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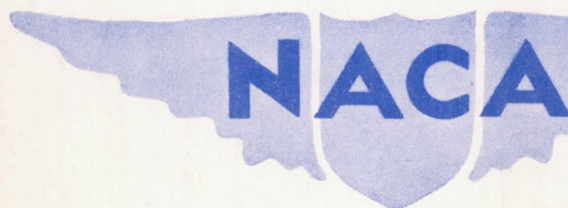
NAVY SB2C-1 AIRPLANE (ARMY A-25) IN

LANGLEY TANK NO. 2 AND ON AN

OUTDOOR CATAPULT

By George A. Jarvis and Carl D. Kolbe

Langley Memorial Aeronautical Laboratory
Langley Field, Va.



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NACA LANGLEY MEMORIAL AERONAUTICAL LABORATORY

MEMORANDUM REPORT

for the

Bureau of Aeronautics, Navy Department

MR No. L5L07

DITCHING TESTS OF A 1/8-SIZE MODEL OF THE
NAVY SB2C-1 AIRPLANE (ARMY A-25) IN
LANGLEY TANK NO. 2 AND ON AN
OUTDOOR CATAPULT

By George A. Jarvis and Carl D. Kolbe

SUMMARY

Tests were made to determine the best way to land the SB2C-1 airplane in calm and rough water and to determine its probable ditching performance. A 1/8-size dynamically similar model of the SB2C-1 airplane was ditched in Langley tank no. 2 and in calm and rough water at the outdoor catapult. The behavior of the model was determined by making visual observations by recording the maximum longitudinal decelerations and by taking motion pictures of the ditchings.

The following conclusions were drawn from the results of the tests:

1. The airplane should be ditched in a normal tail-down landing attitude (thrust line at 15°) with the flaps half down.
2. In rough water, ditchings should be made along the wave crests when feasible. If a strong cross wind exists, it may be necessary to land across the waves and, in such a case, an attempt should be made to have the tail of the airplane touch the windward side of a wave.
3. If the bomb-bay doors do not fail, skipping will probably occur, but if the bomb-bay doors do fail, an event which probably will occur in the full-scale airplane, a dive may result.

4. If one wing tip digs into the water, a violent turn may result.

5. The arresting gear hook should not be extended in ditching.

6. A slight improvement in the ditching behavior is obtained when the tail wheel is retracted.

INTRODUCTION

Tests were conducted in the Langley tank no. 2 and on an outdoor catapult in order to determine the best way to land the SB2C-1 airplane in calm and rough water and to determine its probable ditching behavior. These tests were requested by the Bureau of Aeronautics, Navy Department, on July 2, 1943.

PROCEDURE

Description of model.- A 1/8-size dynamic model of the SB2C-1, shown in figure 1, was used in the tests. The type of construction used in building the model was similar to that described in reference 1. The model had a wing span of 6.2 feet and an over-all length of 4.57 feet. The scale weight of the model was determined from the following relationship:

$$\text{Weight of model} = \text{Weight of full-scale airplane} \\ \times (\text{scale of model})^3$$

In order to obtain scale strength flaps, an aluminum bracket was attached to each flap at its midspan and another bracket was attached to the wing directly in front of the bracket on each flap. The arrangement of these brackets is shown in figure 2. String was fastened around the brackets in such a manner as to hold the flaps in position. When the scale load which would cause failure of the flaps on the airplane (505 lb/sq ft, given in a letter from the Curtiss-Wright Corporation) was applied to the flaps, the string of known strength would break allowing the flaps to retract.

Test Methods and Equipment

Tank tests.- When the model had been statically balanced, it was attached to the aerodynamic gear that is located at the rear of the towing carriage in Langley tank no. 2. The aerodynamic gear permits the model to roll, yaw, or pitch without restraint (fig. 3). With the model supported at the center of gravity the model was towed through the air at the various scale speeds at which it was to be ditched. These speeds were obtained by using Froude's Law of Similitude,

$$\text{Speed of model} = \text{Speed of full-scale airplane} \\ \times \sqrt{\text{scale of model}}$$

Movable tabs were adjusted to balance the model aerodynamically in roll and yaw. The elevator settings required to trim the model in pitch for each of the attitudes and conditions of simulated damage were determined.

The aerodynamic gear was replaced by the launching gear which is arranged so that the model can be set at various attitudes and heights above the water. After the elevators on the model were adjusted for the condition to be tested, the model was attached to the launching gear as shown in figure 4. When the model was to be ditched, the towing carriage was run at a constant speed and the model was released from the front and rear suspension hooks simultaneously. The model glided into the water at approximately the attitude at which it was released. Each ditching occurred at about the same location in the tank.

Two observers at the ditching station determined the length of run and noted the behavior of the model. A photographer took 16-millimeter motion pictures, at approximately 64 frames per second, of all the ditchings. The attitude of the model at contact with the water and its vertical speed were determined for a few representative ditchings by measurements from the motion pictures.

Maximum longitudinal decelerations and time-history records of the decelerations were obtained with small accelerometers that were placed in the model as close to the pilot's cockpit as possible.

With the launching gear at the rear of the towing carriage, it was found that the air flow is such that it gives the effect of a slight head wind. Since no power is provided in the models, the aerodynamic lift at speeds corresponding to power-on landings tends to be less than the correct value. With the model located at the rear of the carriage, some of the lift increment that would result from the use of power is obtained. This additional lift probably enables a more accurate simulation of power-on landings with the model. However, in the tank, at speeds corresponding to power-off landings, the lift from the aerodynamic surfaces of the SB2C-1 model tended to be too great at speeds above 46.7 feet per second (78.2 knots full scale). Spoilers as shown in figure 5 were added to the wings for the tests at speeds above this value to reduce the lift to the proper amount.

When the flaps were deflected, the elevator control of the model was insufficient to cause the model to maintain the desired attitudes, so an auxiliary elevator surface made of 1/16-inch aluminum was mounted on the rudder as shown in figure 6.

Catapult tests.- The test methods used at the outdoor catapult are given in reference 1.

Test Conditions

(All values given refer to the full-scale airplane.)

Gross weight.- The gross weights of the airplane used in the tests were: maximum overload, 15,704 pounds; normal gross load, 13,060 pounds; scout condition, less entire expendable load, 11,090 pounds.

Location of center of gravity.- A center-of-gravity position of 30.2 percent of the mean aerodynamic chord and 1.2 inches below the thrust line was used in the tests.

Attitude of thrust line.- Three attitudes were used in the tests: 15° near stall, 8° medium attitude, and 2° approximate attitude at cruising speed.

Landing gear.- The landing gear was retracted in all of the tests.

Flaps.- The flap settings used in the tests were: full up, half down (30°), and full down (60°).

Landing speed.- The landing speeds may vary considerably, depending on the conditions of wind, power, flaps, and attitude. A range of landing speeds covering a reasonable variation in wind, power, and flap setting was used. (See table I.) The catapult tests were made at the normal-weight power-off condition only. The speeds were computed from data furnished by the Curtiss-Wright Corporation and are given in the following table:

Attitude of thrust line (deg) Flaps	15	8	2
Full up	84.3 knots 97 mph	113 knots 130 mph	
Full down	70.4 knots 81 mph	83.5 knots 96 mph	104.3 knots 120 mph

Conditions of simulated damage.- From inspection of the actual airplane it was concluded that the bomb-sight doors will collapse upon contact with the water, for these doors fold inward at the center and can be moved upward by pushing hard with one's hand. It was therefore assumed that the bomb-sight doors would fail in every ditching. The following are the conditions of simulated damage used in the tests:

- (a) Bomb-sight doors removed (fig. 7(a)).
- (b) Bomb-sight doors and bomb-lever doors removed (fig. 7(b)).
- (c) Bomb-sight doors, bomb-lever doors, and bomb-bay doors removed (fig. 7(c)).

As the ditching behavior in the tank for damage conditions (a) and (b) was practically identical, only conditions (a) and (c) were tested at the outdoor catapult.

Tail wheel.- In some versions of the SB2C-1 airplane the tail wheel is retractable. The tail wheel and the fairing of the oleo gear were placed on the model as shown in figures 2 and 8 to represent the version with a nonretractable tail wheel. Retraction of the tail wheel was simulated by removing this unit. Tank tests were made both with and without the tail wheel attached. Catapult tests were made only with the tail wheel attached.

Condition of seaway.-

- (a) Calm water in the tank and at the catapult
- (b) Wave crests parallel to the flight path; height approximately $1\frac{1}{2}$ feet to 2 feet, wave length approximately 30 to 40 feet
- (c) Wave crests perpendicular to the flight path; height approximately $1\frac{1}{2}$ feet to 4 feet, wave length approximately 20 to 80 feet

Ditching-aid devices.-

- (a) Regulation arresting hook for the SB2C-1
- (b) Hydrofoil arresting hook, figure 9

RESULTS AND DISCUSSION

Summaries of the results of the tests are presented in tables I to V.

The symbols used in defining the ditching behavior of a model are as follows:

- b deep run - model travels through the water partially submerged exhibiting a tendency to dive, although the attitude of the model is nearly level
- d₁ violent dive - a dive in which the wings are submerged and the angle between the water surface and the fuselage reference line is between 15° and 90°

- d_2 slight dive - a dive in which the wings are not submerged completely and the angle between the water surface and the fuselage reference line is 15° or less
- h smooth run - a run in which there is no apparent oscillation about any axis during which the model settles into the water as the forward velocity decreases
- p porpoising - an undulating motion about the transverse axis in which some part of the model is always in contact with the water surface
- s skipping - an undulating motion about the transverse axis in which the model clears the water surface completely - in general, the motion is more severe than porpoising and greater damage would probably occur
- t sharp turn - a violent angular motion about a vertical axis, generally caused by one wing tip digging into the water

Most of the violent dives listed in the tables were vertical dives. Vertical dives are considered especially hazardous because of the probability that the airplane may overturn and trap the occupants.

In the tank when the model dived the maximum deceleration ranged from 4g to 8g. When the model did not dive the maximum deceleration ranged from 0.9g to 2.5g (table I). In accord with the Laws of Similitude the decelerations would be the same for the actual airplane. No decelerations were measured in the catapult tests.

Photographs showing the characteristic behavior are shown in figures 10 through 13. Figures 14 and 15 give typical time histories of longitudinal decelerations.

Effect of Flaps

In the tank tests, lowering the flaps to the full-down position caused the model to dive consistently while lowering the flaps to the half-down position caused an occasional dive. (See table I and fig. 10.) In these

tests the flaps rarely failed. In the catapult tests lowering the flaps did not generally cause the model to dive (table II) because at least one flap always failed and both flaps failed in 80 percent of the tests. The more frequent flap failure in tests at the catapult may be due to higher impact loads. Higher loads might be caused by the rougher water surface (ripples occurred even in calm water) or by the slightly higher vertical velocities found in the catapult tests.

From the test results it might be expected that in ditching the full-scale airplane at a low sinking speed in smooth water, the flap structure might be bent in such a way as to obtain a stress just below the yield point of the flap structure, thereby producing a diving moment. In rough water the probability of a dive due to this moment is minimized because the impact loads are severe enough to either shut or tear away the flaps before they have had very much effect on the attitude of the airplane.

It appears likely that the flaps can be lowered half down without causing a dive but, with flaps full down, the probability that diving will occur is increased. If ditchings are made with flaps up, the landing speeds will be so high that very severe damage may be expected. These considerations indicate that this airplane should be ditched with the flaps half down.

Effect of Attitude

Table I shows that, for the condition of least damage, decelerations tended to decrease slightly with decreasing attitude. At the worst damage condition, however, decelerations increased substantially as the attitude was decreased.

Since damage is generally expected to be greater than that simulated in the condition of least damage, a near-stall landing should generally cause less deceleration than a low attitude ditching.

Effect of Weight

The general behavior of the model did not vary much with change in gross weight and the effects of

gross weight on decelerations were inconsistent. (See tables I, III, and IV.) Since the results show that a reduction in weight does not tend to cause any increase in violence of behavior, ditchings made at the lightest gross weight obtainable should be the safest because of the accompanying decrease in landing speed; as a result of the lower landing speed less damage may be expected.

Effect of a Wing-Low Landing

In the course of the tests a number of landings were inadvertently made in which the wings were not laterally level. When the wing tip dug into the water, the model usually made a violent turn coming to a sudden stop as shown in figure 12(a). If the wing that was low made contact with the water all along its undersurface, the model usually rode the waves or made a skidding turn.

Effect of Simulated Damage

Skipping and porpoising usually occurred in both the tank and catapult tests when the bomb-sight doors were removed (tables I and II). Tank tests showed that the removal of the bomb-lever doors in addition to the bomb-sight doors, had little effect on the performance. Removal of the bomb-bay doors in addition to the bomb-sight and bomb-lever doors caused the model to behave more violently. In the tank tests, dives occurred fairly regularly and, although dives were obtained only occasionally in the catapult tests, a tendency to dive was shown by deep runs.

