During this procedure the available colume in the pressure line is increased by the displacement of the valve plunger. The fuel in the pressure line is thereby relieved very quickly and the nozzle needle closes immediately.

III. Pneumatic Governor

The injection pump of the Model OM 636 is equipped with a pneumatic governor or a centrifugal governor depending on the intended use of the engine. The pneumatic governor is controlled by the vacuum in the intake manifold and consists of 2 major parts, the throttle duct and the diaphragm unit.

The injection pump, in connection with the diaphragm unit and the throttle duct, has the task of supplying the engine with the optimal fuel quantity depending on the respective load. In addition, the pneumatic governor, independent of the respective load, must prevent surpassing of the permissible maximum speed and, during coasting (exploitation of the full engine braking effect) with closed throttle butterfly in the throttle duct, stop injection, guarantee a constant idling speed and must keep the speed selected with the gas pedal and/or control lever as constant as possible.

The vacuum in the intake manifold of the engine is transferred via the throttle duct to the diaphragm unit and, by moving of the control rod, causes a change in discharge rate.

a) Throttle Duct

The throttle duct is only installed in engines with pneumatic governor and is mounted on the intake manifold. The throttle duct has the task of tranferring the vacuum present in the intake manifold to the diaphragm unit and controlling the vacuum and the engine speed by the respective position of the throttle butterfly. By moving the throttle butterfly with the accelerator, the vacuum in the governor can be influenced via the vacuum line and consequently the engine speed is controlled. The throttle duct is a venturi pipe, meaning it becomes gradually wider in direction of intake (starting at the narrowest point). A pivoted throttle butterfly, an auxiliary venturi pipe and the connector of the vacuum line are situated at the narrowest point. The throttle butterfly is connected with the gas pedal via the linkage and the adjusting lever.

A calibrated air jet for the vacuum connection is installed in the auxiliary venturi pipe and protrudes about to the middle of the latter (see Figure 07–23/2). The bore diameter and the protruding length of the air jet in the auxiliary venturi pipe influence the vacuum and therefore the governing. The air jet should not be modified (also see Job No. 07–23 Checking and Repairing Throttle Duct).

The velocity of flow in the throttle duct increases or decreases according to the position of the throttle butterfly and the speed of the engine. The same is true for the vacuum behind the throttle duct and in the vacuum chamber. If the vacuum is strong enough to overcome the pressure of the control spring, governing sets in.

The position of the diaphragm and the control rod depends on the force of the difference in pressure between the vacuum chamber and the chamber open to the atmosphere. This difference in pressure is controlled by the position of the throttle butterfly and the engine speed.

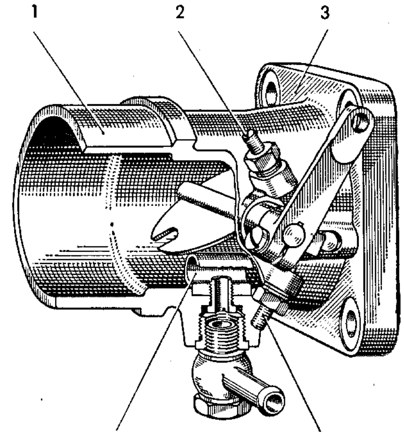
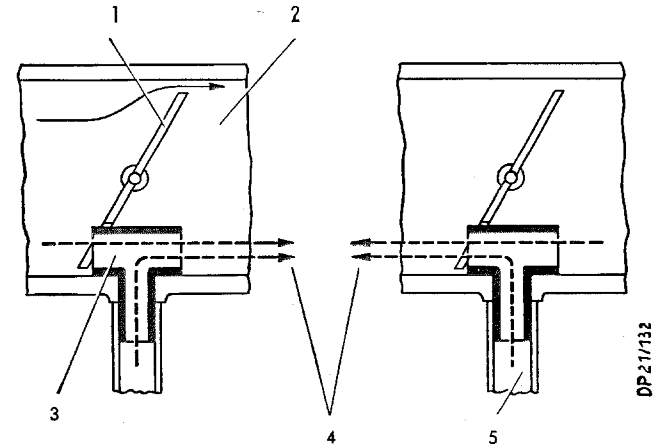


Figure 07–4/6

Throttle duct with auxiliary venturi pipe

1 Slip-on joint for air filter
2 Idling stop screw
3 Mounting flange
4 Auxiliary venturi pipe
5 Full load stop screw



Air flow during normal engine rotation

Air flow during reverse engine rotation

Figure 07–4/7

1 Throttle butterfly
2 Throttle duct
3 Auxiliary venturi pipe
4 Air flow
5 Vacuum connector at throttle duct

The auxiliary venturi pipe (3) serves to boost the vacuum and protects the engine from racing during reverse operation (Figure 07–4/7).

