Porous Electron Emitters

IN a recent publication[1] it was shown that the electron emission at zero field from a porous cathode was very dependent on the size of the pores and their emitting apertures. In particular a reduction in the slope of the Richardson plot, with increasing temperature, is to be expected because the space charge is constrained and can only exist near to the walls of the cavities. The resulting electron emission through apertures in the cavities is then in the form of 'quasi hollow' beams. Curvature of the Richardson plot commences when:

$$\frac{D}{2} = d = 1{\cdot}54 \times 10^{-2} T^{\frac{3}{4}} j_0^{-\frac{1}{2}} \mu\text{m}$$

where D is the diameter of the apertures, d is the distance from the emitting surface for which $\rho = \rho_0/4$; ρ being the charge density at a point distance r from the centre of a spherical cavity, ρ_0 the charge density at the cavity surface and j_0 the emission current density at zero field from the emitting surfaces. For spherical cavities:

$$R \gg d; \ \rho = \rho_0 \frac{\pi^2}{4} \frac{d^2}{(R + dc^{\frac{1}{2}})^2} \sec^2\left(\frac{\pi}{2} \frac{r}{R + dc^{\frac{1}{2}}}\right)$$

$$R \ll d; \ \rho = \rho_0$$

where R is the radius of the spherical cavities.

For normal oxide cathodes with a pore diameter of about 3 μm (ref. 2) $R \gg d$ at high temperatures. The emission from the cathode is considerably lower than would be the case from cathodes with a larger number of smaller pores having smaller emitting apertures. Therefore, the porosity of porous cathodes should, if possible, be controlled so that the condition $R \ll d$ will hold at the operating temperature, and the maximum possible emission should then be obtained.

Since the emission current density from an aperture is then the same as that which would be obtained from an equivalent area of exposed uncontaminated surface it is important that the exposed surface area of the cathode (including apertures) should be maximized. The additional emitting surfaces within the pores do not contribute to the overall emission from the cathode. The main advantage of a porous cathode is the fact that the emitting surfaces are more protected from contamination. If the coating is too thick then the temperature gradient existing in the matrix will make it necessary to heat the cathode base to a higher temperature for the same emission than would be the case for a thinner coating. On the other hand, the matrix should contain sufficient material so that evaporation effects do not unduly shorten the life of the cathode.

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GEOPHYSICS

Shock Wave Propagation from a Nuclear Blast

SINCE the American nuclear explosion on July 9, 1962, at Johnston Island, independent reports from different parts of the world[1–5] have become available relating to the time of onset of some of its magnetic and earth-current effects. Apparently, in some places, the first impetus of the signal, almost instantaneously with the detonation, has not been noticed for some reason or other. The more intense impulse registered after 2 sec after zero time has been, perhaps, thought to be the first. At some other places, no mention is made of anything other than that received almost simultaneously with the blast. This note is to point out a substantial possibility of a hydromagnetic shock propagation due to the blast giving rise to almost simultaneous signal at different parts of the globe. Both the impulses, one at zero time, and the other 2 sec later, are treated from this point of view. It is, incidentally, pointed out that some of the auroral luminosity reported on this occasion might be attributed to the interaction of shock waves with the magnetosphere.

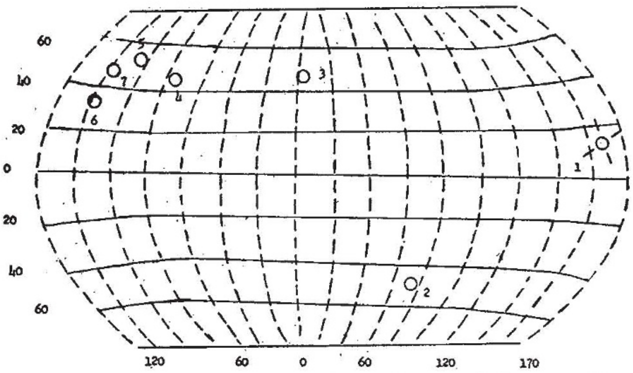

Fig. 1. Approximate locations of the different stations recording magnetic or earth-current or both effects due to the blast: 1, Johnston Island; 2, Kerguelen Island; 3, Chambon-la-Forêt; 4, Ottawa; 5, Prince Albert; 6, Los Angeles; 7, Penticton

Fig. 1 shows the approximate locations of the several stations of observation over different parts of the globe. From these places, either magnetic or earth-current effect or both have been reported. The reported times of onset of the effects at the respective stations are shown in Table 1. At some places, such as Prince Albert, Canada (53·2° N, 105·9° W.), mention is made only of the signal after 2 sec or so after detonation. In the Antarctic French station, Dumont d'Urville, the supposed first impulse has also been noticed only after 2 sec after zero time. However, other French stations (for example, Chambon-la-Forêt, France) did notice both the impulses referred to. The interesting feature is that, besides the first signal at almost zero time, the second, seen about 2 sec later, is also simultaneous at different parts of the globe. It may be recalled that, for *Argus* III explosion, the onset of some of the earth-current effects was registered within 1 sec interval over a range of 120° in longitude[6–8].

Table 1. TIME OF ONSET OF SIGNAL DUE TO BLAST AT DIFFERENT STATIONS OF THE GLOBE

(Detonation time 09 : 00 : 09 U.T.)

Station	Signal arrival time (U.T.) h min sec	Ref.
S.T.L., Los Angeles, U.S.A.	09 : 00 : 09 (± 0·1 sec)	1
Penticton, Canada	09 : 00 : 09·1 (± 0·1 sec)	3
Chambon-la-Forêt, France	09 : 00 : 08·8 (± 0·2 sec) Also a second strong impulse 2 sec later	2
Kerguelen Island, South Indian Ocean	09 : 00 : 08·7 (± 0·5 sec)	2
Prince Albert, Canada	~ 2 sec after detonation	5
Christchurch and Lauder, New Zealand (earth-potential)	0·2 ~ 0·5 sec after detonation	4
Ottawa, Canada (Rb vapour magnetometer)	09 : 00 : 12 (± 2 sec)	3
Amberley, New Zealand (magnetic effect)	09 : 00 : 12 (± 1·5 sec)	4

Considering the very small time in which the signal due to the blast is propagated over the globe, one would be led to think of either electromagnetic propagation, or a hydromagnetic shock, among others (for example, very fast neutron propagation[9]). We now consider the case of a hydromagnetic shock in the following.

For a shock front, it is known that the Rankine–Hugonoit equation must be satisfied, namely:

$$\frac{\rho}{\rho_0} = \frac{P(\gamma + 1) + P_0(\gamma - 1)}{P(\gamma - 1) + P_0(\gamma + 1)}$$