of the second phase and therefore the sharpness of the braking action resulting from the downshift,can be varied by means of the adjusting screw (9). Screwing the adjusting screw in advances the timing of the second phase and softens the action of the clutch. If the adjusting screw is backed out, the timing is retarded and the clutch action is therefore fiercer. A further device is now necessary in order to accelerate the engagement of the clutch. This is necessary when the accelerator is depressed immediately after the gearshift since the clutch would slip under these conditions because it is not yet completely engaged. The fast engagement of the clutch necessary in this case is brought about by the spring-loaded diaphragm (13). One side of the diaphragm is connected via the air cleaner (12) direct to the external atmosphere and the other side is connected via the canal (15) to the intake manifold of the engine. When the throttle valve is closed and there is a considerable vacuum at the intake manifold, the atmospheric pressure, overcoming the spring pressure, presses the diaphragm down. When the accelerator is depressed, that is, when the throttle valve is opened, the vacuum in the intake manifold decreases. This decrease in vacuum enables the spring once more to press the diaphragm upward and oppose the action of the reducing valve (10) and force it open via the pin connected to the diaphragm. The vacuum in the servo assembly can therefore be very quickly dispersed via the opened reducing valve (10) and the rate of dispersal actually increases, the more the accelerator is depressed (see Fig. 25 – 0/10). The interplay of reducing valve and spring-loaded diaphragm thus effects a rapid or gradual engagement of the mechanical clutch according to the driving requirements.

In order to effect a further improvement of the downshift, an additional electrical switch contact (G) is fitted at the rear axle. This electrical contact can detect, from the attitude of the rear axle, whether the car is pulling or is overrunning the engine. This is possible by virtue of the fact that when the car is pulling, the suspension bolt of the rear axle is inclined toward the rear, due to the reaction torque, while when the car is overrunning the engine, the suspension bolt moves forward and makes contact at the switch (Fig. 25 – 0/11).
As soon as the rear axle switch is making contact, the solenoid (14) is energized via the relay (16). The solenoid (14) then exerts a magnetic pull upon the spring-loaded diaphragm (13) and thus prevents any opening of the reducing valve (10) even when the accelerator is suddenly depressed, for as long as the car is overrunning the engine. This means that the engagement of the clutch proceeds gradually. As soon as the acceleration of the vehicle takes effect and the suspension bolt of the rear axle moves toward the rear, the contact of the rear axle switch opens and the current supply to the solenoid (14) is cut off. The spring loaded diaphragm (13) can now move upward and can force open the reducing valve (10) so that a faster clutch engagement can take place. In order to prevent the solenoid (14) from being energized each time, when during normal driving the car is ascillating between the two sets of conditions, a limit switch (20) is fitted to the servo assembly and this switch breaks the circuit when the clutch is engaged.

With its continuously progressive (stepless) change of speed, the hydraulic coupling (E) gives a very smooth start-off and a controlled drive, particularly when driving in a line of cars and in city traffic. It is impossible for the engine to stall when the gear is engaged.

