Table 2. ANALYSIS OF A MIXTURE OF *H*-PHASE AND $M_{23}C_6$ (IN THE APPROXIMATE RATIO OF 2 : 1)

Element	Atomic weight
C	8·8
N	2·8
Mn	0·8
Ni	4·0
Cr	18·8
Mo	1·2
V	8·2
Fe	20·8
Si	34·6

but the large amount of silicon is significant. After allowing for the $M_{23}C_6$ the new phase appears to be a silicide of formula MSi_x, where M stands for Fe, Cr, V, Ni and Mo, and x is probably greater than 1.

The full elucidation of the composition and structure of this phase must await further attempts to isolate or synthesize it.

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PHYSICAL SCIENCES

An Effect of Oxide Layers on the Behaviour of Vacuum Arc Cathode Spots

IN the course of a preliminary experiment to study the effect of electrode surface condition on the behaviour of the cathode spot of a d.c. vacuum arc an interesting phenomenon was observed.

The surface of a vacuum-cast copper cathode was prepared by abrasion on emery paper and hand polishing on a 'Selvyt' cloth. After degreasing in a petroleum ether still, the surface was cathodically etched in argon and the grain boundaries were clearly revealed. The surface was then oxidized to cuprous oxide by heating in air.

The d.c. arc discharge was struck by touching a pointed tungsten anode on to the prepared surface, both electrodes being mounted in a glass vacuum chamber exhausted to 0·01μ mercury pressure. A mechanical switch shorted the arc after 20 millisec.

The cathode spots left characteristic continuous tracks on the electrode surface, and it was found that the markings were absent from certain grains as shown in Fig. 1. The characteristic tracks stop abruptly at the grain boundaries and it appears that the cathode spot is able to operate more easily on some grains than others, and a definite preferential action was observed.

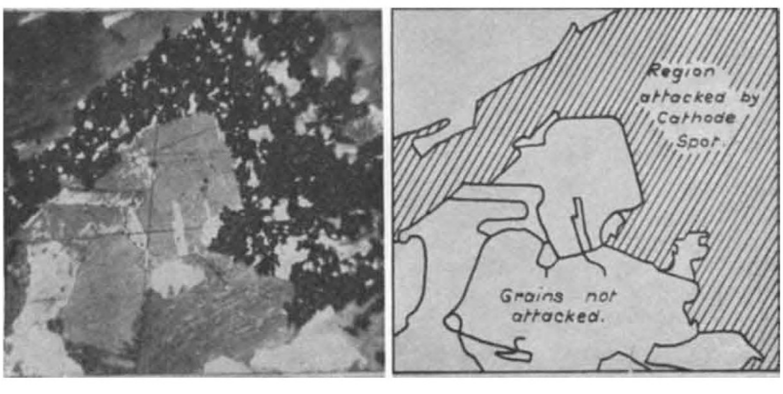

Fig. 1. Copper cathode, etched and oxidized, after attack by cathode spot. (× c. 62)

This effect occurred when the current flowing before the electrodes were separated was 5 amp., and did not occur when the arc current was greater, for example, 50 amp. short-circuit current.

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The λ-Transition in Helium

RECENT experiments on the inelastic scattering of neutrons by superfluid helium[1,2] have given a direct confirmation of the correctness of the elementary excitation spectrum (rotons and phonons) of Landau's theory[3]. As it is usually formulated, the theory postulates that the excitation spectrum is independent of temperature. However, the velocity of sound is known to vary somewhat with temperature[4], and the neutron scattering experiments[1] show an appreciable fall in the minimum roton energy Δ, as the temperature approaches the λ-point.

It is possible to understand the non-existence of superfluidity above the λ-point if one has reason to believe that Δ vanishes at the λ-point[5]. But if Δ really were to vanish at the λ-point, it would almost certainly imply the existence of an Ehrenfest[6] second-order transition, that is, a finite discontinuity in the specific heat. Recent measurements of the specific heat of liquid helium[7] show a more complicated anomaly—a finite discontinuity is superimposed on a logarithmic infinity.

A phenomenological model can easily be constructed for the dependence on temperature of Δ, leading to a specific heat anomaly of the kind observed, while agreeing closely with the observed $\Delta(T)$ within the temperature region covered by the neutron scattering experiments[1]. One such model for $\Delta(T)$ is :

$$\left.\begin{aligned} \Delta &= \Delta_0, & \xi &< -1 \\ &= \Delta_0(|\xi| + \xi\ln|\xi| + e^{-2})/(1 + e^{-2}), & -1 &< \xi < e^{-2} \\ &= 0, & \xi &> e^{-2} \end{aligned}\right\} \quad (1)$$

where

$$\xi = \alpha(T/T_\lambda - 1), \quad (2)$$

and the constant of proportionality α is to be chosen to give the best fit with experiment.

Fig. 1 illustrates the postulated behaviour of Δ (where the scale factor α in equation (2) has been put equal to 4); for comparison the experimental points of Larsson and Otnes[1] are also shown. The specific heat anomaly arises from the singularity in $d\Delta/d\xi$ at $\xi = 0$. This derivative has a finite discontinuity and a logarithmic infinity, and the ratio of the coefficient of the logarithm to the magnitude of the discontinuity is ½. The experimental value[7] of this ratio is ~ 0·3.