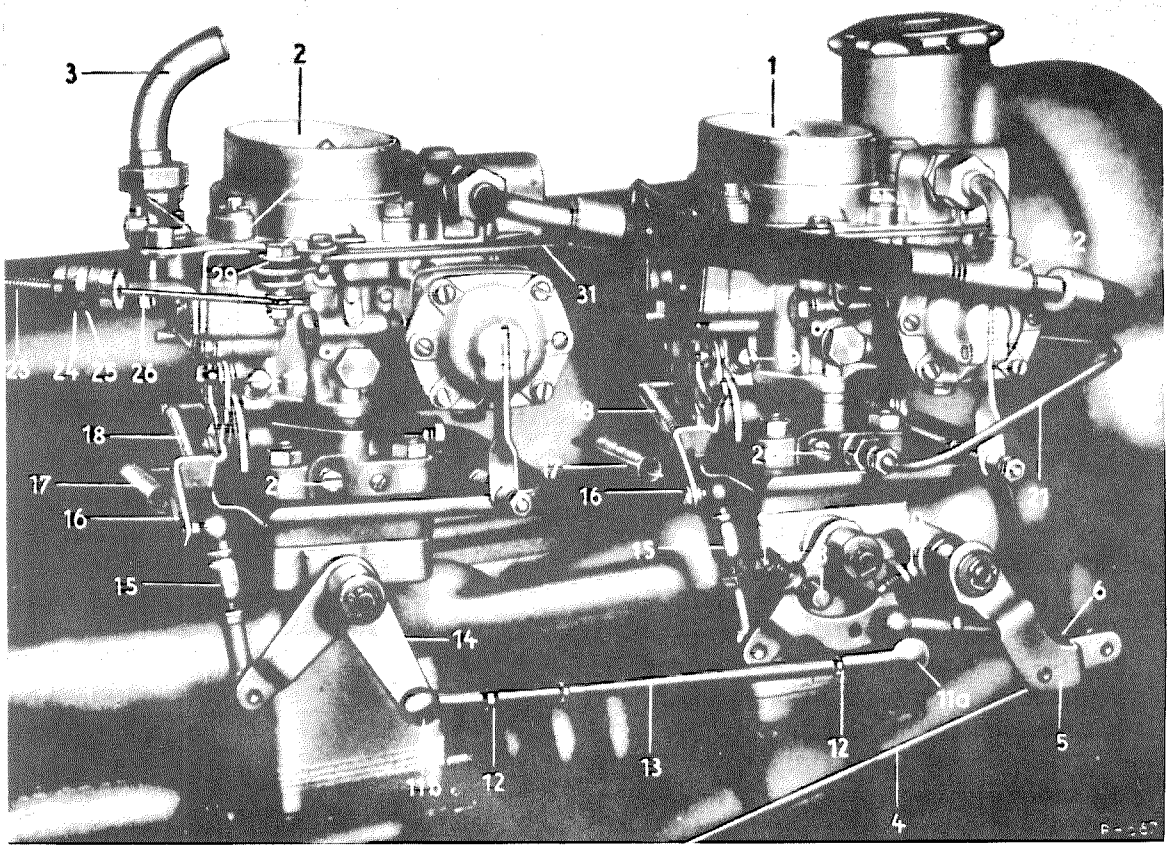


Fig. 01-3/18

1 Front carburetor	11b Ball socket	22 Fuel line
2 Rear carburetor	12 Hexagon nut	23 Coil spring
3 Vent tube	13 Push rod	24 Rubber bushing
4 Pull rod	14 Angle lever	25 Adjusting nut
5 Relay lever	15 Spring-loaded push rod	26 Spring steel wire
6 Push rod	16 Throttle valve lever	27 Angle lever
7 Control lever	17 Return spring	28 Clamping screw
8 Stop bolt	18 Tension spring	29 Rubber bushing
9 Idle stop screw	19 Idle adjustment screw	30 Hexagon nut
10 Aperture limiting screw	20 Idle mixture adjustment screw	31 Connecting rod
11a Ball socket	21 Vacuum line to distributor	32 Hexagon screw

Fig. 01-3/18 shows the 2nd version of the carburetor linkage (installed as from Engine End No. 75 06477).

On the 1st version (installed up to Engine End No. 75 06476) the push rod (13) was carried not by ball heads, but by bolts (see Fig. 01-3/19).

a) **Adjustment of Carburetor Linkage**

1. Detach the push rods (6) and (13) at the control lever (7) and the spring-loaded push rods (15) at the two carburetors (Fig. 01-3/18).

