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МЕХАНИЗМ УПРАВЛЕНИЯ СЦЕПЛЕНИЕМ С КОМПЕНСАЦИЕЙ ИЗНОСА ФРИКЦИОННЫХ НАКЛАДОК. АНАЛИЗ СВОЙСТВ И ЭФЕКТИВНОСТИ ИС-ПОЛЬЗОВАНИЯ

Ю.А. Рябуха, аспирант, ХНАДУ, Н.Г. Михалевич, канд. техн. наук., доцент, ХНАДУ, Е.М. Воронова, доцент, А.А. Ярита, канд. техн. наук., ассистент, ХНАДУ, В.И. Клименко, канд. техн. наук, профессор, ХНАДУ

Аннотация: *Рассмотрена конструкция механизма управления сцеплением уменьшенных габаритов. Проанализированы её свойства и показан эффект от применения данной конструкции в эксплуатации.*

Ключевые слова: *ПГУ, механизм компенсации износа фрикционных накладок, экономия топлива, уменьшение потребления сжатого воздуха.*

МЕХАНІЗМ КЕРУВАННЯ ЗЧЕПЛЕННЯМ З КОМПЕНСАЦІЄЮ ЗНОСУ ФРИКЦІЙНИХ НАКЛАДОК. АНАЛІЗ ВЛАСТИВОСТЕЙ І ЕФЕКТИВНОСТІ ВИКОРИСТАННЯ

Ю.О. Рябуха, аспірант, ХНАДУ, М.Г. Михалевич, канд. техн. наук., доцент, ХНАДУ, Е.М. Воронова, доцент, О.О. Яріта, канд. техн. наук., асистент, ХНАДУ, В.И. Клименко, канд. техн. наук, професор, ХНАДУ

Анотація: *Розглянуто конструкцію механізму керування зчепленням зменшених габаритів. Проаналізовано її властивості і показаний ефект від застосування даної конструкції в експлуатації.*

Ключові слова: *ПГУ, механізм компенсації зносу фрикційних накладок, економія палива, зменшення споживання стисненого повітря.*

CLUTCH OPERATING DEVICE WITH FRICTION LINING WEAR COMPENSA-TION ANALYSIS OF PROPERTIES AND UTILIZATION EFFICIENCY

Riabukha Iu.A. Ph.D student, Mikhalevich N.G., Ph.D. in Engineering Science, assistant professor, Voronova E. M., assoc., Yarita A. A., Ph.D. in Engineering Science, assistant, Klimenko V. I. Ph.D. in Engineering Science, Prof.
Kharkiv National Automobile and Highway University

Abstract: *Design of the clutch operating device with reduced dimensions is examined. Its properties have been analysed and effect of using of the design in operation is shown.*

Key words: *PHB, compensation mechanism for friction linings wear, fuel economy, reduction of compressed air consumption.*

Introduction

Significant attention is paid to comfort under the contemporary competitive environment conditions. The use of clutches with the wear compensation system enables not only to improve comfort by maintaining a sustained pedal effort but also improves the performance standard of a clutch [1].

Analysis of the publication

Enough authors in Ukraine and abroad in their activities focus on development and enrichment of drive clutch operating of vehicles.

Objectives and targets

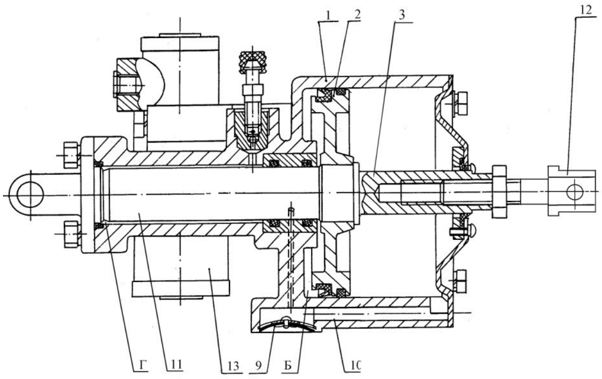
The purpose of this activity is analys of clutch operating device with friction lining wear compensation. Several positive changes are expected to be obtained as a result of the proposed design application:

- the item mass and materials intensity reduction;
- maintaining high clutch response regardless of the friction linings wear degree;
- reduction of air consumption during operation (reduced fuel consumption as a result);
- reduction of PHB overall dimensions;

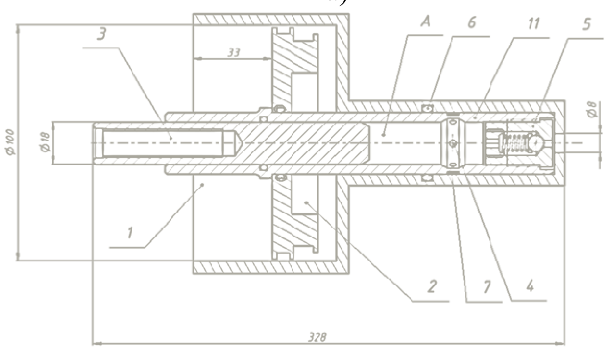
Clutch operating device with friction lining wear compensation.

In the vast majority of the clutch designs the wear compensation mechanism is not available. In such a case, the clutch releases pneumatic hydraulic booster (PHB) permanently, shifts the initial piston position to maintain a zero gap between the fork and releases bearing, thus the performance standard of the clutch drive deteriorates with increasing of the clutch wear [2]. Review of PHB design can become the problem solution. As an option to reduce the dimensions and mass of PHB with the simultaneous compensation for the wear of clutch, the proposed design with PHB two-section rod may be observed. Owing to this design, friction lining wear compensation will be ensured by changing the length of the rod rather than by moving the cylinder as in conventional designs (figure 1 a). Transfer of the effort between two sections of a rod is executed through a cavity A (Figure 1 b). The ingress of a liquid to cavity A is monitored by non-return valve 5. Owing to the friction linings compensation system, cylinder 1 (figure 1) is designed shorter in comparison with traditional designs and provides only the stroke required to release a clutch. Automatic wear compensation mechanism consists of two rods: internal 3 and external 11. Cavity A with a brake fluid which is separated from the clutch disconnecting gear circuit with a ball with a non-return valve 5 is located between them.

The operation is similar to hydraulic compensator in the valve train. During depressing a clutch pedal, the brake fluid pressure enters the cavity between two rods through a non-return valve and pushes inner rod against stop. Besides that, pressure affects sensitive element of the relay valve providing thereby air delivery to the power cavity B of cylinder 1. Moving forward, piston 2 pushes outer rod 11 the hydraulic cavity A between pistons 11 and 3 owing to the blocked non-return valve 5 turns to be closed and ensures an effort transfer from piston 2 with rod 11 to rod 3. When the clutch is released air is released from cavity B and entire mechanism is returned to its original state by the pull-back springs. If the clutch is released multiple times, the lining is worn, which results in a gradual slight displacement of rod 3 into rod 11, an excess pressure which remains in the closed hydraulic cavity after the clutch has been released over time (when moving without turning off the clutch) bleeds down through leakiness in valve 5.



a)



b)

a - general view of proposed design of the pneumatic hydraulic booster; b - design of the friction linings wear compensation mechanism which is located in the pneumatic hydraulic booster rod.

Figure 1 - Proposed pneumatic hydraulic booster design

Possible bubbles of air in the hydraulic cavity A are removed through radial openings 4 adjacent to the valve and covered with ring 7 made of a porous material which lets air to penetrate in. At activation of the booster, the ring is moved jointly with rod 11 under sealant 6, which ensures insulation of hydraulic cavity A from the clutch disengagement circuit. Part of idle stroke of rod 11 is provided for this procedure.

We'll calculate the economy of air and fuel on a bus route for confirmation of the effective implementation of the proposed design: MAN A10 or MAN A15.

Based on figure 1, we can preliminary estimate the reduction of mass, dimensions, materials intensity and volume of operating cavity B.

For illustration purposes we will mention as an example the map of the 1st route (figure 2) which the bus MAN A10 or MAN A15 moves according to.

