

Section III

# THE INTERNATIONAL HYDROGRAPHIC REVIEW

Vol. XXXIV

N° 1



(N° 61 OF THE SERIES)

PUBLISHED BY

THE

**INTERNATIONAL HYDROGRAPHIC BUREAU**  
**Quai des Etats-Unis - Monte-Carlo**

**MONACO**  
PRINCIPALITY



**MAY 1957**

IMPRIMERIE MEYERBEER  
21, RUE MEYERBEER  
NICE

# THE ANALYSIS AND PREDICTION OF TIDES IN SHALLOW WATER

by A. T. DOODSON, C.B.E., D.Sc., F.R.S., Hon. F.R.S.E.,  
Liverpool Observatory and Tidal Institute

(Extract from *International Hydrographic Review*, May 1957).

## ERRATUM

Page 86, paragraph 2, 12th line, instead of  $\mu$  should read  $u$ .

— 23rd line should read:

Here  $b_1$  is the cotangent of the angle of inclination...

Page 87, 13th line should read:

...with amplitude proportional to  $M^3$

Page 89, 20th line, formula should read:

$$R = (1 + 2r \cos \theta + r^2)^{\frac{1}{2}}$$

Page 90, paragraph 7, formulae (10) should read:

$$\sigma_0 t_0 = \varepsilon_0 + m \pi, \quad \sigma_0 t = \varepsilon_0 + m \pi + \eta \quad (10)$$

— last formulae (11), suffixes should be aligned:

$$\sigma_0 p_1 = \Sigma \sigma Y \cos \theta, \quad \sigma_0 q_1 = \Sigma \sigma Y \sin \theta$$

Page 91, formulae (13) should read:

$$\tan \eta = -\frac{q_1}{1+p_1}, \quad \frac{\zeta}{Z_0 \cos m \pi} = (1+p) \cos \eta - q \cos \eta \quad (13)$$

— formulae (14), raise suffix 1 for:

$$\frac{1}{2} q_1^2 \quad \text{and} \quad \frac{1}{2} p q_1^2$$

delete suffix 1 for:

$$p_1 q_1^2$$

— formulae (15), close up to line:

$$\left. \begin{aligned} \varphi &= \frac{\sigma - \sigma_0}{\sigma_0} m \pi - \left( \varepsilon - \frac{\sigma}{\sigma_0} \varepsilon_0 \right) \\ \text{with } \theta &= \varphi + \frac{\sigma - \sigma_0}{\sigma_0} \eta = \varphi + \xi, \text{ say} \end{aligned} \right\} \quad (15)$$

— formulae (17), close up to line:

$$\dots \Sigma \left( \frac{\sigma}{\sigma_0} \right)^n \dots \quad \Sigma \left( \frac{\sigma}{\sigma_0} \right)^n \dots$$

— 6th line from bottom should read:

Substituting into (14) ...

Page 92, last line should read:

... which makes for cheaper

Page 93, 12th line from bottom, letters between brackets should read in italics.

Page 94, paragraph 10, 24th and 25th lines should read:

Jan. 5, Feb. 4, (Mar. 5), Apr. 4, (May 3), Jun. 2, (Jul. 1), Jul. 31, (Aug. 29),  
Sep. 28, (Oct. 27), Nov. 26.

Page 96, 12th line, reduce size of figure 1 to read:

$s_{11}, s_{1a}, s_{a1}, s_{aa}$

Page 99, suppress the bar at end of page.