   On the 1st version push rod (13) loosen the hexagon nut (3) and the knurled nut (1) at the angle lever (14) for the rear carburetor and slacken it off until the pivoted drive pin (2) is completely free (Fig. 01-3/19).

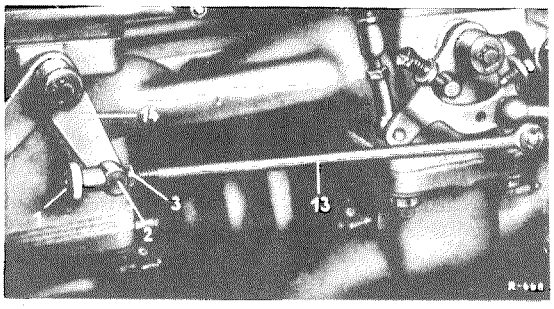


Fig. 01-3/19

1 Knurled nut
2 Drive pin
3 Hexagon nut
13 Push rod
14 Angle lever

2. Check the throttle valves of the carburetors for freedom of movement and if in doubt detach the return springs (17) and (18) (Fig. 01-3/18).

3. On both carburetors back out the idle adjustment screws (19) until the throttle valves of Stage 1 are completely closed. Then turn in the idle adjustment screws once more until the throttle valves are on the point of opening. From this position turn the screws in by exactly one turn.

4. Now back out the idle stop screw (9) on the control lever (7) until the lever rests against the stop bolt (8). Then turn in the screw by about two turns.

5. Check the length of the spring-loaded push rod (15) of the front carburetor. The push rod is adjusted to the correct length if both the control lever (7) and the throttle valve lever (16) rest against the idle stop. On no account should the push rod be extended against the spring pressure.

   Then check the length of the spring-loaded push rod (15) of the rear carburetor. The front and rear push rods must be of equal length. If necessary, adjust the length of the rear push rod to that of the front push rod.

   After adjusting the spring-loaded push rods, tighten the hexagon nuts on the ball sockets.

6. When the spring-loaded push rods have been adjusted to equal length, push them into position on the two throttle valve levers (16). Then make an accurate adjustment of the idle stop screw (9). To do this, back out the idle stop screw a little and screw it in again to the point where the control lever (7) is on the point of being moved. Then back out the idle stop screw 1/8 turn. This will ensure that there is no play in the mechanism even if the ball joints are slightly worn.

7. Press the push rod (13) in position on the control lever (7) and the angle lever (14).

Note: The push rod has a ball socket with a right-hand thread on the one side and a ball socket with a left-hand thread on the other side. The ball socket with left-hand thread should be pressed onto the angle lever for the rear carburetor.

8. In orde. to adjust the push rod (13), loosen the hexagon nuts (12) and slacken them off. Then adjust the push rod in such a way that the throttle valve lever (16) of the rear carburetor is on the point of being moved. From this position turn the push rod about 1/8 turn and tighten both hexagon nuts, making sure that the adjustment is not altered.

Note: When adjusting the push rod (13), do not pull it out too far, since otherwise the throttle valve lever (16) of the rear carburetor will be opened; on the other hand, it must not be turned too little, since otherwise the rear spring-loaded push rod (15) will be extended.

In order to adjust the 1st version push rod, turn the hexagon nut (3) toward the angle lever (14) as far as is necessary to ensure that the throttle valve lever (16) is on the

point of being moved; then turn the hexagon nut back 1/8 turn and tighten the knurled nut and lock by tightening the hexagon nut (see Fig. 01-3/19).

9. Adjust the idle stop screw (9) on the control lever (7) in such a way that there is a clearance of 0.1–0.2 mm between the stop screw and the bolt (8).

Note: Turning back the stop screw on the control lever has the following effect: When the accelerator pedal is released quickly, the shock force is absorbed by the spring-loaded push rods and as a result the throttle valves are relieved to a large extent.

10. To adjust the full-load stop, loosen the aperture limiting screw (10) on the control lever (7) and back it out. Then move the carburetor linkage to the full-load position and turn the aperture limiting screw toward the stop bolt to the point where the control lever is on the point of being moved. The mechanical throttle valves of both Stage 1 and 2 of both carburetors must be fully opened in this position. Then lock the limiting screw by tightening the hexagon nut.

