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J21411-001

Gaydamaka A.V.

CYLINDRICAL ROLLER BEARINGS OF HIGH RELIABILITY AND CAPACITY FOR JOURNAL BOXES OF RAILCARS

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Abstract. The paper presents a review of original domestic structural solutions to improve the reliability and load capacity of cylindrical roller bearings of supporting nodes of railway cars within the given size by increasing the number of rollers and changing design of spacing ring.

Key words: roller, spacing ring, roller bearing, wagon, capacity, reliability

Low back-to-back endurance of rolling surfaces of rings and rollers, as well as lack of strength of brass spacing ring of standard roller bearing 42726LM and 232726L1M of journal box of railcars, which are operated in extremely difficult conditions, leads to their destruction and creation of an emergency with negative consequences for the environment and human life [1].

It is therefore important to improve the reliability and capacity of these bearings given the most dangerous types of damage − back-to-back endurance of the rolling surfaces of rings and rollers considering the strength of spacing ring. At the same time, an important condition was the requirement to keep the same dimensions of bearings in order to minimize expenses for their modernization.

Back-to-back endurance of bearings can be increased with help of the following ways [2, 3]:

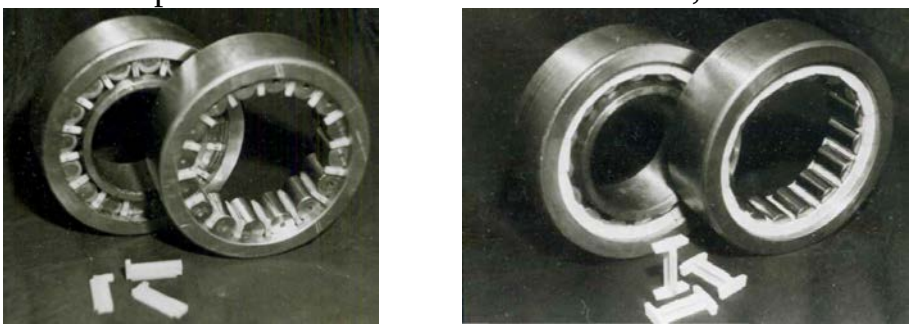
- structural modifications, which take into account: materials of components, macro and micro-geometry of their elements, dimensions and clearances, construction of bearing units, fit of components, lubricants, lubrication systems and protection against environmental impact;
- technological improvements that include: technology for production of billets, modes of strengthening of the friction surfaces, methods of forming protective films and antifriction coating, automation of the manufacturing process and quality control;
- operational measures, which define: cleanup system, activation and lubricant change intervals, maintenance, diagnostics and repair.

The analysis of design, technological and operational ways of increasing back-to-back endurance of bearing, keeping the same dimensions, shown that increase in the number of rolling elements in the bearing is the most effective way, but not developed in practice. The implementation of this direction to improve the reliability and load capacity of bearings requires a change in the construction of spacing ring, calculations of the spacing ring strength and reliability of bearing.

A number of original designs of the polymer spacing ring with bigger number of gaps for rollers were offered to use for this purpose in the cylindrical roller bearings of journal boxes of wheel sets of railcar [4-9].

An effective construction solution instead of brass spacing ring of cylindrical roller of journal boxes of railcars is represented in form of several options of non-

integral (split) spacing ring in form of separating elements of pure polyamide using various designs: plate and I-beam. The roller bearings with such spacing ring design [4, 5], which allowed to place instead of 14 rollers 16 rollers, are shown in Fig. 1.



a *b*

Fig. 1. Roller bearings type 2726 with the split designs of polyamide spacing rings:

a – plate element; b – I-beam element

The bench tests of plate and I-beam separating elements in the journal box concluded that introduction of split designs of polymeric spacing rings for cylindrical roller bearing of journal boxes of railcars is inexpedient. All of the embodiments of split polymeric spacing rings of roller bearings within the tested operating modes contributed to the increased heat of axle unit compared with typical brass spacing rings. Additional difficulties during mounting/dismounting and washing operations were arising.

After bench tests and detailed analysis of the process of production of cylindrical roller bearings it became necessary to give up the idea of implementing spacing ring with frame (one-piece) structure of pure polyamide reinforced with metal rings [6].

In the mid-80-ies of the last century in practice of manufacture of bearing's spacing ring of small size (hole 60 mm) a new glass-filled polyamide began to be used. First overseas developments of frame structures of glass-polyamide spacing ring for large size bearings have appeared. Adding to polyamide of fiber and stabilizers in form of metal and organic additives provides improved resistance to ageing, good stability of the geometric shape of the structure after manufacture. Furthermore, it increases structural rigidity, reduces the influence of the viscoelastic properties of matrix (pure polyamide) during operation, when the temperature and humidity of the environment are changing.

The design of the glass-polyamide spacing ring of cylindrical roller bearing must satisfy the following requirements [10]: it must be universal for all types and sizes of bearings; it must provide a bigger number of rolling elements in the bearing and improve lubricating of elements.

Therefore, the structural elements of glass-polyamide spacing ring have the following features: rings are more often performed with the profile cross section due to obtain better casting; shape of the gap is different from the shape of the rolling element; there are additional functional elements (lubricant pockets; locking elements, etc.). The pockets for lubrication, as well as the different elements that facilitate lubrication of the surfaces of friction parts can be placed on the rings and

bridges. The grooves, channels, holes, which provide additional lubrication of friction parts of bearing, are made on the bridges and rings of such spacing rings. Flexible locking elements in the form of projections, supports, lobes, lugs are made on the bridges for securely hold of the rolling elements in the gap of spacing rings when removing external or internal rings. The shape of the gap of spacing ring, for example, of cylindrical roller bearing is sometimes performed so to make the roller maintains more precisely the direction of rotation axis.

Taking into account basic requirements for glass-polyamide spacing ring of cylindrical roller bearing of journal boxes of railcars two options of its frame construction were proposed with bigger number of gaps from 14 to 15 compared with brass prototype [7-9]. Increase of the designed life $L_{10}^{(15)}$ of bearing with such spacing ring, where number of rollers is increased while maintaining the dimensions and design of other parts, compared with the durability $L_{10}^{(14)}$ of standard bearing is determined as $\frac{L_{10}^{(15)}}{L_{10}^{(14)}} = \left(\frac{C_{(15)}}{C_{(14)}}\right)^{10/3} = \left(\frac{15^{3/4}}{14^{3/4}}\right)^{10/3} = 1{,}188251$, where $C = f_c(i \cdot l_p \cdot \cos\beta)^{7/9} \cdot z^{3/4} \cdot D_w^{29/27}$ – dynamic load rating; f_c – tabular coefficient; i – number of rows of rollers; β – contact angle of bearing.

Therefore, the estimated 90-percent life of back-to-back endurance of bearing race of rings and rollers of upgraded roller bearing of railcar's wheel sets with fifteen rollers compared with standard bearing, which had fourteen rollers, increased by almost 19%.

The glass-polyamide spacing ring, which combines the advantages of structures [7, 8], as shown in Fig. 2, is put into production of cylindrical roller bearings type 30-232726 and 30-42726 of journal boxes of railcars at Stepnogosk (SBP) and Kharkov (HARP) bearing factories.

Fig. 2. Glass-polyamide spacing rings of roller bearing of journal box of railcar

Improved glass-polyamide spacing ring [9], shown in Fig. 3, includes: rings *1* with cavities *3* and transverse walls *4*, bridges on each lateral side *2* corbels *5*, gaps *6* with bulges *7* inwards, microgrooves *8* on the working surfaces of rings (Fig. 3). The geometric parameters of the cavity *3* in rings are chosen based on the aspects of improving casting technology of spacing rings, and the size of bulges *7* – to provide contact between friction surfaces of roller with the midpoint of bridge.

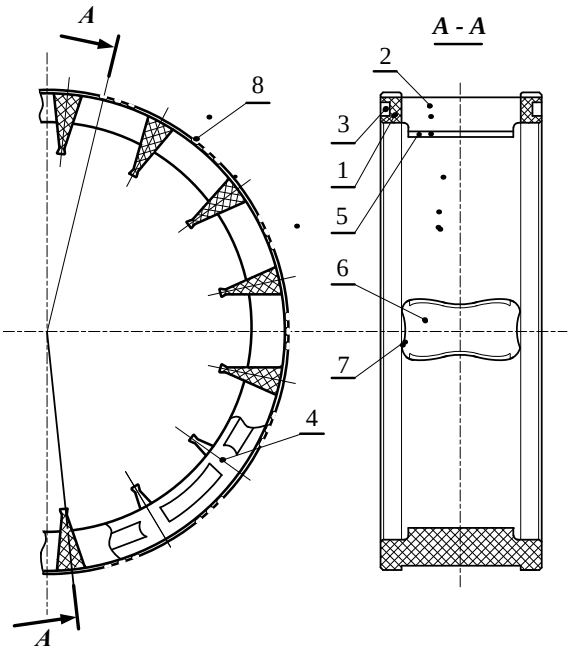


Fig. 3. Construction of the improved glass-polyamide spacing ring of cylindrical roller bearing of journal boxes of railcars

The main advantages of the improved glass-polyamide spacing ring, firstly, are the contact of the rollers with the midpoint of bridges, which reduces the load concentration of construction, and, secondly, the improvement of lubrication of coupling of spacing ring with outer ring.

Strength of improved spacing ring and bearing reliability within the impressive wear, taking into account the fatigue resistance of spacing ring, is tested using calculation methods [11] and tests [12-15], which are developed by the author.

Conclusions:

1. The set of the original domestic structural solutions for spacing ring of heavy duty cylindrical roller bearing were developed, improving their designed life and load capacity.

