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CONSIDARATIONS REGARDING THE DIAGNOSTIC OF THE HYDRAULIC SYSTEMS FROM AUTOVEHICLES AND AGRICULTURAL MACHINES

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ABSTRACT:

The paper presents the possibilities of diagnostic for some elements parts of hydraulic systems of drive from auto vehicles and agricultural machines. The approach is made systematically sowing the specific particularities of the hydraulic systems.

KEY-WORDS:

hydraulic system, malfunction, diagnostic, maintenance, mathematical model

1. Introduction

The hydraulic systems have a distinct importance for the auto vehicles and agricultural machines construction and functioning while the diagnostic domain has been too little approached.

The importance of the hydraulic systems is showed in fig. 1. Specially for actuating the technological mechanisms from specific working machines, it is necessary an important link - the transmission. His roll is to modify the output parameters of the prime mover, for to adapt the input variables, necessary to the specific technological mechanisms.

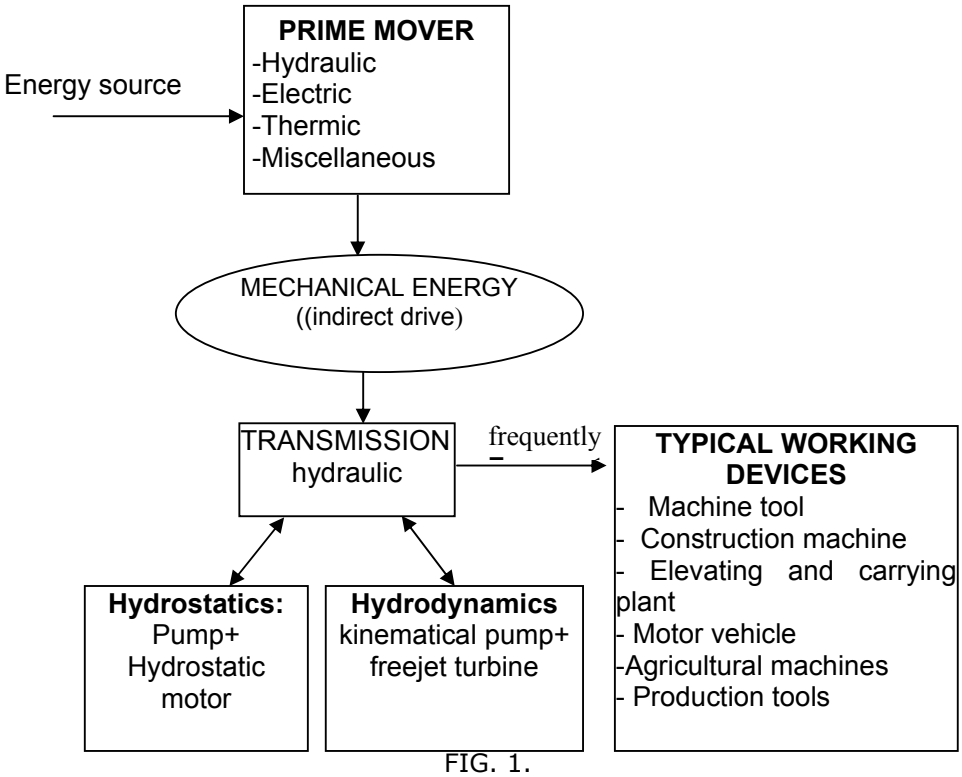
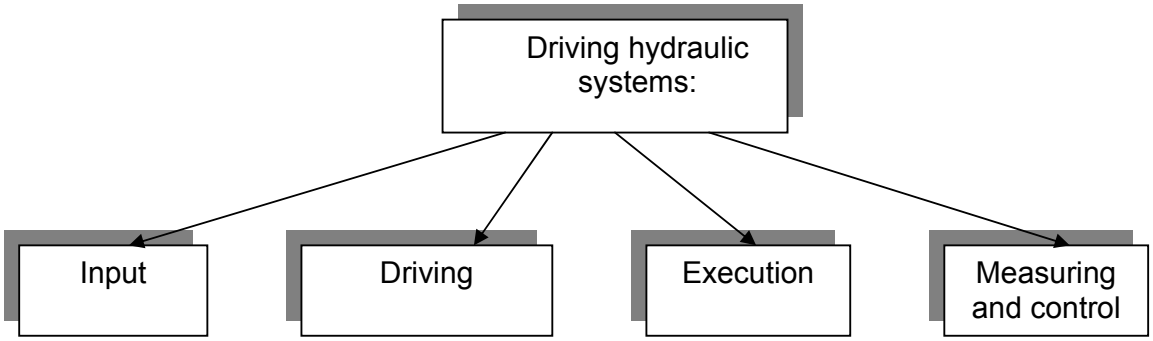


FIG. 1.

