conventional instruments. At lower rates, of course, resolution could be as good, or even (with electronic 'sharpening') a little better.

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¹ Gregory, R. L., and Donaldson, P. E. K., *Nature*, **182**, 1434 (1958).

² MacKay, D. M., Brit. Prov. Pat. Spec. 844/49.

³ Teegan, J. A., *BEAMA J.*, 378 (1949).

⁴ Roberts, F., and Young, J. Z., *Proc. Inst. Elect. Eng.*, **99**, IIIA, 747 (1952).

⁵ Parker, E., and Wallis, P. R., *J. Inst. Elect. Eng.*, **95**, III, 371 (1948).
MacKay, D. M., *Electronic Eng.*, 248 (July) and 281 (Aug. 1949).

⁶ MacKay, D. M., Brit. Pat. No. 592,372 (1947); *Electronic Eng.*, 284 (July 1950).

We were not aware of Dr. MacKay's most interesting experiments in this field when we constructed our first prototype 'solid image' microscope, and it seems unfortunate that his work was interrupted, and not made generally available.

It should perhaps be stressed that our attempt to produce a 'solid image' is based on purely optical principles. A 'flying spot' technique requires scanning in three dimensions, rather than one only, imposing serious demands on the band-widths available with the single channel involved.

It does not seem impossible to produce brightness 'inversion' by optical means. Thus standard dark-ground illumination gives bright objects in a dark field. We are at present experimenting with various types of illumination, in an attempt to produce acceptable contrast and resolution with magnifications sufficient to reveal such structures as nuclear particle tracks in emulsion and suitably stained nerve fibres.

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Suppressed Light Emission of the Reaction Zone in Detonation

THE detonation of high explosives in water can be photographed with an open camera and a flash light as the explosive gases do not emit light. The method has been used¹ to investigate the spread of shock waves and explosive gases, and to investigate the initiation by shock waves². We have found that it can be used also in certain gases such as butane and propane. The method is not suitable, on the other hand, for explosives with two levels of detonation velocity in the case of low velocity. A great part of the reaction then occurs after the reaction zone has passed and the expanding explosive gases are very luminous even in water.

In detonation with high velocity the original surface of the explosive is luminous due to the emission of light at the passage of the reaction zone. The luminosity of the surface is often very heterogeneous. Compressed TNT thus gives a distinctive pattern of small, rather sharply defined surfaces with different light intensities. Sometimes dark coherent sections appear. In transmitting detonation through water between two coaxial cylindrical charges with plane ends, the receptor charge has at its initiating end a dark band which extends right across the charge, and which increases in its axial length with the transmission distance. The detonation in the receptor

charge is slightly delayed in starting, and in the meantime the shock wave from the primary charge is propagated and the dark part of the secondary charge is exposed to a high pressure.

Fig. 1 shows clearly how the light emission of the reaction zone is suppressed by an external pressure of water. The experiment was made with a spherical charge of 50 mm. diameter and two cylindrical charges of 20 mm. diameter and a length of 100 mm. in a cubical tank with a 35-cm. edge-length. The charges were of compressed TNT of density 1.53 gm./cm.³. Behind the tank was placed an argon flash with a pentolite charge and a screen of paper which gave a diffuse light. All charges were initiated with detonation fuses and blasting caps, the spherical charge in the centre and the cylindrical charges at their lower end. The detonation fuses were connected to a common fuse, and their lengths were adjusted so that the argon flash was lit when the shock wave from the spherical charge met the detonation front approximately at the middle of the right cylindrical charge. It is evident from Fig. 1 that the light emission diminishes very rapidly when the reaction zone enters the pressure field of the shock wave from the spherical charge. The pressure was about 2,500 atmospheres. The left cylinder charge was initiated later, and its boundary line is therefore somewhat lower down.

To determine whether the dark part of the charges detonates in a normal manner, an experiment was made with a charge of two cylinders joined at right angles (Fig. 2). It was initiated at the lower end of the right leg so that the detonation-front met the shock wave from the spherical charge below the angle joint. The charge is dark above the intersecting line, but the detonation proceeded round the corner and on its downward course along the left leg it passed the shock wave. Below the passage line the charge again becomes luminous. In this experiment the flash was lit when the detonation front was in the dark part of the charge. The outgoing shock wave gives further confirmation that the dark part of the charge detonated in a normal manner.

Measurement of the porosity of the TNT charges has given values between 5 and 8 per cent by volume. It seems reasonable to assume that the pores of the surface layer become filled with water when the shock wave passes, and that as a consequence the luminosity weakens. It was found, however, that evacuated and water-filled charges gave a similar pattern to that of charges with air-filled pores, although the luminosity was weaker. Further, the suppression of light was about the same in cast as in compressed TNT. Part of the black-out may therefore be directly due to the pressure.

For cast pentolite with 60 per cent PETN and 40 per cent TNT the emission of light is also

Fig. 1

Fig. 2