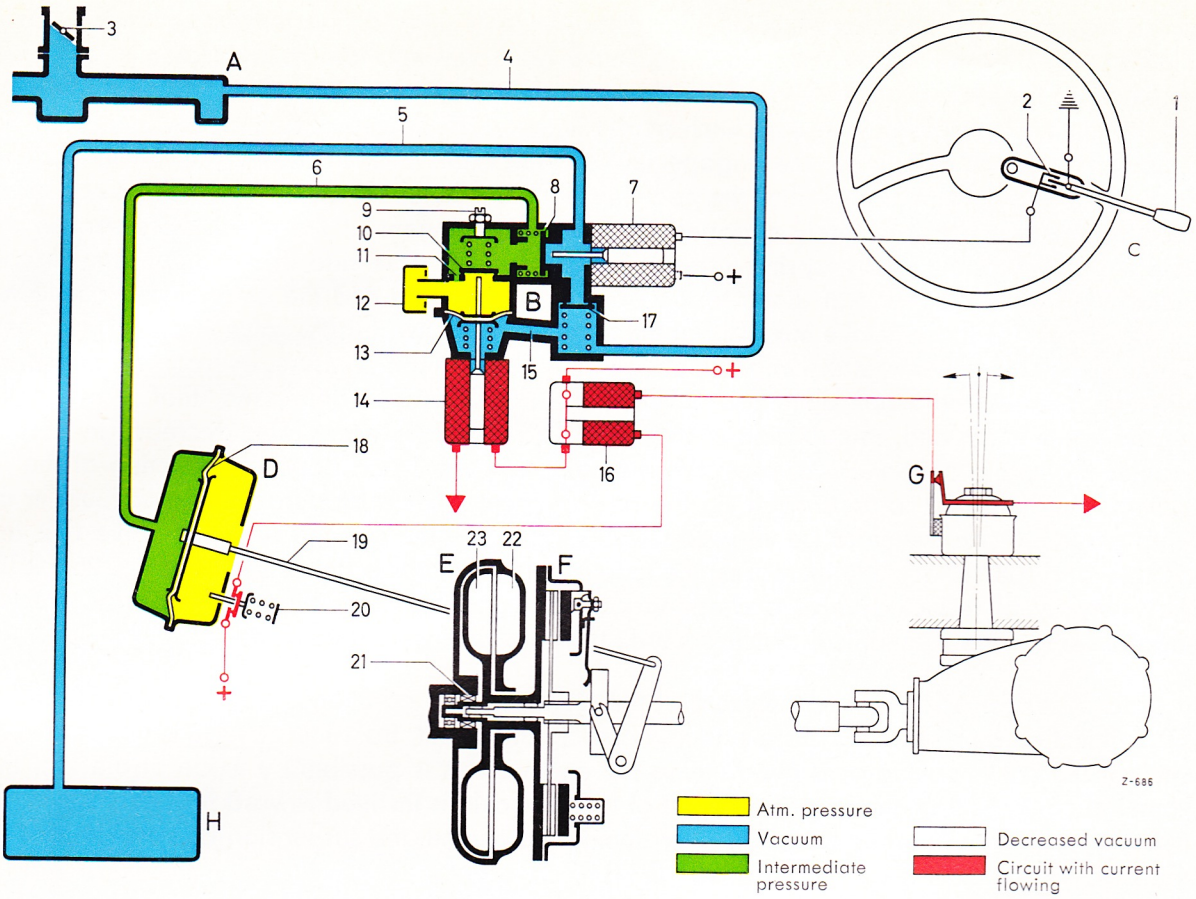

Fig. 25–0/11

A Intake manifold
B Control element
C Shift lever
D Servo assembly
E Hydraulic coupling
F Mechanical clutch
G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intakte manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly
7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal
16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

IV. Hints on Operating the Gears and on Driving

1. General

Gear shifting is done with the shift lever alone and the lever is handled in the normal way. The gear positions of the shift lever are the same as hitherto.

2. Starting the Engine

The engine should only be started when the shift lever is in the neutral position. It is not advisable to start the engine when the gear is engaged since this causes the car to jerk forward immediately.

But if this should have to be done on occasion, the foot brake should be applied firmly enough to arrest the motion of the car.

After the engine has started, depress the accelerator two or three times and then release it immediately so that the necessary vacuum for operating the servo assembly can form.

When starting from cold, the rotary control knob on the instrument panel on cars fitted with a device for increasing the idle speed, should be turned hard over to the right so that the throttle valve moves into the idle position (this ensures the correct starting mixture!).

3. Start-Off

The car can be driven from a standstill in 2nd gear when on the level, but when it is standing on a hill, the 1st gear must be used. Although it is possible to start off in 3rd or in 4th gear (which of course reduces the accerelation considerably), a practice must not be made of this since it would overheat the hydraulic coupling. **The accelerator must not be depressed when the gear is being engaged since this causes the car to jerk forward.** Moreover, the left foot should be used to apply the brake in order to avoid the inevitable slight shock when engagement takes place. Starting off on a hill is extremely easy. The left foot is used to operate the brake, the right foot to operate the accelerator pedal and the foot brake is then gradually released.

4. Driving Hints

When driving, gear-shifting should be done in the usual way. The hydraulic coupling shows to the best advantage in city traffic and when driving in a line of cars since the movement of the car can always be kept under smooth control. The common practice of driving with the right hand resting on the shift lever should be avoided since this immediately releases the mechanical clutch via the electrical contact in the shift lever.

When climbing hills, particularly with the accelerator pedal fully depressed, the downshift must be made in good time. **The minimum speeds for downshift in the various gears are marked on the speedometer and these minimum speeds must be strictly observed because of the danger of overheating the hydraulic coupling. Be sure, therefore, to shift down in good time on hills.**

While waiting at intersections, 1st or 2nd gear can remain engaged until the traffic-lights change. In view of the slight tendency to creep, a tendency shared by cars with hydraulic coupling and cars with automatic transmission, the car must be held with the hand brake or the foot brake.

