THE X-RAY SYSTEM WITH SUB-SYSTEM OF SHAPING OF FAN-SHAPED BEAM AND ITS APPLICATION IN THE CUSTOMS INSPECTION SYSTEMS

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Abstract

The analytical survey of X-ray sources based on linear electron accelerators applied in the customs inspection systems (IDK) was carried out on the grounds of requirements to customs inspection systems.

The test results of the linear electron accelerator IDK-6/9 MeV which allows to generate the X-ray mode with energies of 6 and 9 MeV are given in this article.

The questions of unification of linear electron accelerators for different IDK are also studied.

It is proved that the D.V. Efremov Institute of Electrophysical Apparatus (JSC "NIIEFA") has the necessary scientific and technical potential and is ready to work out and to produce the X-ray sources for Automobile, Sea and Railway Inspection Systems (IDK). In addition to that the JSC "NIIEFA" is ready to organize the serial production of X-ray sources for inspection systems.

INTRODUCTION

Integration of the Russian Federation into the world economic processes leads to the significant increasing of cargo traffic through its territory. The work-load of the Customs has also increasedgreatly. The most serious problem is an inspection of large-sized cargos; air, sea and railway containers; vehicles and refrigerators

The effective solution is possible with using of the customs inspection systems (IDK). The operating principle of the IDK is based on scanning of monitored objects by a narrow fan-shaped beam of bremsstrahlung with the following recording of a received shadow image and its computer reconstruction by a special software**.**

ANALYSIS OF REQUIREMENTS

As a result of analysis of different IDK types and taking into account the customs problems the Customs of the Russian Federation formed technical requirements for different IDK types: stationary (with energy 8-9 MeV), easy-to-build (relocated) (with energy 5-6 MeV) and mobile (with energy 2,5-4 MeV). This conception was fulfilled within the framework of the Federal target program "The State border of the Russian Federation (2003-2010)".

The experience of creating of IDK in «Ilek» as well as the analysis of development tendencies of IDK of leading world manufacture sallow to form new uniformed requirements for IDK andX-ray sources. The main characteristic sof IDK are given in Table 1.

Table 1: IDK maincharacteristics

Parameter	Mobile	Relocated	Stationary
Penetration capability forsteel	260 mm	400 mm	410 mm
Detection of steel wire without a barrier, diameter not more than	2,0 mm	0,7 mm	0,5 mm
Detection of steel wire behind a 100 mm steel barrier, diameter not more than	5 mm	1.5 mm	1,5mm
Detection of steel wire behind a 250 mm barrier, diameter not more than	-	7 mm	6 mm
Contrast sensation	3%	1%	1%
Carrying capacity, pcs	80 pcs	25 pcs	25 pcs
«Dual energy» mode	+	+	+

The realisation of the parameters given in Table 1 (especially Penetration capability and «dual energy» mode) [1]) requires the accelerators with energy up to 9-10 MeV with a possibility of energy changing. The parameters are given in Table 2.

THE LINEAR ELECTRON ACCELERATOR IDK-6/9 MEV

The linear electron accelerator IDK-6/9 MeV is used as asource of the X-ray bremsstrahlung. It was developed for using in customs control systems of large-sized cargos and vehicles [2].

The base operating mode of the accelerator is 6 MeV of the bremsstrahlung which provides penetration capability for steel more than 300 mm. If necessary the accelerator can be switched to an operating mode with energy 9 MeV of the bremsstrahlung. It provides the possibility to divide studied objects in accordance with a criterion organics/non-organics using the method of "two

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energies". The transit time from the mode 6 MeV to 9 MeV is 15 sec.

Table 2: Parameters of accelerators with a possibility of energy changing DK maincharacteristics

Parameter	Manufactures		
	Varian, USA	Nuctech, China	JSC «NIIEFA», RF
Energy of accelerated electrons, low	6 MeV	6-7 MeV	6 MeV
Energy of accelerated electrons, upper	9 MeV	9 MeV	9 MeV
Absorbed dose for 1 m in different modes, Gy/m×minute			
6 MeV	1	10	2
9 MeV	3	30	5
6/9 MeV	0,5 (6 MeV) 1 (9 MeV)		
Pulse frequency	300 Hz		300 Hz
Focal spot	2 mm	-	2 mm

The accelerating structure working on a stationary wave is used in the accelerator. The structure length is 950 mm. The accelerating structure is powered from a UHF generator that works on a magnetron MG6090. The operating vacuum in the accelerating structure is provided by two magnet-discharged pumps placed near the electron source and near thetarget.

The triode circuit with its own modulators is used in the electron source. This decision optimized the bremsstrahlung level on the scale of recieving detectors independently of the accelerator mode.

The frequency automatic adjustment system adjusts the magnetron accelerating structure operating frequency which is changed during the operating as the equipment is heated. The system minimizes the pulse level of the reflected UHF capacity.

The development of the «dual energy» mode is completed at present. The alternation of the bremsstrahlung pulses with energies 6 and 9 MeV is provided by changing of load of the accelerating structure by accelerated electron current beam with the help of an additional grid modulator of the triode electron source.

Bremsstrahlung generator is controlled in automatic and semi-automatic modes. The control system is designed with a programmable logical controller which allows to use a flexible interface and wide range of peripheral equipment and algorithmic solutions. Also it allows to simple integration of the generator control system into the complex external control system.

OPPORTUNITIES "NIIEFA" AS THE IDK EQUIPMENT MANUFACTURER

Equipment for the production of "NIIEFA" allows you to perform, manufacture, assembly, testing and commissioning of the accelerators and systems based on them. The quality system for all kinds of activities for the production of particle accelerators complies with ISO 9001-2001.

JSC "NIIEFA" is ready to participate in the development of new IDK and commercially supply the following IDK equipment:

- X-ray systems based on linear electron accelerators with fan-beam collimators;
- Detector systems with electronic data collection system;
- Software of data collection, archiving, imaging;
- Software of data collection, archiving, imaging;
- Software of data collection, archiving, imaging;
- Automatic control systems, systemsof monitoring and diagnostics;
- Gantry systems and / or systems of moving of the inspected object;
- Set of auxiliary equipment (shielding doors, automatic control systems, systems of the television surveillance, systems radiation safety, etc.) to ensure safe and smooth operation of the IDK.

REFERENCES

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