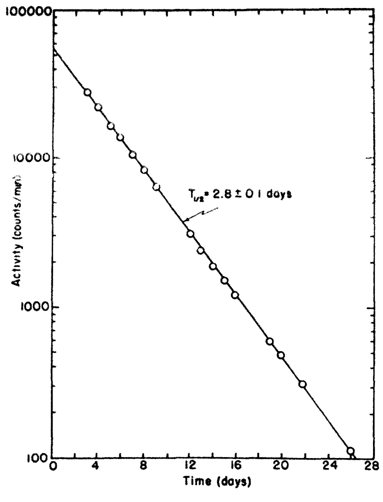

FIG. 5. Decay curve of the 2.8-day Tc activity produced by deuteron bombardment of Mo enriched in Mo^{98}.

energy and gamma-rays of 0.9±0.1-Mev were found to be associated with this period (Fig. 6). Previously half-lives

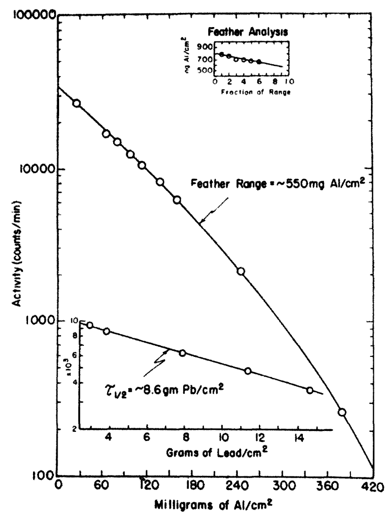

FIG. 6. Aluminum absorption curve for the beta-rays and a lead absorption curve for the γ-rays from the 2.8-day Tc.

of *ca.* 2d and 2.7d in element 43 have been reported,[4–6] but the radiation characteristics found were different from the above. The yield in the production of our 2.8-day Tc activity makes its assignment to mass 98 probable.

* This document is based on work performed under Contract Number W-7405eng26 for the Atomic Energy Project at Oak Ridge National Laboratory.
1 Ewing, Perry, and McCreary, Phys. Rev. **55**, 1136 (1939).
2 Gugelot, Huber, Medicus, Preiswerk, and Steffen, Helv. Phys. Acta **19**, 418 (1946); *ibid.* **20**, 240 (1947).
3 D. T. Eggen and M. L. Pool, Bull. Am. Phys. Soc. **23** [3], 56 (1948).
4 G. T. Seaborg and E. Segrè, Phys. Rev. **55**, 808 (1939).
5 Glendenin, Plutonium Project Record 9B (12.9).
6 P. Abelson, Phys. Rev. **56**, 753 (1939).

Phase of Scattering of Thermal Neutrons by Titanium

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May 28, 1948

SCATTERING of x-rays by the orbital electrons is always in the same phase as of the incident wave. Scattering of neutrons by the nuclei, however, has been shown[1] to be either in the same phase or in the opposite phase. Of the elements previously investigated three elements, H, Li and Mn, have been found to scatter in the opposite phase. We wish to report here that titanium, too, scatters in the opposite phase.

The criterion used in establishing the neutron scattering phase of titanium was the same as for the other elements. Each element is contained in a compound which has a NaCl type of structure, i.e., NaH, LiF, MnO and TiC. Except for NaH, x-ray diffraction patterns of these compounds show that the reflections from even Miller indices atomic planes such as (200), (220), (222), etc., give strong intensities, and those from odd Miller indices planes such as (111), (113), (133), etc., give weak intensities. In the neutron diffraction patterns of these compounds the intensities are reversed.

Our results were determined from a neutron diffraction pattern of TiC obtained with the rotating shutter mechanism.[2] They were confirmed with the neutron crystal spectrometer by Dr. C. G. Shull of the Oak Ridge National Laboratory to whom we are greatly indebted.

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1 E. Fermi and L. Marshall, Phys. Rev. **71**, 666 (1947).
2 T. Brill and H. V. Lichtenberger, Phys. Rev. **72**, 585 (1947).

Electrode Vapor Jets in Arc and Spark Discharges

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A MOST interesting investigation was recently published by J. R. Haynes[1] in which he proves that high velocity mercury vapor jets are ejected from mercury electrodes by spark discharges. It is the purpose of this note to direct attention to the relation of this work to some investigations on the high current carbon arc,[2] with which similar jet phenomena have been studied extensively in the stationary state. A comparison of our results with those of Haynes seems to support his reasonable assumption "that the mechanism of vapor jet production is the same in arc and spark discharge," and leads to an understanding of the mechanism of vapor jet production.

