BIOGRAPHY

Raul Turmanidze born in 1950 in 1972 graduated from the Faculty of Mechanical Engineering of Georgian Polytechnic Institute by specialty "Mechanical Engineering, Metal Cutting Machine Tools and Toolware". By distribution I was left at the Department of Mechanical Engineering where I worked in positions of senior laboratory assistant, educational master and assistant.

From 1976 to 1982 I studied at the Post Graduate Course after finishing of which continued work at the same Department as an assistant. In 1982 I defended PhD thesis that was dedicated to investigation of contact effects during diamond grinding of single carbide, double carbide, little tungsten and tangstenfree hard alloys. The wear nature of diamond rings was established during grinding of hard alloys of different characteristics in different conditions of machining.

For definition of the medium integral temperature of the contact and characteristics and distribution of temperature in the depth of the ground part was elaborated an experimentally analytical method of definition of the temperature field in the grinding area that was defended by the Patent of Georgia.

The method is characterized by the increased precision of definition of medium integral temperature in the grinding area in comparison with other existing methods.

On the basis of conducted theoretical and experimental investigations were determined the optimal modes of diamond grinding of various hard alloys for each specific case of machining depending on the required characteristics of the ground part.

Under the guidance of R. Turmanidze in 1984 was organized the Problem Scientific Laboratory "Designing and manufacture of precision micro-tools and technological rig of various purpose".

In the laboratory were elaborated and practically implemented the technological processes of manufacture of hard metal precision drills in the range of work diameter of 0,5÷3 mm and also a precision mills of different design and special micro-tools for precision machinery construction, micro-electronics, instrument making, jewelry industry etc.

On new designs of tools and separate technological operations for their manufacture Author's Certificates have been obtained that are defended with corresponding patents.

Many special tools manufactured in this laboratory are introduced into the enterprises of Georgia, Russia, Ukraine, Belorussia, Armenia etc.

In 1990 R. Turmanidze defended Doctor's thesis and became the Professor of the Department.

From 1993 to 1995 he worked the Head of Department of Scientific-Research works and from 1995 to 2004 he was the Vice-Rector in Scientific Work of Georgian Technical University. At present he is a Manager of Direction of Mechanical Engineering.

Simultaneously he systematically carries out International Projects by the International Science and Technology Center (ISTC) and Science and Technology Center of Ukraine (STCU).

By the ISTC under his leadership were carried out the projects on elaboration of new designs of the rotors with variable geometry parameters. These designs enable to change simultaneously the rotor diameter, setting angle of blades and the twist character of each blade in the flight process. The Collaborators of these Projects are the leading specialists of such well-known world aviation companies as "Boeing", "AgustaWestland", "ONERA" etc.

These designs besides aviation can be successfully used in windmills, shipbuilding and other fields of engineering. At present the negotiations are being held with representatives of many companies for joint works.

By the STCU are carried out the Projects on elaboration of the effective technology of manufacture of spherical surfaces of implants of the human hip-joint. New methods of definition of optimal pairs are being elaborated with use of such various modern wear resistant materials of medical purpose as titanium, tantalum, ceramics, mono-crystal of sapphire and their combination. The basic criteria of selection of these materials and technological processes of their development are their compatibility with human organism and term of service without violation of their operational indices. The influence of anisotropic characteristics is investigated on the one hand on the workability and on the intensity of wear of mono-crystal on the other hand.

At the present time together with the colleagues of Magdeburg Technical University is also carried out the Project on manufacture of small sized hardmetal spiral drills with the variable inclination angle of the chip grooves and definition of the effectiveness of use of such drills during boring of various intractable materials in comparison of drills with the standard geometry parameters.

R. Turmanidze is the author of more than 170 published scientific works including 35 patents, three text-books and two monographs. He is a member of American Society of Mechanical Engineers, Academician of the Engineering Academy of Georgia and a member of the Helicopter Union of America. He is a participant and organizer of International and Republican Scientific-Technical Conferences and also the Manager and participant of the number of significant projects and scientific investigations.

