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HYDRODYNAMIC RETARDER FOR COMMERCIAL VEHICLES

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Abstract: *Retardant devices are braking systems of electromagnetic or hydrodynamic type acting either the transmission or the engine without friction elements in contact, the braking being performed through electromagnetic induction or using a hydraulic fluid which opposes the rotation of an impeller. Devices retarder can act on the transmission by means of induction currents generated by means of electromagnets supplied electric currents oppose the rotation of disks mounted on the drive and rotate around these electromagnets, in this case the retarder is electric drive or with a hydraulic fluid which is moving in a torque converter, fluid on which that action is taken by increasing the pressure it in turn to oppose the rotation of the drive generating the braking gear and thus the vehicle in this case is the retarder hydraulic.*

Key words: *electromagnetic and hydrodynamic braking systems, transmission, hydraulic fluid, retarder, torque converter, pressure.*

1. INTRODUCTION

The retardant devices having hydraulic action may be of Retarder type, being mounted on the output shaft of the gearbox and acting on the axle shaft of the vehicle via the gear ratio of 1: 2, type Intarder, having the same function as the Retarder, except that the hydraulic fluid necessary for braking is the oil used to lubricate the gearbox; Aquatarder being mounted out of the gearbox, using as working fluid the engine coolant; or Pritarder, being mounted at the front of the engine, the crank-shaft using the coolant for engine braking. The Retarder, Intarder and Aquatarder devices have the advantage of keeping unchanged the braking torque during the shift [1].

2. RETARDER DEVICE

The retarder (Fig. 1) consists mainly in an impeller (1) and a stator (2) acting one against the other. The rotor is similar to a pump impeller and is connected through a gear reducer to the output shaft of the gearbox. The stator can be compared to a turbine wheel fixed permanently in the device housing. The oil (3) is set in motion that pushes it against the rotor to stator. If the stator cannot rotate, the flow of the oil is delayed, which results in the braking of the rotor and, therefore, of the entire vehicle. The value of the braking torque for any speed depends on the amount of oil accumulated between the rotor and stator. The working pressure defined by the throttle forces the oil to enter the chamber between the rotor and stator through the main oil circuit. The higher working pressure is, the greater volume of oil is pumped in the circuit. When the device is operated, the oil goes back into the tank through the main oil circuit. A small amount of oil is pumped continuously into the secondary oil to lubricate the bearing of the rotor shaft. When the device is actuated, the braking energy is converted into heat. The thermal energy stored by the oil is then transferred to the engine coolant heat exchanger. The coolant is then withdrawn from exchanger by the engine cooling system [3].

2.1 Retarder off (without braking torque)

In this case (Fig. 2) the throttle is off, there is not pressure in the oil tank, the rotor and stator are completely drained and the ventilation valve is open. The economical regime of the oil cooling circuit is active for lubricating the retarder [3].

2.2 Retarder activated (with braking torque applied)

In this case (Fig. 3) the control valve is activated, the oil tank is under pressure, the rotor and the stator are completely filled with oil, and the ventilation valve is closed. The cooling oil is in the retarder, the main circuit and economical regime circuit being also active [3].

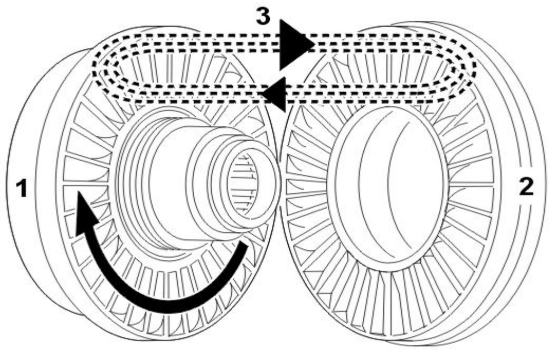

Fig. 1. The operation principle of the retarder [4]: 1-Rotor; 2-Stator; 3- Oil circuit.

