bond) were taken as the standard, and the other measurements referred to a best-fit line through these. Another series of measurements was made with a V9 bond between the buffer and the sample. All runs were duplicated. It can be seen in Figure 12 that the results are consistent with a bond having a value of τ_f between 1 and 2 nsec. For the wave velocity of 1 km/sec measured for V9 (Table 2), this corresponds to a bond thickness between 1 and 2 μ. These results indicate that the phase shift due to the bond has been resolved and that it is described by equation (17) derived from plane wave theory.

Results of similar measurements with compressional waves are not so easily interpreted, however. Figures 13 and 14 compare calculated phase shifts with measured residuals for the cases of

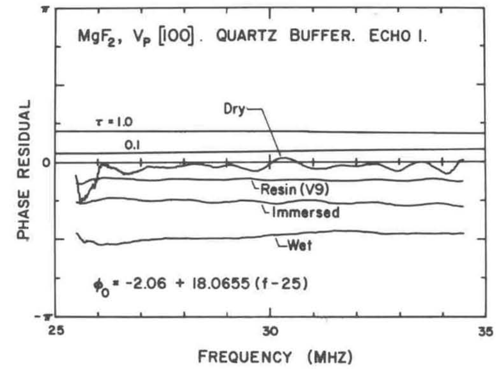

Fig. 13. As in Figure 12, for echo 1 of compressional [100] waves in MgF_2, τ_f = 0.1 and 1.0 nsec, and various buffer-sample contacts (see text).

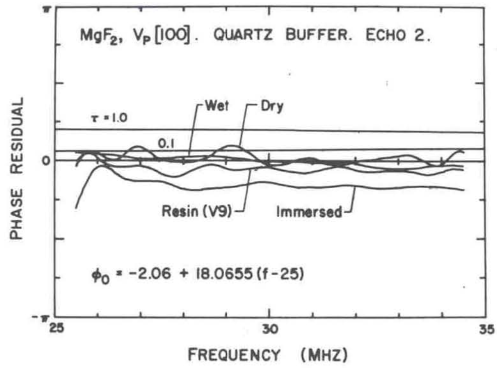

Fig. 14. As in Figure 13, for echo 2.

[100] compressional waves in MgF_2, echoes 1 and 2, with a fused quartz buffer rod. The measurements with the dry lapped contact have again been taken as references for the calculation of residuals. It can be seen that the measured effect of the V9 bond relative to the dry lapped contact is smaller and of opposite sign than expected.

Measurements were made in two other situations. First, in an attempt to get a very thin bond, a dry lapped contact was first achieved and the contact was then squirted with isopentane (used in other experiments as a pressure medium). The result was an immediate enhancement of the signal, indicating that the liquid quickly penetrated the contact. Although isopentane is quite volatile, the enhancement would persist for some time (5 to 15 min) before the signal would drop to its original level relatively rapidly (the order of one minute), indicating that the isopentane had evaporated. The phase shift measured for this "wet" contact was very small for echo 2, but about 90° for echo 1 (Figures 14 and 13)! To test for the possibility that the above procedure had not completely wetted the contact, a dry lapped contact was again established, and the part of the assembly (the sample and part of the buffer rod) was immersed in isopentane. The resulting phase shifts are different again (Figures 13 and 14): they are more negative than with the V9 bond for both echoes 1 and 2. This suggests that the previous procedure had indeed only partially wet the interface.

The explanation for these results is not clear at this stage, but one interpretation will be suggested below. There is an indication that the assumptions of simple plane wave theory may not be appropriate. The maximum calculated phase shift (see Figure 12) is controlled by the impedance ratio of the buffer and sample, Z_b/Z_s (at least, when Z_b is less than Z_s; when Z_b is greater than Z_s, the phase shift increases to π at zero frequency). It is about 40° in Figures 13 and 14 ($Z_b/Z_s = 0.61$) and about 20° in Figure 12 ($Z_b/Z_s = 0.36$). It approaches 90° only as Z_b/Z_s approaches 1.0. Thus, even if the wrong reference were used in calculating the residuals, or if their signs were wrong, the plane wave theory cannot explain the range of measured residuals of about 90° for echo 1 (Figure 13).

It may be seen in Figures 13 and 14 that the measured phase shifts with the V9 bond and the immersed contact are mutually consistent if it is assumed that the "dry lapped" measurements are not the correct reference (i.e., do not correspond to zero phase shift). The V9 bond and immersed results can be matched by the calculated curves by assuming τ_f is about 1 nsec for the V9 bond (comparable to the results found with shear waves, Figure 12) and about 0.1 nsec with the contact immersed in isopentane (consistent with the expectation of getting a much thinner bond in that case). The results for the wet and dry contacts then require some other explanation.

Even with accurately lapped surfaces, only partial contact between the buffer and the sample can be expected (considerable