there is only a weak vacuum in the vacuum chamber. The vacuum necessary for governing and the required force to pull back the control rod in the direction STOP will only be reached during full load max. speed with the throttle butterfly completely opened. The adapting spring will then be fully released, but the pressure bolt of the adapting spring still lightly touches the full load stop (see Figure 07–4/13). As soon as the engine has reached its full load max. speed the returning of the control rod in the direction STOP begins and with it the limiting of the full load max. speed (beginning of governing).

b) No-Load Maximum Speed

The no-load max. speed is the speed which the engine can possibly reach, but should never exceed for a longer period, without endangering the engine.

If for instance the throttle is opened fully while stationary or during a down-hill drive, the speed rises beyond the full load max. speed. The vacuum becomes now so strong that the diaphragm is lifted off the full load stop and is pulled further in the direction STOP against the Stupser.

Governing begins when the diaphragm leaves the full-load stop (the injection rate becomes lower), but the engine speed still increases due to the small load. The speed increases until the diaphragm is drawn so far back that the pump plungers pass through the partial load and idling position into the no-delivery range. During this procedure the additional spring (Stupser) is compressed by the diaphragm. The diaphragm and/or the control rod travel then beyond the idling position into the no-delivery range of the injection pump, exactly similar to the stopping operation of the engine (Figure 07–4/14 and Figure 07–4/15). A further increase of speed in this position of the governor is therefore not possible while the engine is stationary (end of governing), but not so during the down-hill drive under certain conditions due to the inertia of the vehicle.

Note: The above description clearly shows that the position of the Stupser is of essential importance for the no-load max. speed of an engine. A readjustment of the Stupser must only be conducted in accordance with specified test data sheet of the respective injection pump design and/or governor type (see Job No. 07–8, Pos. III).

c) Idling Speed

The idling speed of an engine is the lowest speed at which an engine without load continues to run without stalling; the engine is only loaded down through its internal friction and the aggregates continuously coupled to the engine such as generator, injection pump, fan etc.

The engine requires therefore only a low injection rate. This is automatically adjusted by the governor, as soon as the throttle butterfly is brought into the idling position.

V. Centrifugal Governor

a) General

As can be seen in the above description, the desired speed between idling and max. speed is kept in a certain range with the gas pedal or the gas linkage, if the engine is equipped with a pneumatic governor.

This kind of governing is not suitable for engines driving machinery sensitive to speed changes, which must therefore be operated with an operating speed as constant as possible.

Due to this fact built-in engines of individual types are equipped with centrifugal governors.

The degree of unbalance (difference in speed under varying load) at max. speed is considerably lower when using centrifugal governors than with pneumatic governors.

The degree of unbalance is calculated as follows:

$$\delta = \frac{n_h - n_v}{n_m} \qquad n_m = \frac{n_h + n_v}{2}$$

Example: An engine has a full load speed $n_v = 3000$ rpm
The no-load speed is $n_h = 3200$ rpm

The degree of unbalance is then

$$\delta = \frac{\frac{3200-3000}{3200+3000}}{2} \cdot 100 = \frac{2 \cdot 200}{6200} \cdot 100 = \frac{400}{6200} \cdot 100 = 6.45\,\%$$

Centrifugal governors (Bosch, type EP/RSV) may be repaired only by a Bosch service agency, because the design of these centrifugal governors is considerably more complicated than that of pneumatic governors.

This is the reason for omitting a detailed description in the following; only a brief outline on the design and operation of the governor is given.

