

VI. PHYSICAL ACOUSTICS*

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A. OBSERVATION OF INTERACTION BETWEEN ACOUSTIC SURFACE WAVES AND ELECTRON SURFACE WAVES[†]

There have been numerous studies of the amplification of acoustic surface waves on a piezoelectric by drifting electrons in an adjacent semiconductor.¹ The process is a nonresonant coupling of the acoustic wave to the electrons, and amplification occurs over a broad frequency range.

In the presence of sufficiently large transverse magnetic fields, electron density waves can propagate on a semiconductor surface.² In a recent paper, Bers and Burke³ showed theoretically that these electron surface waves can resonantly amplify the acoustic surface waves: The predicted amplifications are considerably larger than for the nonresonant case.

We have observed this resonant interaction and our results are in good agreement with the theoretical predictions. Room-temperature measurements were made on an LiNbO₃-GaAs surface-wave amplifier at 30 MHz and 150 MHz, using magnetic fields of up to 143 kG.

A paper describing these experiments in detail is being prepared for publication.

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References

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B. NONLINEAR INTERACTION BETWEEN A SOUND FIELD
AND A LIQUID SURFACE

In an earlier progress report¹ we described a study of the nonlinear interaction between a sound wave and a liquid surface and proposed a mechanism to explain

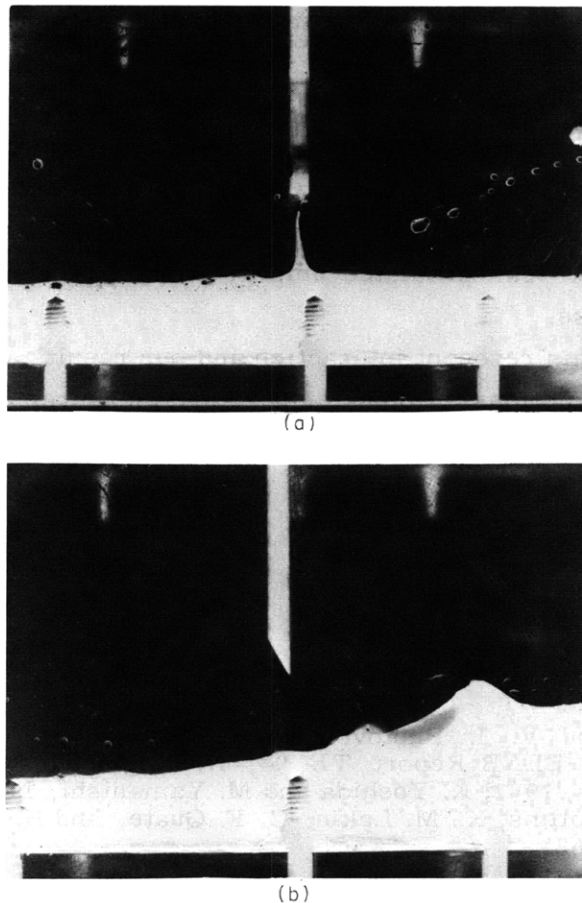


Fig. VI-1. (a) Nonlinear interaction of sound with a liquid in a partially filled tube. Note that the liquid is pulled up toward a partition that is inserted into the tube. (b) An asymmetrical partition induces "rectification" in the sound field, yielding different mean pressures on the two sides of the partition as indicated by the difference in liquid level.

the rupture of the liquid surface which occurs at sufficiently high sound levels. This mechanism is based on the observation that the mean pressure in a sound field generally is smaller in the vicinity of a surface irregularity because of the increase in the local particle velocity caused by the diffracted near field. To test this hypothesis, we have carried out an experiment in which a transverse partition was introduced in a duct, as shown in Fig. VI-1a. The duct is partially filled with a liquid, as shown. As the sound field is turned on, it is found that the liquid is sucked up toward the partition, in support of the hypothesis.

In this context another experiment was tried in which a symmetrical partition was used, as shown in Fig. VI-1b. The partition was placed close to the rigid termination of the duct so that a cavity resonator was formed. The opening formed between the partition and the liquid-covered floor of the duct has a different flow coefficient in the forward and backward directions. Consequently, in the nonlinear regime we expect that an incident sound wave will give rise to mean pressure which will be different on the two sides of the partition. As a result of this asymmetry, an increase in the mean pressure and a corresponding depression of the liquid surface are expected inside the cavity when the partition is oriented in the manner shown in Fig. VI-1b. As the sound field was turned on, however, we found that the liquid level was increased rather than decreased inside the cavity. This paradoxical result is due presumably to vortex formation by the sound field in the vicinity of the orifice, and, at present, we are exploring this matter further.

U. Ingard

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C. TECHNIQUES FOR MEASURING DENSITY FLUCTUATIONS IN JETS

The use of gas-discharge techniques for studying the shock fronts in supersonic gas flows appears very promising. Three methods of measuring the density have been tried: DC- and RF-excited gas discharges with Langmuir probes, and with a corona discharge probe. The first two methods raised technical problems that made their use undesirable, whereas the corona probe circumvents these limitations.

The DC discharge method is limited because of the large fluctuations of the floating potential of the Langmuir probe, which make it difficult to attach the probe to the recording equipment that must also be floated at the plasma potential. The RF discharge method is complicated by recombination of the electrons and ions in

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the flow. This masks the true density function of the gas under the ion decay function. Moreover, RF excitation leads to severe noise problems.

The corona probe makes use of the corona discharge at the point of a 5-mil tungsten wire raised to a potential of 750 V above the ambient. The discharge current is a function of the pressure, which increases monotonically to a maximum, decreases, and then finally drops discontinuously to a small value. The behavior of the probe's characteristic curve warrants further study. In the pressure region of interest the curve is single-valued, and, therefore, when calibrated, makes an excellent pressure probe that has none of the limitations of either the DC or RF discharge techniques.

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