2. The hydraulic systems characteristic

For the hydraulic systems utilised for automotive and agricultural machines we use the following systems:



The experimental identification and the obtaining of a mathematical model for hydraulic driving installations are specific to each system.

The estimation of the parameters and the conditions of the hydraulic driving systems constitute the essence of the identification operation.

The purpose of the identification of the hydraulic driving systems is necessary and for the analysis and "diagnostic" too. In this case, the estimation of the parameters is made measuring the transfer characteristics, the determination of the answer at impulse, the determination of the zeros of the system transfer function etc. The obtained results are utilised for the system analysis or for his performance criteria determination.

For the identification of the hydraulic driving systems are taking into consideration the following characteristics, specific to this systems:

- the big diversity of the hydraulic systems that compose a driving hydraulic system;
- the large variation domain of parameters that intervene in the mathematical model of the hydraulic driving system;
- the complexity of the hydraulic nature phenomena that appear in the hydraulic driving installations;
- the possibility of going from stirring motion (eddying flow) regimen to laminar motion (static flow) regimen of the fluid and reverse, function by the disturbing factors;
- the main utilised equipments in driving hydraulic systems have a working characteristic;
- the existence of some constructive asymmetries, imposed by the concrete working requirements in the calculus of linear hydraulic engines;
- the existence of the friction in the driving engines (dry friction, viscous friction etc);
- the big costs necessary for the realisation of some functional models for hydraulic driving systems destined exclusively to experimental researches;
- the hydraulic driving systems are non-linear, variable with time, multidimensional and generally unfit to common mathematical models.

The diagnosis model must to respond to the following questions:

- how the output parameters of the physical-chemical processes are used to the hydraulic systems diagnostic;
- how is design the diagnostic and prognosis procedure for the hydraulic systems condition at automotive;
- is it possible the realisation of some recognition systems for the condition of the hydraulic systems which can be implement to diagnostic systems for automotive;
- if the answer to the above question is affirmative, is it possible the efficient improvement of the diagnostic of technical condition for hydraulic systems;
- if is possible, beside the above requests, the efficient improvement of the hydraulic systems management for automotive and working machines.

3. The analysis of malfunctions for hydraulic systems

The researches in the repair units show the following malfunctions and failures.

The defectives that appear at the components of the hydraulic systems are presented in figures 2-8.

