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STUDY OF AUTOMATIC TRANSMISSION SYSTEM WITH POWERSHUTTLE OF AN AGRICULTURAL TRACTOR

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Abstract: *The objective of the article is to show the complete construction of the tractors automatic transmission with electro-hydraulic control. Transmission kinematics are presented using six packs of multi-disc clutches to shift the four speed ranges and the PowerShuttle. The automatic transmission contains six gears with three synchronizers serving those gears. The structure of the transmission made in this way allows operation of 24 gears of the tractor for forward movement and reverse movement at speeds of up to 50 km/h.*

Keywords: *automatic transmission, multi-disk clutches, speed ranges, electro-hydraulic control.*

ПРОУЧВАНЕ НА СИСТЕМАТА НА АВТОМАТИЧНА ТРАНСМИСИЯ С ПАУЪР ШАТЪЛ НА СЕЛСКОСТОПАНСКИ ТРАКТОР

ЙОРДАН СТОЯНОВ

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Резюме: *Целта на статията е да покаже цялостната конструкция на автоматичната трансмисия с електро – хидравлично управление на трактора. Представени са кинематични схеми на трансмисия с използване на шест пакета многодисклови съединители за превключване на четирите скоростни диапазона и „Пауър Шатъл“. Автоматичната трансмисия съдържа шест предавки с три синхронизатора, обслужващи тези предавки. Така направената структура на трансмисията позволява работа на 24 предавки на трактора за движение напред и за движение назад със скорости до 50 km/h.*

Ключови думи: *автоматична трансмисия, многодисклови пакети съединители, скоростни диапазони, електро – хидравлично управление.*

1. Introduction

The tractor plays a key role and has proven to be a universal machine both in agriculture and for other branches of economy [3, 5, 7]. The necessary condition for the movement of tractors is the presence of a driving force, which must overcome the resistance forces acting on them. The driving force is obtained from the interaction of the driving wheels with the road, resulting in a reaction of the

road directed in the direction of movement. The drive wheels interact with the road under the action of torque, which they receive from the engine through the transmission. The transmission increases the transmitted torque and decreases the rotation frequency depending on the number of engaged cog gears in it. When transmitting the movement from the engine to the driving wheels, the rotation frequency is reduced several times,

depending on the gear ratio in the transmission. In proportion to the gear ratio, torque and driving force increase. Automatic transmissions consist of the following main mechanisms: clutches, gearbox, main gear, differential and final gears [6, 9]. Transmissions include gearboxes and gear ranges that work sequentially and with which they make different configurations of 6, 8, 12, 16 or 24 gears for forward movement and their equivalent number for reverse movement [6]. The large range of gears achieved by the speed ranges and gearboxes gives a wide range of speed options starting from 0 and reaching up to 50 km/h or more within very narrow limits. The use of final gears in the transmission further increases the torque on the wheels, especially necessary when performing energy-intensive agricultural operations known as ploughing, discing, etc. The powershift clutches and clutches control unit are responsible for moving the tractor forward and backward. The introduction and use of Powershuttle in transmissions aims to make it

easier to start with the selected gear. The functional structure of Powershuttle consists of wet clutch, which require electro-hydraulic actuation [4]. The very functionality of the Powershuttle and clutches are in a smooth change of the directions of movement forward and backward of the tractor and changes gears in gearbox [5]. High torque loads and long slip times must be handled in the case of inversion (Powershuttle), as the speed of the entire tractor mass has to be reduced to zero and re-accelerated to its previous value [3, 8]. The efficiency of such a gearbox to transmit the power flow is affected by the time required for the hydraulic actuators to move the clutches packs from its biting point (kiss) to its fully locked position [1].

2. Material and methods

The main components of tractors automatic transmission of ZF Group, model T7200 shown on figure 1.

