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# Physics

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Fig. 1

Figure 1: Fig. 1

**Abstract****Full Text***Physics*

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**Some Results of Studying the Passage of Radio Waves Through an Explosion Region***(Presented by Academician A. Yu. Ishlinskii, 23 II 1970)*

The study of the features of the interaction of radio waves with an explosion region is of interest because its results may contain data on the physical processes occurring in the internal regions of an explosion, which are inaccessible to study by other methods.

In works <sup>(1)</sup> devoted to the study of the interaction of centimeter-range radio waves with an explosion region, it was shown that the spherical shock wave of an explosion is opaque if its velocity exceeds 2.4 km/sec.

**Fig. 1**

As the velocity decreases, the shock wave becomes increasingly transparent. Beginning at a certain moment in time, the explosion products are exposed, and the character of the interaction of radio waves with the explosion region becomes more complicated: in addition to purely diffraction effects, as is the case while the shock wave is ideally conducting with respect to the radiation field, direct passage of radio rays through the explosion products begins to have an effect. In this connection the question arises of the relative role of these effects in the mechanism of interaction of radio waves with explosion products. It is shown below that the study of the temporal characteristics of the scattered field makes it possible to monitor the development in time of the geometrical dimensions of the volume encompassed by the explosion, and also to distinguish the contribution of the diffraction mechanism of radio-wave propagation through the explosion region.

In the experiments carried out, detonation of TG 50-50 charges with a mass of  $(10 \div 52)$  g was performed midway between centered horn-lens antennas operating at a wavelength  $\lambda$  of 8 mm. The beamwidth of both the transmitting and receiving antennas was  $16^\circ$  (at the 0.5 level), and the distance between the antennas was  $2R = 232$  cm. The signal from the receiving antenna, after

Fig. 2

Figure 2: Fig. 2

square-law detection and two-stage amplification, was recorded by an S1-33 oscilloscope. The sweeps were triggered at the moment when the detonation wave reached the surface of the charge.

Figure 1 shows a typical oscillogram of the envelope of a signal that has passed through the explosion region of a charge with a mass of 25 g.

The sweep duration was 125  $\mu\text{sec}$ . The upper line corresponds to free propagation of the radio waves. As can be seen from the figure, the level of pro-

of the arriving signal in the first  $(10 \div 20)$   $\mu\text{sec}$  falls rapidly, and then is restored relatively slowly. In addition to the smooth signal, oscillations are recorded whose period increases with time. In numerous experiments it has been found that the period of the oscillations decreases with increasing charge mass. A connection of the oscillations with the geometry of the experiment has also been established: the number of different maxima is equal to the number of Fresnel zones fitting into the cross section, passing through the center of the explosion, of the bundle of radio rays perpendicular to the axis of the bundle.

Fig. 2

The results of analyzing the diffraction factor in a model problem in which the explosion region is replaced by an opaque disk with an effective radius  $r^*(t)$ , illuminated by a conical bundle of radio rays uniform over its cross section and with its axis passing through the center of the disk, prove suitable for a quantitative description of the observed temporal characteristics of the oscillations. If  $r^*(t)$  is the law of expansion of the effective surface on which radio waves are diffracted, then the instants  $t_k$  corresponding to the  $k$ -th maximum are determined by the condition

$$r^*(t_k) = R \left( \psi - \frac{k \lambda}{2 R} \right)^{1/2} .$$

This relation makes it possible to determine the radius  $r^*(t_k)$  at the instants  $t_k$  ( $R$ ,  $\psi$ ,  $\lambda$ ,  $k$  are given;  $t_k$  is determined from the oscillogram).

The function  $r^*(t)$ , found from the results of different experiments with charges of different masses, is shown in Fig. 2 (curve 1) in the coordinates  $r^*/r_0$ ,  $t/\sqrt[3]{m}$ , where  $r_0$  and  $m$  are the initial radius and the mass of the charge. The same figure, in these same coordinates, shows the dependence of the radius  $r'(t)$  of the shock wave (curve 2) and of the leading boundary of the explosion products  $r''(t)$  (curve 3), constructed from the data of Ref. (2). It is evident from the figure that at the initial instants of time (a strong shock wave) the surface

$r = r^*$  coincides with the shock-wave front, and subsequently with the leading boundary of the explosion products.

Thus, from the recorded dependence of the intensity of the scattered field it proves possible to find the law of motion of the boundary of the volume encompassed by the explosion.

It should also be noted that from the results of these experiments (for example, from the oscillogram in Fig. 1) one can obtain that, for  $r \geq 4r_0$ , the energy flux to the receiving antenna associated with the diffraction mechanism of propagation amounts to  $\sim (10 \div 30)\%$  of the flux passing directly through the explosion region.

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### CITED LITERATURE

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2. V. V. Adushkin, *Applied Mechanics and Technical Physics*, No. 5 (1963).

*Note: Figure translations are in progress. See original paper for figures.*

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