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Wind-Tunnel Tests of the XA2A and XA3A Fuse-Arming Mechanisms for Weapon "A"

(None)

Beebe, J.

David Taylor Model Basin, Washington, D. C.

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Two prototype XA2A and XA3A air vanes and fuse-arming mechanisms for weapon "A" were tested in a wind tunnel to determine the rotational speed of the vanes, time to reach constant speed, and the drag of the vanes. The tests were conducted at wind velocities of approximately 60, 96, 113, 138, and 160 knots. The time to reach constant speed decreased with an increase in wind velocity between 2.4 and 1.2 sec for the windmilling condition. Drag did not increase in regular manner with the wind velocity. The average time to arm the XA2A and XA3A arming mechanisms is also discussed.

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NAVY DEPARTMENT

DAVID TAYLOR MODEL BASIN

WASHINGTON 7, D.C.

WIND-TUNNEL TESTS OF THE XA2A AND XA3A FUSE-ARMING MECHANISMS FOR WEAPON "A"

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DAVID TAYLOR MODEL BASIN
UNITED STATES NAVY
WASHINGTON, D.C.

WIND-TUNNEL TESTS OF THE XA2A AND XA3A FUSE-ARMING MECHANISMS FOR WEAPON "A"

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J. Beebe

INTRODUCTION

At the oral request of the Naval Ordnance Laboratory, two prototype XA2A and XA3A airvanes and fuse-arming mechanisms for Weapon "A" were tested in the David Taylor Model Basin 8- by 10-foot Wind Tunnel 1. Tests were made to determine the rotational speed of the vanes, the time to reach constant speed, and the drag of the vanes. This was a continuation, at higher wind speeds, of an investigation made in the 6' - 4" wind-tunnel at the Naval Gun Factory. Subsequent tests were made (Reference 1), to determine the arming times of the prototypes of the XA2A and the XA3A fuse-arming mechanisms, and the minimum rotational velocity of the airvane necessary to arm the XA3A mechanism. Naval Ordnance Laboratory personnel assisted with the tests. The results of these tests are presented herein.

MODEL AND APPARATUS

The two prototype airvanes, one XA2A and one XA3A fuse-arming mechanism, and all test equipment and instruments, except those necessary for the measurement of the drag force, were supplied by the Naval Ordnance Laboratory.

Airvanes - Basically the airvanes designated Propeller 1 and Propeller 2 were similar; both had 10 blades, a 49 degree blade angle, and were 6 inches in diameter. However, Propeller 1 had each two consecutive blades formed from a single piece of sheet steel having a thickness of 0.0625 inch and a chord of 1 inch, while the individual blades of Propeller 2 were formed from 0.040-inch thick sheet steel, were mutually reinforcing, and had a 1.125-inch chord, as shown in Figure 1.

The airvane was mounted on a shaft at the small end of a truncated cone which represented the fuse-arming housing. The cone was mounted on the balance support for the drag tests, Figure 2, while a streamlined strut, as shown in Figures 3 and 4, was used for the rotational speed tests. For these tests a disk 9.75 inches in diameter or a rounded-nose shape 12.75 inches in diameter was installed at the large end of the cone to simulate the aerodynamic effect of the bomb on the airvane. A torque load could be imposed upon the airvane by loading a small electric generator which was mounted behind the disk or the rounded nose, as shown in Figure 5.

The airvane rotational speeds were measured by a Strobotac, and the time to reach a constant speed by a stop watch and the Strobotac.

Fuse-Arming-Mechanisms - The major difference in the XA2A and the XA3A mechanisms is that the XA2A arms the fuse when the air-vane has made a fixed number of revolutions, and the XA3A arms the fuse when the airvane has attained a certain rotational speed. The XA2A fuse-arming mechanism is shown in Figure 6.

The fuse-arming mechanism was mounted on a streamlined strut together with a 12.75-inch diameter rounded fairing to simulate the nose of the actual missile, see Figures 7 and 8. A wire was provided to release the airvane when the wind speed was at the desired value. To prevent damage to the wind tunnel, a metal guard, which may be seen in Figure 7, retained the air-vane and arming assembly upon arming.

TEST PROCEDURE

The tests on the airvanes were conducted in the David Taylor Model Basin 8-by 10-foot closed-throat atmospheric Wind Tunnel 1 at wind speeds of approximately 60, 96, 113, 138, and 160 knots.

The first series of tests were made to determine the constant rotational speed of the airvanes for each wind speed. Then with the wind speed held constant, and the Strobotac set for the previously measured constant rotational speed, the propeller was released and the time for the airvane to reach full rotational speed was obtained. This procedure was re-peated for a free windmilling condition (zero torque) and for a load run (10 inch-ounces of torque) with several combinations of propeller, wind speed, and simulated bomb nose. The rounded nose shape and the disk were each mounted behind Propeller 2, while only the disk was used with Propeller 1.

The drag tests were made with only Propeller 2 and the truncated cone housing. An image support was installed as shown in Figure 2 for obtaining the tare and interference drag.