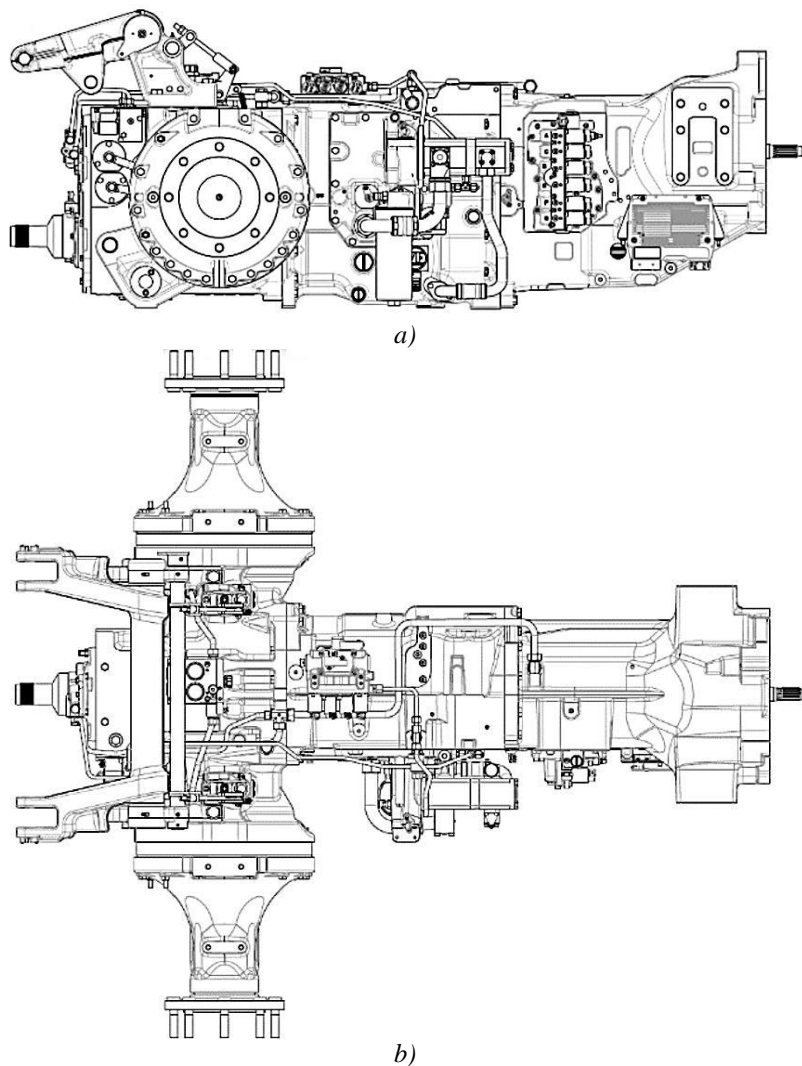


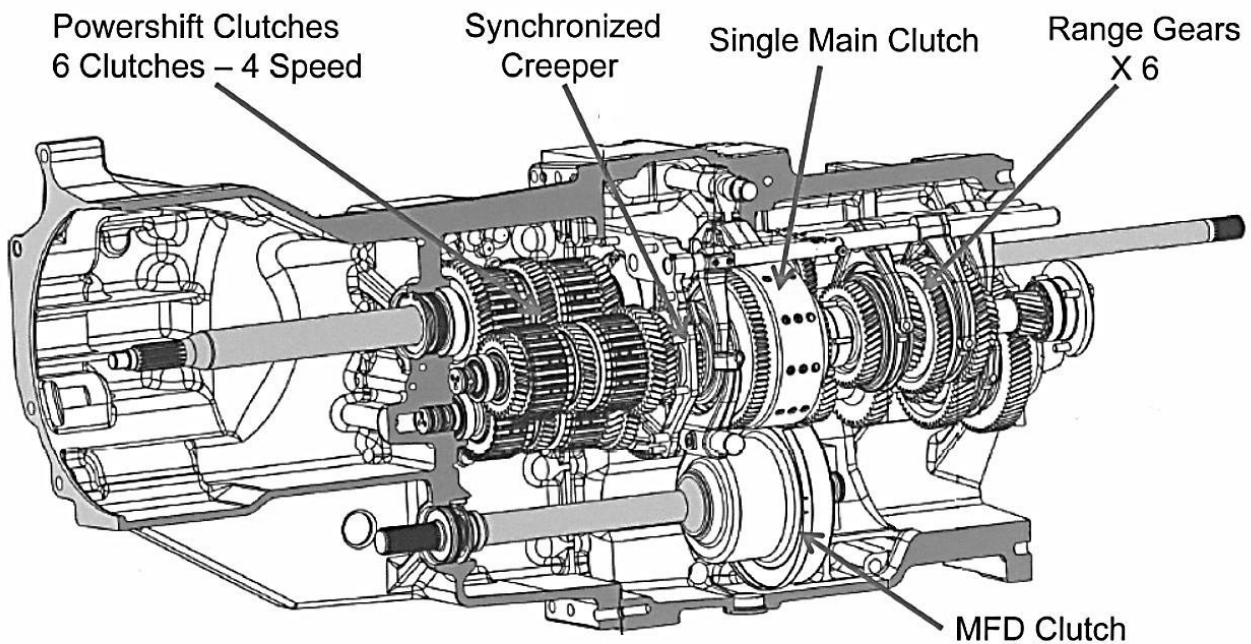
Fig 1. The tractors automatic transmission

