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A PRELIMINARY STUDY OF MACHINE-COUNTERSUNK FLUSH RIVETS SUBJECTED TO A COMBINED STATIC AND ALTERNATING SHEAR LOAD

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INTRODUCTION

In previous studies of the tightness and flushness of machine-countersunk flush rivets (references 1 to 3) it has been found that, if the countersunk head protrudes above the sheet surface before the rivet is driven, a much tighter riveted joint is obtained than if the countersunk head is below the sheet surface before the rivet is driven. The purpose of the present investigation is to study the effect of the height of the rivet head on the number of cycles required to cause failure of a machine-countersunk flush-riveted joint under a combined static and alternating shear load.

SPECIMENS AND TEST PROCEDURE

The specimens, which consisted of 24S-T aluminum-alloy strips riveted with A17S-T rivets, were of two types (fig. 1). Figure 2 illustrates the two methods of riveting investigated for each type of specimen. In the ordinary flush-riveting procedure the height of the rivet head above the sheet surface before driving h_b was measured as described in reference 1 by means of a dial gage graduated to 1/10000 inch. These rivets were driven according to method B of reference 1, in which the manufactured head of the countersunk rivet is bucked on a flat plate while the shank end is driven with a vibrating gun (fig. 2(a)). Three specimens of each type were fabricated according to the NACA procedure, method E of reference 1; that is, by using round-head rivets inserted from the back of the joint and bucking the shank end into the countersunk hole while the manufactured round head is driven with a vibrating gun, as illustrated in figure 2(b). The countersunk rivet heads on the specimens riveted by method E were milled off flush with the sheet surface prior to testing.

The specimens were tested in the fatigue-testing machine shown in figures 3 and 4. The specimen was subjected to a static load of 38 pounds per rivet and, in the case of tight rivets, to an alternating load of 137 pounds (±5 lb) per rivet at a frequency of 2700 cycles per minute. The amplitude of vibration was measured in each case with an optical micrometer (fig. 5). On the assumption that the weight vibrated with harmonic motion, the alternating load was computed from the amplitude of vibration, the frequency of vibration, and the mass of the weight. A correct value of the alternating load was obtained from this computation provided the rivets were tight. In the case of loose rivets the motion of the weights could no longer be considered harmonic and the alternating load became an impact load of undetermined magnitude.

RESULTS AND CONCLUSIONS

The results of the investigation of the number of cycles required to cause failure of flush-riveted joints under the combined static and alternating load described in the preceding paragraph are presented in figure 6 for type I specimens and in figure 7 for type II specimens. From these figures, the following conclusions are drawn:

1. The number of cycles to failure for both type I and type II joints using the ordinary flush-riveting procedure dropped from between 500,000 and 1,000,000 cycles for positive values of h_b (tight rivets) to between 50 and 100 cycles for negative values of h_b (loose rivets).

2. The number of cycles to failure for NACA flush rivets is as great as or slightly greater than the number of cycles to failure for the tightest flush rivets driven by the ordinary flush-riveting procedure.

3. For the tight joints in the ordinary flush-riveting procedure (h_b zero or positive), fatigue failure usually occurred in the sheet; whereas for the

loose joints in the ordinary flush-riveting procedure (h_b negative) failure occurred by shear of the rivets. Only two of the 19 specimens for which h_b was zero or positive failed by shear of the rivets.

