Description of Compound Carburetor for Model 220 S

A. General

On Model 220 S, two compound or twin-stage carburetors, type Solex 32 PAITA, are used.

The carburetors are similar in their essentials to the type used for Models 300 b and 300 c, but they have no automatic starter mechanism and no automatic switch-over mechanism for the float chamber ventilation.

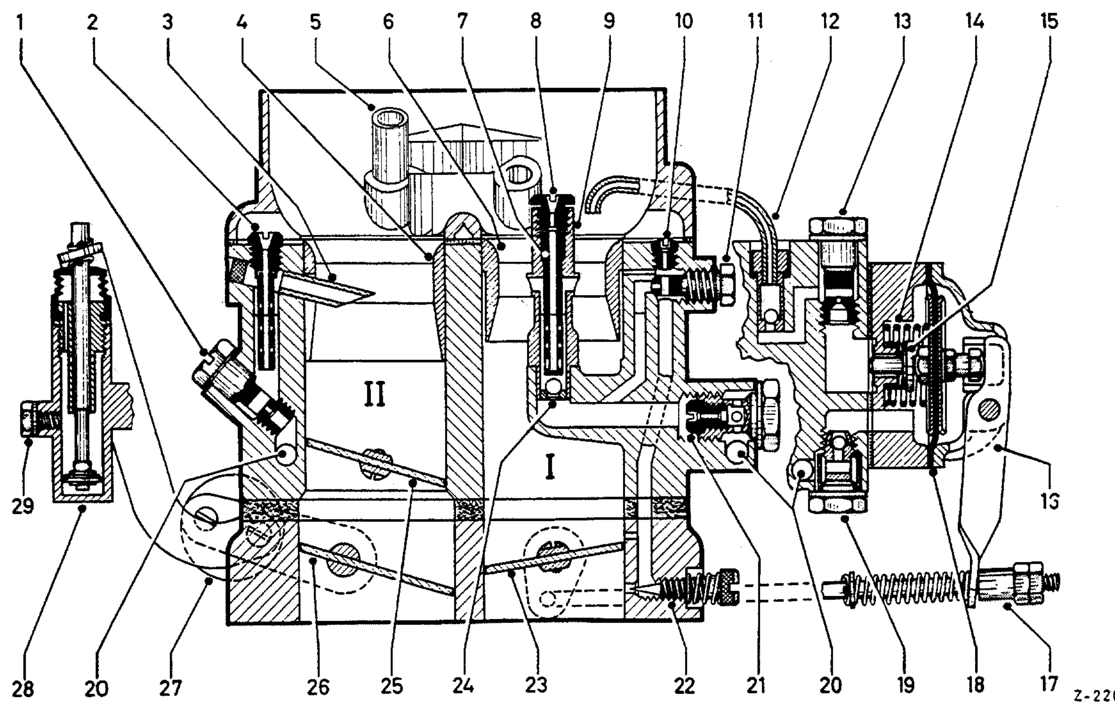


Fig. M 31 S/01

II Stage 2

1 Main jet of Stage 2
2 Air correction jet with mixing tube of Stage 2
3 Discharge tube for main jet system of Stage 2
4 Air horn of Stage 2
5 Float chamber ventilation
6 Air horn of Stage 1
7 Mixing tube of Stage 1
8 Air correction jet of Stage 1
9 Mixing tube holder of Stage 1
10 Idle air jet
11 Idle fuel jet
12 Injection tube
13 Pump jet
14 Diaphragm spring
15 Plate valve

I Stage 1

16 Pump arm
17 Connecting rod with compression spring (adjustable)
18 Pump diaphragm
19 Check valve
20 Fuel feed
21 Main jet plug with main of Stage 1
22 Idle mixture adjustment screw
23 Throttle valve of Stage 1
24 Check valve in mixing tube holder
25 Throttle valve of Stage 2
26 Vacuum valve
27 Counterweight with lever
28 Oil shock-absorber
29 Plug and filler screw

Fast-running engines need carburetors of large section. This large section has, however, the disadvantage that at low engine speed the air flows through the carburetor at relatively low velocity, which results in relatively poor carburetion. This poor carburetion makes the engine sluggish at low engine speed and results in poor speed build-up. The compound carburetor has none of these disadvantages. In principle, it consists of two coupled carburetors, the so-called stages. At low engine speed, only Stage 1 is in operation. The small section of the air horn and suction tube results in perfect carburetion even at low engine speeds. When, at intermediate and high engine speeds, the engine demands more air and mixture, Stage 2 is brought into operation. Thus the required large section of the carburetor is available to the full extent.

B. Arrangement and Function of the Throttle Valves

Both stages of the carburetor are combined in one housing (Fig. M 31 S/01). Throttle valve (23) of Stage 1 is located as usual in the lower part of the carburetor, set an angle of 8°. Stage 2, however, has two throttle valves, set an angle of 17°, the one (25) in the center section of the carburetor and the other (26) in the lower section. Throttle valves (23) and (25) of Stages 1 and 2 are coupled together by a linkage. The second throttle valve (26) of Stage 2 is not coupled to the other two. It is operated automatically by the pressure flow. The off-set shaft of the throttle valve is fitted with a lever, bearing a weight (27) (Fig. M 31 S/02).

