

# The JOURNAL of THE INSTITUTE OF NAVIGATION

VOL. XIII, NO. 1

JANUARY

1960

<b>The Duke of Edinburgh's Lecture : Mathematics and the Navigator in the Thirteenth Century</b>	1
E. G. R. TAYLOR	
<b>Limitations of the Dead Reckoning Reference at Sea</b>	13
H. C. FREIESLEBEN	
<b>The Limitations of Airborne Dead Reckoning Today</b>	19
E. W. ANDERSON	
<b>The Information to be Displayed on an Automatic System in the Air</b>	22
W. H. MCKINLAY	
<b>The Nature of the Information to be Displayed at Sea</b>	39
L. S. LE PAGE	
<b>Radio Techniques for Automatic Systems in the Air</b>	47
J. R. MILLS	
<b>Inertial Techniques for Marine Navigation</b>	58
H. N. BAILHACHE	
<b>Inertial Methods in Hybrid Navigation Systems</b>	61
D. E. ADAMS	
<b>The Use of Radio Sextants in Automatic Navigation Systems</b>	70
C. M. CADE	
<b>Self-contained Polar Navigation</b>	76
E. S. PEDERSEN	
<b>Some Considerations of Free-gyro Failure in Air Navigation</b>	78
J. F. GREEN	
<b>The Role of the Computer in Automatic Navigation</b>	88
P. A. HOUGHTON AND J. H. R. LEWIS	
<b>Height Information from Doppler Navigators</b>	96
G. E. BECK	
<b>A Roller Map Equipment</b>	98
G. WIKKENHAUSER	
<b>The Human versus the Automatic Navigator</b>	105
A. M. A. MAJENDIE	
<b>FORUM</b>	
A New Navigation System Using Artificial Earth Satellites	109
Navigation in Channel Swimming	111
<b>Record</b>	118
<b>Reviews</b>	122

THE INSTITUTE OF NAVIGATION  
AT THE ROYAL GEOGRAPHICAL SOCIETY  
1 KENSINGTON GORE LONDON SW7

JOHN MURRAY (PUBLISHERS) LTD., 50 ALBEMARLE STREET, LONDON W1

PRICE FIFTEEN SHILLINGS

## THE INSTITUTE OF NAVIGATION

### *Patron*

H.R.H. PRINCE PHILIP DUKE OF EDINBURGH, K.G., K.T.

### OFFICERS AND COUNCIL

#### *President*

Wing Commander E. W. Anderson, O.B.E., D.F.C., A.F.C.

#### *Vice-Presidents*

Air Marshal Sir Edward Chilton, K.B.E., C.B.

Captain F. J. Wylie, R.N.(ret.)

*Hon. Treasurer:* Commander P. C. H. Clissold, R.D., R.N.R.(ret.)

#### *Chairman of the Technical Committee*

Dr. D. E. Adams

#### *Chairman of the Membership and Fellowship Committee*

Rear Admiral K. St. B. Collins, C.B., O.B.E., D.S.C.

#### *Other Members of the Council*

Captain W. Baillie, M.V.O., O.B.E.

Mr. C. S. Durst, O.B.E.

Mr. D. O. Fraser

The Hon. Mr. Justice Hewson,

R.D., R.N.R.

Air Commodore D. C. McKinley,

C.B.E., D.F.C., A.F.C.

Lieut. Commander R. B. Michell,

D.S.C., R.N.(ret.)

Mr. E. W. Pike

Captain A. J. R. Tyrrell

Mr. G. Wikkenhauser, M.B.E.

Captain C. J. Wynne Edwards,

D.S.C., R.N.

The directors of navigation at the Admiralty, the Air Ministry and the Ministry of Transport and Civil Aviation attend meetings of the Council as *ex-officio* members.

*Executive Secretary:* M. W. Richey

## The Journal of the Institute of Navigation

The *Journal* is published quarterly by the Institute and is edited by the Executive Secretary. It contains original papers contributing to the science of navigation, including those presented at meetings of the Institute together with the ensuing discussion. In addition the *Journal* includes a record of current navigational work, reviews of important books, and other matters of concern to those interested in navigation. The views expressed in the *Journal* are not necessarily those of the Institute, or of any organization or department to which the authors may belong.

