Talk Presented at Physical Research.
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1949 BI PRD (BREWER)

MUFFLER TALK

May 1949 Inspection

Many of you will recall that two years ago we quieted a lightplane by changing propellers and adding an engine exhaust muffler. At that time we found that both the engine and the propeller must be quieted to obtain a substantial noise reduction. The muffler used seemed excessively large so a theoretical and experimental muffler investigation was started at the Langley full-scale tunnel. A muffler selection procedure which was developed in the course of this investigation has made it possible to design a suitable muffler less than half aslarge as the muffler used two years ago.

The first step in this muffler selection procedure is to obtain an envelope engine noise spectrum covering the operating range of engine speeds from cruising to takeoff. Such an envelope spectrum for a 185 horsepower engine at a distance of fifty feet is shown by the solid line in the top figure, with decibels as the unit of noise intensity plotted against frequency in cycles per second.

The next step is to draw on this figure a curve, such as this dashed line, representing the desired noise characteristics of the muffled engine. The muffler must reduce the engine spectrum to the level of the dashed line, eliminating the yellow portion of the noise spectrum; consequently, any muffler whose attenuation, or in other words, noise reduction curve completely encloses this yellow portion of the engine noise will provide at least the required noise reduction. The yellow portion of the noise spectrum has been superimposed on the lower figures, which also show the attenuation spectrums for three mufflers of different types. These mufflers are about the smallest mufflers of their particular types which would satisfy the requirements chosen in this example. It is evident that for this specific case the last muffler is the one to select because it is smaller and lighter than the others.

It is difficult to convey the performance of a muffler in words, so we will demonstrate plastic models of the last two mufflers. A recording of the noise of an aircraft engine will be played into a two-inch pipe and the two mufflers will be attached in order. The air in the demonstration pipe is at room temperature; therefore, the velocity of sound is much lower and the wave lengths are shorter than in an actual hot exhaust pipe, so the plastic models are only about six-tenths the length of the corresponding flight mufflers. The diameters, however, are the same.

Although the noise level will vary considerably from place to place in the audience because of the acoustics of this room, it will be about as loud as a 185 horsepower engine heard at a distance of three hundred feet.

The first muffler is simply an expansion chamber with no internal parts.

The next muffler consists of two identical resonators, each formed by a closed volume surrounding a perforated central pipe.

The last and smallest muffler is a single carefully selected resonator. Note that although it is much smaller than the other muffler it produces about the same noise reduction.

Because of the psychological and physiological peculiarities of the hearing process, the desired noise spectrum will not, in general, be a simple straight line such as was used in this example; but the muffler selection procedure described is general and may be used for any desired noise spectrum which may be chosen. The required muffler becomes smaller as the desired noise reduction is reduced, as the engine power is reduced, or as the engine speed at rated power is increased. Because different engines have different noise characteristics, and because the muffler required depends upon the noise characteristics of the particular engine being treated, different mufflers would be required for different types of engines. We feel that we now understand the basic theory of muffler design and we hope that this research will help the industry to develop quieter airplanes.