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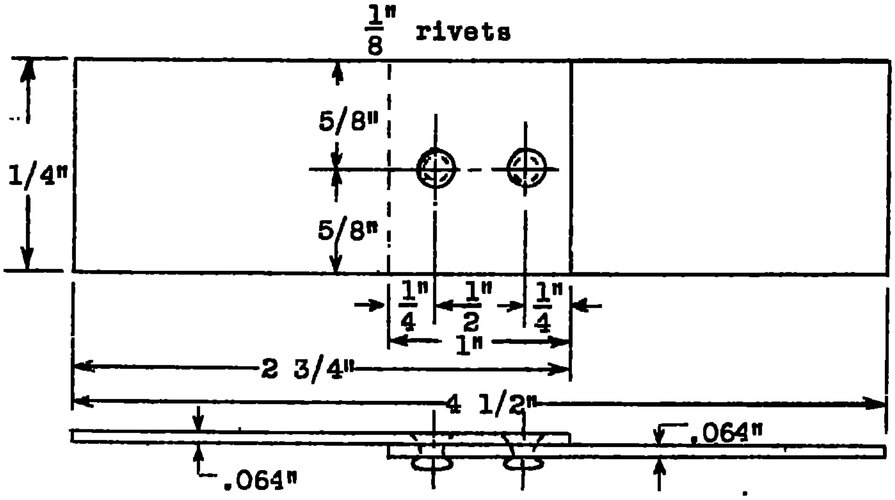
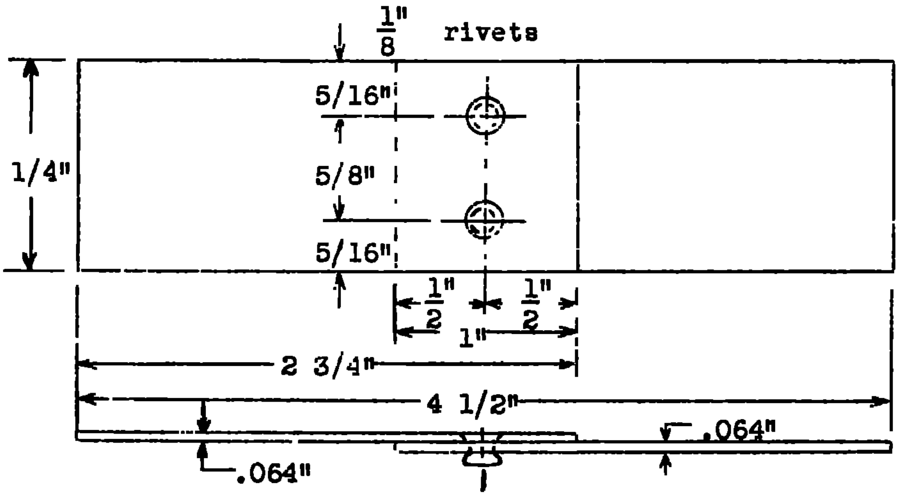


(a) Type I.



(b) Type II.

Figure 1.- Test specimens.

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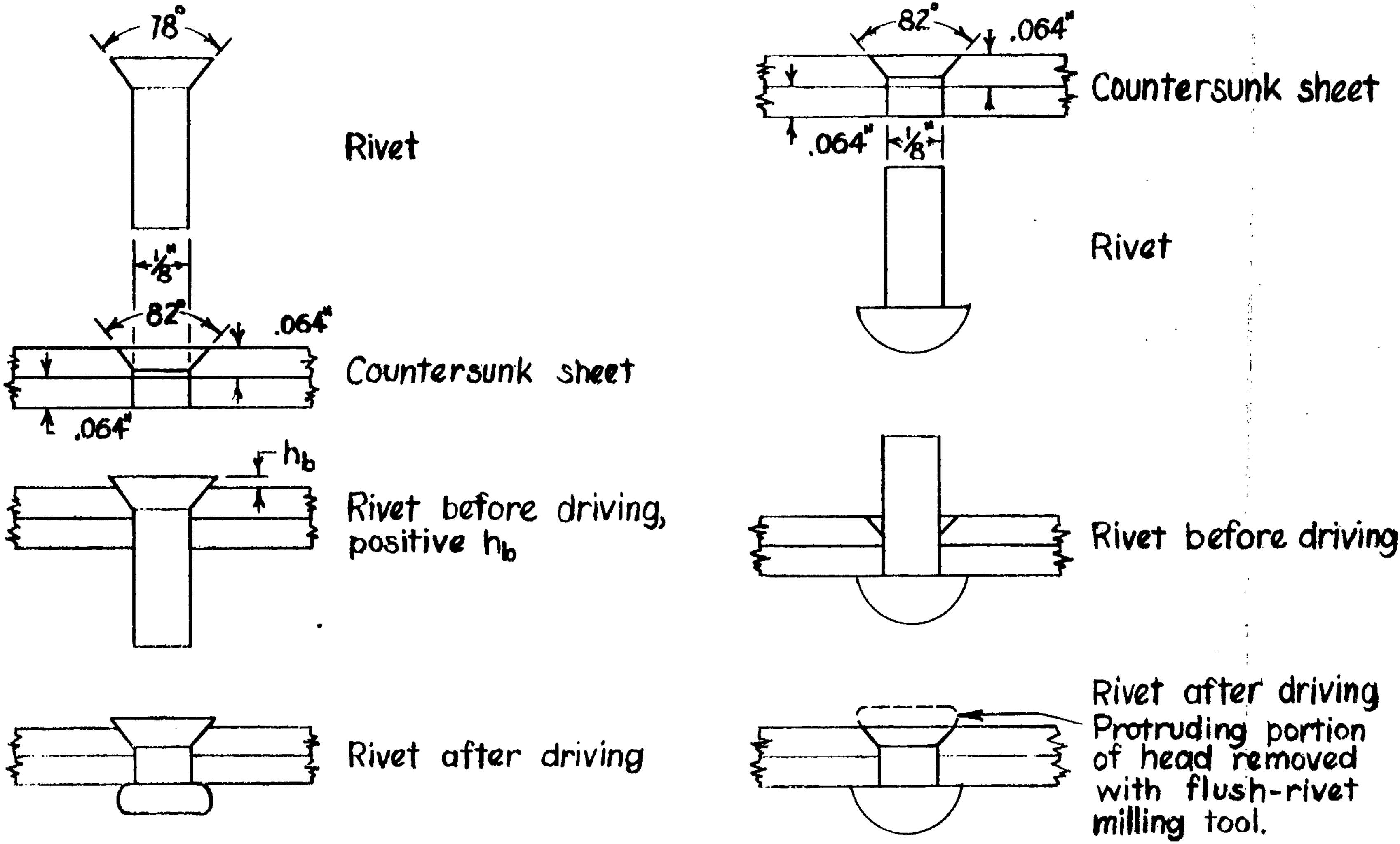