The *Journal* is free to all members of the Institute. It is sold to the public at fifteen shillings per copy or, by subscription, at sixty-two shillings per annum (post free) and may be obtained through all booksellers and John Murray (Publishers) Ltd., 50 Albemarle Street, London W1.

Contributions, which are welcomed from both members and non-members, should be addressed to the Editor.

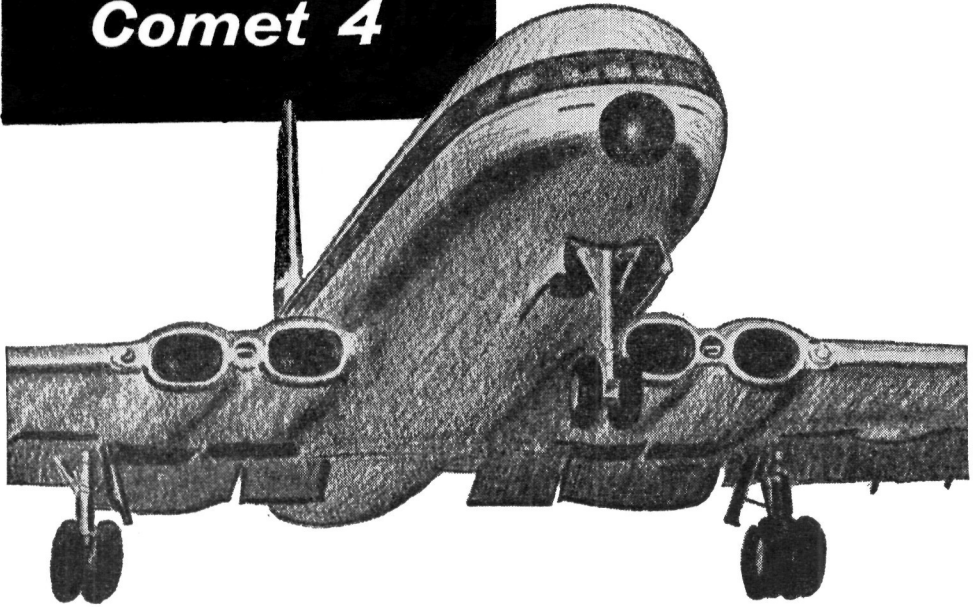
Enquiries for advertising space should be addressed to the Institute offices.

The postal address of the Institute is :

The Institute of Navigation,  
at The Royal Geographical Society,  
1 Kensington Gore, London SW7.

*Telephone:* Kensington 5021.

