IVAN SMERDU M.Sc.
Intereuropa Koper

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IMPACT OF BRAKE SYSTEMS ON SPEED OF FREIGHT VEHICLES

SAŽETAK

UTJECAJ SUSTAVA ZA KOČENJE NA BRZINU TERETNIH VOZILA

Rad se bavi prednostima dodatnih sustava za kočenje i posebice mogućnostima povećanja brzine vožnje bez utjecaja na sigurnost i bez dodatnog napajanja energijom. Ti su sustavi ekološki povoljni, budući da ne onečišćuju okoliš štetnim emisijama. Opisani se sustavi danas uvelike koriste i posjeduju dobre mogućnosti za dalji razvitak.

Dodatni sustavi za kočenje temeljito su promijenili način vožnje, jer je i psiho-fizičko stanje vozača koji upravlja vozilom opremljenim tovrsnim sustavom na visokoj razini. Prednosti koje donose dodatni sustavi za kočenje mnogostruko premašuju nabavnu cijenu; preporuča se opremanje svih motornih teretnih vozila ovim sustavima.

INTRODUCTION

The basic objective of each carrier is to deliver the goods to the consignee as soon as possible. This objective is founded on two assumptions, the payment per route distance and undertaking the responsibility for goods for the shortest time, or in other words, maximum productivity and minimum risk. The duration of transportation depends to a large extent on the travelling speed, even more than normally assumed. In certain respects, one hour lost or even less than that can cause the loss of the whole 'truck day'. The trucker is namely bound to keep to the schedule for loading or unloading, customs clearance and regulations on the resting time of drivers. The travel speed depends on road traffic regulations, vehicle load, driving resistance, engine power, road traffic volume, meteorological condition, and the brake systems. These elements reveal that the only area allowing influence to be exerted upon involves the engine power and brake systems. Thereby the maximum permitted speed, e.g. 80 km/h has to be considered, that can be achieved by any 40-ton freight vehicle, with a minimum power of 120 KW and an appropriate acceleration rate. The situation is completely different with speed in a slope (ascent or descent), particularly such as cannot be overpowered by inertia. A more powerful engine is the solution for higher speed in the ascent. As a rule, reduced fuel consumption and better acceleration support more powerful engines; however, for the optimum solution we must consider the purchase price, maximum speed of 80 km/h, maximum total mass of 40 tons, configuration of the roads on scheduled routes, and fees and insurance cost based on the power of the engine.

2. GAINS WITH RETARDERS

The cheapest way to increase the travel speed is an increase of speed in descent, which is subject to safety rules. The rule of driving downhill in the same gear as uphill only applies to the technologically outdated freight vehicles. Freight vehicles furnished with retarders can in a descent safely achieve the maximum allowed speed. The function of retarders is only to reduce the speed or maintain it on the same level, and not to stop the vehicle: a high degree of safety at higher speed levels is provided by a maximum efficient main brake system, which may not be overheated. The retarders require an additional investment, which is returned already through the gain by essentially lower wear of the main brake system. Experience of several years has proved that the brake lining, if a retarder is applied, can hold out even three times more kilometers covered. The gain is visible also in the engine, since the retarders allow for driving downhill in higher gears - or even in the highest one - at a relatively low revolution number, as well as for saving on tyres, depending on the type of the system selected. At first sight the saving obtained on tyres is a bit illogical: it originates from a totally different manner of driving and braking. The braking is not effected in intervals, as characteristic of the vehicles without retarders in downhill driving on long descents. The burden of the engine is lower if electric and hydraulic retarders are applied - that on the other hand increase the weight of the vehicle and are more expensive than other systems. The basic purpose of all brake systems is to neutralise as evenly as possible the energy of the vehicle, consisting of the kinetic, inertial and potential energy.

Particular emphasis should be laid on the influence of a reliable and efficient brake system, on the driver's

psychological stability and self-trust, being decisive for his making fast and correct decisions in critical situations. A professionally trained driver who trusts in the efficient and reliable action of the braking system in particular, will also operate and employ the vehicle efficiently and safely.

There are various retarders in use: they differ in efficiency, additional weight and price.

