

NATIONAL RADIO ASTRONOMY OBSERVATORY  
CHARLOTTESVILLE, VIRGINIA

ELECTRONICS DIVISION TECHNICAL NOTE. NO. 135

Title: Vibration Signature of CTI Model 22 Cryogenic Refrigerators

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Date: February 18, 1986

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## Vibration Signature of CTI Model 22 Cryogenic Refrigerators

S. Weinreb and H. Dill

It may be possible to monitor the performance of cryogenic refrigerators by observing the output of a microphone or accelerometer mounted on the refrigerator. The resulting waveform is repetitive with a period of 300 ms and is shown in attached photographs. During the 300 ms period several bursts of mechanical energy are displayed and each of these could be associated with some mechanical event such as opening of a valve or top of the displacer stroke. This association is not known at present but could be determined by additional measurements such as a strobe-light viewing through the window of a Model 21. A possible interpretation of the waveform is given in the attached Figure 4. The relation of the waveform to failure mechanisms is also unknown at present but may be learned through future experience. If the information proves to be useful, a method of digitizing the waveform and sending it through the VLBA monitor and control system could be devised.

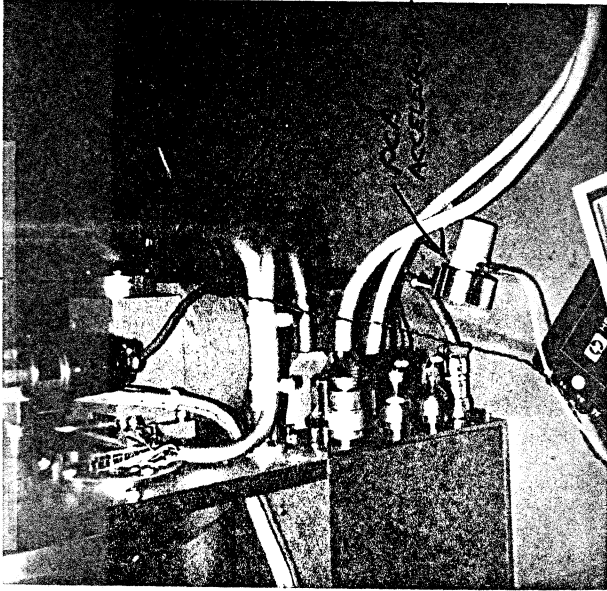
An inexpensive (< \$1) piezoelectric transducer, Radio Shack 273-069, has been tested as a pickup and compared with a calibrated piezoelectric accelerometer, PCB Model 308B02 (~ \$800). Photographs of the Radio Shack transducer mounted on the large nut on the refrigerator and its output waveform is shown in Figure 1; a sketch of the mounting clamp is shown in Figure 2. The PCB transducer was mounted on a similar clamp and the results are shown in Figure 3.

The comparison of the two transducers shows that the PCB transducer has much wider bandwidth extending to 100 kHz, whereas the Radio Shack transducer bandwidth is of the order of 1 kHz. When viewed with 300 Hz scope bandwidth, the waveforms are similar and show the sensitivity of the Radio Shack transducer is approximately

100 mV per G and the peak vibration level is approximately 2G in 100 kHz bandwidth and 0.2G in 300 Hz bandwidth. The Radio Shack transducer gives a peak output of 200 mV with a wideband scope. The bandwidth and sensitivity are probably adequate for diagnostic purposes.

If we decide to install transducers permanently on front-ends, we should remember that piezoelectric elements are destroyed by moisture and have limited life (as evidenced in crystal microphones and phonograph pick-ups).