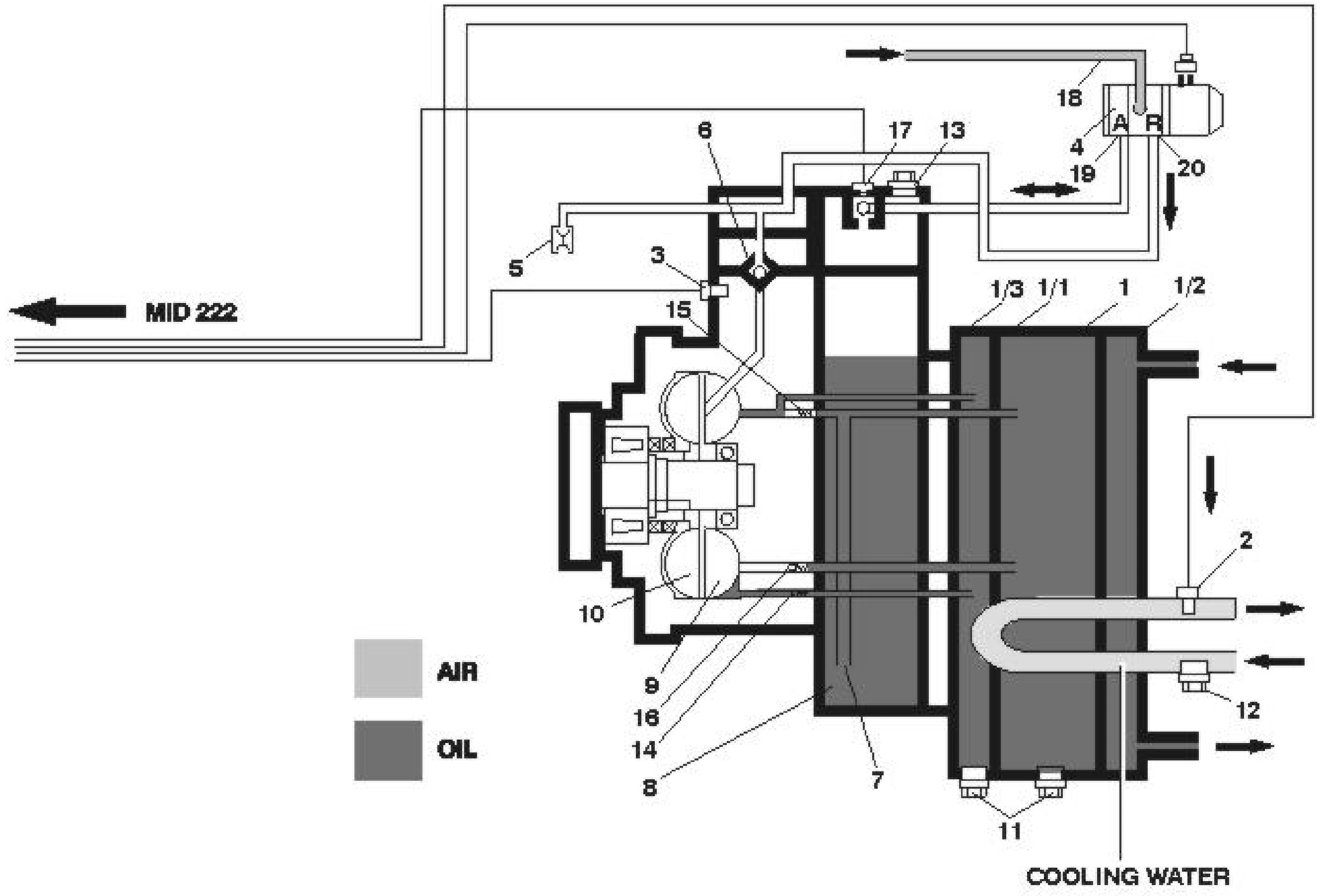

Fig. 2. Retarder off [4]

1. Temperature sensor temperature; 1/1. Oil cooling circuit retarder (main circuit); 1/2. Circuit gearbox oil cooler; 1/3. Cooling circuit of retarder (economy mode); 2. Temperature Sensor, coolant; 3. Temperature sensor, oil; 4. Control valve; 5. Sintering filter, ventilation / silencer; 6. Ventilation valve; 7. Oil inlet pipe to the stator / rotor; 8. Oil sump; 9. Stator; 10. Rotor; 11. The drain plug hole, economic system and main circuit; 12. The drain plug hole, cooling liquid; 13. Plug oil supply; 14. Overflow valve; 15. The one-way valve (intake); 16. The one-way valve (exhaust); 17. Pressure sensor; 18. Pressure air intake; 19. A-working pressure; 20. Canal ventilation-R.