The arming time tests on the fuse arming mechanisms were made at a constant dynamic pressure of 87.13 pounds per square foot which corresponds to a wind speed of about 160 knots. Two observers measured the time to arm and three trials were made with both the XA2A and XA3A (centrifugal mechanism) which was allowed to windmill while the wind speed was increased and the rotational velocity at the instant of arming was measured by means of the Strobotac.

RESULTS AND DISCUSSION

The results of the tests are given in Table 1 and in Figures 9 and 10. The drag forces were corrected for the tare and interference of the support strut. No tunnel-wall or blocking corrections were applied to these data.

The measured rotational speeds of Propeller 2 were greater than for Propeller 1. This difference in speed is probably due to the smaller thickness ratio of the blades of Propeller 2. The time to reach constant speed decreased with an increase in wind speed and varied between 2.4 and 1.2 seconds for the free windmilling condition (Table 1). This time, however, is merely qualitative since the difference in time over the wind-speed range was of the order of one-half second, for a particular condition, and the individual observer's reaction time was too slow to obtain a low percentage error.

The measured drag did not increase in a regular manner with the wind speed, Figure 10.

The average time to arm the XA2A arming mechanism (gear type) was 1.3 seconds at a wind speed of 160 knots (plus or minus one percent), while the average time for the XA3A (centrifugal type) was 1.7 seconds.

When the wind speed was gradually increased the XA3A fuse-arming mechanism armed at 5600 revolutions per minute at a wind speed of 142 knots. This mechanism was designed to arm at 6000 revolutions per minute.

REFERENCES

1. Naval Ordnance Laboratory Conf Ltr EN-27/S76-2 (2642) to TMB dated 19 May 47.

Aeromechanics Division
David Taylor Model Basin
Washington, D.C.
August 1947

TABLE I

Table Showing RPM and Time to Reach Constant Speed for Various Wind Velocities

Pro-Peller	Free Run (No Torque)			Load Run (10 In-Oz Torque)		
	Wind Speed in knots	RPM	Time to Reach Constant Speed in seconds	Wind Speed in knots	RPM	Time to Reach Constant Speed in seconds
DISK NOSE						
1	95.2	4,025	1.7	95.8	3,600	2.1
	112.5	4,975	1.6	113.2	4,450	1.6
	138.2	6,050	1.5	135.9	5,600	1.5
	160.0	7,000	1.2	160.2	6,700	1.6
2	95.4	4,150	1.8	96.3	3,750	1.6
	112.6	4,925	1.7	113.8	4,600	1.5
	138.7	6,175	1.2	140.2	5,925	1.3
	160.3	7,225	1.2	161.3	6,925	1.4
ROUNDED NOSE						
2	60.8	2,400	2.4	60.4	1,700	2.1
	95.3	4,200	1.7	94.7	3,800	1.7
	112.5	5,000	1.5	111.9	4,650	1.5
	138.5	6,250	1.4	137.7	6,000	1.5
	160.1	7,325	1.4	159.3	7,025	1.5