**Marconi  
in the  
Comet 4**

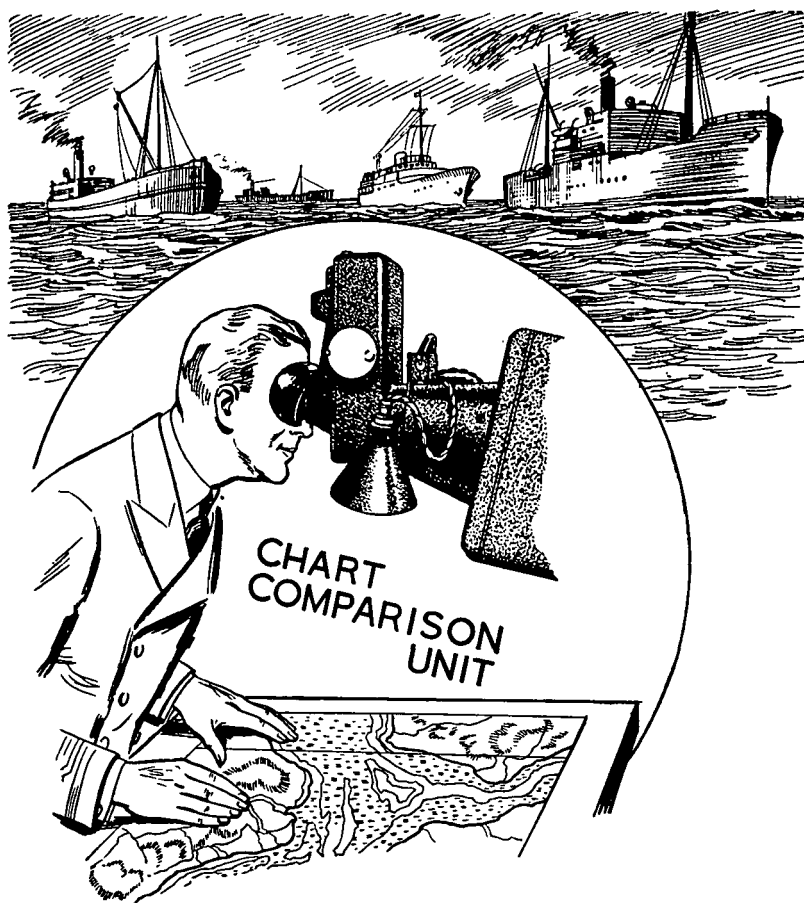


**Equipped by Marconi  
to meet the  
major radio requirements  
of a modern airliner**

**MARCONI**

**COMPLETE AIRCRAFT AND AIRPORT RADIO SYSTEMS**

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND  
M2A



## **PILOTAGE** **in Congested Channels**

By superimposing an image of the P.P.I. on a large scale chart, at the scale of the chart, the Unit gives an almost instantaneous fix of the ship's position and provides a continuous fix on other ships, etc. It increases considerably the accuracy of navigation ordinarily obtained by radar, particularly where True Motion equipment has been installed.

# **BARR & STROUD LTD.**

**ANNIESLAND, GLASGOW, W.3. Kinnaird House, 1 Pall Mall East, S.W.1**

## THE INSTITUTE OF NAVIGATION

**T**HE OBJECT of the Institute is to unite in one body those who are concerned with or who are interested in the science and art of navigation. Membership is not restricted to those who hold professional qualifications, but is open to others who wish to further the aims of the Institute.

By coordinating the knowledge and achievements of marine and air navigators, scientists and those associated with the development and production of navigational equipment, the work of the Institute is directed towards raising the standard of navigation. In the field of education it is the aim of the Institute to bring practical navigators into contact with teachers and research workers to increase a common appreciation of the issues involved. It is an object of the Institute to encourage research in equipment and methods; through its publications it gives a wide circulation to original work on navigation so that new developments and suggestions can be appreciated by those most directly concerned with them.

The activities of the Institute include the holding of monthly meetings to discuss specific problems, the publication of a Journal and of other works concerned with different aspects of navigation, and such other activities as the Council may deem necessary to promote knowledge in navigation and its associated sciences.

*The Journal of the Institute of Navigation* is issued free each quarter to all members and contains a full account of the Institute's proceedings. It prints the papers which are presented at meetings, together with their ensuing discussion, and other original papers contributing to the science of navigation. It also contains a record of current navigational work, reviews of important books, and general papers of interest to navigators and those with similar interests.

The work of the Institute is coordinated with that of similar societies abroad, and in particular with the work of the United States and Commonwealth Institutes of Navigation, whose proceedings are available to members.

**Membership.** There are five classes of membership of the Institute:

(1) HONORARY MEMBERS, who shall be distinguished persons upon whom the Council may see fit to confer an honorary distinction.

(2) FELLOWS, who shall be members, of at least three years' standing who, in the opinion of the Council, have made a contribution of value to navigation.

(3) MEMBERS, who shall be persons over twenty-one years of age who can satisfy the Council of their interest in navigation.

(4) STUDENT MEMBERS, who shall be persons under twenty-five years of age studying with a view to making navigation, or an allied interest, their career.

(5) CORPORATE MEMBERS, who shall be companies, universities, navigation schools, government departments and other organizations, here and abroad, who are directly or indirectly interested in the science of navigation. Corporate Members are entitled to send representatives to all Institute meetings and to receive six copies of the *Journal*, and other publications. They are encouraged to take an active part in the Institute's work. Application should be by letter addressed to the Executive Secretary.

