Measurements of neutron spectra in various media, obtained by the transit-time method in the fast pulse reactor IBR with a resolution of 0.04 μsec/m, are presented. The spectra of neutrons emerging from iron and nickel prisms of various thickness and also those from stainless-steel prisms are studied. The "fine structure" due to the resonance character of the cross sections of the media studied was clearly seen in the spectra measured. The experimental neutron spectra are compared with calculations made with a multigroup system of constants allowing for resonance self-screening of the cross sections. The reasons for the slight discrepancies found are analyzed.

The most widespread methods of measuring space-energy distributions of fast and intermediate neutrons in various media are those based on measuring the spatial dependence of the rates of reactions possessing different energy/cross section relationships [1-5]. Conclusions based on the results of such measurements are not always unequivocal, since at certain points of the set studied it is often necessary to determine the energy spectrum of the neutrons with more precise (and complex) direct methods of neutron spectroscopy, by means of photoemulsion [1, 2], the Wilson chamber [1], He³ chambers and counters [2, 3], or in some cases by means of resonance detectors [3-5].

All these methods, however, lack the resolving power needed to reveal the "fine structure" of the neutron spectrum, associated with the resonance nature of the cross section, explicitly in the experimental results. At the same time, a study of just this structure is extremely important for checking and developing ideas on the propagation of neutrons in media containing neutron-resonance scatterers and absorbers. I. I. Bondarenko first showed the necessity of considering the resonance structure of cross sections when calculating fast reactors in 1957. Since then a great deal of work has been done on developing methods of allowing for the resonance structure of cross sections in reactor calculations [6-12], studying the influence of resonance effects in macroscopic experiments [13, 14], and developing methods for determining the mean cross-section characteristics needed to allow for resonance effects in reactor calculations [12, 15]. In all these papers, however, the influence of the resonance structure of the cross sections on the propagation of neutrons in matter was considered only from the point of view of determining integral characteristics. Detailed neutron spectra in the resonance region were not examined.

At the present time, the only experimental method making it possible to measure neutron spectra with a high resolving power is the transit-time method. Use of this method for studying the spectrum of fast neutrons retarded in matter is complicated by the fact that the minimum pulse length is determined by the statistical indeterminacy of the slowing-down time, which for nuclei with mass number ~50 is ~15 μsec. Thus, for such investigations we need a pulse source of high intensity, making it possible to increase the resolution on account of the greater transit-time base. Owing to the absence of such a source, it appeared, until recently, impossible to use the transit-time method for studying fast-neutron spectra.

Such a possibility re-emerged with the arrival of the fast pulse reactor IBR [16]. The pulse length of the IBR reactor, equal to ~36 μsec, is great enough for the slowing down of the neutrons in a heavy moderator not to lead to serious prolongation of the pulse. At the same time, the high intensity of the pulse makes it possible to use an
Fig. 1. General arrangement of the experiment: 1) scintillation detector; 2) collimator; 3) boron-counter detector; 4) monitor on 50-m base; 5) prism of material studied; 6) active zone of IBR reactor; 7) monitor on 100-m base.

Fig. 2. General view of the disposition of the prism in the reactor room: 1) active zone of IBR reactor; 2) prism of material being studied; 3) platform for moving prism; 4) motor for moving platform; 5) neutron guide; 6) slide; A) position of prism "at the zone;" B) position of prism "at the wall."

extremely large transit-time base (1 km) and thus, ensure a high resolving power of the system. It was, therefore, decided to make a cycle of experiments to study the spectra of neutrons emerging from blocks of nickel, iron, and stainless steel. The choice of materials was based on the following considerations.

As we know, the resonance structure of the nuclei of nickel and iron appears right up to energies of the order of several MeV [4], and in the region of several keV it is extremely strong [6]. A characteristic feature of the resonances in the keV range of energies is the presence of deep interference minima, which exert a very great influence of the diffusion and slowing-down of the neutrons [10]. The effect of interference between resonance and potential scattering arises most strongly in the distribution of neutrons in media containing even-even nuclei (iron, nickel), especially in those cases where one isotope predominates in the natural mixture (iron).

Study of the slowing-down spectrum of neutrons in stainless steel is interesting from the point of view of checking the accuracy of existing methods of describing the propagation of neutrons in a mixture of resonance scatterers [6]. In the choice of materials for study, of course, the important fact that iron, nickel, and stainless steel are widely used in reactor construction was borne in mind.