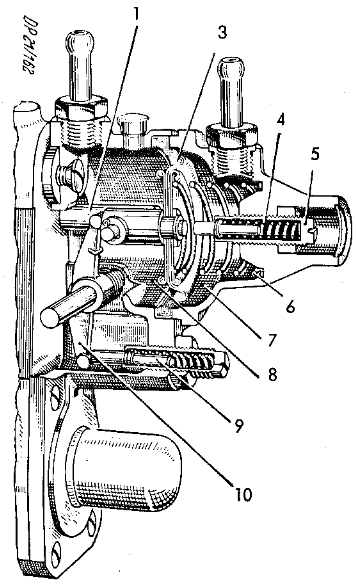
If the engine is operated incorrectly, it can happen that the engine starts in the direction opposite to its normal sense of rotation and keeps on running, which cannot be prevented by the pneumatic governor. The auxiliary venturi pipe, however, prevents over-speeding and makes it possible that the reverse-running engine can be stopped, provided the stop cable control has been properly adjusted. An engine started in this way must be stopped immediately (see Job No. 0–10).

If the auxiliary venturi pipe were not installed in the throttle duct, a high dynamic pressure would be produced in the intake manifold while the engine is reversing with the throttle butterfly closed. This dynamic pressure would very forcefully move the diaphragm in the direction "full" via the vacuum line and the vacuum chamber. The engine would increase its speed quickly and start racing.

The auxiliary venturi pipe, which is mounted in the throttle duct above the vacuum connector passes through the throttle butterfly and is therefore located in the flow of the intake air, allows the exit of the exhaust gases through the auxiliary venturi pipe and through the air filter while the engine is running in the opposite direction, even if the throttle butterfly is closed (see Figure 07–4/7). During this process the air contained in the vacuum chamber is sucked out; a certain vacuum thus created in the chamber returns the control rod to the partial load position.

b) **Diaphragm Unit**

There are two different diaphragm unit designs, namely on the OM 636 the M-governors without additional spring and the MZ-governors with additional spring (Figure 07–4/8 and 07–4/9) and with the OM 621, the MN governors with additional spring and engageable cam (mechanical additional control, see Figure 07–4/26).



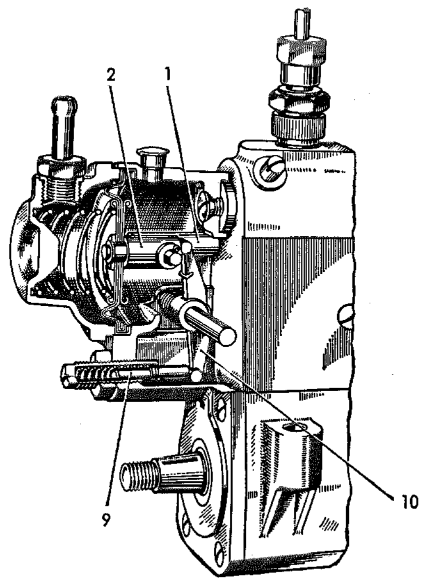


Figure 07–4/8

MZ-Governor with Additional Spring

Figure 07–4/9

M-Governor with Additional Spring

1 Control rod
2 Diaphragm rod
3 Diaphragm (of leather)
4 Additional spring (Stupser)
5 Adjusting screw
6 Control spring
7 Vacuum chamber
8 Atmospheric chamber
9 Adjustable spring-loaded full load stop
10 Double lever with adjusting lever

The diaphragm unit is mounted at the front side of the injection pump and is subdivided by a diaphragm (3) in two chambers: the vacuum chamber (7) and the atmospheric chamber (8) (see Figure 07–4/8).

The atmospheric chamber is connected with the atmosphere by means of a small filter or a hole depending on the design of the governor. A line connects the vacuum chamber with the throttle duct.

The vacuum chamber contains the control spring (6) and, depending on the design of governor, also a helper spring (4). The control spring (6) presses the diaphragm (3) with attached control rod (1), while the engine is not in operation, in the direction full against the double lever (10), which in turn presses against the spring-loaded full load stop (9) (see Figure 07–4/8).