**Subscriptions.** Annual subscriptions to the Institute are payable in advance as follows:

Members and Fellows . . . . .	Three guineas
Student Members . . . . .	Half a guinea
Corporate Members . . . . .	Thirty guineas

The Institute's financial year begins on 1 July. Members in any category who are elected after 1 January in any year are only due for one half of their subscription until 1 July, when the full subscription for the next year becomes due.

# The Institute of Navigation

## Form of application for membership

Name in full (including title)  
(Please use block letters)

Permanent Address

Class of membership for which you wish to be considered

Branch of navigation or related science in which you have particular interest

Profession or Occupation

Professional and/or Academic qualifications

Summary of experience

Date of Birth

“ If accepted for membership of the Institute of Navigation, I hereby agree to abide by its Constitution and By-Laws and to advance the objects of the Institute as far as shall be in my power.”

Date

Signature  
(See note below)

*Note.—In the case of applications for Student Membership this form should be countersigned by the Principal of the Educational Establishment at which the applicant is studying.*

**Copies of this form can be obtained from the Executive Secretary.**

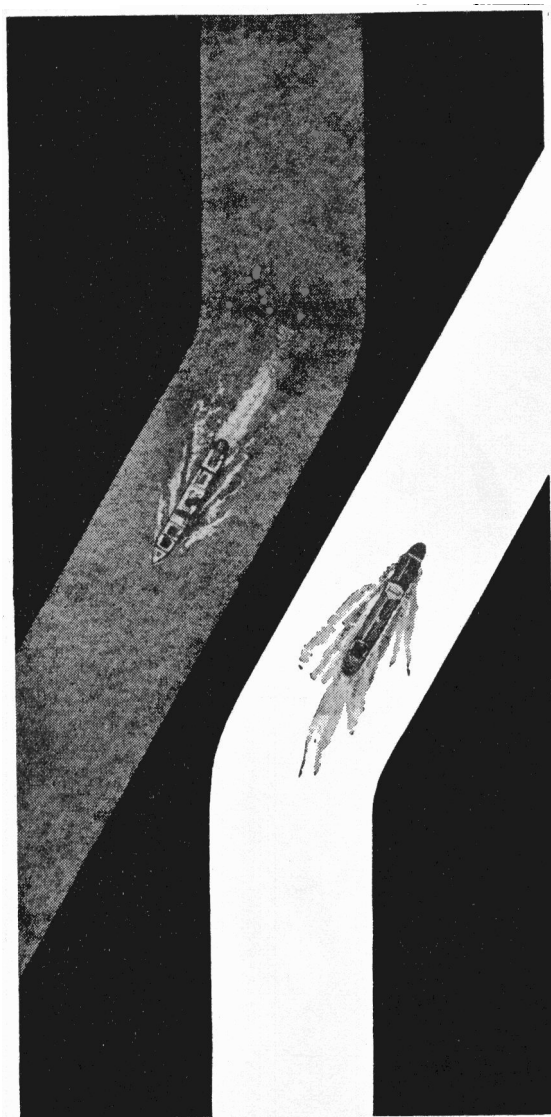
# AT SEA IN 500 SHIPS

## DECCA TRUE MOTION RADAR

True Motion Radar was pioneered by Decca Radar Limited in 1956 and made the most important advance towards increased safety at sea since the introduction of radar itself.

The latest Decca True Motion Radars, the TM 909 and TM 707 developed from the original TM 46, are without parallel in performance, reliability and price anywhere in the world.

Over 500 ships are fitted with Decca True Motion Radar. Approximately half the world's radar fitted ships are fitted with Decca Marine Radar.



**The world's most experienced  
manufacturers of marine radar—  
Decca True Motion Radar  
is the safest type of radar at sea today**