2. Framed construction of glass-polyamide spacing ring can be used not only for cylindrical roller bearing of wheel sets of railcars, but for locomotives, and for supporting elements of tractive motor placing the spacing ring on the sides of the outer ring.

3. The glass-polyamide construction of spacing ring with bigger number of gaps (one more gap compared to brass construction) is put into production in cylindrical roller bearings type 30-232726 and 30-42726 of journal boxes of railcars at Stepnogosk (SBP) and Kharkov (HARP) bearing factories. These measures showed an increase in bearing life of 19% and reduced the cost of the spacing ring 14 times.

4. The introduction into operation of cylindrical roller bearings of reference nodes of mounted wheels of railcars with polymer spacing ring, according to the Department of railcar facilities of JSC "Russian Railways", resulted in reducing the number of uncoupling of railcars due to damage of spacing rings in 2002 ... 2005 from 12 to 0.14%, i.e. 85 times.

5. Improved construction of glass-polyamide spacing ring has a higher strength and provides improved conditions of lubrication of bearing.

List of references:

1. Цюренко В.Н., Петров В.А. Надежность роликовых подшипников в буксах вагонов. – М.: Транспорт. 1982. - 96 с.
2. Черменский О.Н., Федотов Н.Н. Подшипники качения. – М.: Машиностроение. 2003. - 576 с.
3. Harris, T. (2006), Rolling bearing analysis, New York, USA.
4. А.с. 1488623 СССР, МКИ F16C 33/46. Сепаратор подшипника качения / В.Г. Андриевский, А.В. Гайдамака, Б.А. Лагутин, С.Г. Иванов, Б.А. Яхин (СССР). − Опубл. 23.06.89, Бюл. № 23. – 4 с.
5. А.с. 1626102 СССР, МКИ F16C 33/46. Сепаратор роликоподшипника / В.Г. Андриевский, А.В. Гайдамака, Б.А. Лагутин, С.Г. Иванов, Б.А. Яхин (СССР). − Опубл. 07.02.91, Бюл. № 5. – 3 с.
6. А.с. 1626011 СССР, МКИ F16C 33/46. Металлопластмассовый сепаратор / В.Г. Андриевский, А.В. Гайдамака, Б.А. Лагутин, Б.П. Пшеничный (СССР). – Опубл. 07.02.91, Бюл. № 5. – 2 с.
7. А.с. 1733750 СССР, МКИ F16C 33/46. Сепаратор роликоподшипника / В.Г. Андриевский, А.В. Гайдамака, С.Г. Иванов, В.Н. Цюренко, И.М. Максимов, В.И. Седов, Б.А. Яхин (СССР). − Опубл. 15.05.92, Бюл. № 18. – 4 с.
8. Пат. України 20679А, МПК F 16C 33/46. Сепаратор роликопідшипника / А.В. Гайдамака, В.Г. Андрієвський (Украина). − № 97020547. Заявл. 10.02.97. Опубл. 2.09.97.− Бюл. № 12.− 2 с.
9. Пат. України 50093, МПК F 16C 33/46. Сепаратор роликопідшипника / А.В. Гайдамака, В.Ю. Алефіренко (Україна). − № u200912229. Заявл. 27.11.2009. Опубл. 25.05.2010.− Бюл. № 10.− 2 с.
10. Гайдамака А.В. Склополіамідний сепаратор роликопідшипників букс вагонів: конструкція, технологія, виготовлення, контроль стану / А.В. Гайдамака. – Х. : ХарДАЗТ. – 2002. – 34 с.
11. Гайдамака А. В. Надійність циліндричних роликопідшипників букс вагонів і локомотивів / А.В. Гайдамака // Зб. наук. праць УкрДАЗТ. – Харків, 2013.− Вип. 139. – С. 103-111.
12. Божко А.Е. Вибрационно-усталостные испытания сепараторов роликоподшипников / А.Е. Божко, А.И. Федоров, В.И. Ляшенко, О.Ф. Полищук, А.В. Гайдамака // Залізничний транспорт України. – 2004. − №5. – С. 2−3.
13. Гайдамака А.В. Випробування на знос деталей роликопідшипників важких режимів експлуатації. 1. Способи та обладнання / А.В. Гайдамака // Проблеми трибології. – 2011. – № 1. – С.19–24.
14. Гайдамака А.В. Випробування на знос деталей роликопідшипників важких режимів експлуатації. 2. Теоретичне обґрунтування / А.В. Гайдамака // Проблеми трибології. – 2011. – № 2. – С.54–58.
15. Гайдамака А.В. Випробування на знос деталей роликопідшипників важких режимів експлуатації. 3. Підвищення зносостійкості / А.В. Гайдамака // Проблеми трибології. – 2011. – № 3. – С. 52–59.

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J21411-002

Blokhin A.L., Morozova O.V., Morozov V.A.

DIAGNOSTICS OF THE SYSTEMS OF THE MODERN CAR

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Abstract. The article considers current issues about operation of modern vehicles, namely, the methods of creation and application of systems of automatic diagnostics of the technical condition. Currently, due to the saturation of modern car by electronics, increasing complexity of their design, and the need to improve security and reliability the issue of reliability is becoming the priority direction.

Keywords: car, diagnostics, technical condition.

The modern car is a complex technical system, the elements of which mutually influence each other. Individual information about hidden or emerging breakdowns of the vehicle systems enables to repair it timely, to avoid breakdown on the way, and to conduct quality control of the works and other maintenance operations.

The number of cars in Russia is continuously increasing, accordingly, the number of drivers is also increasing, but the number of technically competent professionals among them is continually decreasing. At the same time, the complexity of car design and increasing requirements for safety, reliability, enhances the role of technical diagnostics [1]. These factors lead to the fact that extensive range of modern technical equipment of the car by electronics and microprocessor technology, the main function of which is to manage, is accompanied by the functions of automatic diagnostic system [2].

In our opinion, the diagnostic system of a modern car should consist of three interacting parts. These parts include the primary data collection, transformation and transfer of information, device management and software with the appropriate hardware. The primary data collection includes a complex of devices of receiving and improving the diagnostic parameters, which are often analog. The transformation and transfer of information includes the analog-digital converter and common channels for the transfer of digital signals from all systems, which are diagnosed, to the storage device of real values. In modern cars, this channel is typically realized in form of CAN-bus (Controller Area Network) or LAN-bus (Local Area Network). These networks provide the opportunity to realize multiplexing technology. These technologies allow to share the power between the network of power supply and control circuit. They also simplify control. This control is performed by separate control wire that connects several different components or independent units, transmitting the encoded signal to a particular device, informing whether it should be switched on or off in a given mode of operation. Multiplex systems are based on reliable electronic power switches, which allow avoiding the problems of fragility of mechanical relays. Moreover, in this case, it is possible to use power supply network of minimal length, and this network is made of massive wire with a large cross section, because there are no branched circuits, which are connected to controlling elements. The third component of the diagnostic system is the microprocessor unit, which is the base of algorithms recognition of conditions of diagnosed objects basing on analysis of the saved arrays of received diagnostic parameters. Moreover, all

breakdowns have individual code and are accompanied by additional information about the frequency or time of occurrence of the defect.

The significant problem of selection and use of diagnostic parameters is a need to develop methods of separating useful information about a specific object from accidental interference and noise, which are in the recorded signal. Special diagnostic parameters can be very informative. Among these parameters are engine compression at certain moments of its operation, presence of oxygen in exhaust gas, current and voltage values in electrical circuits, etc. In addition, these parameters stand out better by their nature against other signals.

Since the diagnostics of the system or unit of the car is performed without disassembling, then the characteristics, which are related with the condition of S, should be taken as diagnostic parameters y_i. In order to make the diagnostic parameter more informative and provide reliable conclusions, it is necessary for it to be sensitive, single-valued and stable. Figure 1 shows three variants of the function of changes of the diagnostic parameter y_i in process of usage of the object and change of its condition S.

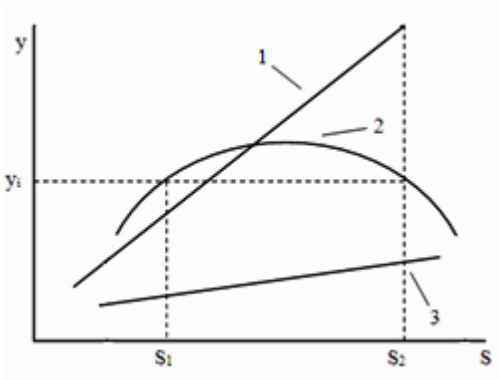

Fig. 1. Types of dependencies of the change of diagnostic parameters from the object condition.

1. Not single-valued and sensitive parameter.
2. Single-valued parameter.
3. Not single-valued, but insensitive parameter.

Parameters y_1 and y_2 are single-valued, since each possible condition corresponds to a quite definite value of the characteristic. Parameter is not single-valued, because the same value of this characteristic may correspond to two or more conditions S1 and S2, which are characterized by varying operating life of the object.

Comparing the parameters y_1 and y_2, it should be noted, that by increasing condition characteristic on the value Δ S the change of the value Δ y of the first parameter is greater than for the third, and i.e. the first parameter is more sensitive. Thus, we need to choose the first parameter, because it is single-valued and sensitive.

Stability of the diagnostic parameter is determined by the measure of variation with help of repeating measurements of the objects with the same condition. Spread in parameter values can be expressed in standard deviation for obviously fault-free G_1 and fault G_2 condition of diagnosed object [3]. To assess the stability and informativeness of the diagnostic parameter some match criterion should be used, such as (1).

$$J(y) = \frac{\left|\overline{y}_1 - \overline{y}_2\right|}{\sigma_1 + \sigma_2} \quad (1)$$

Here: y_1 and y_2 – average value (n) of measurements of the diagnostic parameter for fault-free y_1 and fault y_2 conditions of the system or device.