The sparks studied by Haynes had current intensities of a few hundred amperes, anodic current densities (computed from his photographs) of the order of 20,000 amperes/cm² and a duration of 0.25 to 5 micro-seconds. Our high current carbon arc, on the other hand, burned continuously with currents between 50 and 1000 amperes and an anodic current density of 100 to 500 amperes/cm^2, the positive vapor jets having a length up to more than 10 cm. One more difference between the two discharges should be mentioned: While the current density at the electrodes of the spark seems to adjust itself automatically to a more or less constant value, the current density of most forms of the high current carbon arc is determined by the current and the anode surface, which in these cases is completely covered by the discharge. Only the hissing high current carbon arc with a homogeneous positive carbon (without core) shows an anodic contraction, the current density in the anodic spot reaching a value of about 50,000 amperes/cm^2 independent of the anode surface and the absolute current intensity.[3]

In order to demonstrate, after these general remarks, how far the similarity between the jet phenomena of high current carbon arc and mercury spark goes, the following comparison of our results with Haynes' summary of experimental facts (see reference 1, p. 901) is given:

1. A jet of vapor consisting of the vaporized material of the positive carbon and its core is ejected from the positive arc crater and at very high currents some vaporized material is ejected also from the negative tip, in agreement with Haynes' findings for the mercury spark.

2. The anodic jets are ejected normal to the electrode surface, i.e., in the prolongation of the positive carbon, again in agreement with Haynes' results.

3. Spectrograms show that the jets are composed of the dissociated and partly ionized compounds of the positive carbon, in agreement with Haynes' findings.

4. The velocity of the jet decreases exponentially with increasing distance from the anode. Its initial velocity depends on the anodic current density and is of the order of 5×10^3 cm/sec. The first result is in agreement with Haynes' findings while his larger velocity of 1.5×10^5 cm/sec can be explained by the larger current density of the spark, *viz.*, two orders of magnitude larger than that for the arc. Finally, a dependence of the initial jet velocity on the current density could not be found by Haynes because he could vary only the current and not the current density.

5. The afterglow of the jet vapors (the "anode flame" of the arc) is several orders of magnitude larger than the average lifetime of excited atoms (10^{-8} sec), again in agreement with Haynes' results. The same applies for the explanation of this effect, published in 1939.

6. The potential of the anodic vapor jet is constant throughout its extent, being negative to the anode by the amount of the anode drop.

7. The anode drop of the fully developed high current carbon arc is 30 ± 5 volts and the cathode drop is approximately 10 volts, the sum being in agreement with Haynes' result for the spark. The anode drop increases with increased anodic current density.

This summary reveals the striking similarity of the vapor jet phenomena of high current carbon arc and mercury spark, at least as far as positive jets are concerned. For the large number of detailed results on the carbon vapor jets and their electric and magnetic behavior, as well as for the "negative flame" of the arcs, the reader is referred to our publications.[2] In spite of the agreement between the experimental results, the mechanisms of the jet production proposed by Haynes and the author differ considerably. While Haynes offers an essentially electric theory of the jet phenomenon, the author, in the years since 1939, has developed a thermal theory which, having been checked independently by Rohloff,[4] seems to be able to describe satisfactorily the mass of observations on high current carbon arc vapor jets.

On the same basis, we hope to publish shortly a theoretical treatment of the production of vapor jets by sparks and arcs which seems to account quantitatively for all experimental results known at the present time.

[1] J. R. Haynes, Phys. Rev. **73**, 891 (1948).
[2] W. Finkelnburg and collaborators, Zeits. f. Physik **112**, 305, **113**, 562, **114**, 734 (1939); **116**, 214 (1940); **117**, 344 (1941); **119**, 206 (1942); **122**, 714 (1944). Naturwiss. **33**, 55 (1946); Zeits. f. Naturforsch. **1**, 305 (1946); Zeits. f. Physik, 1948 (in press). Monograph, including unpublished data, *Der Hochstromkohlebogen*, Springer-Verlag, Heidelburg und Berlin, 1948. English presentation: *The High Current Carbon Arc*" FIAT Final Report 1052, 1947 (PB-81644, Office of Technical Services, Department of Commerce, Washington, D. C.).
[3] H. Schluge and W. Finkelnburg, Zeits. f. Physik **122**, 714 (1944).
[4] E. Rohloff, Reichsberichte f. Physik **1**, 47 (1944).

Saturation Effects in Microwave Spectroscopy

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June 1, 1948

THE results of experimental investigations[1–3] of saturation effects in microwave spectroscopy[4] as well as conflicting theoretical discussions[5,6] have recently been published. Since the experiments were carried out under different conditions, a theory is needed to reduce the data to a comparable basis.

The two derivations of the shape of saturated, collision-broadened absorption lines[5,6] start from the same assumptions and use essentially the same method. The difference in the final equations can be traced to the fact that the value of $|V_{12}|^2$ used in reference 5 to obtain Eq. (13) is inconsistent with the "slightly relaxed" assumption (*b*) of the introduction. The prescription dictates that one averages the *absorptions* produced by the (independent) Zeeman components and not the squares of the matrix elements of the interaction potential. In other words, one must take into account the fact that the Zeeman components are not all saturated to the same extent. Hence, Eq. (35) of reference 6, averaged over a suitable energy distribution in space, is appropriate to describe phenomena that occur in a wave guide, where the transitions are induced by plane polarized radiation.

The data of Bleaney and Penrose[2] have been shown to substantiate this theory.[7] In an entirely similar way, it may be shown that the data of Carter and Smith[3] also agree (see Table I, second and fourth columns). Agreement