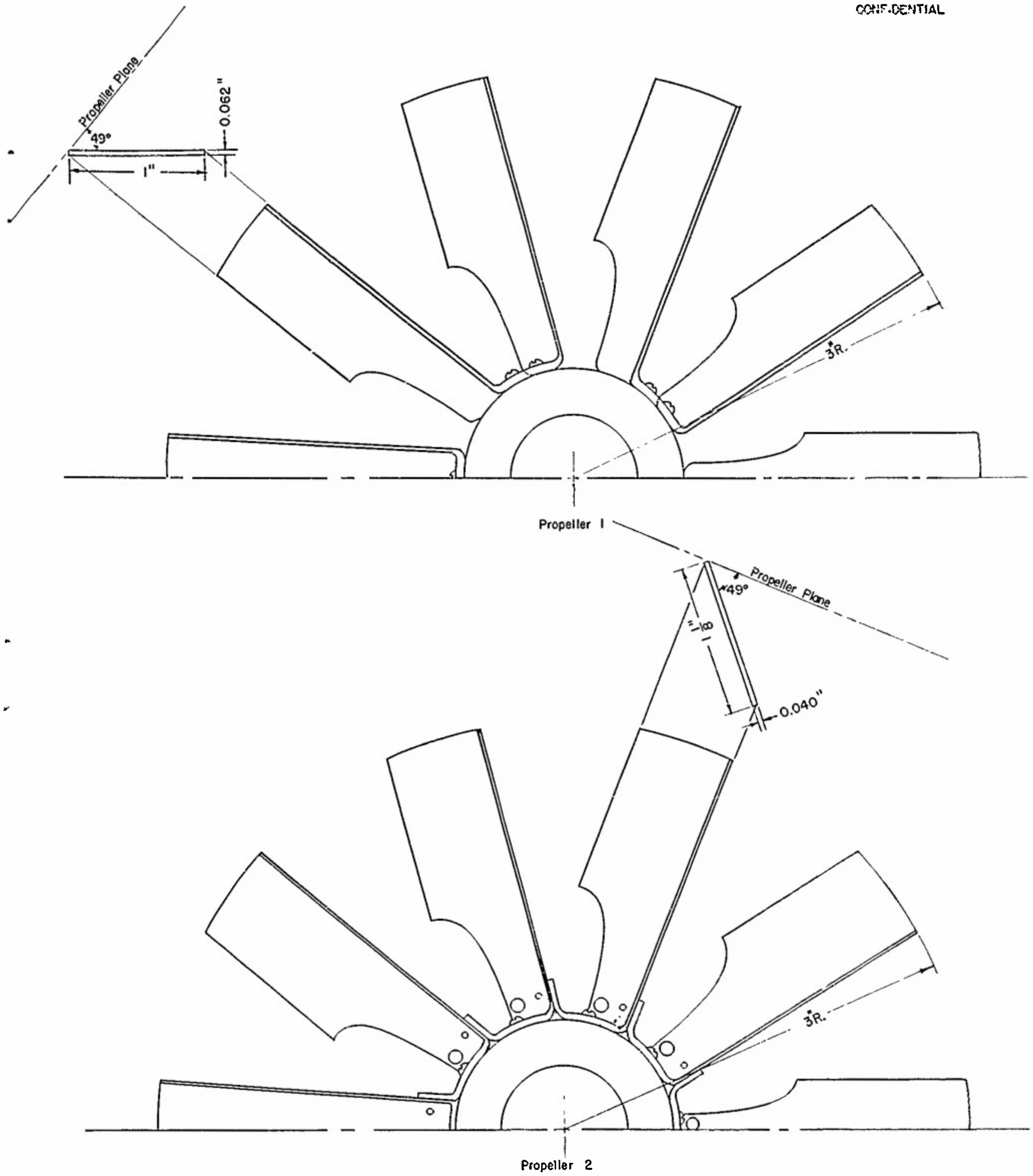

Figure 1 - Sketch Showing Types of Blade Construction for the two XA2A Airvanes

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Figure 2 - Propeller 2 and Truncated Cone Housing Mounted for Drag Tests.

The image strut for determining tare corrections is shown in place.

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Figure 3 - Front View of Airvane
Assembly with Propeller
and Disk
Rotational speeds were measured with this installation.

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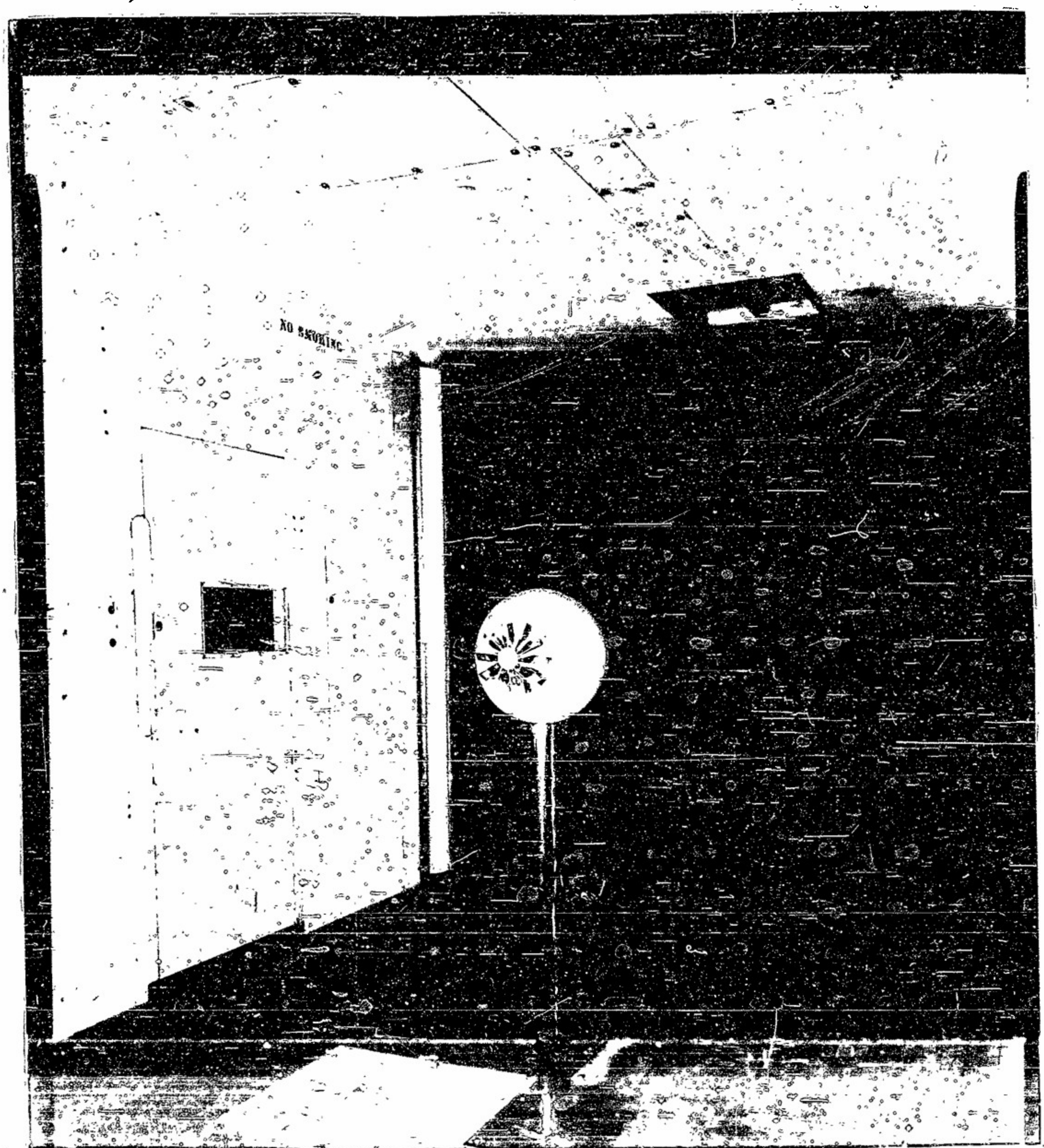