σ_1 and σ_2 – standard deviation of the parameter of fault-free and faulty objects, which are diagnosed.

Practice of the technical diagnostics has proved that justified conclusion about condition of a system or device can be made on the basis of several factors. For example, leakage of the locking element of the injectors of one of the cylinders D_1 is accompanied by a slightly higher fuel consumption – Y_1, high content of hydrocarbons C_xH_y in exhaust gases – Y_2, and CO in exhaust gases – Y_3, in exhaust gases by reduction of the maximum torsion torque Y_5. Naturally, if a leakage occurs in the injectors of two or more cylinders, the value of diagnostic characteristics should be increased.

Description of diagnostic parameters can be conveniently listed in a matrix, denoting measure of the presence of characteristic 1,2,3,…, and its absence – 0. An example of such a matrix is shown in Table 1.

Table 1

Matrix of standard conditions

Conditions of the system	Diagnostic parameters				
	Y_1	Y_2	Y_3	Y_4	Y_5
D_1	1	1	1	-1	-1
D_2	3	3	3	-3	-3
D_3	2	0	0	0	0

In this table, the condition D1 corresponds to wear and leakage of the needle valve, D2 – to leakage of the injectors in three cylinders, but condition D3 – to leakage of the supply line from fuel pump to fuel rail or leakage of the rail.

Nowadays the analysis of the accumulated set of diagnostic parameters using microprocessor technology is not a problem.

In conclusion, this method makes it possible to develop an advanced system of automatic diagnostics of the technical condition of the car's systems, as a basis for the algorithm of diagnostics.

List of references

1. Озорнин С.П. Основы работоспособности технических систем: учебн.пособие – Чита: Изд – во Чит ГУ, 2006 – 123 с.

2. Сидоров В.И. Техническая диагностика: учебн. пособие – М.: Изд – во МАДИ. 2008 – 113 с.

3. Авдокин Ф.Н. Теоретические основы технической эксплуатации автомобилей М.: Транспорт, 2005 – 215 с.

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Rakov V.A.

EVALUATING THE EFFECTIVENESS OF RECUPERATION OF HYBRID ENGINE

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The paper presents the methodology and results of experimental studies of the effectiveness of the hybrid motor recuperation. The main regularities of recovery.

Keywords: hybrid vehicles; the regenerative braking, battery, hybrid engine.

Conducting research hybrid engine (HE) vehicles connected with the necessity of them tested in a research lab. For these purposes, the Vologda State University experts made laboratory prototyping hybrid propulsion system. The experimental setup and methods of research allow research to study and optimize recovery processes. Recovery process that ensures the return of the kinetic energy of the vehicle, thereby increase the energy efficiency of the drive [1-7].

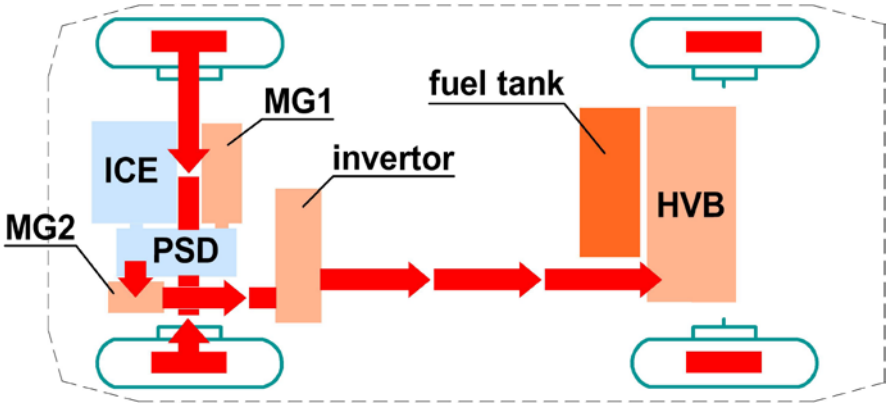

Fig.1 The scheme of energy recovery during braking

Theoretical study on the impact of recovery energy efficiency described in the scientific literature. In the experimental efficiency apply super capacitor drives200ПП-28/026, with the following specifications:

- Rated voltage - 200 V;
- Electric capacity - 1.4 F;
- Stores electric energy at rated voltage - 28 kJ;

Number of capacitors used - 2 pcs. (Series connection). Energy in the capacitor is calculated by the formula

$$W = \frac{C \times U^2}{2}, \text{ J} \quad (1)$$

where C is the electric capacitance, F U - voltage on the capacitor, V.

Energy capacitors connected in series at the beginning of the discharge is

$$W_1 = \frac{C/n \cdot (U_{max} n)^2}{2000}, \text{ kJ} \quad (2)$$

where n - number of series-connected capacitor units.

Energy at the end of the discharge capacitors

$$W_2 = \frac{C/n \cdot (U_{min} n)^2}{2000}, \text{ kJ} \quad (3)$$

energy given capacitor during the discharge is

$$W = W_1 - W_2, \text{ kJ} \quad (4)$$

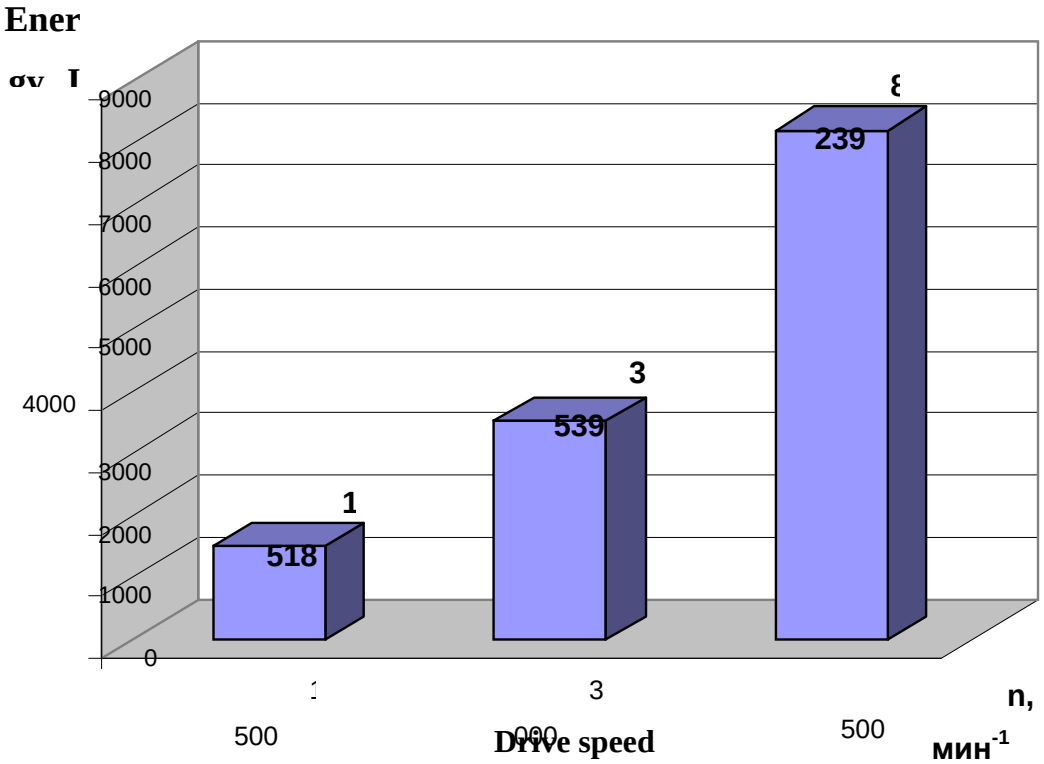

Fig. 1. Histogram energy during acceleration drive

Acceleration is performed before reaching the motor shaft speed - 3000 min^{-1}.

Braking is performed with an initial velocity of motor shaft - 3000 min^{-1}, until complete recovery.

Increase the voltage on the storage capacitor is explained by returning the kinetic energy of the rotating masses, coupled to drive an asynchronous machine in [8].

Drive recovery value can be interpreted in different ways. First. The ratio of energy generated by braking the drive to stop at a constant speed ω to the energy used to drive acceleration from a standstill to a speed ω.

Second. The amount of kinetic energy of the moving actuator during braking converted to a stop and electric power stored in the energy accumulator.

To compare the energy consumption, a series of experiments in which measured the amount of energy W_{P100} consumed to drive acceleration up to 3000 min^{-1} (100 Hz) and the amount of energy returned to the storage of energy during braking with the same speed to a stop W_{T100}.

Return rate (recovered energy) for the first case:

$$K_{P1} = \frac{W_{T100}}{W_{P100}} = \frac{794}{3281} = 0{,}242 \quad (5)$$

Thus, the drive can be returned to an average of 24.2% spent on acceleration energy.

In the second case, to calculate the efficiency of recovery known to be the kinetic energy of the moving actuator.

Calculate the energy of a moving actuator can determine the energy loss in the process of acceleration and calculate the energy of the rotating masses drive during acceleration. To determine the loss of drive during acceleration recorded loss characteristic. The measurements are performed using a recording system L-Card.

Total losses in the drive for over clocking up in 1061 by J.

The kinetic energy of motion with a frequency of 100 Hz (3000 min^{-1}) is equal to

$$W_K = W_{T100} - W_{\Pi} \quad (6)$$

Efficiency of recovery, there may be calculated by the formula

$$K_{P2} = \frac{W_{T100}}{W_{P100} - W_{\Pi}} = \frac{794}{3281 - 1061} = 0{,}357 \quad (7)$$

General conclusions on the test

Effectiveness of the kinetic energy recovery drive movement was 35.7%, compared with the real performance characteristics given value is high enough, usually in asynchronous traction drives value recovery is 15-35% [8-11].