Page 101, formula 6th line from bottom should read:

$$R_o \cos \chi_o + \frac{l}{N+1} R' \cos \chi', \quad R_o \sin \chi_o + \frac{l}{N+1} R' \sin \chi'$$

---

INTERNATIONAL HYDROGRAPHIC REVIEW, Vol. XXXIV, N° 1  
REVUE HYDROGRAPHIQUE INTERNATIONALE, Vol. XXXIV, N° 1

---

**Received the above Publication.**

*Reçu la publication ci-dessus.*

Name } \_\_\_\_\_  
Nom } \_\_\_\_\_

Address } \_\_\_\_\_  
(or office stamp) } \_\_\_\_\_  
Adresse } \_\_\_\_\_  
(ou cachet du Bureau) } \_\_\_\_\_

Date \_\_\_\_\_

No. of copies	}	_____	{ English text.
Nombre d'exemplaires		_____	{ <i>Texte anglais.</i>
	}	_____	{ French text.
		_____	{ <i>Texte français.</i>

**N. B. — Only one receipt should be completed and returned to the International Hydrographic Bureau.**

**N.B. — *Un seul reçu doit être complété et retourné au Bureau Hydrographique International.***

**IMPRIMÉ**

**PRINTED MATTER**

Timbre

Stamp

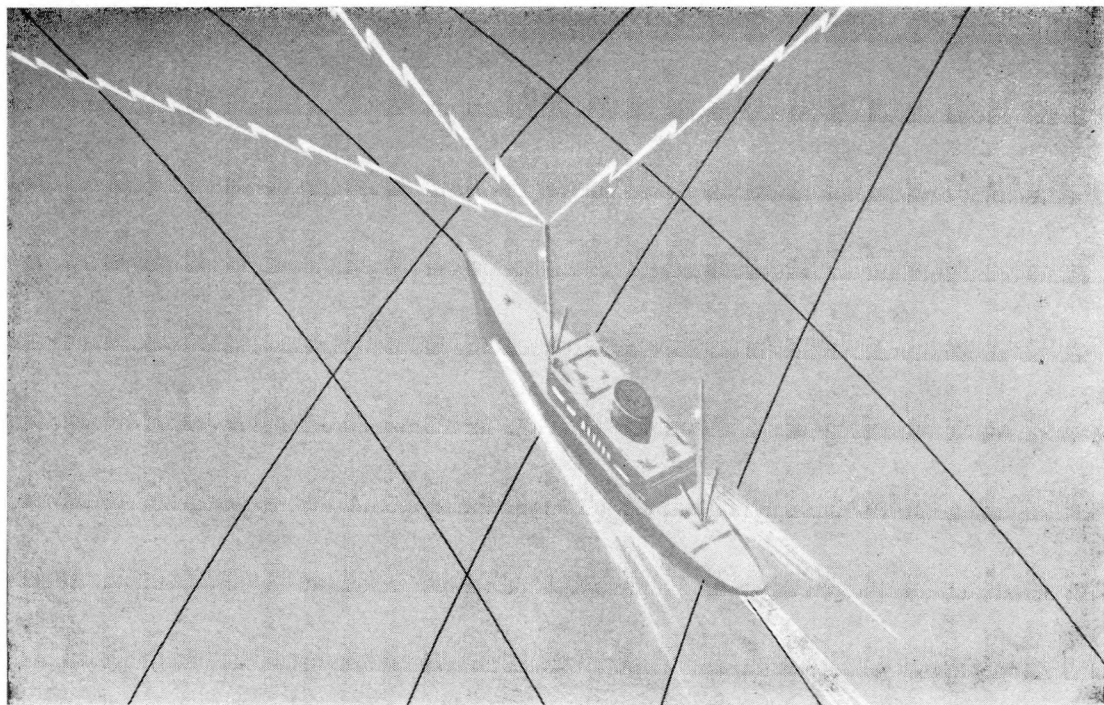
**BUREAU HYDROGRAPHIQUE INTERNATIONAL**

Quai des Etats-Unis

**MONTE - CARLO**

**Principauté de MONACO**  
(Europe)





# RADIO AIDS

## TO MARITIME NAVIGATION AND HYDROGRAPHY

(INTERNATIONAL HYDROGRAPHIC BUREAU SPECIAL PUBLICATION N° 39)

---

This publication contains the latest theoretical and practical information available regarding radio aids currently used for position-fixing in both maritime navigation and hydrography. The summary of chapters is as follows :

**CHAPTER I. — Spectrum and Propagation of Radio Waves.**

- 1) Frequency Spectrum of Electromagnetic and Radio Waves - 2) Propagation of Radio Waves.