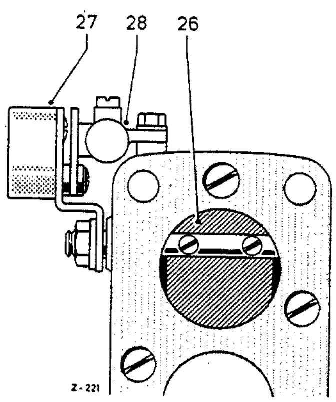


Fig. M 31 S/02

26 Vacuum valve
27 Counterweight with lever
28 Oil shock-absorber

This weight keeps the throttle valve closed under normal conditions. It is only when a certain pressure, coupled with decreased pressure in the body of Stage 2, develops that the effect of the weight is overcome and this throttle valve, the so-called vacuum valve, opens. In order to prevent the vacuum valve from being forcibly opened by the centrifugal effect on narrow left-hand bends, the movement of the vacuum valve is neutralized via the valve lever by an oil shock-absorber (28) (see Fig. M 31 S/02).

In the idle position the two throttles (2) and (3) of Stage 2 are completely closed (Fig. M 31 S/03). When the accelerator pedal is depressed only the throttle valve (1) of Stage 1 opens at first (Fig. M 31 S/04).

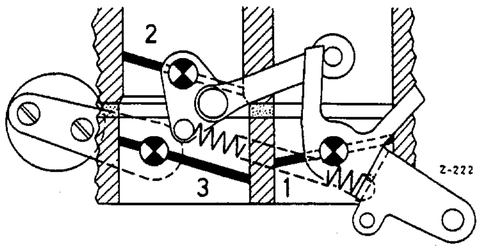


Fig. M 31 S/03

Idle

1 Throttle valve of Stage 1
2 Throttle valve of Stage 2
3 Vacuum valve

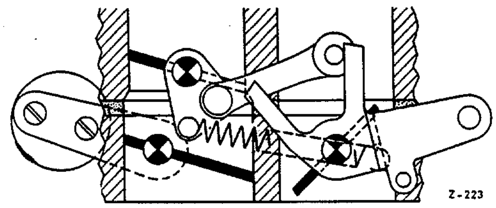


Fig. M 31 S/04

Partial Load

Only when this valve is rather more than half opened, does throttle valve (2) of Stage 2 begin to open by virtue of the linkage. The vacuum valve (3) is still closed. When the throttle valve of Stage 1 is further opened, the linkage opens the throttle valve of Stage 2 still further (Fig. M 31 S/05). The increasing pressure in Stage 2 now overcomes the effect of the weight on the vacuum valve and opens it until at the corresponding full load speed, all three throttle valves are completely open (Fig. M 31 S/06).