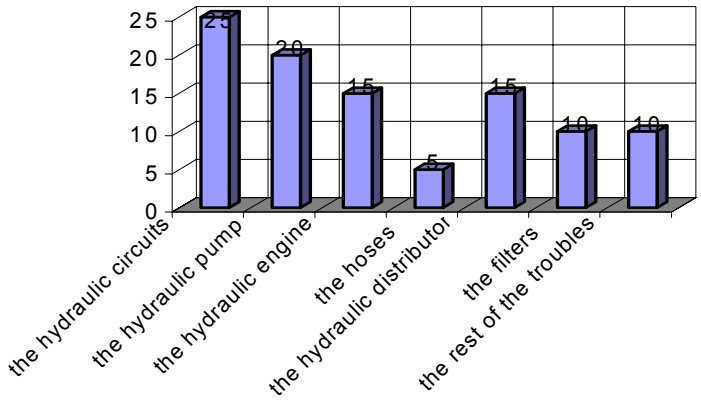


FIG. 2 IN THE HYDRAULIC SYSTEMS

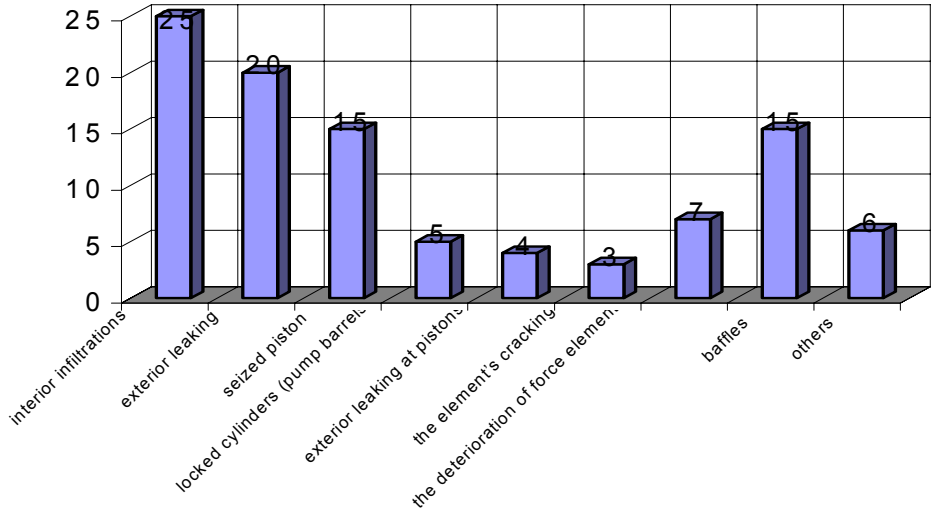


FIG. 3 IN THE FORCE CIRCUIT

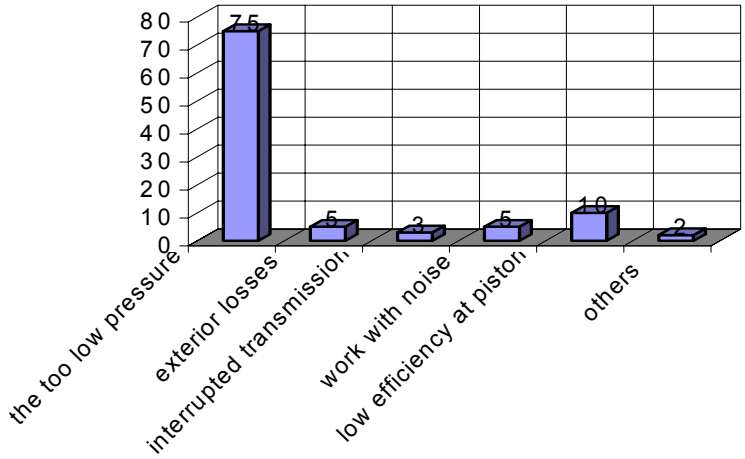


FIG. 4 AT THE PUMPS

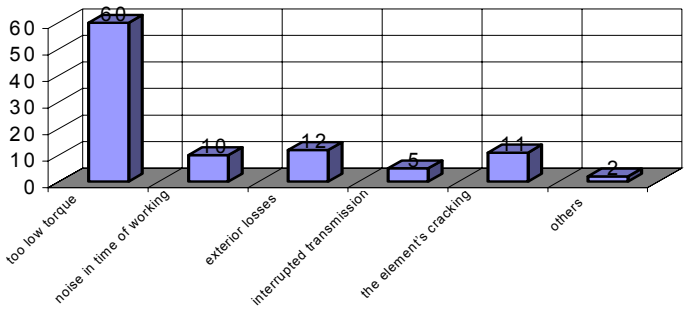


FIG. 5 AT THE HYDRAULIC ENGINES

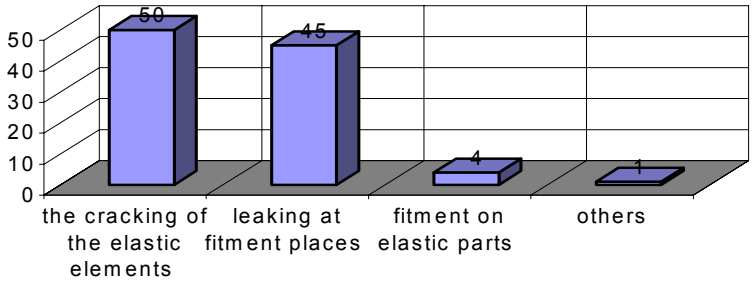


FIG. 6 AT HOSES

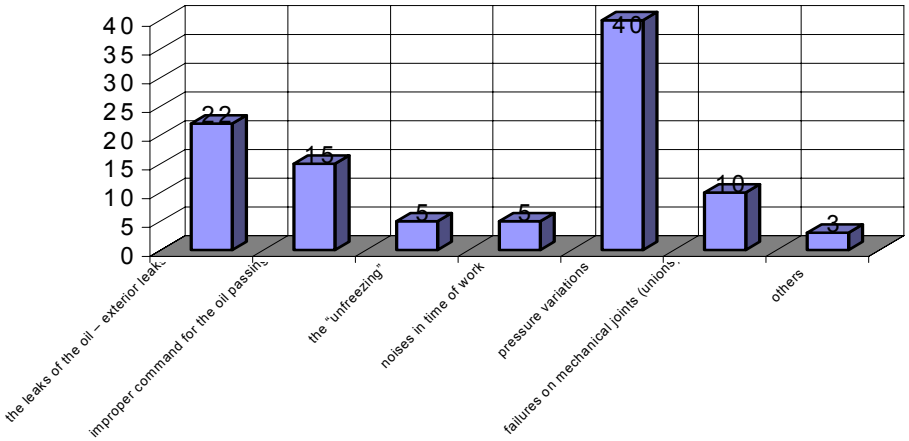


FIG. 7 AT DISTRIBUTORS

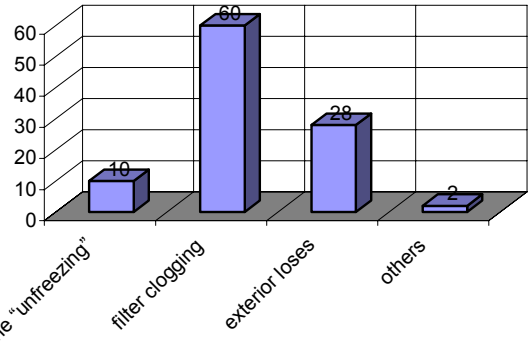


FIG. 8 AT FILTERS

The rest of the malfunctions:

- improper indications of the measurements and control apparatus – 5%;
- breakings in electrical installations zone – 25%;
- improper protection function – 5%
- improper joints with the medium – 5%;
- improper oil or hydraulic systems temperature – 15%;
- oil pollution – 30%;
- operating staff improper selected – 15%;
- others – 5%.

The construction of the models for the determination of the technical condition must to include the following elements:

- the determination of the general technical condition (state);
- the optimal determination of the general parameters for diagnostic;
- the structure of the basic relations of the diagnostic parameters;
- the determination of the tests and the programmes for the diagnostic and the control of the technical condition and the fault location;
- the determination of predicted values of the parameters or the parameters' defining that modify the condition of the systems in the working time;
- the determination of the dates and the domains of the diagnostic and operating of the hydraulic systems.

4. The elaboration of the diagnostic and maintenance systems

The control of the technical condition of the hydraulic installations appears like an important component of the insurance system of the machines reliability. For different categories of machines the reliability and durability requests are established in relation with the work conditions.

