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MODERNIZATION OF THE FUEL SUPPLY SYSTEM FOR THE INTERNAL COMBUSTION ENGINE OF A GENERATOR SET

In order to optimize and improve the operation of autonomous electric energy sources, the paper proposes an embodiment of electromechanical regulator for the rotation speed stabilization system (RSSS) of the shaft of the generator set internal combustion engine. Generator set of АБ-12-Т/400 type has been modernized by introducing a variable-frequency electric drive of the fuel supply throttle, its operation being regulated by a programmable logic controller in accordance with the created functioning algorithm.

Keywords: *rotation speed stabilization system, generator set, variable-frequency electric drive.*

Today, a growing number of industrial enterprises are creating generating systems that satisfy, fully or partially, their own needs in heat power and electric energy. Those are mostly units with the power of up to 1MW that operate on liquid or gaseous fuel. The quality of their operation depends, to a great extent, on the performance of internal combustion engine (ICE) that drives the shaft of a synchronous generator (SG). One of the main ICE functional systems is a rotation speed stabilization system of the electric machine rotor in dynamic and static modes, particularly, during abrupt growth or reduction of the load. The majority of ICE – SM units are equipped with outdated mechanical rotation speed stabilization systems (RSSS) that do not provide sufficient quality of controlling the amount of fuel supplied to ICE depending on the generator load, which results in deterioration of the electric energy quality.

Taking into account the fact that development and research of alternative RSSS involves consumption of significant amounts of fuel, functioning algorithms were elaborated by the author with the application of a low-power unit of АБ-12-Т/400 type, driven by internal combustion engine 320-01 with a mechanical rotation speed regulator.

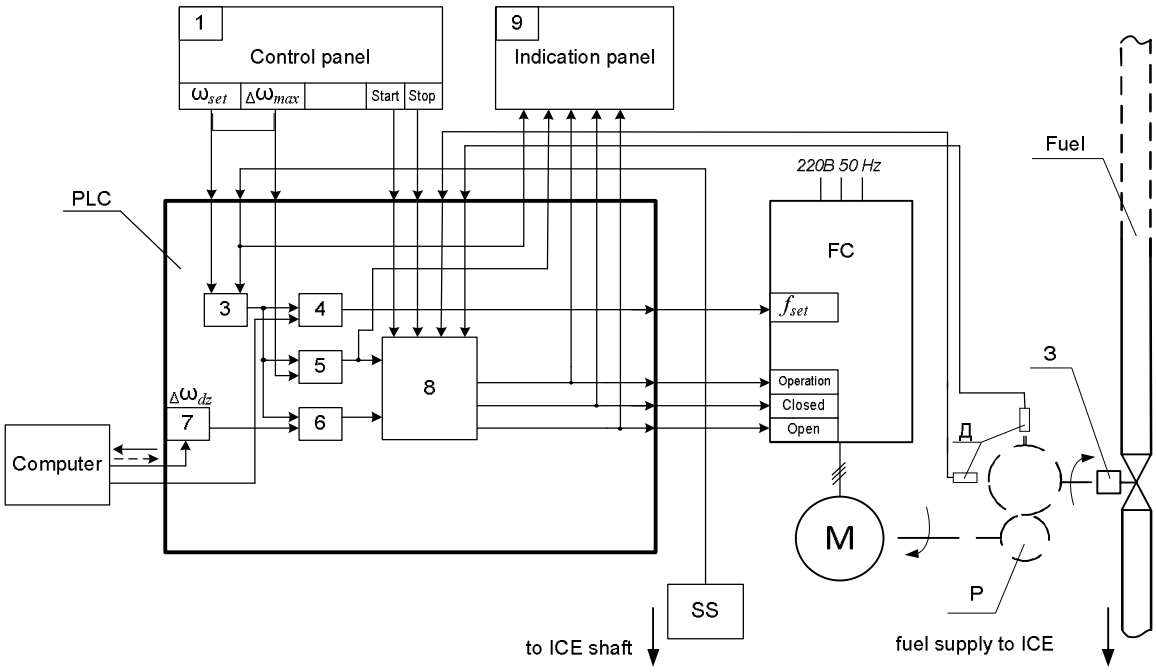


Fig. 1. Functional circuit of the modernized generator set

Proceeding from the analysis of the characteristics of the existing RSSS with a mechanical regulator and taking into account special features of the mechanism, the authors have elaborated the following requirements to electromechanical RSSS of the autonomous electric energy source:

current rotation speed control; stabilization of the given rotation speed of the generator set by regulation of the throttle opening angle that changes the amount of fuel supplied to ICE; control of the throttle extreme positions and prevention of its operation against the stop position; selection of the idle stroke mode or loading mode operation in accordance with the operator command.