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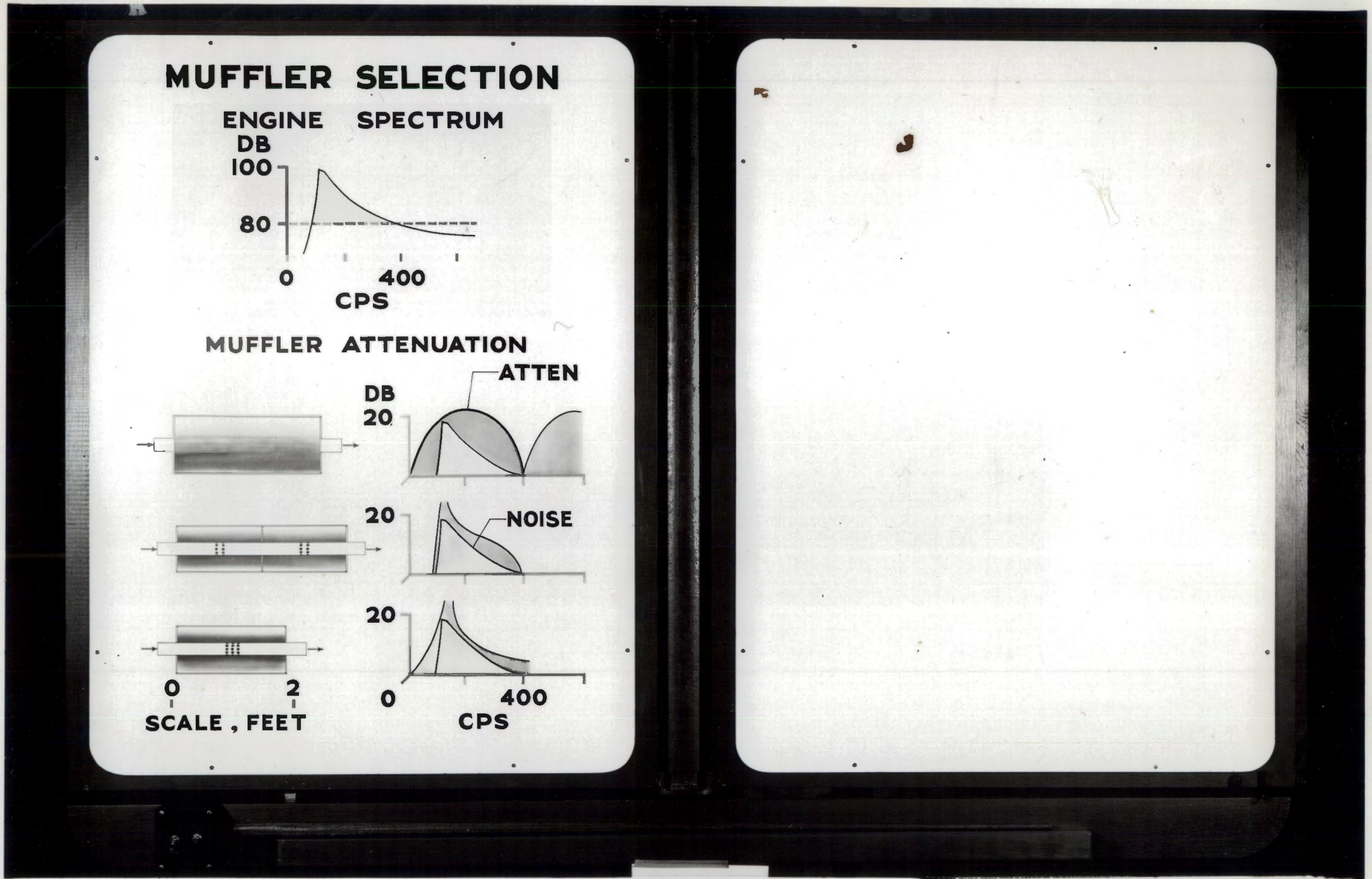