The planed – preventive system for technical attendance and patching assume the observation, the maintenance and the job work of the machine, the systems and his components. At the technical attendance it is necessary to determine not only the technical condition but also the evaluation of the resources at futures remanence, which is the technical condition prognosis.

The prognosis – the confirmation of his validity – depends by the futures behaviour of the system as respect to the potential run and to the working conditions. It is based on the modifications of the output parameters of the system under the disturbing factors effect. The complete cycle of the prognosis has three stages:

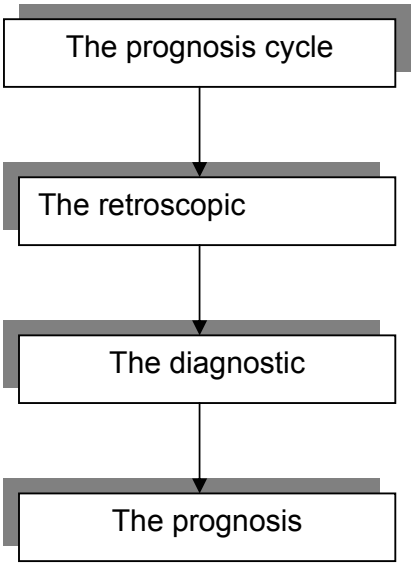
During working time, the modification of the technical condition of the hydraulic systems and his component elements is produced:

1 – without the change of the running quality of the elements;

2 – with the change of the running quality, but without the modification of the hydraulic transmission;

3 – with the change of the running quality of the machine.

For the solution of the problems raised by the running of the hydraulic systems are used methods for mathematical simulation based on reliability theory.



The mathematical simulation of the running process of the hydraulic installations specific to the vehicles offers opportunities regarding:

- the determination of the optimal periodicity for technical service and control of the hydraulic system for the transmission during working (running) time;
- the minimization of the working costs in the conditions of the asked reliability;
- the determination of the function which combine the diagnostic parameters and the structural parameters, that for the elaboration of the normatives, such as limit and admissible values of the diagnostic parameters

For the analysis of the optimisation for the technical service of the hydraulic systems of the machines, an essential problem is the chosen of the parameters that can be optimised. In many cases such parameters are the resource of the hydro-aggregates and the rate of wear for his components.

