The article is about the history of Kharkiv Plant of Self-propelled Chassis, producer of unconventional layout tractors – so-called self-propelled Chassis. The information about tractors’ technical options and its models is highlighted. The facts about the creation, design and modifications of self-propelled chassis, their usage in different specific areas are uncovered

Keywords: tractorbuilding, self-propelled chassis, classic layout, tractor design, agriculture

1. Introduction

Tractorbuilding is considered to be one of the most important branches of agricultural engineering in the world. Ukraine has a great experience in tractor producing. This is explained by the fact that our country has huge land resources, agriculture is one of the priorities of the state economy, and tractors have been in demand everywhere and always.

The tractorbuilding has gone all the glorious way and includes well-developed research and production base, powerful design departments, network of machine stations. The domestic tractors as well as foreign units are still working in our fields today.

2. Problem statement

Nevertheless, the subject of the history of the tractorbuilding in the USSR and in Ukraine is still poorly understood despite the fact that the developments of various types of machinery and tractors as well as the scope of production in the last hundred years are staggering.

Today the situation of the domestic tractor industry is quite deplorable. It is regrettable that due to the various problems and shortcomings of the domestic economy our tractor industry today is almost underdeveloped. There is a risk that within a couple of decades we will only use the foreign manufactured models. Thus, the glorious history of the domestic tractorbuilding just sinks into oblivion. We do not want if this will be true because we have a significant positive experience in this industry that is not ashamed to transfer to subsequent generations not only in our country but also abroad. Therefore, the important objective of this publication is to review the history of the creation, manufacturing, implementation and operation of domestic tractors.

The deep analysis of the tractorbuilding history has been done by a wide range of scientists. However, there is one type of tractor that has not been mentioned in the articles: self-propelled chassis.

The aim of the article is to uncover the facts about the creation, design and modifications of self-propelled chassis, their usage as agricultural tractors, military and civil trucks. Besides, the publication analyses the historical and design pass of the Kharkiv Plant of Self-propelled Chassis, the only one plant producing self-propelled chassis in Ukraine, one of two such plants in former USSR, one of the few world plants that designed and developed the unusual layout tractors.

3. Literature review

The history of self-propelled chassis is totally unrevealed in scientific publications. Only designers and engineers of Kharkiv Plant of Self-propelled Chassis – V. Adolf, A. Vasernis, S. Libtsis – published the notes on technical specifications of non-classic layout tractors. The article is based on this works and archival documents as a chronological background.
4. The history of self-propelled chassis and Kharkiv Plant of Self-propelled Chassis in particular

Establishing of the first steam tractor and then replacing it with the internal combustion engine inventors copied the already known for hundreds of years model of the animals strength usage (ponies, oxen, camels, llamas and others) to perform labor-intensive agricultural operations.

Traditionally, animals were used for labor-intensive plowing in many countries. They were dragged behind a plowed device and the person watching the quality of plowing followed it and provided necessary corrective actions such as leaning on the handle and resetting plow blade or moving it to prevent the formation of bald spots. Therefore, first tractors were "mechanical horses" that dragged a trailer plows. Such decision was convenient to facilitate the work but created certain difficulties for managing towed implements as it were behind the back of the tractor operator. The solution was to use additional workers beyond trailed implements.

The wasp-waist tractors appeared for that to free up additional workers and to limit operation of just one tractor. This kind of tractor was constructed with the rear wheels drive from the front engine and gearbox in the form of a rotating shaft put in the bearing pipeline that connected the front and rear of the tractor. It was assumed that the working bodies of machines and tools would be set in the vacant space under the pipe with the shaft in tractor drivers’ vision range. This should eliminate the need of additional employees and made a tractor driver to be able to monitor and control the working bodies with the help of lever systems, cables or hydraulic rams.

Wasp-waist tractors were issued in 1930–1940 but were not widely spread. The main reason for it was a sharp increase in the complexity of the front linkage machines and tools in the space between exes compared with rear linkage tractors of traditional layout. With the advent of hydraulic three-point rear hitch (or different versions of “triangular” etc.) benefits of rear mounting became particularly illustrative as it was easy to drive back up to the tool and connect it to the tractor quickly and simply.