When stopping on a hill, for example, when travelling in a line of cars, the car must not be held with the accelerator, since this may cause overheating of the hydraulic coupling. Instead, the hand brake or foot brake should be used. If the car is held up in traffic for any length of time, the shift lever must be put in neutral.

It is common knowledge that when the engine is cold, a richer fuel mixture is required, this enriched mixture being obtained by pulling the start choke. When driving with engine and automatic clutch cold, the start choke should therefore be put in the position "Warm-up" – choke control pulled half-way out – until the idle is quite normal. This is done in order to avoid stalling of the engine when the gear is engaged and when the car is standing still.

Note: On cars already equipped with a device for increasing the idle speed (rotary control knob on instrument panel), the idle speed can also be adjusted to suit the prevailing conditions. It is particularly necessary to increase the idle speed when travelling at higher altitudes. Turn the rotary control knob to the left.

5. Parking

In order to be able to maneuver the car slowly when parking, it is advisable to keep the engine running at an increased engine speed, adjusted to the requirements of the moment, using the right foot on the accelerator pedal. By exerting the various pressures required with the left foot on the brake pedal, the car can be moved inch by inch. The brake pedal has been made with a specially wide plate for this purpose.

When not actually engaging 1st or 2nd gear for start-off or parking, the **right** foot should always be used for braking. This avoids the danger of confusion between the pedals when driving a car not fitted with the hydraulically-operated automatic clutch.

6. Leaving the Car Unattended

When leaving the car unattended, the hand brake should be firmly applied. If the car is standing on a hill, it should be put in gear as an extra precaution against rolling.

When standing on a down-grade, engage first gear,
when standing on an up-grade, engage reverse gear.

7. Emergency Starting

If for any reason the engine cannot be started with the starter, the car can be towed in the usual way or can be allowed to run down a hill in 3rd gear. The 3rd gear must, however, be engaged before moving the car since in most cases the shift lever has already been touched and the reservoir vacuum supply dispersed so that the mechanical clutch no longer releases.
When towing, it is absolutely essential to use a tow-rope which is sufficiently long in order to avoid the danger of the towed vehicle overtaking and colliding with the rear of the towing vehicle after the engine has started.

V. Service Instructions

1. Safety Precautions

As in the case of cars fitted with automatic transmission, special safety precautions have to be observed on cars with the hydraulically-operated automatic clutch in order to avoid accidents. Whenever servicing or repair work is being done, the rear wheels must be chocked in both directions and the hand brake applied in order to avoid any accidental movement of the vehicle.

2. Checking the Oil Level

The oil level in the hydraulic coupling must be checked every 4,000 km. It is important to observe this rule as the efficient functioning of the coupling is dependent on it.

The simplest way to check the oil level is to determine the so-called stall speed. The stall speed is that speed which the engine can reach under full-load conditions with the secondary member held stationary. For this test, a commercially available electric revolution counter is connected. Then the 4th or another gear is engaged and the accelerator fully depressed, with the hand brake on, and the foot brake applied. If the oil level is correct and the engine is in good condition, the stall speed must be

$$n = 1550—1600 \text{ r. p. m.}$$

If the stall speed is higher, there is insufficient oil in the hydraulic coupling or the mechanical clutch is slipping. If the stall speed is appreciably lower, this indicates that the engine is not delivering its full power. Before carrying out this test, therefore, the engine must be warmed up to normal working temperature or the full engine power will not be available.

Note: Owing to the fact that the secondary member is held stationary, the whole of the energy transmitted to the hydraulic coupling from the engine is converted into heat. Thus, to avoid damage which may be caused by overheating, the engine must not be allowed to run for longer than 3 seconds at full load when making this test.

At high altitudes, the normal stall speed will not be reached because of the reduced engine efficiency. To obtain truly representative data at such altitudes, the correct stall speed should be ascertained by testing several vehicles known to be in good condition. The data obtained on these tests can then be used as a standard in all cases.
If an electric revolution counter is not available, the oil level check must be made by opening one

of the two screw plugs on the hydraulic coupling. Turn back the strip of carpet at the transmission tunnel and take out the cover plug at the right on the clutch housing (Fig. 25 – 0/12).

