ELECTRICAL MACHINE – FLUIDE MACHINE STANTCHEV AGGREGATION SET

Technical field

This invention relates to an aggregation (ganging) set that replaces in operation the work of the following conventional units: electric motor driven pump, electric motor driven compressor and fluid motor driven electric generator.

Prior Art

Patent JP2007051611 (A) features a vane pump, the vanes of which are also permanent magnets of the rotor of a brushless DC axial motor.

Patent GB2295857A features a fluid machine with two chasing pistons operational within a half-cycle of its rotation. Synchronization of the action of its pistons within a half-cycle of rotation is provided by a mechanical transmission.

Existing (classical) units - electric motor driven pump, electric motor driven compressor and fluid motor driven electric generator are made up of two units with connected shafts. These are structurally bulky and heavy units, necessitating steady positioning of bearings, seals between shaft and housing, damping of vibrations and

moisture – imperviousness of electrical parts. Their fabrication, maintenance and repair are costly.

Subject - Matter of the Invention

It is the objective of this invention to develop a highly-adjustable, compact unit, structurally simple and easy to fabricate.

This task has been accomplished by means of developing a rotating machine of the "cat-and-mouse" type, herein called "Electrical machine – Fluid machine Stanchev Aggregation Set" (EFSAS), comprising: a stator/body unit, rotor/piston units and an electronic control and power supply module.

It is characteristic of EFSAS that its stator/body unit is made up of two components as a minimum, shaping a volume of rotation, in which there are two segmental rotor/piston units. Their profile corresponds to that of the volume of rotation. Both rotor/piston units are with equal geometric dimensions, and their central angle is less than π radians (180°). In the walls shaping the rotary volume there are IN and OUT channels, the central angles of which are smaller then - but can also be equal to - those of the rotor/piston units. When they are equal there is no break of phase in suction and discharge and there is no ripple in fluid flow either. It is also reasonable to have other channels, opposite the IN and OUT channels, with equal faces ensuring alignment of the radial (not frontal)

force of working fluid to the rotor/piston units and thereby eliminating friction forces between the rotor/piston units and the rotary volume surfaces. Each pair of channels is in contact with two external spaces, to and from which fluid is fed and discharged. There are permanent magnets in the rotor/piston units, equidistant from each other, oriented so that the direction of their magnetization is parallel to the axis of the rotation volume. There are electromagnets, along the whole length of the leading circle of the rotation volume, with poles matching the trajectory of the poles of the permanent magnets in the rotor/piston units. The terminals of the coils of the electromagnets are connected to an electronic control module. Through power switching elements in the module, position sensors in the stator/body unit near the permanent magnets, opposite the rotor/piston units, an interface for external control and display ensures control over the electromagnets. Their magnetic fields induce synchronized rotation of both rotor/piston units, which evenly expels, in a half cycle of rotation (π rad., 180°), an amount of fluid, the while also receiving a charging amount of it.

Advantages of EFSAS, according to the invention:

- Combining in one assembly the operation of an electric motor driven pump, an electric motor driven compressor and a fluid motor driven electric generator, the work of EFSAS spells out attainment of very high values of the ratios POWER/WEIGHT and FLOWRATE/WEIGHT;

- Lack of shafts with bearings, seals and coupling between them leads to:

= Saving on materials and structural elements;

= No leak of working fluid, hence no pollution of environment; possibility to use the innovation in hazardous fire - and explosion ambient, and in vacuum (e.g. in Outer Space);

= Minimal value of resistance moment (no friction forces), i.e. energy efficiency;

= Very small rotary masses amount - hence, low moment of inertia, securing exact regulatory features;

= No need for readjustment of driving - and driven components;

- Equalized pressures in radial direction to two opposite walls of rotor-piston units ensured by couples of channels in the volume of rotation, with negligible frictional forces between the rotor/piston units and the walls of the rotary volume. Hence, complete absence of operational wear;

- Algorithm-defined relative speeds of parts during operation; absence of break in cycles and even flow of fluid in both modes of operation - electric motor-pump(compressor) and fluid motor (turbine)-generator; hence reduction of hydro- and aero-dynamic loss, noise and vibration;

- Smooth and accurate control of flow rates, from *zero* to *maximum* value;

-Possibility for working fluid dosing, owing to “the volume principle of design” and the electronic control of operation;

- Use of EFSAS as a regulator of fluid flow in a given static position of the rotor/piston units;

- Extremely high tech level of fabrication of the invention and its repair due to the following:

= All contact surfaces between which there is motion are flat and cylindrical, easy to shape and to treat surfaces;

= Windings: made ready on separate spools prior to the assembly of EFSAS;

= The design of EFSAS is modular, with screw connection assembly – securing simple installation and quick servicing;

- Electrical control of operating parameters ensures remote control, in addition to low moments of inertia and precise feedback – i.e. attainment of complex and program modes executable with precision.

