HYDRODYNAMICS LABORATORY
OPERATING UNDER U.S. NAVY CONTRACT NORD 9612
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA
Visit of the
COMMITEE ON INTERSTATE AND FOREIGN COMMERCE
of the
UNITED STATES HOUSE OF REPRESENTATIVES
April 10, 1947

Charles A. Wolverton, New Jersey, Chairman

Lindley Beckworth, Texas
Marion T. Bennett, Missouri
Virgil Chapman, Kentucky
James I. Dolliver, Iowa
Harris Ellsworth, Oregon
Robert Hale, Maine
Richard F. Harless, Arizona
Oren Harris, Arkansas
John Heselton, Massachusetts
Carl Hinshaw, California
Evan Howell, Illinois
Clarence F. Lea, California
Joseph P. O'Hara, Minnesota
Dwight L. Rogers, Florida
Hugh B. Scott, Jr., Pennsylvania
MAJOR APPARATUS OF THE LABORATORY

I. The High Speed Water Tunnel

Perspective Drawing of Present High Speed Water Tunnel

Used For: Determination of cavitation characteristics; coefficients of drag, cross force, lift, and moment; either with or without cavitation; and pressure distribution, all in connection with projectiles.

Tests Give: Cavitation influence, probable performance of projectile, proper location for hydrostatic control openings, opportunities for specific design improvement, new facts applicable to general design.

Improved Tunnel: Construction is well advanced on improvements for this tunnel which will give better and extended performance. Principal improvements are increased velocities and lower pressures for cavitation studies.

Illustrative Model: THE 12.75-INCH ANTI-SUBMARINE ROCKET, the original design and two views with modified noses.

The new noses recommended by this Laboratory give materially increased terminal velocities and a choice as to other characteristics. This is typical of a service this Laboratory can give.
MARK 13-1 TORPEDO

This shroud ring tail was designed here and resulted in improved control and entrance performance.

MARK 25 TORPEDO

This Laboratory made contributions to the design and studies of exhaust arrangements.

7.2-INCH ANTISUBMARINE ROCKET

Two of eight models tested for comparative performance.

500 LB. T 16 S. P. BOMB with Air- and Water-flight Afterbodies.

Performance in air can be determined in Tunnel if air velocities are appreciably below sonic.

The Full, Clear, Cavitation Bubble.
Top (right) and Profile (left) Views of Cavitation Development on the Mk 53 Bomb.

Such views are related to the cavitation characteristics of a specific projectile as contrasted with those relating to the nature of cavitation itself.
(A) $K = 1.93$
$\psi = 0^\circ$

(B) $K = 1.29$
$\psi = 0^\circ$

(C) $K = 0.93$
$\psi = 0^\circ$

(D) $K = 2.04$
$\psi = 5^\circ$

(E) $K = 1.63$
$\psi = 5^\circ$

(F) $K = 1.31$
$\psi = 5^\circ$

(G) $K = 1.07$
$\psi = 5^\circ$

(H) $K = 0.86$
$\psi = 5^\circ$

CAVITATION PHOTOGRAPHS
High Speed Photographs of Cavitation Phenomena

Such pictures taken at 20,000 frames per second or higher relate to the inception, growth, decline, extinction, and subsequent cycles in the life of an individual cavitation bubble. This is part of an attack on the problem of the fundamental nature of cavitation itself. The nature of this problem requires still higher speeds for clarification. They have been taken at 30,000 per second and still higher rates are necessary.
II. The Controlled Atmosphere Launching Tank

Two Perspective Drawings of Controlled Atmosphere Launching Tank.

Used For: Study of the special problems of water entry. This is a relatively new field of investigation with many important problems. This apparatus has reached the stage of experimental operation.
CONTROLLED ATMOSPHERE LAUNCHING TANK
HYDRODYNAMICS LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
Enlarged Photograph of Trajectory in Launching Tank

Overlapping camera fields will permit the accurate reconstruction of the entire trajectory and action of the model at each point. This tank is the only one existent in which the air pressures are controlled in order to simulate full-scale conditions.

III. The Free Surface Water Tunnel

Perspective Drawing of the Free Surface Water Tunnel

Used For: Measurement of the hydrodynamic forces on models of bodies which move on the surface or with shallow submergence. This piece of apparatus extends the range of problems which may be studied in this Laboratory. It is nearing completion at the present time.
FREE SURFACE WATER TUNNEL
HYDRODYNAMICS LABORATORY
California Institute of Technology
IV. The Polarized Light Flume

Photograph of Apparatus

Used For: Visual study of flow patterns. Light passing through polaroid screens and the water which contains a dilute suspension of Bentonite, permits the observation of actual flow patterns in color. This is of varied usefulness, as in the determination of the most satisfactory angle for a shroud ring.

An Ordinary Photograph which "Stops" the Flow, Shows Only Turbulence

An Example of How the Observed Flow Pattern is Recorded and Reported

Such photographs have been superceded by complete diagrams showing the model only in outline.
POLARIZED LIGHT FLUME

FLOW PATTERN AS OBSERVED WITH POLARIZED LIGHT

FLOW DIAGRAM AS CONSTRUCTED FROM OBSERVATIONS IN POLARIZED LIGHT FLUME
Looking Ahead

The completion of current construction will enable this Laboratory to extend greatly the range of information it can supply with regard to specific projectiles. Such tests and specific design improvement are not the most valuable service which it can render. The vast mass of specific data already obtained is a rich mine, now being worked, to extract new facts applicable to general projectile design. Such information should shorten materially the time between first design and eventual production. In addition to data already obtained and now being analyzed, the new tools, herein described briefly, can be powerful factors in the solution of old and new basic problems in projectile design and performance.