VOITH GETRIEBE KG D-7920 HEIDENHEIM

VOITH

Instruction Manual
DIWA Transmission

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1. General remarks

The DIWA transmission 502 is a fully automatic, hydrodynamic transmission in which a differential gear unit - distributing the flow of mechanical input power - is positioned in front of the torque converter. Adjacent and to the rear of this differential-converter unit is an epicyclic gearbox with lamellar brakes for the forward range and reverse gear.

At low speeds, the differential gear unit distributes the power transmitted from the engine between one hydraulic power channel and one mechanical power channel, whereby the power quota transmitted into the hydraulic channel diminishes progressively with increasing road speed. With this split-power principle, the inherent advantages of a hydrodynamic torque converter - high starting tractive effort, smooth acceleration, automatic matching to load - are combined with the high efficiency and economy of a mechanical system. At higher speeds, input power is transmitted purely mechanically with minimum losses.

Mechanical design and mode of operation

Coupling between engine and transmission Fig. 3

Flexible slip-clutch: mounted on the flywheel between engine and transmission is the flexible slip-clutch (3/A) comprising one clutch plate and one pressure plate assembly. Its function is

to absorb torsional vibration from the engine - particularly in idling and low speed ranges - and thus prevent the incidence of resonant modes within the transmission. This is achieved by means of a flexible member connecting the splined hub of the clutch plate to the friction plate,

to compensate errors in concentricity when the transmission is directly flange-fitted to the engine,

to limit the torque transmitted to the transmission. This is necessary because, during an automatic shift when the engine is lugged-down to approximately 60 % of its rated speed, torque lying way above the maximum engine torque is briefly transmitted. With each individual installation, the spring tension by which the clutch plate is pressed against the flywheel is matched to the maximum engine torque. As soon as the torque which can be transmitted by the slip-clutch is exceeded, the clutch plate slips for one or two revolutions.

Torque converter Fig. 1

The hydraulic torque converter incorporates three bladed wheels - pump impeller, turbine wheel and stationary guide wheel. Theses are arranged within a housing in such a way that a closed flow circuit is possible. The pump impeller accelerates the hydraulic fluid and produces an oil stream which is more or less sharply deflected by the blades of the turbine wheel. The greater the amount of deflection at the turbine wheel the greater the force applied to the output shaft. Torque multiplication is at its greatest when the turbine wheel is stationary; with increasing turbine wheel speed and thus increasing vehicle speed, output torque diminishes and in this way matches itself automatically to driving resistance. The stationary guide wheel takes up the difference between input and output torque arising with torque multiplication and guides the fluid stream back to the pump impeller at the same inflow angle irrespective of turbine speed.

Differential converter Fig. 2

The DIWA transmission incorporates an epicyclic distributor gear unit in front of the hydraulic torque converter. This so-called differential-converter unit functions as follows:

On starting, the intermediate shaft (2/b) and sunwheel (2/r) are stationary; planet carrier (2/p) and pump impeller (2/P) are driven at double the engine speed via ring gear (2/q) and planet wheels (2/s & 2/t).

The engine is in this way lugged down to 60-65 % of its rated speed in full throttle position, and thus into the range of maximum torque and lowest fuel consumption. This torque is multiplied in the converter.

As soon as the vehicle is in motion, output drive and intermediate shaft (2/b) together with output sunwheel (2/r) begin to rotate. In this operating range, part of the power is transmitted mechanically via the planet wheels and output drive sunwheel.

With an increase in vehicle speed, i.e. increase in speed of intermediate shaft (2/b), the ratio between input drive shaft and pump impeller (2/P) - and thus the hydraulically transmitted power quota - decreases, while the mechanical power quota transmitted via output drive sunwheel (2/r) and engine speed increase proportionately.

This distribution of power achieved by the simultaneous transmission of mechanical and hydraulic power produces an improved overall transmission efficiency and ensures maximum utilisation of the most economical engine speed range.

When the nominal engine speed range has been reached, the differential gear brake (2/d) is automatically applied, causing a switch-off of the hydraulic-mechanical operating range (hereafter briefly referred to as the DIWA drive) and the arresting of the torque converter. Simultaneously, the turbine wheel (2/T) ceases to rotate after having been disengaged from intermediate shaft (2/b) via freewheel (2/f).

When planet carrier (2/p) is held stationary, the total engine power is mechani - cally transmitted to intermediate shaft (2/b) via ring gear, planet wheels and output drive sunwheel. At the point of automatic shift, the engine is lugged down to approximately half its maximum speed.

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With a further increase of road speed, the differential gear unit is by-passed by means of the primary lamellar clutch (2b/e) and the input drive shaft becomes directly coupled to the output shaft.

Change-speed and reverse gearbox Fig. 3

The change-speed and reverse gearbox comprises two planetary gear sets with pertinent hydraulically actuated lamellar (multi-disc) brakes.