Tests with regenerative braking with higher speed (4.5 thousand rev / min. Before stopping) showed low energy gain, which indicates the restriction of the maximum inverter current and in accordance with the algorithm of recovery is limited, stop the drive motor stator occurs fed DC . This fact must be taken into account in the calculation algorithm of the theoretical model.

Literature:

1. Aleksandrov, IK Evaluation of the energy efficiency of the internal combustion engine under transient operating mode / IK Alexandrov, OL Belkov, VA Rakov // Bulletin of mechanical engineering. - 2008. - № 6. - pp.17-20.

2. Rakov, VA Determine the required power engine hybrid engine / VA Rakov, AV Smirnov // Bulletin of mechanical engineering. - 2010. - №4. - S. 32-35.

3. Rakov, VA Hybrid car. Economical city car concept. Effectiveness research. Designing. Calculations: monograph / VA Rakov. - Saarbrücken: LAP, 2012. - 104.

4. Rakov, VA Mathematical model to calculate the main parameters of the hybrid power plant on the specified operating conditions / VA Rakov // Automation and energy efficiency engineering and metallurgical industries, technology and

reliability of machines, devices and equipment: Materials eighth Intern. Scientific and Technical. conf. - Vologda: VSU, 2013. - pp. 175-180.

5. Rakov, VA Improving energy efficiency of hybrid engines sequential circuit. / VA Rakov // Alternative energy in road transport: problems and prospects of sustainable use: Sat scientific. Works based on the International scientific-practical. conf. - Voronezh, 2014. - T.1. - pp.112-117.

6. Rakov, VA Improving energy efficiency of hybrid engines with parallel layout elements / VA Rakov / / Alternative energy in road transport: problems and prospects of sustainable use: Sat scientific. works based on international scientific-practical conference. - Voronezh, 2014. - T. 1. - pp.118-123.

7. Rakov, VA Improving energy efficiency of hybrid engines with parallel layout elements / VA Rakov / / Alternative energy in road transport: problems and prospects of sustainable use: Materials Intern. scientific-practical. conf., - Voronezh, 2014. - Vol.1, pp.118-123.

8. Rakov, VA Results of the study recovery hybrid propulsion systems / VA Rakov / / Automation and energy efficiency engineering and metallurgical industries, technology and reliability of machines, devices and equipment: Materials ninth Intern. scientific-tech-th Conf., - Vologda: VOGU, 2014., pp.186-190.

9. Rakov, VA The test results of hybrid propulsion systems of various schemes on a cycle of motion P-1.0. / VA Rakov // Automation and energy efficiency engineering and metallurgical industries, technology and reliability of machines, devices and equipment: Materials ninth Intern. scientific-tech-th Conf., - Vologda: VOGU, 2014. - pp. 181-186.

10. Rakov, VA Study recovery efficiency hybrid power plant. / VA Rakov / / Energy: Efficiency, reliability, security: Materials XIX All-Russian Scientific-Technical-th Conf. / Tomsk Polytechnic Univ-t. - Tomsk: Publishing House Ltd. "Scan", 2013. – pp.138-141.

11. Rakov, VA Research and testing hybrid vehicle engines / VA Rakov, AV Smirnov, DA Kolesnichenko // Youth. Science. Innovation: Proceedings of the I International Scientific and Practical Internet Conference. - Penza: Penza branch ITBU 2010. - pp. 246-257.

J21411-004

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TOOLS DIAGNOSIS TECHNICAL STATE HYBRID ENGINES

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This article discusses the problem instrumental support for maintenance of hybrid cars.

Keywords: diagnosis of technical conditions, the hybrid engine, technical condition parameters.

State service infrastructure of hybrid cars in Russia is characterized by underdevelopment and technical base, a small number of service stations that specialize in maintenance and repair of hybrid engine (HE).

Technical condition diagnostics and troubleshooting, vehicles with HE currently difficult and is performed by checking piecemeal, which increases labor costs and complicates the process of diagnosis. Insufficient level of confidence in the diagnosis leads to errors during repair damage and expensive elements of a hybrid drive. Repair work complicated by the absence of the necessary diagnostic equipment.

Primary means of technical diagnostics (TD) hybrid propulsion vehicles, as well as any modern car is onboard diagnostic system, diagnostic scanner to read the fault information and current values of the parameters of elements of the HE. In developing the full post for service vehicles with HE should be considered especially diagnosing nodes HE (such as electric motors, inverters, high-voltage energy storage, transmission, electronic control system).

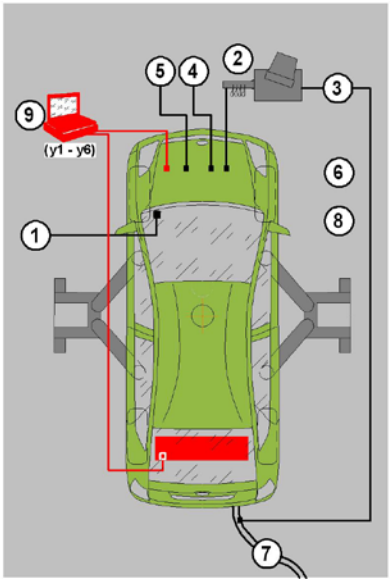
For the diagnosis of the technical state of HE was previously proposed a method of exit tests for a given cycle [1-6]. The technique is based on the simulation speed and load modes of operation of the car, the definition of output parameters and comparing them with standard quantitative values obtained by calculation. Diagnosis is carried out directly in the operation of the vehicle.

TD used car in motion are portable in accordance with GOST 25176-82 they are subject to the following requirements: TD power must be taken from the DC voltage sources 12 and 24; equipment weight, not exceeding 25 kg.

STD diagnosis for individual elements of the HE. Voltmeter, ohmmeter, proximity sensor current in the circuit, a device for measuring the internal resistance of the current sources, the device for measuring the capacitance elements and sections of CDH, multi-channel oscilloscope, Charger for CDH (Fig. 1).

For diagnostic and repair work at service stations decisive factor is the speed and accuracy of work. For these purposes, can be used the method developed [7-12].

Experimental studies were carried out in a laboratory setting, to which were attached a number of sensors which measure the energy parameters, in practice it can be difficult. For these purposes was investigated electric car Toyota Prius, is the foundation of most of the fleet with the HE in Russia at the moment. Service bulletin service vehicles provides for diagnostic tests and troubleshooting, account being taken of the list of alleged owner of the work. Diagnosis involves identifying faults at an early stage, thus avoiding the occurrence of a failure during operation and a serious problem.



Standard diagnostic equipment

1. Diagnostic Scanner
2. Motor-tester ICE
3. Analyzer
4. Kompressometr
5. Gauge fuel system
6. Apparatus for testing and pro-washing with fuel injectors
7. Setting for exhaust hoods
8. Workbench

Additional diagnostic equipment

9. Motor-tester high systems

Fig. 1. Scheme post diagnosis of a hybrid car

Troubleshooting using methodology. Set of activities includes the following works: Adjust the tire pressure; connection diagnostic scanner; warm engine to operating temperature; connection of the sensor current and voltage power circuit HVB; connection of the sensor voltage and current to the DC bus of the inverter MG1, MG2; connect the vehicle speed sensor; connection of the measuring system; entry vehicle load (the number of additional passengers and cargo with an accuracy of ± 20 kg); test the vehicle on the test site, or test stand traction qualities. During the test, recorded instantaneous velocity and sensor voltage and current; after the test data are entered into the analysis program results.

Fig. 2. Monitoring the current in the DC bus voltage of the inverter

Data recording process is controlled by using a dialog box L-Graph. When testing engineer diagnostician can control the visual elements of the drive. Such as failures in the chain charge of ICE →MG1→ In, as shown in Figure 2. Similarly, the ability to control the parameters of the drive: the pressure in the fuel supply system, the composition of the exhaust gases, instantaneous fuel consumption, etc. Thus, the maintenance and repair of hybrid engine of vehicles can be carried out using the universal means of diagnosing engine and power electronics, as was done on the car Toyota Prius [11-12].

Skill level engineer diagnostician serving hybrid propulsion systems must comply with category 4 electrics and third group of electrical admittance.

Literature

1. Rakov, VA Technical evaluation of hybrid propulsion vehicles / VA Rakov // Proceedings SWorld. Proceedings of the international scientific-practical conference "Modern lines of theoretical and applied research in 2012." Issue 1. - Odessa: Kuprienko, 2013 - Volume 1. - pp. 102-107.

2. Rakov, VA Rationale for the methodology for assessing the technical condition of hybrid propulsion systems Car / VA Rakov // University Science - region: Materials XII All-Russian scientific conference. - Vologda: VSU, 2014. - pp.192-194.

3. Rakov, VA Investigation of operational reliability hybrid propulsion vehicles / VA Rakov // Transport company. - 2013. - № 4. - pp. 44-49.

4. Rakov, VA Diagnosing hybrid propulsion systems for vehicles operating parameters and associated processes / VA Rakov // Safety and structural design in engineering and construction: proceedings of the International scientific conference (14-15 October 2013) - South-West. Reg. Univ.: Kursk 2013. - pp. 399-403.

5. Rakov, VA Selection of parameters for assessing the technical condition of hybrid propulsion systems Car / VA Rakov // Proceedings SWorld. - Issue 4. Volume 3. - Odessa: Kuprienko SV, 2013 - pp.21-26.