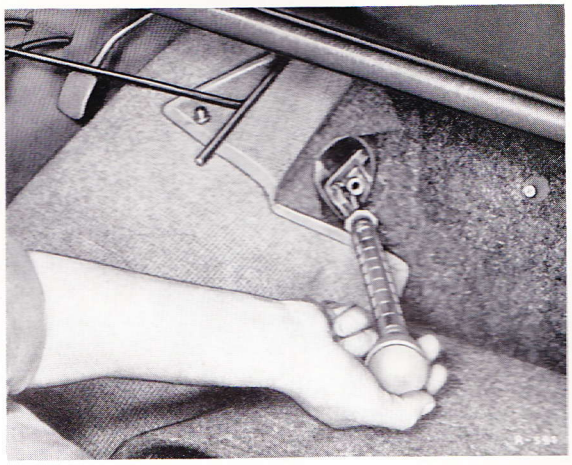

Fig. 25 – 0/12

Now use an SW 22 Box Wrench at the vibration damper at the front to turn the engine until one of the two screw plugs of the hydraulic coupling appears opposite the hole in the clutch housing. The mark stamped on the hydraulic coupling at the side of the screw plug must correspond with the mark stamped on the clutch housing. In the case of the first Hydrak-equipped cars where no marks have been stamped at these points, the hydraulic coupling must be so turned that the filler hole is just beyond the lower edge of the aperture in the clutch housing. Use a 6 mm socket wrench to unscrew the screw plug. With the two housings in the position specified, fill up with oil to the brim, using Oil Gun 000 589 00 72 or some other suitable oiler.

Note: A dip-stick is not fitted.

Allow the coupling to cool down for approx. 10 minutes before opening the screw plug. The screw plug should first be unscrewed a few turns to allow the overpressure in the coupling to escape gradually and only when the pressure is equalized, should the screw plug be completely removed. **When unscrewing the plug, take care that it does not fall into the clutch housing since otherwise the hydraulic coupling will have to be removed.**
We therefore recommend that a magnetic socket wrench should be used or the hexagon socket in the screw plug greased before unscrewing.
The aluminum rings for the screw plugs should always be replaced.

The oil used in the coupling is Transmission Fluid Type A. Further details about make and type of suitable, approved oils are given in the approved list in the operating instructions issued with the car or in the latest edition of the booklet on fuels. When in doubt, detailed information may be obtained by application to our department Export Service.

Oil changes are not specified for the hydraulic coupling. The oil level is merely checked and the coupling topped up if necessary. In general there should be no oil loss. If topping-up shows that considerable oil loss has taken place, the hydraulic coupling is leaking. In this case the axial seal should be checked (see Job No. 25 – 4). The filling capacity is 1.5 liters and the total internal volume of the hydraulic coupling approx. 1.9 liters. **Do not overfill.**

3. Cleaning of the Cooling-Air Cover Plates

For cooling the hydraulic coupling, openings have been made in the clutch housing for air inlet and air outlet. Cover plates in the form of grilles are fitted to prevent the entry of foreign bodies.

After every 8,000 km these cover plates must be carefully cleaned. To do this, unscrew the cooling-air cover plate (1) on the front of the clutch housing (Fig. 25 – 0/13).

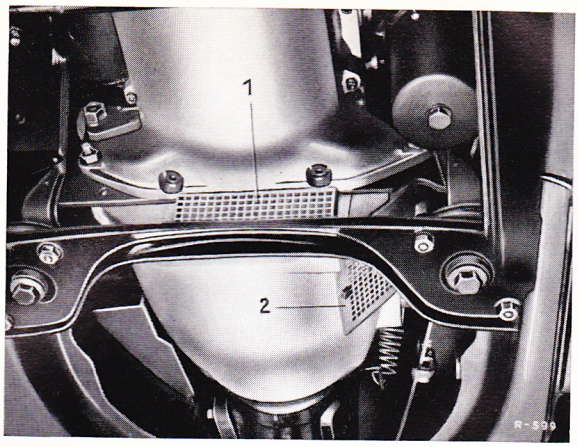

Fig. 25–0/13

1 Cover plate
2 Cover plate

The cooling-air cover plate which is fitted to the top of the clutch housing, cannot be unscrewed with the transmission installed in the vehicle; it must therefore be cleaned from underneath or through the aperture in the transmission tunnel, using a clean rag for the purpose.