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In forward range, the ring gear of the respective planetary gear set is arrested by the lamellar brakes and, in reverse range, the planet carrier.

The DIWA transmission has two forward gears and one reverse.

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In first and second speeds of forward range, the ring gear of the respective planetary gear set is arrested by the lamellar brakes and, in reverse range, the planet carrier.

The DIWA transmission has three forward gears and one reverse.

With the automatic shift into third gear, the primary lamellar clutch is engaged and thus the input shaft is directly coupled to the output shaft, i.e. in this operating state, input and output speeds are the same. While the differential gear unit brake remains under oil pressure, the brake for forward range in the change-speed and reverse gearbox is released during the shift into third gear.

In neutral, both brakes of the change-speed and reverse gearbox are released.

Control

Oil circuit

Operating pump (5/a), running at engine speed, holds the torque converter under pressure and provides lubrication for bearings and gears. It supplies oil from the sump to the torque converter (5/e) via filter (5/g) and operating pressure valve (5/h).

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Oil is also supplied by the operating pump to the control block and from there - according to the position of the selector and control pistons - to the differential gear unit brake (5a/i) and change-speed gearbox brakes (5a/c).

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Oil is also supplied by the operating pump to the control block and from there - according to the position of the selector and control pistons - to the differential gear unit brake (5b/i), the change-speed gearbox brakes (5b/c), and to the primary lamellar clutch (5b/s).

The pressure retarder valve (5/y) incorporated in the line to the differential gear unit brake ensures a slow build-up of oil pressure on the differential gear unit brake, and thus a smooth change from first to second gear.

The converter pressure is limited by converter pressure governor (5/f). The line to the oil cooler (with air-cooled engines) or heat exchanger is connected to the converter pressure governor.

Automatic shift

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The shift from the DIWA drive into the mechanical drive is released by control pump (5a/b) which is driven by the output drive shaft. It supplies oil from the sump to the control piston ($5a/k_1$) via the restrictor screw (5a/d).

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The shifts from the DIWA drive into the two mechanical gears are released by the control pump (5b/b) which is driven by the output drive shaft. It supplies oil from the sump to control piston ($5b/k_1$) via the restrictor screw (5b/d) and to control piston ($5b/k_2$) via selector piston (5b/q).

The control oil pressure is dependent upon the output drive speed, and thus road speed, and upon the position of restrictor screw (5/d) for the setting of the change-over point.

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Automatic shift from DIWA drive into mechanical drive

With increasing road speed and thus an increase in output shaft speed, the oil pressure produced by the control pump (5a/b) builds up until it overcomes the spring tension on control piston (5a/k_1), thus allowing the oil from the operating pump to pass to the differential gear unit brake (5a/i) via pressure retarder valve (5a/y).

Automatic down-shift from mechanical into DIWA drive

With decreasing road speed, the speed of the control pump drops and the control oil pressure decreases. As soon as the tension of the spring in the control piston (5a/k_1) overcomes the control oil pressure, the piston returns to its initial position, thus cutting off the flow of oil to the differential gear unit brake which then releases.

By means of restrictor screw (5a/d), the control oil pressure is so adjusted that at engine full throttle the transmission shifts from the DIWA drive into the mechanical drive at approx. 50 % of maximum road speed.

Influencing the shift via engine throttle control

The engine throttle control in road vehicles is normally effected by an accelerator pedal, yet in rail vehicles by means of a handwheel or hand lever. For the sake of simplicity, only the term "gas pedal" will be employed in the following paragraphs.

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Automatic shift from first into second gear

With increasing road speed and thus an increase in output shaft speed, the oil pressure produced by the control pump (5b/b) builds up until it overcomes the spring tension on control piston (5b/k_1), thus allowing the oil from the operating pump to pass to the differential gear unit brake (5b/i) via pressure retarder valve (5b/y). The first shift is independent of accelerator pedal position.

Automatic shift from second into third gear

With further increasing road speed and thus a further build up in control oil pressure, control piston (5b/k_2) is moved against spring tension far enough to allow oil from the operating pump to flow to the primary lamellar clutch (5b/s). At the same time, the brake for forward range in the change-speed and reverse gearbox is released. The second shift is only dependent to a minor degree upon the position of the accelerator pedal.

Automatic down shift from third into second gear

A down-shift into second gear can only be effected at engine full throttle - accelerator pedal in pressure point position.

With decreasing road speed, the speed of the control pump drops and the control oil pressure decreases. As soon as the tension of the spring in control piston (5b/k_2) overcomes the control oil pressure, the piston returns to its initial position, thus cutting off the flow of oil to the primary lamellar clutch which then disengages. At the same time, the brake for the second gear is applied.

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The cam plate (5a/n1) for the automatic shift is connected to the fuel injection pump in such a way that a movement of the gas pedal brings about a corresponding change in the tension on the spring in control piston (5a/k_1), thus inducing the automatic shift.