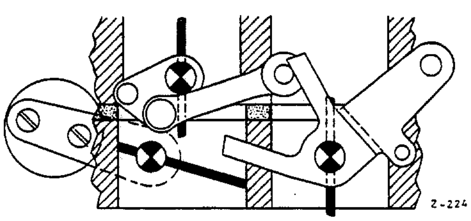


Fig. M 31 S/05

Full load at low engine speed

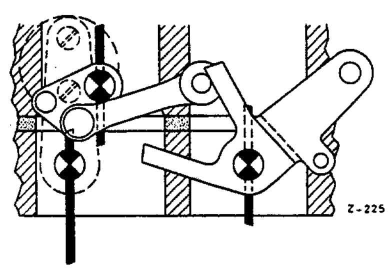


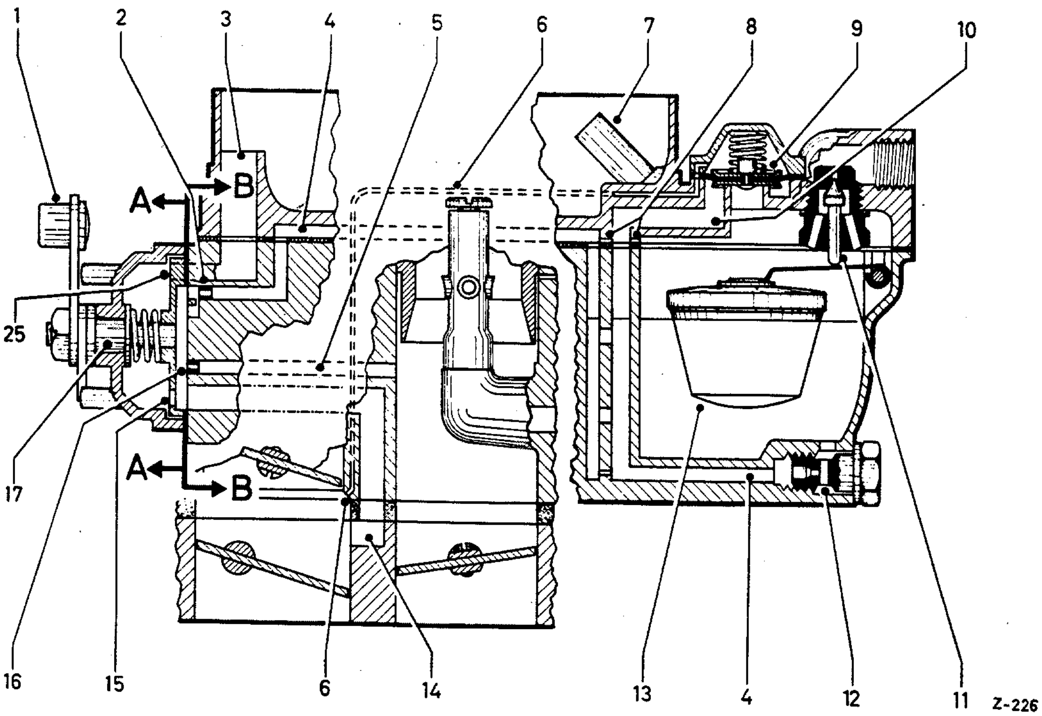
Fig. M 31 S/06

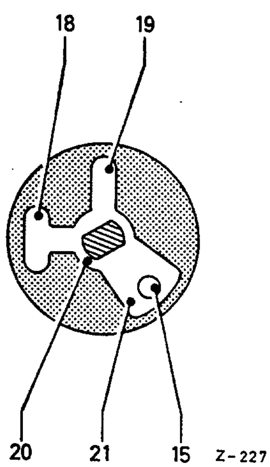
Full load at high engine speed

The special function of the vacuum valve is seen when the accelerator pedal is depressed for acceleration or is depressed through the whole of its travel at low r. p. m. The throttle valves of Stages 1 and 2 are automatically opened via the linkage. But at low engine r. p. m. Stage 2 should still be inoperative at this point. This condition is achieved by the vacuum valve which, by virtue of the weight attached to it, remains closed (see Fig. M 31 S/05). Not until the engine r. p. m. have increased (approx. 2000 r. p. m. at full load) is the effect of the decreased pressure sufficiently great to open the vacuum valve and thus gradually bring Stage 2 into operation.

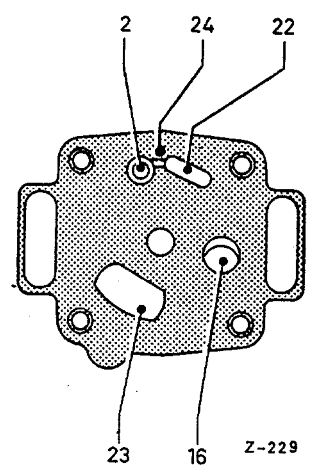
C. Starter Mechanism

The starter mechanism is manually operated by means of a bowden cable. If the starter knob is pulled right out, the starter mechanism is set in the cold start position. If the starter knob is pressed in toward the instrument panel until it clicks into the notch position, the mechanism is set to the warmup position. Finally, when the starter knob is pressed hard against the instrument panel, the starter mechanism is switched off completely.





Starter rotary slide valve, view AA



Starter flange, view BB

M 31 S/07

1 Starter lever
2 Graded bore in starter rotary slide valve
3 Air canal for starter mechanism
4 Fuel duct in starter system
5 Canal from starter flange to suction tube of Stage 1
6 Vacuum canal to starter air valve
7 Float chamber ventilation
8 Notch in carburetor cover
9 Starter air valve
10 Air canal from starter air valve to fuel duct (4)
11 Float needle valve
12 Starter fuel jet
13 Plastic float
14 Start mixture canal
15 Graded bore in starter rotary slide valve
16 Graded bore in starter flange
17 Starter rotary slide valve
18 Chamber in starter rotary slide valve
19 Chamber in starter rotary slide valve
20 Mixing chamber in starter rotary slide valve
21 Cavity in starter rotary slide valve
22 Fuel slot in starter flange
23 Entry to starter canal
24 Canal from 22 to 2
25 Graded bore from air canal to starter flange

a) **Cold start position** (Starter knob pulled right out)

The partial vacuum obtaining in the suction tube exerts an influence on the starter system (Fig. M 31 S/07), via the gaps at the side of the vacuum valve and the start mixture canal (14). As a result of the partial vacuum, fuel is drawn up from the float chamber via the starter fuel jet Gs (12) into the canal (4). Air enters through the notch (8) in the carburetor cover which connects up with the float chamber. Thus there is already a kind of pre-mixture present in the canal (4) leading to the starter rotary slide valve. Furthermore, the notch is designed above all to prevent fuel from being drawn up by the siphon effect when the starter is not switched on and the starter rotary slide valve is not quite gas-tight. The pre-mixture enters the chamber (19) of the starter rotary slide valve through the graded bore (2). At the same time, air is drawn from the suction canal of Stage 1 into the chamber (18) of the rotary slide valve via the canal (5) (with the graded bore [16]). This air combines with the pre-mixture in the mixing chamber (20). From the mixing chamber (20), this pre-mixture, with air added, passes into the cavity (21). There is a further supply of air which comes from the air canal (3) via the graded bore (15) of this cavity which acts as a starter air jet. The pre-mixture, which with this additional air has now become a rich starting mixture, passes via the orifice (23) into the starting mixture canal (14). The fuel flow for this first phase — when starting the engine — is shown in Fig. M 31 S/08.