Approbation of the results of scientific investigations and international projects in direction of creation of the rotors with variable geometry parameters

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2. R.Turmanidze, S.Khutsishvili, G.Sanadze

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New versions of designs of the rotors and stand for their tests in dynamics

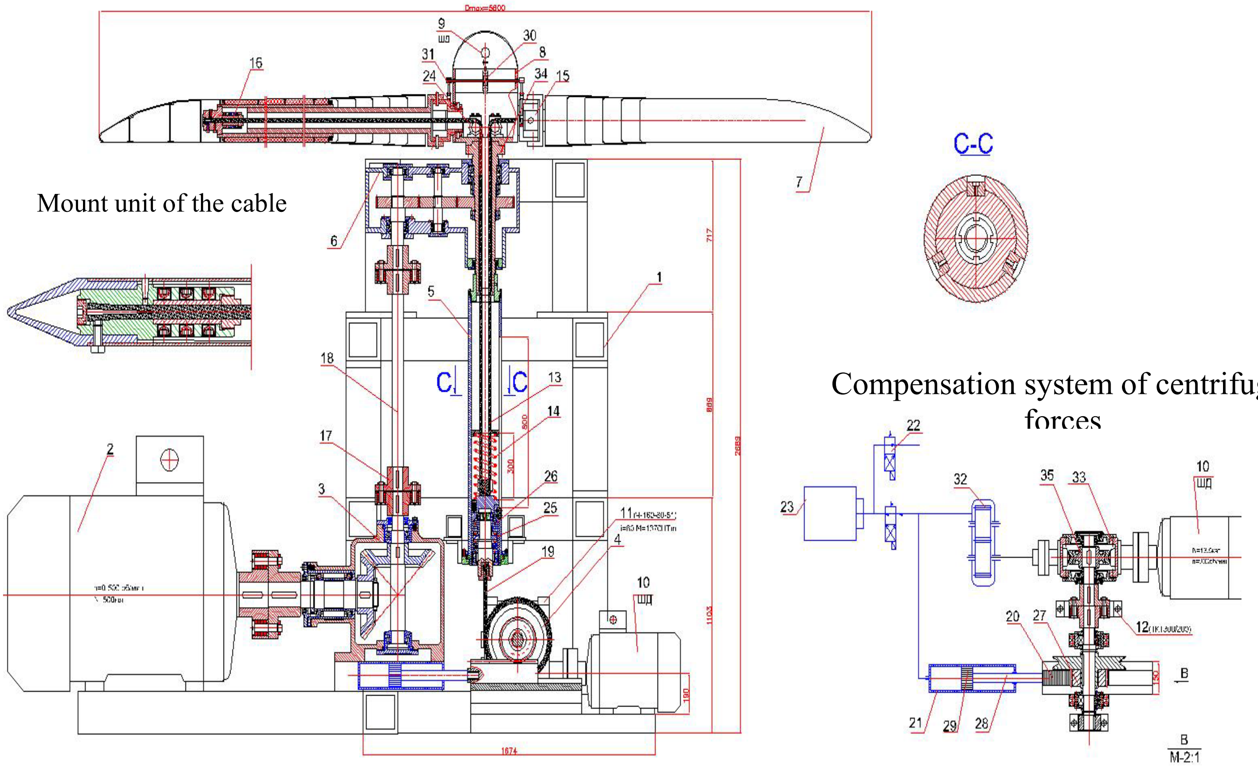
1. Work principle of the VGR with a mechanical drive

In Fig.1. as an example is presented the schematic arrangement of one of the VGR designs and the test stand with mechanical drive of the diameter change combined with the system of compensation of centrifugal forces and a big precision of positioning in all the range of the rotor diameter value change.

The scheme has the following consequence of work. From the drive by steeples adjustment 2 via conical reducer 3 and cylindrical reducer 6 the rotation is transferred to the body of hub 8, together with it rotate blades 7, pulleys 24, cable 13, thrust bearings 25, radial bearings 26 and guiding 5 which is connected with hub 8. In the start process of the VGR the arisen centrifugal forces open the blade movable parts to D_{max} of the rotor.

The rotor control takes place by pitch drive 10, worm reducer 11, drum 4 and drive cable 19.

The compensation of centrifugal forces in the VGR is carried out by three systems. Two of them (see Fig.1) are concentrated in hydro-accumulator 23 and the third in mechanical accumulator 14, i.e. in a spring of big diameter.