Figure 4 - Front View of Airvane Assembly
With Propeller 2 and
Rounded-Nose Shape

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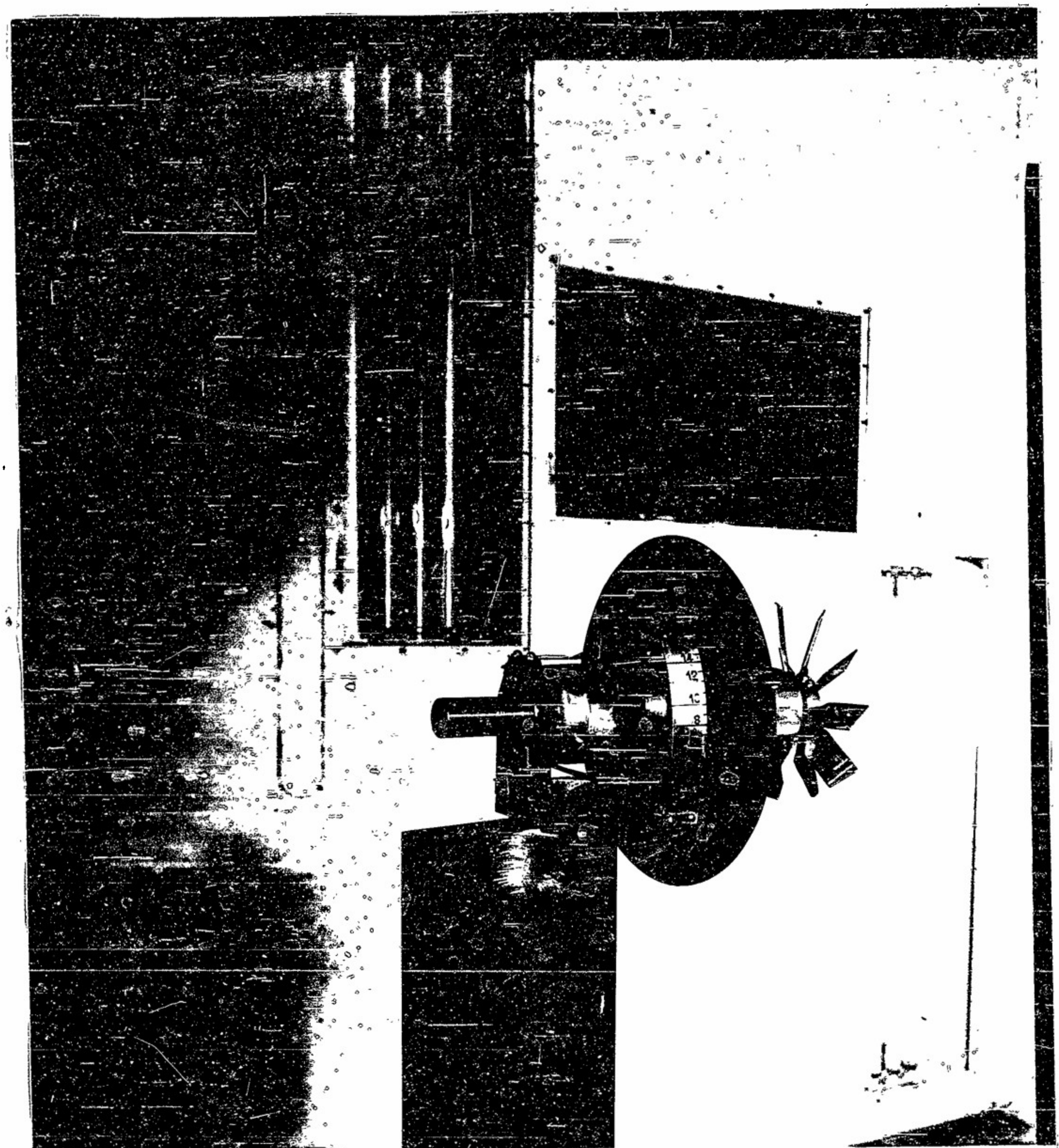

Figure 5 - Side View of Airvane Assembly Showing
Generator Modified for use as
Torque Indicator