**CHAPTER II. — Radio Systems Used in Maritime Navigation.**

- 1) Radio Direction-Finding - 2) Loran - 3) Decca - 4) Consol.

**CHAPTER III. — Radio Systems Used in Hydrographic Surveying.**

- 1) Decca in Hydrographic Surveying - 2) Shoran - 3) Electronic Position Indicator (EPI) - 4) Shoran and EPI in Offshore Hydrographic Surveying - 5) Raydist - 6) Lorac - 7) Rana - 8) Computation and Plotting of Hyperbolic Lattices on Survey Plotting Sheets.

**CHAPTER IV. — Radar Technique.**

- 1) Radar Technique in Navigation - 2) Use of Marine Radar in Surveying.

**CHAPTER V. — Radio Systems in Geodetic Surveying.**

- 1) Outline of Present Situation - 2) Operational Reports.

**CHAPTER VI. — Reports on Use of Radio Systems in Hydrography.**

- 1) Decca - 2) Shoran - 3) EPI - 4) Raydist - 5) Lorac - 6) Rana.

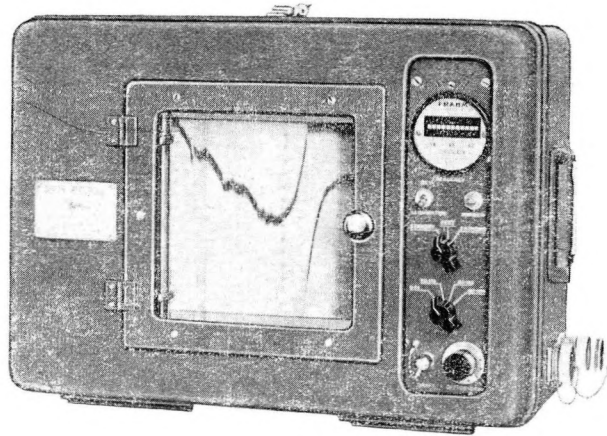
The publication has been prepared in the two official languages of the I. H. B. : English and French. Both editions, which appeared in 1956, contain approximately 450 pages, and 223 figures including 50 full-page illustrations.

The price per volume in either edition has been set at 8 U.S. Dollars. Conditions of sale are as follows : Owing to fluctuations of exchange, the price is given in U.S. Dollars. Packing and carriage expenses are extra.

A reduction of 30 % on the price is allowed to Government Offices and Naval and Mercantile Marine Officers of States-Members of the Bureau if the order is sent *direct* to the Bureau and not through a bookseller. A reduction of 30 % on the price is allowed to any bookseller.



# SURVEY DEPTH RECORDER



## For Economical, Extremely Precise UNDERWATER SURVEY

The Edo Survey Depth Recorder, Model 255, was developed at the request of experts in the field of hydrographic survey. It is the finest equipment on the market for measuring the depth of water for survey purposes and for presenting in permanent form an accurate and legible record of the water's depth.

Accurate to within one-half of one per cent, the Survey Depth Recorder is designed in all respects to satisfy the most stringent requirements of cartographers, oceanographers, dredgers and all others concerned with the exact depth of the water in channels, harbors, inland or coastal waters.

The equipment is readily installed to operate aboard survey vessels of all types... traveling at any speed up to 15 knots... in any water depth from three feet to 250 fathoms... whether fresh, brackish or salt. Its light weight permits permanent or temporary installation on large or small survey craft.