b) **Design and Operation**

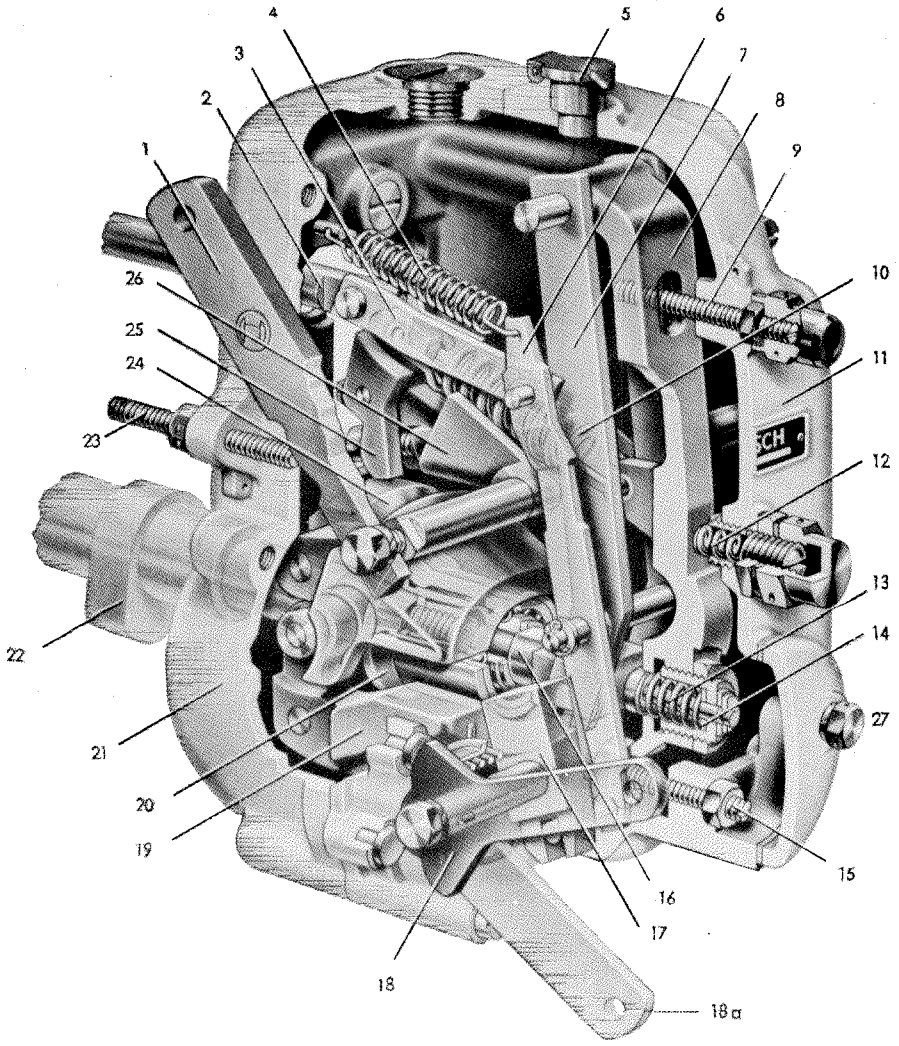
The centrifugal governor is mounted on the injection pump and is driven by the camshaft of the injection pump. Unlike the pneumatic governor this governor is not controlled by the air flow but by the engine speed. The throttle duct is therefore not required for engines with centrifugal governor.

The governors are adjusted to the desired idling and max. speed depending on the intended use of the engine. The respective pump speed (half of engine speed) is indicated on the model plate of the governor.

Furthermore, the governor has a starting spring, which automatically brings the control rod into the maximum position, thus giving the engine the required higher injection rate for starting. The Figure 07–4/16 shows a cross section of the governor and its components. The actual shape and arrangement of the governor components (double lever) can be observed better in Figure 07–4/17.

Figure 07–4/16

Bosch Governor (Type EP/RSV), Drive Mechanism



1 Adjusting lever
2 Control rod
3 Link
4 Starting spring
5 Cap oiler
6 Control lever
7 Guide lever
8 Tension lever
9 Stopping or idling stop
10 Control spring
11 Governor cover
12 Idling additional spring
13 Adapting or idling
14 Spacer washers
15 Full load stop tension spring
16 Adjusting bolt
17 Stopping device
18 Stopping lever during operation
18a Stopping lever in stop position
19 Centrifugal weight
20 Guide bush
21 Governor housing
22 Camshaft of injection pump
23 Max. speed stop
24 Hub
25 Balance jack
26 Swivel arm
27 Oil level check screw