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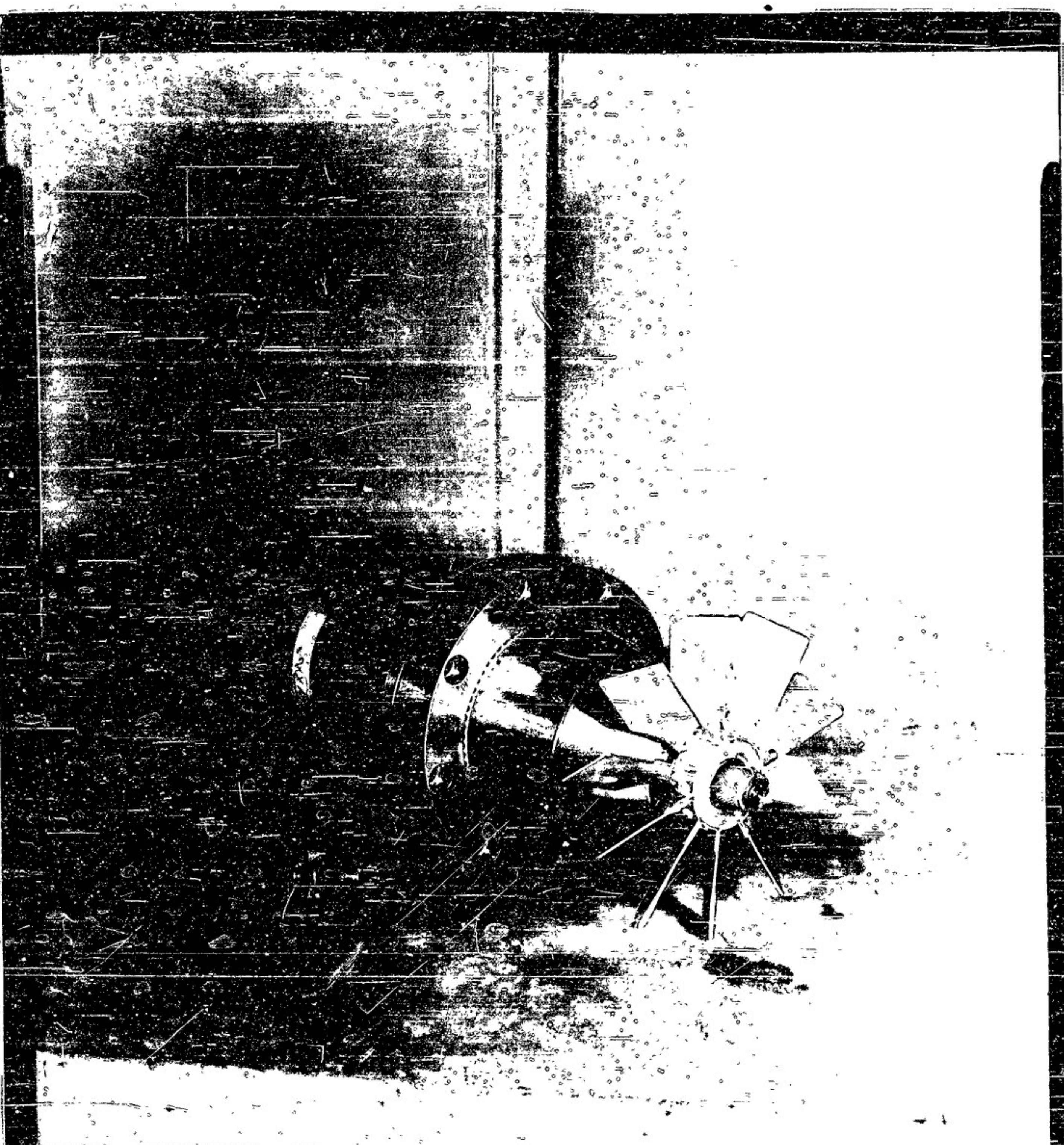