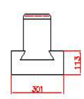


Fig. 1. Schematic arrangement of the VGR and mechanism of its control

1-Body, 2-Drive, 3-Conical reducer, 4-Drum, 5-Guiding, 6-Cylindrical reducer, 7-Blade, 8-Hub, 9-Pitch engine for change of the blade setting angle, 10-Pitch engine, 11-Worm reducer Ч160-80-51,12-Shoe brake ТКТ300/200, 13-Cable ЛКО (ЛКО 6х20=114 Q=25,95т ГОСТ 3077-90), 14-Compensation unit of centrifugal forces, 15-Horizontal hinge of blade, 16-Mount unit of the cable, 17-Resilient coupling, 18-Shaft, 19-Drive cable (ЛКО 6х20=114 Q=25,95т ГОСТ 3077-90), 20-Rack pair m=4mm, 21-Hydro-cylinder, 22-Hydro-distributor, 23-Hydro-pneumo-accumulator, 24-Pulley, 25-Thrust bearing, 26-Radial bearing, 27-Rack wheel, 28-Rod, 29-Piston, 30-Worm pair, 31-Lever, 32-Gear pump, 33-Worm reducer, 34-Spindle, 35-Worm.

In the control process of the rotor they work simultaneously. During extension of blade 7 drive cable 19 and cable 13 together with mechanical accumulator 14 travel upwards to the full its pressure.

From pitch drive 10 the motion is transferred from one side to worm 15 and from the worm to oil gear wheel pump 32 and then to hydro-accumulator 23 simultaneously to drum 4 and via rack pair 20 and hydro-cylinder 21 to hydro-pneumo-accumulator 23. As a result in process of opening of the blades to $D_{\max}$ drive 10 and drum 4 rotate free, the accumulators are charged and the VGR works in the takeoff mode. In this mode after the end of the extension cycle of blades shoe brakes 12 are switched on, in consequence of which the control system exactly fixes the position of installation of the rotor diameter.

For the reduction of the rotor diameter pitch drive 10 is switched on in back direction, simultaneously shoe brakes 12 are switched off and retraction of blades with flexible elements takes place. The blades having movable work ribs and copier set-ups of position of each rib on the preliminarily calculated value during retraction convolve by the required law.

During the retraction of blades accumulators 14, 23 and 23 adding the energy to pitch drive 10 decrease the consuming power of electrical engine. This is also conduced by the gradual reduction of the rotor diameter.

The blade setting angle is carried out by the separate drive, in particular, by pitch engine 9, worm pair 30 and levers 31.

The advantage of the VGR and the test stand of this version is:

1. Control of the rotor diameter change from $D_{\max}$ to $D_{\min}$ with high precision and reliability of positioning to any value of the diameter.
2. The developed VGR has the blades with movable ribs of new design flexible elements manufactured by the new technology enabling its twisting to $32 \div 35^0$.
3. Rotor blades are controlled by one whole cable 13 the loose ends of which are reliably fixed on the movable parts of blade.
4. In control system are used mechanisms well showing themselves by reliability and durability on hoisting devices during their existence.
5. The system design is manufacturability and is subject to the simple service and repair.
6. The mechanism is equipped with the compensation system of centrifugal forces by that providing the reduction of consumable power of drive of the control mechanism of the VGR parameters.

2. The design version of control of the VGR parameters on the basis of “jackscrew” and free-running coupling

In this version of the VGR (in Fig. 2) the rotation of blade 3 is carried out similarly to previous Version 1.1.

Control of the rotor diameter is carried out from pitch engine 16 via worm reducer 14 and ball-screw pair 11 and 12.

After the start of drive 5 due to arisen centrifugal forces of blade 3 by cables 7 via pulleys 2 opening, rotating and moving nut 12 with free-running coupling relatively to the movable screw takes extremely top position.

Simultaneously by rotating worm reducer 14, particularly from worm 27 the rotation is transferred to gear pump 23 and then the oil is transferred to hydro-pneumo-accumulator 24, i.e. charging of accumulator 24 takes place.

In this cycle the rotor opens to Dmax and the VGR takes parameters characteristic to for the takeoff mode.

For retraction of blades rotor 11 via pitch engine 16 receives rotation in back direction, in nut 12 the free-running coupling is switched on and with its travel pulling cable 7 carries out the retraction and twist of blade on the chosen angle of twisting.