11. After attaching the push rod (4) to the relay lever (5) again check the position of the throttle valves, actuating the carburetor linkage by depressing the accelerator pedal from inside the car (see also Job No. 30-3).

b) **Idle Adjustment**

1. To adjust the idle, screw the idle mixture adjustment screw (20) on both carburetors right in and back it out by two turns.

2. Warm up the engine to normal working temperature (cooling water temperature 70–80° C) and adjust the idle by evenly adjusting the idle adjustment screws (19) of both carburetors to n = 700–800 rpm by means of a revolution counter.

3. Adjust the two idle mixture adjustment screws by turning them evenly in or out, so that

   a) the engine turns smoothly and

   b) the highest possible idle engine speed is obtained.

4. Readjust the idle speed to n = 700–800 rpm by adjusting the idle adjustment screw (19).

5. By making a further slight correction with the idle mixture adjustment screws check whether the idle can be further improved. If necessary, again adjust the idle speed with the idle adjustment screws.

6. After adjusting the two carburetors, check whether the control linkage and the throttle valve levers work properly. The same applies to the two start mechanisms, which are connected by the connecting rod (31) (see also Job No. 30-6).

Note: When adjusting the idle, the mechanical throttle valves of Stage 2 and the start mechanism of the two carburetors must be completely closed.

7. Check the functioning of the vacuum valves of Stage 2 and of the oil shock-absorber. The cushion effect of the oil shock-absorber must be noticeable almost down to the end of the stroke. If necessary, check the oil level in the shock-absorber and top up (see Model 190 Workshop Manual, Job No. 07-3).

Note: On no account should the idle speed be adjusted by means of the idle stop screw (9), since otherwise the carburetor linkage adjustment is no longer satisfactory (see under a) Adjustment of carburetor linkage, para 9).

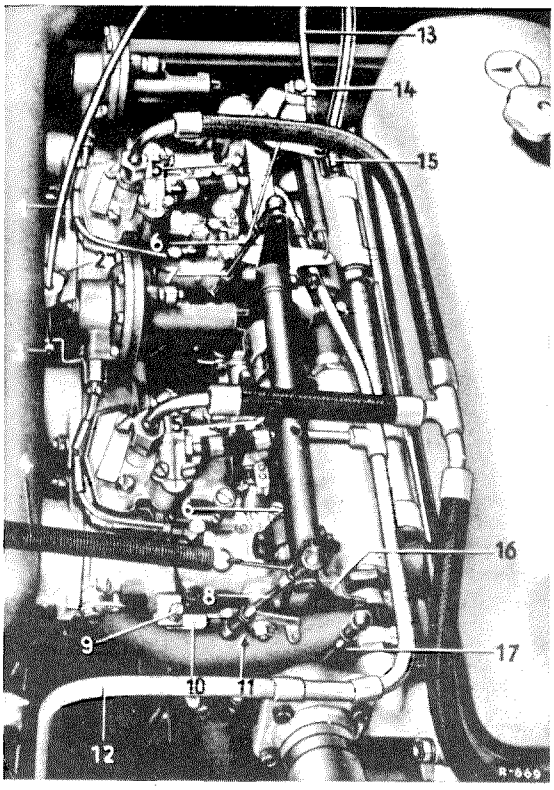


Fig. 01-3/20

1 Choke control
2 Clamping screw for choke control sleeve
3 Clamping screw for choke control
4 Return spring for carburetor linkage
5 Idle mixture adjustment screw of Stage 2
6 Idle mixture adjustment screw of Stage 1
7 Push rod for rear carburetor
8 Push rod for front carburetor
9 Idle adjustment screw
10 Throttle valve lever
11 Aperture limiting screw
12 Overflow line
13 Hot-start control
14 Clamping screw for hot-start control sleeve
15 Threaded union for vacuum connection of ATE Power Brake
16 Control shaft
17 Push rod from angle lever to control shaft

a) **Adjustment of Carburetor Linkage**

1. Detach the push rod (17) between the angle lever and the control shaft and detach the two push rods (7) and (8) between the control shaft and the throttle valve levers (see Fig. 01-3/20).

2. Back out the idle adjustment screw (9) on the two carburetors until the throttle valve of Stage 1 is closed. In this position the throttle valve of Stage 2 must have a certain amount of play; if this is not the case, the adjustment screw (3) on the relay lever of the throttle valve shaft of Stage 1 must be backed out (see Fig. 01-3/21).

Note: The picture shows the 2nd version of the adjustment screw locking device.

On the 1st version there was a lock nut instead of the clamping strap (1) and the clamping screw (2).

