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HARDWARE IMPLEMENTATION OF THE SYSTEM FOR PROJECTILE *N*-WAVE GENERATING AND RECORDING

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The problems of generating and measuring parameters of pressure disturbances caused by flight of projectile supersonic speed are described in the paper. Attention is paid to difficulties in the measurement process and hardware requirements of measurement equipment. There is presented description of the research system to generating and recording of projectile N-wave parameters, where the computer is worked simultaneously as a generator and registration and data acquisition device.

Keywords: N-wave, measure of shock wave parameters, supersonic projectile.

The projectile motion with supersonic speed creates the system of shock and rarefaction waves, moving with the projectile (Fig. 1). Such system of waves corresponds to the characteristic pressure distribution called *N*-wave [1].

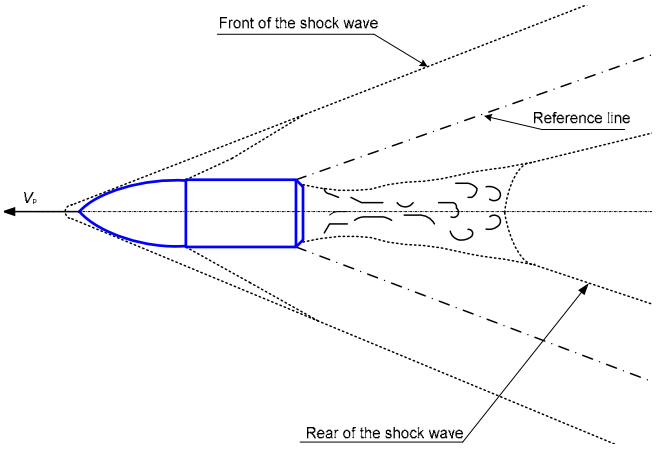


Fig. 1. The system of shock and rarefaction of pressure disturbances caused by the supersonic projectile moving

The configuration of this system of waves depends on shape of the projectile and its dimensions, attack angle relative to the plane of projectile flight and Mach number. Detailed knowledge of spatial-temporal parameters of *N*-wave pressure distribution is very important. The results of registration of the *N*-wave pressure disturbances are the basis for development of passive location and identification systems [2].

The study of *N*-wave distribution parameters involves the need to meet a rigorous requirements of safety and measurements reliability. It is important for configuration and mode of measuring equipments and measuring systems. Measurements should be automated and adapted to remote start and recording.

All measurement conditions make it advisable to develop the laboratory stand, that allows to conduct experiments quickly and safely without the use of ammunition and weapons.

Construction and operation of laboratory stand

Block diagram of the designed laboratory stand is shown in Fig. 2.

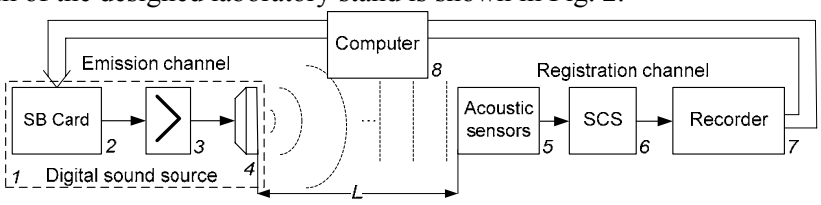
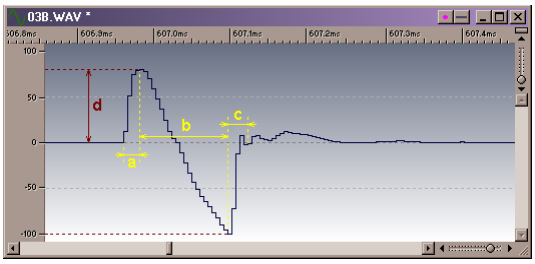


Fig. 2. Block diagram of the test bench to projectile *N*-wave generating and recording [3]:
1 — digital sound source; *2* — Sound Blaster card (SB card); *3* — power amplifier; *4* — piezoelectric speaker; *5* — acoustic sensors; *6* — signal conditioning circuits (SCS); *7* — recorder; *8* — computer

The laboratory stand consists of two main channels: one for emission and another for registration. Sound Blaster card (2) is used as a digital source of sound (1), which digital signal through power amplifier (3) is fed to the piezoelectric speaker (4). Sound Blaster card (1) is controlled by computer (8). Acoustic sensors (5) are placed at distance *L* from the digital sound source (1). Microphones designed by B&K Company are performed function of sensors with signal conditioning circuits (6). Recorder (7) with specialized software is used as a data acquisition device.