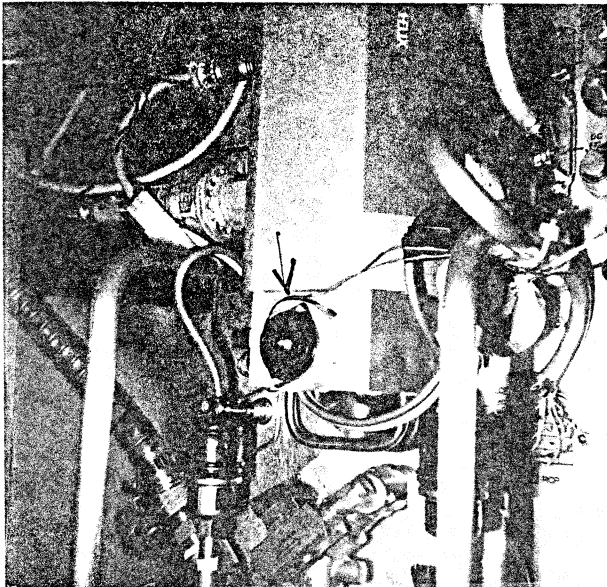
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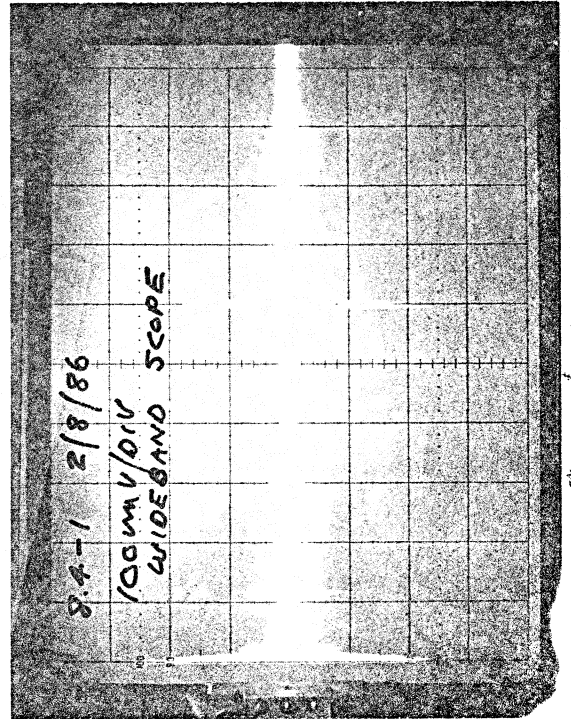
2/8/86

RADIO SHACK 273-069 ON MODEL 22.