In addition, it is essential for the oil film to be removed from the engine. The engine must therefore be thoroughly cleaned. This is necessary because of the danger of the cooling-air carrying with it oil particles as it enters through the cover plate and depositing these on the clutch plate faces, which would cause the mechanical clutch to slip. Particular care must be taken to ensure that the corners between the crankcase and the jointing plate are clean.

4. Cleaning of the Fuel Pre-Filter

Hydrak-equipped cars have a paper fine-filter element in the fuel pre-filter instead of the usual metal screen. This filter element must be replaced every 48,000 km. The pre-filter should be cleaned as usual every 4,000 km. Do not clean the paper element.

5. Checking the Electrical Switch Contact at the Rear Axle

The adjustment of the electrical switch contact at the rear axle should be checked every 4,000 km (see Section VI, Point 3).

VI. Adjustment and Checking

1. Adjusting the Free Play of the Mechanical Clutch

The free play of the mechanical clutch is adjusted at the turnbuckle (1) of the pull-rod (3) from the servo assembly to the throw-out lever (5) of the clutch (Fig. 25–0/14).

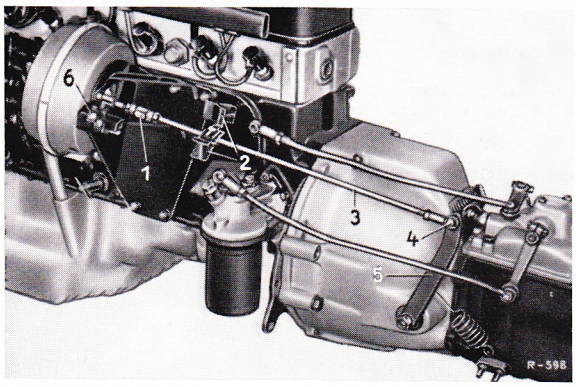

Fig. 25–0/14

1 Turnbuckle
2 Adjusting Clamps 180 589 12 23 for adjusting the free play
3 Pull-rod
4 Connector head
5 Throw-out lever
6 Limit switch

To facilitate measurement of the free play, the two adjusting clamps (2) 180 589 12 23 are fitted to the crankcase and the pull-rod in such a way that the pointer on each corresponds with the start mark on the other. The free play, measured at the pull-rod, should be 10–12 mm. Two marks are made this distance apart on the other clamp so that checking and adjustment of the free play is easy. With the engine stopped, the pull-rod is moved by hand as far as the stop, that is to say, to the point where the thrust bearing lies against the thrust ring of the mechanical clutch. After some experience of this job, it will be found that checking of the free play can be carried out satisfactorily by touch alone.

2. Control Element

a) Regulation of the Engagement Flexibility of the Clutch

The engagement flexibility of the mechanical clutch can be altered by means of the adjusting screw (2) (Fig. 25–0/15).

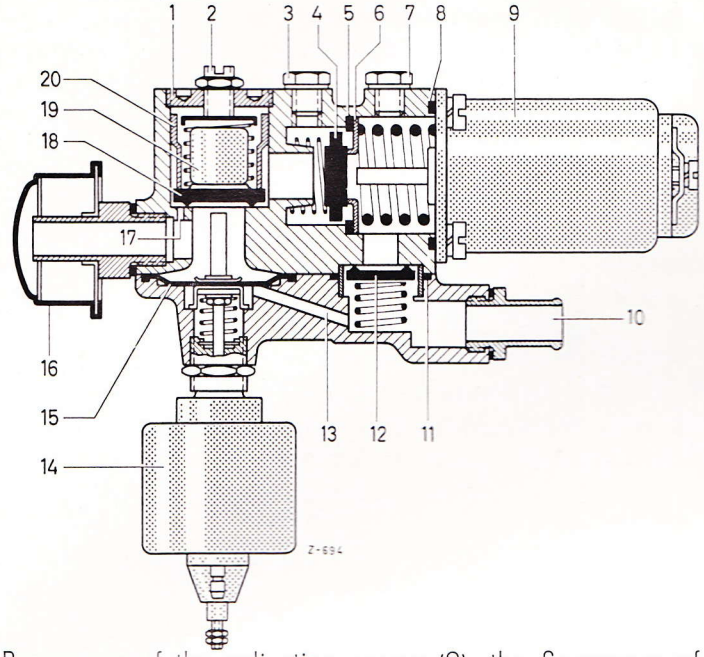

Fig. 25–0/15

1 Threaded ring
2 Adjusting screw with lock nut
3 Screw plug
4 Control valve
5 Rubber washer
6 Valve head
7 Screw plug
8 Rubber washer
9 Electro-magnet for control valve
10 Vacuum union for intake manifold
11 Rubber washer
12 Check valve
13 Vacuum canal
14 Solenoid for spring-loaded diaphragm
15 Spring-loaded diaphragm
16 Air cleaner
17 Jet in reducing valve
18 Reducing valve
19 Damper weight
20 Damper sleeve