Recorded waveforms of *N*-wave of 7,62 mm projectiles disturbances during ballistic tests [4, 5] and at the shooting range timing, after conversion to a sound file format were generated from a computer through the piezoelectric speaker of the emission channel received with acoustic sensors and processed via registration channel. Then the processed results were recorded on the computer in digital form. Examples of such waveforms are shown in Fig. 3.

a) 

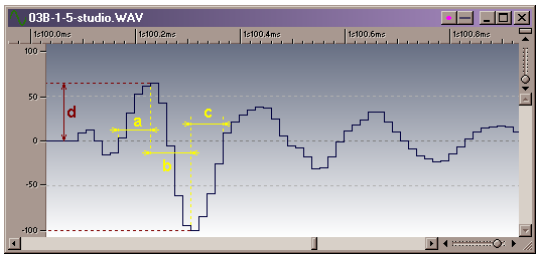
b) 

Fig. 3. Waveforms of *N*-wave of projectiles disturbances:
a — generated; *b* — recorded [3]

To provide high-effectiveness of arms acoustic noises recording we need to specify the requirements for parts of the laboratory stand. The use of digital devices, including a computer with specialized software for the construction of the laboratory stand, solves the problems of safety performance measurement and results analysis in real-time mode, data collection and reproduction. Digital devices are easily available and can be integrated with common interfaces (e. g. USB or FireWire). Developed in this way, the apparatus allows to quickly preview, modificate and repeat the same experiment with no need to wait for the readiness, for the safety conditions, ammunition, etc. Another advantage is the possibility to process the measured data.

The construction and starting up of the described laboratory stand allowed us to perform experiments, which consisted of the following stages:

— *N*-waves emission of previously recorded projectile disturbances for any point in measurement space;
— monitoring the quality of recorded acoustic signals;
— study of various spatial configurations of sensors during design process of passive location systems.

REFERENCES

1. Rodzik D., Szczurko J. Sound source spatial-temporary localization method // Proceed. of 13th ISPC “Modern information and electronic technologies”.— Ukraine, Odessa.— 2012.— P. 315.

2. Rodzik D. Investigation of N-wave propagation parameters of free field projectiles moving // Proceed. of 58th Open Seminar on Acoustics. T. 2.— Poland, Jurata.— 2011.— P. 217—228.

3. Szyba Ł: Research of acoustic signals parameters emitted by the arms / Master thesis.— Warszawa, WAT.— 2009.

4. Pietrasieński J., Rodzik D., Żygadło S., Warchulski J., Warchulski M. Research of spatial-temporary parameters of projectile sound propagation // Biuletyn WAT (Warsaw).— 2007.— Vol. LVI, N 1.— P. 413—422.

5. Pietrasieński J., Rodzik D., Warchulski J., Warchulski M. Frequency analysis of projectile sound propagation // Biuletyn WAT (Warsaw).— 2007.— Vol. LVI, N 1.— P. 433—443.

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Аппаратная реализация системы для генерирования и регистрирования реактивной волны типа „N”.

Рассматриваются проблемы генерации и измерения параметров нарушения давления при полете ракеты со сверхзвуковой скоростью. Обращено внимание на текущие трудности измерения и требования, предъявляемые к измерительной аппаратуре. Описаны эксперименты, в которых компьютер выступает в качестве генератора сигналов и системы регистрации и сбора данных.

Ключевые слова: волны типа "N", измерения параметров ударной волны, сверхзвуковой снаряд.