Simultaneously hydro-accumulator 23 adds the energy to the rotation of pitch engine 16 and reduces the consumed power for control of the VGR.

At the end of this cycle the rotor will be installed to size $D_{\min}$ and the VGR geometry parameters correspond to the mode of cruise flight.

The basic advantage of this design additionally to the previous Version is the fact that the number of used units and parts reduces.

The disadvantage is:

That the control of the rotor diameter happens by two cables by which in comparison with Version 1 the number of units of the cable mount increases.

In the scheme a ball-screw pair is foreseen that at big loads requires the increase of big sizes.

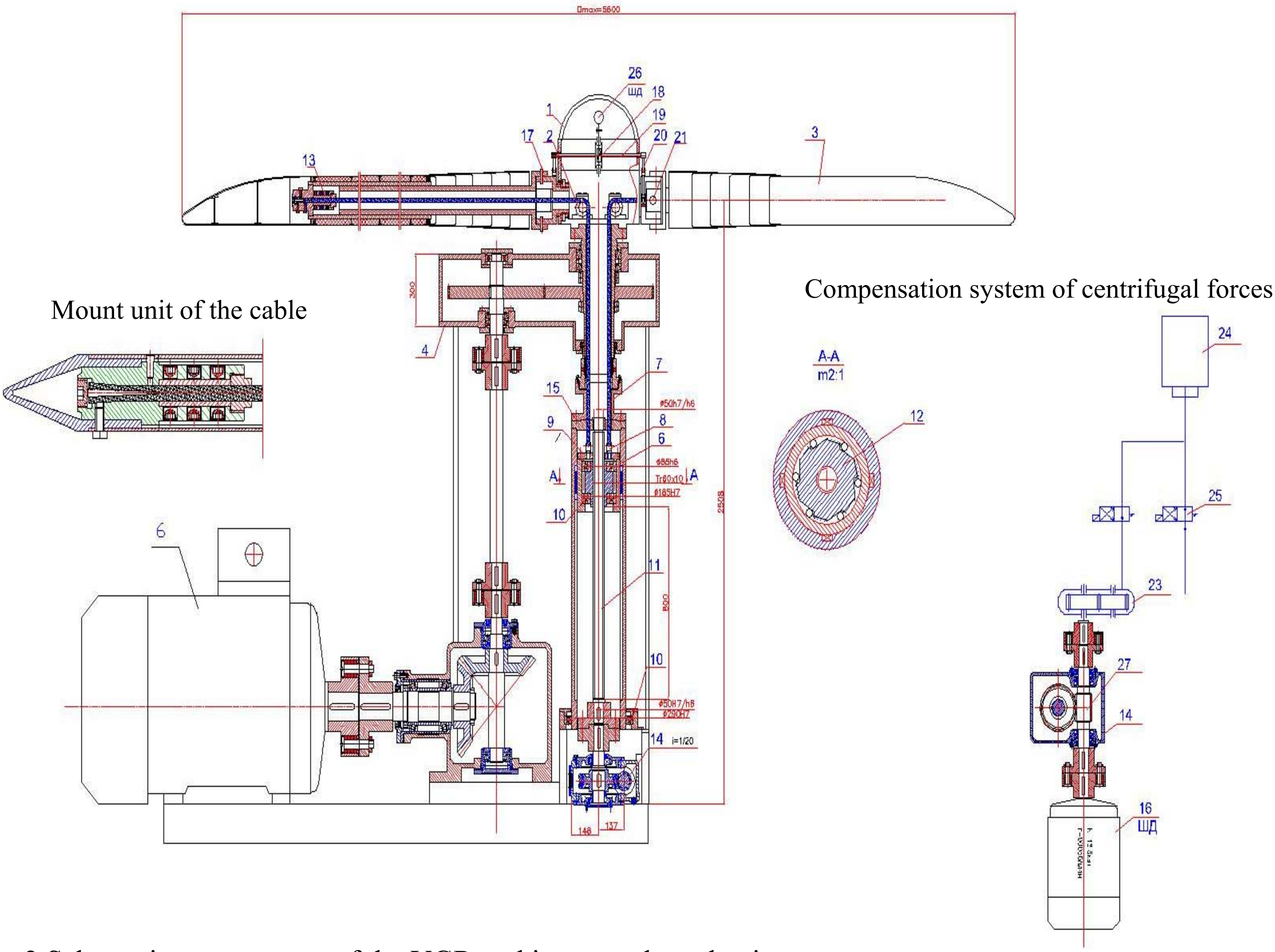


Fig. 2 Schematic arrangement of the VGR and its control mechanism.