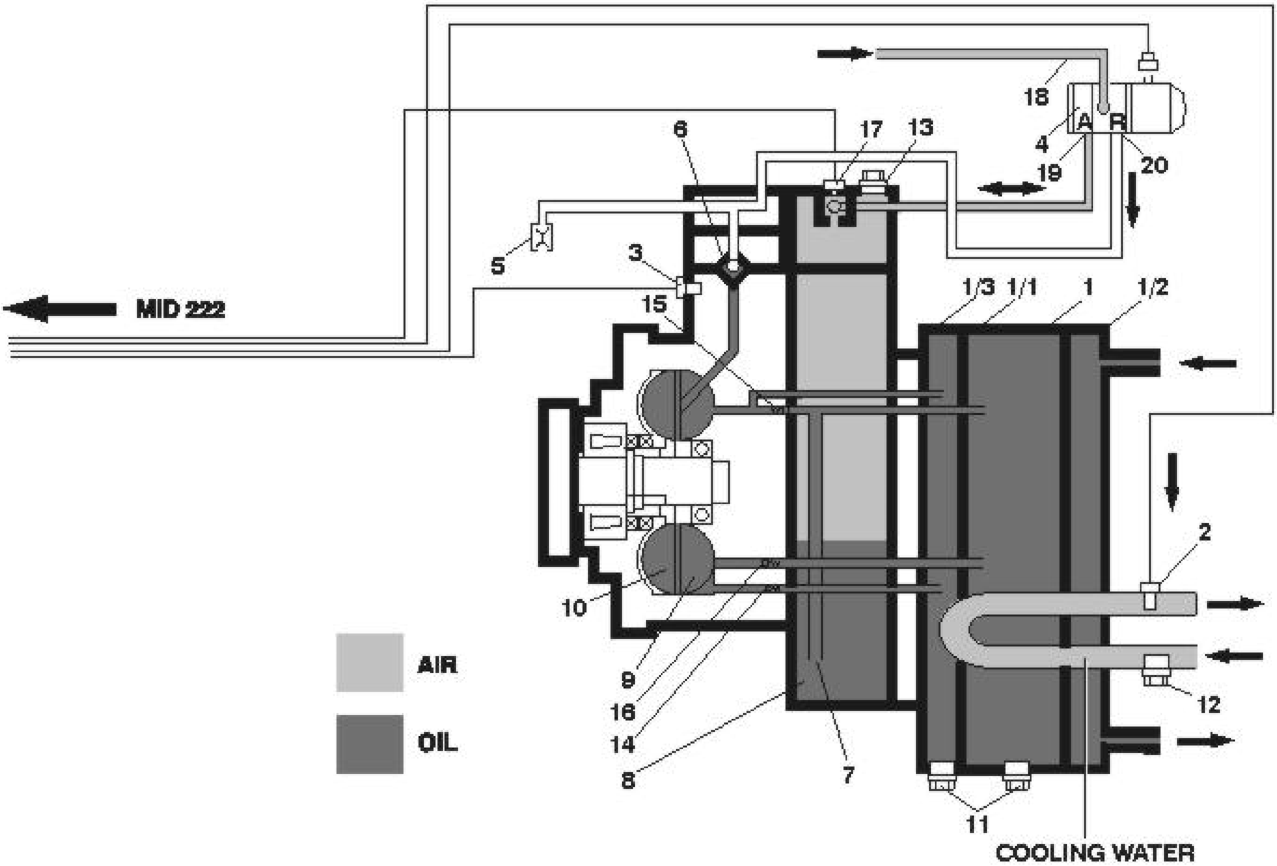

Fig. 3. Retarder activated [4] (The notations are the same as in Fig. 2)

