Southern federal University

Institute of high technologies and piezotechnics

SCTB “Piezopribor”

POLARIZING EQUIPMENT

Handbook

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History of technological equipment of SCTB “Piezopribor”

Modern technological equipment of the SCTB "Piezopribor" cannot exist without the experience and developments that were once received by the "founding fathers" of the school "Piezoelectric instrumentation" in Rostov-on-don, Russia.

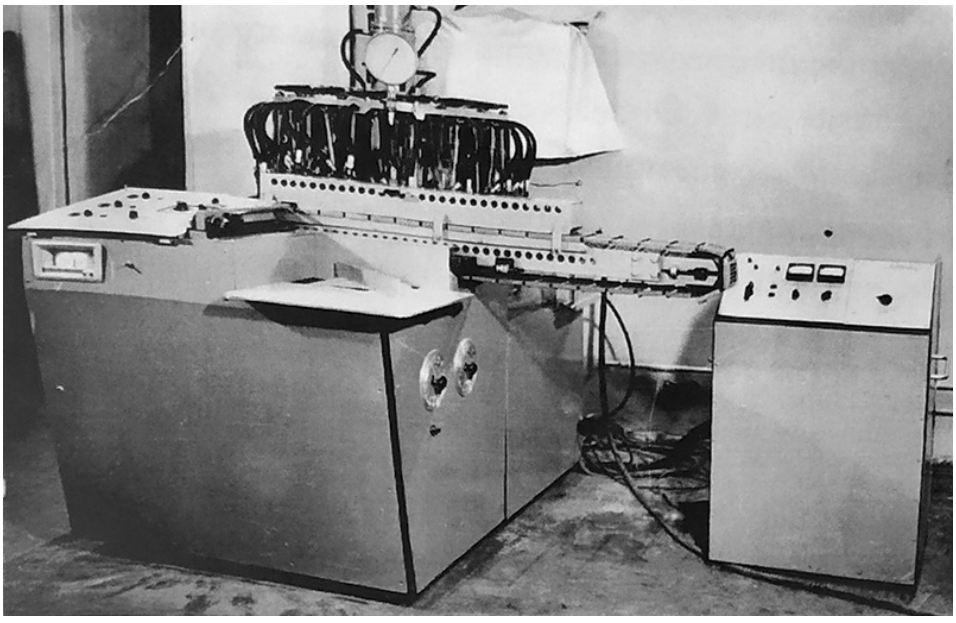
The expansion of the application areas of piezoelectric elements based on piezoceramics stimulated not only instrumental research of ferroelectric and piezoelectric phenomena in polycrystalline ferroelectrics, but also forced to pay serious attention to improving the technological process of production of such materials, of which polarization is an integral part.

Ferroelectric ceramics acquire piezoelectric properties in the process of polarization-the impact of strong electric fields. The polarization mode - a set of external influences on ferroelectric ceramics (the value of the polarizing field, temperature, time of exposure to the field) determines both the achieved level of piezoactivity and the persistence of the parameters of piezoelectric elements during their operation.

The need to influence ferroelectric ceramics with strong electric fields requires (according to the classical technology) immersing it for the time of polarization in a liquid dielectric, which is usually used as various synthetic organosilicon liquids. The use of a liquid dielectric allows for polarization at high values of the electric field strength, but the polarization temperature is limited by the ignition temperature of the liquid dielectric.

Liquid dielectric gets into the pores of ceramics during polarization and its removal from there is very difficult, and it is almost impossible to completely remove it.

Since 1976, dozens of different types of polarizing devices have been developed, tested, and put into production chains that are capable of polarizing piezoceramic elements in vacuum, inert gases, air, and liquid dielectrics. The accumulated experience and modern technologies allow you to create installations for a wide variety of purposes and tasks.



Polarizing equipment "Volt", 1977

The new generation of polarizing equipment of SCTB "Piezopribor" supplemented the experience of previous developments with the use of modern materials, technologies and controls, as a result of which the latest products received new technical, aesthetic and operational qualities. Below are some of the innovations and results of their application.