When the model was ditched at speeds above 104.3 knots, with the bomb-bay doors, bomb-lever doors, and bomb-sight doors removed, the water forces on the bottom of the model were frequently large enough to tear out about one-third of the bottom of the fuselage aft of the bomb bay.

Effect of Tail Wheel

Tables I and III show inconsistent effects due to the removal of the tail wheel. However, studies of the

motion pictures taken during the tests, indicate that the motions tended to be somewhat more violent when the tail-wheel unit was on than when it was off.

Effect of Ditching Aids

In general, the tests showed that the ditching behavior was more violent with the regular arresting hook extended. (Compare tables I and V.) The decelerations were increased by about 0.5g to 2.0g and the length of run shortened. When it was found that no improvement in the ditching performance was obtained with a regular arresting hook, tests were made with the lower portion of the hook replaced by a hydrofoil, shown in figure 9. The hydrofoil was made as large as could be fitted into the arresting-hook tunnel and no attempt was made to shape it so that it would be practicable for picking up the arresting-gear cable for it seemed desirable to evaluate the possible improvement that could be obtained before entering into such a design problem. An improvement in the ditching behavior at the 15° attitude, flaps up (with simulated damage of the bomb-sight doors, bomb-lever doors, and bomb-bay doors) was obtained with this hydrofoil arresting hook. This change in behavior was from violent dives to skipping or porpoising. The length of run was also increased. The ditching behavior for the 30° and 20° attitudes was not changed appreciably.

Effect of Seaway

The wave height obtained for a given wind velocity at the catapult is smaller than the wave height obtained in the open sea for the same velocity. Consequently, in ditchings, the wave heights are lower than they should be to correspond to the ground speeds at which the model lands. It is possible then that the ditching behavior obtained at the catapult, in rough water, may be somewhat optimistic.

When ditched parallel to the wave crests, the model generally skipped or porpoised (table II and fig. 13(a)). When the model was ditched across the waves, skipping was predominant although some smooth runs were obtained when

the model touched the water surface in the trough of a wave. A dive resulted when the tail of the model hit the leeward side of a wave near the crest.

Since diving is such a severe motion, the airplane should generally be ditched parallel to the waves to reduce the possibility of a dive occurring; however, if a strong cross wind exists, it may not be feasible to ditch parallel to the waves. (See reference 2.)

CONCLUSIONS

From results of the tests of a 1/8-size model of the SB2C-1 airplane, the following conclusions were drawn:

1. The airplane should be ditched in a normal tail-down landing attitude (thrust line at 15°) with flaps half down.
2. In rough water, ditchings should be made along the wave crests when feasible. If a strong cross wind exists, it may be necessary to land across the waves and, in such a case, an attempt should be made to have the tail of the airplane touch the windward side of a wave.
3. If the bomb-bay doors do not fail, skipping will probably occur but if the bomb-bay doors do fail, an event which probably will occur in the full-scale airplane, a dive may result.
4. If one wing tip digs into the water, a violent turn may result.
5. The arresting-gear hook should not be extended in ditching.

6. A slight improvement in the ditching behavior is obtained when the tail wheel is retracted.

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REFERENCES

1. Fisher, Lloyd J., and Steiner, Margaret F.: Ditching Tests with a 1/12-Size Model of the Army B-26 Airplane in NACA Tank No. 2 and on an Outdoor Catapult. NACA MR, Aug. 15, 1944.
2. Anon.: Landplane Ditching Manual Prepared. Air Sea Rescue Bull. No. 4, Air Sea Rescue Agency (Washington), Oct. 1944, pp. 4-8.

TABLE I.- SUMMARY OF THE RESULTS OF TANK DITCHING TESTS OF A 1/3-SIZE MODEL
OF THE SB2C-1 AIRPLANE WITH THE TAIL-WHEEL UNIT ATTACHED

[All values are full scale; gross weight, 13,060 pounds]

Attitude of thrust line (deg)		15												8												2											
Speed	knots	60.8			69.5			78.2			86.8			78.2			86.8			95.6			104.3			112.9			95.6			104.3			112.9		
	mph	70			80			90			100			90			100			110			120			130			110			120			130		
Damage condition	(1) Flaps	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks			
Bomb-sight door removed	Full up							1.3 1.2	13 15	s s	1.2 .9	19 19	s s										1.4 1.8	18 19	p p	1.3 2.0	22 21	jr jr									
	Half down				5.0 5.3	3 3	d1 d1	6.0 5.4	3 4	d1 d1				1.4 1.1	15 13	s s	1.8	10	p	2.0 2.3	15 14	h h										2.0 1.7	14 15	s s			
	Full down	4.8 4.8	2 2	d1 d1	5.8 5.9	2 2	d1 d1							6.5 7.0	4 2	d1 d1	7.4 7.0	5 3	d1 d1										2.9 1.6	9 13	s s	6.0 5.8	3 3	d1 d1			
Bomb-sight door and bomb-lever doors removed	Full up							1.3 1.6	18 19	s s	1.5 2.0	24 20	s s										1.8 3.8	22 21	p p	1.8 1.8	24 26	s s									
	Half down				1.4 1.6	5 6	d1 d1	1.6 2.8	8 7	d1 d1				2.0 1.9	5 5	s s	5.8 2.4	4 6	d1 d1	2.5 2.3	14 13	s s										2.0 1.7	16 17	s s			
	Full down	4.6 4.3	5 2	d1 d1	4.1 6.0	4 5	d1 d1							6.0 5.8	6 6	d1 d1	7.0 7.5	2 3	d1 d1									7.1 5.3	4 4	d1 d1	6.5 6.0	5 7	d1 d1				
Bomb-sight door and bomb-lever doors and bomb-bay doors removed	Full up							4.0 3.8	6 5	d1 d1	4.5 4.5	6 6	d1 d1										5.2 4.6	8 7	d1 d1	6.5 7.0	11 12	s s									
	Half down				5.1 5.1	3 3	d1 d1	4.8 5.0	4 4	d1 d1				5.0 5.0	3 2	d1 d1	5.0 5.3	3 2	d1 d1	4.8 5.0	7 4	d1 d1										7.8 7.8	3 4	d1 d1			
	Full down	3.6 3.8	2 2	d1 d1	3.2 5.0	5 5	d1 d1							6.2 6.0	5 5	d1 d1	7.1 7.4	4 5	d1 d1								7.8 7.7	2 2	d1 d1	7.7 7.7	3 2	d1 d1					

(1) Column headings are explained as follows:

Max. - Maximum deceleration, given in multiples of the acceleration of gravity
Run - Length of run, given in multiples of the length of the airplane
Remarks - Notations under this heading have the following meaning:

d1 - dived, violently
h - ran smoothly
p - porpoised
s - skipped

TABLE II.- SUMMARY OF RESULTS OF CATAPULT DITCHING TESTS OF A 1/8-SIZE MODEL
OF THE SB2C-1 AIRPLANE

[All values are full scale; gross weight, 13,060 pounds]

Damage condition	Attitude of thrust line (deg)	Flaps	Air-speed (knots)	Calm		Along the waves crests			Across the waves crests		
				Wind range (knots)	¹ Remarks	Wind range (knots)	Wave height (in.)	¹ Remarks	Wind range (knots)	Wave height (in.)	¹ Remarks
Bomb-sight door removed	15	Full up	84.3	0 - 14	s	5 - 18	16 - 24	s,p,h	3 - 36	16 - 48	s,h, ² d ₁
		Full down	70.4		s,p,b		16 - 24	s,h,t		16 - 48	s,h
	8	Full up	112.9		p,h		8 - 16	s		8 - 16	s,p
		Full down	83.5		s, ³ d ₁		16 - 24	s		8 - 16	s,p
	2	Full down	104.5		t,s		16 - 24	s		8 - 16	s
	15	Full up	84.3		b		16	p,b		16 - 24	h, ² d ₁
		Full down	70.4		b,s		16 - 24	p		16 - 48	h, d ₂
Bomb-sight doors, bomb-lever doors, bomb lever doors removed	8	Full up	112.9	0 - 11	p	2 - 17	16 - 24	s,d ₂	4 - 40	16	s
		Full down	83.5		s, ³ d ₁		8	s,t		8 - 24	s,b
	2	Full down	104.5		t,s		16 - 24	s,t		8 - 24	s,h,t

¹Notations used are identified as follows:

- b - ran deeply
- d₁ - dived, violently
- d₂ - dived, slightly
- h - ran smoothly
- p - porpoised
- s - skipped
- t - turned sharply

²Dive caused by the tail of the model hitting the leeward side of a wave near the crest.

³One flap failed.

TABLE III.- SUMMARY OF THE RESULTS OF TANK DITCHING TESTS OF A 1/8-SIZE MODEL OF THE
SB2C-1 AIRPLANE WITHOUT THE TAIL-WHEEL UNIT ATTACHED

[All values are full scale; gross weight; 13,060 pounds]

Attitude of thrust line (deg)		15												8												2									
Speed	knots	60.8	69.5			78.2			86.8			78.2			86.8			95.6			104.3			112.9			95.6			104.3			112.9		
	mph	70	80			90			100			90			100			110			120			130			110			120			130		
Damage condition	(1)	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks				
	Flaps																																		
Bomb-sight door removed	Full up						1.2 1.4	17 18	h h	2.0 1.9	13 14	p p							3.8 2.4	19 21	p p	2.3 2.9	34 26	p p											
	Half down				3 3	d ₁ d ₁		4 3	d ₁ d ₁					4 4	d ₁ d ₁		2 3	d ₁ d ₁	8.0 8.0	1 1	d ₁ d ₁										5 5	d ₁ d ₁			
	Full down		1 2	d ₁ d ₁		2 2	d ₁ d ₁						8.0 7.7	4 4	d ₁ d ₁	8.0 7.9	4 4	d ₁ d ₁									2 2	d ₁ d ₁	1 2	d ₁ d ₁					
Bomb-sight door and bomb-lever doors removed	Full up						0.7 1.0	18 15	p p	5.9 5.1	18 14	p p									4.2 4.1	19 19	h h	3.0 2.8	26 25	s s									
	Half down				6.0 5.4	2 1	d ₁ d ₁	4.1 5.0	2 3	d ₁ d ₁			7.3	1 1	d ₁ d ₁	8.0 8.0	1 1	d ₁ d ₁	8.0 8.0	1 1	d ₁ d ₁									3 4	d ₁ d ₁				
	Full down	6.1 6.0	2 3	d ₁ d ₁		3 3	d ₁ d ₁						6.8 6.4	3 2	d ₁ d ₁	6.4 8.2	4 4	d ₁ d ₁								4 4	d ₁ d ₁	4 3	d ₁ d ₁						
Bomb-sight door, bomb- lever doors and bomb- bay doors removed	Full up						3.4 3.9	9 10	s s	3.9 4.0	12 9	s s									7.3 7.0	3 4	d ₁ d ₁	7.0 7.0	2 4	d ₁ d ₁									
	Half down					2 3	d ₁ d ₁		3 5	d ₁ d ₁			4.3 3	3 3	d ₁ d ₁	4.2	5 4	d ₁ d ₁	3.2	5 3	d ₁ d ₁								7.0	5 5	d ₁ d ₁				
	Full down	1.9 2.6	3 2	d ₁ d ₁	4.8 2.9	2 3	d ₁ d ₁						5 4	d ₁ d ₁		4 4	d ₁ d ₁									3 5	d ₁ d ₁	5 5	d ₁ d ₁						

(1) Column headings are explained as follows:

Max. - Maximum deceleration, given in multiples of the acceleration of gravity.

Run - Length of run, given in multiples of the length of the airplane.

Remarks - Notations under this heading have the following meaning:

d₁ - dived, violently

h - ran smoothly

p - porpoised

s - skipped

TABLE IV.-SUMMARY OF THE RESULTS OF DITCHING TESTS OF A 1/8-SIZE MODEL OF THE SB2C-1 AIRPLANE
AT TWO GROSS WEIGHTS, 11,090 POUNDS AND 15,704 POUNDS

[All values are full scale]

Attitude of thrust line (deg)			15												2																	
Gross weight (lb)	Speed	{ knots mph	69.5			78.2			86.8			95.6			86.8			95.6			104.3			112.9								
			80			90			100			110			100			110			120			130								
			(1)			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks								
Damage condition (2)			Flaps			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks			Max. Run Remarks					
11,090	1-R	Full up	7	p		5.8	7	p																								
	1-E	Full up	7	p		5.8	6	p																								
	2-R	Full down													8.0	1	d ₁	1	d ₁													
	2-E	Full down															2	d ₁	3	d ₁												
15,704	1-R	Full up							7.0	8	s	1.8	21	s																		
	2-E	Full down																														

(1) Column headings are explained as follows:

Max. - Maximum deceleration, given in multiples of acceleration of gravity.

Run - Length of run, given in multiples of the length of the airplane.