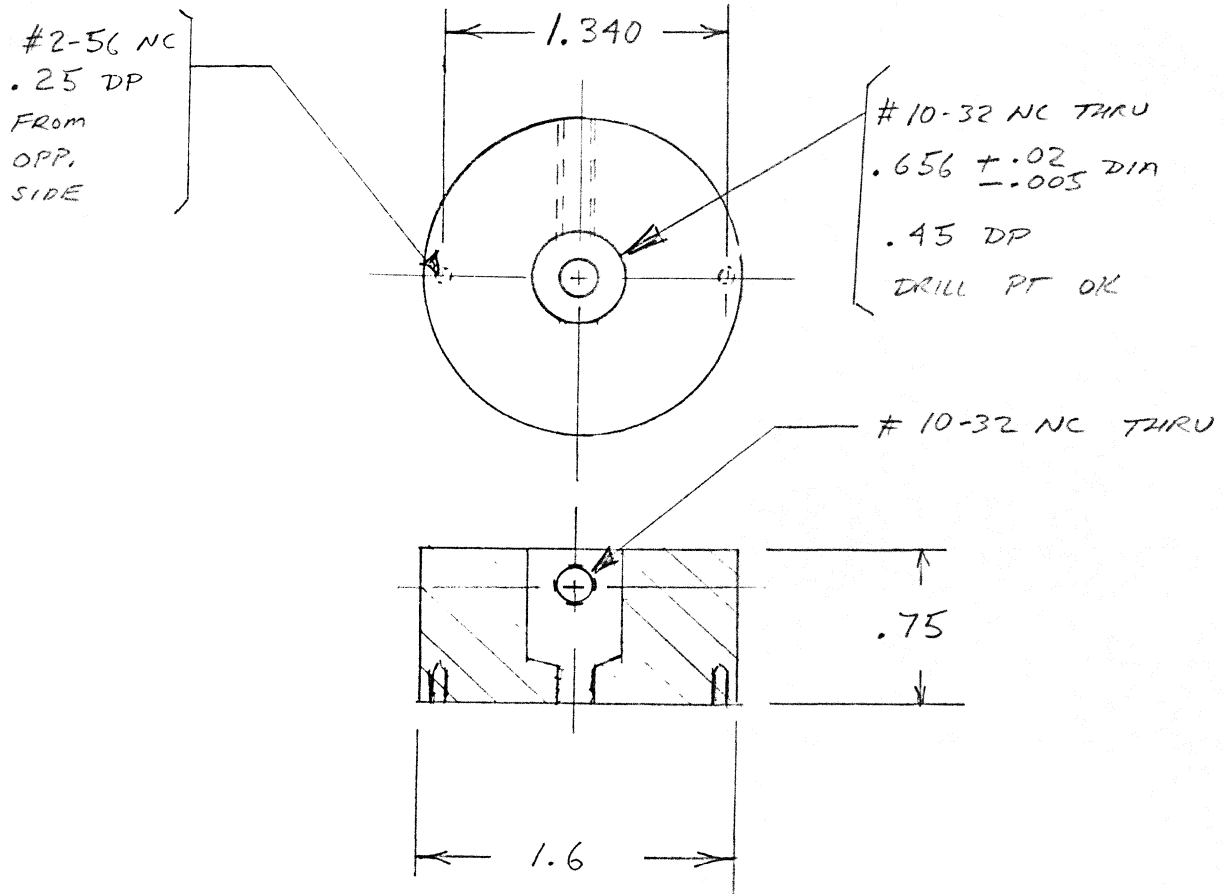
RADIO SHACK 273-069  
ON REFRIG MOTOR NUT CLAMP  
2/9/86

RADIO SHACK 273-069 ON REF. MOTOR



Somsfor

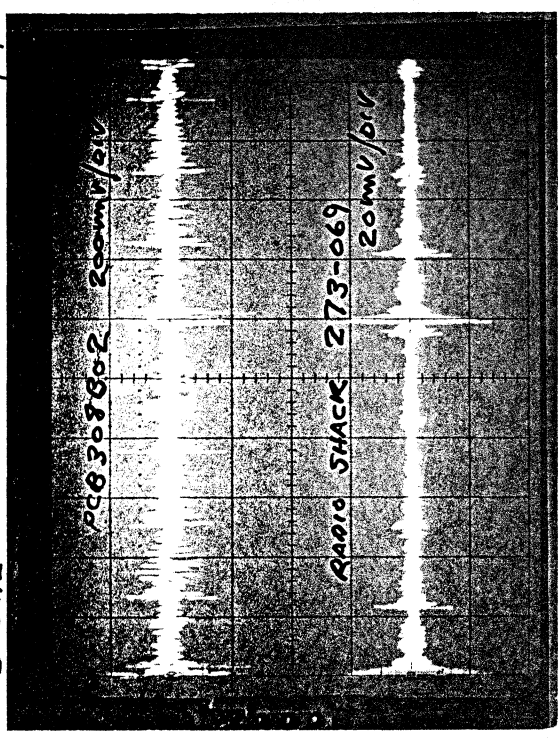
Fig. 1. Mounting of transducer on a CTI 22 refrigerator and resulting waveform.



MAT. ALUM.