By means of the adjusting screw (2), the fierceness of the braking shift (downshift with car overrunning engine) and also the fierceness of the gearshift shock when the 1st or 2nd gear is engaged, can be modified. Screwing the adjusting screw in makes the braking shift and the gearshift shock smoother and screwing it out makes them fiercer. As a rule, a half-turn is enough.

Note: The adjustment can be made during a test run. **The accelerator must not be depressed during the downshift because the rear axle switch contact must not be allowed to affect the shift. The simplest way is to disconnect the electric cable at the solenoid (14).**

No alterations must be made to the spring-loaded diaphragm (15). An accurate adjustment is only possible on a test stand.

b) Removal and Cleaning of Reducing Valve

If the downshifts are irregular, that is to say if they are sometimes good and sometimes bad, the cause is usually dirt or a small foreign body at the reducing valve.

Remove the valve, using Socket Wrench 180 589 15 07 to unscrew the threaded ring at the top of the control element (Fig. 25–0/16).

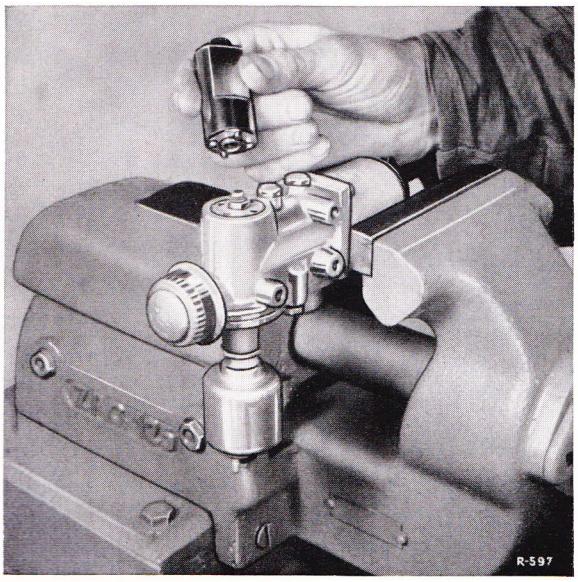

Fig. 25–0/16

Note: If this job is done with the control element installed, the control element must be steadied by a second mechanic because the threaded ring is put in with sealing compound and is therefore difficult to slacken.

After unscrewing the threaded ring, the pressure spring (6), the damper sleeve (4), the damper weight (5) and the valve head (7) can be taken out (Fig. 25–0/17).

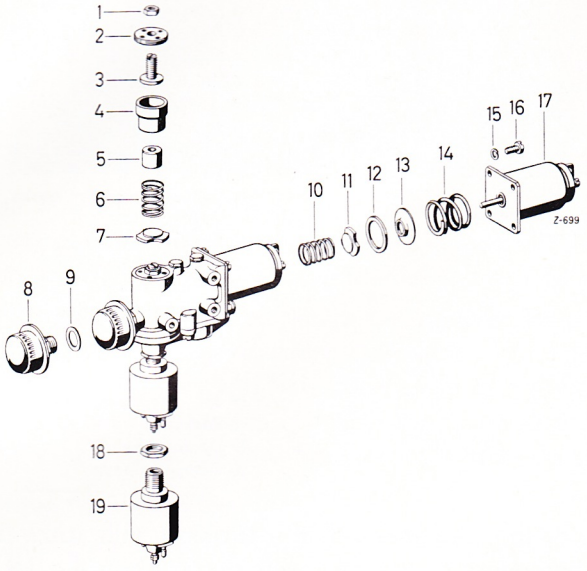

Fig. 25–0/17

1 Hexagon nut
2 Threaded ring
3 Adjusting screw
4 Damper sleeve
5 Damper weight
6 Pressure spring
7 Valve head
8 Air cleaner
9 Sealing ring
10 Pressure spring
11 Valve head
12 Sealing ring
13 Valve head
14 Pressure spring
15 Lock washer
16 Slotted screw
17 Electro-magnet of control valve
18 Hexagon nut
19 Solenoid of spring-loaded diaphragm

Before re-installing, all traces of dirt must be removed with the greatest of care. This also applies to the housing. The thread of the threaded ring must be thinly coated with Teroson Fluid sealing compound.

