Each ultrasonic generator stage comprises a transistor operating in a switching mode. To avoid inter-channel interference the generator switches alternately. The generator is located on the same board which is mounted in a metal housing. A twisted pair of wires in the screen provides the connection to the radiating elements.

The receiving and emitting transducers are spaced about 10 cm. Apart. Each of them is placed in a special cone concentrator. This performance is caused by two factors. Firstly, the area provided by the audio control zone is reduced, which improves resolution. The increased concentration of the acoustic field increases the response signal. Secondly, there is a sharp decrease in the parasitic coupling between the receiver and generator. This construction is fixed on a metal plate so as to provide a slight change in the geometry of the acoustic rays. This is required to collimate the radiation. At the same time the metal plate serves as a bottom of the metal casing that protects the package from environmental influences.

The amplifier of each channel is assembled on a separate board that is located in a separate metal housing. This is necessary to eliminate the co-channel interference within the electron path. The input stage is a differential amplifier assembled on transistors VT1 ... VT3. The second stage is a band-pass that ensures the inclusion of the collector circuit in oscillation circuit elements L4, C3. This combination significantly reduces the noise caused by high-power operation of electrical machines. The third stage is the process of harmonizing the analog part of the receiver input circuit with a microcontroller. An amplitude detector is placed at its output, which increases the comfort of adjusting operations.

Thus, the method of ultrasonic echolocation can be used to determine the linear dimensions and properties of the tested pallets. The sensor has been designed and assembled. The prototype of the device is going to be built.

REGULATION OF TECHNICAL STANDARDS OF DIGITAL RADIOGRAPHY: LITERATURE REVIEW

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Currently, radiographic control technology develops rapidly. Modern digital technologies supplant film radiography step by step. There is radiography with application of semiconductor detectors and radiography with application of reusable phosphor plates. Computed radiography (CR) using storage plates is an alternative to film radiography.

Radiography using storage plates has several advantages. One of them is the economic efficiency. In most cases, computed radiography is cheaper than film radiography. CR system and storage plates have a tendency to become cheaper gradually. The reason is that the number of manufacturers increase, business competition enhances, production technologies is optimized. The film has a tendency to rise in price because of silver evaluation, as silver is part of films. An important advantage of CR technology is the environmental safety. Computed radiography does not require chemical for image development processes as opposed to film radiography.

There are some studies that experimentally demonstrate the usefulness of phosphor plates in dosimetry, electron microscopy and for neutron irradiation registration and cosmic radiation in astrophysics. The ever-growing field of digital radiography application is an evidence of its relevance. [2]

In practice radiographic test is regulated by normative and technical documentation, standard operating procedures, technological flow charts. There are some problems that suppress the large-scale implementation of digital radiography in Russia. The most important of them is the lack of normative and technical documentation and technical literature that describes the sequence of actions and physics of digital radiography using storage plates.

Digital radiography can be carried out according to documents that specify film radiography: GOST 7512-82; GOST 20426-82; GOST 23055-78; EN 14784-1:2008; EN 1435:1997; EN 12517:1998; RD 19.100.00-KTN-001-10, SRT 2-2.3-561-2011. Unfortunately, Russian standard base is far behind up-to-date. It does not set forth the employment of new technology and equipment for digital radiography implementation. In Russia, the basic standards for radiographic testing are still the GOST 7512-82, GOST 20426-82, GOST 23055-78. These standards describe radiography testing with the usage of films as the radiation detector.

Abroad, there are standards that describe in detail digital radiography testing procedure. Unfortunately, there are no such standards in Russia. Nevertheless, the industry needs to use modern technology of digital radiography. Some organizations themselves produce radiology documents and company standards for computed radiography testing due to the lack of federal standard. It is necessary for products export; companies ought to rewrite foreign standards of quality. [1]

However, the development of these documents does not solve the problem completely. There is no integrated training and certification system in the field of computed radiography due to the lack of federal standards.

Company standards can come into collision with regulatory document of Federal Service for Environmental, Technological, and Nuclear Supervision and other assessing organizations due to lack of federal standard. Assessing organizations accustom to film radiography and often require to show the proof that the plate image complies with GOST 7512-82 for image density. In many cases, there are no personnel in assessing organizations who understand that "image density" is not applicable for computed radiography. Most of them do not understand that "signal-to-noise ratio" and "base spatial resolution" are the key quality attributes of a digital image. [3]

Until recent time, the main documents for the digital radiography testing were ISO 16371-1, -2 and its European counterpart is EN 14784-1, -2.

These standards include:

–terms and definitions;

–set of image quality indicators for system quality evaluation;

–classification system of computed radiography and estimation procedure of CR system against system response;

–practical guide for the classification systems of computed radiography for producers and end customers;

–guide for the periodic CR system quality evaluation while in operation.

In 2013 international standard ISO/FDIS 17636 was off the press. This standard consists of two parts. The first one (ISO/FDIS 17636-1) specifies the main aspects of non-destructive testing of weld seal using radiographic films; the second part (ISO/FDIS 17636-2) specifies the main aspects of non-destructive testing of weld seal using radiation detectors. In fact, ISO/FDIS 17636-1 is an analog of GOST 7512-82, but there is no analog for standard that prescribe digital radiation detector in Russia. ISO/FDIS17636-2 contains:

–terms and definitions;

–types of penetrameters and rules of their location;

–radiographic inspection schemes;

–equations to determine the focal distance and collocation of radiation emitter, testing object, radiation detector;

–selection rule for choosing radiation emitter, tube tension;

–recommendations for use of metallic shield.