3. MOTOR RETARDERS

3.1. Exhaust vent

The retarder is an exhaust vent which is usually not efficient enough; its efficiency is based on heightened exhaust pressure, the revolution number of the engine and the quality of the vent tightness. The braking power is equivalent to the induced range of the exhaust pressure in the 'p-V'-diagram, number of cylinders, surface of pistons and revolutions of the engine. The kinetic energy of the loaded freight vehicle normally exceeds the braking work of the exhaust vent: that is why its efficiency is generally inadequate for slopes with 3% decline or more. Its efficiency can however be improved through better sealing and the shortest distance possible between the exhaust valve and the exhaust vent. Such a solution to this problem usually comprises a bypass-valve which protects from excessive pressure. Solutions improved in this way highly increase the exhaust pressure and consequently the braking power, as sufficient for the required demands. The braking power may also be continually controlled by increase or decrease in the tightness of the exhaust pipe. Particularly the improved systems with an exhaust vent are very widespread, relatively inexpensive and of a low weight. The improved variants satisfy the requirements of the ADR-regulations.

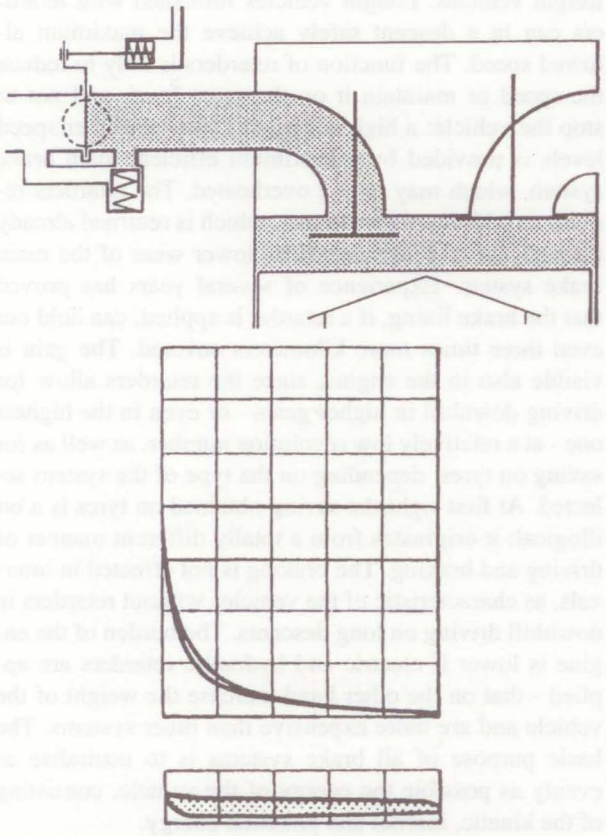

Figure 1 - **Dotted range in the 'p-V'-diagram represents the work of the brake.**

3.2. Constantly open choking valve

This system operates on the principle of a constantly open choking valve that is open into the exhaust collector and usually combined with the exhaust vent. The work of the brake is represented by the two dotted ranges in the field of compression and exhaust in the p-v-diagram.

The comparison of this system to the preceding one results in the difference in the p-v-diagram: this system has slightly lower pressure at the exhaust and exploits a part of compression, which is not done by the preceding system. The braking power depends on the pressure, number of cylinders, surface of pistons and engine revolution number; it is regulated in two-stages. The braking power is usually satisfactory for normal exploitation of