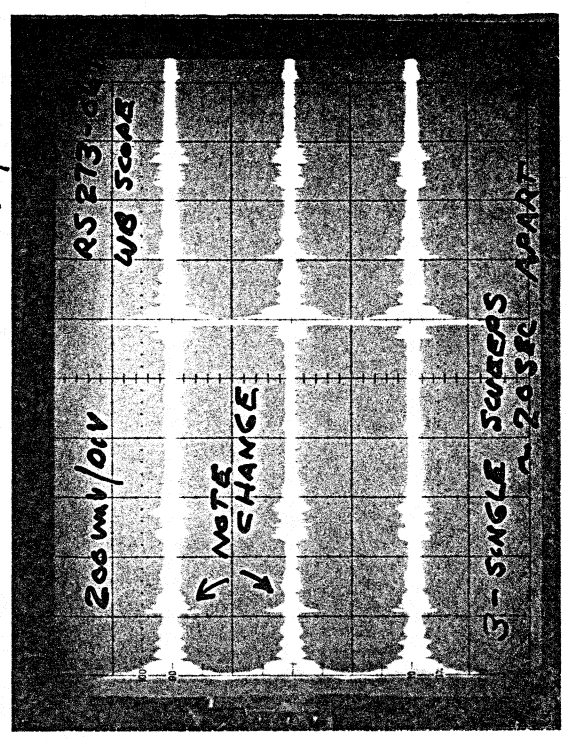
Fig. 2. Sketch of mounting clamp for Radio Shack 273-069 transducer.