6. Rakov, VA Investigation of the factors affecting the reliability of hybrid propulsion vehicles / VA Rakov // Engineering - the foundation of modern innovation system, II International Scientific. Conf. conf., March 25. 2013 / Volga Research Center. - Yoshkar-Ola, 2013. - pp. 128-130.

7. Rakov, VA Improving methods of diagnosing internal combustion engines / VA Rakov // Ledentsovskie reading. Business. Science. Education: Materials III Intern. scientific-practical. conference, Vologda: Vologda Institute of Business, 2013. - pp. 270-273.

8. Rakov, VA Parameters estimation of technical condition hybrid propulsion systems Car / VA Rakov / / Youth. Science. Innovation: Proceedings of the VIII International Scientific and Practical Internet - Conference - Penza: Penza branch 2013-2014. - pp.281-288.

9. Rakov, VA Study of factors affecting the maintenance intervals of hybrid cars. / VA Rakov / / Alternative energy in road transport: problems and prospects of sustainable use: Sat scientific. works based on the International scientific and practical conference - Voronezh, 2014. - T. 1. - pp.307-312.

10. Rakov, VA Means of diagnosing technical condition hybrid propulsion systems / VA Rakov // Automation and energy efficiency engineering and metallurgical industries, technology and reliability of machines, devices and equipment: Materials ninth Intern. Scientific and Technical. conf. - Vologda: VSU, 2014. - pp.177-181.

11. Rakov, VA Diagnosing hybrid propulsion systems for vehicles operating parameters and associated processes / VA Rakov // Safety and structural design in engineering and construction: proceedings of the International scientific-practical conference. - South-West. Reg. Univ., Kursk, 2013. - pp.399-403.

12. Rakov, V.A. Assessment of technical condition hybrid engine CARS. / V.A. Rakov // Author (s), 'Title of Paper, "in Modern scientific research and their practical application. - Odessa, 2013. - Vol.J21311. URL: http://www.sworld.com.ua/e-journal / J21311.pdf.

J21411-005

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GLOBALIZATION ON TRANSPORT: PROBLEMS AND PROSPECTS OF THE RUSSIAN TRANSPORT SYSTEM

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Abstract. This paper deals with the effect of economic globalization on the transport and defines the role of the Russian transport system in the creating of the Global transport universe. The issues of the national transport system, preventing its integration into the Global transport universe, are researched. The analysis of the Russian transport system future development is carried out.

Key words: transport system, globalization, integration, Global transport universe

Transport, as the serving industry, on the one hand depends on general economic trends, on the other hand, it extensively determines the pace of economic development in a settled course. Therefore the concordination of the strategic objectives of regional development of the Russian transport system and the "integration into the global transport universe" [1] in the process of globalization of the market of transport services is very important question.

The global market focuses on the needs of the entire world community. Currently, however, the process of creation the unified commodity-transport universe is concentrated in the European part of continent. This is due to the fact that some countries have adopted anti-globalization policies, some - does not have sufficient resources to provide the required level of transport service. Russia belongs to the second type of countries, despite the possible negative consequences of integration for national carriers, expressed in expanding access for foreign transport companies to the Russian market and the weakening of state protection (removal of administrative and tariff wall). Nevertheless, the creation of the integrated economic system, the emergence of transnational companies, the growing interdependence of developed economies from each other, the need to create a common information space indicate the inevitability of globalization and its impact on the Russian transport system.

Today Global transport universe is a system of transport-warehousing and transport-commodity systems connected by a network of international transport corridors, ensuring the high quality transportation services demand in accordance with the ecological and safety standards. Existing problems of regional transport systems do not allow complying with the world standards. Therefore, before proceeding to the execution of the objective of the Russian Transport strategy for the period up to 2030 - "Integration into the global transport universe and realization of transit potential of the country," - the competitive position of national carriers should be strengthened.

The first obstacle to achieving this goal is the unbalancing development of national transport system. That means, there are disparities in progress of different modes of transport, in the low pace and space disproportion of transport

infrastructures development. For example, since 2010, there has been an innovative activity and a significant increase in passenger rail and air transport, while the inland waterway transport is still in stagnation. But for all that, the growth the amount of passengers (the index growth rate since 2010 is from 13% to 24% [4]) take place when the technological equipment in the field of air traffic management is still obsolete, 251 civil aerodromes is still unused [5], more than 50% of fixed assets are wear out.

The second problem is a technical and technological lag of the Russian transport system. Building of the required transport infrastructure, including transport-storehouse places, is going slower than it's required due to the pace of transport work growth and scientific-technological progress. In addition, transport enterprises specialized in inland carriage, have low rates of innovation activity, preferring extensive growth path. This directly affects the inefficient ecological, safety and technical performance indicators of the transport work made by national enterprises. The auto transport is still produced 80% of all air pollution in large cities despite the measures taken by. The number of car accidents in 2013 was 142.2 per 100 thousand persons. Wear of fixed production assets of transport enterprises ranges from 30% to 35% for the last 5 years. The value of this index runs up to 50% in inland waterway-, auto- and air transport. [6] Choosing not innovative development, many small and medium transport enterprises become less competitive in the international transport market due to the low quality of service.

The third problem is the lack of a common information space for the transport sector, which is unacceptable in the context of globalization. Engineering and implementation of automated databases, the navigation and information software modeling road routes, the introduction of the automated control Russian transport system are still be just projects and do not have a mass application. Deficiency and unreliability of transport statistical information are caused with the unwillingness to disclose the real financial and economic enterprises performance. The lack of complete statistical data and accountant balance of transport sector will not reliably predict, plan, simulate traffics and systems based on mathematical methods in order to choose the best options.

The decision of the referred above complex problems become more difficult due to the lack of qualified professionals in transport sector. The auto transport industry is represented by small businesses and entrepreneurs, whose chief managers, as usual, have no special transport graduate education and manage their business, relying only on intuition and personal experience. This leads to a significant part of loss-making enterprises: 61% of freight auto transport enterprises had a negative financial result in 2013 year. [6]

Integration of the Russian transport system also requires the adoption of national legislation and technical and technological transport standards to the international agreements and conventions:

• agreements and conventions of European economic commission of UNO Europe regulating relationships between subjects of auto, rail, inland water transport markets;

• agreements and conventions of the International Civil Aviation Organization regulating relationships between subjects of air transport market;

• agreements and conventions of the International Maritime Organization, regulating relationships between subjects of sea transport market.

Such methods as the conclusion of multilateral agreements and systematization of transport legislation in accordance with the procedure «Transport Acquis», developed within the legal framework of the European Union, may allow to eliminate the current national transport legislation system shortcomings.

Despite the difficulties and problems, the Russia transport system is actively developing. During the first two quarters of 2014 year 1473 km of automobile roads were built and reconstructed, production capacity of Russian seaports increased up to 20 million tons, 100 km of railway tracks and power lines, 3 airport complex were put into operation. Growth made and upgraded highly productive workplaces cumulatively amounted to 50 thousand in 2014 in relation to 2012. [2]

Development of cluster production gives the functional evolution to the transport and logistics networks, which are the link for the relating businesses. Innovative clusters play the special role in the integration processes. There are approved 25 innovative regional clusters in the Russian Federation, including aircraft, automotive and shipbuilding clusters.

The geographical setting of Russian Federation contributes to the appearance of transport transnational companies, second tier which currently includes only four: rail company JSC "Russian Railways", shipping company JSC "Sovcomflot", a group of transport companies "N-Trance" and a group of airline companies "UTair" .

Russia also is very important for the building of international transport infrastructure and supporting Euro-Asian economic relations. International transport corridors, such as "North-South", "Transsiberian", "Northern Sea Route", the Pan-European transport corridors №1, №2, №9, «Primorye-1", "2-Primorye" pass through the territory of Russia. Further integration into the international transport corridors will provide access to information, technological and financial extra resources to develop the Russian transport system. According to the scenario of European community transport-oriented strategy, directed to develop "growth poles" - the European Union (EU) and the Asia-Pacific Region (APR), Russia is creating a common transport market with these regions by including the national transport system in the net global transport cluster "Transnet". The implementation of this strategy involves the creation of the necessary communicative-transit transport complex in the Far East, North-West and South of Russia. But it does not solve social and economic problems of the country in common.

By 2030, in the case of innovative development way of the Russian Federation Transport Strategy, it is planned to increase the amount of transit cargo through the territory of Russia by 2,5 times and bring it up to 100 million tons per year, transport services export - almost by 4 times. According to optimistic forecasts, by 2030 the share of Russian carriers in the international cargo transport services should be 50%, the share of exports in air transport services - 30%. [1]

Thus, the Russian transport system plays a significant role in the process of economic globalization. Therefore, the problems, hindering the integration of the

national transport system in the Global transport universe, are in the interests of Russia, and economically dependent countries of the EU and APR too. But the issue is still open: on what conditions will be the integration process? Or resources of the Russian Federation will come under the control of the industrially more developed countries as a result of Washington Consensus policies, or control over resources will remain in the state, which declared national interests above the interests of the world economic country-leaders.

References:

1. Transport Strategy of the Russian Federation for the period up to 2030, approved by the Decree of the Government of the Russian Federation of November 22, 2008 № 1734-p.

2. Report for the II quarter of 2014 the implementation of the Action Plan of the Ministry of Transport of the Russian Federation, aimed at the solution of the tasks set out in the Presidential Decree of May 7, 2012 № 596-606 and main government activities for the period till 2018.

3. Noskov V.A., Noskov I.V. The theory of economic universe and the development of transport infrastructure in the region // Bulletin of the Samara State University of Economics. 2009. N 5 (55). P. 73-77.