Remarks - Notations under this heading have the following meaning:

d₁ - dived, violently

d₂ - dived, slightly

p - porpoised

s - skipped

(2) Damage:

1-R - bomb-sight door removed, tail wheel retracted

1-E - bomb-sight door removed, tail wheel extended

2-R - bomb-sight door, bomb-lever door, bomb-bay doors removed, tail wheel retracted

2-E - bomb-sight door, bomb-lever door, bomb-bay doors removed, tail wheel extended

TABLE V.- SUMMARY OF THE RESULTS OF TANK TESTS OF A 1/8-SIZE MODEL OF THE SB2C-1 AIRPLANE
(TAIL-WHEEL UNIT ATTACHED) WITH THE REGULAR AND A MODIFIED ARRESTING HOOK

[All values are full scale; gross weight, 13,060 pounds]

Attitude of thrust line (deg)				15												8												2					
Speed	{ knots mph	60.8			69.5			78.2			86.8			78.2			86.8			104.3			112.9			95.6			104.3				
		70			80			90			100			90			100			120			130			100			120				
Damage condition	(1) Flaps	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks	Max.	Run	Remarks		
Bomb-bay doors, bomb-lever doors, bomb-sight doors removed	Regular arresting hook																																
	Full up							4.0 4.8	1 2	d ₁ d ₁	7.2 7.4	3 3	d ₁ d ₁							8.2 8.2	2 2	d ₁ d ₁	8.2 8.2	2 2	d ₁ d ₁								
	Full down	3.8 4.1	2 3	d ₁ d ₁	3.7	3 1	d ₁ d ₁							4.9 6.3	2 2	d ₁ d ₁	5.3 7.6	2 2	d ₁ d ₁														
	Hydrofoil arresting hook																																
	Full up							4 5	s s		8 8	s s								2 2	d ₁ d ₁		3 2	d ₁ d ₁									
	Full down		3 2	d ₁ d ₁		2 2	d ₁ d ₁							4 5	d ₁ d ₁		3 3	d ₁ d ₁								1 3	d ₁ d ₁	3 3	d ₁ d ₁				

(1) Column headings are explained as follows:

Max. - Maximum deceleration, given in multiples of the acceleration of gravity.

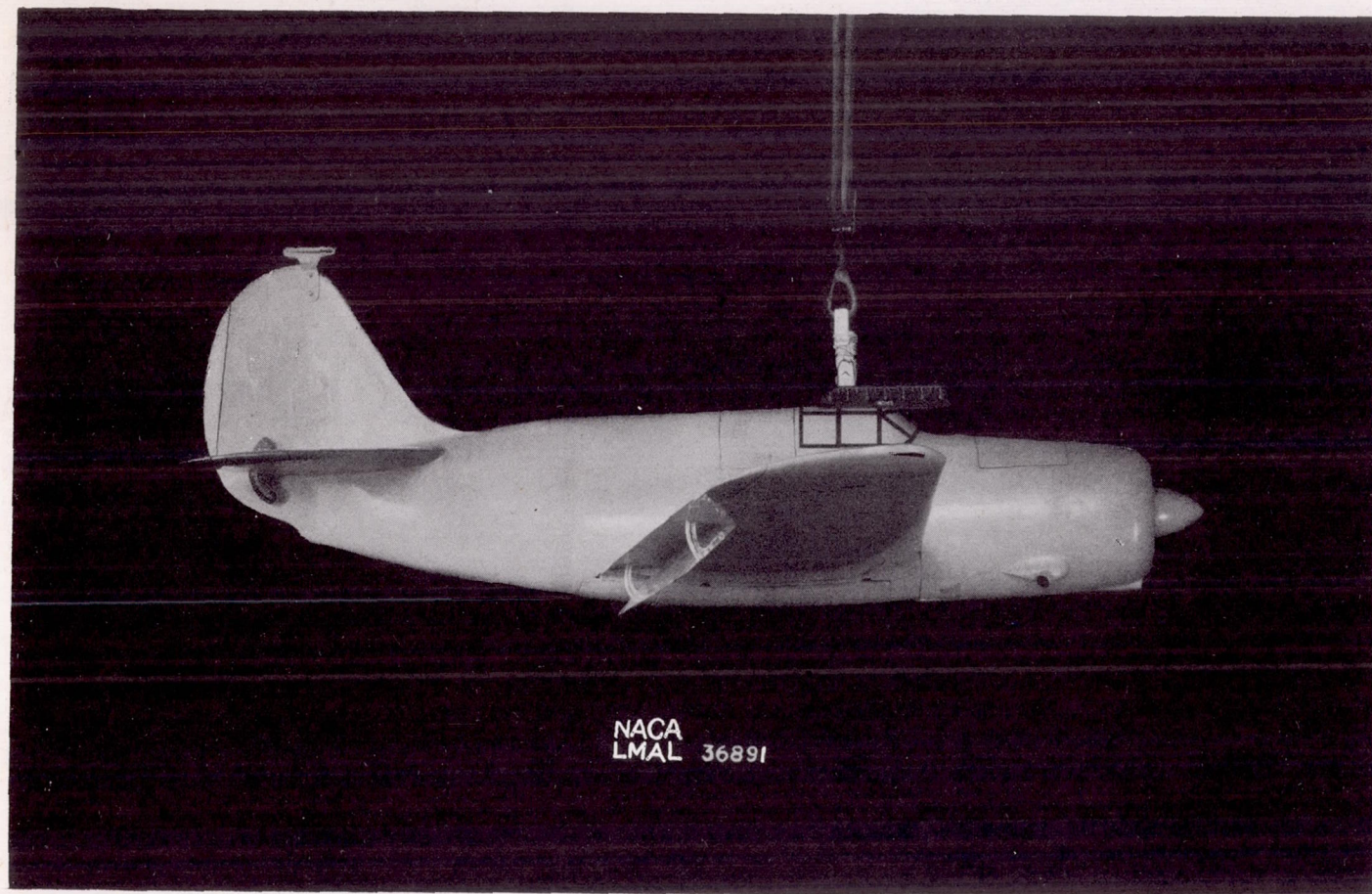
Run - Length of run, given in multiples of the length of the airplane.

Remarks - Notations under this heading have the following meaning:

d₁ - dived, violently

p - porpoised

s - skipped

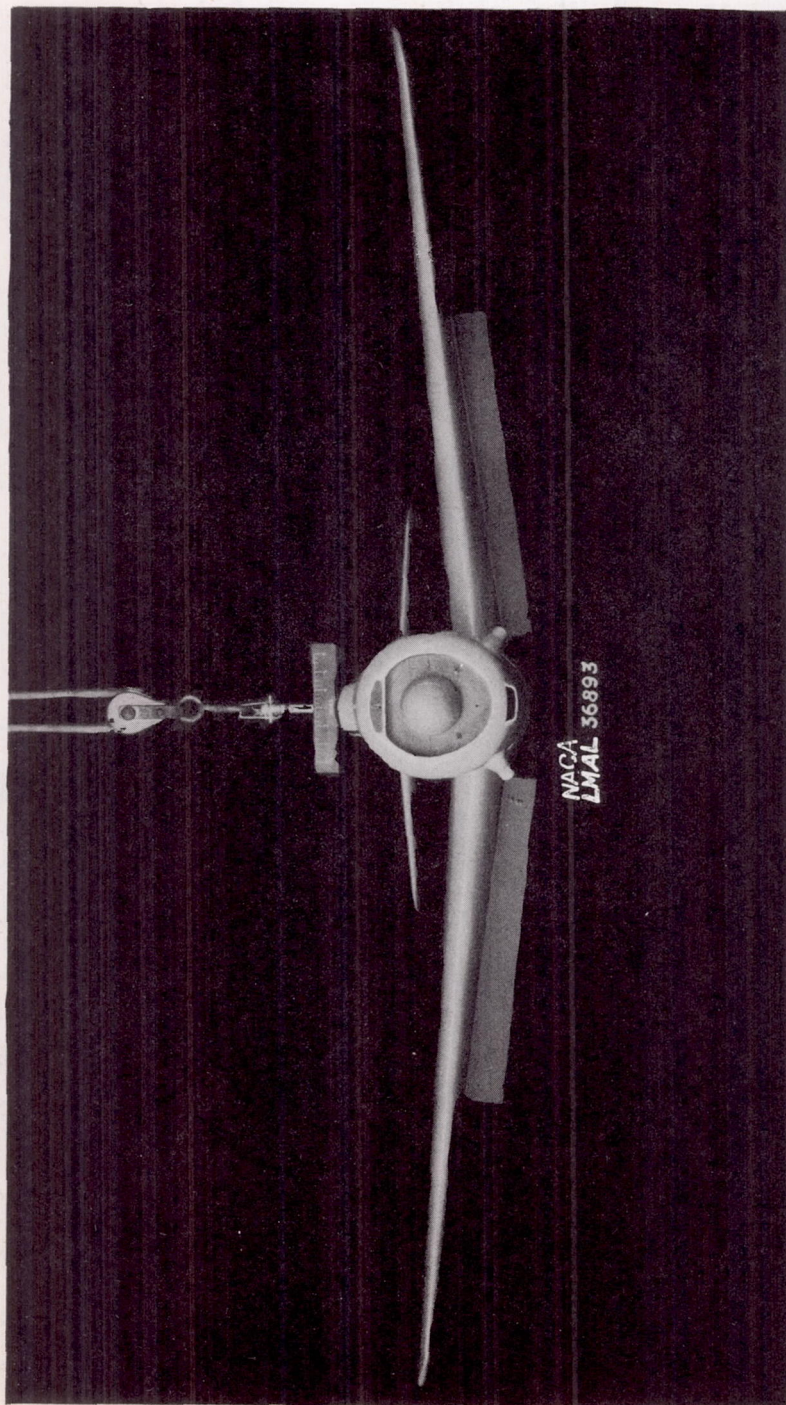


(a) Side view.

Figure 1.- Photograph showing a 1/8-size ditching model of the Navy SB2C-1 airplane.

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(b) Front view.
Figure 1.- Concluded.

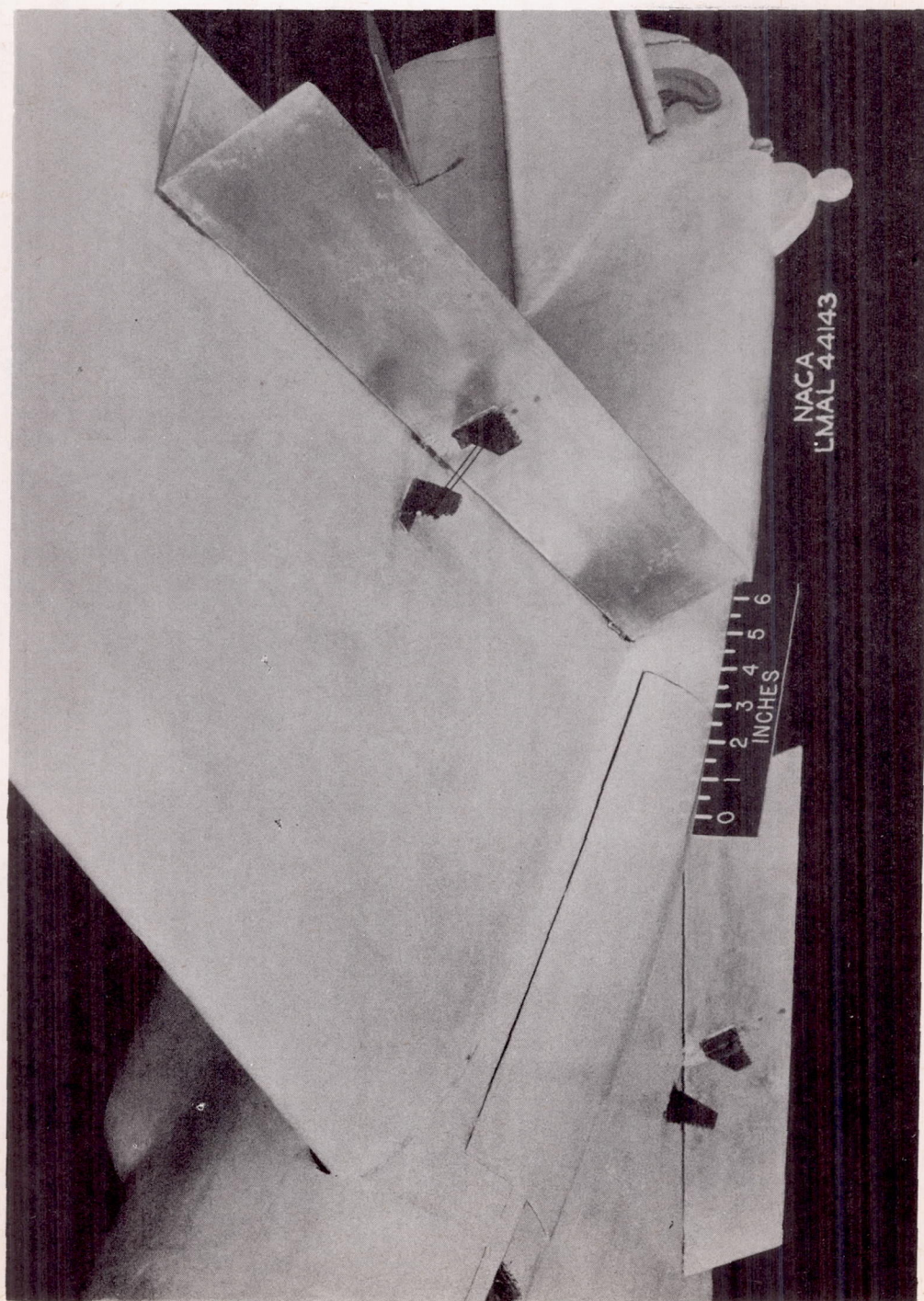


Figure 2.- Arrangement for tests with scale-strength flaps.