DECCA RADAR

DECCA RADAR LIMITED · LONDON · ENGLAND

 DR99d

# THE "ROTORACE"

## C.L.11

### GYROSYN COMPASS

is now in production  
for military and  
civil orders

Elf  
Elva  
Onze  
Once  
On bir  
Eleven  
Elleve  
Undici  
Yksitoista

十一

十一

ΕΥΔΕΚΑ

इ.मि. ११

۱۱ = ۱۱

گیا (۱۱) = ۱۱

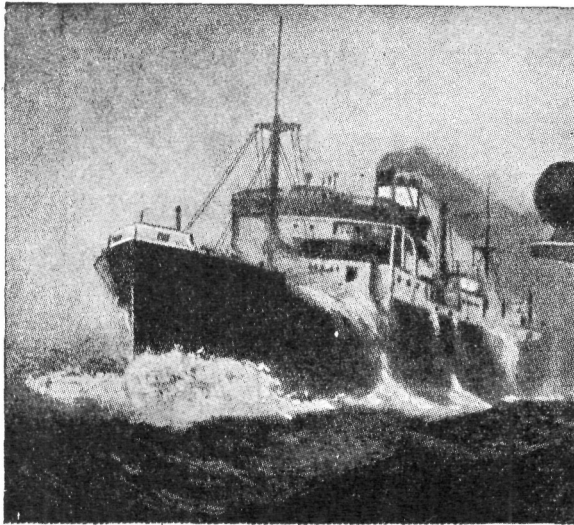


# SPERRY

SPERRY GYROSCOPE COMPANY LTD., GREAT WEST ROAD, BRENTFORD, MIDDLESEX

Telephone: ISLeworth 1241. Telex: 23900





# **FULL SPEED AHEAD!**

**WITH**



## **NAVIGATIONAL INSTRUMENTS**

The "HEZZANITH" Patent MARK VII

### **PROJECTOR BINNACLE AND COMPASS**

*By means of a series of optical elements an enlarged erect image of a portion of the card covering an arc of 40° in length is produced on a ground glass screen which is viewed in an adjustable plane mirror.*

*All stray light is effectively screened, and there is a completely unobstructed view of the card from above, permitting the normal use of an azimuth instrument by day or night.*

*Send for our special Projector Binnacle Leaflet (NJ.59).*

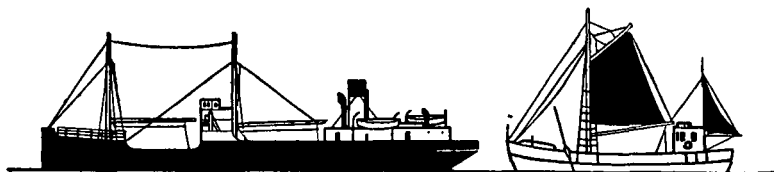
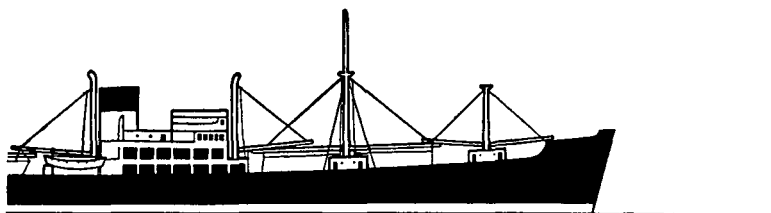
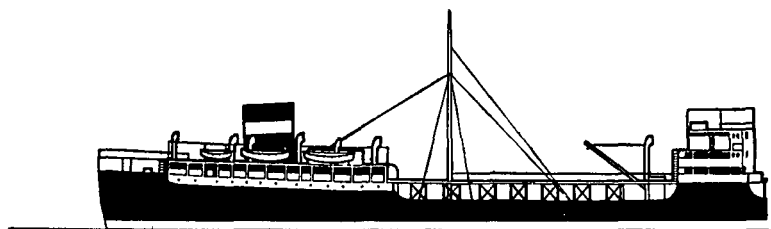
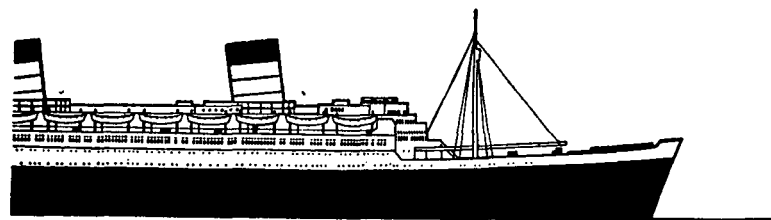
# **HEATH & COMPANY**

(Incorporated with W. F. Stanley & Co. Ltd.)