In addition, the standard introduces two degrees of quality control: A and B. In some ways they are analogs to penetrameter classes described in GOST 23055-78. These classes define the minimum image quality. Criteria are standard samples of contrast penetrameter (wire or hole) and standard samples of spatial resolution (double wire penetrameter).It should be noticed is that the introduced quality control classes correlate with the same classes for the film that are mentioned in ISO/FDIS 17636-1. This means that, for example, digital radiography equipment of B-class represent image of defects as well as film radiography of B-class. [3]

It is important that there are clearly defined mathematical criteria to determine the spatial resolution, calculating signal-to-noise ratio, contrast-to-noise ratio and so on in ISO/FDIS17636-2.

Annex D of ISO/FDIS17636-2 contains exhaustive information how the gray levels can be measured with optical density of the film. It is commonly known that the degree of obscuration of the film determines of the rentgenographic image quality. The darker film is, the more it is irradiated, the higher signal-to-noise ratio. This ratio defines a class film. Similarly, signal-to-noise ratio for CR system defines a class system. Standards of CR and film radiography specify detection of defects in the same class systems is identic. [3]

Due to the fact that the procedure of determining the signal-to-noise ratio is complex and requires a regular radiation field, the standard introduces the rule of designation of gray levels and signal-to-noise ratio. The criterion of image quality is gray level value that is easily measured by software, which is an integral part of the CR systems. Designation of gray levels and signal-to-noise ratio is calculated when the parameters of the scanner and the type of storage plates are known.

The computed radiography has been used abroad for a long time as compared to Russia. Also relevant federal standards were developed and accepted abroad. The implementation of standards that specify computed radiography is necessary in Russia. These standards should be based on international standards. This greatly simplifies the usage of CR technology that was approved by Russian NDT community. [3]

To apply digital radiography technology into wide practice of industrial applications need to rewrite existing regulated normative and technical documentation and federal standards. It is necessary to add a set of permissive provisions (or annexes) about application of CR technology, which include approval to accept the results of radiography with digital image without copies on a solid support.

Also worth noting is that the progress of method is accompanied by the inevasible growth of publications. Available publications can be divided into three groups: specialized articles of scientific character (physics, technology, medicine, etc.); advertising, information and reference resources of manufacturing company; popular and informational brief communications.

However, there are no studies (especially in Russian) that contain reasoned exposition of physical basis of phosphor technology, contain technical screening of image reading process implementation, contain discussion of special aspects of image processing using computer, etc.

The main literary source about digital radiography technology, that describes the physics of the process, is the essay of the Candidate of Physical and Mathematical Sciences. It is called “Introduction to digital radiography” and written by Alexander Vsevolodovich Martynuk. The work includes a classification of phenomena that underlie of phosphor plate technology and an explanation of their essence. Also the physical processes are discussed that underlie of “latent image” formation and its read-out. The principal variants of image reading-out process are considered in the essay. [2]

Another source that briefly describes digital radiography technology is the journal called “In the world of non-destructive testing”. The archive articles are described the basic equipment for testing and the process of digital radiography using storage plates. Such famous authors as V.V. Kluev, F.R. Sosnin, A.A. Mayorov, give an analysis of the existing normative and technical documentation, write about the advantages and disadvantages of digital radiography technology, analyze the results of experiments that are performed using the storage plates at different monitored items (pipes, tanks, intricate details, etc.).

In spite of lack of information in the literature and technical sources, digital radiography technology is practiced on a wide scale in different branches of industry (oil and gas industry, construction engineering, aircraft industry, energy industry, etc.). While digital radiography technology replaces film radiography technology step by step, it is worthwhile noting that this technology meets quality control requirements: it achieves the required response, image contrast, better detection of certain defects (interstices, undercutting, inclusions).

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MATHEMATICAL MODELS OF THERMAL PROCESSES IN THE MULTI-ZONE THERMAL INSTALLATIONS FOR GROWING CRYSTALS

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Introduction

The needs of practice constantly stimulate the need to increase the geometric dimensions of the grown crystals and therefore toughening of requirements to their quality. This is especially true for non-linear optical crystals, which must operate at high laser intensities, and therefore have a low optical loss and high optical damage threshold [1]. Experimental studies show that the most effective non-linear optical materials for the conversion of infrared radiation in the terahertz are single crystals of compound $ZnGeP2$. At present developed the technology of growing single crystals $ZnGeP2$ of required quality by the Bridgman method with a diameter of 30 mm and a length of 200 mm in the multi-zone thermal installations (MTI). However, to create terahertz radiation converters needed samples with a diameter of 50 mm. As a rule, a simple increase in the sizes of the working volume MTI and growth containers (GC) does not allow obtaining a single crystal of a larger nominal value, and leads to a decline in the quality and the deterioration of the physical characteristics of the sample. This is caused by many of physical and technical problems associated primarily with the problem of providing the assigned temperature conditions with the required accuracy. Because of the complexity of heat transfer processes occurring in the conversion of the melt into the crystal, the lack of technical measuring means of the temperature field near the crystallization front, predicting behavior of temperature field without the use of computer models is not possible.

Therefore one of the urgent problems arising in the development and improvement of MTI is the creation of mathematical model that allows for real-time to predict with acceptable accuracy during the process of crystal growth in varying thermal conditions.