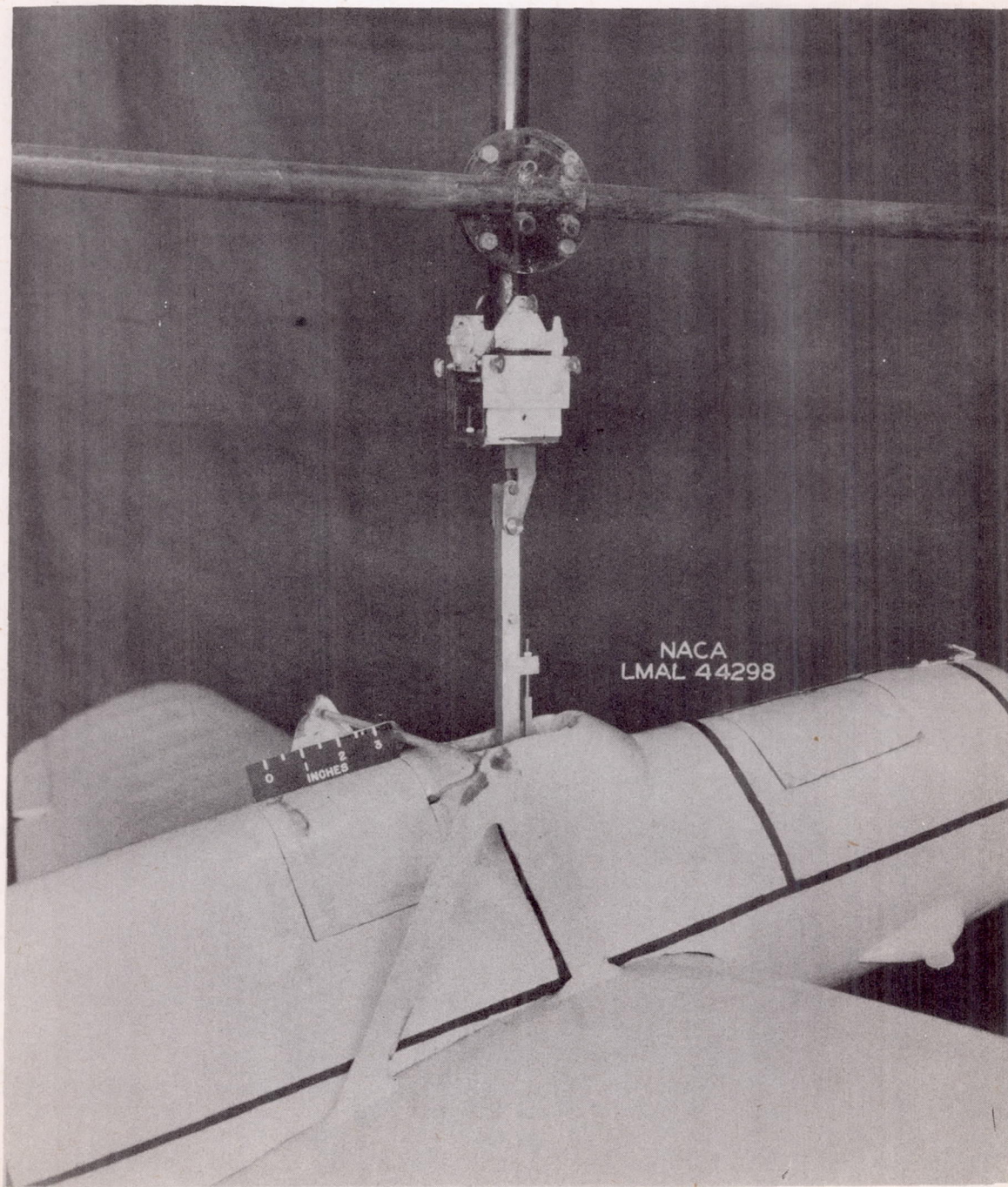


Figure 3.- Photograph of a ditching model attached to the aerodynamic gear that replaces the launching gear at the rear of the towing carriage.

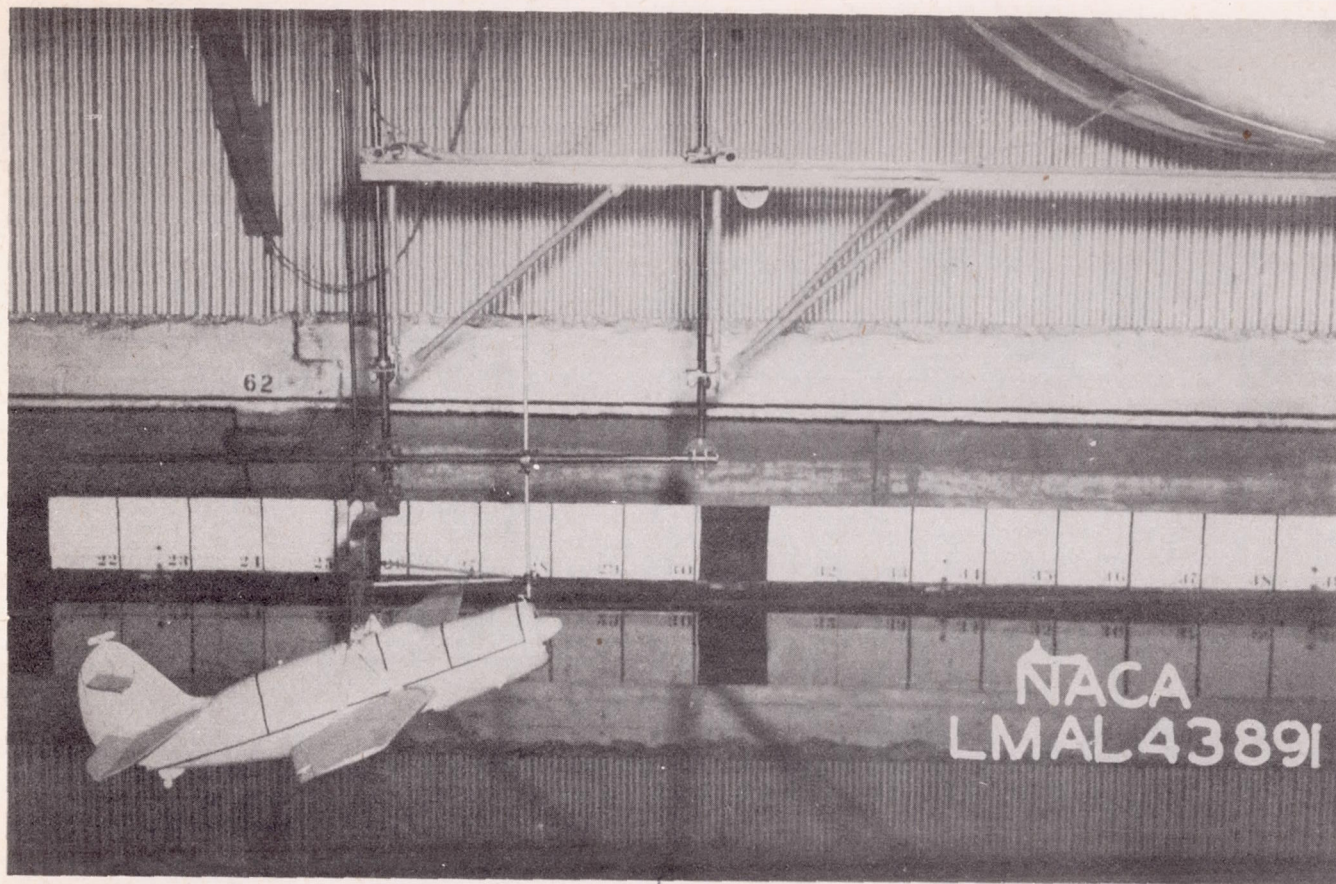


Figure 4.- Photograph of a ditching model attached to the launching gear at the rear of the towing carriage.

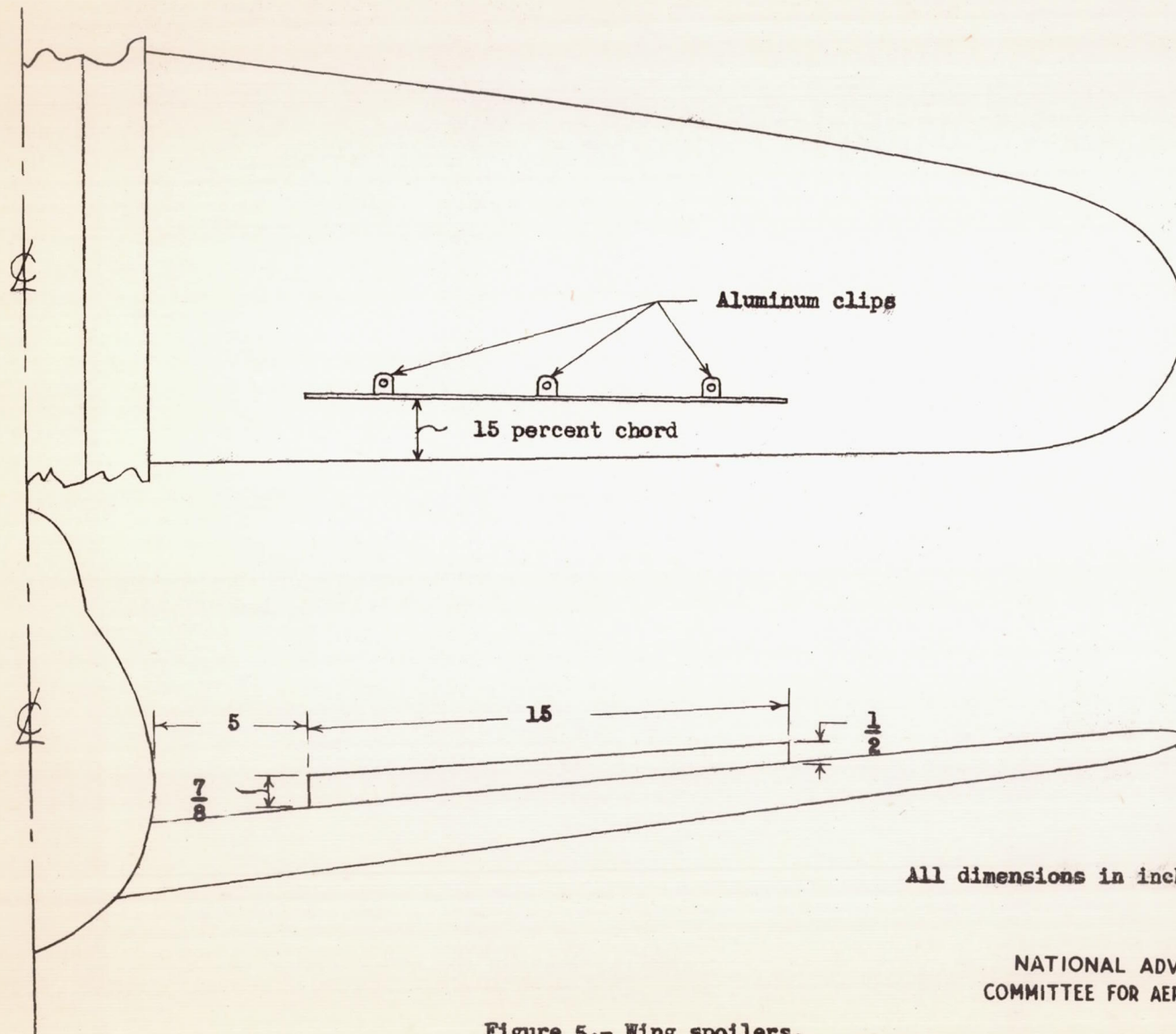
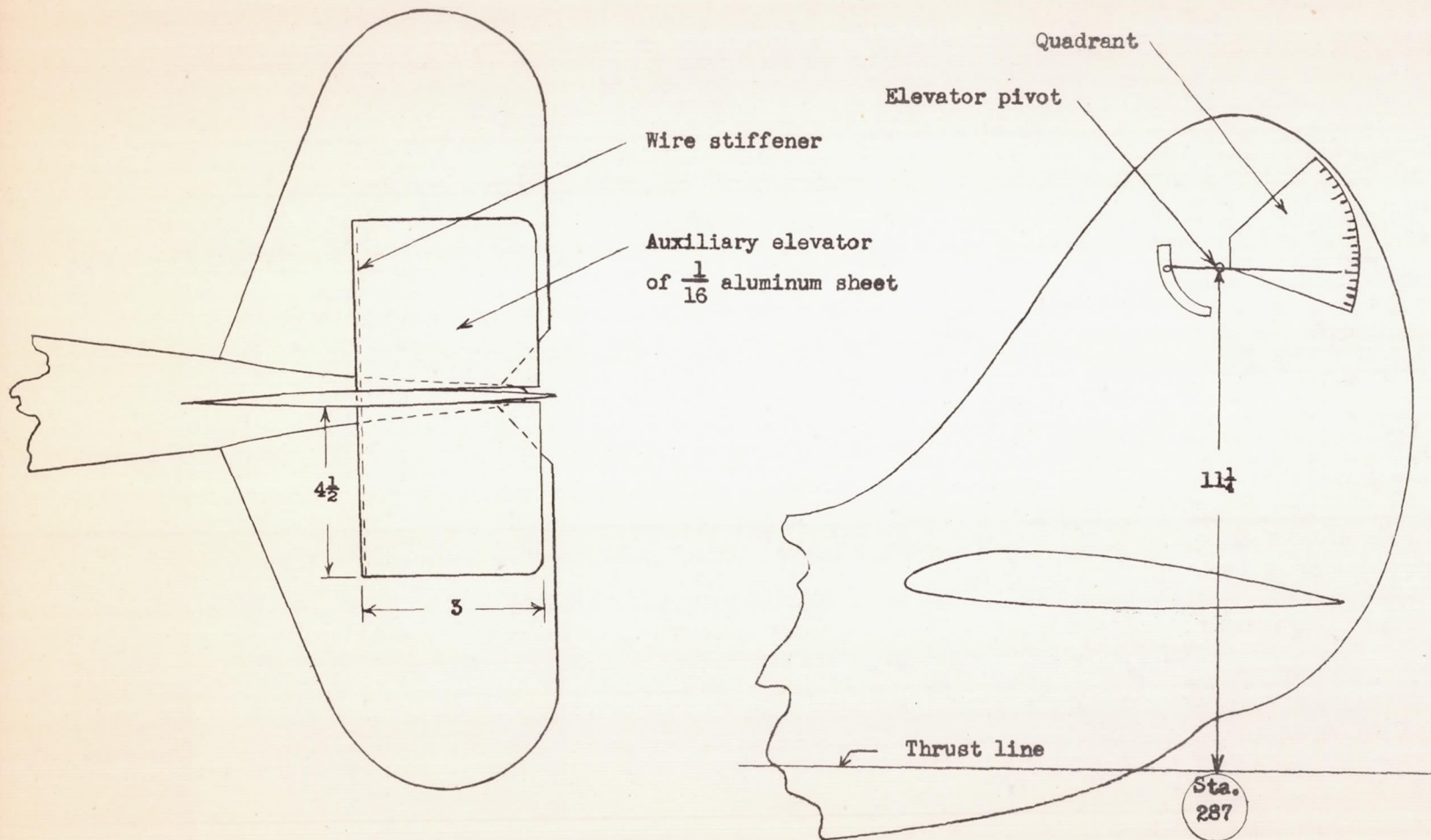