2.3 Temperature regulation

If the retarder is operated for long periods of time, and this leads to very high temperature increase in the retarder, the control unit successively reduces the operating level to restore the normal working temperature. In order to minimize the time of the temperature control, it should be kept revving the engine when braking using the retarder. The retarder temperature is detected by two temperature sensors, one for coolant temperature and another for oil temperature. A yellow warning lamp lights up on the dashboard if [3]:

- Retarder oil temperature is over 195 °C;
- Retarder coolant temperature is over 120 °C.

2.4 Commands

Retarder control lever. The auxiliary brake is activated with the engine brake control lever from the steering column (Fig. 4).

The positions of the retarder control lever are as follows [4]:

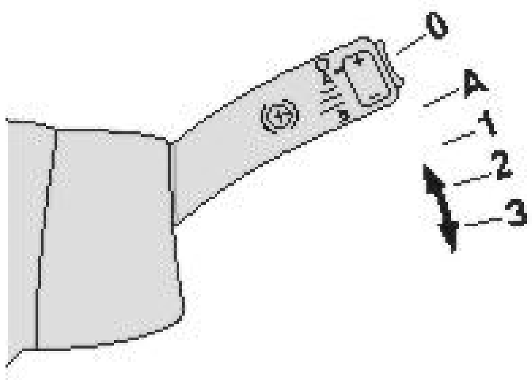

Fig. 4. Retarder control lever located on the steering column [3]

- *Position 0:* auxiliary brake function is disabled;
- *Automatic position:* ensures braking using the cruise control only through the auxiliary brakes (brake cruise), and if activated the cruise control of the motor (brake cruise control), and through the coordination system

braking (coordination brake). The coordination braking system provides the concurrent operation of auxiliary brake and the service brake when the driver presses the brake pedal;

- *Manual position 1-3:* the auxiliary brake will be applied for each increasing stage to which the lever moves. It offers fixed levels of the auxiliary brake between 20-60% for unloaded and loaded trucks, and between 40-100% for trucks completely loaded, depending on the type of suspension system. These are standard production settings. The values for the various positions can be changed using the tester. There are also manual levers with only one position. Manual position means that the auxiliary brake is engaged. The accelerator pedal must be released and the cruise control must be disconnected in order to the auxiliary brake take effect.

The activation of the cruise control to retarder is displayed on the dashboard next to the driver. The retarder always deactivates the accelerator pedal.

Brake pedal. For coordination of the brake system, the lever position A has to be selected. The brake pedal produces an increase of the application level. This applies only if the vehicle has EBS. If the vehicle has ABS, a fixed value is added to the service brake, which is a simplified coordination of the brake (or coordination plus).

Cruise control motor position A. When activating the cruise control engine (C), the lever (D) auxiliary brake is in position A, the auxiliary brake is used to brake if the vehicle speed is higher by 7 km/h faster than the set. The value of 7 km/h is factory preset but it can be changed between 3 and 15 km/h by pressing the + or - switch (E). After making the selection, the value is indicated on the display for 5 seconds. The selected value is stored until it disengages contact or change the setting (Fig. 5).

If the speed drops to 4 km/h over the speed setting, the auxiliary brakes are off. The trucks can be braked by hand lever (D) in positions 1-3 and can return to the set speed braking if coupled again from position A lever. The display shows both CC and symbol with a + enclosed in a circle. The cruise control deactivates the accelerator pedal or shift lever position 0.