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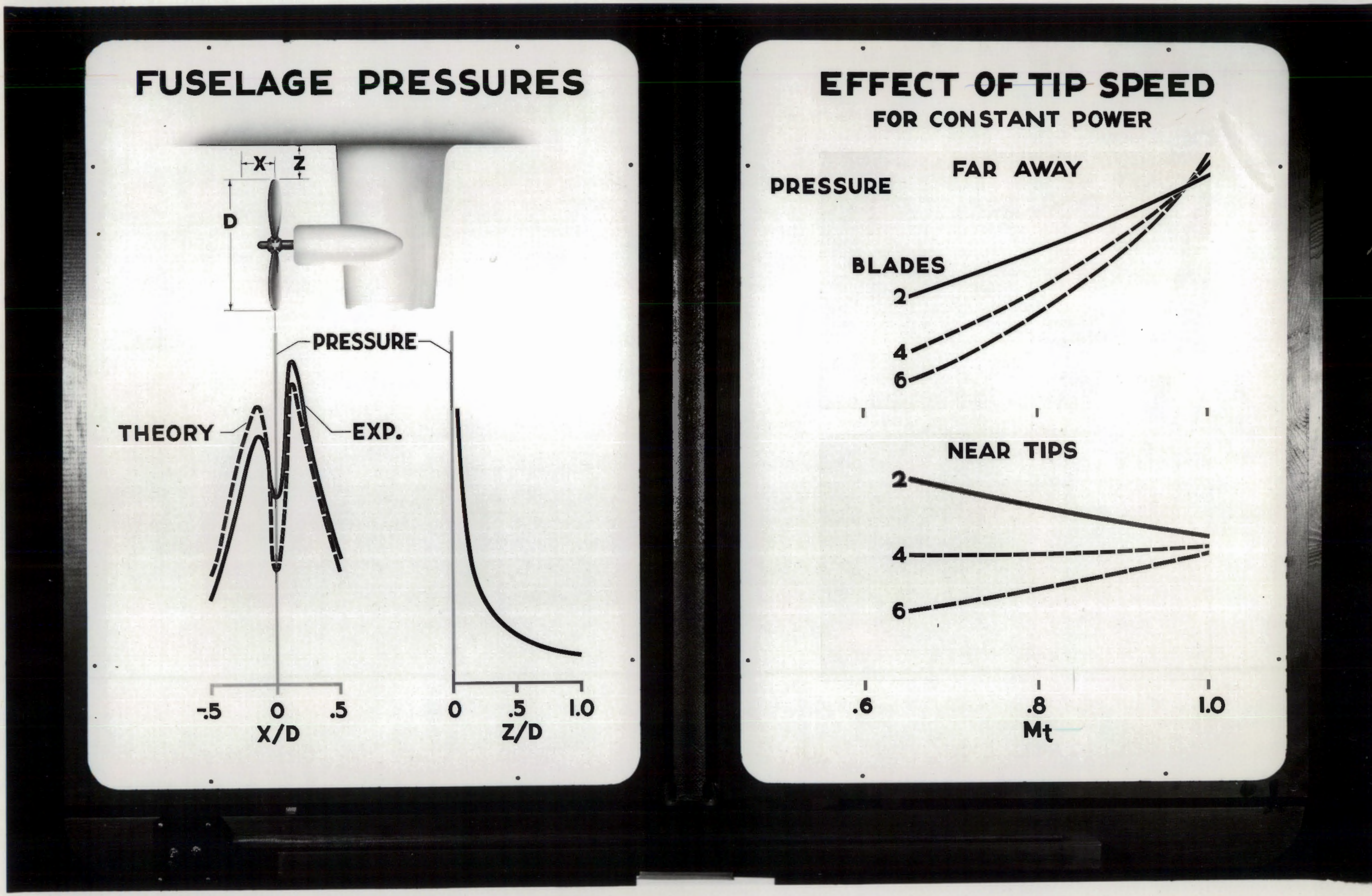