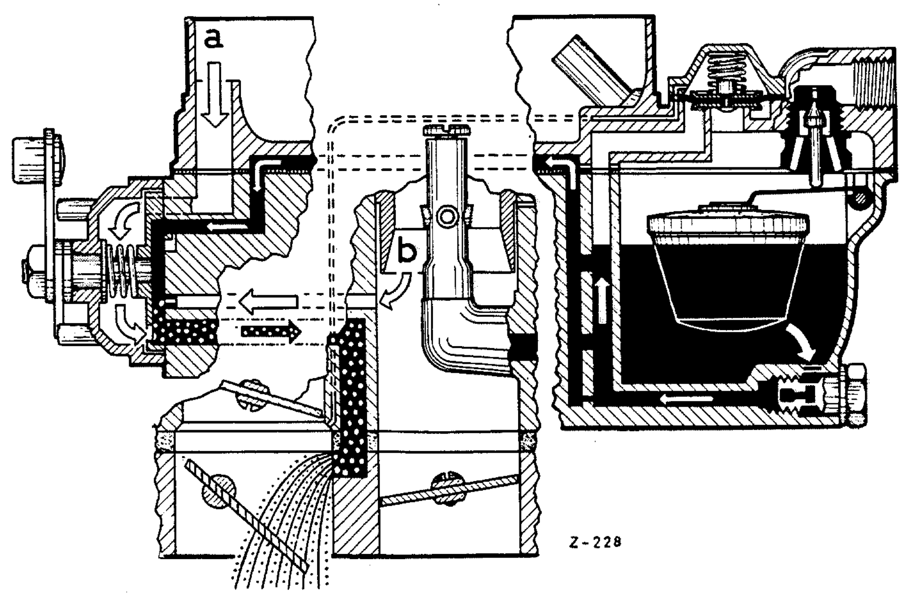


Fig. M 31 S/08

Cold start — Phase 1 — starting
Engine not yet started

a) Starter air entry
b) Additional air entry

As soon as the engine starts, the increase in engine speed causes an effective partial vacuum beneath the mechanical throttle valve of Stage 2. This partial vacuum exerts a pull on the spring-loaded side of the diaphragm of the starter air valve (9), via the vacuum canal (6) (Fig. M 31 S/09). At the same time the pressure flow which is now appreciable opens the vacuum valve slightly and raises the counterweight a little.

Due to the partial vacuum effect, the starter air valve opens and admits more air from the float chamber via the air tube (10) to the starter system via the canal (4). This additional air immediately attenuates the starting mixture after the engine has started, thus ensuring the proper conditions for it to continue running (Fig. M 31 S/09).

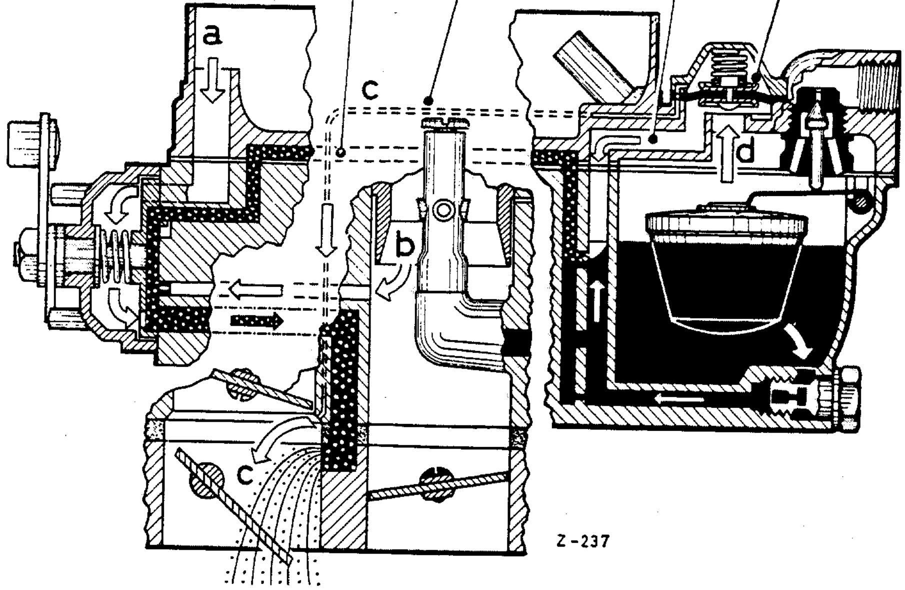


Fig. M 31 S/09

Cold start — Phase 2 — after the engine starts

a) Starter air entry
b) Additional air entry
c) Vacuum
d) Air entry for attenuating start mixture

b) **Warm-up position** (starter pushed half-way in)

As soon as the engine has warmed up a little, after the car has been driven away, the starter knob can be pushed half-way in. The starter rotary slide valve then turns to the right; the chamber (19) of the slide valve is now opposite the slot (22) of the starter housing (see Fig. M 31 S/07). As the slot (22) is connected to the graded bore (2) only by a fine canal (24) the amount of fuel passed is greatly decreased. The flow of the fuel is shown in Fig. M 31 S/010).