## **NEW ELTHAM - LONDON, S.E.9**

Phone: ELTHAM 3836

Cables: "Polaris, Souphone, London"



**FROM THE LARGEST  
TO THE SMALLEST**

Over 5,000 ships of all sizes, from the largest passenger liners to small fishing vessels, sailing on a multitude of different purposes, are navigated more accurately and operated more efficiently with the Decca Navigator.

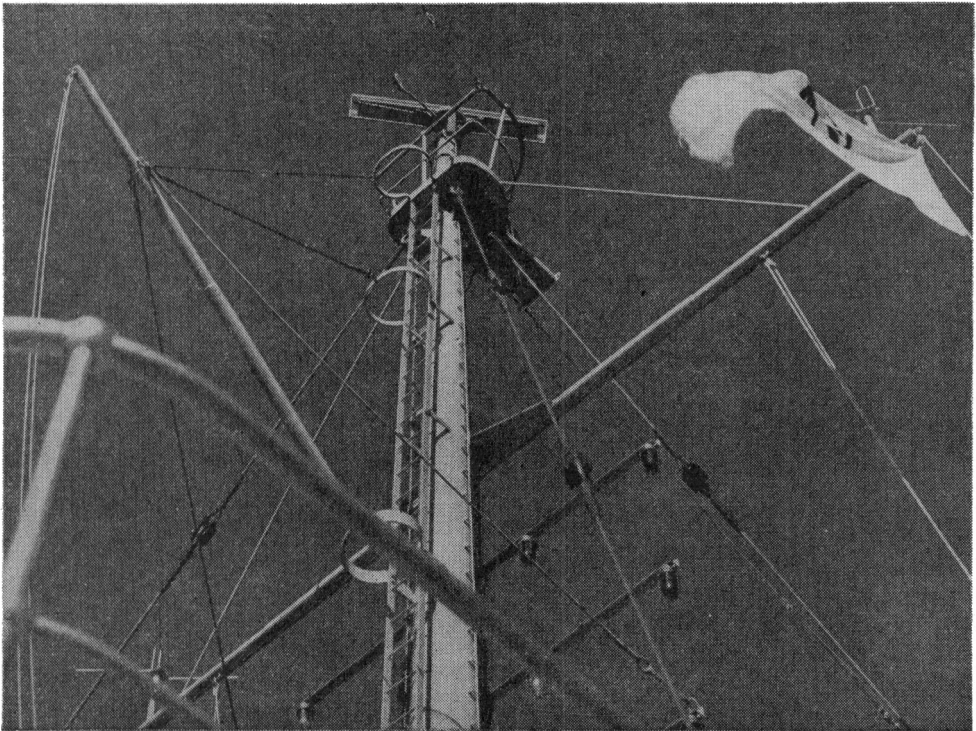
**THE DECCA  
NAVIGATOR**

*the world's most accurate navigation system*

THE DECCA NAVIGATOR COMPANY LIMITED · LONDON

You can be  
sure of  
**SHELL**





# For the largest tanker



OR THE SMALLEST FISHING VESSEL

This new Kelvin Hughes radar equipment has been designed as a range of standard units which can be assembled to meet the particular operational requirements of any vessel. Where lack of space limits the display to a 9-in P.P.I., the complete radar incorporates the same high-powered (60 kW) transmitter and highly efficient slotted waveguide scanner as used with the 16-in display.

**VERSATILITY** A choice of four displays is available. 9-in or 12-in P.P.I. and a 12-in or 16-in True Plot. Two separate displays can be operated from one transmitter and scanner.

**ECONOMY** Standardisation of basic units enables owners to have the best possible radar for operational needs — at a competitive price.

