

Electric motor-transformer aggregate in hermetic objects of transport vehicles

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Abstract. The construction and features of operation for new electrical unit – electric motor-transformer aggregate (DTA) are considered. Induction motors are intended for operation in hermetic plants with extreme conditions surrounding gas, steam-to-gas and liquid environment at a high temperature (to several hundred of degrees). Main objective of spent researches is the substantiation of possibility reliable and effective electric power transform with electric machine means directly in hermetic objects with extreme conditions environment by means of new DTA. The principle and job analysis of new disk induction motors of block-module type are observed.

1. Introduction

Increased requirements to safety with a simultaneous intensification of modern production cause of engineering new electric motors for work of various equipment in closed objects at abnormal parameters of environment [1-4]. To such parameters is possible to refer high values of temperature, pressure, radiation, chemical aggression, etc. In some cases, it is required to provide reliable work of hermetic vehicles in the form of deep-water vehicles, working in water at big pressure [5].

2. Electric motor-transformer aggregate in hermetic objects of transport vehicles

The known designs of hermetic electric motors, sometimes named submersible electric motor [1], contain hermetic seals between rotating shaft and leakproof case, or hermetic stator, concluded in leakproof package and rotor, twirled in operating environment. Disadvantage of such electric motors are limited application area and low reliability, caused by difficulties of maintenance service and repair, and also, a small resource of shaft seal. Other constructions of electric motors for a drive of devices working in hermetic objects or excited environments (canned electric motors) contain stator, taken out for limits of hermetic object (environment), in which the rotor separated from stator by hermetic partition-screen [2] rotates. The screen is usually carried out in the form of continuous thin-walled cylindrical sleeve from material intended for work in the concrete environment. Deficiency of such drives are low power indexes, at the expense of clearance augmented shield width between stator and rotor. Besides, the part of magnetic field energy is not transmitted in rotor, and selected in the form of heat from of eddy currents effect turned in the screen. Difficult enough systems of unloading of a thin-walled sleeve from axial-radial efforts are, in addition there are difficulties with heat removal with a rotor.

Main objective of spent researches is substantiation of possibility reliable and effective electric power transform with electric machine means directly in hermetic objects with extreme conditions environment by means of new developed designs of electric motor-transformer aggregates (DTA) [4, 6].



These units were comprehensively theoretically and experimentally investigated, and results of researches are elucidated in numerous papers at international conferences and publications in scientific magazines [13-14].

Advanced constructive decisions with increased energy characteristics are offered for expansion of a scope designed early hermetic electric motors for extreme environments. New constructions of electric motor-transformer aggregates DTA-1 [11] and DTA-2 [12] with following features described in more detail below.

The electric motor-transformer aggregate DTA-1, which longitudinal section is presented on figure 1, and cross-section – on figure 2 consist of the cylindrical three-phase transformer 1 with a rotating magnetic field and a disk electric motor 2. The transformer 1 is realized with the primary distributed winding 3 attached to a three-phase circuit of alternate current and a secondary z-phase bar winding 4, located in z slots of transformer core.

Rods 4 secondary winding of transformer 1 closed on opposite side by short-circuited ring 5 and connected with Z hermetic rods, which are installed in leakproof partition 9. The induction motor 2 has short-circuited rotor and the stator with rod winding 6, located in radial slots of disk stator core. Rods 6 of stator winding on the one end are connected through rods-hermetic input 7 to a secondary rod winding 4 transformer, and on other end are closed by second short-circuited ring 8. The electric motor 2, located within hermetic object, is separated from transformer by partition 9.