If the vehicle is accelerated to e.g. approximately 30 % of maximum speed and then the gas pedal is relieved, the transmission shifts into the mechanical drive, which can also be retained when braking down from higher speeds to this figure. When the vehicle speed decreases further, the DIWA drive is induced again so that the engine can never be lugged down to below idling speed.

Constant changeover point

A different design of the above control system does not alter spring tension applied to the control piston for the automatic shift between "idling" and "full throttle" positions. This means that, irrespective of engine throttle setting, the automatic shift always takes place at around 50 % of top speed. The same result is achieved by locking the cam in "full throttle" position. In this case, a linkage between fuel pump and transmission is no longer necessary.

Kickdown position (figs 5 & 7): by means of a spring cartridge (7/f) in the linkage to the fuel pump, the gas pedal, and thus cam plate (5a/n_1), can be

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Automatic down-shift from second into first gear

With decreasing road speed, the tension of the spring in control piston (5b/k_1) overcomes the control oil pressure, and the piston returns to its initial position. The flow of oil to the differential gear unit brake is cut off and the brake released.

Automatic shift from third into first gear

Such a shift can only be effected at partial load or idling position of the gas pedal. In this case, control piston (5b/k_2) is pushed against spring tension by both the control pressure and the operating pressure applied to the hysteresis pin (with the shift 2-3, the operating oil flows into the control piston and pushes the hysteresis pin against the stop within the piston). For this reason, with decreasing road speed and thus decreasing control oil pressure, control piston (5b/k_1) is first pushed into its initial position by spring tension, thus cutting off the flow of operating oil to the differential gear unit brake and causing the latter to be released. If the vehicle speed continues to decrease so that also the spring tension in control piston (5b/k_2) overcomes the pressure of the operating oil on the hysteresis pin and the control oil pressure on piston (5b/k_2), the latter returns to its initial position and cuts off the supply of oil to the primary lamellar clutch, causing this to disengage. Simultaneously, the brake for second gear in the change-speed and reverse gearbox is applied again.

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moved beyond the "full throttle" position, whereby the plunger roller rides up the cam and the spring is placed under further tension. By means of this gas pedal position (kickdown), the DIWA drive with its higher tractive effort up to about 60 % of max. vehicle speed can either be retained or - providing that the speed is not higher than 65 % of max. vehicle speed - returned to after change-up.

During the transition from the "full throttle" position to "kickdown" position, a definite resistance on the gas pedal has to be overcome. For this reason, the position "full throttle" is often termed the "pressure point" position.

Automatic shift lock (where fitted):

(Fig. 5) The automatic shift from the DIWA drive into the mechanical range can be blocked by opening a drain port in the line between control pump and control block.

This is effected by releasing the air pressure applied to a pneumatic piston (pneumatic design 5a/u) or by opening a solenoid valve (hydraulic design 5b/u).

With the hydraulic design, the shift lock can only be pre-selected when the transmission is in the mechanical drive.

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Influencing the shifts via engine throttle control (gas pedal) - see fig. 8 c:

The first shift is independent of gas pedal position.

The second shift is to a slight degree dependent upon gas pedal position. For this purpose, the cam plate ($5b/n_2$) for the automatic shift is connected to the fuel injection pump via control lever (7/c) so that in the last third of the movement of the gas pedal a corresponding alteration of spring tension in control piston ($5b/k_2$), and thus of the second changeover point, is effected.

In idling or partial load position of the gas pedal, the second up-shift is effected at approx. 55 % of maximum speed and at approx. 60 % in the full throttle or pressure point position. The down-shift in the full throttle position of the gas pedal is effected at approx. 40 % of max. speed and at approx. 32 % in idling or partial load position.

Kickdown (figs. 5 & 7): by means of spring cartridge (7/f) in the linkage, the gas pedal, and thus the cam plates ($5b/n_1$ and $5b/n_2$) can be moved beyond the "full throttle" position. By means of this gas pedal position (kickdown), the DIWA drive with its higher tractive effort up to about 40 % of max. speed can either be retained or - providing the speed is not considerably higher - returned to after change-up. In the kick-down position, the transmission cannot shift into third gear.

During the transition from "full throttle" position to "kickdown" position, a definite resistance on the gas pedal has to be overcome. For this reason, the position "full throttle" is often termed the "pressure point" position.

Selection of speed range Figs. 4 & 5

Generally speaking, the speed ranges of the DIWA transmission are actuated by electro-magnets (4/h) mounted on the cover of the differential gear unit. With transmission version 502-2, it is also possible to have the speed range selection actuated mechanically or pneumatically.

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When button "V" is depressed (fig. 4a), the selector piston (5a/o) is in its lower end position while selector pistons (5a/p & 5a/q) are in their upper positions. In this state, the reverse gear brake is released.

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When button "V" is depressed (fig. 4a), selector piston (5b/o) is in its lower end position and selector piston (5b/p) in its upper position. In this state, the reverse gear brake is released.

Blocking the second speed shift via the selector position "V+B".