In order to ensure maximal flexibility and versatility of the control system, it was decided to build the system on the basis of a programmable logic controller (PLC) that provides quick adjustment of the set taking into account special operation conditions [2]. In the process of modernization the mechanical actuator device for the fuel throttle position regulation has been replaced by an electromechanical one based on the "frequency converter – asynchronous motor (FC-AM)" system.

Functional circuit of the modernized generator set is presented in Fig. 1 [3] where the following designations are adopted: PLC – programmable logic controller; ICE – internal combustion engine; FC – frequency converter; M – asynchronous electric machine; G – gear; S – sensors of the extreme positions of the fuel supply throttle; SS – sensors of ICE shaft rotation speed; T – throttle; C– computer; 1 – control panel; 2 – unit of converting SS information to actual value; 3 – unit for comparing the given and actual values of the shaft rotation speed; 4 – unit of the digital speed controller; 5 – unit for comparing actual control error with the maximal permissible value; 6 – unit for comparing actual and given dead zones of the control system during regulation process; 7 – unit for setting the size of dead control zone; 8 – actuator operation control unit; 9 – panel for indicating the current state of the entire sys

The throttle drive control algorithm is presented in Fig. 2. Due to the presence of integrating circuit – a reducer, installed between AM shaft and the fuel supply throttle in the mechanical system, a proportional - differential controller is used in this algorithm.

Control algorithm of the generator set RSSS provides:

– switching of the electric drive and full opening of the fuel supply throttle after pressing the "start" button;

– reading of the nominal speed (ω_{set}) parameters, that are set by the operator, maximal regulation error ($_{\Delta}\omega_{max}$) and permissible regulation dead zone ($_{\Delta}\omega_{dz}$);

– reading of the information about the actual speed (ω_{ac}) of ICE shaft rotation;

– calculation of the value of control signal (u_t) supplied to FC; – comparison of the actual error with the dead zone (if $|\Delta\omega| > |\Delta\omega_{dz}|$ condition is not satisfied, FC operation is blocked; otherwise,