### Precise Measurement in 8 Ranges

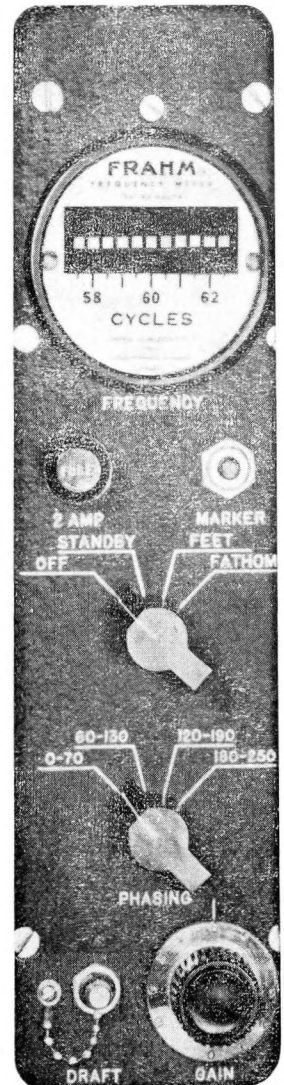
*Edo Model 255 is easily adjustable for transducer draft or sound velocity and records in eight ranges :*

- 0 to 70 feet or fathoms
- 60 to 130 feet or fathoms
- 120 to 190 feet or fathoms
- 180 to 250 feet or fathoms

*Notes can easily be made on chart through large hinged window or positions marked automatically with marker button. One roll of paper operates 10 hours continuously on « foot » scale; 20 hours on « fathom » scale. Equipment is housed in rugged cast aluminum case. Send for brochure today.*



**CORPORATION**  
COLLEGE POINT, NEW YORK





**OFFICINE  
GALILEO**

Makers of Scientific Surveying  
and Photographic Instruments

**PHOTOGRAMMETRIC  
EQUIPMENT DESIGNED FOR THE STUDY OF THE SEA SURFACE**

Aerial Photogrammetric cameras

1<sup>st</sup> 2<sup>nd</sup> 3<sup>rd</sup> class plotting instruments Galileo-Santoni patents (Stereocartograph Galileo-Santoni mod. IV - Stereosimplex mod. II and mod. III. Cartographic Stereo-micrometer)

Photogrammetric equipments for special works

High accuracy topographic instruments.

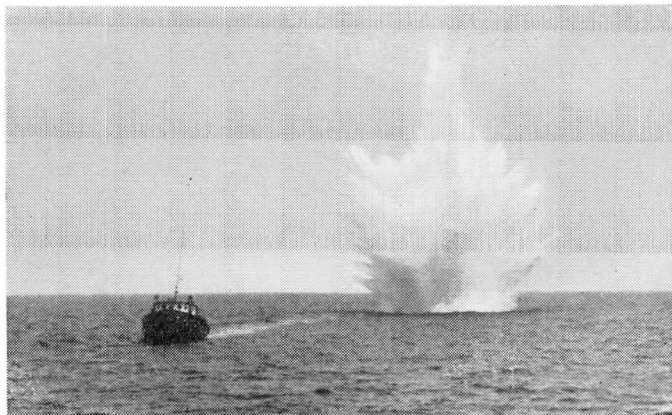
**OFFICINE GALILEO - 44 VIA CARLO BINI - FIRENZE (ITALY)**



**1,300,000\*** *Seismic Shot Points*  
*and Gravity Stations*  
 have been located in this area  
 by **LORAC**

The majority of the geophysical crews operating off the coast of Texas, Louisiana and Mississippi are utilizing this Radio Positioning service.

For complete details on LORAC contract rates and service in this or other areas, ask your geophysical contractor, or contact



\*Up to August 1 1955



## *Lorac Service Corporation*

Tulsa, Oklahoma  
 Box 1590  
 CHerry 2-8187

Houston, Texas  
 Box 6842  
 JACkson 9-4601

" Accurate to One Foot In a Mile "

# RAYDIST

## Radio Location Systems

for precise

**HYDROGRAPHIC SURVEYING**

MAPPING AND CHARTING

HARBOR AND CHANNEL CONTROL

GEOPHYSICAL EXPLORATION

AIR AND WATER CURRENT RESEARCH

VELOCITY AND WATER SPEED MEASUREMENTS

NAVIGATION AND POSITIONING

TRACKING

ENGINEERS AND TECHNICIANS

AVAILABLE FOR OPERATIONS

OR TRAINING

---

Developed and Manufactured

Sold or Leased

By

**HASTINGS-RAYDIST, INCORPORATED**

Hampton, Virginia (U.S.A.)