Figure 6 - The Prototype XA2A Fuse-Arming Mechanism

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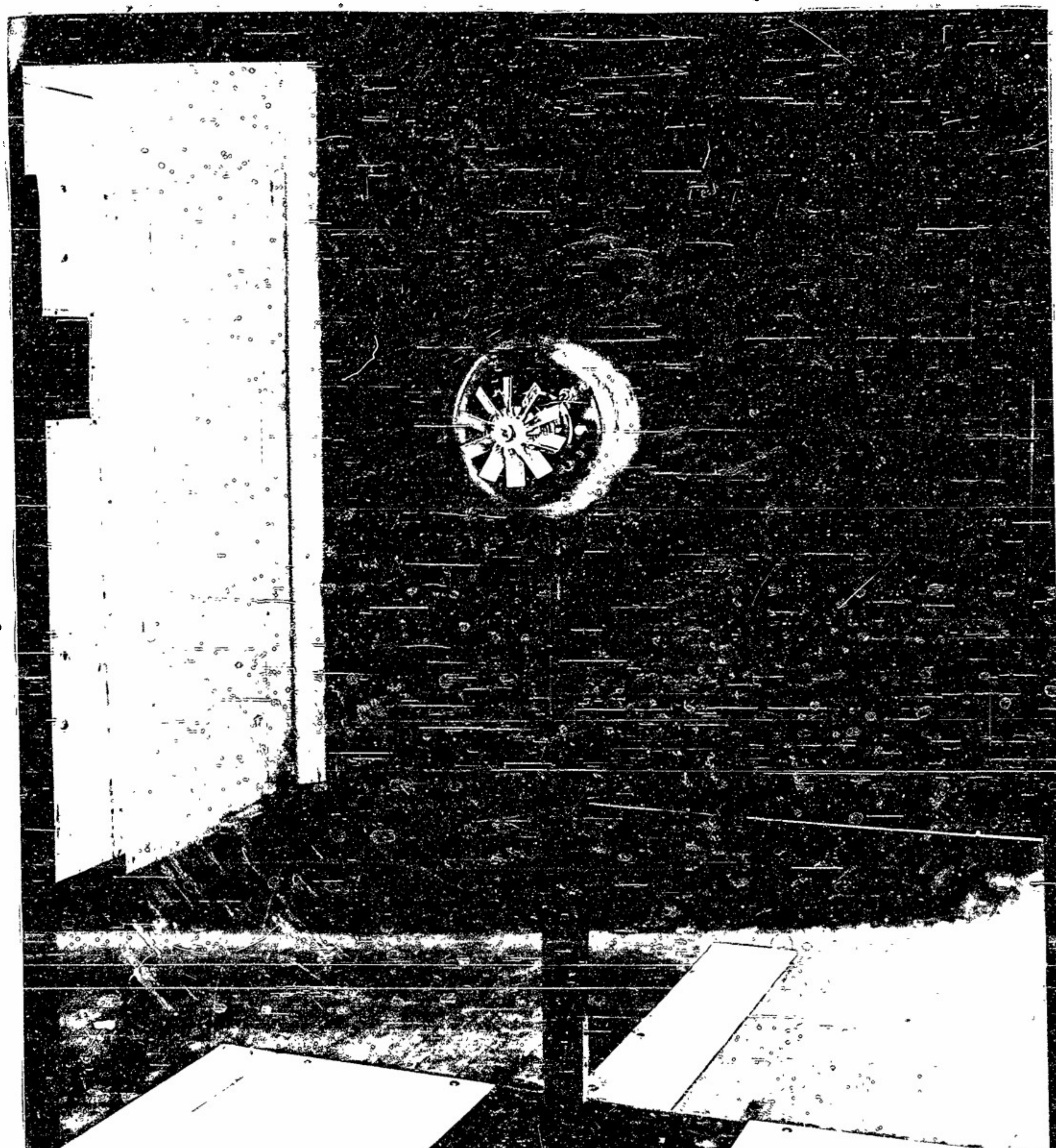

Figure 7 - The XA3A Fuse-Arming Mechanism Mounted in the Wind Tunnel

The simulated missile nose and the metal retaining guard may be seen.

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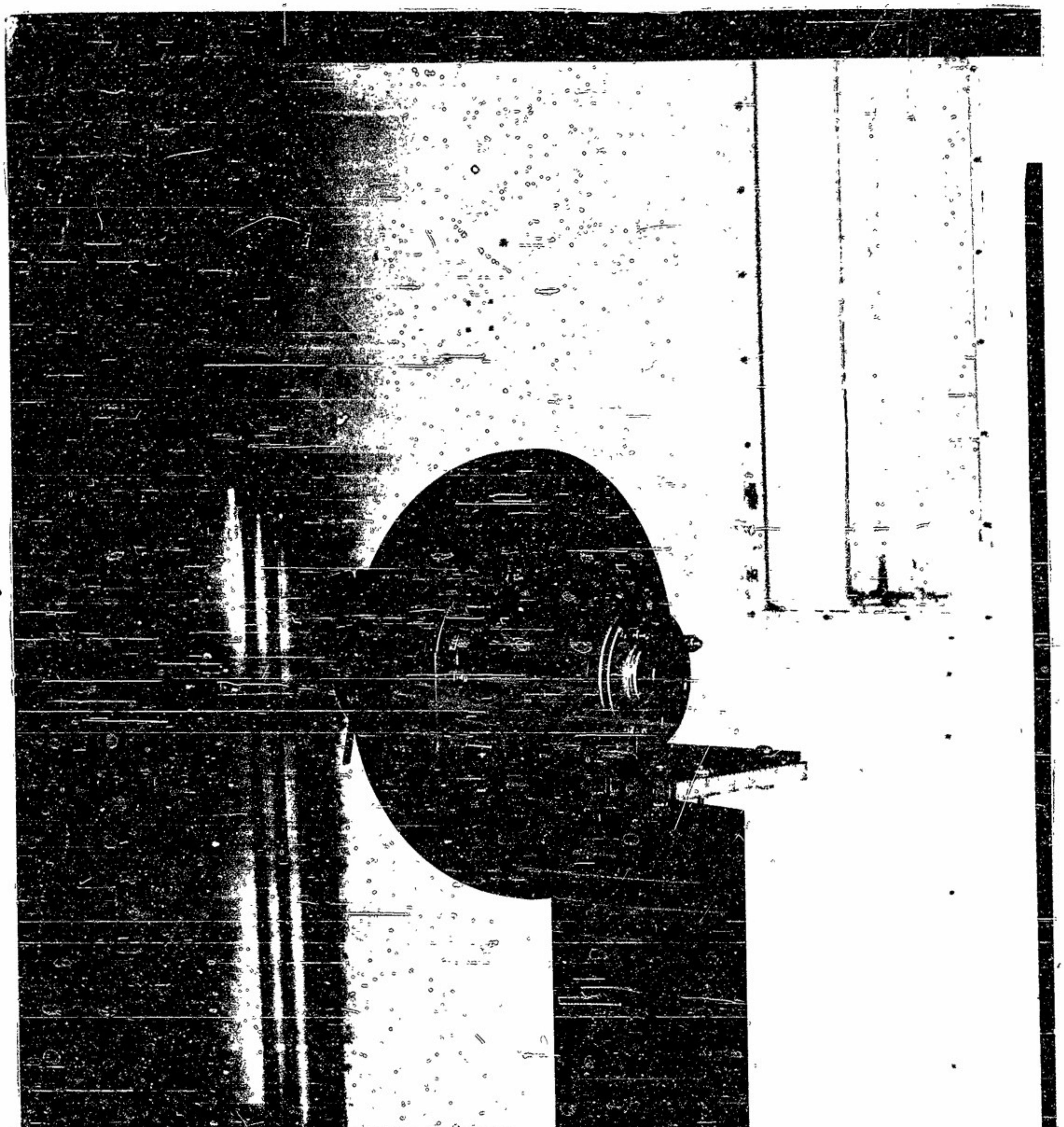