300 HZ SCOPE BW 8.4-1 2/8/86

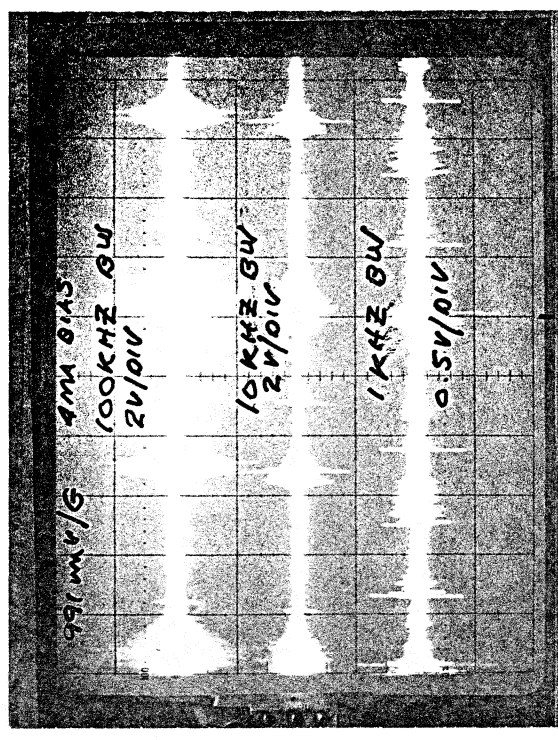


50ms/DIV SINGLE SWEEP

14.0K 1530 2/8/86

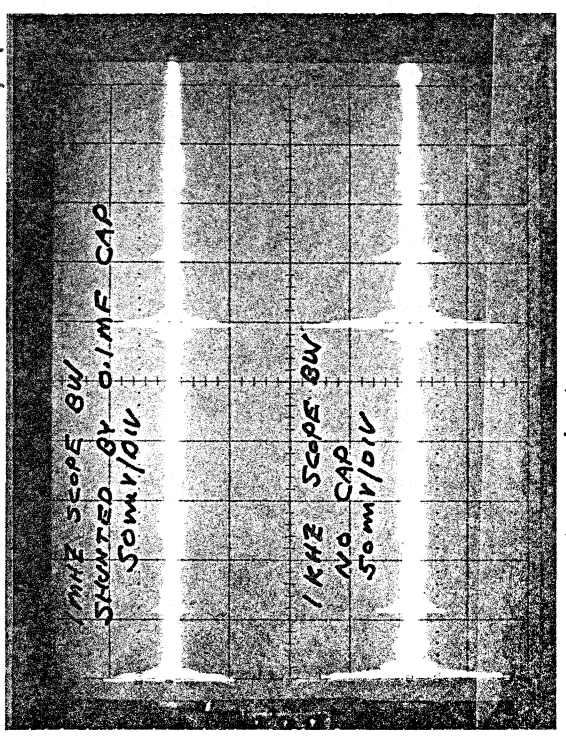


PCB 308002 ACCELEROMETER ON 8.4-1



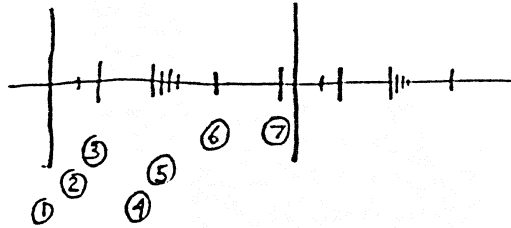
0 50ms/DIV 300ms 2/8/86

RADIO SHACK 273-069 8.4-1 2/8/86



50ms/DIV

Fig. 3. Comparison of two transducers and effect of oscilloscope bandwidth.



- ① EXHUST VALVE OPENS
- ② SEE NOTE
- ③ BOTTOM DEAD CENTER
- ④ EXHUST VALVE CLOSES
- ⑤ INTAKE VALVE OPENS
- ⑥ TOP DEAD CENTER
- ⑦ INTAKE VALVE CLOSES.

NOTE - LINE ② AND LINES (DECAYING) AFTER ⑤ COULD BE FLUCTUATIONS DUE TO VALVES OPENING (SHOCK WAVES?).

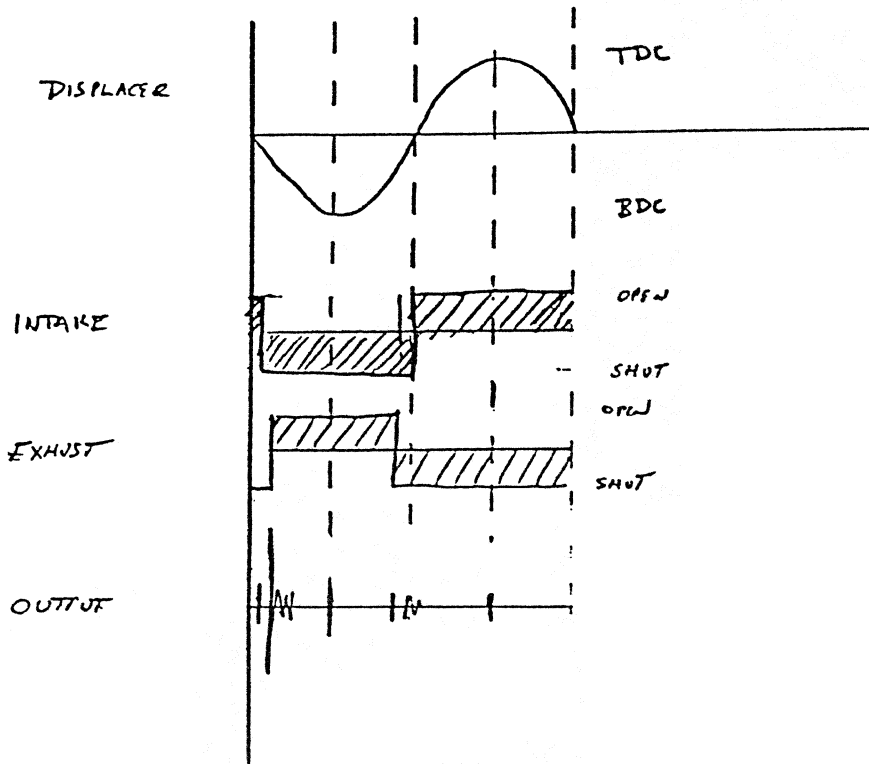


Fig. 4. Possible explanation of waveform. The large peak which triggers the oscilloscope may be due to escaping gas as the exhaust valve opens.