## PORT OF BENGHAZI - LIBYA

All hydrographic survey work in connection with the re-design and improvement of Benghazi Harbour was carried out by Kelvin Hughes on behalf of the Consulting Engineers: Sir William Halcrow & Partners, acting for the Libyan Public Development and Stabilisation Agency. Hydrographic surveys of every description are undertaken by Kelvin Hughes. Their specialist Surveyors, using the most modern equipment, are available for surveys anywhere in the world.



### **KELVIN HUGHES**

*CONTRACT SURVEY SECTION*

**KELVIN & HUGHES (MARINE) LIMITED - 99 FENCHURCH STREET - LONDON - E.C. 3**

TGA KHM 65

# FRENCH INSTITUTE OF NAVIGATION

13, Rue de l'Université — PARIS (7<sup>e</sup>)

**Publishes a Technical Review on  
Maritime and Aerial Navigation  
entitled :**

# NAVIGATION

which is issued quarterly



● **Membership.** — Applications should be addressed to the Secretary-General. They are decided by the Council. Membership in the French Institute of Navigation automatically ensures regular delivery of the Review.

● **Dues.** — Annual rates are as follows :

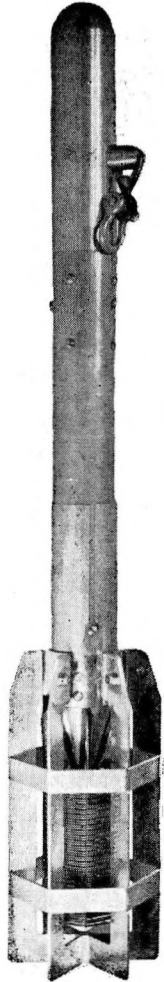
- Active Member ..... 2.200 fr.
- Associate Member (resident abroad) ..... 2.500 fr.

● **Payment.** — Preferably by transfer or payment to the Association's Postal Order Account : I.F.N. 1581-32 Paris.

Bank cheques are accepted, payable in Paris in French francs.

# USE THIS WALLACE and TIERNAN Thermarine Recorder

to measure and record water temperature vs depth.



Wallace and Tiernan  
Thermarine Recorder

## THERMARINE RECORDER (Bathythermograph)

	MODEL N <sup>o</sup>		
	FA-190011	FA-190021	FA-190031
Depth range *	0 to 200 ft.	0 to 450 ft.	0 to 900 ft.
Accuracy	2 ft.	4.5 ft.	9 ft.
Temperature range *	+ 30° to + 90° F.	+ 30° to + 90° F.	+ 30° to + 90° F.
Accuracy	± 0.1° F.	± 0.1° F.	± 0.1° F.
Maximum allowable depth	225 ft.	562.5 ft.	1125 ft.
Length	31"	31"	31"
Diameter: Nose	2 1/8"	2 1/8"	2 1/8"
— Tail	5"	5"	5"
Weight (pounds)	21 3/4 lb.	21 3/4 lb.	22 lb.
Shipping weight (pounds)	75 lb.	75 lb.	75 lb.

### ACCESSORIES :

200 smoked glass slides. — Two individually calibrated grids and holders. — Two grid viewers. — Two pts. slide lacquer.  
— One pt. lacquer thinner. — One slide forceps. — One thermometer. — One nose casting.

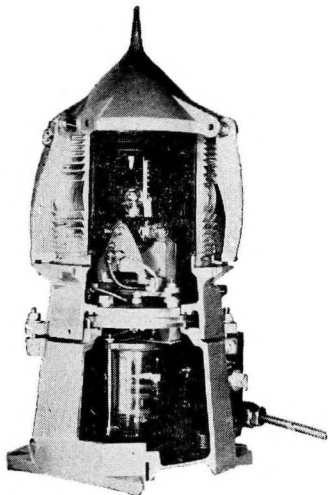
\* Temperature and depth may be calibrated in °C and meters, if desired.