- using an individual controlled polarization voltage source for each polarized piezoceramic element;
- no series-connected ballast resistor between the output of the polarization voltage source and the piezoceramic element electrode;
- the presence of a resistance connected in parallel to the polarization voltage source;
- use of a microprocessor controller and related peripherals.
- These technical solutions and the use of a modern element base made it possible to implement new technological and experimental capabilities:
- setting different values of the polarization voltage for each polarized piezoceramic element within a single heating/cooling cycle, which allows simultaneous polarization of several identical piezoceramic elements at different field strengths, thus speeding up the process of selecting the polarization mode or simultaneously polarizing elements of different chemical composition and configuration;
- easily set and control polarization modes using the touch screen;
- monitoring the voltage directly on the piezoceramic element electrodes over the entire temperature range;
- automatic control of dial speed and temperature stabilization;
- gradual change of the polarization voltage level depending on the current value of the piezoceramic element temperature;
- realization of linear-increasing polarization voltage at the final stage of the temperature regime;
- ensuring a shock-free reduction of the potential of the capacitive component of the piezoceramic element after disconnecting it from the polarization voltage source;
- archive recording and subsequent use of up to 20 successful polarization modes;
- data exchange with an external computer network;
- further improvement of technological and service functions of the equipment by updating the software.

PKVS-20 EQUIPMENT

The equipment PKVS-20 is designed for polarizing a wide range of piezoceramic elements in the air at normal atmospheric pressure. The installation is a heating and cooling chamber equipped with high-voltage inputs and guides for installing cassettes. Piezoceramic elements to be polarized are installed in cassettes, which when installed in the chamber are connected to the contacts of high-voltage inputs. A microprocessor controller controls the heating and cooling modes of the air medium and the PCE located in it, as well as the regulation of the polarizing voltage supply. Setting and controlling modes is performed using the touch screen.

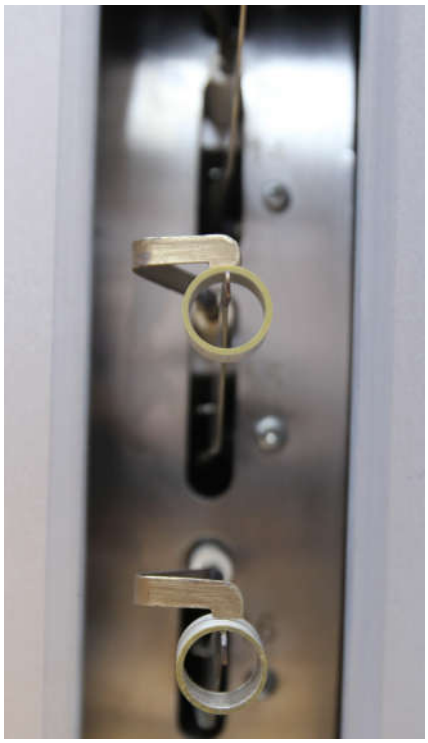
Parameter	Value
disks, rings in diameter, mm	10 .. 80
plates, length, width, mm	10 .. 100
in the interelectrode gap, mm	1 .. 12
The range of the polarization voltage, kV	0,8 .. 20
Maximum temperature in the chamber, °C	200
The number of positions of the polarization	6
Maximum power consumption, kW	4
Overall dimensions (WxHxD), mm	1450x1900x810

PKLS-70 EQUIPMENT

The PKLS-70 equipment is designed for polarizing large-size piezoceramic elements. It combines with a bath equipped with heaters, coolers and high-voltage bus that is placed in the chamber of the exhaust Cabinet. The piezoceramic element is installed in a cassette, which is placed in a bath filled with dielectric liquid, while the PCE electrodes are connected to the high-voltage bus and the bath body via contact devices. A microprocessor controller controls the heating and cooling modes of the dielectric liquid and the piezoceramic element located in it, as well as the regulation of the polarizing voltage supply. Setting and controlling modes is performed using the touch screen.

