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THE CASCADE PRESSURE EXCHANGE REACTIVE ROTETION DISK ENGINE CREATION REASONS

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Summary. The theoretical reasons of creation the reactive rotation disc engine on cascade pressure exchanger base (ERR CEP) have been stated. The particularities of ERR CEP working process in collation with wave disc engine on wave pressure exchanger base have been considered. It is in particular shown that cascade pressure exchange principles use allows vastly to increase the pressure of preliminary compression of charge and also to reduce the loss of expanding products of combustion in useful work turning moment of engine.

Key words: cascade pressure exchanger, wave pressure exchanger, reactive stream, mass-exchange, disc engine of reactive rotation.

INTRODUCTION

Now the need for supernumerary and simple internal combustion engines on a design, working at different types of hydro-carbonic fuel, including natural gas (methane) with low cleaning degree increases.

The pistons ICE which have gained the greatest distribution practically have settled a reserve of considerable improvement of specific power and fuel profitability. Besides, existence of a large number of the precision details, difficult systems and units causes high cost of their production and service.

In heat power machines, reforming heat in mechanical work the main part of internal work make up compression of a gaseous body in an installation cycle. Charge compression by means of a mechanical ouster (the piston or shovels of driving wheel) thermodynamic is irrational and interfaced to complication of engine design. The use wave or cascade pressure exchangers in the capacity of main or additional air charge compressor unit is a new direction of multipurpose heat machines development. In pressure exchangers direct transformation extending gases energy to compressed air located energy in the course of direct contact between compressing and compressed environments is carried out.

THE ANALYSIS OF PUBLICATIONS

The first successful attempt of application of a wave exchanger (WPE) as the first step of compression was carried out by Claud Seippel from the Brown Bovery company in Switzerland on the locomotive gas-turbine engine (GTE). In the early sixties in the Ruston-Hornsby company under the direction of Rhone Pearson the wave rotor turbine (WRT) in which disk rotor spiral-shape channels at the same time was created and tested served as combustion chambers for an air and kerosene mix. At the beginning of the 2000th years a row of known research centers such as NASA, Rolls-Royce, Indiana University, Purdue University Indianapolis, the company ABB, Michigan State University have renewed interest to integration of WPE of a various configuration in mini- and microGTE [Akbari P. A, Nalim M.R., Muller N., 2006., Akbari, P., Muller, N., 2003, Benini E., Toffolo A., Lazzaretto A., 2003., Rogers C., 2003., Welch G. E., 2000, Krajniuk A.I., Storcheous J.V., 2000, Wilson, J. and Paxson, D. E., 1993, Zauner, E., Chyou, Y. P., Walraven, F. and Althaus, R., 1993].

It is necessary to note, however, that the appreciable effect of integration of WPE in a working cycle of GTE is reached only if efficiency processes of compression and expansion of working bodies in wave exchanger excess efficiency these processes in installation turbo-compressor part. Besides, use of WPE as the top step («Top stage») doesn't eliminate, and in some cases aggravates the main lack of the gas-turbine engine – unsatisfactory efficiency on transitional and partial modes. Strongly pronounced of exchange processes wave nature in WPE determinate sensitivity of its consumption characteristics to thermodynamic parameters of working environments in gas-distributing ports and rotor frequency rotation. The deviation of an operating mode of GTE from settlement conditions leads to destruction of waves interaction adjusted picture with gas-distributing ports and to sharp decrease its efficiency. But even on a settlement mode the inevitable energy dissipation in the course of formation and interaction of strong shock waves in a rotor limits efficiency the best samples of WPE values 0,59… 0,63 [Krajniuk A.I., Storcheous J.V., 2000].

In 2005 scientists of Michigan university under the direction of N. Muller started development of the new disk engine on the WPE basis. Unconditional advantage of the wave disk engine (WDE) in relation to known heat engines is compactness and simplicity. Authors of the project argue that the demoversion of the motor which will be constructed according to conditions of APRA-E provided by agency (A Department of Energy of the USA) a grant in $2,5 million will has efficiency not lower than 30%. At the same time realization of high profitability, within WDE declared by designers is represented very not a simple task. Along with noted features of wave processes restrictive factors of a working cycle of WDE are: low extent of preliminary compression of a fresh charge (allegedly less than 2,5); considerable losses of flooding of jet streams in a type of high (above-critical) differences of pressure in jet nozzles; not full exploitation of a radial component of jet streams speed.

Research objective is increase of efficiency of the disk engine by application of a cascade exchange by pressure.