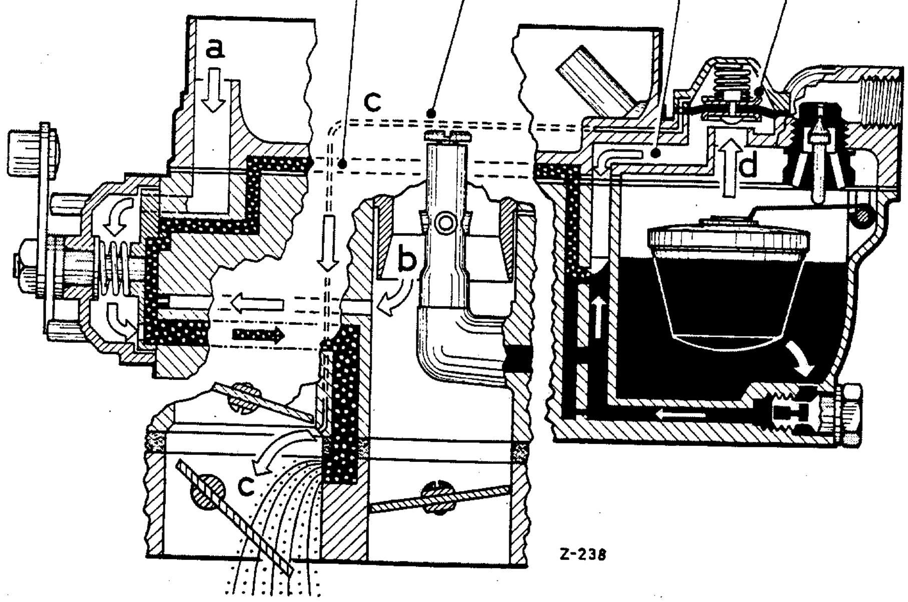


Fig. M 31 S/010

Warm-up

c) **Driving away with starter knob pulled out**

When the car is driven away, the throttle valve of Stage 1 is opened by the depressed accelerator pedal. The deep depression (vacuum) which has hitherto prevailed at the throttle and vacuum valve moves into the mixing chamber of Stage 1 and in consequence considerably reduces the supply of start mixture which is passing via the start mixture canal (14) (Fig. M 31 S/011). But this is compensated for by the start mixture drawn in via the canal (5) so that the supply of start mixture for the engine remains unaffected.

If as a result of quick acceleration from low engine speed the throttle valves are still further opened, the partial vacuum which has hitherto been appreciable, now loses considerably in effect. The starter air valve (9) which had opened immediately the engine started, now closes again so that the starter system produces a rich start mixture for the change-over just as it did at starting. As soon as the engine reaches sufficient r. p. m. the starter air valve, actuated by the partial vacuum which is forming again, once more opens and attenuates the start mixture. By this automatic action of the starter air valve, the cold engine is supplied with a correctly calculated start mixture suitable for any conditions.

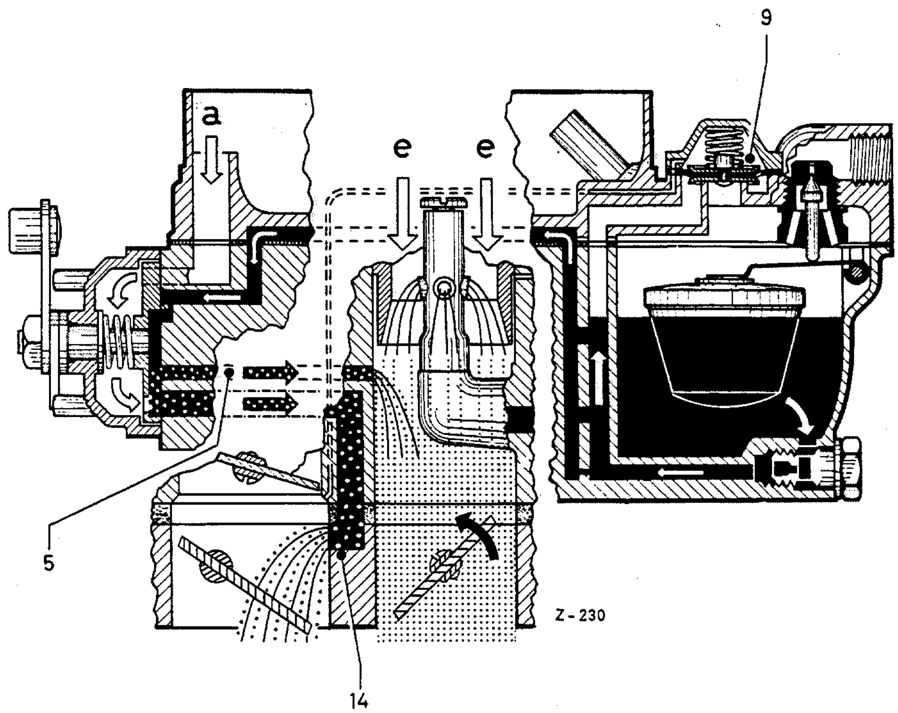


Fig. M 31 S/011

Change-over
a) Entry of starter air
b) Main air supply

d) **Starter knob inoperative** (starter knob pushed right in)

The chamber (19) is turned away to the right, beyond the slot (22), when the starter rotary slide valve is turned (see Fig. M 31 S/07). Thus the chamber (19) is no longer connected to the graded bore (2). The starter system is now rendered inoperative. In order to prevent fuel from being drawn from the starter system when the starter carburetor is switched off, the notch (8), mentioned above, has been made in the carburetor cover. This notch connects the float chamber with the start canal (4) and when slight leakage is present in the starter rotary slide valve, no siphon effect is obtained and only air — i. e., no fuel — can be drawn in (see Fig. M 31 S/07).