Short Description of the Drawings

Fig. 1 - axonometric view of EFSAS, segment cut by 90 degrees;

Fig. 2 - expanded axonometric view of EFSAS;

Fig. 3 - axonometric view of EFSAS, electromagnetic system, segment cut by 90 degrees;

Fig. 4 - diagram of location of the rotor/piston units in 5 different positions, full cycle, π rad (180°); clockwise rotation of the rotor/piston units;

Fig. 5 - axonometric view of body and core, forming a cage-rotary volume

Examples of Embodiment

Operating as an electric-pump, EFSAS (Fig. 1) houses a Stator, two Rotor/Piston Units and a Power Control Unit. Its stator comprises: Body 1, Core 13 and Electromagnets - coil 2, coil pins 5 and 4 (Fig. 3) and a U-shaped magnet yoke - packages 3 in body 1, packages 7 in plates 6 and 16 (Fig. 1) and (Fig. 2). The rotor/piston units 11 - comprise segment bodies, in which the permanent magnets 12 with axial magnetization are fixed equidistantly.

The rotor/piston units 11 in the volume of rotation, with gaps with sliding joints, are radially limited in position by the body 1 and the core 13, and are axially limited in position by the separators 14 and 16 (Fig. 1) and (Fig. 2). The windings 5, spools 2, are connected to the pins 4, providing electrical connection to the power control module 24. The input and the output nozzles 18, the plate 17, the openings in plate 16, the openings in separators 15 and 13 and the openings in the core 13, provide hydraulic (pneumatic) connection to external spaces via the channels 30 and 31, core13, to the rotary volume. A nest in the plate 19 houses a power and control module – a

printed circuit board 24, with the electronic components 26 and an interface connector 25. Through axial openings in the separator 14 and in the plates 6 and 19, the pins 4 ensure electrical contact between PCB 24 connectors and electromagnetic spool windings. Four magnetic sensitive transducers 10, axially mounted opposite fronts of the permanent magnets in the rotor/piston units, detecting change in magnetic fields, manage feedback control of the rotor/piston units 11, by means of power control module commands. Orientation and adjustment of the plates, the separators, the body 1 and the core 13 are defined by the pins 22 and 23 in fixed position. Package of plates and separators, fixed axially by screws, 20, are tightened up in the openings in the plate 19. The power control module 24 is covered by a cooler, 21, fixed by a screw, 27, in the plate 19. The channels 31 in the body 1 and the channels 13 in the core 30 counterbalance radial forces of the working fluid to the rotor/piston units 11; they are with equal surface contact areas, facing each other (fig. 5).

Use of the invention

Two modes of operation:

1. Direct Action - as "electromotor - pump (compressor)", powered by electricity, with revised fluid output (moved, compressed, and diluted);

2. Reverse Action - as "volumetric fluid motor - generator " powered by fluid pressure, generating electricity.

Direct Action - Electromotor - pump (compressor).

Since EFSAS is with bidirectional operation, let us consider the mode in which the coupler 18, on the far side of the interface connector 21, is input, the rotor/piston units 11 are in clockwise rotation, viewed from the cooler 21. In Position One - 5 positions, Fig.4, the two rotor/piston units 11 are in initial position, in which the left-hand rotor/piston unit closes the input channels, connected through the left-hand axial opening 28, with the input coupler (Fig. 5); the right hand rotor/piston unit 11 closes the output channels connected through opening 29 with the output coupler 18 (on the side of the interface connector 25). Since the two rotor/piston units 11 are with nether faces (Fig. 4) in contact, the initial suction volume is V0. The volume of fluid sucked in between the upper faces of the rotor/piston units 11 in a preceding cycle, 180°, is Vmax (V0 matches Vmax). Under the impact of action of a magnetic field generated by the left-hand electromagnets, above the respective rotor/piston unit 11, angular clockwise motion is imparted to this unit. The electromagnetic field, generated by right hand electromagnets above the respective rotor/piston unit 11 causes retardation of the motion of the unit to an angular velocity lower than that of the left hand rotor/piston unit; reaching Position Five, Fig.4, faces “in run” (cat and

mouse principle) become in contact at point V0. Thus, the initial fluid volume Vmax decreases, passing through the volumes Vout1, Vout2, Vout3 - to V0; simultaneously, the other two rotor/piston unit faces withdraw from each other, reaching in succession V0, Vin1, Vin2 and Vin3 - to Vmax. In this cycle, the rotor/piston units 11 function as valves securing input/output switching of fluid flow. In anti-clockwise rotation of the rotor/piston units11, and reverse cycle phasing the fluid flow reverses its direction.

Reverse Action – Volumetric fluid motor - generator.

In this mode, pos. 11 (Figs. 1, 2, 3 and 4), the two rotor/piston units, initially functioning as such, reverse their function and operate as piston/rotor units (pistons in a fluid-driven motor and rotors in an electro-generator). Since the unit is with bidirectional operation, consider the case where the input coupler is 18 located on the far side of the interface connector 21 and the piston/rotor units 11 rotate in clockwise direction if viewed from the cooler 21. In Position One - 5 positions, Fig.4 - the two rotor/piston units 11 are in initial position, in which the left rotor/piston unit closes the input channels, connected through the left axial opening 28, with the input coupler (Fig. 5); the right hand rotor/piston unit 11 closes the output channels connected through opening 29 with the output coupler 18 (on the side of the interface connector 25). In this state no fluid flow forces are applied to the faces of the rotor/piston units 11 and 12, hence there is no torque involved. The two rotor/piston units 11 and 12 are made to leave this

state by a torque resulting from the action of inertial forces and such due to action of the electromagnetic system forces. In subsequent phases (pos. 2, 3 and 4 to 5, Fig. 4) the kinematics remains unchanged in the clockwise rotation of the piston/rotor units 11 (as it is in the direct mode of operation – electric motor/compressor).