4. Business Aviation portal [electronic resource]. URL: http://www.ato.ru/ (date accessed: 08/21/2014)

5. Information and analytical materials of the Ministry of Transport of the Russian Federation [electronic resource]. URL: http://www.mintrans.ru/ (date accessed: 21/08/2014)

6. Federal State Statistics Service [electronic resource]. URL: http://www.gks.ru/ (date accessed: 08/21/2014)

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J21411-006

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ANALYSIS OF PRACTICES OF PURCHASING VESSELS BY WAY OF LEASING ON TERMS OF BAREBOAT CHARTER

This article is represented in the form of analysis of practices of long lease as one of the methods of purchasing vessels. It was implemented as a massive commercial project by the Ministry of Maritime Fleet of the USSR in 1973-1991. This leasing was also partially applied when building vessels of Ukrrichflot JSSC in 2000-2008. Well-worded and generalized conclusions of such analysis may be of interest when solving tasks of expanding the Ukrainian fleet amidst state budget deficit.

Keywords: bareboat charter leasing, purchase and buying of vessels, chartering of vessels, lease payments, credit resources.

Expanding of fleet, either by the state or by shipping companies, require considerable financial resources. In order to optimize their use, the international practice developed several methods of financing the purchase or construction of vessels [1,2]. The centerpiece of these methods is a form called long-term lease of vessels, during which the credit granted in the amount equivalent to the cost of the leased vessel shall be repaid. Such form of purchase of vessels is called leasing or bareboat charter leasing, which depends on the characteristic features of maritime transport. A lot of maritime transport workers, including those who implemented similar commercial project in the past, suggest using this form of lease for purchasing vessels [4,3]. Solutions for expanding the fleet via bareboat charter or leasing are well-grounded in several studies [5,6]. Many studies are dedicated to very specific yet important issues of the leasing under review: methods of economic evaluation of making decision on purchasing vessels as per this commercial scheme [2,7,8]. Finally, the resolutions of the National Security and Defence Council of Ukraine dated May 16, 2008 state the necessity of using long-term lease of vessels for expanding the country's fleet. The National Security and Defense Council of Ukraine offers the government "to deem it expedient to create a state-run leasing company in order to stimulate the formation of and development of national shipowners…".

However, in spite of such attention to the issues of expanding the fleet via bareboat charter leasing, the exploratory studies and conclusions of its implementation practice have not been generalized and have been used insufficiently. Some studies [10,11] only give total results of such purchase of foreign vessels. The **purpose** of this article is to generalize the practices of purchasing vessels on terms of bareboat charter in the USSR and Ukraine, and to formulate, on its basis, the conclusions which will help to organize an efficient implementation of similar projects when restoring the Ukrainian fleet.

Of course, the project implemented in 80 - 90s by the Ministry of Maritime Fleet for purchasing of foreign vessels through a leasing scheme is, in many way, unique and instructive; it enriched the maritime practice greatly. The principal feature of it was that it was held on the initiative of and in the best interests of the state which created all necessary conditions to make this new method of expanding domestic

shipping companies' fleet most efficient. The government vested this task in the MMF to be carried out in the foreign market and it issued a special permit to lease foreign vessels in bareboat charter with the right of repurchase. In view of the fact that no legal framework or practice existed for the implementation of this task, some issued were solved at various levels. The country's maritime law regularized the right to form the fleet of the USSR with bareboat chartered vessels; this legalized this type of commercial activity. Governmental documents in the maritime industry clearly defined that leasing foreign vessels in bareboat charter aims to replenish the domestic fleet with various vessels without using budgetary funds. I.e., the costs of such purchase of vessels shall be reimbursed only by the income of their operation while in lease.

New forms of loans granted by the Vneshtorgbank (VTB) and the procedure of their repayment. The institutional mechanism and a special nature of servicing the settlements for bareboat charter leasing of vessels, providing them with fuel, spare parts, making repairs etc. were established at that time. The characteristic feature of this purchase of vessels on these terms id the fact that the bareboat charter lease in the MMF was carried out for the first time, the number of transactions, of acquired vessels and their types is enormous, and the project implementation lasted for a long period (nearly 17 years). Finally, this work was carried out on a free freight market in compliance with the state monopoly on foreign trade by lease holders (buyers) of the vessels. The project should be divided into two periods by the character of organization of bareboat charter and by their operation while in lease for the entire duration of the project. The first one lasted from 1973 to 1986, and the second one - from 1987 to 1990.

The first period was distinguished by the fact that all commercial activity under review was carried out with the direct participation and the strict control of the central management bodies of the MMF represented by: State Self-Supporting Associations (SSSA), Offices of Fleet and Port Operations (OFPO), Economic Planning Administration (EPA) etc., as well as the exclusive broker - Sovfracht All-Union Association (Sovfracht Foreign Trade Association). Their functional responsibilities as to the lease of vessels and their operation were exclusively regulated by specifically issued orders, directives and instructions of the MMF and shipping companies.

In order to optimize organizational and management efficiency of the entire vessels' lease and operation process, the MMF and shipping companies created subdivisions for work with bareboat chartered vessels. This management structure looked as follows. Sovfracht Foreign Trade Association was the exclusive charterer (lessee) of foreign vessels on the part of the MMF in all bareboat charter transactions. Commercial transactions at Sovfracht Foreign Trade Association were carried out by a specially created subdivision: Commercial Transactions Bureau (CTB) which was given very wide powers.

To finance the acquisition of vessels through leasing, Currency Revolving Fund of Commercial Transactions (CRFCT) was created in the structure of the Ministry of Maritime Fleet. It was formed with the participation of the shipping companies which transferred a part of the currency funds received from the operation of bareboat

chartered vessels to its account. The funds were used a par with bank loans to pay for the lease or purchase of vessels.

Payment of the vessels' leasing to foreign companies, as well as repayment of loans was done by a specialized Central Currency Agency (CCA) of the MMF. It kept records of the income and expenses for each leased vessel and shipping company; it also controlled the flow of the CRFCT funds. At some SSSA, leased vessels were monitored by specially created subdivisions: bareboat charter fleet operation departments. They managed the production, economic, planning and financial, technical activities of the SSSA fleet; they also coordinated the actions of SSSA and shipping companies in organization of functioning of this fleet upon transportation of domestic and foreign goods.

In some shipping companies (Black Sea Shipping Company, Novorossiysk Sea Shipping Company), operation of bareboat vessels was organized by specialized self-supporting operational vessel groups - bareboat charter SSSOVG. Their main task was to ensure the efficient operation of bareboat chartered vessels assigned to the shipping company.

The established procedure of bareboat chartering and operation, for the period from 1973 to 1986, can be summarized as follows.

Since any foreign tonnage was purchased with a specific purpose for specific shipping companies, they were customers in conclusion of lease contracts for specific types of vessels. To perform such freight operations, shipping companies gave Sovfracht Foreign Trade Association orders which indicated which vessels (type, size, specifications) should be taken in bareboat charter.

Given the fact that the bareboat charter lease market is a closed one, Sovfracht Foreign Trade Association built its work through foreign brokers. In the first place, they were instructed to conduct appropriate market quotes, and after obtaining the required information, the association picked out proposals of available vessels and transferred them for consideration to the shipping companies being the customers.

The latter prepared a well-grounded feasibility report for selecting an acceptable proposal and a calculation of economic expediency of conclusion of a lease contract for this vessel. Such feasibility reports coordinated with Sovfracht Foreign Trade Association were sent to SSSA which gave its permission or refusal to conclude this bareboat charter contract. Justifying calculations of expediency of leasing of vessels were performed using the appropriate "Methods" [8].

The criterion of feasibility of conclusion of a bareboat charter contract in such "Methods" was based on a comparison of the values of net foreign exchange earnings from operation of the leased vessel and the expenses for its lease. A positive decision was made provided that the resulting net currency revenue from operation of the vessel for the period of the lease should fully cover the costs of the payment of the lease and the costs for loan resources. $\Delta F \ T$ I.e., the following condition shall be met:

$$\sum_{t=1}^{T} \Delta F \geq \sum_{t=1}^{T} K, \tag{1}$$

where K are the costs for lease and loans for the period T.

These costs are defined as follows

$$\sum_{t=1}^{T} K = K_c + \sum_{t=1}^{T} \Delta K; \tag{2}$$

where K_c are the costs for compensating the market value of the leased vessel;

ΔK is the payment for using load resources for the period T.

The net foreign currency earnings for the period T is

$$\sum_{t=1}^{T} \Delta F = \sum_{t=1}^{T} F - \sum_{t=1}^{T} R; \tag{3}$$

where F is the income from operation of the leased vessel for the period T;

R are the total expenses for operation of the vessel for the period of lease T.

In their turn, the total operating expenses are composed of commercial $\sum_{t=1}^{T} R_{pe}$ and technical $\sum_{t=1}^{T} R_{ne}$ operation expenses, i.e.

$$\sum_{t=1}^{T} R = \sum_{t=1}^{T} R_{ne} + \sum_{t=1}^{T} R_{pe}; \tag{4}$$

Upon 100% use of loan resources, the amount of payment towards them is defined as follows

$$\sum_{i=1}^{T} \Delta K = \left[K_C - \frac{K_C}{T}(t-1) \right] * \kappa; \tag{5}$$

Inserting in (1) accordingly (3), (4) and (2), (5), we will get a model of economic feasibility criterion of the lease of vessels under bareboat charter in such expanded form:

$$\sum_{t=1}^{T} F - \sum_{t=1}^{T} R_{ne} - \sum_{t=1}^{T} R_{pe} \geq K_C + \left[K_C - \frac{K_C}{T}(t-1) \right] * \kappa; \tag{6}$$

When making final decision on leasing a vessel, apart from the economic criterion, its technical condition and compliance with its operational requirements were taken into account. After this, the time, place and procedure of vessel's inspection were coordinated with the shipowner. The inspection was carried out by the shipping company's and the Register's experts who defined, upon inspection, the list of necessary repairs and their cost. Then an inspection report was made, using

which, Sovfracht Foreign Trade Association gave its final conclusion as to the lease of the relevant vessel. Upon a positive decision, a bareboat charter in written form was entered with the shipowner.