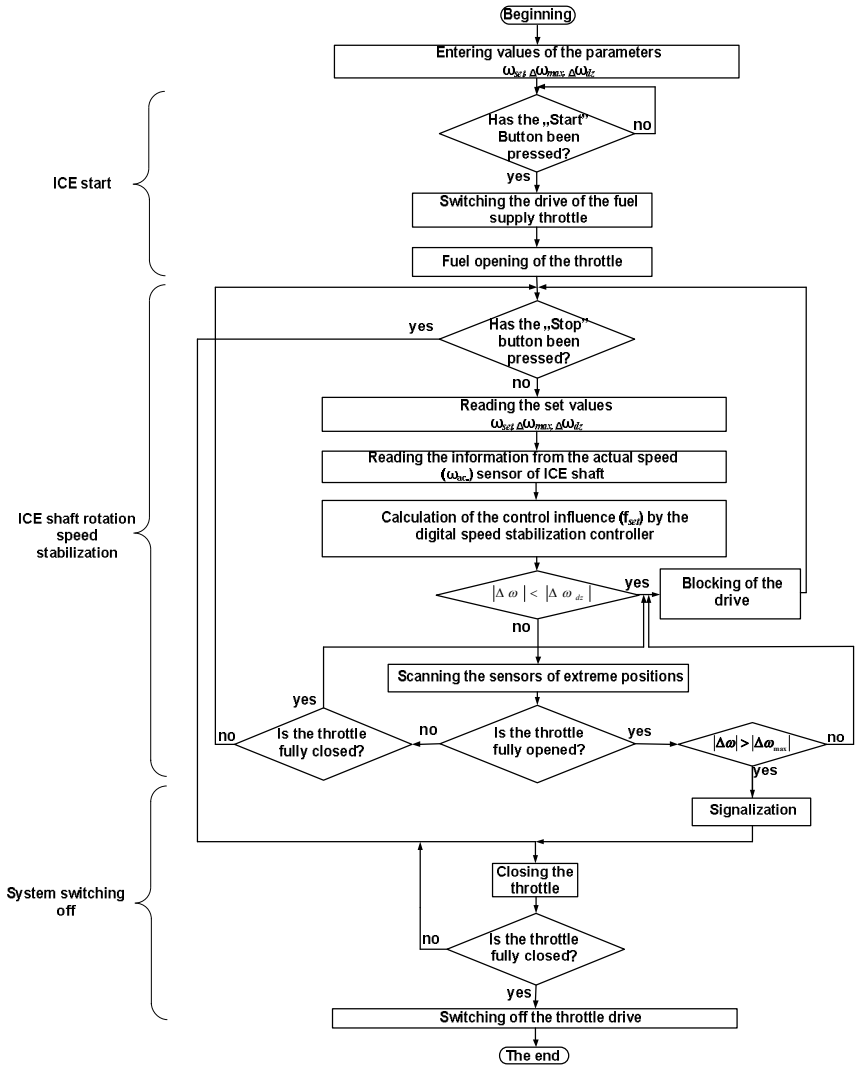
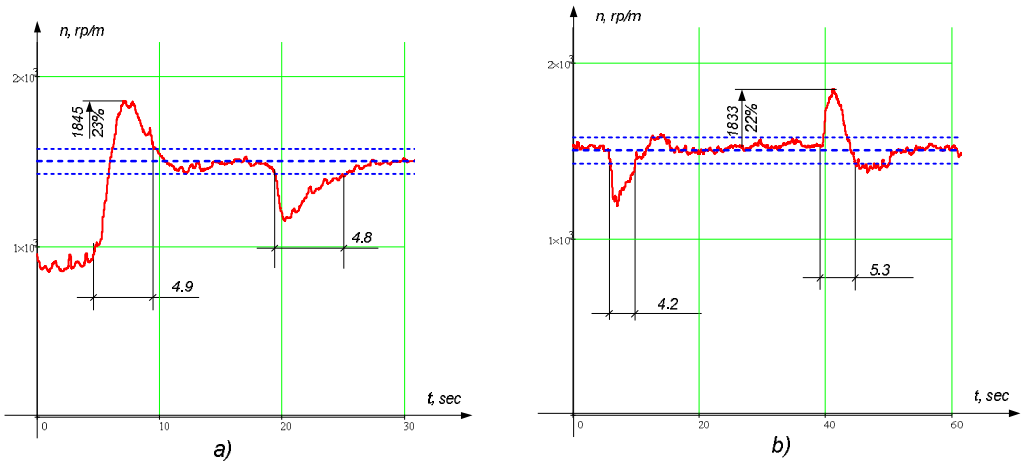


Fig. 2. Algorithm of controlling the drive of ICE fuel supply throttle valve

regulation process is realized with simultaneous control over the extreme positions of the fuel supply throttle);

– closing of the fuel supply throttle to the full closed position and switching off the drive when the



Fig, 3. Experimental curves of the modernized RSSS investigation during dynamic changes of the load

"Stop" button is pressed;

– increasing, if necessary, the actual ICE shaft speed and if the maximal regulation error ($|\Delta\omega| > |\Delta\omega_{max}|$) is exceeded, blocking the fuel supply, i.e. the entire process is stopped.

RSSS operation was investigated with the application of generator set of АБ-12-Т/400 type. Transient processes during the transition from 900 rpm to 1500 rpm without load with further connection of the electric energy consumer (Fig. 3, a) as well as with connection and disconnection of the electric energy consumer (Fig. 3, b) have shown good regulation characteristics.

Conclusions

With the application of the modern automation facilities a system for controlling fuel supply to ICE of the generator set has been developed. Operation of the given system has passed successful tests on the generator set of АБ-12-Т/400 type and further research of its operation with high-power units is required.

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