Figure 5.- Wing spoilers.

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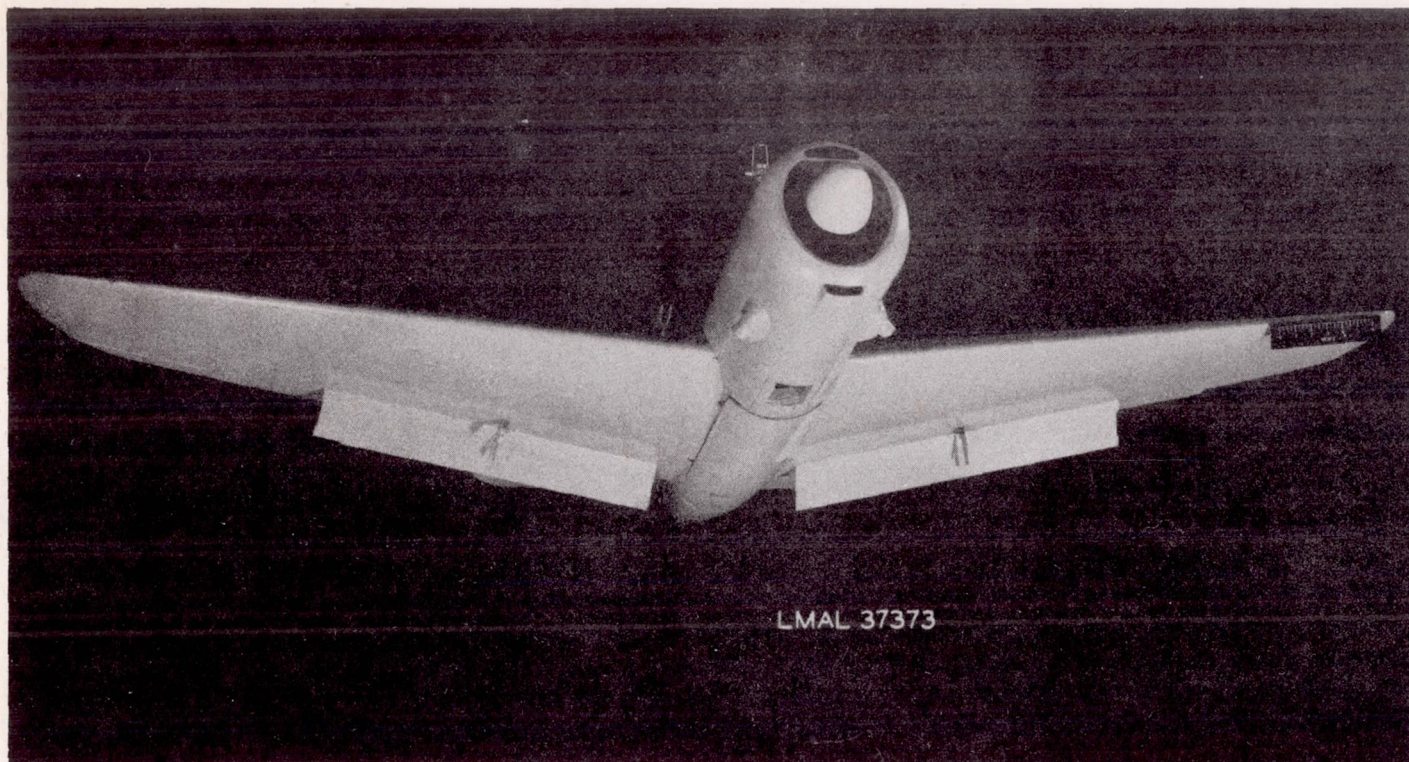


All dimensions in inches, model scale.

Figure 6.- Auxiliary elevator.

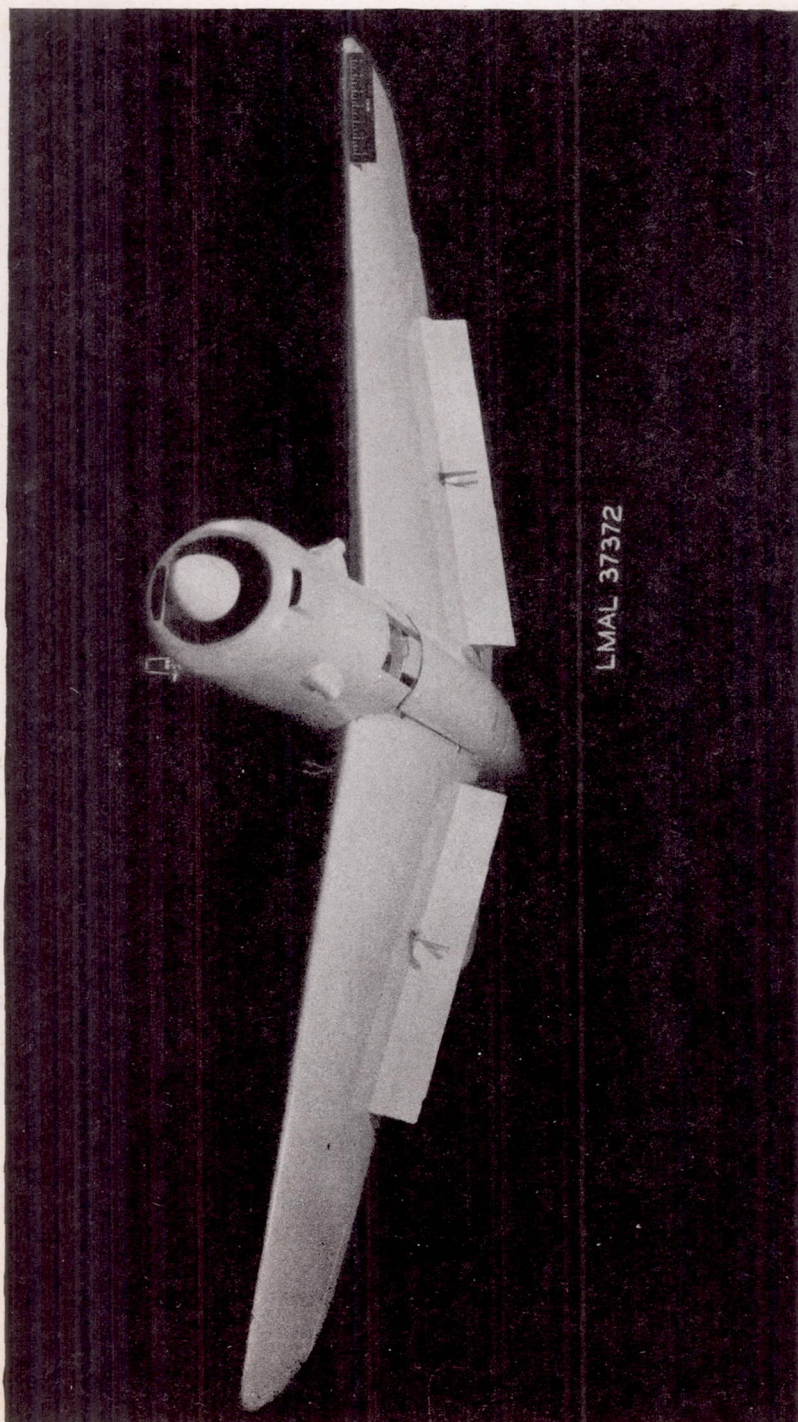
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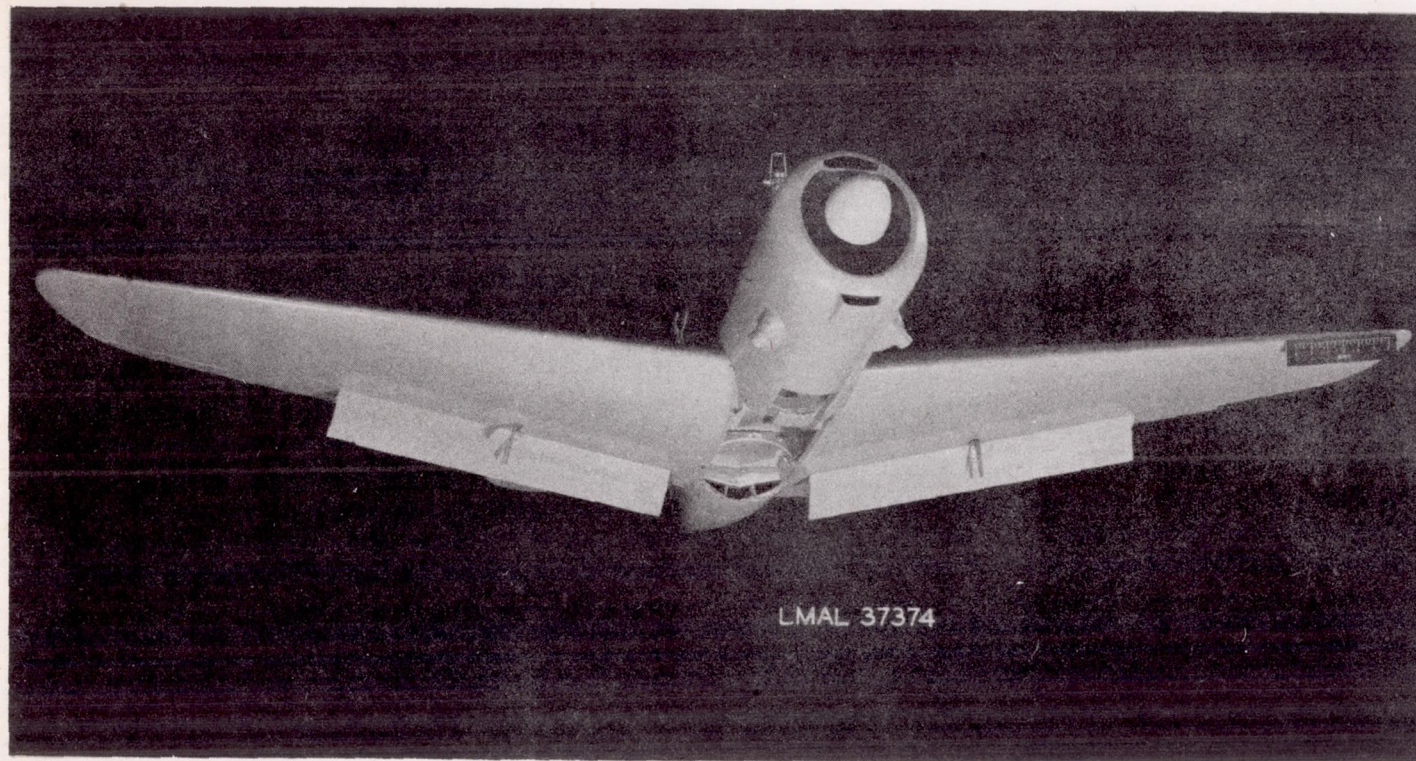
(a) Simulated damage of the bomb-sight doors.