In position V+B, as selected by the driver, the automatic shift into third gear is blocked. At speeds below the top speed of second gear, the selector piston (5b/q), which in the normal position for forward range is held raised by a spring - allowing control oil to flow to control piston ($5b/k_2$) - is forced into its lower end position by the electro-magnet.

When depressing V+B in third gear at speeds above the top speed of second gear, the oil pressure switch (5b/l) in the control oil line for the blocking of the second speed shift interrupts the supply of current to the electro-magnet, so that in this speed range the transmission does not immediately change down into second gear. Only when the vehicle has been braked down to at least the top speed of second gear, does the electro-magnet become energized via the oil pressure switch.

If the V+B position is selected at low speeds, the supply of control oil to the control piston ($5b/k_2$) is interrupted immediately, while when selecting V+B in third gear this supply of oil is maintained until the vehicle has been braked to at least the top speed of second gear.

In reverse gear "R", both selector pistons (5/o & 5/p) are in their lower end positions, while control piston (5/q) is in its upper position. In this state, the brake for forward range is released. In the neutral position, all three selector pistons (5/o, 5/p & 5/q) are in their upper end positions in which the supply of operating oil to the brakes is blocked.

Braking

Braking with the engine: with the gas pedal released, the vehicle can be braked by the engine down to approximately 30 % of engine rated speed.

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Additionally, the vehicle can be retarded with the engine brake in mechanical drive.

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Additionally, the vehicle can be braked with the engine brake in third and second gear.

The electrically controlled engine or exhaust brake - if fitted - is automatically switched off via oil pressure switch (5/r) with a down-shift into the DIWA drive.

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Braking with the converter brake: A converter brake is installed in the DIWA-transmission which can be used as a continuous brake on downhill gradients as follows:

If in the DIWA drive the third selector piston (5a/q) is actuated in addition to the piston for forward range (5a/o), the operating oil forces two pins apart via tapered plunger (5a/s), thus arresting freewheel (3a/l). After shifting into the mechanical drive, the vehicle drives the turbine wheel via the output drive shaft. The hydrodynamic resistance produces a braking effect which increases sharply with vehicle speed.

Cooling

Heat generated when operating in DIWA drive or when braking with the converter brake must be dissipated.

For this reason, the torque converter is encased in a cooling jacket (converter cover closed off) through which cooling water circulates in the case of employment with water-cooled engines. Under exceptional operating conditions, the converter cover can also be employed as a cooling jacket.

Under extremely arduous operating conditions, oil is drawn from the torque converter via the converter pressure regulator and cooled in a heat exchanger mounted on the transmission through which the cooling water also circulates.

With air-cooled engines, the heated oil is taken from the torque converter via the converter pressure regulator, cooled in an oil cooler, and then returned to the sump.

2. Operating and driving

Starting the engine

Ensure that the transmission is in neutral and the handbrake applied before starting the engine. After lengthy stationary periods, allow the engine to run for 1-2 minutes in neutral to ensure full lubrication of the transmission. Engine speed should then be increased slowly. Do not exceed 1500 rpm when filling up the compressed air system.

Speed range selection and take-off

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The DIWA transmission has one forward range with two speeds:

	Power transmission:
1st gear	hydraulic-mechanical
2nd gear	mechanical

The following three button-positions may be selected:

V (Fig. 4a) Forward
Shift into mechanical drive fully automatic

R (Fig. 4a) Reverse
Hydraulic-mechanical drive only. Fully automatic shift into mechanical drive only possible with rail and special vehicles.

V+B (Fig.4a)Forward with converter brake

Only depress buttons V & R when the engine is idling and the vehicle stationary to avoid premature wear on the brakes in the change-speed and reverse gearbox.

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The DIWA transmission has one forward range with 3 speeds:

	Power transmission:
1st gear	hydraulic-mechanical
2nd gear	mechanical reduction
3rd gear	mechanical direct

The following three button-positions may be selected:

V (Fig. 4b) Forward
Shift into 2nd and 3rd gears fully automatic

V+B (Fig.4b)Forward
Shift into 2nd gear fully automatic.
Shift into 3rd gear blocked.

R (Fig. 4b) Reverse

Under normal traffic conditions, button-position V should be selected. In heavy traffic or on routes with steep up and down-gradients, it may be more expedient to engage V+B.

Only depress buttons V & R when the engine is idling and vehicle stationary to avoid premature wear on the brakes in the change-speed and reverse gearbox.

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The B-button may also be additionally engaged while on the move. It will only become effective, however, up to two thirds of maximum vehicle speed. Button B can be returned to its initial position by depressing it a second time.

Take-off is possible in both V and V+B positions.

Where the maximum tractive effort of the vehicle is desired, e.g. on an open stretch or on up-gradients, after releasing the handbrake, the gas pedal should be quickly depressed until the resistance of the pressure point position is felt (engine has full throttle). In all other cases, accelerate away as required.

Speed is governed purely by means of the gas pedal and footbrake.