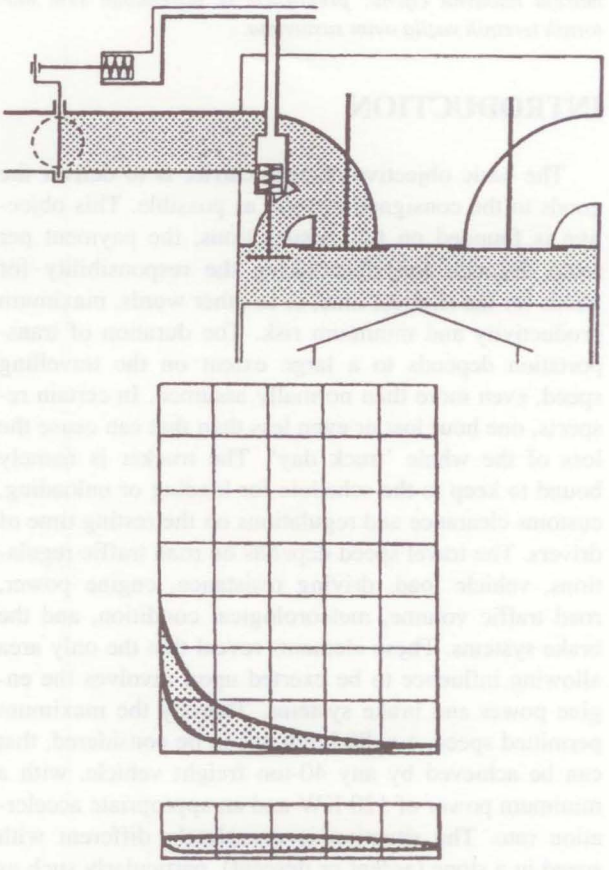

Figure 2

fully loaded freight vehicles. Also this system is relatively inexpensive and low-weighed, and is therefore all the more in use. It also meets the requirements of the ADR-regulations.

3.3. Decompression systems

All decompression systems are based on decompression at the end of compression, i.e. by opening the exhaust valve or opening a special decompression valve. In this case the engine operates roughly like a compressor; the kinetic energy of the freight vehicle is neutralised at the expense of the work of compression. Technical construction of this system is more demanding than of the proceding two systems, because the opening of decompression valves in the stroke of the engine is required. Hence its purchase price, as well as maintenance, is more expensive. The braking power of this system, compared to the preceding systems, depends on the average compression pressure: however, the revolution number of the engine, the surface of pistons and the number of cylinders may likewise influence the braking power. The decompression system can be combined with an exhaust vent, which additionally increases its efficiency and allows for a two-stage operation. These systems also meet the ADR requirements as regards power or other requirements.

4. AXLE RETARDER

4.1. Electric retarder

An electric retarder has a double braking effect; a part of kinetic energy is transformed into electric energy in the retarder generator part, and the electric power so gained is used up for the braking of the disc by means of whirling currents produced in electromagnet coils. A part of the remaining kinetic energy is also neutralised on the disc. There is a three- or four-stage power control (regulation), depending on the requirement.

Retarders are usually placed on the Cardan shaft behind the gearing, but also on the rear trailer axle. The braking power of electric retarders complies with the requirements, however, its price is costly and the weight considerable. Electric retarders are not recommendable for transportation under ADR-regulations, because they release heat at relatively high temperatures; if they are applied, however, they must be fully secured.

4.2. Hydraulic retarder

This is essentially a hydraulic pump with flow choking in outflow channels, much resembling the hydraulic clutch. By opening and closing the outflow channels, the braking power of the retarder changes and conforms to the braking requirements. The braking power fully com-