Figure 8 - Rear View of the XA3A Fuse-Arming Mechanism Showing the Method of Mounting on the Strut for the Arming Tests

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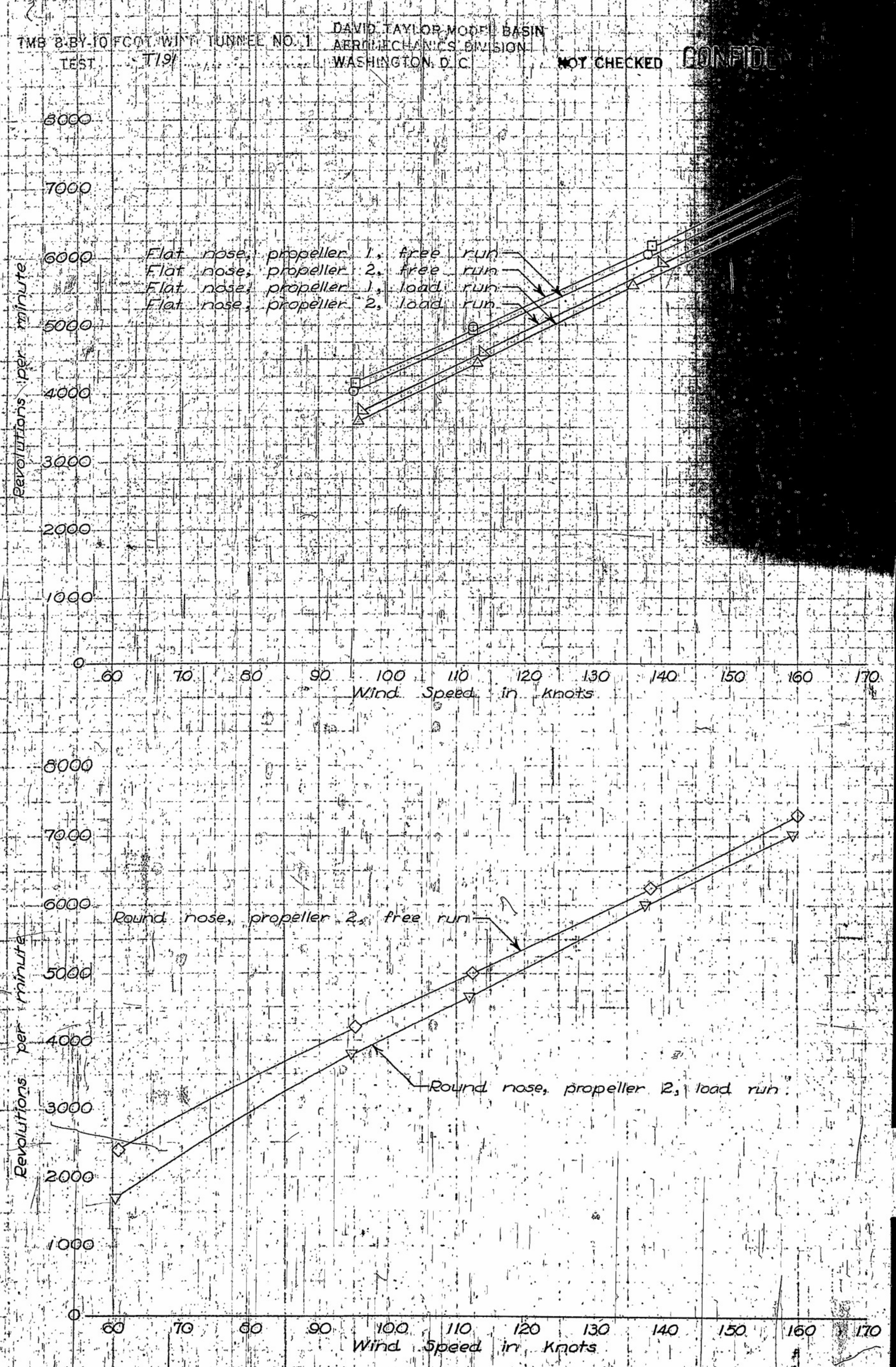