Speed at the point of automatic shift

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Generally speaking, the road speed at the time of shift is lower, the less throttle is given to the engine (see also section 1. "Influencing the shift via engine throttle control").

Where vehicles with the DIWA transmission are in operation on predominantly level routes, the ability to retard the vehicle down to low speeds with the exhaust brake is not of great importance.

For this reason, the transmissions of these vehicles are often provided with a constant shift mechanism which causes the transmission to shift both up and down at around 50 % of top speed irrespective of gas pedal position.

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The speed at the point of automatic shift into second gear is always the same (constant shift point) and independent of gas pedal position.

The speed at the point of automatic shift into third gear is to a slight degree dependent upon engine throttle (see section 1. "Influencing the shift via engine throttle control").

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Since with shunting locomotives equipped with the DIWA transmission the engine throttle has only very little effect upon the automatic shift due to the low top speeds, most transmissions for such applications are provided with a constant shift mechanism which causes up and down-shifts to take place at 55-60 % of top speed irrespective of handwheel position.

Kickdown position

If, on an incline, the tractive effort of the mechanical drive is too low, yet that of the DIWA drive too great, the transmission may commence to "hunt", i.e. repeated changing up and changing down.

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This can be avoided by fully depressing the gas pedal - into kickdown position - thus retaining or re-inducing the DIWA drive. In this position, up to approximately 60 % of top speed, the tractive effort is higher than in gas pedal full throttle position. If the transmission does not automatically change back into the mechanical drive with increasing road speed, the pressure on the gas pedal should be briefly released.

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This can be avoided by fully depressing the gas pedal into the kickdown position. While the first gear will then be retained somewhat longer at low speeds, the third gear is blocked in the top speed range of second gear. If the transmission does not automatically shift into the next highest gear with increasing road speed, pressure on the gas pedal should be briefly released.

Note:

No improvement in acceleration is gained in relation to the full throttle position when undertaking a take-off with the gas pedal in the kickdown position.

Driving on downhill gradients

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While in mechanical drive, the vehicle can be braked down to approx. 30 % (approx. 50 % with constant shift) of the maximum road speed by means of the engine, exhaust brake, or converter brake where fitted. The transmission then shifts down into the DIWA drive. Simultaneously, the exhaust brake is automatically switched off via the oil pressure switch on the transmission or via a governor on the engine.

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In third and second gear, the vehicle can be braked down to low road speeds by means of the engine and exhaust brake. Even when applying the vehicle brakes, the engine can never be stalled.

If the braking effect of third gear is inadequate, engage V+B, and brake the vehicle down to at least two thirds of its top speed to allow the transmission to change down into second gear.

Braking with the converter brake (where fitted)

The converter brake is a hydraulic brake employed for sustained braking on long downhill gradients.

The converter brake can most simply be switched on with the vehicle stationary or at low speeds - depress the B-button and briefly press the gas pedal into kick-down position.

If the transmission is already in mechanical drive, depress the B-button, brake the vehicle down to at least half the maximum road speed and induce the DIWA drive by briefly pressing the gas pedal into the kickdown position; the DIWA drive can be recognised by the sudden sharp increase in engine speed. Simultaneously, the pilot light for the converter brake must come on.

With the converter brake switched on exceptionally long downhill gradients, the transmission may overheat excessively. Should the transmission oil temperature warning light come on, the converter brake should be switched off.

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Providing the transmission remains in the DIWA drive, stopping and starting may be undertaken with the converter brake switched on. Driving in mechanical drive with this brake switched on - except with the gas pedal in engine idling position - causes inadmissible heating of the oil.

Switching off the converter brake:

Switch off the B-button; brake the vehicle down to at least 50 % of its top speed and induce the DIWA drive by briefly pressing the gas pedal into the kickdown position. The converter brake is switched off as soon as the pilot light goes off.

Monitoring of oil temperature

Normal operating temperature: 80-90° C. 100° C should not be exceeded. When the oil temperature rises above 110° C an oil temperature thermostat switches on a warning light. If the warning light comes on during operation or if the temperature gauge shows an excessive reading, place the transmission in neutral and allow the engine to run until normal working temperature is restored.

Stopping and parking

When stopping for short periods of time, it is not necessary to place the transmission in neutral; the vehicle can be held by the brake. For longer periods of time or when parking, the transmission must be placed in neutral.

N.B.: When the vehicle is parked on a slope, the wheels should be chocked.

Towing

The transmission should be placed in neutral for towing over short distances, whereby a speed of 30 km/h should not be exceeded. Where the vehicle has to be towed over a longish distance or in the event of the transmission being damaged, the connection between transmission and final drive should be interrupted by removal of rear axle half shafts or uncoupling of the cardan shaft.

Tow starting

Tow starting of the engine is not possible. Any attempt to do so may cause damage to the transmission.