The next step in agricultural machinery after wasp-waist tractors was a self-propelled chassis. There was a common opinion of experts that self-propelled chassis layout as the tractor was more promising than the classic layout tractor.

It was known that self-propelled chassis with the same engine as the classic layout tractor had better traction and grip, better handling, less traumatic crops cultivated in the works, had better performance and better fuel economy. Besides, it had a range of additional qualities such as good visibility of the working area of machines and tools, direct connection between the steering wheel and the direction of tools displacement that was more convenient for a tractor driver.

Patent for tractor layout as a self-propelled chassis was received in 1935 in Germany but it had not been designed because of The World War II. After the war many countries embarked on the project, especially there were many companies that manufactured motor vehicle chassis in Germany, including such well-known as Eicher Yebr, Tractorenfabrik, Fendt Xaver & C°, Lanz Hermann and others. Among smaller firms there were Wesseler Ho
The chassis had four speed forward gears: three working - 2.24; 3.77; 5.23; and one transport – 10.5 km/h. There was a rear speed 3.39 km/h. With an increase of crankshaft rotation frequency by ~16 % to 2090 rpm above, the speed increased to 2.66; 4.45; 6.16, and transport – to 12.35 km/h. This increased the reverse speed to 3.99 km/h. Chassis had a relatively low base in 1828 mm (about 72”), was based on the rear 6–22 and front guides tires 4–15.

These dimensions provided a relatively low ground clearance of 380 mm, which was not allowed to work with high row crops but only with those that have not high tops (sugar beets, potatoes, tomatoes, onions, etc.).

This chassis was in a focus of the traditional annual British tractors show in 1955. The British named new tractor «tool carriers». Production of this model was continued until 1961. There were released 2008 such self-propelled chassis.

In general, self-propelled chassis failed that led to the termination of its production. Farmers did not use a new vehicle due to the hanging difficulties, need of special machines and tools and the complexity of storage. Thus, there were some tries to create more useful vehicle.

Opperman Motocart was designed by SE Opperman in 1946 with the capacity of 8 HP and wheel formula $3 \times 1$ that corresponded to one of the top front wheels on which gasoline engine was mounted. Motocart replaced nearly 3 horse sleds during transportation agricultural cargo. Transport speed at 4 gears was 17.7 km/h. Engine was single cylinder and four-stroke. It weight 1500 kg and freely drove the same load.

Czechoslovakian chassis ran over the located in the same direction machine, then raised it to a hydraulic swivel device (at 90°) and put the car in the space between axles with the temporarily hydraulically lifted one steering wheel. In Switzerland, the self-propelled chassis moved over the hinged machine or tool by the front wheels at special troughs and then put in it on the three-point linkage behind the front axle.

As experience showed, none of these solutions was successful for self-propelled chassis competing with classic layout tractors. This restrained their development and was the reason for the phase-out of most manufacturers of self-propelled chassis issue. Two large German firms "Eicher" and "Fendt" were the last manufacturers in the market. Manufacturing of tractors with internal combustion engines was established on the territory of Ukraine (Kharkiv, Barvenkovo, Kinchasy) before The First World War [3].

Information about development of Ukrainian tractor-building is gathered in State Archive of Kharkiv Region. Particularly the fund WF-5652 and fund numbered P-5592 [4] are about the history of the establishment and operation of one of the most unusual tractor plants in Ukraine and the USSR – Kharkiv Tractor Assembling Plant that then has been renamed and now is called Kharkiv Plant of Self-Propelled Chassis [5].

The Ukrainian plant was essentially the only one in Ukraine and the USSR tractor plant producing universally-rolling tractors, not traditional but fundamentally new type of the tractor layout. It was a four-wheeled self-propelled chassis tractor 4x2, i.e. with two rear-wheel drives and opened front frame for hanging machines and tools [1, 2].
internal friction, i.e. a worm can rotate the wheel but it is impossible to rotate the worm with the wheel. Therefore, worm gear steering does not transmit kickback.

Until hydraulic steering was not implemented on self-propelled chassis T-16 MG, tractor drivers experienced significant discomfort from the German constructive solutions of vehicles drive transferred to the landing gear.