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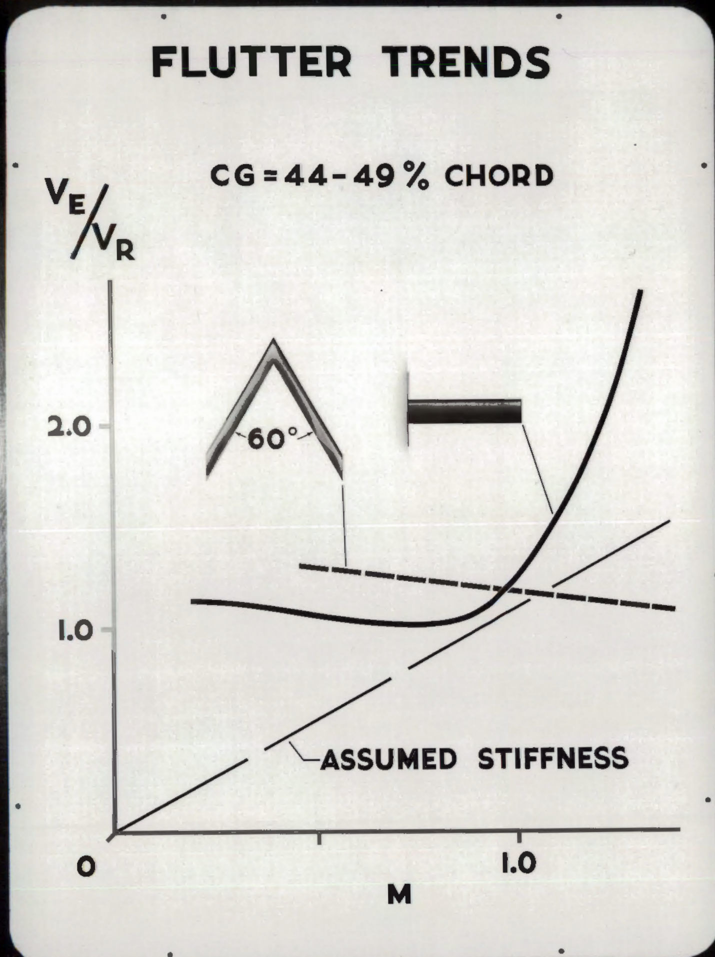