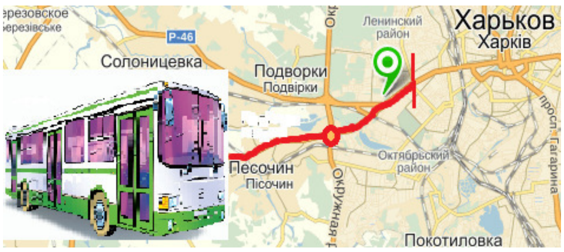


Figure 2 - Pesochin - Kholodnaia Gora route map

The complete route length makes 7 km. The route Pesochin - the subway station "Kholodnaia Gora" contains 7 stops, 4 traffic lights and 7 pedestrian crossings. Full travel time makes 11 min. 30 provided there are no obstacles.

We'll calculate the fuel consumption of the MAN A10 bus
Under V_{0min} = 73.5 cm3

$$V_{trip} = V_{0min} \cdot n_{stop} \cdot n_{press} = 6615 cm^3 \quad , \quad (1)$$

where $Vtrip$ - the volume of air that is spent on one trip cycle of a bus for the clutch drive under nominal pressure;
V_{0min} - minimum amount of the power cavity of PHB;
n_{stop} - number of stops on the route
n_{press} - number of depressing the clutch pedal after one stop has been executed.

Air consumption volume during the whole day:

$$V_d = V_{trip} \cdot n_{trip} = 6615 \cdot 54 = 357210 cm^3 = 357.2 l,$$

where n_{trip} is the number of "trip cycles" per day.
Air consumption volume during a year:

$$V_y = 357.2 \cdot 365 = 130378 \text{ l/h}$$

We'll calculate the compressor operating time necessary to provide the volume considering that the air used for operation of PHB is stored in the receiver with a capacity of 20 l:

$$V_{rec} = 130378 \div 20 = 6518.9 \text{ min} \qquad (2)$$

Similar calculation under V0max = 294.4cm_3:

$$V_{trip} = V_{0max} \cdot n_{stop} \cdot n_{press} = 26490 cm^3 \qquad (3)$$

where V_{0max} - the maximum amount of the power cavity of PHB;

Air consumption volume during the whole day:

$$V_d = V_{trip} \cdot n_{trip} = 26490 \cdot 54 / 1000 = 14307.84 \ l$$

Air consumption volume during a year:

$$V_y = 14307.840 \cdot 365 = 5222361.6 \text{ l/h};$$

$$V_{rec} = 5222361.6 \div 20 = 261118.08 \text{ min}. \quad (4)$$

The complete route that a bus passes in a year:

$$S = l \cdot n_{trip} = 7 \cdot 54 = 378 km \cdot 365 = 137970 km / h,$$

Where n_{trip} is the number of "trip cycles" per day.
l - distance from Pesochin to the subway station "Kholodnaia Gora".

Let's assume that the average velocity of a bus Vav = 20 km/h, 6518.9 min - compressor pumps the receiver for PHB needs.

$$t = 6518.9 \div 60 = 108.6483 \text{ h};$$

$$S_1 = \mathbf{V}_{av} \cdot t = 20 \cdot 108.6483 \approx 2173 \quad km,$$

where S = 2173 km - the path on which the compressor operates under the minimum volume of PHB.

The volume of fuel Q1, l, spent by bus MAN A10:

$$Q_1 = S_1 \cdot 1.6 = 2173 \cdot 1.6 = 3476.8 \text{ l},$$

where Q_1 is the fuel volume 1.6 litters per 100 km are spent for the compressor drive, assuming that the compressor requires about 4% of the engine power for operation.

Let's execute the same calculations for the maximum volume of PHB power cavity.

$$t = 261118.08 \div 60 = 4351.968 \ \ hours;$$

$$S_2 = V_{av} \cdot t = 20 \cdot 4351.968 = 87039.36 \text{ km},$$

where *S*=87039.36 km - the path on which the compressor operates under the maximum volume of PHB.

The route difference *S*, km and the volume of fuel Q, l between the compressor operation under maximum and minimum volumes:

$$S = S_1 - S_2 = 87039.36 - 2173 km;$$

$$Q = Q_1 - Q_2 = 3476.8 - 1392.7 = 2084.1 l;$$

Conclusions.

Thus, the proposed PHB design for a bus can save about 4.5 million (sum per year).
The invention has the technical result of reduced overall dimensions and simplified assembly and servicing

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