The automatic transmission is used on Landini, McCormick and others brands and works with a four- and six-cylinder engine. The transmission concept allows both 4x4 and 4x2 drive wheel operation and the ability to switch the power flow to the front axle. The transmission includes a mechanical gearbox with six gears and six clutches for four speed ranges, which include slow, normal, fast and creeper. Creeper gears are optional and a transmission with such a speed range is manufactured according to customer requirements. The transmission has a reverse gear to switch the movement of the tractor forward and backward.

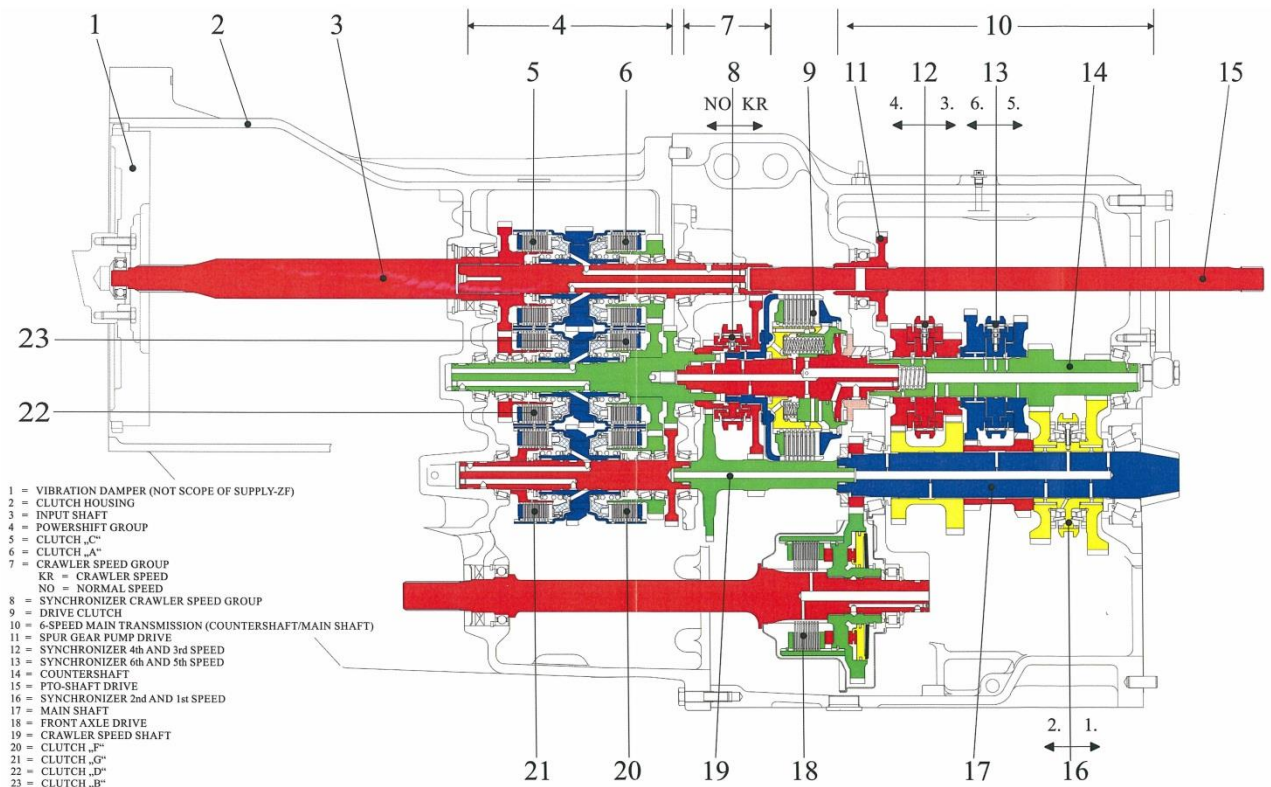
3. Results and discussion

The automatic transmission supports four speed ranges, three of them are engaged through the multi-disc clutches A, B, C, D, F and G. Depending on the combination of engagement of the multi-disc clutches, the direction of movement of the tractor is determined. Immediately after the speed range,