Note: Use sealing compound sparingly in order to avoid it penetrating into the housing.

The remaining parts of the control element should not be unscrewed since otherwise it will be necessary to readjust the whole assembly on the test stand.

3. Adjustment of Electrical Switch Contact at the Rear Axle

The electrical switch contact at the rear axle is adjusted with the aid of a testing light. After removing the cover plate (1) in the trunk compartment, a testing light (5) with an adequate length of cable, is connected to the positive terminal of the battery and to the switch connection marked with a + (Fig. 25–0/18).

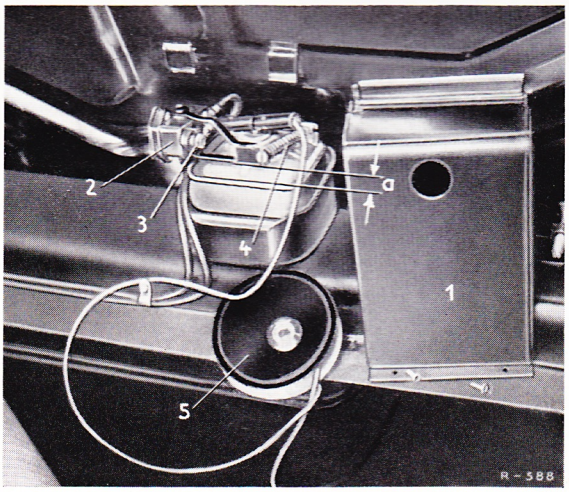

Fig. 25–0/18

1 Cover plate
2 Electrical switch contact
3 Adjusting screw
4 Pressure pin with tension spring
5 Testing light
a = approx. 15 mm

The car must be placed on a level floor, the hand brake released, the shift lever put in neutral and the adjustment then made by turning the adjusting screw (3) so that the testing light just begins to light up. While this is being done, no one other than the mechanic himself must touch or put any weight on the car since this would result in false adjustment.

Backing out the adjusting screw causes fiercer shifts and screwing it in causes smoother shifts. When the adjustment is being made, care must be taken to ensure that the adjusting screw is not screwed in too far since this might cause the clutch to slip on full-accelerator upshifts owing to the engagement taking place too slowly.

The electrical switch contact must be fitted to the housing of the rear axle suspension in such a way that the distance 'a' between the clamping ring and the switch contact is approx. 15 mm (see Fig. 25–0/18). This distance must be strictly maintained because it decreases when the car is jacked up at the rear axle or when the car is fully loaded.

4. Adjustment of Electrical Contact at Shift Lever

The electrical contact at the shift lever is also adjusted with the aid of a testing light. The testing light is connected with one cable to the positive terminal of the battery and the other to the black cable of the electro-magnet for the control valve. After slackening the lock nut (8), screw in the cover cap (2) to the point where the two contacts (3) and (6) touch, that is to say, the point where the testing light just lights up (Fig. 25–0/19).