Parameter	Value
disks, rings in diameter, mm	10 .. 80
plates, length, width, mm	10 .. 150
in the interelectrode gap, mm	20 .. 80
Maximum temperature in the chamber, °C	170
The number of positions of the polarization	1
Maximum power consumption, kW	1,2
The range of the polarization voltage, kV	2 .. 70
Overall dimensions (WxHxD), mm	1350x2000x700

PVS-5 CONVEYOR SYSTEM



The equipment provides high performance and the ability to polarize a wide range of shapes and sizes of piezo ceramic elements. The main advantage of the installation is the absence of influence of liquid dielectric on the electrodes and the structure of piezo elements, which is especially important for subsequent bonding of products. The exclusion of dielectric and washing liquids from the process reduces the cost of production, including by eliminating additional technological and environmental problems.

Parameter	Value
disks, rings in diameter, mm	3 .. 30
plates, length, width, mm	<30
in the interelectrode gap, mm	0,5 .. 10
Maximum temperature, °C	500
Technical performance, PCs / hour, at least	1200
Continuous operation time, h	8
Range of conveyor holding time, s	0,1 .. 999
The number of positions of the polarization	40
Maximum power consumption, kW	4
The range of the polarization voltage, kV	0,3 .. 20
Overall dimensions (WxHxD), mm	1800x1500x600
Max. Weight, kg	200

EQUIPMENT FOR POLARIZATION OF PIEZOCERAMIC ELEMENTS IN A LIQUID ENVIRONMENT (PLS)

The equipment provides polarization of a wide range of piezoceramic elements from most modern piezoceramic materials. The polarization technology is "classic" in a liquid dielectric layer. Creating the maximum electric field strength in the volume of the piezoceramic element (PE) by additional isolation of the interelectrode surfaces of the PE blank with a liquid dielectric makes the installation indispensable at the stages of development and development of new types of piezoceramic materials and piezoceramic elements. Another important advantage of the installation for polarization in a liquid dielectric medium is the uniformity of heating and cooling of the PE blank, which is especially important when polarizing large-sized products.

Parameter	Value
disks, rings in diameter, mm	3 .. 30
plates, length, width, mm	<30
in the interelectrode gap, mm	0,5 .. 8
Maximum temperature, °C	150
Technical performance, PCs / hour, at least	70
Continuous operation time, h	8
The number of positions of the polarization	40
Maximum power consumption, kW	4
The range of the polarization voltage, kV	0,1 .. 2,5
Overall dimensions (WxHxD), mm	1200x690x2400

It is possible to increase the overall dimensions polarized elements while reducing performance

EQUIPMENT FOR POLARIZING LARGE-SIZE PIEZOELECTRIC ELEMENTS MADE OF FERROCONCRETE MATERIALS IN THE AIR ENVIRONMENT (PVSK)

The equipment provides a chamber process of polarization of large-sized pieces of piezoceramic elements made of ferroconcrete materials without the use of a liquid dielectric.

When using two or more cameras, which are alternately in the stages of loading/unloading and polarization of PE, the installation provides high performance of a wide range of large-size PE blanks. The absence of liquid dielectric influence on the electrodes and the PE structure is important for subsequent bonding of products. The exclusion of dielectric and washing liquids from the process reduces the cost of production, including by eliminating additional technological and environmental problems.

Parameter	Value
disks, rings in diameter, mm	30 .. 80
plates, length, width, mm	<80
in the interelectrode gap, mm	3 .. 12
Maximum temperature, °C	200
Technical performance, pcs / hour, at least	100
Continuous operation time, h	8
Maximum power consumption, kW	8
The range of the polarization voltage, kV	0,5 .. 20
Maximum field strength kV / mm	1,3 .. 1,8
Overall dimensions (WxHxD), mm	1300x850x1700

It is possible to increase the overall dimensions polarized elements while reducing performance