3. Servicing and maintenance

Servicing schedule

Special attention should be paid to prompt and accurate maintenance checks since such form an unqualified condition of our liability in respect of guarantee claims, and are also a prerequisite for the perfect serviceability of the transmission.

The following tasks are to be punctually carried out in the sequence given or at even earlier intervals in accordance with the vehicle servicing schedule.

Servicing a new transmission:

After 500 km or 20 hours
1st oil change

After 5,000 km or 200 hours
2nd oil change

Periodic checks

Every week Oil level check

After every 10,000 km or 400 hours
Clean oil filter

After every 20,000 km or 800 hours additionally
Change oil
Check the pressure point
the kickdown position
the shift point (502-2) or
the shift points (502-3)

After every 40,000 km or 1,600 hours additionally
Remove oil sump
Clean suction filter

After every 100,000 km or 4,000 hours additionally
Check the clutch friction plate and rubber elements in the flexible slip clutch

After every 200,000 km or 8,000 hours
Transmission inspection

Transmission oil

Oil filling: the oil in the DIWA transmission transmits power in the torque converter, lubricates all bearings and meshing gears and controls and actuates the brakes of the differential gear unit and change-speed and reverse gearbox.

DIWA 502 transmissions are to be filled with automatic transmission fluids (ATF) or Dexrons which have been tested and approved by Voith for employment in 502 transmissions.

Oil level: it should be noted that transmissions whose longitudinal axis tilts more than 5° toward the output end when installed must have a shorter dip-stick. The length of the normal dip-stick, measured to the cork seal in the cap, is approx. 268 mm. The corresponding length for the shortened dip-stick is approx. 253 mm.

Approximately 13 litres of oil are required for a new filling, i.e. with empty torque converter and filter housing. Check the oil level at engine idling speed, with button "V" depressed, and at an oil temperature of at least 60° C; the level should lie between the two marks on dip-stick (10). The oil level should under no circumstances be allowed to sink below the lower mark.

Oil change: (fig. 6) Oil is best changed immediately on completion of a run. To do this, unscrew oil drain plugs for sump (6/c), change-speed and reverse gear-box (6/y), and converter (6/b) and drain off the oil; the oil sump is not removed for an oil change.

Oil filter: (fig. 6) To clean the oil filter (6/r), remove filter element, dismantle, and carefully clean all parts, particularly the strainer (wash in petrol or kerosene and blow through with compressed air); undo filter drain screw (6/s) and remove any sludge from the filter housing.

Checking of full throttle and kickdown positions Fig. 6 and 7

With transmissions whose automatic shift can be influenced by the engine throttle and with transmissions which have a kickdown position, gas pedal, transmission, and fuel injection pump are connected via a linkage; transmissions with a constant changeover point have no linkage between gas pedal and transmission.

Full throttle position: For purposes of checking, place the gas pedal into the full throttle position (not kickdown). In this position, the fuel injection pump lever should be against its stop. Lengthen or shorten the linkage as necessary.

Undo the connection between the fuel pump and transmission, place the fuel injection pump lever against its stop, and turn the transmission control lever until the pointer (6/h) on the transmission is aligned with its mark. In this position again, the linkage joints should mate up perfectly. Where this is not the case, adjust the linkage accordingly.

N.B. The pressure point position should be clearly noticeable to the driver, since continuous driving in the kickdown position leads to heavy fuel consumption due to the high engine speed; where necessary, strengthen the spring in stop (7/g).

Kickdown position:

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It must be possible to depress the gas pedal beyond the full throttle position far enough for the cam plate in the transmission to safely reach the "kick-down position" (control lever must turn through approx. 20° from the full throttle to kickdown position. This corresponds to a control lever travel of approx. 22 mm at a lever length of 60 mm).

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It must be possible to depress the gas pedal beyond the full throttle position far enough for the cam plates in the transmission to safely reach the "kick-down position" (control lever must turn through approx. 20° from the full throttle to kickdown position. This corresponds to a control lever travel of approx. 22 mm at a lever length of 60 mm).

For checking purposes, disconnect the linkage from the transmission control lever which is then brought up to its stop in the transmission and released somewhat. With the gas pedal fully depressed (kickdown position), the connections on control lever and linkage should mate up exactly; where this is not the case, the gas pedal stop must be adjusted.

Checking and adjustment of the point(s) of automatic shift Figs. 5 & 6

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If the point of automatic shift (change-over point) is correctly set, with the oil at normal operating temperature and the gas pedal in the full throttle position, i.e. with the engine at full throttle and increasing road speed, the transmission will automatically shift from the DIWA into mechanical drive at 50 % of max. road speed.

In the case of very heavy vehicles, it is recommended that the changeover point be set at 50-55 % of top speed for reasons of improved acceleration.

In the case of locomotives and railcars, the changeover point is normally set at 50-55 % of maximum speed.

502-3

If the changeover points are correctly adjusted, with the oil at normal operating temperature and the gas pedal in the full throttle position, i.e. with engine at full throttle and increasing road speed, the transmission will automatically change from 1st into 2nd gear at 30-35 % of top speed and from 2nd into 3rd at approx. 65 % of maximum speed.