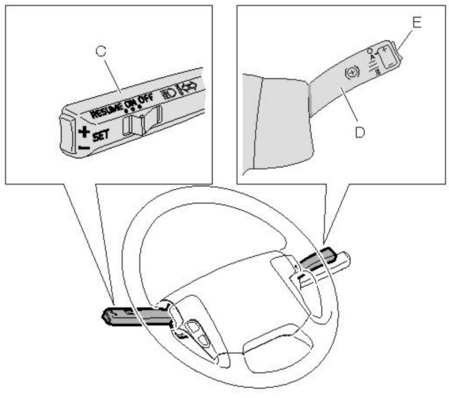

Fig. 5. Cruise control [3]

Pure cruise control with brake can always be done when the cruise control is disengaged CC engine and the lever is in position A. The display shows the symbol with a + framed in a circle. By pressing the switch (E), the current speed is stored in the control unit as cruise retarder for braking. The speed is set, and the accelerator pedal can be released. When braking, the set speed can be finely adjusted by pressing the + or - . When the driver shifts gears or if the brake pedal is pressed to activate the coordination of the brake systems, the cruise brake function is maintained. The truck can be braked by hand lever (D) in positions 1-3 and can return to the set speed braking if coupled again from position A lever. If the throttle (idle switch) is used for turning retarder, when the lever is in one of the fixed positions, function application is engaged harder. This causes a very high pressure variation in the retarder, can cause jolts when adjusting the speed and throwing a larger quantity of oil to the vent valves, which can be perceived as a loss of oil. This can be avoided by using brake cruise, which ensures a smooth application of the coupling function.

3. INTARDER

The Intarder device is a hydrodynamic transmission brake working without friction, which becomes valuable when the driver brakes the vehicle at high speed while rolling downhill a greater distance. The service brake is protected through the intervention of the Intarder and the emergency braking effect is available throughout the service brake. While the retarder brakes the vehicle, the driver may shift the motion speed at any time. The Intarder also ensures constant and economic functionalities of the vehicle.

The Intarder is mounted on the transmission working area (Fig. 6). Its main components are [2]: housing, stator, rotor, actuator housing, electronic control unit, and heat exchanger oil tank.

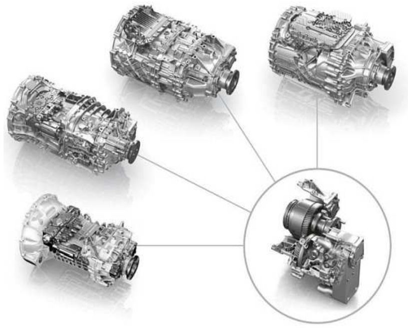

Fig. 6. Association of the Intarder with different types of gearboxes [5]

The braking action is obtained by means of the oil that is in the Intarder. Depending on the commands sent by the driving computer of the vehicle, the Intarder fills with oil as needed to achieve the desired brake torque. The time to connect the Intarder up to the desired brake torque is approximately 0.75s, while the duration for disconnecting it to reduce the braking torque (e.g. when setting the ABS) is approximately 0.3s. The pump of the Intarder has the task of transporting oil from the gearbox tank through a filter to the Intarder circuit.

When the Intarder is switched on, the magnetic valve of the reservoir opens, the volume of the tank is emptied in the Intarder space and thereby the operation time is shortened. The proportional valve is controlled by the electronic control unit to fill the Intarder with the required amount of oil.

A high-speed rotor is operated through a transmission gear shaft of the gearbox. The oil accelerated by the rotor blade is braked by the turbine blade of the fixed part (stator), so that an extra braking energy is converted into heat. The braking torque is conserved when the gear is engaged.

The heat is transferred to the heat exchanger of the oil/water cooling circuit. A temperature sensor measures the temperature of the cooling water and sends it to the electronic control unit. If a fault or over-heat of the Intarder is detected, the vehicle must be stopped by the service brake. The advantages of the Intarder are as follows:

- short activation time;
- common service with gearbox oil;
- low weight;
- low working temperature;
- Bremsomat operation (constant speed when driving downhill);
- opportunity to build on all secondary drives, which can be combined with the gearbox.