1-Hub, 2-Pulley, 3-Blade, 4-Cylindrical reducer, 5-Drive, 6-Guiding, 7-Cable, 8-Rimbolt, 9-Cover, 10- Radial-thrust bearing, 11-Screw, 12-Nut with the element of free-running coupling, 13-Unit of the cable mount, 14-Worm reducer, 15-Special bushing, 16-Pitch engine, 17-Special dowel, 18-Worm pair, 19-Shaft of the mechanism of the blade setting angle change, 20-Lever for setting angle, 21-Horizontal hinge of blade, 22-Coupling, 23-Gear pump, 24-Hydro-pneumo-accumulator, 25-Hydro-distributor, 26-Pitch engine, 27-Worm.

3. Version of the VGR with combined control mechanism

In order to keep all the advantages achieved by the range extension of use of the hydro-drive in Project G-1600 and to prevent the inaccuracies of positioning of movable parts of blades in this version of the VGR is put in the “jackscrew” pair located in hollow rod 13 of hydro-cylinder 12 (see Fig. 3), the control of motion of the rotor diameter change and fixation at different values is carried out by pitch drive 26, worm reducer 22, “jackscrew” pair 23 and by hydro-cylinder 12 only compensation of centrifugal forces.

During extension of blades after switching on of main drive 6 (to low rotations) because of arisen centrifugal forces blades 3 by cables 8 via pulley 2 pull the body of bearings 9 and rod 13. Despite the rising of certain centrifugal force the extension of blades 3 is impossible as the motion of rod 13 holds worm reducer 22 with jackscrew 23 that is wrapped in the rod from the side of piston 14.

With the increase of rotations of main drive 6 pitch drive 26 is switched on, the hydro-system and by switching on of the electrical magnet of hydro-distributor 16 accumulator 15 is connected with work cavity 11 of hydro-cylinder 12. The blades begin extending. The motion of blades, extension speed is carried out and adjusted by pitch drive 26 which transfers the rotation to jackscrew 23 via worm reducer 22. During motion of the rod the oil placed in work cavity 11 of cylinder 12 overflows to hydro-pneumo-accumulator 15 in which the energy of centrifugal forces is accumulated, kept and then used during the reduction of the rotor diameter.

At a certain rotational speed of the rotor the extension of blades finishes, pitch drive 26 is switched off, at the command hydro-distributor 16 is switched off breaking the link of hydro-cylinder 12 from hydro-pneumo-accumulator 15.