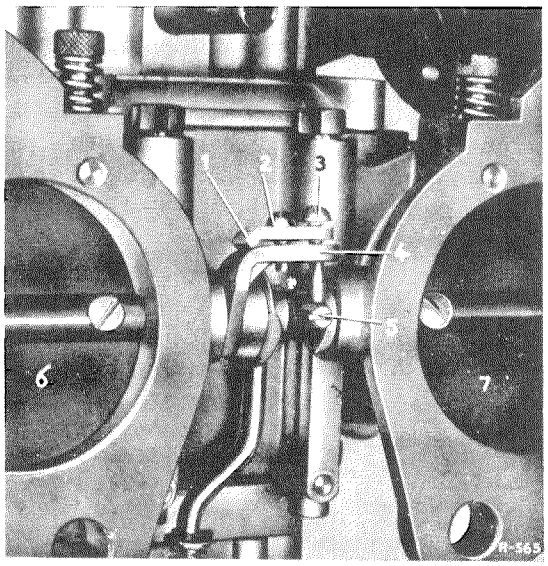


Fig. 01-3/21

1 Clamping strap
2 Clamping screw
3 Adjustment screw
4 Relay lever on throttle valve shaft of Stage 1
5 Drive pin on throttle valve shaft of Stage 2
6 Throttle valve of Stage 1
7 Throttle valve of Stage 2

3. Now turn in the idle adjustment screw (9) on both carburetors to the point where the throttle valves are just about to open. From this position turn the screw in exactly one turn (Fig. 01-3/20).

4. Adjust the push rod (17) between the angle lever and the control shaft (16) to the prescribed length of 175 mm (measured from center ball socket to center ball socket) and attach it.

5. Adjust the push rod (8) between the control shaft (16) and the throttle valve lever (10) of the front carburetor to the prescribed length of 100 mm (measured from center ball socket to center ball socket) and attach the push rod.

6. Now press the push rod (7) onto the rear carburetor, making sure that the ball socket with left-hand thread points downward. Then adjust the push rod so that the throttle valve levers of both carburetors are in the idle stop position.

   When doing this, make sure that the two ball sockets are absolutely parallel after the lock nuts on the ball sockets have been tightened. The adjustment of the push rod must be very accurate, since too long a push rod will push open the throttle valve of Stage 1 of the rear carburetor and too short a push rod will push open the throttle valve of the front carburetor. When the control linkage is being operated, the throttle valves of both carburetors must open simultaneously without any idle travel.

7. Press the control linkage as far as the full load stop and check whether the aperture limiting screw (11) of the front carburetor rests against the full load stop of the carburetor housing.

8. On both carburetors check the drive pin (5) on the throttle valve shaft of Stage 2 for tightness and turn in the adjustment screw (3) for the automatic return of the throttle valve of Stage 2 until the adjustment screw just rests against the drive pin (5) (Fig. 01-3/21). In this position the control linkage must be in the idle position and the throttle valve (7) of Stage 2 must be closed. This position can be checked at the throttle valve lever of Stage 2, which in this position should still have a small amount of play. On no account should the adjustment screw (3) be turned in till the throttle valve of Stage 1 is being turned open.

   After having made the adjustment, tighten the clamping screw (2).

b) **Adjustment of Idle**

1. Turn in the idle mixture adjustment screw (6) of Stage 1 on both carburetors and from this position back it out by exactly 1½ turns.

Note: The idle mixture adjustment screw (5) of Stage 2 remains closed on both carburetors.

2. Warm up the engine to operating temperature (cooling water temperature 70–80°C) and adjust the idle by evenly adjusting the idle adjustment screws (9) on both carburetors by means of a revolution counter.

   In the case of distributors

   VJUR 4 BR 11 and VJ 4 BR 12
   adjust to 1200–1300 rpm,
   VJ 4 BR 11 and VJR 4 BR 24
   adjust to 900–1000 rpm.

3. Adjust the idle mixture adjustment screw (6) of Stage 1 on both carburetors by turning it in and out evenly until

   a) the engine turns smoothly and

   b) the highest possible idle engine speed is obtained.

4. Readjust the idle speed to the specified values by means of the idle adjustment screws (9).

5. By making a further slight correction with the idle mixture adjustment screws check whether the idle can be further improved. If necessary, again adjust the idle speed with the idle adjustment screws.

6. After adjusting the idle again adjust the automatic return mechanism for the throttle valves of the 2nd stage (refer to a) adjustment of carburetor linkage, para 8).

