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First SQUIDs

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The Superconducting QUantum Interference Device (SQUID) is the most sensitive magnetic flux sensor and the most widely applied superconductor electronic device, whose applications range from magnetocardiography to picovoltmeters, from digital logic to quantum computing, and from non-destructive testing to Gravity Probe B, a spaceborne test of Einstein's theory of gravity. In this presentation, I describe the initial experiments and device modeling at the Ford Scientific Laboratory that produced the early versions of the SQUID during the 1960's. That history originated in an anomalous observation during microwave ENDOR experiments and led to the first report of macroscopic quantum interference in superconductors in 1964 [Phys. Rev. Letters 12 (1964)]. The SQUID is based on London's electrodynamic theory of multiply-connected superconductors [Superfluids Wiley, New York (1950)], the magnetic flux quantum (h/2e=2.07E-15 Wb), and Josephson's theory of weakly-connected superconductors [Phys. Lett. 1 (1962)]. Physically, it incorporates Josephson tunnel junctions in a low inductance, superconducting ring. Two distinct types of SQUIDs were demonstrated: first the "dc SQUID" and then the "rf SQUID." The former has two Josephson junctions and produces a dc frequency response; the latter has only one junction and responds only at rf and microwave frequencies. The first phase, conducted by Lambe, Jaklevic, Mercereau, and Silver, used type I thin film superconductors and Josephson tunnel junctions. The second phase, conducted by Silver and Zimmerman, used bulk niobium structures with "cat whisker" junction technology [Phys.Rev. 157 (1967)].