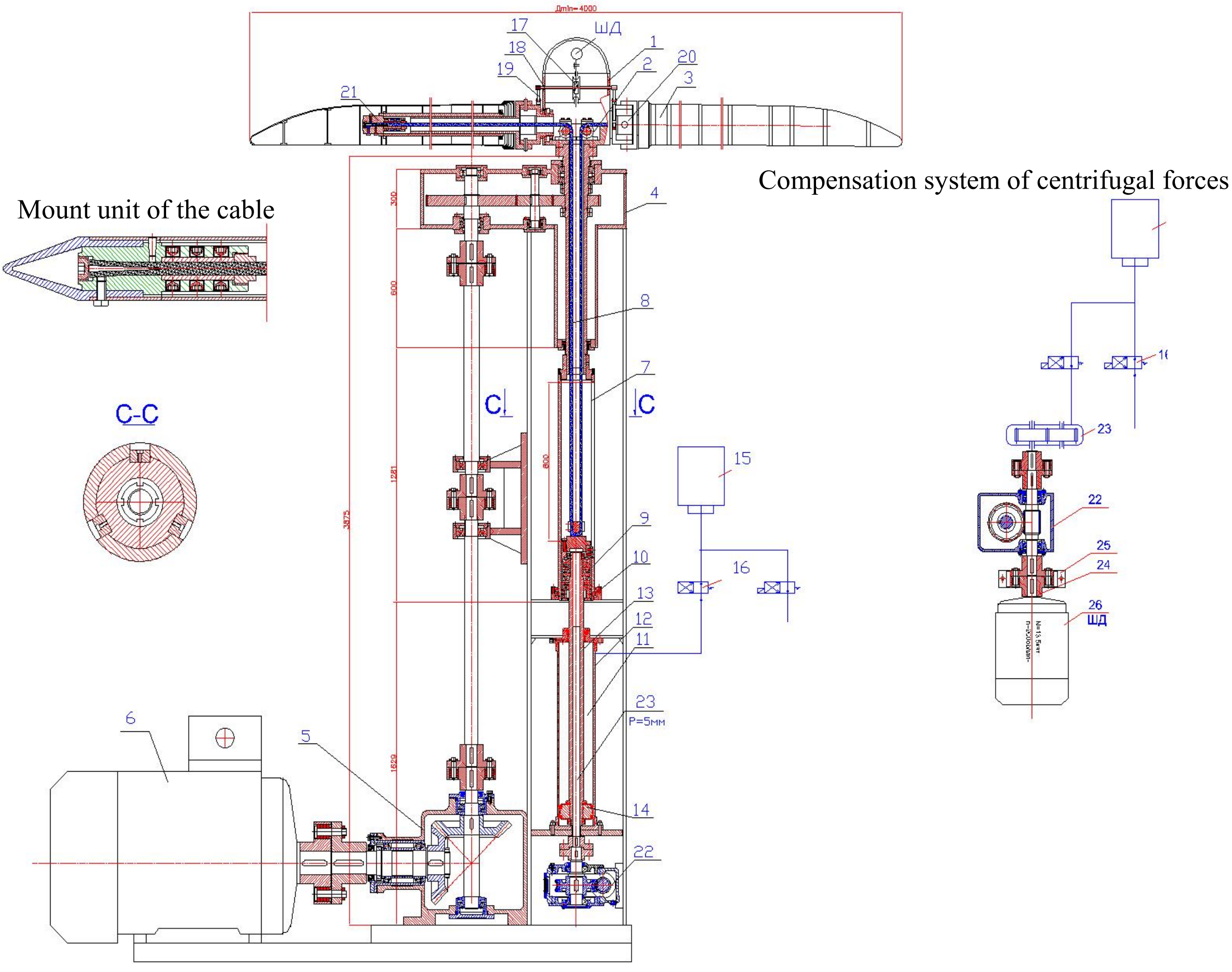


Fig. 3 Schematic arrangement of the VGR

1-Hub, 2-Block, 3-Blade, 4-Cylindrical reducer, 5-Conical reducer, 6-Drive, 7-Guiding, 8-Cable, 9-Thrust bearing, 10-Radial bearing, 11-Work cavity of the cylinder, 12-Hydro-cylinder, 13-Rod, 14-Piston, 15-Hydro-pneumo-accumulator, 16-Hydro-distributor, 17-Worm pair, 18-Shaft of the mechanism of change of the blade setting angle, 19-Lever of the setting angle, 20-Horizontal hinge of the blade, 21-Unit of the cable mount, 22-Worm reducer, 23-Jackscrew, 24-Coupling, 25-Shoe brake, 26-Pitch engine.

For the retraction of blades hydro-distributor 16 is switched on and accumulator 15 is connected with work cavity 11 of hydro-cylinder 12. Simultaneously pitch drive 26 is switched on and the rotation is transferred to worm reducer 22 and jackscrew 23. Rod 13 with piston 14 as a result of the oil pressure in work cavity 11 and rotation of jackscrew 23 begins traveling downwards and pulling the body of bearings 9, cable 8 and blades 3. During the retraction with travel of blade in its flexible part the twist is carried out.

The advantage of this version is:

1) Increase of precision and reliability of fixation of blades by saving the advantage of hydraulics at transfer of big forces at minimum metal consumption.
2) Possibility of implementation of compensation of centrifugal forces and use of the accumulated energy with the minimum number of parts.
3) Control of speed of the blades retraction is carried out by the mechanical drive at minimum loads precisely and reliably as the action of centrifugal forces practically is entirely balanced.

The disadvantage is:

1) Designing-technological complexity of location of the screw in the rod of hydro-cylinder. However, in case of the necessity this problem is solvable and the ways of its technical solution are already elaborated.

4. Methods for selection of the geometry sizes of elastic elements of blades of the VGR and versions of their manufacture

Is at the stage of development...