7. Set the adjustment screw at throttle valve lever of rear carburetor in such a manner that there is a clearance of 0.4 mm between the screw and the relay lever. Then tighten the locking nut of the adjustment screw. During the adjustment the control linkage should be in idle position and the start mechanism should be completely disengaged, that is, the choke valves should be horizontal. The relay lever should be pressed to the choke valve lever and cam by means of the return spring. If required, the return spring should be replaced (Fig. 01–3/22).

Note: The start mechanism on the front carburetor has no cam and no relay lever. Raising of the 1st stage throttle valve with the start mechanism engaged is effected by way of the control linkage.
When the start mechanism is switched off the choke valves of both carburetors should be completely open. The stop lever of the choke valve shaft should then abut against the carburetor housing.

8. Check start mechanism for proper functioning (refer to Job No. 30–6 and Job No. 07–0, Section IV).

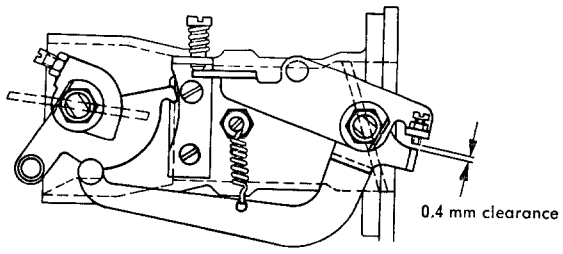


Fig. 01–3/22

9. Check return spring for carburetor linkage.

The 1st version of the return spring (free length 169 mm) has a connecting strap, which is attached at the bottom of the lever on the control shaft.

The 2nd version of the return spring (free length 214 mm) uses no such connecting strap. In addition, the lever on the control shaft is provided with a bolt to hold the return spring.

As from engine end No. 85 02730 the 2nd version of the return spring is installed as a standard part.

If a vehicle having a return spring of 1st version shows signs of chafing at bottom of control shaft lever, both the 2nd version of the return spring and control shaft should be subsequently installed.

L. Testing Valve Timing

Checking and corrections, if required, of the valve timing for models 180 a, 180 b, 180 c, 190, 190 b, 190 c, 190 SL, 220 a, 219, 220 S and 220 SE are the same as described in the Workshop Manual for model 190.

Valve Timings with a Test Clearance of 0.4 mm

Model	Camshaft		Code No.[2]	Inlet		Outlet		Remarks
	Design acc. to Part No.	Assembly[1] acc. to Part No.		opens BTDC	closes ABDC	opens BBDC	closes ATDC	
180 a 180 b 190, 190 b	121 051 11 01	121 050 00 01	11	12°	44°	51°	15°	–
180 c 190 c	121 051 42 01	–	42	10°	46°	44°	12°	improved valve control
190 SL	121 051 14 01	121 050 01 01	14	16°	63°	60°	25°	1st Version: standard equipment up to engine No. 5500183
	121 051 15 01	121 050 02 01	15	17.5°	60.5°	61.5°	22.5°	2nd Version: standard equipment as from engine No. 5500184
190 SL	121 051 44 01	–	44	13°	55°	51°	17°	improved valve control
220 a	180 051 14 01	180 050 03 01	14	9°	41°	51°	15°	1st Version: standard equipment up to engine No. 5504778
220 a, 219 220 S	180 051 14 01	180 050 03 01	14/1	12°	44°	51°	15°	For model 220 a: 2nd Version (standard equipment as fr. engine end No. 5504779) For models 219 and 220 S with compression $\varepsilon = 7.6:1$
219, 220 S	180 051 33 01	180 050 06 01	33	10°	46°	42°	10°	with compr. $\varepsilon = 8.7:1$
220 SE	180 051 50 01	180 050 08 01	50	9°	41°	44°	8°	–

[1] Camshafts are supplied complete only (with one cover, for 6-cyl. engine with an additional oil transfer tube acc. to part No. named in column "Assembly".
[2] The Code No. of camshaft is always punched-in on camshaft end face.

Note: If replacements are required, only camshaft part No. 180 050 06 01 will be supplied for models 220 a, 219 and 220 S. Camshaft part No. 180 050 06 01 may be used only in combination with sodium-filled exhaust valves. If instead of camshaft part No. 121 050 01 01 camshaft part. No. 121 050 02 01 is installed in models 190 SL, the supporting surfaces at the cylinder head for the thrust rings at the inlet valves opposite the top edge of the cylinder head should be milled deeper by 1.0 mm, because otherwise the larger stroke of the inlet cams might punch solid the valve springs when the valves are fully open (refer to Fig. 01–4/32).