Figure 7.- Photograph of the model showing the damage conditions used in the tests.



(b) Simulated damage of the bomb-sight doors
and bomb-lever doors.

Figure 7.- Continued.



(c) Simulated damage of the bomb-sight doors,
bomb-lever doors, and bomb-bay doors.

Figure 7.- Concluded.

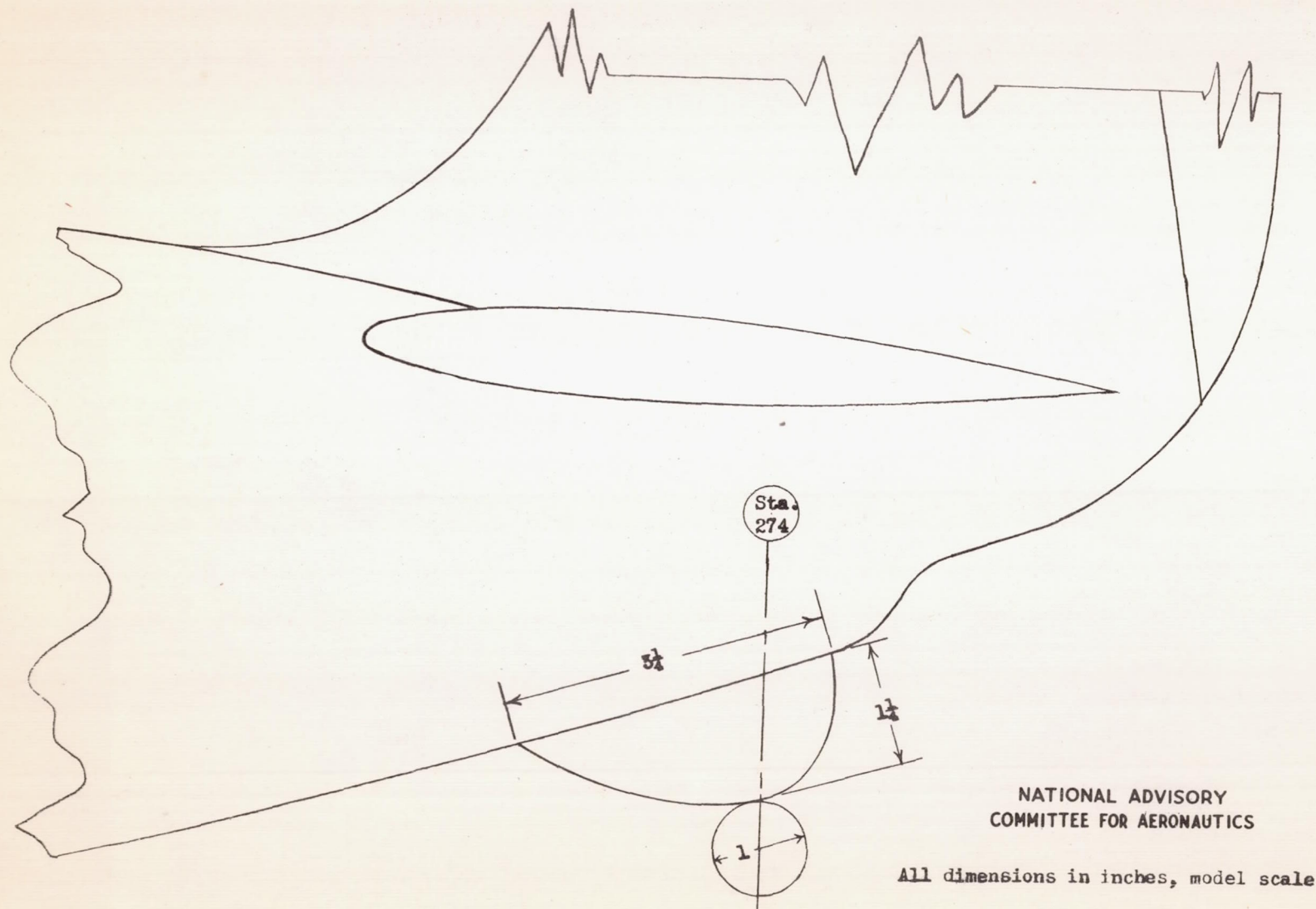
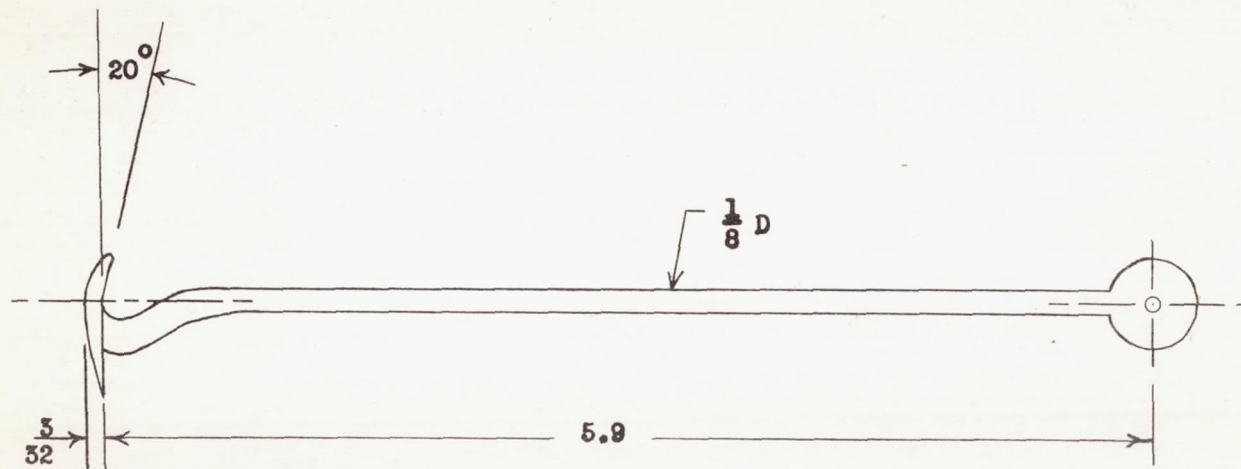
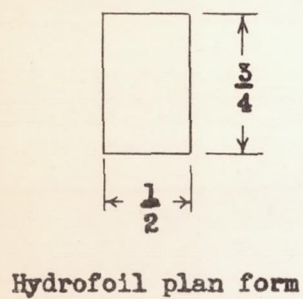


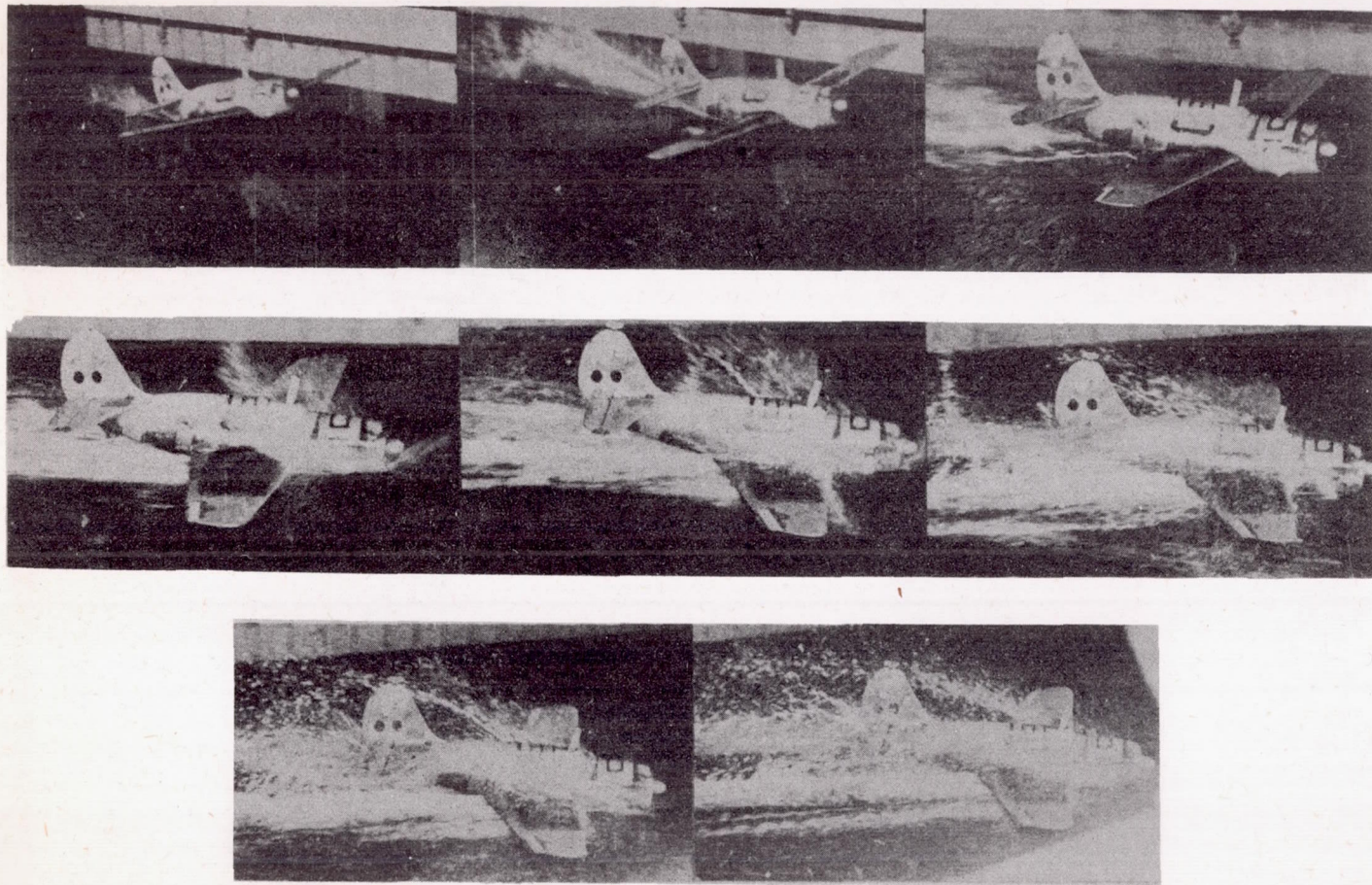
Figure 8.- Tail-wheel installation.



