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## DISCUSSION

### F. G. Hammitt[4]

I believe this is a very interesting paper in an area where relatively little has been done, i.e., the study of the detailed effects and mechanisms involved in the interactions between bubbles in a liquid.

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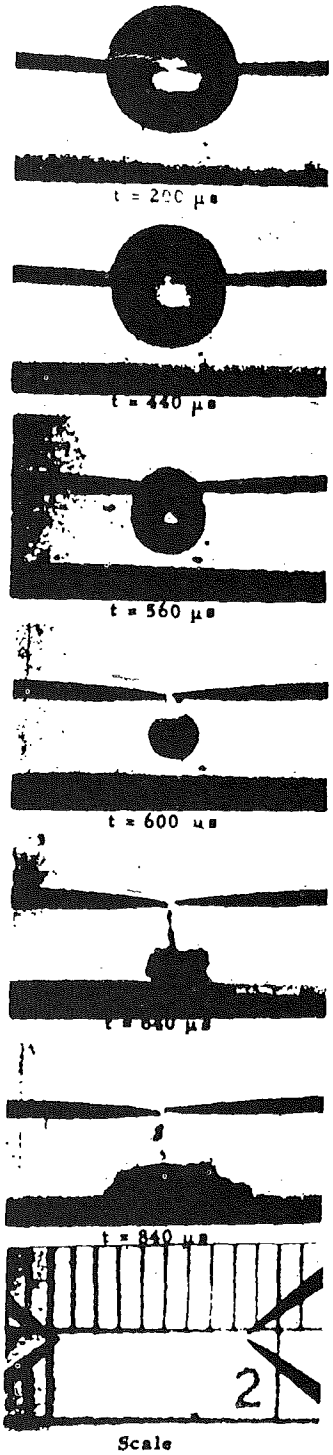


Fig. 11(a)

I would like to include in the record at this point somewhat related experiments which we have done with spark generated bubbles in a small, transparent tank in water. High-speed motion pictures (Fig. 11 of discussion, reproduced from reference