**SERVICE** Unit construction and the use of many common parts simplify service administration and maintenance.



## KELVIN HUGHES

*The two greatest names in navigation*

### UNIT RADAR SYSTEM

Type 14/9 Display



Type 14/12 Display



Type 14/12P (True Plot)

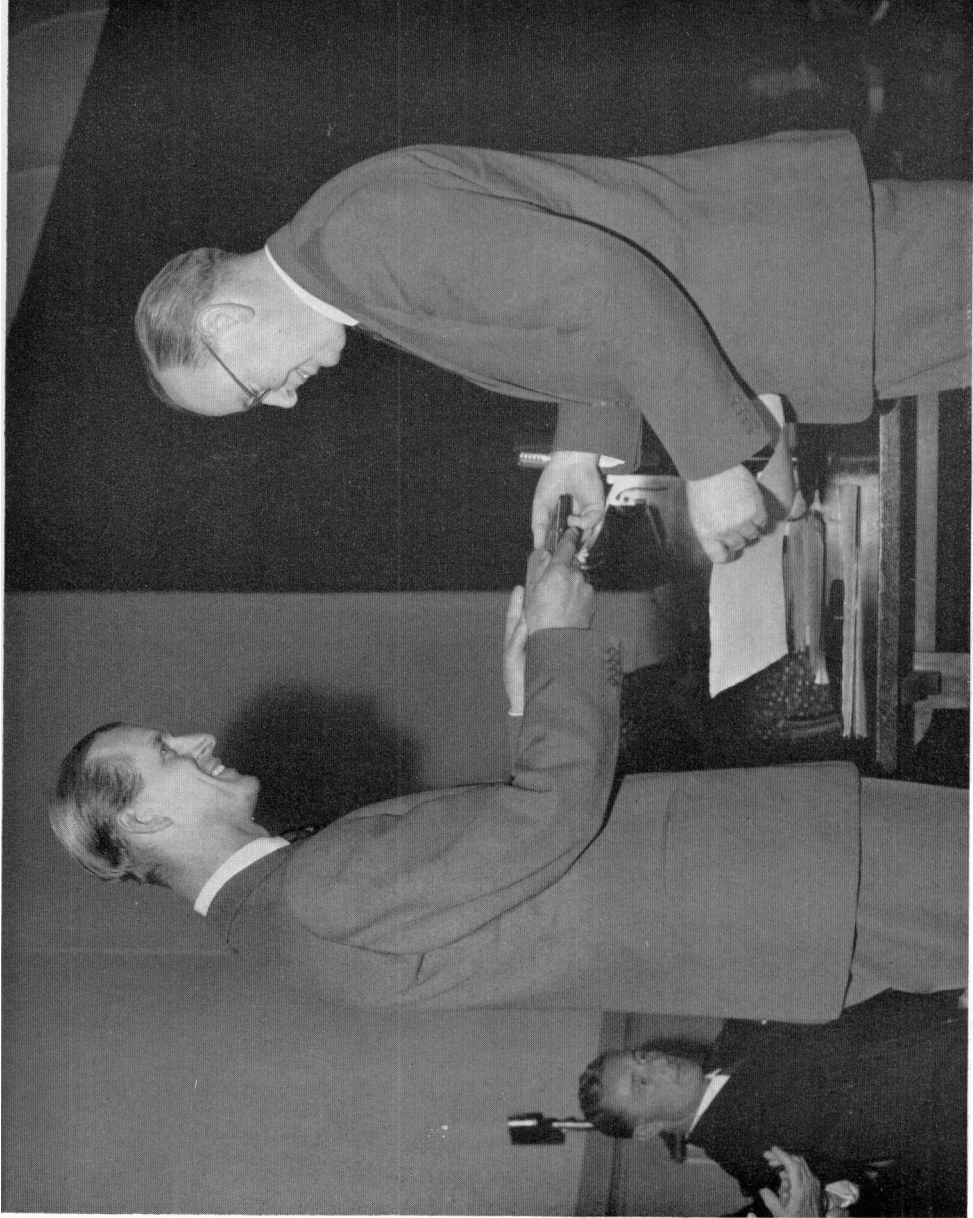


Type 14/16P (True Plot)



KELVIN & HUGHES (MARINE) LIMITED, ST. CLARE HOUSE, MINORIES, LONDON, E.C.3

TGA KHM115A



*His Royal Highness The Duke of Edinburgh, Patron of the Institute, presenting the Gold Medal to Mr. J. Clegg. An account of the Annual General Meeting, at which this award was presented, is given on page 118.*