(a) Ordinary flush-riveting procedure, method B.

(b) NACA flush-riveting procedure, method E.

Figure 2.- Methods of riveting investigated.

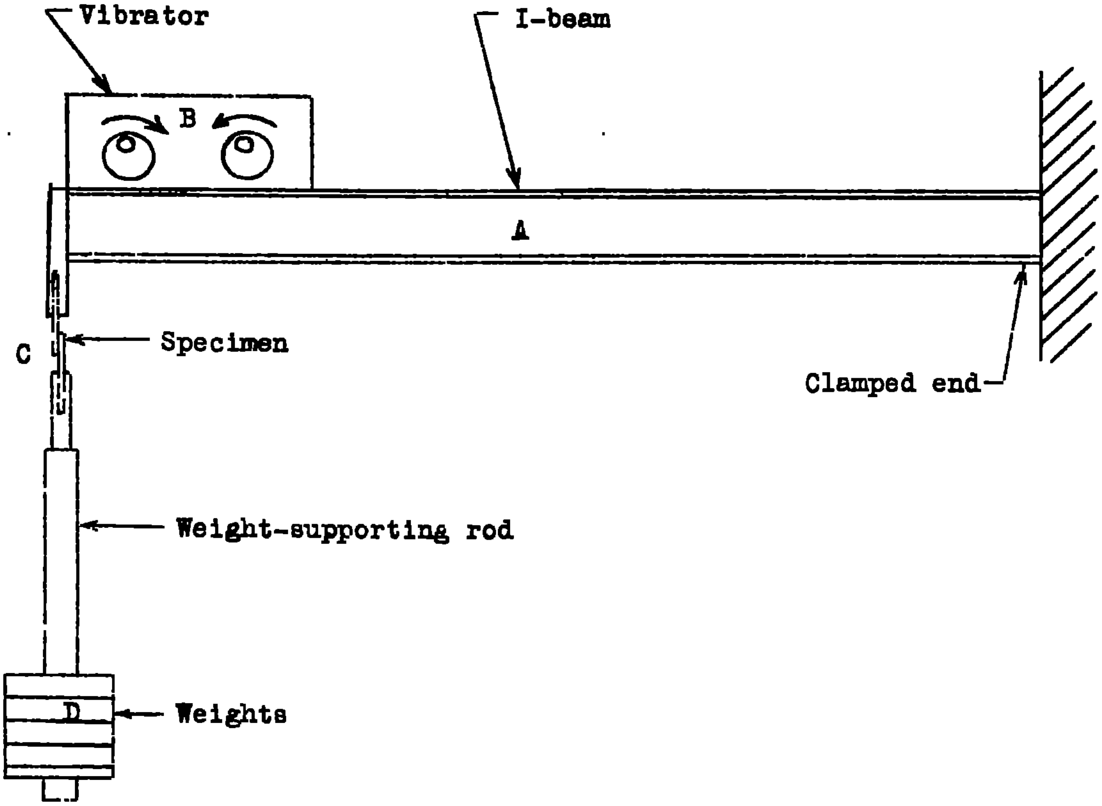

Figure 3.- Diagram of fatigue-testing machine.