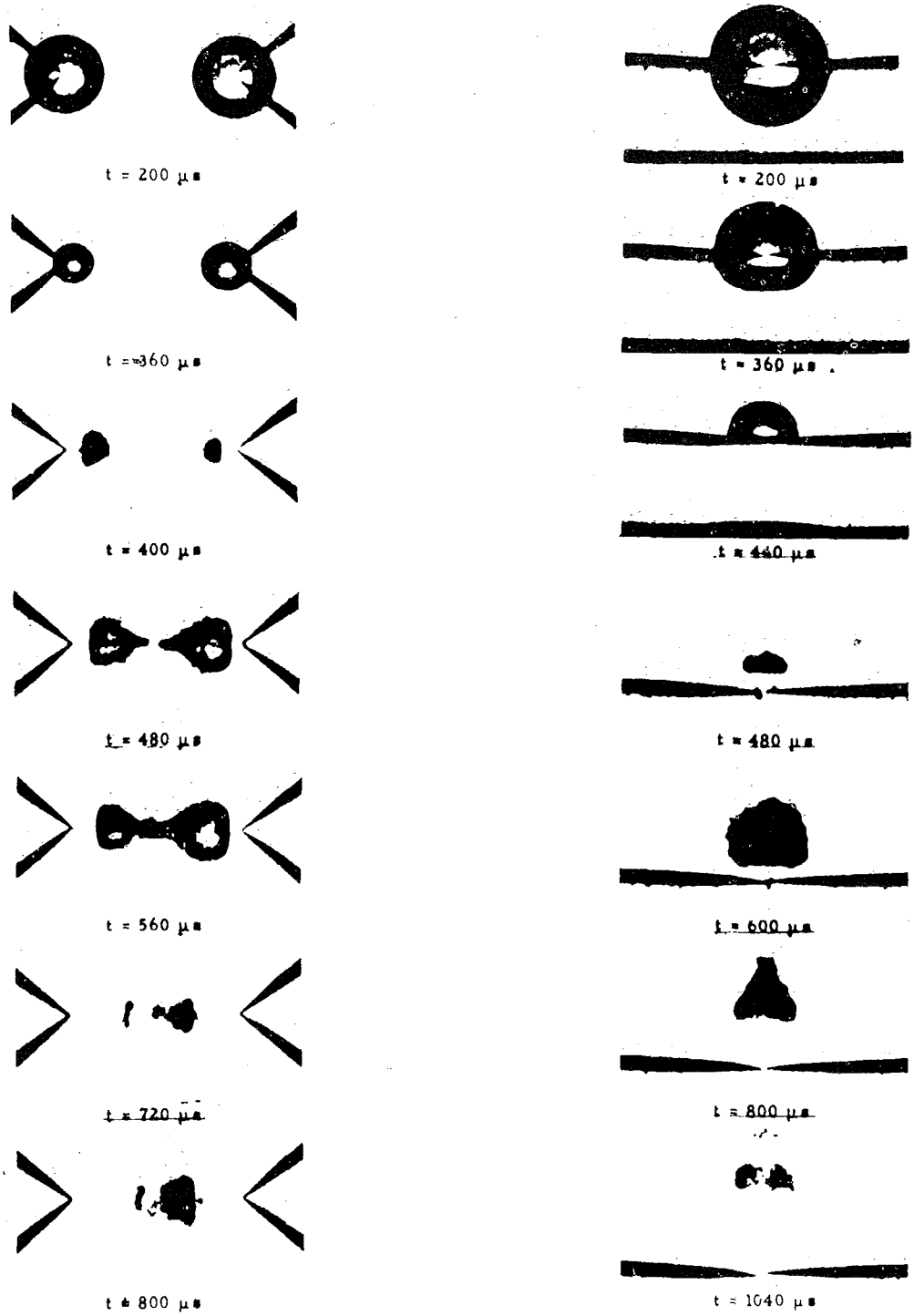


Fig. 11(b) Fig. 11(c)

**Fig. 11 Spark bubble collapse as function of adjacent objects**

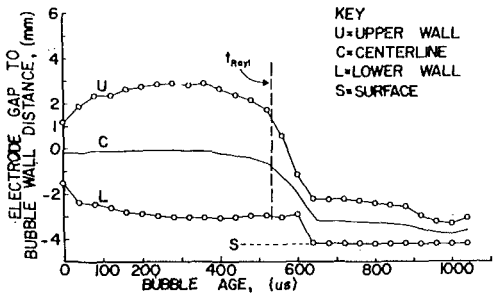


Fig. 12(a)

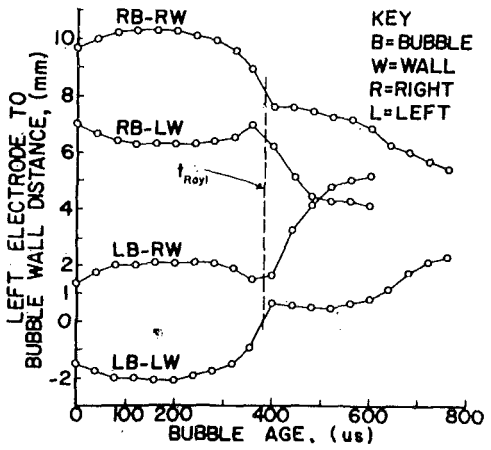


Fig. 12(b)

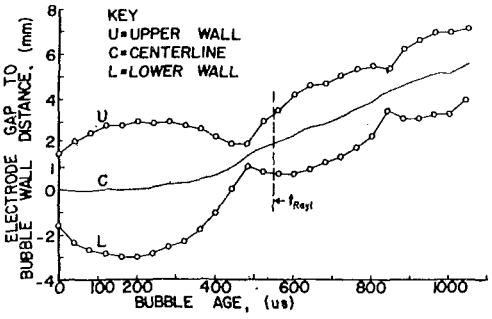


Fig. 12(c)

**Fig. 12 Wall motion of collapsing bubble near adjacent objects**

[13][5] of discussion for convenience) show collapse sequences (*a*) close to a solid plate, (*b*) two bubbles of similar size collapsing in proximity to one another, (*c*) a bubble collapsing close to a rubber diaphragm (backed by an air cushion). As expected from numerous theoretical analyses (reference [14], e.g.) the bubble collapsing close to a solid surface is attracted toward the surface during the collapse. The "double-bubble" case (Fig. 11(*b*) of discussion) is similar in that it is almost equivalent to a single bubble near a solid wall. A hypothetical solid wall would thus form a plane of symmetry for the double-bubble case.

The bubble collapsing close to a flexible membrane has been investigated recently by Gibson (reference [15]). The case is somewhat similar to a bubble near a free surface, where it is known that the bubble will be repelled from the surface during its collapse (reference [16], e.g.). The same is true of a sufficiently flexible membrane as is shown by Fig. 11(*c*) of this discussion. In addition, the jet formed during collapse is oriented away from the surface. Fig. 2 (from reference [13] also) shows the velocity of upper and lower bubble walls during each of these collapse sequences. These latter facts may be of considerable importance in explaining the surprising cavitation damage resistance capability of some rubber and elastomeric coatings. Experiments of this type also appear to offer hope for a rational design of a cavitation-resistent soft material.

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## Authors' Closure

The authors wish to thank Dr. Hammitt for his interest in the paper. His discussion provides a valuable addition to the paper.

[5] Numbers 13–16 in brackets designate Additional References at end of discussion.