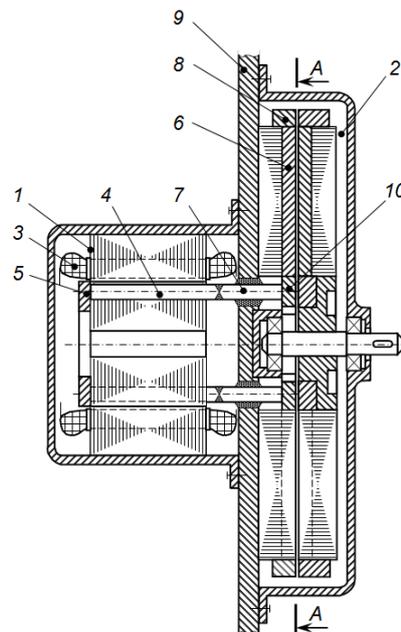


Figure 1. Longitudinal section DTA-1

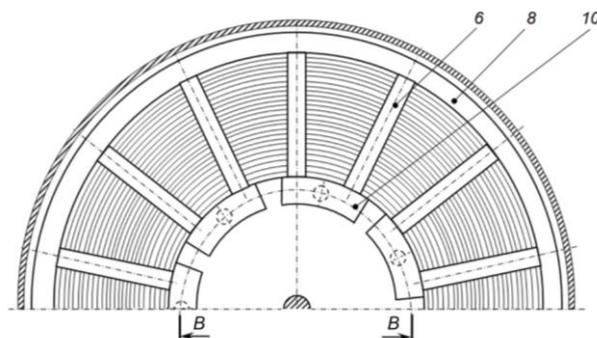


Figure 2. Cross-section DTA-1 on A-A

The figure 3 presents ring cut $B-B$ on axes of rods-hermetic inputs 7. The figure 4 shows scanning active surfaces of transformer and stator (figure 4,*a*). The figure 4,*b* and figure 4,*c* are shown distribution magnetizing forces on average diameter of transformer and motors from currents in transformer rod windings.

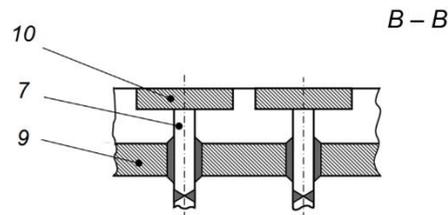


Figure 3. Fragment of cylinder-section $B-B$ (expanded on plane) aggregate DTA-1

Each of Z rods- hermetic lead-in 7, located in a partition 9, is connected with n rods 6 of stator winding through intermediate conductive arched segments 10, (where $n = 1, 2, \dots$ – multiple number between rods of stator winding and rods of transformer secondary winding).

The partition 9 can be a part of case electric motor, tightly closing the hatch in case of tight object (on figure it is not shown), or can be a part of case tight object.

The primary distributed winding of transformer 1 with pair of poles p , being supply from a three-phase circuit with frequency f , creates a rotating magnetic field. The rotating field crosses rods 4 Z -phase secondary windings of transformer 1 and induces in them Z -phase EMF with same number of poles ($2p$). On this winding, connected through rods-hermetic lead-in 7 and arched elements 10 with nZ -phase rod winding of stator, electric current will start flowing, creating stepped curve magnetomotive forces (MMF), as shown on figure 4,*b*. Z -phase currents of secondary winding of transformer by means of arched elements 10 is divided on input of rods winding of stator 6 on nZ -phase currents, keeping number of poles $2p$. For given DTA, as example, $n = 2$.

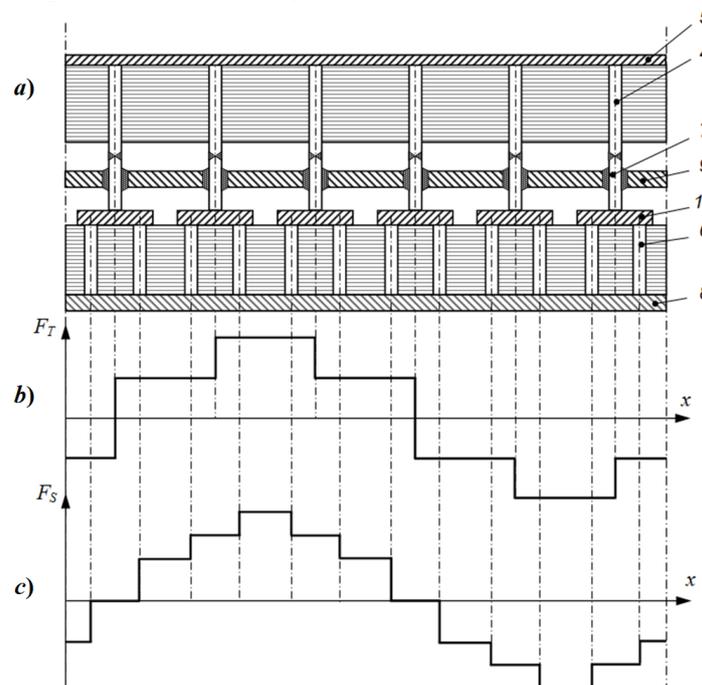


Figure 4. Scanning active surfaces of transformer and stator from outside rods, (figure 4,*a*); Distribution magnetomotive forces of transformer (figure 4,*b*) and induction motor (figure 4,*c*) on effective diameter

In detail principle of work considered aggregates and its technical and economic indicators are considered in [4, 6, 14]

3. Conclusions

1. The designs and features of operation for new disk induction motors of block-module type are a part of motors-transformer aggregates for extreme condition environments are considered.
2. The new patented constructive decisions, allowing to raise technical and economic indicators DTA at the expense of n -multiple division of rod windings in an motor part of aggregate are offered;
3. Manufacturing of a disk rotor is offered with double-sided stator with $Z/2$ the radial grooves, shifted on half beard division and is mutual-cut with cores hexagonal section which are established between axial magnetised rotor inserts-beard from pressed magnetically soft material.

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