The structure of organization, commercial and financial support of the lease of vessels upon bareboat charter is shown on Fig. 1.

Upon chartering any vessels under construction, the client (a foreign shipowner) transferred Sovfracht Foreign Trade Association a contract for construction and a contract for financial support of the vessel's construction. In accordance with their terms and conditions, the representatives of Sovfracht Foreign Trade Association, of the Register and of the shipping companies controlled and supervised the building, and then accepted the ready-made vessel from the builders. The final procedure was also formalized as a bareboat charter contract.

Apart from the main vessel lease contracts, which is bareboat charter, the transaction was accompanied by a loan agreement. It is a separate contract, apart from the bareboat charter, between the charterer and the bank, but it restricts, in some degree, the rights of the charterer when operating the vessel.

The vessels taken in lease were assigned to the relevant shipping companies by special orders; they were registered under the USSR flag and under new names.

The shipping company carried out commercial and technical operation of the leased vessels like others, but with a glance to the peculiarities related to the liabilities to make all timely payment in the relevant currency for the leasing and the loans. They provided the vessels with all which was necessary for their efficient operation, namely: they maintained the hired crews, made repairs, carried out technical maintenance, they conducted classification and insurance of the vessels, provided them with spare parts, bunkering, purchased oils, service water etc.

The shipping companies collected the freight, made payments for sublease and other income of which the bareboat charter lease was paid; they paid the operating costs and transferred monies to the accounts of CRFCT. Depreciation charges, fund charges, surcharges to currency revenues and expenditures, as a special kind of financial operations used for ordinary vessels of the shipping companies did not apply to the bareboat chartered vessels. Planning and reporting of the shipping companies on revenues and expenditures associated with the operation of the leased vessels somewhat differed from other tonnage, giving the former some preferential

conditions. Bareboat chartered vessels, as a rule, were used to transport cargoes of foreign charterers or in foreign sublease. However, if the freight rates in the international market decreased below the listed rates, the vessels were transferred to domestic foreign trade cargo transportation.

Sovfracht Foreign Trade Association and SSSA informed the shipping company on the status and prospects of development of the freight market conditions and made suggestions about the appropriate ways or forms of use of the leased vessels, but the final decisions on their operation were taken, in consultation with SSSA, by the shipping companies.

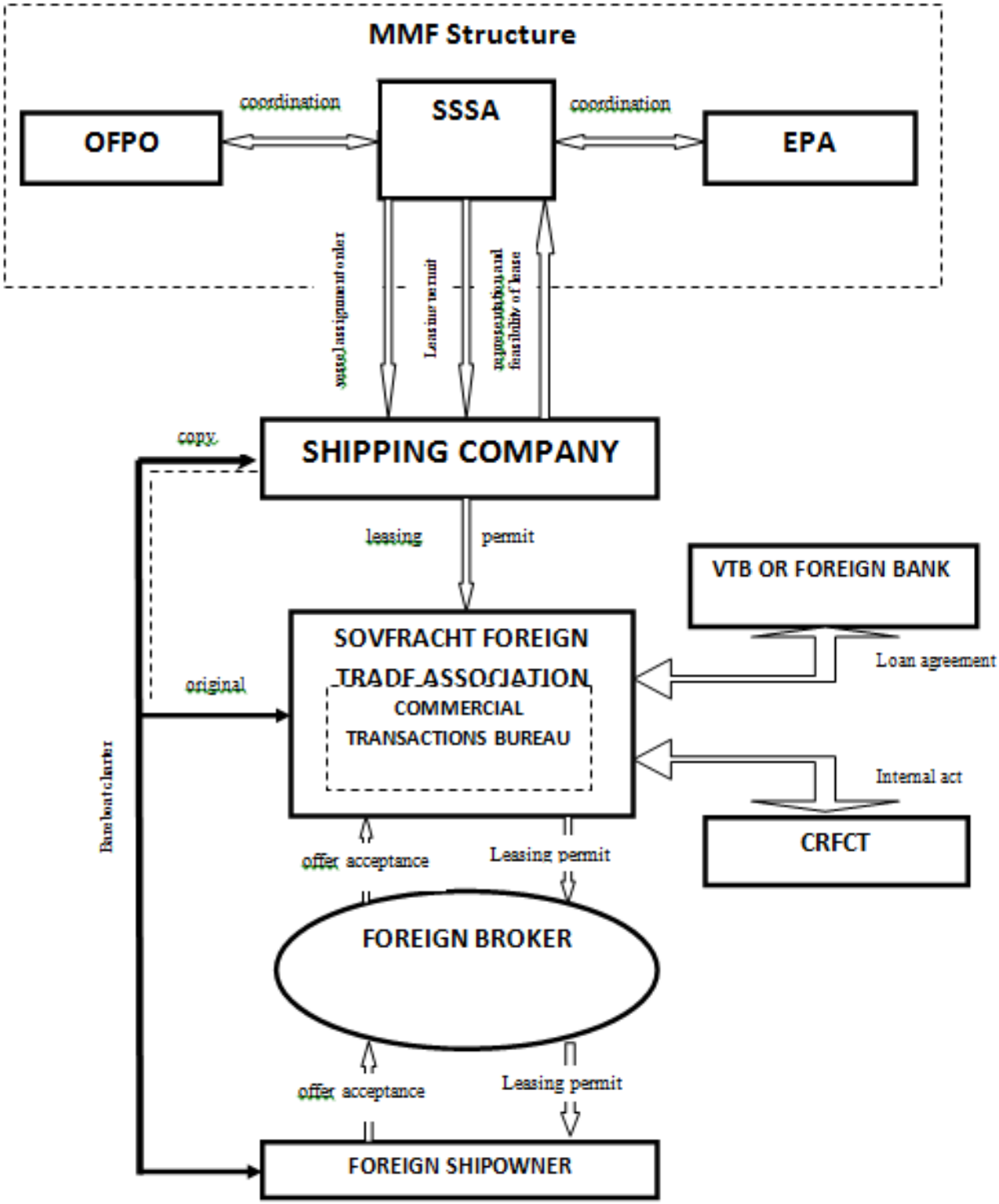

Fig. 1. Organizational and commercial structure of lease of vessels under bareboat charter

After paying the last installment to the shipowner or to the bank for the leased vessels, the latter were transferred, by an order, to the shipping company which operated the relevant leased vessels.

Some of the results of the 10 years [9,10] of the commercial project held in 1973-1986 are shown in the table below.

Summarized data on the project implementation	Values of the data
Leased tonnage: - number of cargo vessels - deadweight, thousand ton	 84 773.1
Tonnage credited to the balance: - number of vessels - deadweight, thousand ton	 19 320.0
Amount of payments for the vessels, mln roubles - growth of the fleet funds, mln roubles	185.3 195.2

During this period, different types of vessels, both old ones (used) and newly-made, were taken in bareboat charter. The used vessels, as a rule, were not older than 10 years. The vessels' deadweight varied within a considerable range: dry cargo vessels: 16 to 73 thousand ton; tankers: 32 to 112 thousand ton; passenger vessels: 21 to 25 thousand ton. Many chartered vessels were of the same type. The terms of leasing were rather short. Old vessels were in lease for 2 to 6 years, while new ones were in lease for 8 years. The amount of payments for a single vessel was 1.0 to 20.0 mln USD. The perfection of organization of foreign trade activity which began in 1987 affected and changed the activity of Sovfracht Foreign Trade Association. First of all, it ceased to be the exclusive lessee of the vessels under bareboat charter. One of CTB was excluded from it; soon it was converted into a separate specialized Joint-Stock Commercial Enterprise "Joint Commercial Fleet" (Sovkomflot JSCE). It defined the second stage of the project of purchase of foreign vessels as per the scheme of bareboat charter lease. Sovkomflot JSCE, in addition to the main activity in leasing of vessels, started transactions in leasing and purchase of vessel equipment, containers and other property for the maritime branch. Sovkomflot JSCE started building its activities in long term lease of vessels based on market relations, both with the MMF shipping companies, some of which became its shareholders, and with foreign shipping companies. In its main activities - leasing of vessels with the right of redemption - Sovkomflot JSCE is not only a lessee, but a broker in purchasing or selling of vessels, as well as a manager with broad powers to operate vessels, a shipowner accepting the purchased vessels etc. When leasing vessels under bareboat charter, these chartered vessels were transferred to operation to both domestic and foreign shipping companies. In order to formalize such relations, Sovkomflot JSCE developed a special form of management agreement and it also used Shipman BIMCO form for this purpose.

The vessels acquired through leasing became the property of Sovkomflot JSCE or were transferred to the domestic shipping companies or foreign shipping companies which issued orders for the lease of vessels and often were involved in

their operation during the lease period. This business stopped with the collapse of the USSR. However, Sovkomflot JSCE not only survived, but also became a major Russian shipping company. On the results of the activity of Sovkomflot JSCE show the following data. By early 1991, it possessed of 3 million tons deadweight tonnage; it also transferred vessels and various equipment for an amount of USD 500 million [11] to other companies in the industry.