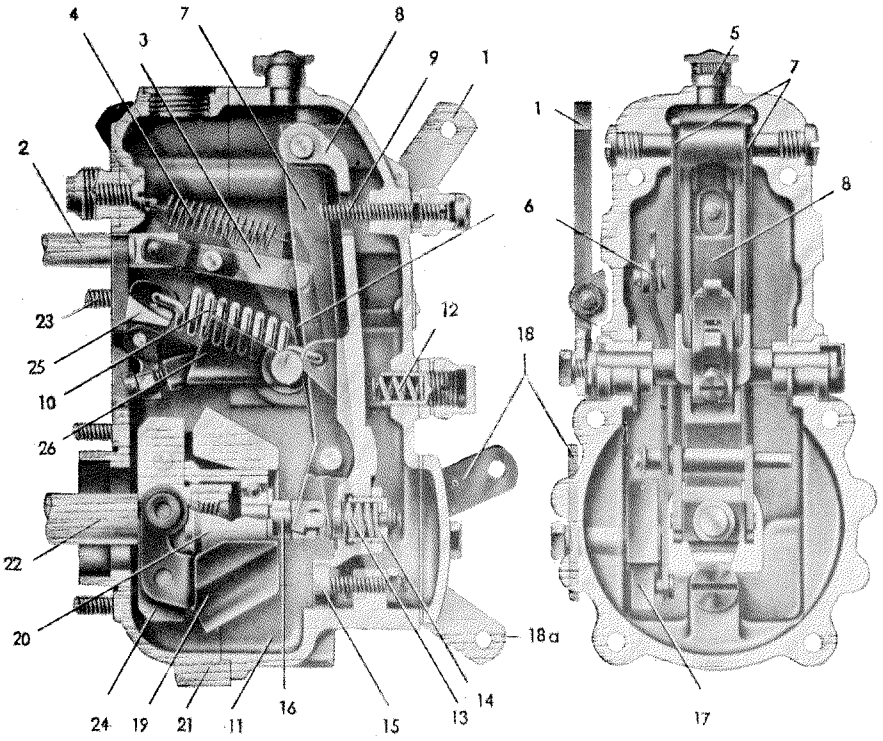


Figure 07–4/17

The camshaft of the injection pump (22) supports the rotating parts of the governor: Hub (24), guide bush (20) and the centrifugal weights (19). The two centrifugal weights are pivoted on bolts attached to the hub. During the deflection of the centrifugal weights the rollers mounted on bell-crank levers are pressed in an axial direction against the guide bush. The guide bush (20) has a sliding seat on the hub end and rotates together with the hub. The guide bush is axially connected with the adjusting bolt (16) by means of a ball-bearing. The adjusting bolt can only move back and forth in an axial direction, because it is linked to the guide lever (7) pivoted in the governor cover. The control lever (6) is hinged to a bolt mounted on the guide lever (7). The control rod (2) is linked to the control lever (6) (see Figure 07–4/16 and 07–4/17).

The starter spring (4) is engaged at the outer top end of the control lever (6). The spring becomes effective only while the engine is stopped or while the engine speed is lower than the idling speed. The tension lever (8) is pivoted on the same bolt as the guide lever (7). The tension lever is pressed against the adjusting bolt (16) and with its bottom end against the full load stop (15) by the strong control spring (10).

The tension lever (8) touches the full load stop as long as the equilibrium is maintained between the spring tension of the control spring (10) and the centrifugal force of the centrifugal weights (19). The initial tension of the control spring can be changed by adjusting the slotted screw at the balance jack. The tension of the control spring (10) is also changed when adjusting the adjusting lever (1), because it is mounted on the pivot of the swivel arm (26).

The desired engine speed can be set by means of the adjusting lever (1), whereby the location and tension of the control spring (10) is changed in such a way, that the tension force acting on the tension lever (8) and the adjusting bolt (16) balances the centrifugal force of the centrifugal weights (19) at a certain engine speed. The process is about as follows:

When the engine speed increases, the centrifugal weights swing outwards as soon as the centrifugal force becomes greater than the spring forces. When the engine speed decreases, the centrifugal force becomes smaller. Finally, the adjusting force of the control springs is dominating and the centrifugal weights swing back again.

The movements of the centrifugal weights are transferred to the control rod by way of the guide bush, the adjusting bolt and the linkage. During an increasing speed of the engine the control rod is moved in the direction STOP, meaning the speed is limited, because the injection pump delivers less fuel now. During a decreasing speed of the engine the process is reversed. The governor acting as an adjusting governor automatically maintains all speeds, including idling and max. speed. It governs the speed after the driver or operator of the engine has adjusted the required engine speed with the gas pedal and/or hand lever by way of linkage and adjusting lever.

In order to adapt the full load delivery rate to the requirements of the engine between idling and full load speed, an adapting device (13) is installed in the tension lever (8). While the speed is decreasing the adapting device moves the control rod in the direction "full" and while the speed is increasing in the direction STOP.

As already mentioned at the beginning, repairs on the governor must only be executed by a Bosch service agency. Inexpert adjustments should never be carried out on the governor, because this will only result in an incorrect adjusting of the governor.

Before taking a new governor into operation it must be filled with good motor oil, so that the oil flows out of the hole at the loosened oil level check screw (27) located at the side of the governor cover. The used lubricating oil must be completely filled up once weekly in stationary engines.