M. Measuring Intake Pipe Vacuum

The amount of intake pipe vacuum is reliable evidence of the sealing properties of the pistons and piston rings, the intake pipe, the cylinder head, the cylinder head gasket, and the valves. The intake pipe vacuum is measured in mm Hg (mercury column) by means of a vacuum measuring instrument, e. g. the instrument produced by the firm of "Sun". When measuring the vacuum, use the test take-off union on the carburetor or on the venturi control unit. (The values in the Table below refer only to these measuring points.)

When measuring the intake pipe vacuum, make sure that both cooling water and oil temperature of the engine are definitely above 80°C.

Model	Vacuum in mm Hg at engine speed rpm (no load)			
	800	1500	3000	4500
180 a	470—520	480—530	470—520	410—460
180 b	470—520	490—540	490—540	460—510
190	410—460	480—530	480—530	460—510
190 b	470—520	510—560	510—560	480—530
190 SL[1])	420—470	480—530	500—550	430—480
220 a, 219	410—460	480—530	510—560	480—530
220 S	430—480	480—530	510—560	480—530
220 SE	430—480	440—490	390—450	340—390
220 SE Convertible and Coupé 1st version[2])				

[1]) For model 190 SL with the 1st and 2nd versions of the distributor (Bosch designation VJUR 4 BR 11 or VJ 4 BR 12) use the vacuum value of 450—500 mm Hg at an idle speed of 1200—1300 rpm.

[2]) Model 220 SE Convertible and Coupé 1st version: Engine Type 127.980 (output 115 HP).

N. Exhaust-Gas Test Values

(applicable only to "Sun" Exhaust-Gas Tester)

The percentage values given refer to the degree of combustion of the fuel-air mixture. At idle speeds the values are on the rich side, whereas as a rule the mixture is leaner when the engine speed increases (see Table). When the prescribed values are obtained, the composition of the fuel-air mixture and consequently the adjustment of the carburetor or injection system is satisfactory.

When the exhaust-gas test is made, both the cooling water and the oil temperature should be appr. 80°C.

Model	Exhaust-gas test values (percentage) at engine speed rpm (no load)			
	800	1500	3000	4500
180 a	77—79	77—83	83—87	87—91
180 b	77—79	77—82	80—86	83—89
190 [1]	77—79	80—84	85—89	85—89
190 b	77—79	77—82	80—86	83—89
190 SL [2]	75—77	80—84	78—82	85—89
220 a 219	77—79	79—83	75—79	80—84
220 S	77—79	82—86	86—90	88—92
220 SE [3]	79—81	78—82	—	—
220 SE Convertible and Coupé 1st version [3] [4]				

[1] For model 190 with the 1st version distributor (Bosch designation VJUR 4 BR 14) the exhaust-gas test value is 70—74% at 1500 rpm.

[2] For Model 190 SL with the 1st and 2nd version distributors (Bosch designation VJUR 4 BR 11 or VJ 4 BR 12) the exhaust-gas test value is 79—81% at an idle speed of 1200—1300 rpm.

[3] For the adjustment of the 220 SE engines the exhaust-gas test values at 3000 rpm and 4500 rpm are not required.

[4] Model 220 SE Convertible and Coupé 1st version: Engine type 127.980 (output 115 HP).

O. Engine Testing on Roller Test Stand

Performance: The performance data given in HP are based on an inlet air temperature of + 20°C and a barometer value of 760 mm Hg (mercury column).

Fuel Consumption: Fuel consumption measurements are based on the flow period for 100 cc or 200 cc measuring vessel capacity.

Note: a) When these measurements are taken, the cooling water and oil temperature of the engine should not be below 75°C.

b) When the car is tested on the roller test stand, the tire pressure should be adjusted to the values for free-way driving given in the Owner's Manual.

Performance Correction

The measured engine output must be corrected to the reference values of + 20°C and 760 mm Hg (mercury column) in accordance with the formula

$$N_k = N_m \times K$$

where N_k is the corrected value, N_m the measured value, and K the correction factor.

The correction factor K is determined in relation to temperature and atmospheric pressure according to the following formula:

$$K = \frac{760}{b} \sqrt{\frac{273 + t}{273 + 20}}$$

where b is the atmospheric pressure in mm Hg and t the temperature in °C.

