a given Mach number, shock tube diameter, and wall material, the magnitude of the delay time is a measure of the purity of the gas undergoing shock-heating. Since to date no two workers in the field have used identical components, comparisons of delay time data will have little significance regarding purity of the shock-heated gases. The factor two discrepancy between the delay times observed in the present work and those observed by Roth and Gloersen[1] has already been discussed. Turner's[6] experiences with variation of delay time as a function of gas purity have also been mentioned. In particular, since Turner used a rectangular ($1\frac{5}{8} \times 2\frac{5}{8}$-in.) cross-section steel shock tube for his studies of shock-heated xenon, a comparison of his results with the present ones will have little significance. However, Turner's delay times were from two to five times less than those of the present work, the discrepancy increasing with Mach number in the range Mach 9.0 to 10.1.

CONCLUDING REMARKS

The assumption that the mechanism of excitation of the delayed luminosity is a simple atom-atom or electron-atom collision process depending only on the temperature and density of the xenon seems inappropriate in the light of the experimental evidence presented here. Namely, as has been shown, there are strong indications that the diameter of the shock tube, the composition of the shock tube walls, and the purity of the driver play important parts in determining the structure of the shock wave.

The strong evidence for the existence of a photoelectric effect and of the production of electrons by interaction of xenon metastable atoms with the walls of the shock tube makes it necessary to reconsider the results of various electrical measurements behind shock waves in rare gases[3,8] and their interpretations, including interferometric determinations of optical refractivity and hence electron densities.[2] It is known that sufficiently clean Pyrex surfaces give extremely poor photoelectric yields.[31] However, the walls must be in a vacuum of 10^{-9} mm Hg or better to qualify as sufficiently clean. In particular, the inside surfaces of the present shock tube (at 10^{-6} mm Hg) certainly do not qualify in this way. Photoelectric yields of the order of 10% may be encountered on a metal-contaminated glass surface or on a metal surface itself if the photon energy is sufficiently higher than the work function of the contaminant or metal.[32] As has been indicated, the yield apparently increases with the degree of contamination of the wall, particularly if the contaminant is metal. Thus, the photoelectric effect might be expected to be higher in a metal shock tube, as compared with a relatively clean glass shock tube, especially since no significant surface charge buildup can take place in the metal tube to inhibit the photoelectric effect eventually. In view of the earlier discussion, it is likely that in regions where the shock-heated xenon is in contact with the shock tube walls, metastable xenon atoms are at least as important as vacuum ultraviolet photons in supplying electrons to the volume of the gas from the shock tube walls. That metastable xenon atoms may be responsible is evidenced by the pronounced electrical signal produced during passage of the shock through the external pickup ring, when the metastable concentration and collision rate with the walls are expected to be the highest.

The production of electrons from the wall by both the foregoing effects can be expected to be even more pronounced for strong shocks in argon in metal tubes, since continuum photons in the 12-ev range are present as well as metastable atoms 11.6 ev above the ground state, and since the work functions of the metals involved are less than 8 ev.

As has been pointed out by Hollyer,[12] consideration should probably be given also to the interesting possibility that circulating currents may arise as a result of the contact between the highly conducting walls of a metal shock tube and any potential differences that might be induced during the shock treatment of the gas.

In view of the complications that have been encountered in the present work, it is felt that the convenience of using the shock tube as a straightforward means of studying high-temperature gases or plasmas is not as great as has been supposed. In spite of this, there appears to be no better means available at this time for producing plasmas with this range of temperatures and densities.

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[31] L. Apker (private communication).
[32] H. E. Hinteregger, Phys. Rev. 96, 538 (1954).