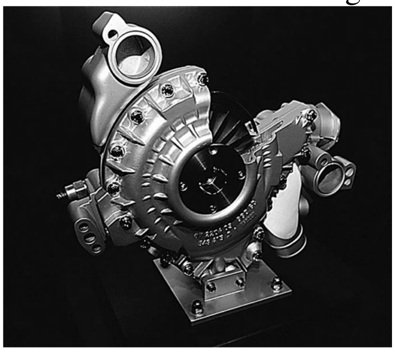

Fig. 7. Aquatarder device [5]

4. AQUATARDER (WATER RETARDER)

The Aquatarder (Fig. 7) is an alternative equipment that can serve as brake retarder type. This device is mounted in front of the engine crankshaft, having incorporated the water pump.

The Aquatarder operates as the primary retarder, it is mounted on the front of the engine and directly connected to the crankshaft. Like all retarders, it works on the principle of hydrodynamics. The engine crankshaft drives the rotor. The rotor accelerates the operating medium, in this case the cooling water. A stator, which is located opposite to the rotor slows down the medium again. This braking moment is transferred via the rotor and the crankshaft to the vehicle driveline. As a result, the vehicle is decelerated [3].

This braking system is distinguished by the following advantages [5]:

- efficiency at low speed;
- high power brake developed at low speed;
- lack of maintenance (the working environment is the water cooling liquid);
- integration with the vehicle management;
- electronic diagnostic possibilities;
- quick stabilization of the working temperature of the engine;
- low emissions of exhaust gases.

The Aquatarder can be mounted on the transmission using the engine coolant as fluid.

5. PRITARDER

The Pritarder device (Fig. 8) is a water retarder with the same functions as the primary Aquatarder, being mounted on the engine crankshaft, with the particularity that the water pump engine is no longer incorporated in the device [2].

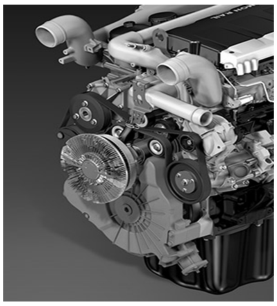

Fig. 8. Pritarder device [5]

The advantages of this device are similar to the Aquatarder, greatly reducing the wear of the brake system, especially the wear of the pad and brake discs. The engine coolant used for braking is cooled in the engine cooling radiator, thus eliminating the accumulated heat during braking. If the temperature of the coolant is exceeded, the braking is reduced by half in the first instance or even completely, in extreme cases.

6. CONCLUSIONS

Retarders are complex mechanisms for braking system, working in harmony with the other braking devices, the engine and the automatic transmission, generating strong, continuous and long-term braking forces.

Due to the fact that there are no parts subjected to friction, the wear of these devices is minimized. The major disadvantage of these devices is the heat taken from the working fluid molecules which rubs during the braking process. This heat is removed by heat exchangers of liquid-liquid or liquid-air type. In the first case, the heat is transferred to the engine coolant and then to the atmosphere, while in the second case the heat is transferred directly to the engine coolant and then directly to the atmosphere.

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DISPOZITIVE DE ÎNCETINIRE HIDRODINAMICE PENTRU AUTOVEHICULE COMERCIALE

Dispozitivele de încetinire sunt mecanisme de frânare cu acţionare electromagnetică sau hidrodinamică,operând fie asupra transmisiei, fie asupra motorului, neavând elemente de frecare în contact, frânarea făcându-se prin inducţie electromagnetică sau cu ajutorul unui fluid hidraulic, care se opune mişcării de rotaţie a unui rotor cu palete. Dispozitivele de încetinire pot acţiona asupra transmisiei prin intermediul unor curenţi de inducţie generaţi cu ajutorul unor electromagneţi alimentaţi electric, curenţi care se opun mişcării de rotaţie a unor discuri montate pe transmisie şi care se rotesc în preajma acestor electromagneţi, în acest caz dispozitivul de încetinire este cu aaţionare electrică, sau având un fluid hidraulic care se află în mişcare într-un convertizor de cuplu, fluid asupra căruia dacă se acţionează prin creşterea presiunii acesta la rândul său se opune mişcării de rotaţie a convertizorului generând frânarea transmisiei şi implicit a autovehiculului, în acest caz dispozitivul de încetinire este cu acţionare hidraulică.

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