Example: Engine performance N_m = 100 HP is measured at b = 740 mm Hg and t = 35°C.

$$K = \frac{760}{740} \sqrt{\frac{273 + 35}{273 + 20}} = 1.053$$

$$N_k = 100 \times 1.053 = 105.3 \text{ HP}$$

The correction factor K can be read off the following diagram with sufficient accuracy for all practical purposes (Fig. 01-3/23). For the above example the necessary procedure for finding the correction factor is indicated in the diagram.

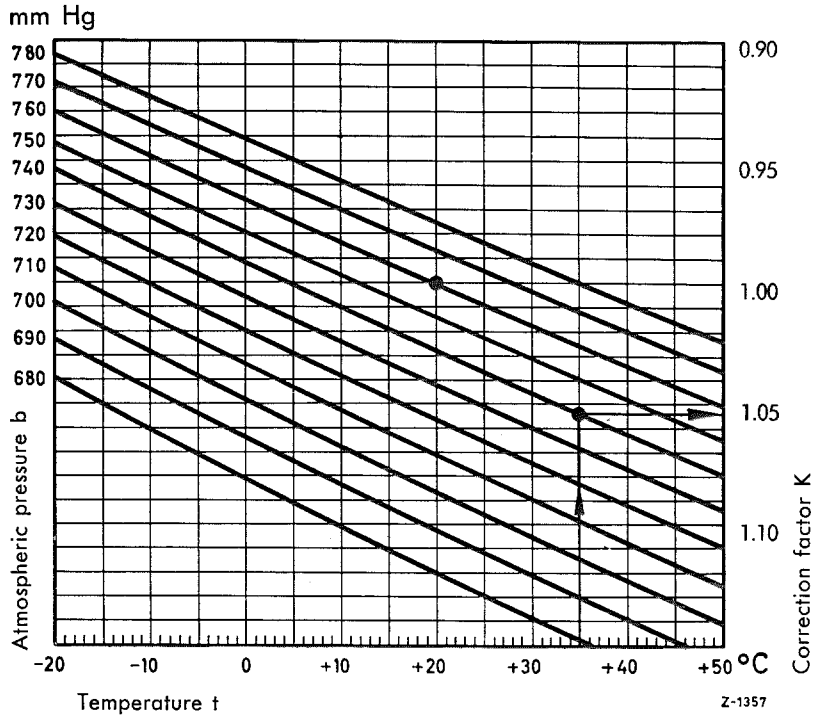


Fig. 01-3/23

Guide Values for Testing the Engine on the Clayton Roller Test Stand

Test				Model				
				180 a	180 b	190	190 b	190 SL
Full-load output		2nd gear n = 4000 rpm	Output HP	47.5	50	—	—	—
		2nd gear n = 4400 rpm		48	51	58	59	67
		2nd gear n = 4800 rpm		—	—	56	61	72
Fuel consumption	Full load	2nd gear n = 4800 rpm	Vacuum mm Hg	60—100				
			Exhaust-gas analysis %	81—86	80—85	80—84		82—86
			Sec. per 200 cc	30—32	28.5—31	27.5—30	27—29.5	22—24
		3rd gear n = 3000 rpm	Exhaust-gas analysis %	79—83	78—82	76—80		80—84
			Sec. per 200 cc	42—45	40.5—43.5	40—43		37—40
		4th gear n = 1500 rpm	Exhaust-gas analysis %	74—78		74—80	74—78	80—84
			Sec. per 100 cc	39—42.5		41—44.5	40—43,5	33.5—39
	Partial load	4th gear 60 km/h load 10 HP	Vacuum mm Hg	300—340				
			Exhaust-gas analysis %	85—90		84—88		86—90
Acceleration		20—80 km/h in 3rd gear with flywheel (adjust to 10 HP load at 60 km/h in 4th gear)	Stop-watch time in sec.	22		20		

Guide Values for Testing the Engine on the Clayton Roller Test Stand

Test			Model	
			180 D, 180 Db	190 D, 190 Db
Full-load output	2nd gear n = 3000 rpm	Output HP	32	—
	2nd gear n = 3200 rpm		33	—
	2nd gear n = 3600 rpm		—	36
	2nd gear n = 4000 rpm		—	38
Fuel consumption Full load	2nd gear n = 3200 rpm	Sec. per 100 cc	29—31	—
	2nd gear n = 3600 rpm		—	26—28
Acceleration	20—65 km/h [1] in 3rd gear with flywheel (adjust to 5 HP load at 60 km/h in 4th gear)	Stop-watch time in sec	22	—
	20—75 km/h [1] in 3rd gear with flywheel (adjust to 5 HP load at 60 km/h in 4th gear)		—	22

Note: When carrying out the performance test, make sure that the engine oil temperature is not less than 80° C.