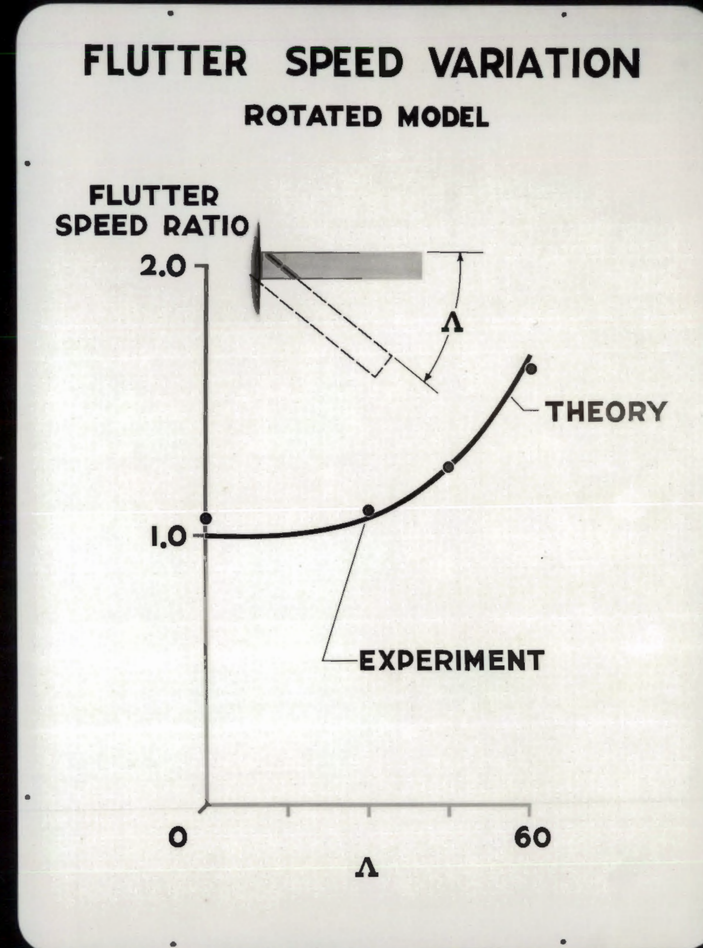

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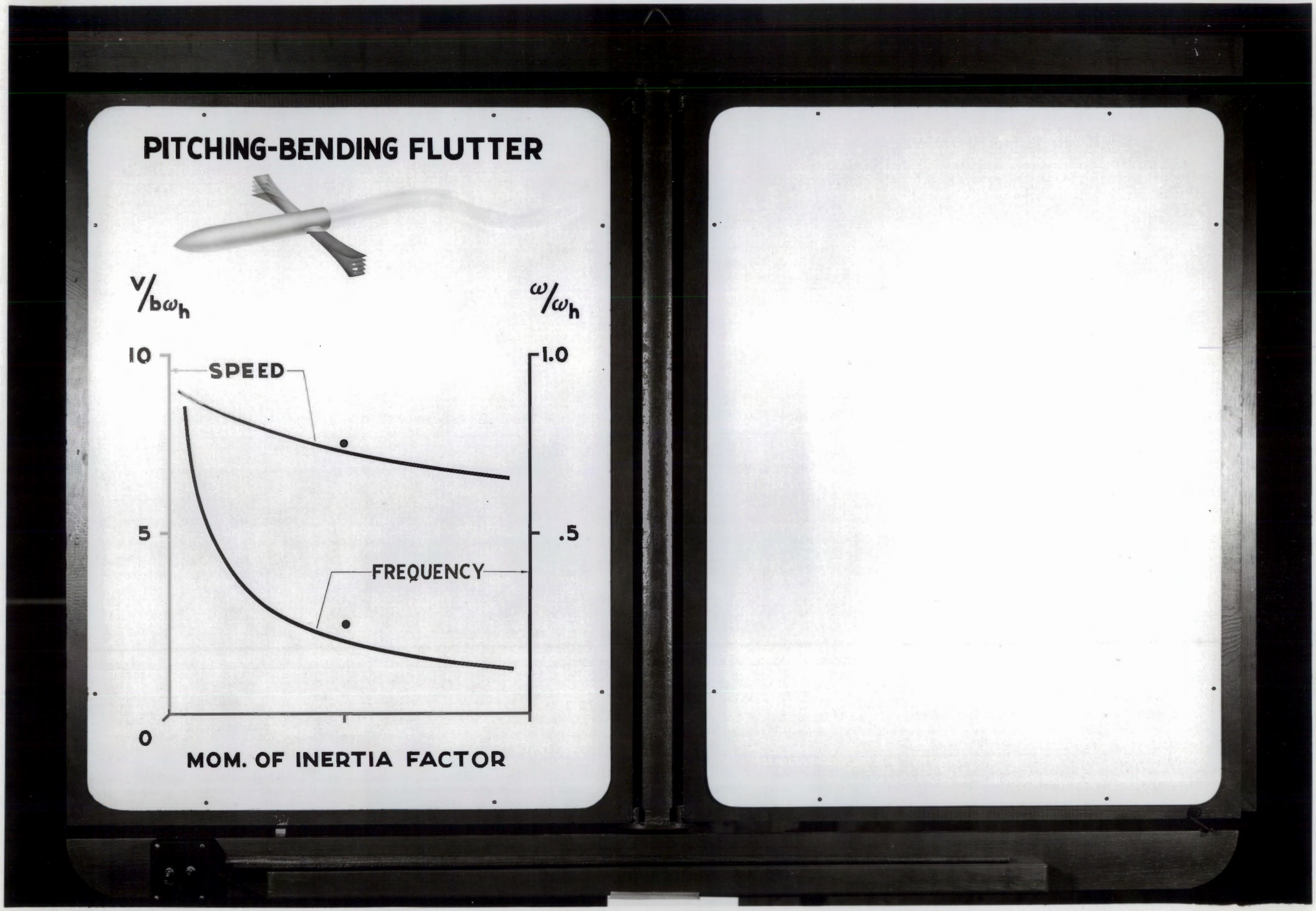
PITCHING-BENDING FLUTTER
$V/b\omega_h$
ω/ω_h
10
1.0
SPEED
5
.5
FREQUENCY
0
MOM. OF INERTIA FACTOR