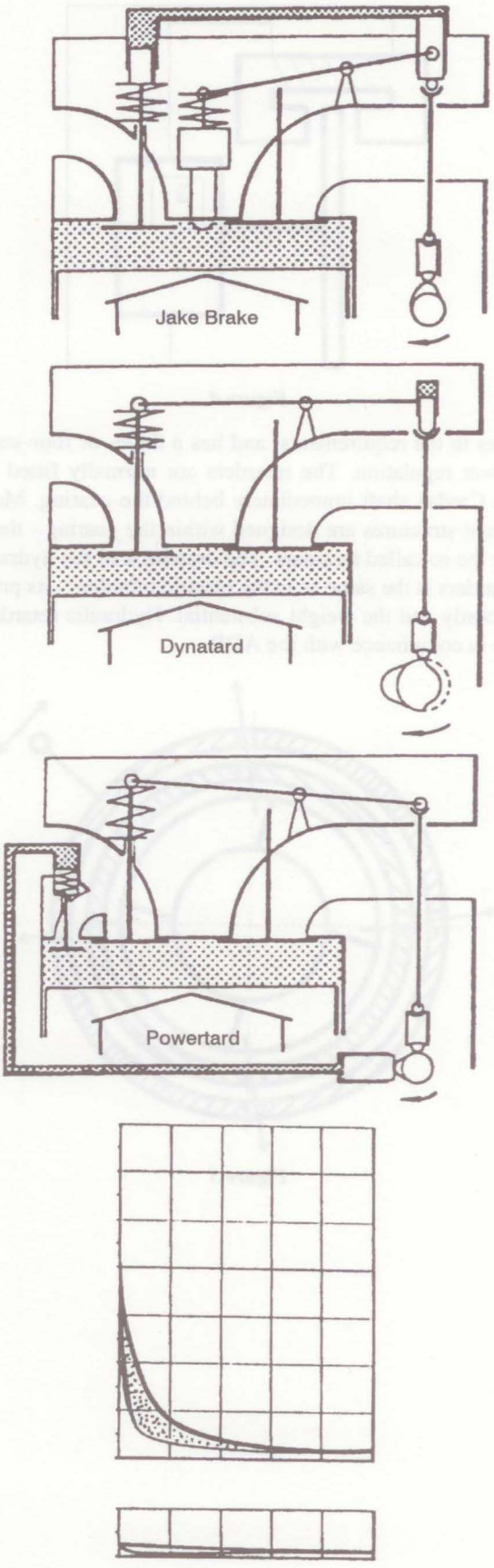

Figure 3

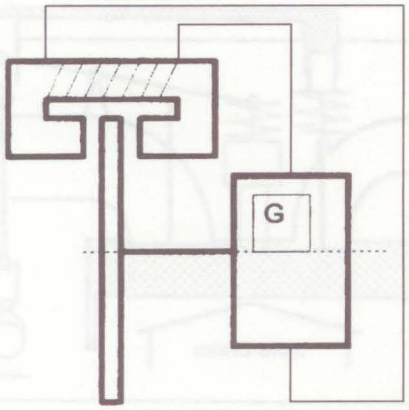

Figure 4

plies to the requirements, and has a three- or four-stage power regulation. The retarders are normally fitted on the Cardan shaft immediately behind the gearing. More recent structures are designed within the gearing - these are the so called intarders. The drawback of the hydrauli retarders is the same as in the electric retarders - its price is costly and the weight substantial. Hydraulic retarders are in compliance with the ADR.

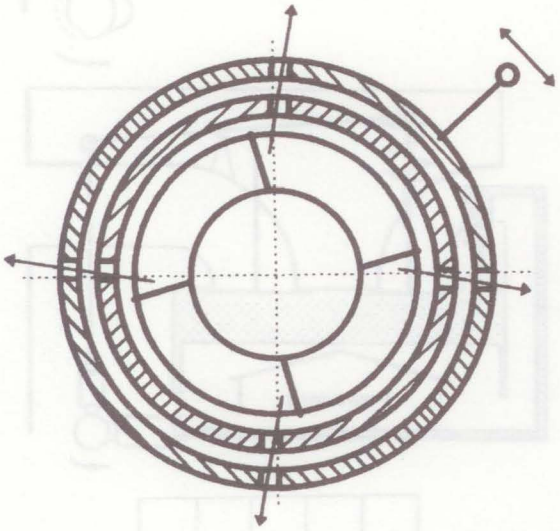

Figure 5

5. CONCLUSION

The use of retarders has great importance in safety and ecology, besides its substantial commercial effects. The ecological effect is a result of less wear of brake drums or discs, particularly the lining: we have to bear in mind that asbestos lining is still used. All the systems shown above absorb the kinetic energy of the vehicle without additional energy consumption, causing no wear to the brake lining, drums and discs.

Several years of experience gained by the users have show an all-round potential in the exploitation of retarders, whose usefulness can be compared to that of the ABS. An enquiry among professional drivers proved that to be one of the greatest technical achievements relating to freight vehicles of the last decade, mainly in terms of increased safety, lesser costs and greater speed.

Future development of retarders will be oriented to lighter, efficient and inexpensive systems, or to the systems of brake the engine resp., as the brake systems on the Cardan shaft or trailer axles are too expensive and weighty.

SUMMARY

The article deals with the benefits of additional brake systems, and especially the potential to increase the travelling speed without an impact of safety and without additional energy supply. These systems are environmentally friendly, as they do not cause any harmful emissions to the environment. The systems described are today most widely used and have the best prospects in the future development.

Additional brake systems have fundamentally changed the way of driving, also because the psychophysical condition of the driver who is operating a vehicle on such a system, is highly satisfactory. The benefits gained from additional brake systems exceed incalculably the purchase cost; it would be recommendable to fit out all motor freight vehicles with these systems.

REFERENCES

Prospects and technical documentation.