[1] Before carrying out the acceleration test with flywheel engaged, run the engine in 4th gear without the flywheel at 60 km/h and a load of 5 HP; then engage the flywheel.

Guide Values for Testing the Engine on the Clayton Roller Test Stand

Test			Model			
			220 a 219 (ε = 7.6 : 1)	219 (ε = 8.7 : 1)	220 S (ε = 7.6 : 1)	220 S (ε = 8.7 : 1)
Full-load output	2nd gear n = 4000 rpm	Output HP	61	64	71	73
	2nd gear n = 4400 rpm		64	67	75	77
	2nd gear n = 4800 rpm		63	68	77	81
Fuel consumption — Full load	2nd gear n = 4800 rpm	Vacuum mm Hg	70—110			
		Exhaust-gas analysis %	80—84		86—90	
		Sec. per 200 cc	25—27		23.5—25.5	
	3rd gear n = 3000 rpm	Exhaust-gas analysis %	72—76		84—88	
		Sec. per 200 cc	31—34		38—42	
	4th gear n = 1500 rpm	Exhaust-gas analysis %	74—80		84—88	
		Sec. per 100 cc	35.5—39		41—45	
Fuel consumption — Partial load	4th gear 60 km/h load 10 HP	Vacuum mm Hg	310—350			
		Exhaust-gas analysis %	84—88		86—90	
Acceleration	20—80 km/h in 3rd gear with flywheel (adjust to 10 HP load at 60 km/h in 4th gear)	Stop-watch time in sec	16.5	16	16.5	16

Note: a) On Models 219 and 220 S with hydraulic automatic DB clutch, consumption measurement under full load and at an engine speed n = 1500 rpm in 4th gear should not be carried out.

b) On Models 219 and 220 S with hydraulic automatic DB clutch, the acceleration test should not be repeated more than once in order to avoid excessive heating up of the hydraulic clutch.

Guide Values for Testing the Engine on the Clayton Roller Test Stand

Test					Model
					220 SE, 220 SE Convertible Engine type 127.980 (115 HP)
Full-load output		3rd gear n = 4400 rpm	Outhut HP		83
		3rd gear n = 4800 rpm			87
Fuel consumption	Full load	3rd gear n = 4800 rpm	Vacuum mm Hg		20—40
			Exhaust-gas analysis %		82—87
			Sec. per 200 cc Inlet air temperature °C	30	21.5—23.5
				20	21—23
				10	20.5—22.5
				0	20—22
		3rd gear n = 3000 rpm	Exhaust-gas analysis %		79—84
			Sec. per 200 cc Inlet air temperature °C	30	34—37
				20	33—36
				10	32—35
				0	31—34
		4th gear n = 1500 rpm	Exhaust-gas analysis %		80—85
			Sec. per 200 cc Inlet air temperature °C	30	38—41
				20	37—40
				10	36—39
				0	35—38
	Partial load	4th gear 60 km/h load 10 HP	Vacuum mm Hg		300—340
			Exhaust-gas analysis %		83—88
Acceleration		20—80 km/h in 3rd gear with flywheel (adjust to 10 HP load at 60 km/h in 4th gear)	Stop-watch time in sec.		15

Note: a) On cars with hydraulic automatic DB clutch, consumption measurement under full load and at an engine speed n = 1500 rpm in 4th gear should not be carried out.

b) On cars with hydraulic automatic DB clutch, the acceleration test should not be repeated more than once in order to avoid excessive heating up of the hydraulic clutch.

P. Adjustment of Gasoline Injection Pump in Model 220 SE

See Workshop Manual Passenger Car Models starting August 1959, Job No. 00-14.

Q. Checking Gasoline Injection System of Model 220 SE

See Workshop Manual Passenger Car Models starting August 1959, Job No. 00-15.

R. Trouble-Shooting Hints on Gasoline Injection System on Model 220 SE

See Workshop Manual Passenger Car Models starting August 1959, Job No. 00-18.

S. Adjustment of Control Linkage, Idle Adjustment, and Readjustment of Speed Build-Up of Gasoline Injection Engine in Model 220 SE

See Workshop Manual Passenger Car Models starting August 1959, Job No. 00-16.