Issue of self-propelled chassis was launched in 1956 by the model DSSh-14 [1]. It was a diesel self-propelled chassis capacity of 14 HP.

The single-cylinder diesel engine D-14B manufactured by Kharkiv Tractor Plant was mounted. The engine had a water-cooling. It could reach 14 HP, had an engine 1,533 litres. Diameter of the cylinder and piston stroke length was 125 mm at 1600 rpm of the crankshaft.

The engine was a four-stroke, without a compressor, with compression-ignition (compression ratio was 14.5). It ran on gasoline started with a crank at a low compression ratio. The alternating-current generator G-30A2 and two front lights for illumination were used on the chassis. There were no batteries on the tractor, so that lights could illuminate the road only when the engine was running. The engine even at those times had a heavy weight of 370 kg without the clutch, air cleaner and radiator bracket.

Taking into account the wishes of the tractor drivers KhTSZ started, firstly, the replacement of the manual start as obsolete with the starter and, secondly, the design of a more modern air-cooled engine that get name D-16 (16 HP).

A starter ST-80B powered by a battery 6-ST-68-EM was set in self-propelled chassis DSM-14M that had been issued from 1957 to 1958 [1].

Constructors replaced carburetor, magneto, candle, secondary camera in the cylinder head and the mechanism of its incorporation. Direct current was changed in the scheme of electric equipment. Travel speed was increased from 13.7 to 17.2 km/h. The length of the open frame was increased by 350 mm to improve the ease of hanging and longitudinal stability (against tipping back at the entrance to the steep climb).

Hard work to improve engine of chief designer G. V. Lebedinsky, his deputies V. A. Barskyi, M. N. Se-rebiakov, engine bureau chief I. E. Linetskyi, his assistants L. M. Kliozh and R. M. Shindnes resulted in the development of the first Soviet air cooling tractor engine. Its weight was 210 kg while the previous generation engine 1,533 litres. Diameter of the cylinder and piston stroke length was 125 mm at 1600 rpm of the crankshaft.

Its weight was 210 kg while the previous generation engine even at 95 vs. 125), slightly smaller stroke (120 vs. 125 mm) but a higher compression ratio (18 vs. 14.5). It belonged to the medium speed engines (1600 rpm) but had a reserve for increasing revving. This construction was implemented in the further engine models D-21 and D-21 produced by Vladimir Tractor Plant that got the engines production for unloading KhTSZ in order to increase the receipt of self-propelled chassis. Thus, the engine D-21 reached power nearly 20 HP with the positive tolerance in different versions and D-21 reached 25 HP at 1800 rpm.

A deep modernization of DVSSh-16 was conducted and the chassis T-16 were produced from 1961 to 1967. The operating speeds were increased on 10 %. Instead of one gear, there were two transmissions for transportation cargo in the cargo dump platform in a variety of road conditions. In this case, thanks to the gear-boxes rational and compact design and front axle, chassis GVW was lowered to 1250 kg versus 1600 kg of DSSh-14m.

This chassis used remote-cylinder hydraulic system of the unified type, consisting of a gear hydraulic pump NSh-10 with the capacity of 10 litres per minute and a pressure of 100 kg/cm², two spool distributor P-75-2V and two remote power cylinders capable for working together and separately.

Exactly this self-propelled chassis T-16 became the basis for all future upgrades and enhancements.

Since 1967, the plant produced T-16M chassis with rigid cabin having an inner protective shell that protected the tractor operator from serious injury even in a side rollover.

The most advanced chassis T-16MG (SSH-25) was created based on T-16M and released in the 70’s. Various significant improvements were carried out in almost all the major components and systems of the chassis during several years. Such improvements resulted in sharply increasing of the service period (from 5–6 to 8–10 years) and rising of the machine reliability at whole (up to 0,992) at 3000-hours pilot tests in a machine-testing stations V/O "Soyuzselhoztehnika". This operational reliability coefficient was determined by the prevailing standard as quotient of the dividing working time in operating hours by the amount of the time and operating time in hours for failures finding and eliminating and then multiplied on a conversion factor of x=1.25 for transfer in operation hours.

The chassis had a single suspension seat with seat belts, windshield wipers (electric front and manual rear), a rear three-point mounted system like the classic layout tractor had. This allowed chassis to work with the machines and tools of tractor T-25 as well as applied a layered hitch (front, face and back) to run three operations in a single pass. The rear light and two front were mounted and so on.