From the existent methods for the optimisation of the algorithm for the malfunctions detection, the most used are the ones based on the reliability indicators of the system and the component aggregates and also the division in half method. In particular cases it can be used the engineering logic-type searching algorithms.

For example, for the diagnostic of the hydraulic transmission of the EO - 4121 excavator it is proposed the use of the method of the volume and loses through tightness determination for every hydraulic transmission in his entirety; the method is based on the measurement of the hydraulic cylinder lift and the machine rotation.

Based on the kinematic chart of the hydraulic system (fig. 9) analyse, we can obtain the equations of loses through escapes for every hydraulic transmission for the actuating part of the machines (B – reservoir; H1,H2 – the first and the second section of the hydraulic pump with intermittent working; P1K – the safety valve of the first distributor; P2K – the safety

valve of the second distributor; P1, P2, P3 – the first, the second and the third valve of (P1) distributor; P21, P22, P23 - the first, the second and the third valve of second (P2) distributor; GHL - the hydraulic engine for the left lift; GHP - the hydraulic engine for the right lift; TL – the left carrier; TP – the right carrier; GPP – the hydro-engine for the platform rotation; P – platform; GP – the hydraulic cylinder of the dipper arm; P – dipper arm; GCI – the first cylinder of the console; GK – the hydraulic cylinder of the dipper; K – dipper; n_{dv} – engine speed; φ_R- the position of the transmission regulator; p_{reg}- the control pressure of the safety valve; X – the action command; R_{Tr}- the friction force; M_s- the resistance moment; R_s - lifted load.).

The leaking volume in the hydraulic installation:

$$Q_{uT} = Q_H(1-\eta_{gp}) \qquad [1]$$

where Q_H is the pump delivery;

η_{gp} is the specific pump delivery (the pump displacement).

The hydraulic pump displacement is determined by the measurement of the speed of the hydraulic piston rod and the measurement of the speed pump shaft.

$$\eta_{gp} = \frac{v_{st}\pi D_P^2}{8 n_{dv} z_p q_H} \qquad [2]$$

where $v_{şt}$ is the velocity of the piston rod; D_P is the piston diameter; n_{dv} is the gyro frequency of the engine shaft; z_p the reduction ratio of the pump reductor; q_H the working capacity of the pump oscillating element.

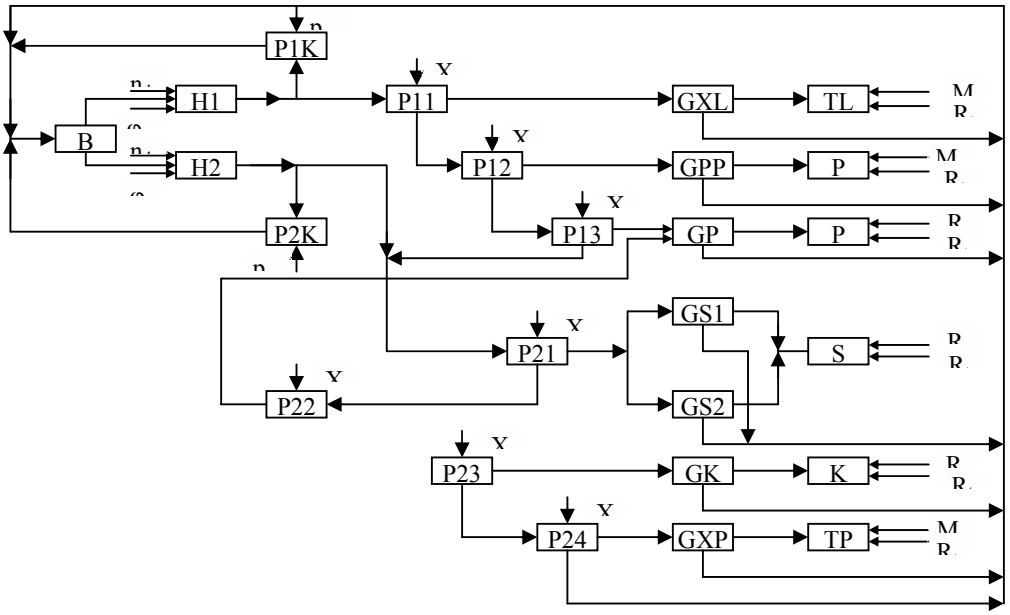


FIG. 9 THE STRUCTURAL CHART OF THE HYDRAULIC SYSTEM OF THE EO – 4121 EXCAVATOR

The entire volume of liquid leak loss from the hydraulic transmission consists in the liquid losses from each aggregate. For the system of the excavator we have the following equations for the liquid losses for each of the hydraulic transmissions of the actuator.