All dimensions in inches, model scale

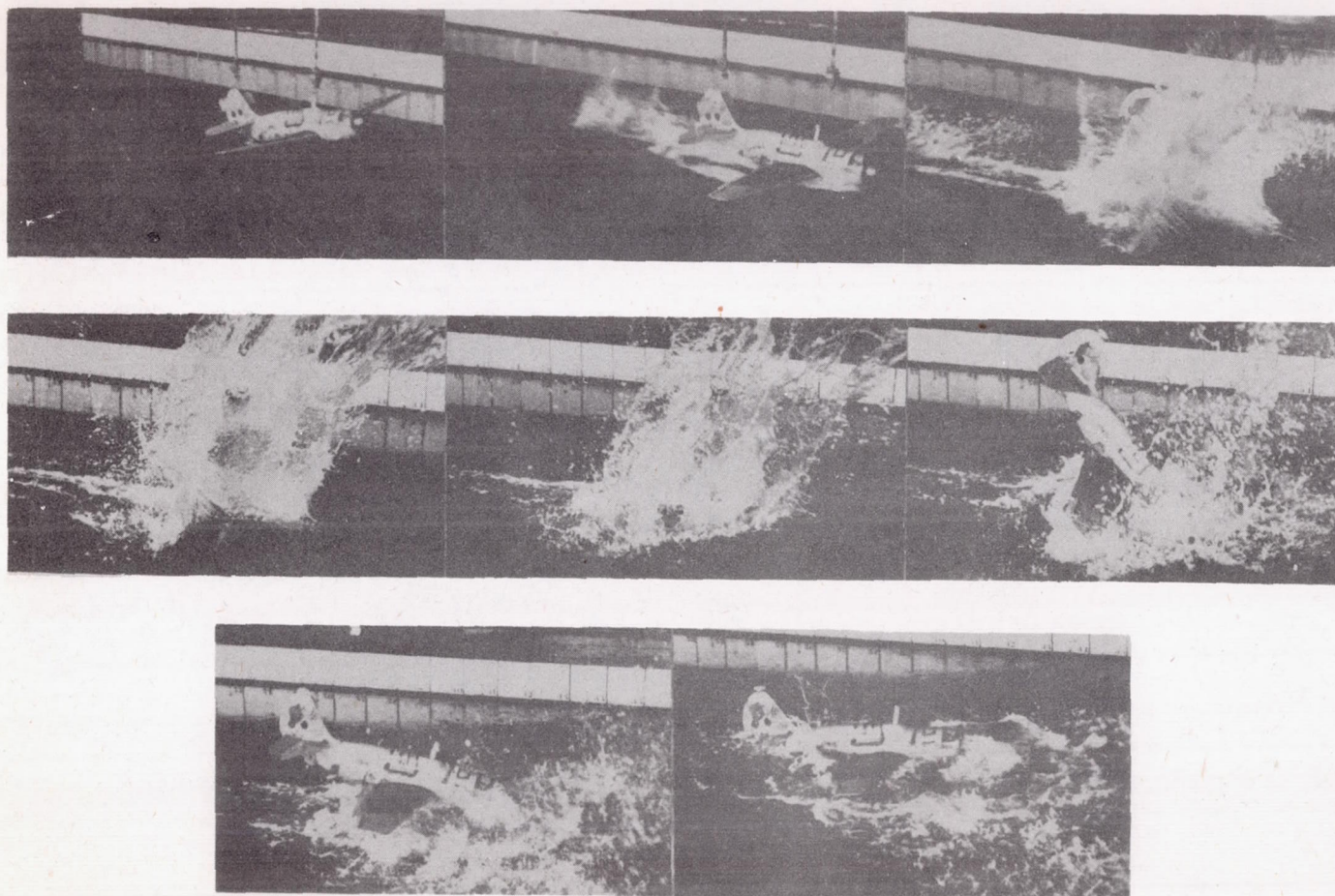
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Figure 9.- Modified arresting hook with hydrofoil.



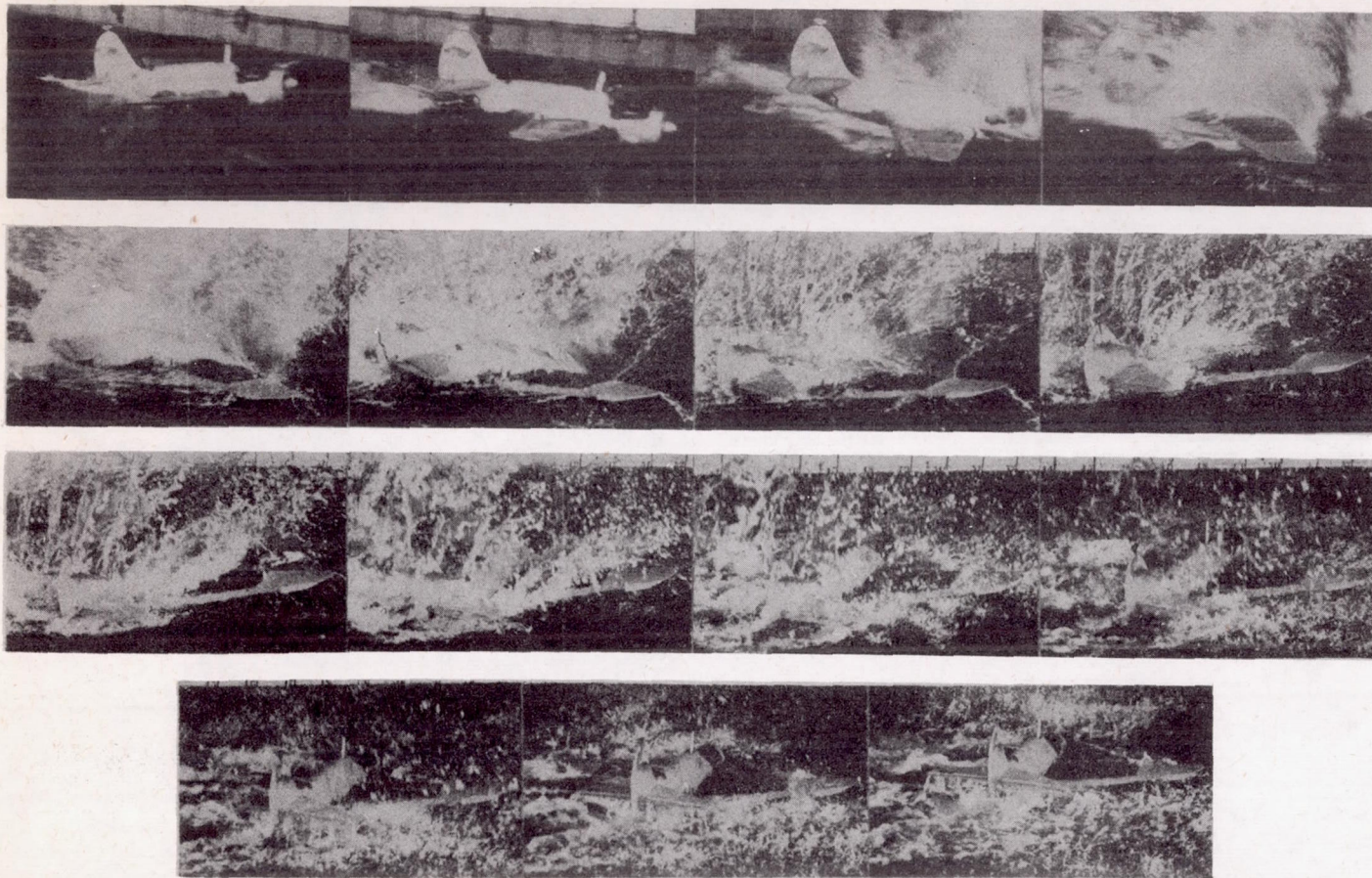
(a) Flaps full up.

Figure 10.- Photographs at 0.53-second intervals, full-scale, of ditchings of a 1/8-size model of the SB2C-1 airplane. Attitude of thrust line, 15° at contact; bomb-sight doors removed; speed 78.2 knots, full-scale.



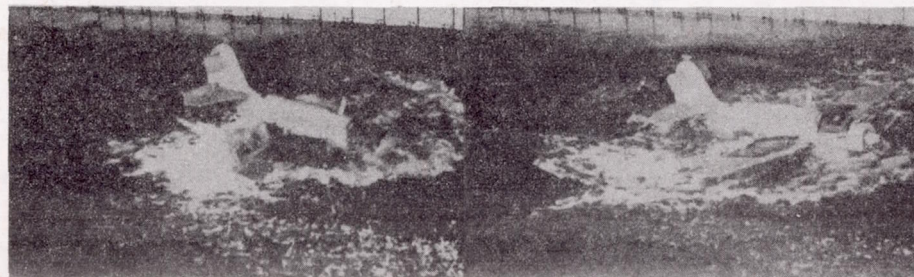
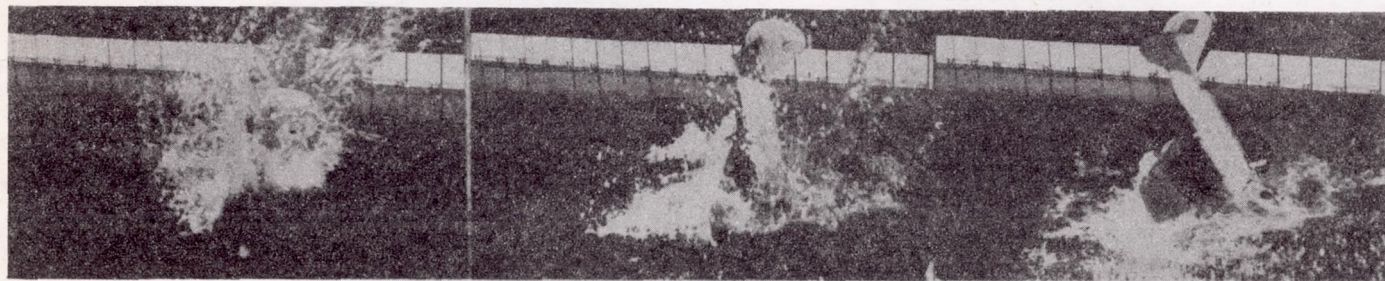
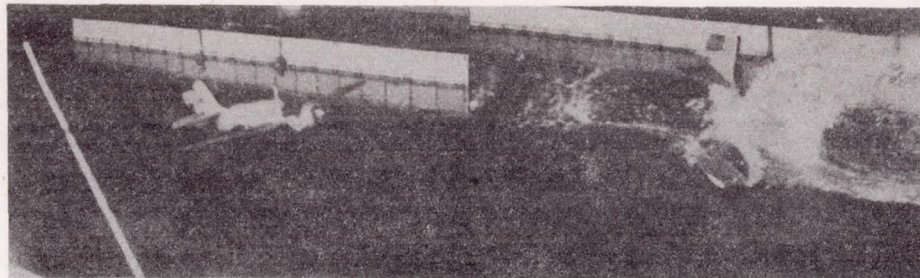
(b) Flaps full down at scale strength.

Figure 10.- Concluded.



(a) Flaps full up; time interval between photographs, 0.354 second, full-scale.

Figure 11.- Photographs of ditchings of a 1/8-size model of the SB2C-1 airplane. Attitude of thrust line, 15° at contact; bomb-sight doors; bomb-lever doors; and bomb-bay doors removed; speed 78.2 knots, full-scale.



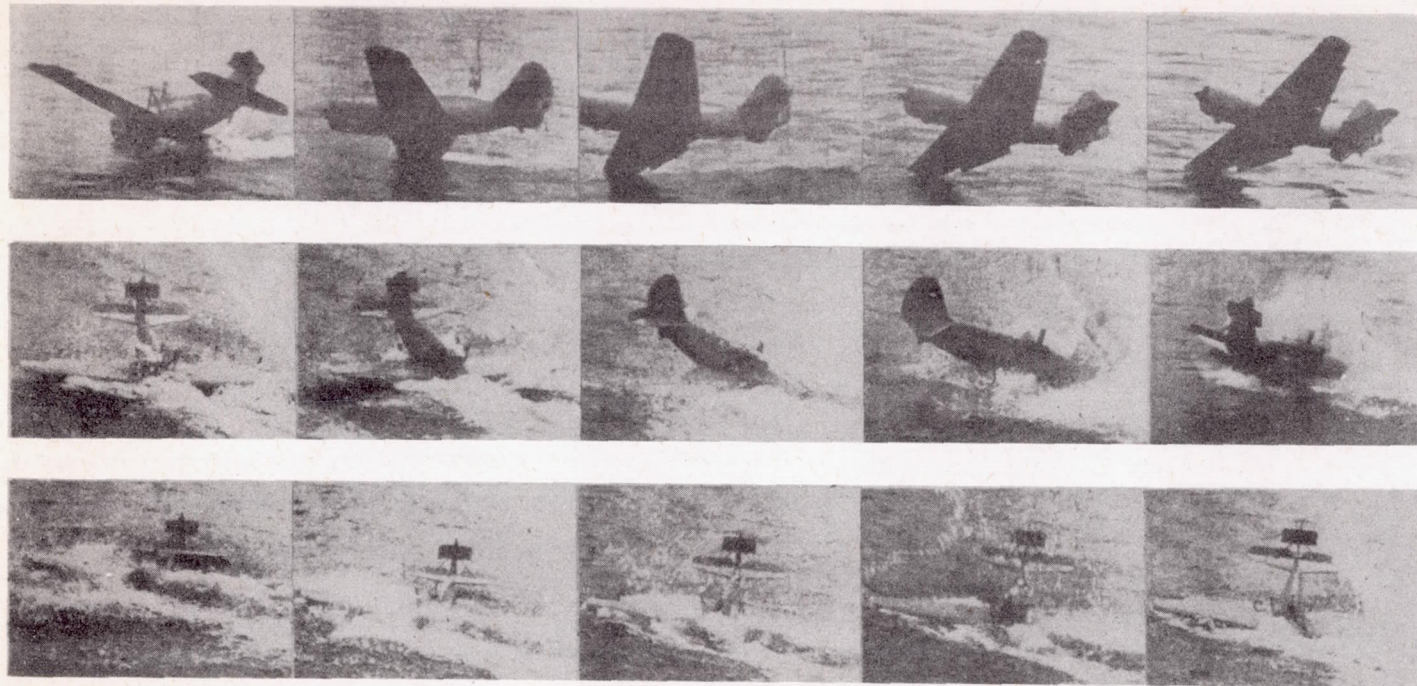
(b) Flaps full down at scale strength; time interval between photographs, 1.061 seconds, full-scale.