While the engine is in operation the position of the diaphragm and with it the position of the control rod depends on the difference in pressure on either side of the diaphragm. If the engine is loaded or unloaded while the throttle butterfly is in a certain position, the speed of the engine decreases or increases and the vacuum changes. If the vacuum is weaker than the pre-tension of the control spring, then the control rod is pressed against its full load stop. If the vacuum becomes stronger, the outer (atmospheric) air pressure moves the diaphragm against the pressure of the spring, so that the control rod is moved in the direction STOP.

The vacuum necessary for governing is produced in the throttle duct by the velocity of flow of the air breathed by the engine. The governing starts as soon as the vacuum can overcome the pressure of the control spring or vice versa. The diameter of the throttle duct has been designed for the full engine output and the control spring has been chosen accordingly, so that the maximum permissible speed is reached with the throttle butterfly wide open. The effectiveness of the pneumatic governor ranges from idling to maximum speed.

In order to improve the idling performance and to prevent stalling at intersections an adjustable additional spring (4) (Stupser) has been installed in the MZ-type governors. The sprung full load stop adjusts the max. permissible full load injection rate and allows the starting injection rate (also see starting).

c) **Adapting Device in the Diaphragm Unit**

Adapting means an auxiliary system in the governor to adapt the full load injection rate to the air charge during the respective speed of the engine. The adapting travel (a) is accomplished by an additional spring (5) installed between the full load stop (2) and the diaphragm (4) (Figure 07–4/12 and 07–4/13).

The injection rate is adjusted at the full load stop in such a way that the discharge rate during full load corresponds exactly to the requirements of the engine in the lower speed range (smoking limit). The air charge decreases with the increasing speed of the engine. The injection rate, however, increases somewhat as long as the control rod touches the full load stop. This would cause too rich a fuel mixture in the higher full load speed ranges, the engine would emit smoke; the adapting must therefore slightly reduce the injection rate.

The beginning of adapting can be adjusted with washers changing the initial tension of the adapting spring. The adapting begins sooner if the pre-load is increased. If the initial tension of the adapting spring is lower, the adapting sets in correspondingly later. **The correct beginning of adapting can only be checked on the injection pump test stand.** Changing the initial tension of the adapting spring at random causes incorrect adjusting values. The adapting data can be found in the Bosch test data sheets.

For a better understanding of the operation of the pneumatic governor the individual operating positions of the governor are described below:

Starting:

While the engine is not in operation the diaphragm (3) is pressed against the full load stop (14) (double lever) by the control spring (4). In order to possibly keep the control rod (16) in the full load position during the starting of the engine, the throttle butterfly can be opened completely by stepping on the gas. Due to the large cross section in the throttle duct only a weak vacuum is produced which will not have the power to adjust the diaphragm and control rod to a low injection rate immediately and the engine will start easier.

Furthermore, during starting by operating the starting switch the full load stop bolt (13) is pressed out of its normal position for a certain additional increase of discharge by way of the adjusting lever (15) and the double lever (14). By this, the highest possible injection rate is given to the engine during the starting (Figure 07–4/10).

When releasing the starting switch the spring (12) presses the adjusting lever (15) immediately back into its normal full load position by way of the stop bolt (13) and the adjusting lever (15) (Figure 07–4/11).

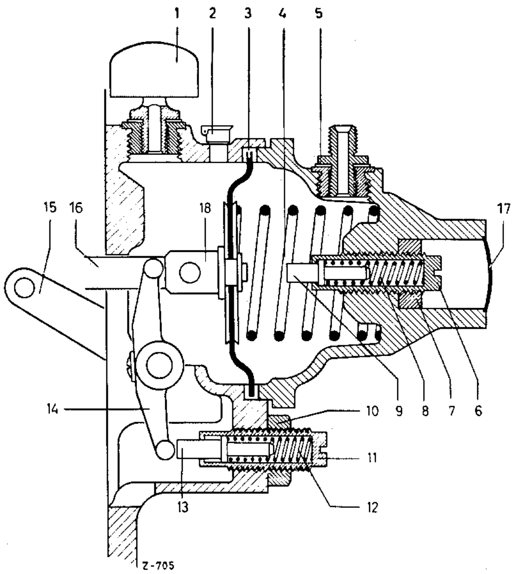


Figure 07–4/10

Starting Position

1 Air filter of the atmospheric chamber
2 Cap oiler to lubricate the governor linkage
3 Diaphragm
4 Control spring
5 Vacuum connector at the vacuum chamber
6 Adjusting screw with additional spring (Stupser)
7 Lock nut of adjusting screw
8 Additional spring
9 Stop bolt (Stupser)
10 Lock nut
11 Adjusting screw with full load stop
12 Spring
13 Stop bolt
14 Double lever
15 Adjusting lever
16 Control rod
17 End plate in governor housing
18 Diaphragm bolt