The accessories listed above are the same for models FA-190011, FA-190021 and FA-190031, with the exception that a deep diving rig is included with model FA-190031.

**WALLACE & TIERNAN Incorporated**  
Belleville 9, New Jersey (U. S. A.)



# ELECTRICITY POWERS THE MODERN AID TO NAVIGATION For Lighthouse or Buoy

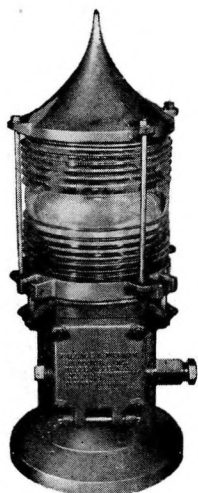


Wallace and Tiernan 200 mm. Lantern  
cut away to show lamp changer and  
flasher mechanism

Recognizing the responsibility imposed on marine lights and their accessories, Wallace and Tiernan has, over the years, developed a complete line of modern **electrically powered** aids to navigation meeting all the requirements of unfailing dependability, low initial cost, negligible maintenance and long unattended service periods.

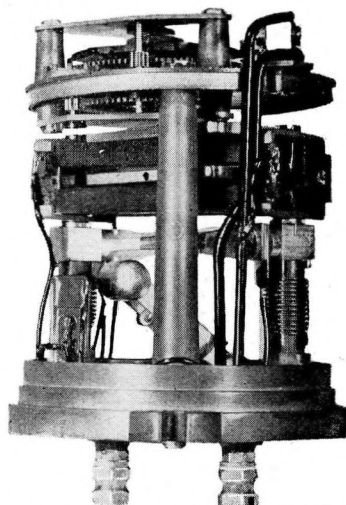
Among the design features of Wallace and Tiernan Electric Marine Beacons which have led to their use by lighthouse authorities the world over are:—

- Electrically powered operation.
- Flasher Mechanisms suitable for any flashing characteristics and operating voltage.
- Automatic lamp changers.
- Corrosion resistant, water-tight construction.
- Efficient candlepower output high visibility with low power consumption.
- Low initial cost.
- Continuous, unattended operation for long periods.



Wallace and Tiernan  
150 mm. Lantern

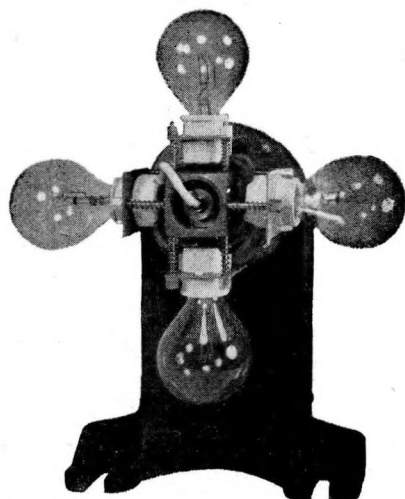
Wallace and Tiernan Specialists on aids to navigation will be glad to make recommendations on your problem without obligation—either on new installations or on the conversion of old gas or oil lights to modern electric operation. Such conversions, utilizing existing optics and structures, are both economical and practical.



Wallace and Tiernan Flasher mechanism

## WALLACE & TIERNAN AIDS TO NAVIGATION INCLUDE :

- |  |                            |
|--|----------------------------|
| • Lighthouse beacons and Lanterns from 90 mm. to 500 mm. | • Automatic lamp changers. |
| • Buoys and Structures.                                  | • Range light lanterns.    |
| • Flasher mechanisms.                                    | • Fog signals.             |
|  | • Batteries of all types.  |



Wallace and Tiernan Lamp changer,  
for electrifying large optics

**WALLACE & TIERNAN INCORPORATED**  
Belleville 9, New Jersey  
U. S. A.



the precise  
position...