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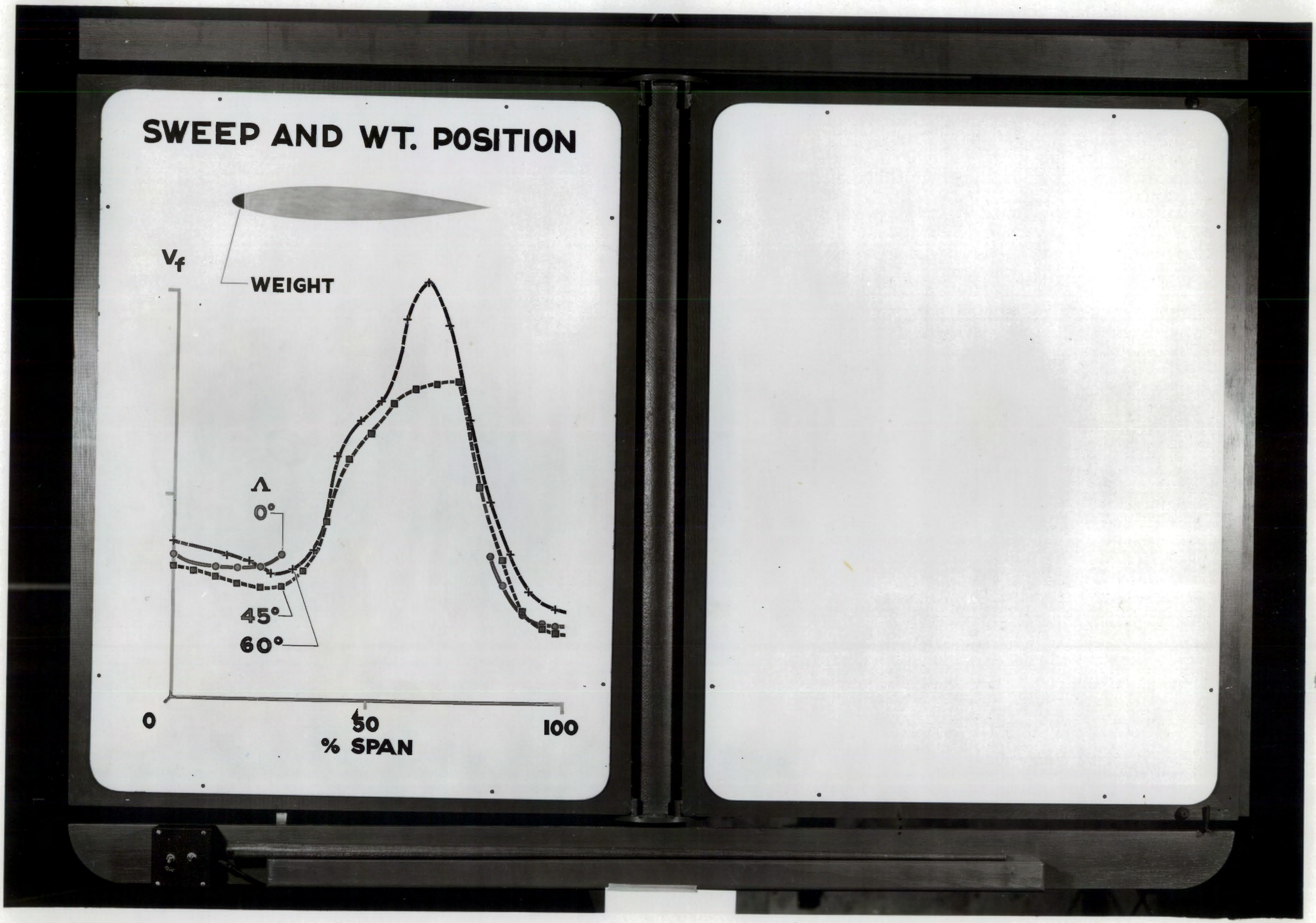