D. Idle System

The idle system is incorporated in Stage 1 only of the carburetor (Fig. M 31 S/012). Stage 2 has no idle system. The appropriate bores are made in the housing but are closed with grub screws.

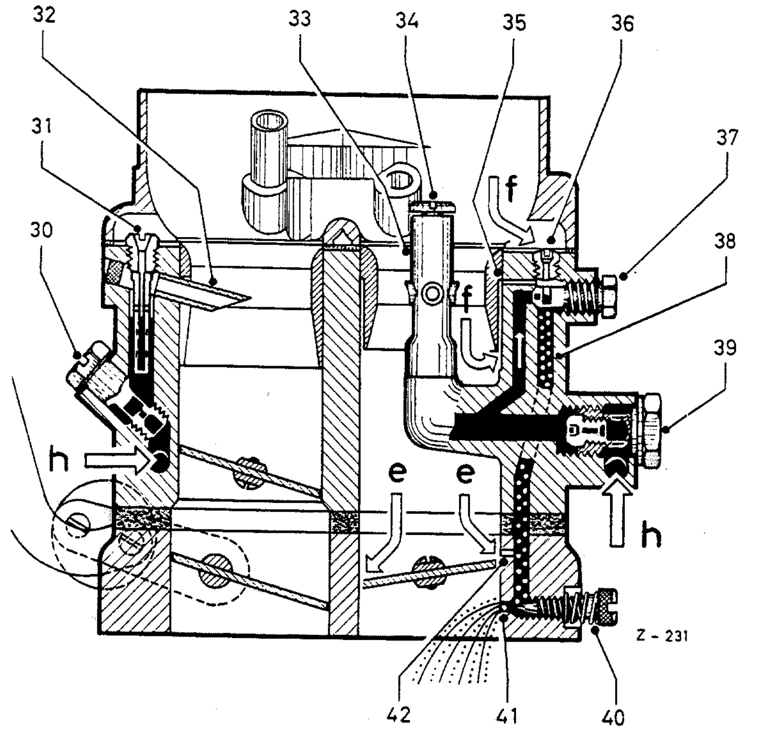


Fig. M 31 S/012

Idle — Phase 1

e) Main air supply
f) Entry of idle air
h) Fuel feed
30 Main jet plug with main jet Gg of Stage 2
31 Air correction jet a with mixing tube of Stage 2
32 Exhaust tube of Stage 2
33 Mixing tube holder with mixing tube of Stage 1
34 Air correction jet a Stage 1
35 Idle air canal
36 Idle air jet u
37 Idle fuel jet g
38 Idle canal
39 Main jet plug with main jet Gg of Stage 1
40 Idle mixture adjustment screw
41 Idle mixture bore
42 By-pass bores

a) **Idle — Phase 1.**

The idle air supply is not only drawn in via the idle air jet (36) but also via the air canal (35) from the mixing chamber below the air horn (vacuum compensation) (Fig. M 31 S/012). The fuel which is drawn in via the idle fuel jet (37) is mixed with the idle air supply, forming a mixture which is then conveyed into the idle canal (38). In the idle position, a further supply of air for the idle mixture enters through the by-pass bores (42) above the throttle valve and this then passes into the suction canal through the idle mixture bore (41) and combines with the air flowing past the throttle valve to form the final idle mixture. The idle mixture bore can be varied in section by the idle mixture adjustment screw (40). The final idle mixture can be attenuated by tightening the idle mixture adjustment screw and enriched by slackening it.

b) **Idle — Phase 2.**

Slight application of the throttle causes the mixture to flow through both by-pass bores. This now ensures a smooth speed build-up (Fig. M 31 S/013).
At the same height as the by-pass bores, but offset to one side, there is a further bore. It leads to the vacuum union on the carburetor flange. The vacuum line to the pneumatic ignition control of the distributor is connected to this vacuum union. As of engine No. 180 924 650 14 20, a further bore, in addition to the vacuum union for the distributor, has been incorporated. This bore leads to the suction canal and is made for connecting a vacuum test gage. It is closed by a grub screw.

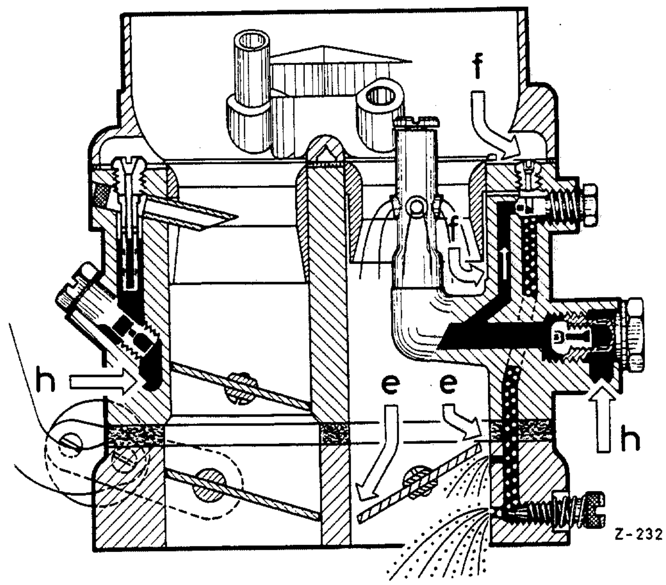


Fig. M 31 S/013

Idle — Phase 2

e) Main air supply
f) Entry of idle air
h) Fuel feed

Normal Running Condition (Main Carburetor System)

a) **Partial load range**

When the throttle is opened still further, the depression (vacuum) moves upward from the throttle valve of Stage 1 and now takes effect at the mixing tube holder, i.e., the carburetor begins to exercise its normal function in Stage 1 (Fig. M 31 S/014). In Stage 1, the down-draft carburetor principle and arrangement of the main carburetor is retained in the form employed hitherto.