In the independent Ukraine, bareboat charter lease of vessels has been used occasionally. However, companies do not have much experience in it. Since 1990, the shipping companies of Ukraine, as well as of other CIS countries, started letting vessels on lease, instead of leasing them under bareboat charter. The reason was the absence, during that period, of necessary cargo base, and sometimes, large external debts, which were covered by giving the vessels in bareboat charter with the right of redemption. A significant number of vessels was leased for operational bareboat charter (without the right of redemption). For example, in 1996 the Black Sea Shipping Company had about 25 different vessels in bareboat charter, which was about 18% of the total tonnage of the shipping company.

The Ministry of Transport of Ukraine made an attempt to purchase vessels through bareboat charter in 2001. For this purpose, it created a special shipping company in the form of association entitled “Ukrainian Commercial Fleet”, to which a number of vessels previously owned by Ukrainian Shipping Company State-Run Enterprise and by Sea Trident Financial Holding was transferred. Further expansion of the fixed assets of the company was planned on the account of leasing of foreign vessels. The State Leasing Fund was created for this project. But in 2002 this fund was only given 36% (40 mln.) of the planned amount, which was the beginning of the end of the project of Ukrainian fleet extension by leasing. An efficient practice implemented in 2000-2008 was the project of extension of the fleet of Ukrrichflot JSSC. It used bareboat charter lease as a form of transfer of vessels to the JSSC. The participants and the organizational and commercial scheme of this project are shown in Fig. 2.

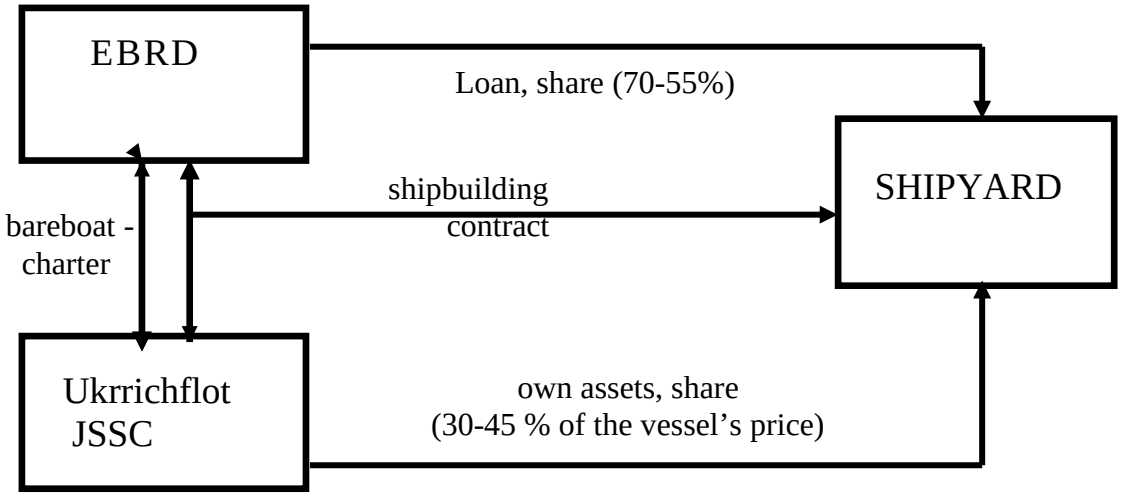

Fig. 2. Organizational and commercial scheme for the construction and leasing of the vessels of Ukrrichflot JSSC.

Ukrrichflot JSSC received loans from the European Bank for Reconstruction and Development (EBRD) by several tranches with the purpose of vessels construction. The loan for the first series of vessels having deadweight of 3800 t (m/v DESNA type) was 70% of the vessels' price, and 30% of them were paid by the company itself. These vessels, containing 7 units per series, were built at a Romanian shipyard during five years (2000-2005). Then, by order of Ukrrichflot JSSC, a series of vessels was built at Damen Shipyards Ocean JSC; it consisted of nine vessels with deadweight of 6300 t each (m/v BUG type). The construction was financed by payment of 55% (EBRD loan) and 45% (at the company's expense). Crediting was made by two tranches and, accordingly, 4 vessel were built in 2005-2006 and 5 vessels were built in 2006-2008.

One of the features of this project was the fact that the vessels built were leased to Ukrrichflot JSSC under bareboat charter. The title of the lessee (JSSC) to the vessels was transferred after paying the last installment towards the EBRD loan.

In this case, bareboat charter lease was in the interests of both JSSC and EBRD. The former got the vessels right after their commissioning and the bank, by the bareboat charter, was provided by a mortgage guarantee for a timely and complete return of the loans issued.

This commercial project showed that purchasing new vessels using loans for their building, with subsequent transfer to bareboat charter can be carried out efficiently on a small scale by individual companies without participation of the state. This last fact differentiates this scheme (Fig. 2) from the scheme of purchasing new vessels used by the MMF of the USSR.

CONCLUSIONS

1. The commercial project of purchasing vessels via leasing under bareboat charter with subsequent transfer of title to the lessee which was implemented by the MMF of the USSR in the 80s was one of the greatest by the time of implementation and by the number of contracts concluded.

2. This project resulted in the purchase of more than 200 different transport vessels, barges and auxiliary vessels for many shipping companies. The vessels were purchased on the basis of a complete self repayment only, including foreign currency funds, i.e. not involving the state budget funds.

3. At the first stage (1973-1986), transactions for bareboat charter lease of vessels and their operation were governed by orders, provisions, instructions and other normative acts of the MMF and of the shipping companies.

4. This project was implemented via a newly created system of main executives (SSSA, Sovfracht Foreign Trade Association, domestic shipping companies) which had specialized subdivisions with specific powers and functions for leasing of vessels, their operation and foreign currency transactions.

5. During the period (1973-1986) of the state monopoly for the commercial activity under review, and during the period (1987-1990) of its liberalization, the whole range of transactions related to the purchase of vessels using lease options was carried out and supervised by the specific leading subdivision, i.e., Sovfracht Foreign Trade Association or Sovkomflot JSCE accordingly.

6. When implementing such projects, there is a need in creating funds which allow decreasing the level of the risks related to an untimely fulfillment, by the lessee, of its contractual liabilities. In the project implemented by the MMF, the role of such stabilization fund was performed by CRFCT which accumulated the proceeds from the operation of the bareboat chartered vessels.

7. Practice shows that the project of purchasing vessels under bareboat charter is very efficient if several shipping companies participate in it (it resonates with the previous conclusion), and the state create certain favorable conditions of operating such tonnage.

8. The second stage of the project (1986-1990) differed by its implementation and by the fact that the commercial work was not governed by departmental acts but by concluding partner contracts, agreements and treaties, i.e. market relations without a strict regulation on the part of the state were applied.

REFERENCES

1. Войниченко В. (2005). Международная практика финансирования приобретения судов. Порты Украины. Одесса. 3 (53), 28-29. /V.Voynichenko (2005). International Practice of Finance of Vessels' Purchase/

2. Горшков Я.А., Ларкин Ю.М., Махуренко Г.С., Рылов С.И. Эффективность финансирования морского флота Украины. (1998) Вісник ОДМУ. Зб. наук. праць. Одеса: ОДМУ. Вип 2. 73-78. /Y.A. Gorshkov, Y.M. Larkin, G.S. Makhurenko, S.I. Rylov. Efficiency of Financing the Ukrainian Maritime Fleet (1998)/

3. В. Збаращенко. (2002). Быть или не быть морскому торговому флоту Украины. Порты Украины.Одесса.3(35).23-25. /V. Zbarashchenko (2002). The Ukrainian Maritime Fleet: To be or not to be/

4. А. Лесник (2002) Для возрождения морского флота. Порты Украины.Одесса. 3(35).26-27. /A. Lesnik (2002). Renovation of the maritime fleet/

5. Судник Н.В. (2009) Формирование стабилизационного фонда при покупке судов на условиях бербоут-чартера. Сб. научн. труд. Судовождение. Одесса. ОНМА. 209-215. /N.V. Sudnik (2009). Creation of a Stabilization Fund when Buying Vessels under Bareboat Charter/

6. Никулин С.Г., Курлянд А.М., Постан М.Я. (2003) Проблемы оптимизации процесса обновления флота в переходный период. Методи та засоби управління розвитком транспортних систем: Зб. наук. праць.- Одеса. ОНМУ. Вип. 5.35-44. /S.G. Nikulin, A.M. Kurlyand, M.Y. Postan (2003). Issues of Optimization of Fleet Renovation in Transition Periods/

7. Морозова И.В. (2001). Методические основи расчёта платежей в договоре лизинга судов. Розвиток методів управління та господарювання на транспорті. Зб. наук. праць.- Одеса: ОДМУ. Вип. 9. 74-80. /I.V. Morozova (2001). Guidance for Calculation of Payments in Vessels Lease Agreements./

8. Ярмолович Р.П., Луговцов А.Ф. (1982) Методика расчёта экономической целесообразности фрахтования судов на условиях бербоут-чартера. БНТИ ЧМП - Одесса. 12с. /R.P. Yarmolovich (1982). Methods of Calculation of Economic Feasibility of Vessels' Bareboat Charter./

9. Архивные материалы ММФ СССР (приказы, положения, инструкции), относящиеся к аренде судов на условиях бербоут-чартера за 1973-1986 гг. /Archive materials of the MMF of the USSR (orders, provisions, instructions) related to vessels' bareboat charter (for 1973-1986)./

10. Рылов С.И. (1984). Фрахтование судов на время. М. В/О «Мортехинформреклама». 40с. /S.I. Rylov (1984). Chartering of Vessels for a Defined Term./

11. Министр эпохи «Золотого века». (1997) Судоходство.- Одесса. №12.6-10. /Minister of the 'Golden Era' (1997)/