Reduction of Airplane Noise and Vibration*

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THE three principal sources of airplane noise are the engine, the propeller, and air turbulence. Because of the impossibility of generating each kind of noise separately from the others, it has been necessary to develop what are in effect means for separating them and studying each one independently as they vary with speed of ship, speed of engine, and horsepower. In brief, the method that was used employs a series of tests under various flight conditions, the resulting data making it possible to solve a set of simultaneous equations. The paper gives numerous curves showing the variation with engine speed of the noise from these three sources.

Fundamental to any consideration of airplane noise are the characteristics of the ear itself. For the most part, physiology does not cooperate with the acoustical engineer when he sets out to increase the comfort of air travel. In fact, it has been necessary to develop several specialized measuring devices in addition to the familiar type of noise meter. Among these may be mentioned particularly a frequency analyzer which permits of selecting either a 20-cycle or a 200-cycle band out of any portion of the noise spectrum from 40 to 11,000 cycles per second. With the 200-cycle band filter the general shape of the noise characteristic is measured, while with the 20-cycle filter the frequency components of engine, propeller and other noise are identified and measured.

It is also desirable to be able to explore surfaces as to the extent to which they radiate noise. A microphone attachment has therefore been developed which quickly measures the characteristics of various interior surfaces. As a result, it has been found possible to improve the efficiency of distribution of the sound absorbing material, increasing its weight in certain locations and reducing it in others, thereby both lowering the noise level in the cabin and decreasing the total weight of acoustic treatment.

In order to measure the noise reduction provided by the cabin walls, another device known as a high-speed automatic level recorder has

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been developed. It is in effect a rectifying and recording oscillograph whose stylus is capable of traveling at various speeds, the highest being such as to indicate in one second a difference of level of 840 db.

To reduce airplane noise within the passengers' and pilot's compartments, it is necessary to provide sound absorbing material as well as sound insulation. If there were no absorption within the cabin, the sound reduction would be zero, no matter how efficient the insulation, as the insulation would in this case only serve to delay the building up of the sound inside to the same intensity as outside. Laboratory equipment suitable for the study of absorbing materials and the measurement of their coefficients is therefore a very necessary adjunct.

Finally, mechanical vibration of audible rates to which various parts of a ship respond must be carefully studied. For this purpose, a so-called vibrometer has been perfected. With it, data are obtainable indicating the extent to which noise is transmitted into the cabin through the fuselage structure as compared to that coming through the air.