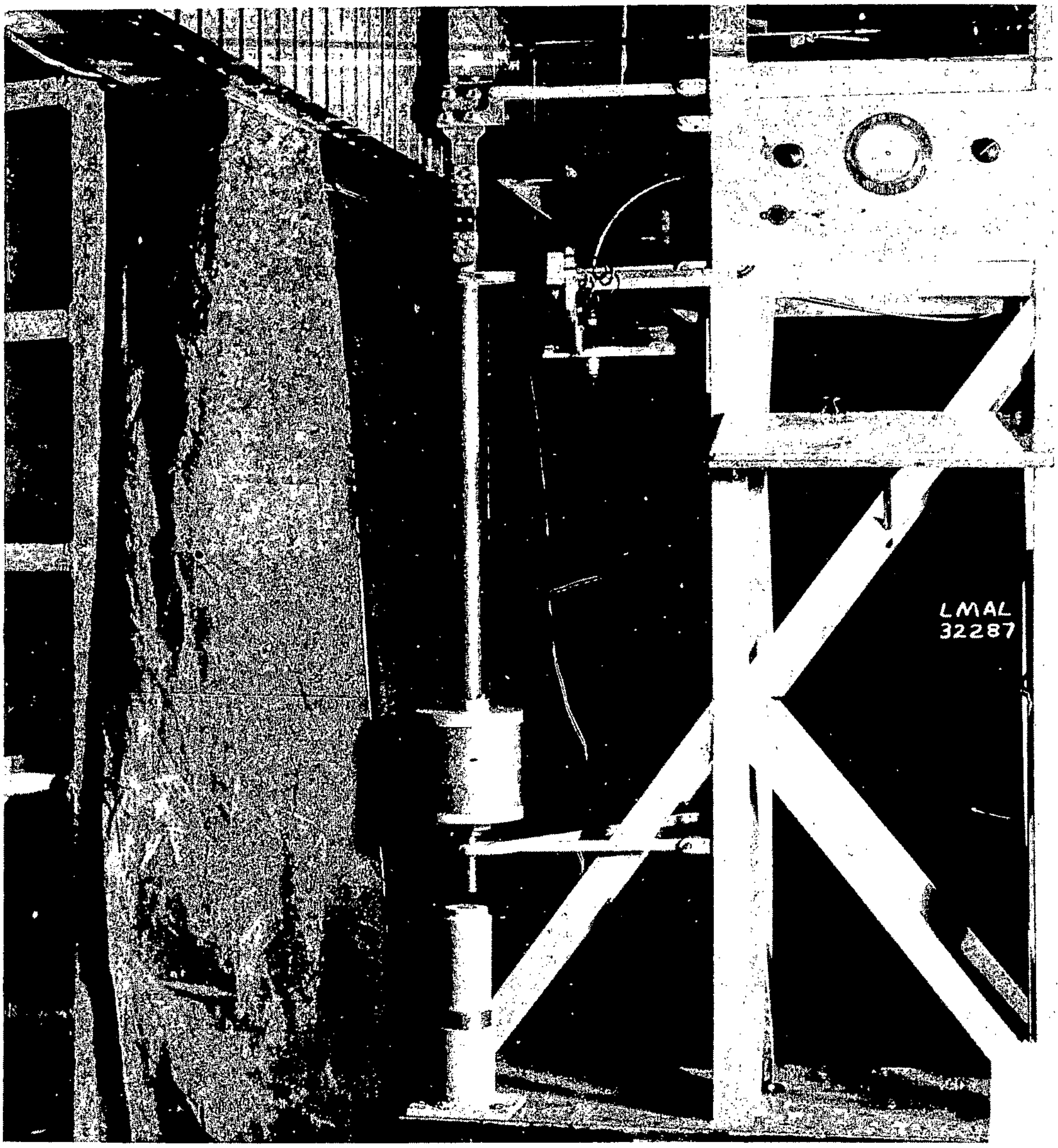

Figure 4.- Fatigue-testing-machine.