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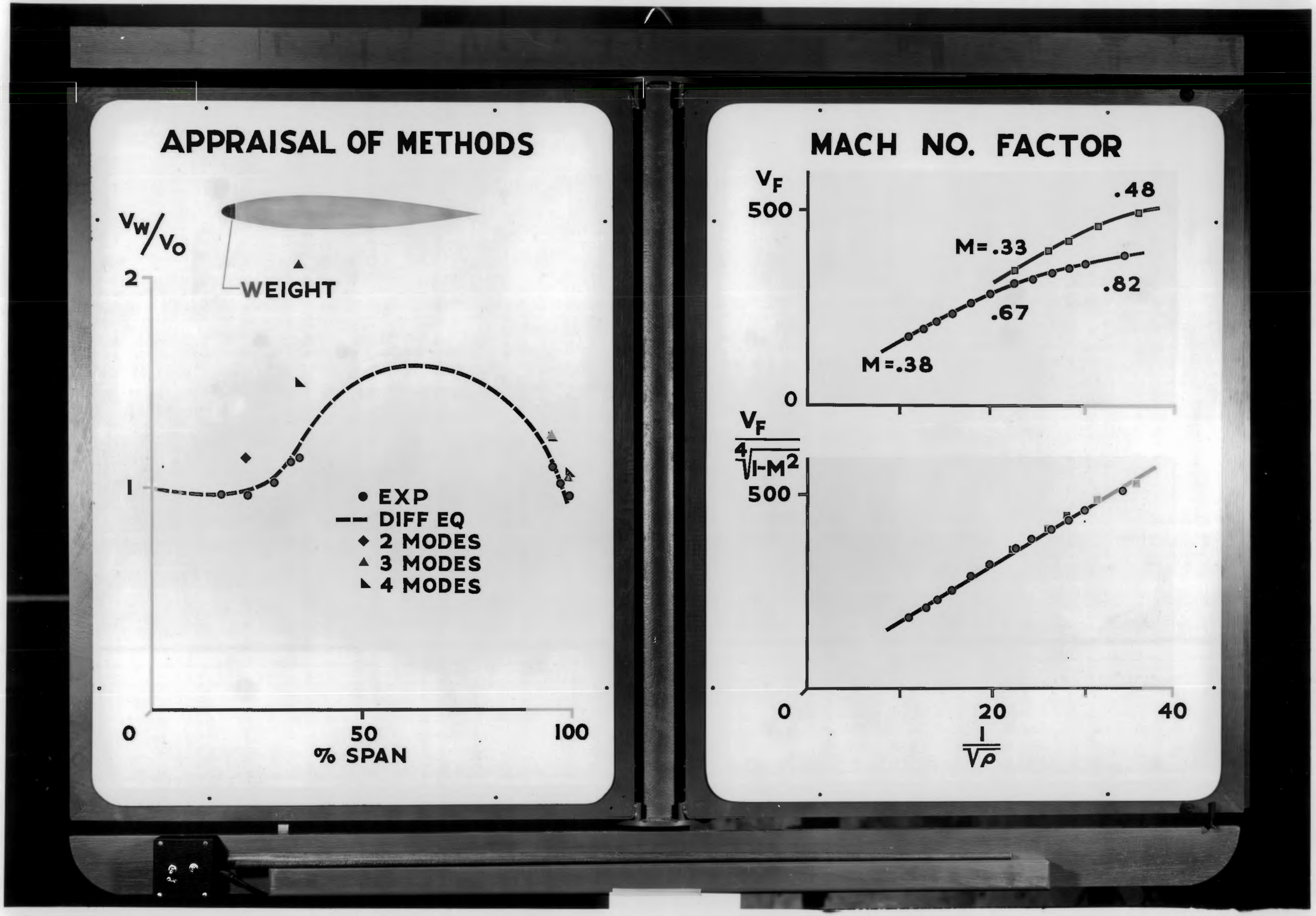

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