$$\begin{aligned} Q_{uT1} &= Q_{H1} + Q_{p1k} + Q_{p13} + Q_{gp} \\ Q_{uT2} &= Q_{H1} + Q_{p1k} + Q_{H2} + Q_{p2k} + Q_{p21} + Q_{gc} \\ Q_{uT3} &= Q_{H1} + Q_{p1k} + Q_{H2} + Q_{p2k} + Q_{p22} + Q_{gc} \\ Q_{uT4} &= Q_{H1} + Q_{p1k} + Q_{H2} + Q_{p2k} + Q_{p23} + Q_{gk} \end{aligned} \qquad [3]$$

Where:

Q_{uT1} – the net loss in the transmission system of the dipper arm for the supply from the first distributor (P1);

Q_{uT2} - the net loss in the hydraulic transmission system of the dipper arm;

Q_{uT3} - the net loss in the transmission system of the dipper arm for the supply from the second distributor (P2);

Q_{uT4} - the net loss in the transmission system of the dipper;

Q_{Hi} – the leak loss in pump "i" section;

Q_{pi} – the leak loss at the safety valve of the "i" distributor;

Q_g – the leak loss to the hydraulic cylinders.

In the figure 10 it is showed the algorithm for the identification of the aggregate from the hydraulic system that presents leak losses bigger than the normal ones. The algorithm allows the separation of the set of aggregates that must be detailed analysed.

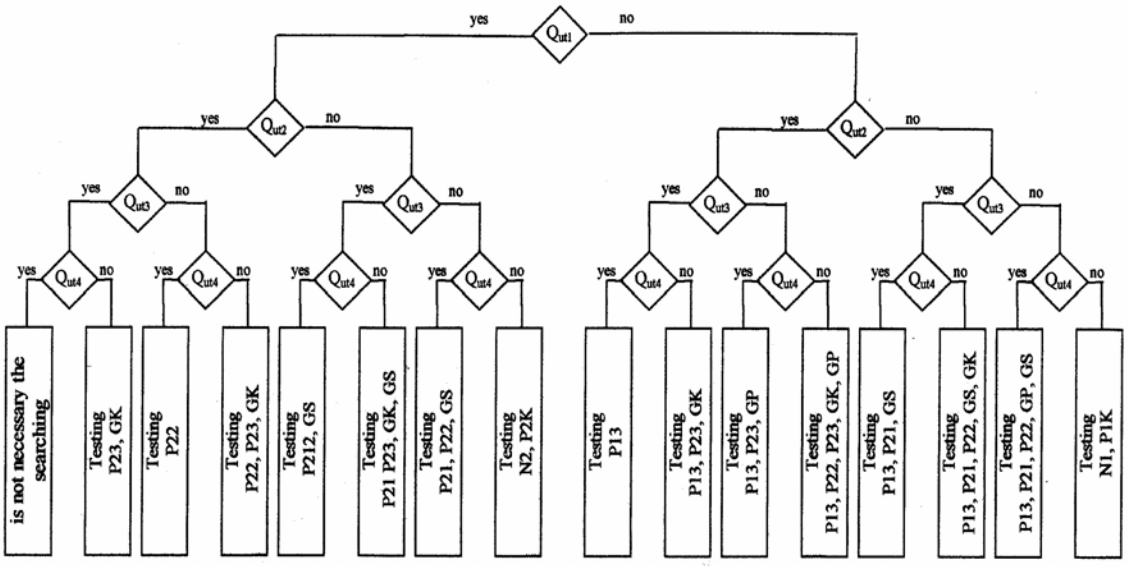


FIG. 10 THE ALGORITHM FOR THE IDENTIFICATION OF THE AGGREGATE WITH RAISED LOSSES FROM THE DIPPER ARM HYDRAULIC SYSTEM

5. Conclusions

- The identification of the hydraulic actuate systems pursue both their analysis and the diagnostic. The parameters estimation consist in:
  - the measurement of the response characteristics;

- the response to impulse determination;
- the use of the results for the system analysis, respectively the evaluation of the performance criteria.

- The control of the technical condition of the hydraulic installation appears like an important element of the machine reliability insurance system.
- For the working optimisation of the hydraulic systems we must to use the mathematical simulation.

6. References

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