After removal of screw plug (6/i), the changeover points can be adjusted on restrictor screw (5/d). If the restrictor screw is screwed further in, the gear shift takes place at a lower speed. It should be noted that 1/8th of a turn on the screw corresponds to an alteration of changeover point by 10-15 %.

502-2
After removal of screw plug (6/i), the changeover point can be adjusted on restrictor screw (5/d). If the restrictor screw is screwed further in, the gear shift takes place at a lower speed. It should be noted that 1/8th of a turn on the screw corresponds to an alteration of changeover point by 10-15 %.

502-3
The points of automatic shift in relation to each other are accurately set by Voith and do not normally need correction. At all events, it is only possible to adjust the first changeover point. For this, the cover of the differential gear unit housing should be removed, the spring cartridge of the output drive control piston held by means of a locking screw, and the adjusting screw turned (fig. 9). After screwing in the adjusting screw and loosening the locking screw, the transmission changes at a lower speed and vice versa.

Functional checking of the slip clutch

With the vehicle fully braked and forward gear engaged, apply full engine throttle (gas pedal to pressure point position). The engine should then reach 60-65 % of nominal rating and no more. If this is not the case, engage reverse gear and repeat the check. If the engine speed rises inadmissibly again, then the slip clutch should be removed, inspected, and repaired as necessary. If the engine speed remains constant in the correct range during the second check, this means that the brake of the previousiy engaged range is slipping. In such a case, check the oil pressure and, if this is found to be correct, the condition of the lamellars.

502-3
Setting of the oil pressure switch (5b/l) for the blocking of the 2nd gear shift: unscrew the adjusting screw, accelerate the vehicle up to 65-67 % of top speed (3rd gear) and remain in this gear. Press the B-button and slowly screw in the adjusting screw until the change-down takes place (oil pressure switch releases current to solenoid ($4b/h_2$). Test: Release B-button and accelerate vehicle up to stop speed of 2nd gear in 3rd gear. Depress the B-button, reduce speed, and wait for the change-down. If the setting is in order, tighten the adjusting screw with the knurled nut and secure both with lacquer. Repeat the test.

Faults

The following section describes the effects of transmission faults upon vehicle operation in order to facilitate location and remedy of same.

Fault 1

Engine speed too high or rises in forward and reverse ranges with vehicle fully braked and engine at full throttle.

Tractive effort diminishes while on the move.

Poor braking effect on downhill gradients.

Maximum speed unattainable or attainable only with difficulty.

Smell and smoke due to burning of friction linings.

Cause 1	Remedy 1
Lamellar brakes of the change-speed and reverse gearbox slipping due to inadequate working oil pressure (checking of working oil pressure at test point ($6/x_4$); approx. 5 bar at stall point necessary).	
Working oil pressure too low due to:	
Oil level too low	Replenish with oil
Suction basket clogged with dirt	Drain oil, remove sump, and clean suction basket.
Working pressure regulator incorrectly set	Re-adjust pressure on the adjusting screw of the working pressure regulator
Cause 2	**Remedy 2**
Clutch plate slipping inadmissibly	Remove transmission from vehicle. Examine the clutch unit (friction surfaces of flywheel and pressure plate must be smooth) and repair as necessary. Friction plate must not be thinner than 9 mm; if this is so the clutch plate must be replaced. If the slip clutch has been subjected to overheating, renew the compression springs.

Fault 2

Engine speed too high or rises in either forward or reverse range only with vehicle fully braked and engine at full throttle.

Overheating in the change-speed and reverse gearbox.

Otherwise similar symptoms as under fault 1. above.

Cause 1	Remedy 1
Lamellar brake of the respective range slipping due to:	
Deficient selection (inaccurate engagement of selector valve) or, with electrical gear selection, faulty solenoid	Check linkage, pneumatic selector valve, or solenoid
Incorrect selection (selection at high engine speed)	Correct selection
Surface of brake piston worn	Renew brake piston
Lamellar brake lining worn	Renew lamellar

Fault 3

Engine speed too high in relation to road speed while in mechanical drive.

Engine is inclined to race when accelerating.

During the automatic shift, the engine speed decreases reluctantly or unevenly.

Control "hunts" and changes into the DIWA drive at low load.

Cause 1	Remedy 1
Differential gear unit brake slipping due to inadequate working oil pressure	See remedy 1 for fault 1

Fault 4

At full throttle position, the automatic shift is consistently too high or too low.

Cause 1	Remedy 1
Control pressure has altered due to change of oil brand or change in operating temperature	Re-set changeover point with the aid of the restrictor screw

Cause 2
Control linkage or cam plate out of adjustment

Remedy 2
Re-adjust control linkage or cam plate correctly

Fault 5
Changeover point(s) constantly vary

Cause 1
Control linkage worn (loose) or spring in spring cartridge too weak or broken

Remedy 1
Renew worn linkage parts or spring. Re-adjust changeover point(s) and linkage.