THE THEORETICAL PRECONDITIONS OF CREATION OF THE DISK ENGINE OF JET ROTATION ON THE BASIS OF A CASCADE EXCHANGER OF PRESSURE

Considerable races of indicators improvement of heat machines of different purpose it can be reached by cascade pressure exchange application for compression of air-gas environments in installation working cycle. Such compression realize the cascade pressure exchangers (CPE) representing itself a new generation of pressure exchangers with mainly static nature of direct interaction of compressing and compressed environments. The working cycle of CPE differs with high efficiency (to 85 … 87 %) and tolerance to removal of an operational mode from settlement conditions. The CPE power efficiency realizes in considerable excess of a consumption of compressed air of rather compressing environment, subjects more than the temperature of the last is higher. This property of «consumption multiplication» opens creation prospect on CPE base of essentially new devices of heat-reforming multipurpose machines: thermal compressors and gas generators [Krajniuk, A.I., 2009.], gas-turbine engines [Krajniuk, A.I., 2010, Krajniuk, A.I., Krajniuk A.A, Bryantsev M.A, 2011.], supercharge systems of high-forced engines [Krajniuk, A.I., Alexeev S.V., Krajniuk, A. A., 2009, Krajniuk, A.I., Alexeev S.V., Kovtoon A.S., 2011], air refrigerators [Krajniuk, A.I., Bryantsev M.A., 2010, Krajniuk, A.I., Bryantsev M.A., Krajniuk, A. A., 2010, Krajniuk, A.I., 2011].

In biggest degree the cascade pressure exchanger potential can be realized in a working cycle of the jet rotation disk engine (JRE CPE) (fig.).

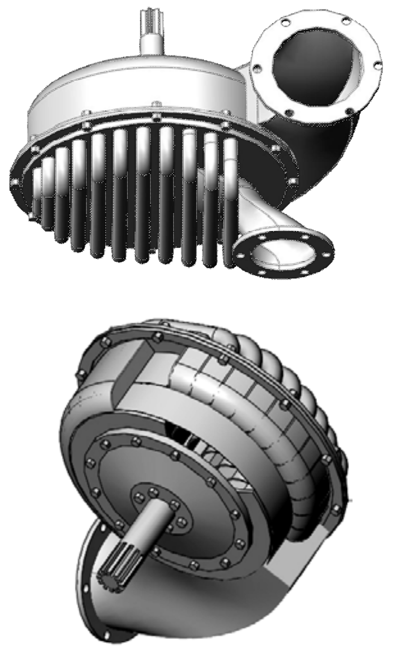

Fig. The common appearance of cascade pressure exchange disk engine

The main idea of use the CPE as the base unit of the engine consists in efficiency increase possibility transformations hot gases energy to located work of a compressed charge and reduces in losses of extending products energy transformation of combustion to useful work of a torque of engine. Theoretical reasons of the noted base on the following features of a working cycle of JRE CPE:

1. The main compression of a fresh charge is realized at the expense of recuperative use of energy of extending gases in the process of cascade mass-exchanger between adjacent cells of sites of compression and expansion. This process provides possibility of essential charge compression preliminary degree increase that promotes to increase cycle thermal efficiency.
2. In the engine on CPE base the expiration of the most part of jet streams is carried out not in the atmosphere, as in WDE, and to mass-exchange canals of a stator. Decrease in differences of pressure in jet nozzles to under-critical level is accompanied by reduction of losses of flooding of a stream. Thus the residual energy of the jet stream which has not been transformed to work, isn't lost quite as it is useful used in the form of a flow substance in mass-exchange channels, promoting additional increase of preliminary compression of a charge without increase in quantity of the brought warmth.
3. Thanks to that fuel - the air mix at the end of compression process concentrates in local volume from an ignition source, partially mixes up with hot gases and it is warmed up by walls of cells, favorable conditions for timely combustion of poor fuels, including, natural methane with low extent of cleaning are created.

Despite complexity of gas-dynamic processes of a working cycle, the design of the engine is simple and laconic, as contains only two mobile interfaced details. Absence of discretely operated bodies of a gas-distribution, ouster and systems of cooling causes reliability and simplicity of operation of an exchanger. According to results of settlement researches the specific capacity of JRE CPE makes from 3 to 4,8 kW/kg. Great values in the specified range correspond to engines of bigger dimension.

CONCLUSIONS

Low cost of manufacturing and reliability in a combination to small dimensions and weight cause to anticipate interest to disk engines of jet rotation the CPE from producers of modern power independent equipment and, first of all, aircraft, armored machinery, means of small-scale mechanization, motorcycles and racing cars.

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ПРЕДПОСЫЛКИ СОЗДАНИЯ ДИСКОВОГО ДВИГАТЕЛЯ РЕАКТИВНОГО ВРАЩЕНИЯ КАСКАДНОГО ОБМЕНА ДАВЛЕНИЕМ

Александр Крайнюк, Александр Данилейченко

Аннотация. изложены теоретические предпосылки создания дискового двигателя реактивного вращения на базе каскадного обменника давления (ДРВ КОД). Рассмотрены особенности рабочего процесса ДРВ КОД в сопоставлении с волновым дисковым двигателем на базе волнового обменника давления. В частности показано, что использование принципов каскадного обмена давлением позволяет значительно увеличить давление предварительного сжатия заряда, а также снизить потери расширяющихся продуктов сгорания в полезную работу крутящего момента двигателя.
Ключевые слова: каскадный обменник давления, волновой обменник давления, реактивная струя, массообмен, дисковый двигатель реактивного вращения.