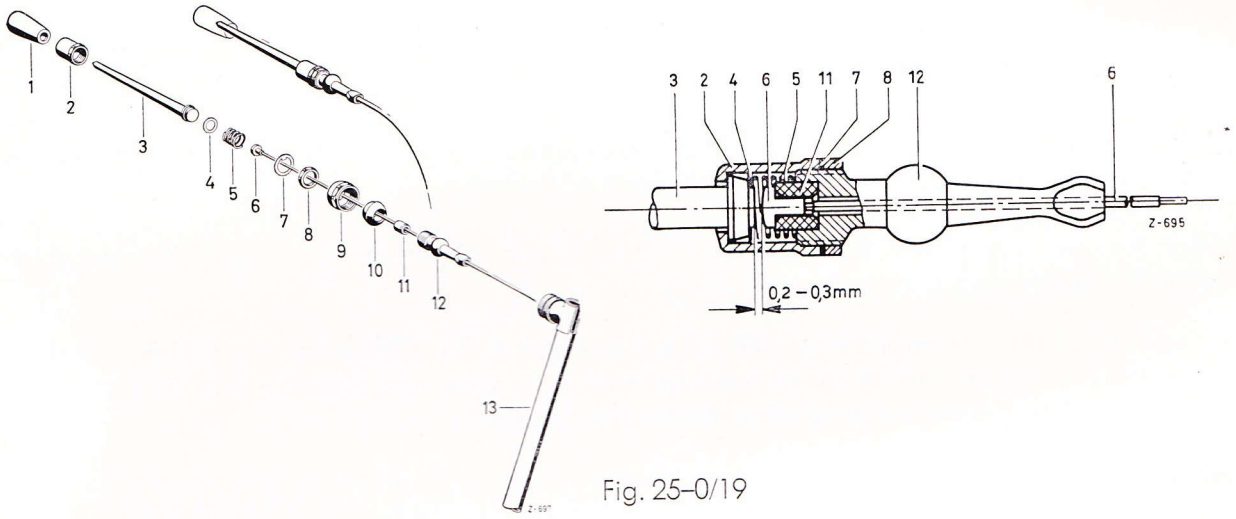

Fig. 25–0/19

1 Knob of shift lever
2 Cover cap
3 Shift lever with contact
4 Backing washer
5 Pressure spring
6 Contact with cable
7 Locking plate
8 Octagon nut
9 Cover cap
10 Rubber pad (cushion)
11 Bushing
12 Selector finger
13 Shift tube

From this position, unscrew the cover cap 1/5 of a turn and this gives the specified contact distance of 0.2–0.3 mm.

After adjusting, tighten up and lock the lock nut (8); when this is done, care must be taken to ensure that the adjustment is not altered.

5. Checking the System for Leakage

The whole servo assembly must be completely airtight. Special attention should therefore be given to the airtightness of the unions and the lines. The airtightness of the check-valve (12) can also be checked with the assembly installed in the vehicle, provided that the vacuum line and the supply reservoir are airtight. A test take-off point (7) has been fitted to the control element for this purpose (see Fig. 25–0/15).

Note: The front test take-off point (3) is fitted for the purpose of adjusting the spring-loaded diaphragm (15). This adjustment can only be carried out on a test stand.

After unscrewing the rear screw plug, a suitable pressure gage should be connected and after the engine has been allowed to run for a short time, the vacuum existing at the take-off point is read off (Fig. 25–0/20).

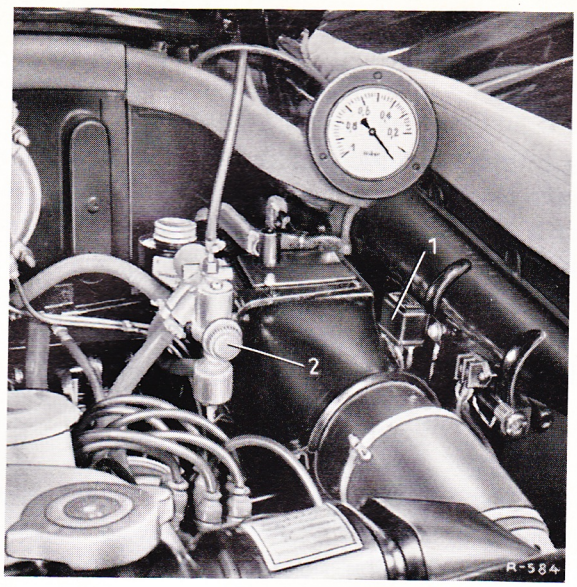

Fig. 25–0/20

1 Relay for the solenoid of the spring-loaded diaphragm
2 Control element

The supply reservoir should hold its vacuum for at least 5 hours so that without starting the engine the mechanical clutch is thrown out by touching the shift lever even after the vehicle has been standing for a long time.

6. Adjustment of Idle

On both Models 219 and 220 S, the idle must be adjusted to n = 750–800 r. p. m. **with the engine at normal working temperature and the shift lever in neutral.**

When the gear is engaged, the engine speed decreases somewhat due to the slight torque which the hydraulic coupling is already transmitting.

Adjustment of the idle must be carefully done because if the idle speed is too high, the shift-surge and the tendency of the car to creep become too marked and if on the other hand, the idle speed is too low, the engine stalls when the gear is engaged.

Note: On cars already equipped with a device for increasing the idle speed (rotary control knob on instrument panel), the idle speed can be adjusted to suit the conditions prevailing during the journey, that is to say, when the engine is cold, when the hydraulically-operated automatic clutch is cold, or when the car is travelling at high altitudes, the idle speed can be increased or diminished at will.

When the idle is being adjusted, the rotary control knob should be turned hard over to the right.