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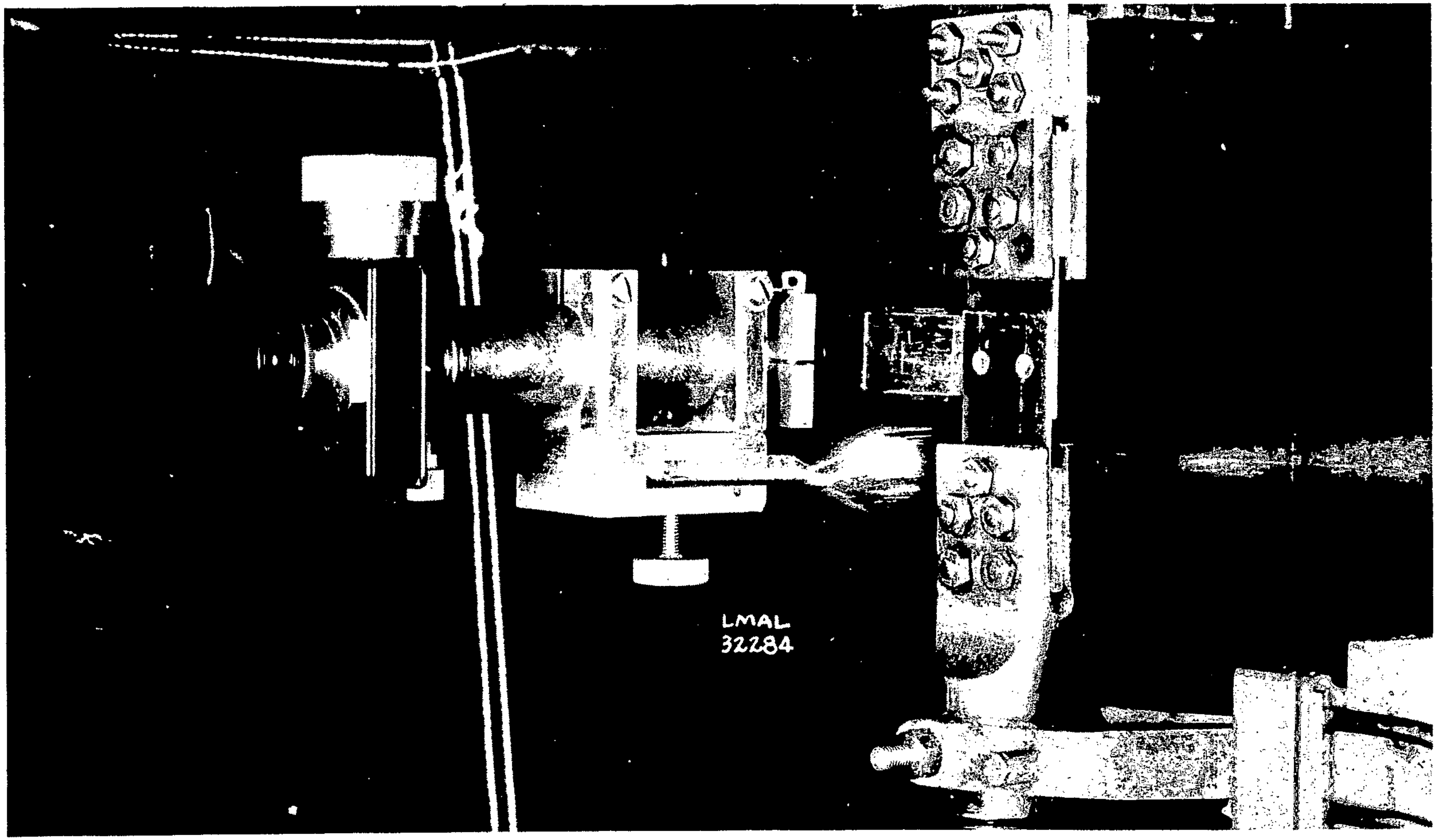

Figure 5.- Optical micrometer used to determine amplitude of vibration.