Figure 9 – Variation of Rotational Speed of XAZA Airvanes with Wind Speed

TMB 8 BY 10 FOOT WIND TUNNEL NO. 1

TEST 7797

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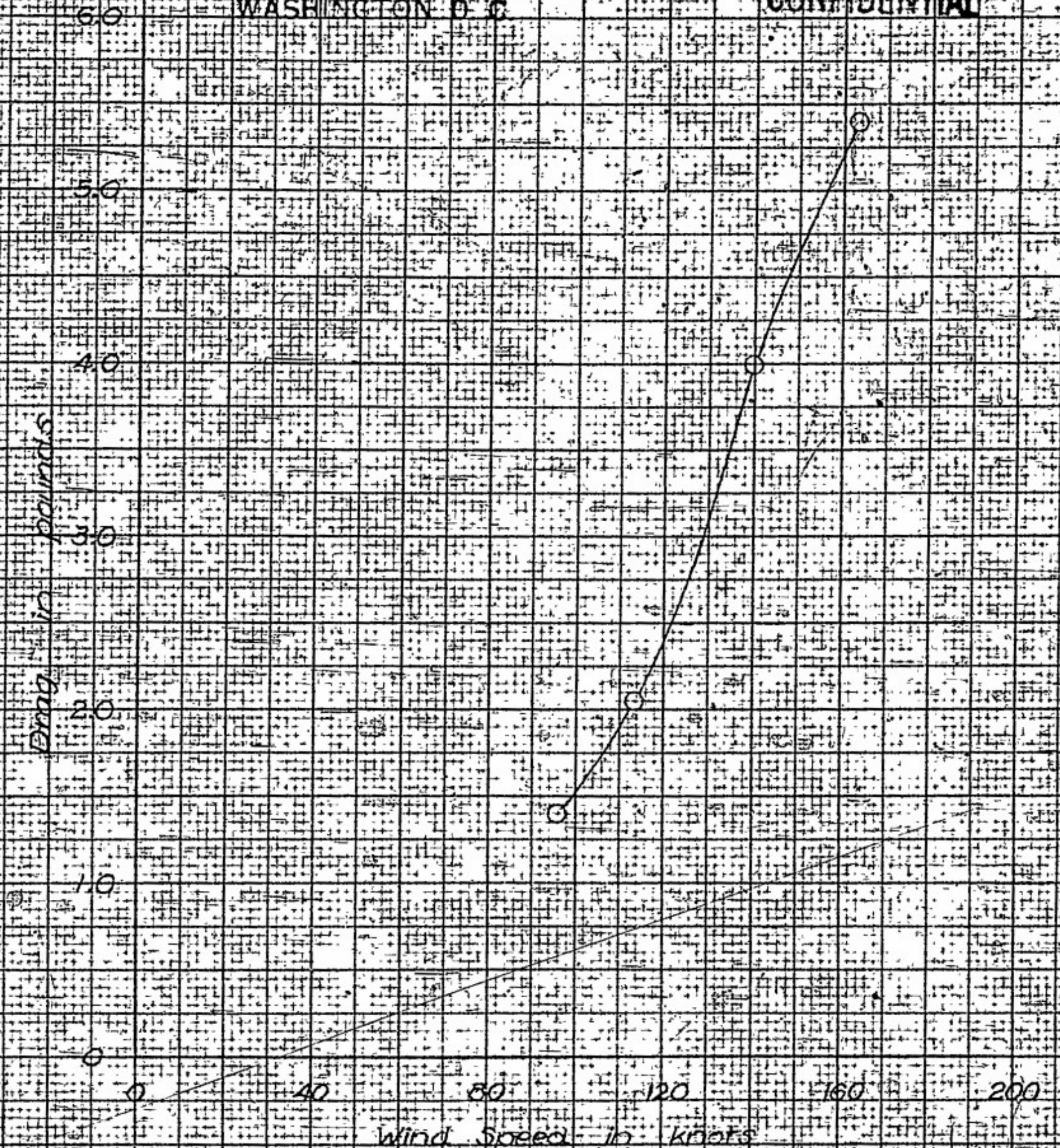

Figure 10 Variation of Drag with Wind Speed for Propeller 2 and Truncated Cone Housing

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