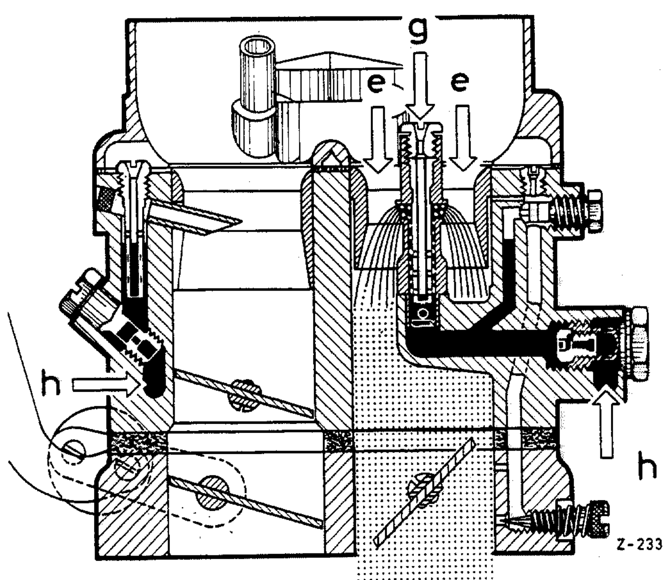


Fig. M 31 S/014

Function in partial load range

e) Entry of main air
g) Entry of compensating air
h) Fuel feed

b) **Full-load range — low engine speed**

In full-load range at low engine speed, the throttles of Stage 1 and 2 are open when full acceleration is applied. But the slight depression is still insufficient to open the vacuum valve of Stage 2. At first, the fuel mixture only reaches the engine via Stage 1 (Fig. M 31 S/015).

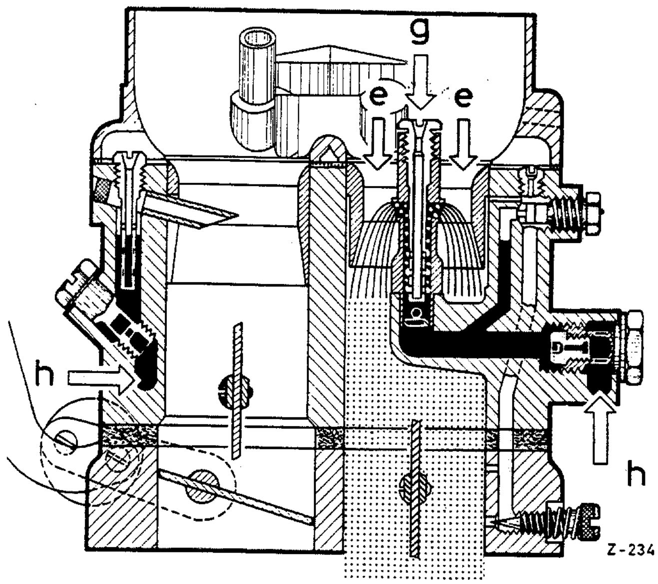


Fig. M 31 S/015

Function in full-load range at low engine speed

e) Main air flow entry
g) Entry of compensating air
h) Fuel feed

c) **Full-load range — high engine speed**

As the engine speed increases in the full-load range, the degree of depression in Stage 2 also increases and in consequence, the vacuum valve opens. Fuel-air mixture is now supplied by both stages (Fig. M 31 S/016). The mixture is supplied from Stage 2 via the main jet (30), the mixing tube with air correction jet (31) and the exhaust tube (32).