... of the X that marks the spot is fixed by a Decca Mobile Chain with a speed and certainty unobtainable by any other means. Providing wide-area coverage under all weather conditions Decca Mobile Chains have been proved in the field to be the most efficient and flexible of all electronic position fixing systems. In a single season the saving in time and manpower achieved by a Decca Mobile Chain can fully cover its initial cost.

**Precise position fixing with low ambiguity and true repeatability over long or short periods.**

**Ease of operation.**

**Built-in electronic referencing, eliminating "reference buoys".**

**Decca operates irrespective of height or terrain—the same Chain can be used by ships, aircraft, vehicles or ground parties.**

**Automatic and continuous map display of track and position with the Decca "Track Plotter".**

# **THE DECCA NAVIGATOR**

**Mobile Chains for  
Survey and Exploration**

THE DECCA NAVIGATOR COMPANY, LIMITED, LONDON, ENGLAND

**THE  
INTERNATIONAL HYDROGRAPHIC REVIEW.**

## FOREWORD

---

The International Hydrographic Review is dependent for its value and interest on original contributions from its readers, as well as on the re-publication, in English and French, of appropriate articles which have already appeared in other publications.

Articles on any branch of hydrographic surveying, navigation and allied subjects, such as radio and other aids to navigation, new instruments, hints to hydrographic surveyors, etc., as well as articles dealing with the history and organization of hydrographic offices with descriptions of surveying ships and boats and their equipment, are of great interest to all Hydrographic Offices.

The Directing Committee of the International Hydrographic Bureau will carefully consider all articles received for publication. Free reprints in English and/or French of original articles will be supplied to their authors on request made when sending manuscript.

Articles should be typewritten if possible in duplicate and addressed to

The Secretary-General

INTERNATIONAL HYDROGRAPHIC BUREAU

Quai des Etats-Unis,

MONTE-CARLO.

(Principality of Monaco)

and should reach the Bureau not later than 31st January or 31st July for the May and November numbers respectively.

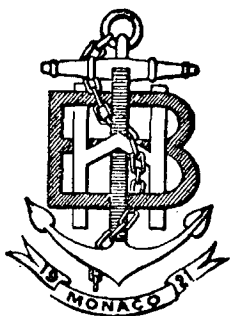
---

*The Directing Committee are not responsible for statements made or opinions expressed in articles or papers published in this Review when written by authors who are not members of the Directing Committee or of the Staff of the International Hydrographic Bureau.*

# THE INTERNATIONAL HYDROGRAPHIC REVIEW

Vol. XXXIV

N° 1



(N° 61 OF THE SERIES)

PUBLISHED BY

THE

**INTERNATIONAL HYDROGRAPHIC BUREAU**  
**Quai des Etats-Unis - Monte-Carlo**

**MONACO**

PRINCIPALITY



**MAY 1957**

IMPRIMERIE MEYERBEER  
21, Rue Meyerbeer - NICE



INTERNATIONAL HYDROGRAPHIC BUREAU

---

LIST OF STATES WHICH ARE MEMBERS OF THE BUREAU

---

ARGENTINA	ITALY
BRAZIL	JAPAN
BRITISH COMMONWEALTH	KOREA
UNITED KINGDOM	MONACO
AUSTRALIA	NETHERLANDS
NEW-ZEALAND	NORWAY
BURMA	PAKISTAN
CANADA	PHILIPPINES
CHILE	POLAND
CHINA	PORTUGAL
CUBA	SPAIN
DENMARK	SWEDEN
EGYPT	THAILAND
FINLAND	TURKEY
FRANCE	UNION OF SOUTH AFRICA
GERMANY	UNITED STATES OF AMERICA
GREECE	URUGUAY
ICELAND	YUGOSLAVIA
INDIA	
INDONESIA	

---

**DIRECTING COMMITTEE**

---

*President* : Rear-Admiral C. L. NICHOLS, U. S. N. (retired).

*Director* : Contrammiraglio A. VIGLIERI, Italian Navy.

*Secretary-General* :

Capitaine de Vaisseau H. BENCKER, Marine Française.

---