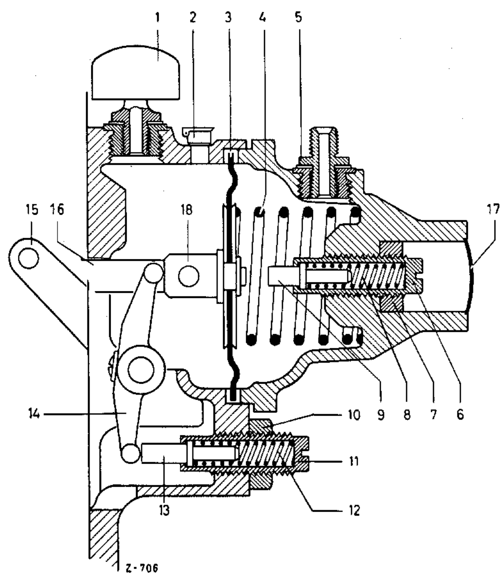


Figure 07–4/11

Driving Position

Full Load and Low Speed:

The throttle butterfly is fully opened, the speed is low and therefore the vacuum still weak. The control spring (4) presses the diaphragm (3) with the diaphragm bolt (18) by way of the double lever (14) against the stop bolt (13) of the sprung full load stop (11) (Figure 07–4/11). The adapting spring (5) in the diaphragm bolt (3) is still compressed by the force of the control spring. The engine receives the full injection rate (Figure 07–4/12).

Increasing Full Load Speed and Beginning of Adapting:

The vacuum in the vacuum chamber increases with the increasing full load speed. The pressure of the control spring applied to the diaphragm (4) and the diaphragm bolt (3) becomes less. The adapting spring (5) is released gradually and pushes the diaphragm (4) with the control rod (1) somewhat in the direction STOP (Figure 07–4/13).

In the Figure 07–4/13 the adapting spring (5) is relieved completely and the control rod (1) has covered the full adapting travel (a) in the direction STOP.

The injection rate is reduced in accordance with the air charge of the engine. Figure 07–4/12 shows the diaphragm in full load position before the beginning of adapting. The adapting spring (5) is still compressed.

Decreasing Full Load Speed and Stopping of Adapting:

When decreasing full load speed, e.g. driving up-hill, the process is reversed. The decreasing engine speed causes a reduction of the vacuum. The control spring is released again and presses the diaphragm bolt (3) against the full load stop (2). During further reduction of the engine speed and decrease of the vacuum the adapting spring (5) is gradually compressed throughout the adapting travel (a) until the maximum full load injection rate has been reached.

The adapting spring and the adapting travel correspond to the control spring and the engine in such a way, that the discharge rate during full load exactly meets the fuel requirements of the engine.

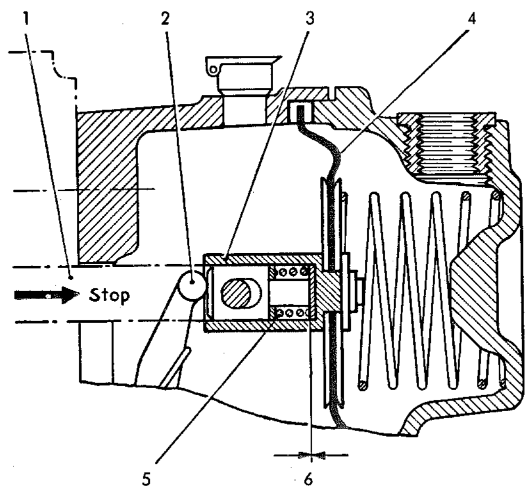


Figure 07–4/12

1 Control rod
2 Full load stop
3 Diaphragm bolt
4 Diaphragm
5 Adapting spring
6 Adapting travel = 0

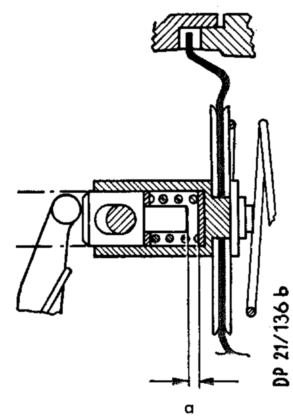


Figure 07–4/13

a = max. adapting travel

Idling of the Engine:

During the idling operation of the engine the gas pedal is released. The return spring at the gas pedal pulls the throttle butterfly shaft with its adjustable idling stop screw against the stop at the throttle duct, so that the throttle duct is closed by the throttle butterfly, leaving only the passage of the auxilary venturi pipe open. The aspirated air passes now through the auxiliary venturi pipe with a very high velocity. The resulting vacuum in the vacuum chamber draws the draphragm and the control rod so far in the direction STOP, that the idling injection rate will be reached. In the idling position the diaphragm and the control rod execute short oscillating movements due to the intake strokes of the engine. In the MZ-governor the control rod taps against the Stupser (9) during the alternating motion's in direction STOP (see Figure 07–4/14).

The bouncing of the diaphragm (3) at the Stupser (9) prevents the control rod (16) from oscillating too strongly, which would cause faltering and hunting of the engine.

Stopping of Engine:

The engine is idling. The throttle butterfly and the diaphragm (3) are in idling position.

When stopping the engine the diaphragm (3) is pressed against the Stupser (9) by way of the stop cable control, the adjusting lever (15) and the double lever (14) (Figure 07–0/15).

By this the additional spring (8) is compressed and the control rod (16) is pushed so far in the direction STOP that the pump plungers come into the no delivery range and the engine is stopped.

During this stopping operation the double lever (14) is lifted off the stop bolt (13) of the full load stop (Figure 07–4/15).

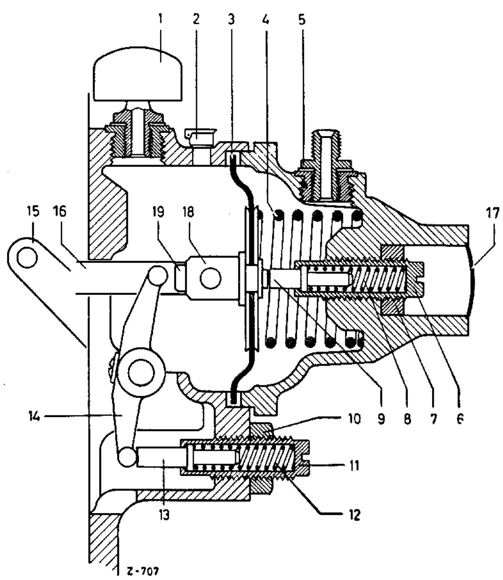


Figure 07–4/14

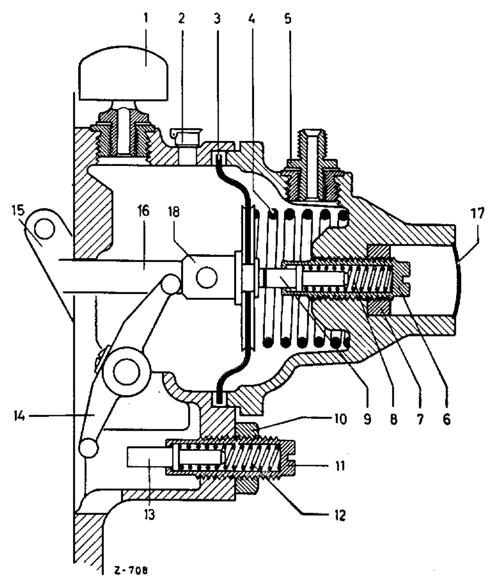


Figure 07–4/15

Idling Position

1 Air filter of the atmospheric chamber
2 Cap oiler to lubricate the governor linkage
3 Diaphragm
4 Control spring
5 Vacuum connector at the vacuum chamber
6 Adjusting screw with additional spring (Stupser)
7 Lock nut of adjusting screw
8 Additional spring
9 Stop bolt (Stupser)
10 Lock nut

Stop and/or No Delivery Position

11 Adjusting screw with full load stop
12 Spring
13 Stop bolt
14 Double lever
15 Adjusting lever
16 Control rod
17 End plate in governor housing
18 Diaphragm bolt
19 Pressure bolt of adapting spring

IV. Speed Ranges

There are two different speeds in the max. speed range of an engine, namely the full load max. speed and the no-load max. speed.

a) **Full Load Maximum Speed**

The full load max. speed, also called rated speed, is the speed which the engine should reach during maximum output. The throttle butterfly is then opened completely. During low speed