Cause 2
Disturbance in the control oil supply due to loose or blocked suction and supply lines or clogged suction basket (Check control oil pressure at test point $6/x_2$); 0,7 - 0,8 bar required for 1st shift and 1,9 ± 0,1 bar for 2nd shift (502-3)

Remedy 2
Drain off oil from sump, remove sump, check pipelines for tightness, clean suction basket, or blow through suction line as necessary

Cause 3
Disturbance in control oil supply due to damage to control pump

Remedy 3
Renew damaged parts (for this, transmission must be removed from the vehicle and partially dismantled)

Cause 4
Oil level too law

Remedy 4
Top up with oil

Fault 6
Transmission does not change into mechanical drive or infrequently, i.e. operation only possible in DIWA drive.

Transmission does not change back into DIWA drive or infrequently, i.e. operation only possible in mechanical drive; this becomes evident, for example, if the engine keeps stalling

a) on engangement of a speed range (V or R-button)
b) when braking the vehicle

Cause 1
Disturbance in the control oil supply (operation only possible in DIWA drive). See fault 5, causes 2 and 3

Remedy 1
See fault 5, remedy 2 and 3

Cause 2
Control piston in the control block sticking

Remedy 2
Dismantle control block and smooth surfaces of piston and bore

Cause 3	Remedy 3
Freewheel in transmission damaged	Replace freewheel

Fault 7
Pressure point (full throttle position) not easily felt on the gas pedal.

Cause 1	Remedy 1
Spring in spring cartridge stop (7/g) of the gas pedal too weak or dirty	Retension spring, clean, or replace as necessary
Cause 2	Remedy 2
Linkage from gas pedal to fuel pump and transmission jammed, worn, loose, or out of adjustment	Check linkage for ease of operation, repair as necessary and re-adjust

Fault 8
Engine speed too low with vehicle fully braked, speed range engaged, and engine at full throttle (pressure point position), i.e. below 55 % of its rating.

Poor acceleration and tractive effort.

Cause 1	Remedy 1
Engine does not develop its full power due to control linkage being out of adjustment; fuel injection pump thus not reaching full throttle setting in the gas pedal pressure point position	Check and re-adjust control linkage and pressure point setting on gas pedal. Re-set changeover point(s).
Cause 2	Remedy 2
Engine does not develop its full power due to some defect in the engine (e.g. fuel injection pump out of adjustment)	Check engine
Cause 3	Remedy 3
Freewheel in transmission damaged, thus lugging down engine speed to around 800 rpm	Replace freewheel

5. Repairs

Where defects cannot be rectified by suitably trained personnel, please get in touch with the After-Sales-Service of Voith Getriebe KG, Heidenheim or their authorized agents.

During the period of guarantee, unless the express approval of Voith has been given, work on the transmission may only be undertaken by Voith service engineers or with their approval. The risk of guarantee invalidation may otherwise be incurred.

In all inquiries, the transmission serial number must be stated. This is marked on the nameplate on the change-speed and reverse gearbox housing.

Please direct orders for spare parts or technician services to the following address:

Voith Getriebe KG - DIWA-Kundendienst
7920 Heidenheim (Brenz) - Postfach 1920 - Alexanderstraße 2

Telegraphic address:	Voithtrieb heidenheimbrenz	
Telex:	7-14 888	
Telephone:	Technician services	07321-329-224
	spare parts orders	07321-329-262

Please quote the following reference in all correspondence: "Re: DIWA transmission 502-2 or 502-3".

Orders for small quantities of Spare parts or technician service requirements may also be directed to the following branches:

Voith Engineering Ltd.
Ambassador House
Brigstock Road

Thornton Heath CR4 7JG
Surrey

Telex:	94 61 29
Telephone:	01-689-0741

Landré-Voith Australia, Pty. Ltd.

98 Cambridge Street
P.O. Box 197

Leederville
West-Australia 6007

Telegraphic address:	Landvo, Perth
Telephone:	81 69 00 / 81 6011 S.T.D Code No. 092
Telex:	93 107

Surtees & Son (Pty.) Ltd.

P.O. Box 25 663

Denver/Transvaal
South Africa

Telegraphic address: Tubeplate
Telephone: 24 93 81/2/3/4

Technical information

To complete or supplement information on our DIWA transmissions, the following additional technical information is available to customers on request:

Spare parts list,

Driving instruction card for the driver, in which the most essential points concerning the operation of the transmission are enumerated in summary form,

Windscreen transfer in which attention is drawn to the most important points regarding tow-starting and towing.

Installation instructions for vehicle manufacturers, in which all important points concerning the installation of the transmission are contained,

Coloured sectional diagram showing the mechanical design of the DIWA transmission.

The assistance of the VOITH DIWA after-sales service is available at all times to deal with any questions or problems.