Kharkiv Tractor Assembling Plant (and now - Kharkiv Plant of Self-Propelled Chassis – KhZTSSh) produced up to 25600 self-propelled chassis per year during 70–80 years of the last century, compared to the several thousand in the early 60 s.

The need of the self-propelled chassis of 0.6 tons usually ranged 100–125 thousand vehicles a year so each vehicle released was on strict accounting and distributed only centrally.

To complete the overall assessment of the performance of KhZTSSh, it should be emphasized that its employees invented and protected by copyright certificates fundamentally new ways of front linkage machines and tools under the chassis frame that essentially decided at least two problems:
the sharp decline in working time for one operation of the hitch that was close to the classic layout tractors with the rear hinge;

– the ability to hang machines and tools hinged to the rear of the classic layout tractor.

As an example, we can name the construction of a self-propelled chassis with swiveling front axle designed by A. I. Vasernis, S. E. Libtsis, A. I. Podrigalo [6], as well as the construction of a self-propelled chassis with a lifting frame designed by a group of authors headed by V. A. Shapiro [7].

Unfortunately, the collapse of the Soviet Union almost did not allow realizing the revolutionary solutions that should made self-propelled chassis quite competitive in comparison with the classic layout tractors.

The self-propelled chassis manufactured by KhTZS (KhZTSSh) were adopted as a power base in 20 departments of the national economy. More than 200 mounted machines and implements were produced for these chassis.

A special tea modification allowed mechanized tea leaves harvesting was created based on a self-propelled chassis T-16. The set of these machines included a special cultivator, fumigator, duster, sprayer, lateral turning mower, tea harvesting machine "Stakartvelo" and many others [8, 9].

To show the wide use of self-propelled chassis KhZTSSh we should remember the Latvian machines complex for patching asphalt pavement containing hole-borers, mowers, pesticides sprayers, mowers side, asphalt heaters and others. A marking machine produced by Kaliningrad Road Machines Plant was widely used in many cities for road marking. The ground lubricating units on the chassis base worked in the mines at depths up to 400 meters. The road marking. The ground lubricating units on the chassis base worked in the mines at depths up to 400 meters.

KhZTSSh produced up to 25600 self-propelled chassis per year in 70-80 years of the last century versus a few thousand at the beginning of the 60's. Over 0.5 million such agricultural tractors were produced during the Soviet years. The need in 0.6 ton self-propelled chassis usually fluctuated in the range of 100–125 thousand vehicles a year so each landing gear was in the strictest accounting and only centrally distributed.

It should be emphasized that KhZTSSh workers invented and protected by copyright certificates new ways of front gear control machines and instruments under the chassis frame that solved at least two problems:

– dramatically reduce the complexity of the self-propelled sample to the values of the rear accessories;

– ability to hang the machines and tools on the back batch of classic layout tractor.

5. Conclusion

We should mention that Kharkiv Tractor Assembling Plant – KhTSS and now – Kharkiv Plant of Self-propelled Chassis – KhZTSSh) takes a special place in the development of Soviet and Ukrainian tractorbuilding, because it has been probably the only one plant producing various models of unconventional layout tractors for agriculture and for many other sectors of the economy. The plant began producing of self-propelled chassis in 1956. Studying the mechanics opinions and considering their priority wishes the plant replaced manufactured chassis model with a more progressive almost every 2 years. Over the 1949–1991 plant produced many models of tractors but its main products were self-propelled chassis in 1956. Issue of self-propelled chassis has not lost relevance today.

References


6. USSR Author's Certificate №206932.

7. USSR Author's Certificate №233319.


References


6. USSR Author's Certificate №206932.

7. USSR Author's Certificate №233319.


Kryvokon Alexander, PhD, Associate professor, Department of Automobile and Tractor Building, National Technical University "Kharkiv Polytechnic Institute", Frunze str., 21, Kharkiv, Ukraine, 61002

E-mail: kryvokon@mail.ru

Дата надходження рукопису 27.03.2015

Рекомендовано до публікації д-р істор. наук Савчук В. С.

С. реквізити