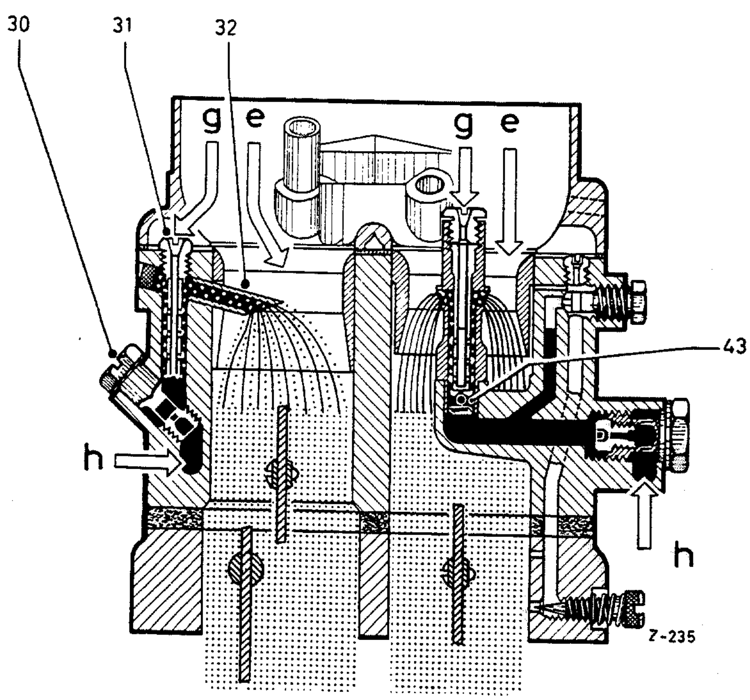


Fig. M 31 S/016

Function in full-load range at high engine speed

e) Main air flow entry
g) Entry of compensating air
h) Fuel feed

30 Main jet plug with main jet Gg of Stage 2
31 Air correction jet a with mixing tube of Stage 2
32 Exhaust tube of Stage 2
43 Ball valve (polyamide ball)

d) **Ball valve in mixing tube holder**

An additional ball valve (polyamide ball) has been incorporated in the mixing tube holder of Stage 1. This ball valve (43) is designed to prevent the engine from stalling even when the brakes are applied suddenly (see Fig. M 31 S/016). When the vehicle is in motion, the polyamide ball is raised from its seat by the fuel emerging. If the accelerator is released, the throttle of Stage 1 closes and the polyamide ball falls back onto its seat because there is no longer any depression at the mixing tube holder. The polyamide ball now prevents air from penetrating into the idle system when the brakes are suddenly applied. This therefore prevents the engine from stalling, as it otherwise would because the fuel flows back into the float chamber at the front by virtue of the inertia.

E. Accelerating Pump

The accelerating pump used is a so-called "neutral" pump, i. e., the engine can draw in fuel via the injection tube according to the degree of depression prevailing in the intake manifold. The accelerating pump (Fig. M 31 S/017) is a mechanically-operated diaphragm pum which is connected to the throttle of Stage 1 by means of an adjustable lever-linkage. When the accelerator is depressed, the diaphragm pump sprays extra fuel into the mixing chamber of Stage 1. By virtue of this additional injection, a smooth speed build-up and good acceleration is achieved. When the accelerator is depressed, the pump arm (49) is moved by means of the connecting rod (51). The pump arm in turn presses on the diaphragm (48) and in consequence, the fuel which is in front of the diaphragm is injected via the plate valve (47), the pump jet (45), the ball valve (44) and the injection tube (43) into the mixing chamber of Stage 1. The aperture of the injection tube takes the form of a precision bore of 0.8 mm ϕ.

During the injection, the ball valve (50), operating as a check valve, is closed. When the accelerator pedal is released, the diaphragm spring (46) presses the diaphragm back. The ball valve (44) now closes (operating as a check valve) and fresh fuel is drawn up from the float chamber via the ball valve (50).

Extra fuel can be drawn in without operating the accelerating pump in proportion to the degree of depression obtaining in the inlet manifold above the air horn, it flows via the drilled plate valve (47).

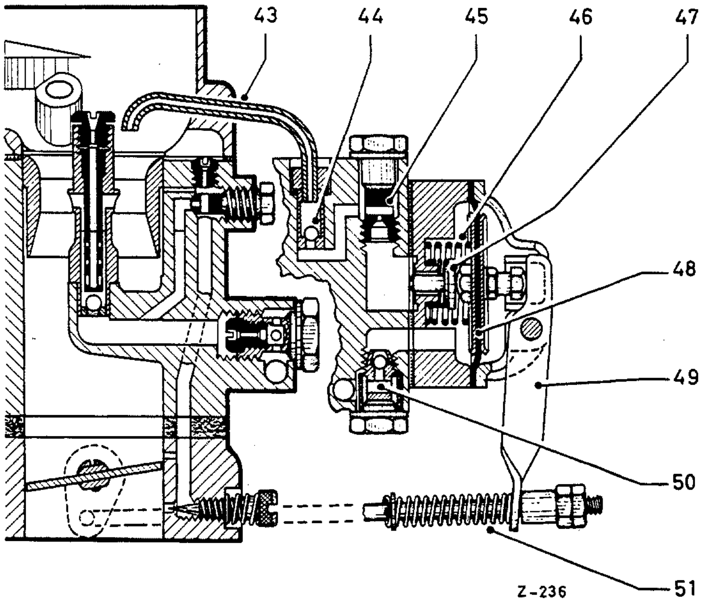


Fig. M 31 S/017

43 Injection tube
44 Ball valve
45 Pump jet Gp
46 Diaphragm spring
47 Drilled plate valve
48 Diaphragm of accelerating pump
49 Pump arm
50 Ball valve
51 Connecting rod

Thus the plate valve, in the case of the "neutral" pump, operates simply as a stop for the diaphragm and limits the amount of delivery.

The injection amount can be altered by adjusting the nuts on the connecting rod (51). When the nuts are tightened, the pump stroke, and in consequence, the injection amount, is increased and vice versa.

The nuts must not be tightened so far that the pump arm (49) moves away from the diaphragm since if they are, the injection does not take place immediately the throttle is opened. Changing the pump jet Gp (45) does not alter the injection amount but merely the duration of injection.