Figure 11.- Concluded.

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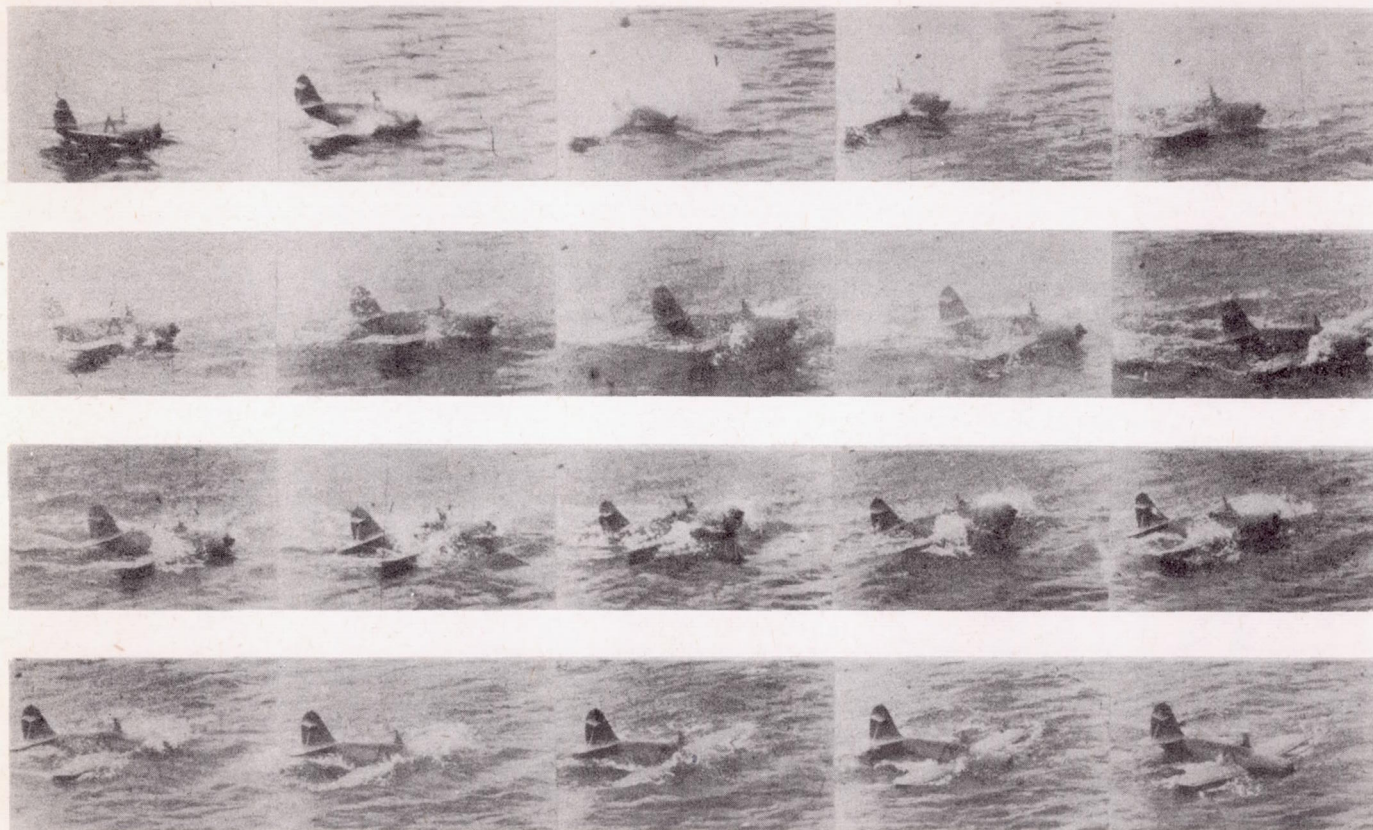
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(a) Wing-low landings across the waves; wave height approximately 2 feet, full-scale; time interval between photographs, 0.212 second, full-scale.

Figure 12.- Photographs of ditchings of a 1/8-size model of the SB2C-1 airplane. Attitude of thrust line, 15° at contact; flaps full down scale strength; bomb-bay doors, bomb-lever doors, and bomb-sight doors removed; speed 70.4 knots, full-scale.

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(b) Landing across the wave crests; wave height approximately 4 feet, full-scale; time interval between photographs, 0.189 second, full-scale.

Figure 12.- Concluded.

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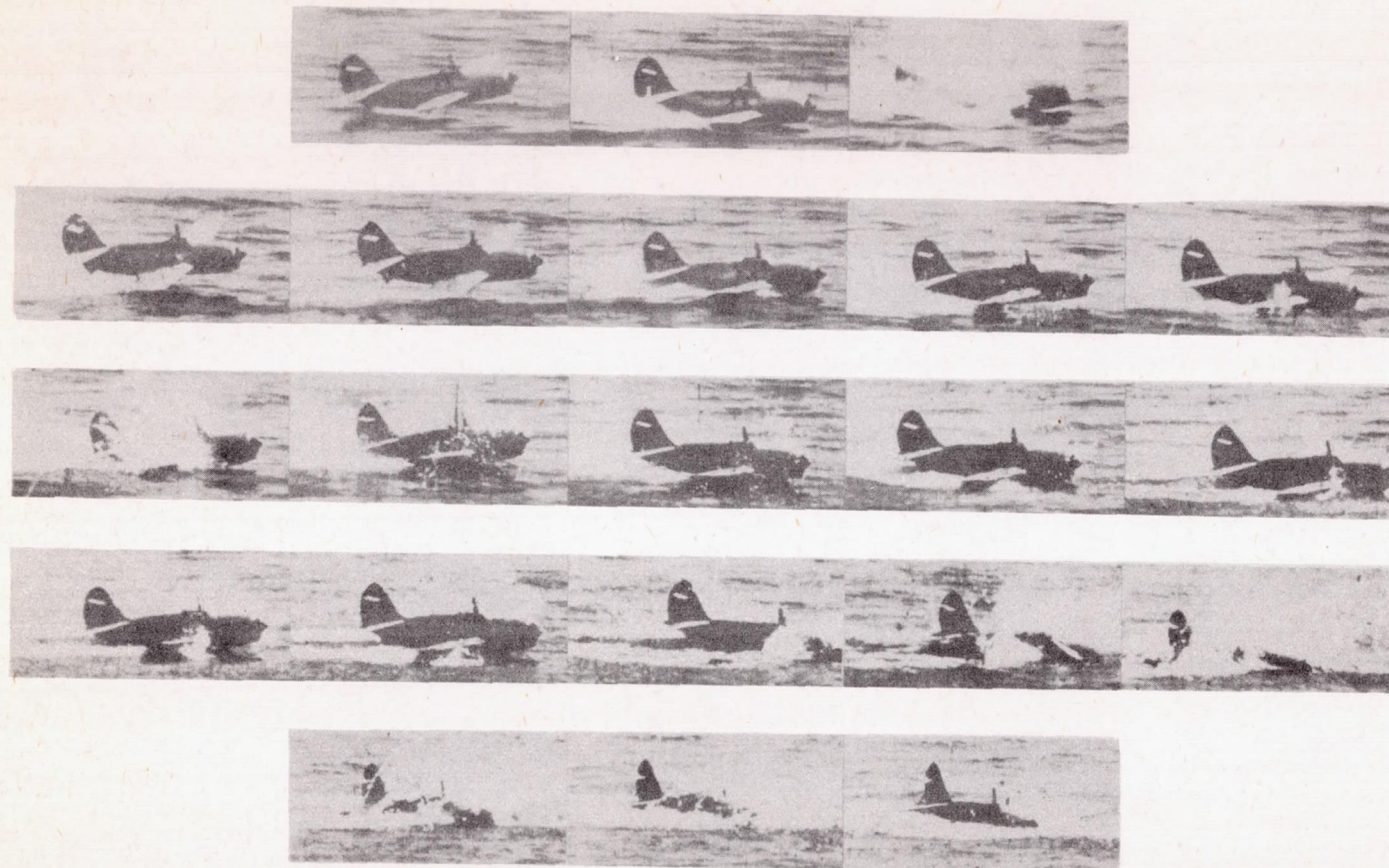
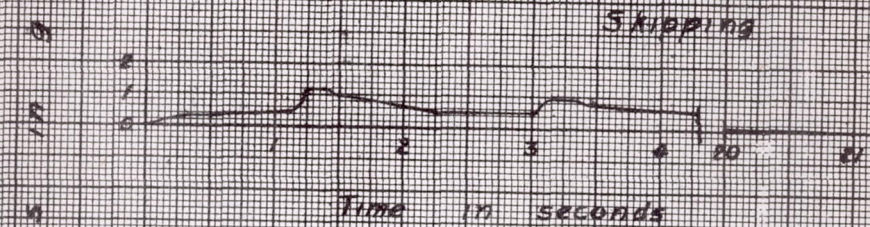
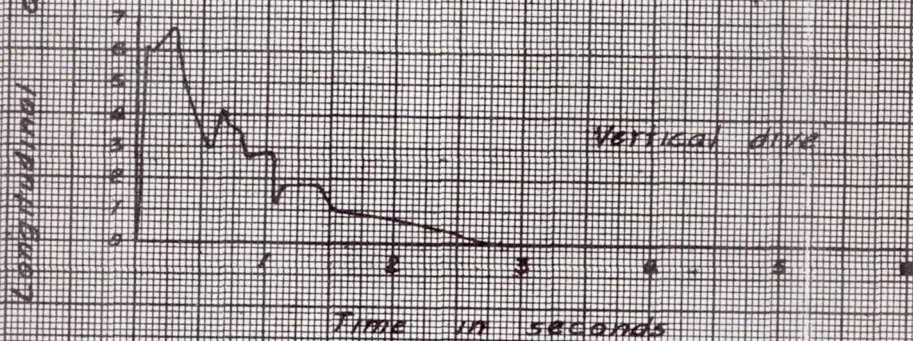


Figure 13.- Photographs at 0.212-second intervals, full-scale, of a ditching of a 1/8-size model of the SB2C-1 landing along the wave crests. Attitude of thrust line, 15° at contact; flaps full up; bomb-sight door removed; speed 84.3 knots, full-scale; wave height approximately 2 feet, full-scale.



(a) Attitude 15° Speed 70.2 knots Flaps 0°

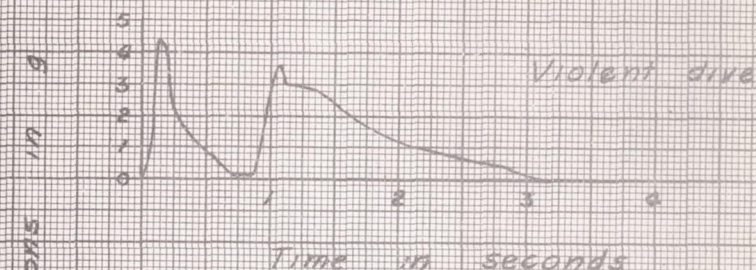


(b) Attitude 15° Speed 68.5 knots Flaps 60°

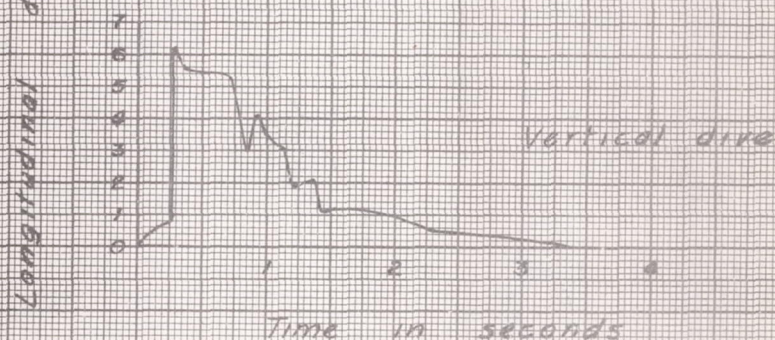
All values are full-scale

Figure 1A.- Time histories of longitudinal decelerations from ditching tests of a 1/10-size model of a Navy SB2C-1 airplane at 13,060 lbs. gross weight. Tests in calm water with simulated damage of bomb-sight doors.

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(a.) Attitude 15° Speed 78.2 knots Flaps 0°



(b.) Attitude 15° Speed 69.5 knots Flaps 60°

All values are full-scale.

Figure 15- Time histories of longitudinal decelerations from ditching tests of a $1/8$ -size model of a Navy SB2C-1 airplane at 13,060 lbs. gross weight. Tests in calm water with simulated damage of bomb-sight doors, bomb-lexer doors and bomb-bay doors.

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