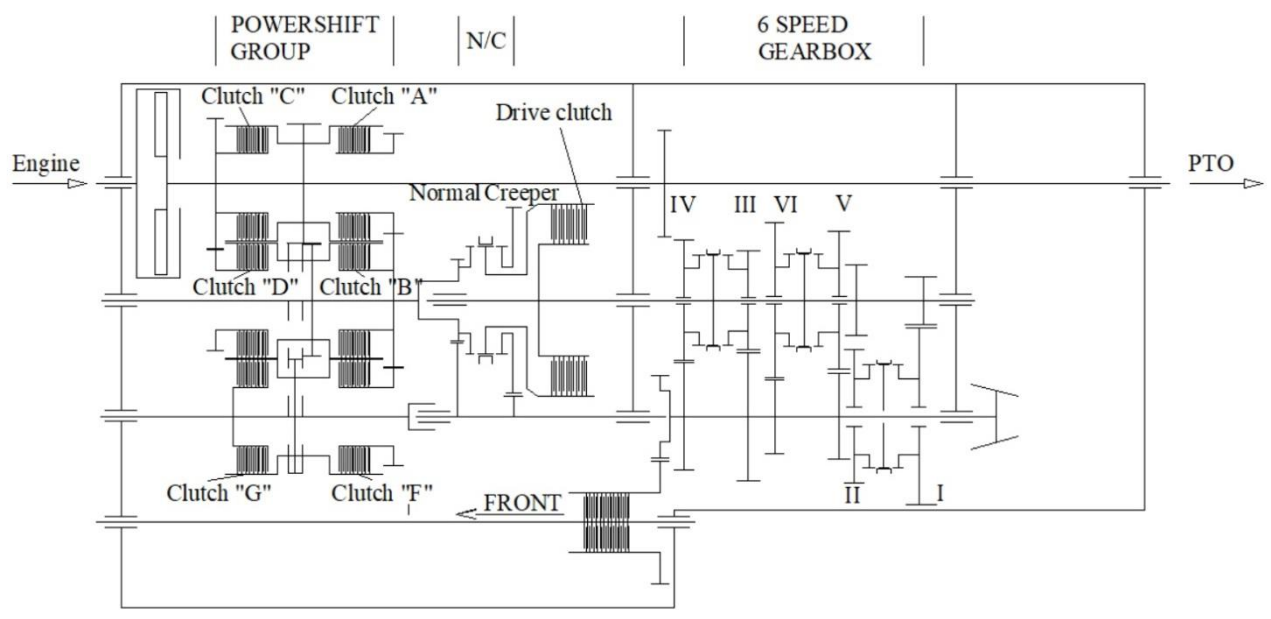
movement at normal or creep speeds can be selected by moving a synchronizer, shown of figure 2. From the kinematic diagram the transmitted power flow to the main drive and differential can be traced. Smooth operation is guaranteed by powershuttle shifting. Shifting of the individual gears in the second part of the transmission is carried out by a hydraulic control unit. Using the hydraulic control unit, the synchronizers are moved to engage the desired gear. The working pressure for engaging the multi-disc packs works up to 20 bar pressure to guarantee the normal operation of the clutches. the transmission is fully automated with a hydraulic control unit, which ensures the correct gear selection in accordance with the load on the running wheels. The numbers of gears reaches 24 forward and 24 reverse in through using the clutches and electro – hydraulically controllers and wet powershuttle shifting.



a)



b)



c)

Fig 2. Mechanical transmission and kinematic diagram – Speedfive

4. Conclusions

An automatic transmission with the possibility of switching the power flow to the front axle was considered. The automatic transmission has four speed ranges and six gears. The speed ranges are served by six packs of multi-disc

clutches, and depending on the engagement sequence, the tractor changes its direction of travel. The powershuttle is considered for legal shifting and the gears. The electro-hydraulic control for the transmission serving the multi-disc clutch packs is shown.

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