

**MADE AND PRINTED IN GREAT BRITAIN BY  
WILLIAM CLOWES AND SONS LIMITED  
LONDON AND BECCLES**

THE JOURNAL OF THE  
INSTITUTE OF NAVIGATION

*Volume 19*  
*1966*

PUBLISHED UNDER THE AUTHORITY OF THE COUNCIL  
EDITED BY M. W. RICHEY

THE INSTITUTE OF NAVIGATION  
AT THE ROYAL GEOGRAPHICAL SOCIETY  
1 KENSINGTON GORE, LONDON SW7  
JOHN MURRAY (PUBLISHERS) LTD., 50 ALBEMARLE STREET W1

# THE INSTITUTE OF NAVIGATION

PATRON

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

## COUNCIL 1965-6

PRESIDENT

Rear-Admiral Sir Edmund Irving, K.B.E., C.B.

VICE-PRESIDENTS

Francis Chichester, C.B.E.

Air Vice Marshal W. E. Oulton, C.B., C.B.E., D.S.O., D.F.C.

HONORARY TREASURER Captain M. E. Butler Bowdon, O.B.E., R.N.

CHAIRMAN OF THE TECHNICAL COMMITTEE

G. E. Beck

CHAIRMAN OF THE MEMBERSHIP AND FELLOWSHIP COMMITTEE

D. H. Sadler, O.B.E.

MEMBERS OF COUNCIL

Air Cmdre D. Bower, O.B.E., A.F.C.	Captain F. Ormonroyd, D.F.M.
Captain A. F. Dickson	D. M. Page
Group Captain E. Fennessy, C.B.E.	Cmdr G. V. Parmiter, R.N. (Retd.)
Cmdr C. E. N. Frankcom, R.N.R.	C. Powell
Captain W. L. Manson	Professor A. Stratton

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

---

EXECUTIVE SECRETARY M. W. Richey

# CONTENTS

THE DUKE OF EDINBURGH'S LECTURE: THE CONTINENTAL DRIFT (Summary). P. M. S. BLACKETT . . . . .	1
A CONCEPT FOR NAVIGATION AND COMMUNICATION USING SATELLITES R. E. ANDERSON . . . . .	2
TRUE MOTION AND RELATIVE MOTION. F. J. WYLIE . . . . .	23
ON THE FREQUENCY DISTRIBUTION OF LARGE ERRORS. A. F. CROSSLEY . . . . .	33
SUBSURFACE NAVIGATIONAL HAZARDS. J. W. CHANSLOR . . . . .	41
HEIGHT MEASUREMENT IN SUPERSONIC AIRCRAFT I—THE REQUIREMENT. W. P. DAVIES . . . . .	56
II—INERTIAL TECHNIQUES IN HEIGHT MEASUREMENT. R. WHALLEY . . . . .	61
III—SOME ASPECTS OF PRESSURE MEASUREMENT TECHNIQUES. B. CAPE . . . . .	68
IV—RADIO ALTIMETRY. W. L. GARFIELD . . . . .	73
V—HEIGHT MEASUREMENT FROM DOPPLER NAVIGATION. G. E. BECK . . . . .	75
HOVERCRAFT NAVIGATION. G. HAMMOND . . . . .	83
ANALYSIS OF LONG-RANGE AIR TRAFFIC SYSTEMS SEPARATION STANDARDS—I. P. G. REICH. . . . .	88
COSTING AIR TRAFFIC CONTROL DEVIATIONS. V. W. ATTWOOLL . . . . .	99
LONGITUDE WITHOUT TIME (Forum). F. CHICHESTER . . . . .	106
THE IMPACT OF RADAR ON THE RULE OF THE ROAD (Forum). P. CLISSOLD . . . . .	109
'THE SECTOR RULE AND THE COLLISION PROBLEM.' (Forum) J. GARCÍA-FRÍAS . . . . .	112
THE THREE STAGES OF RADAR PLOTTING (Forum). H. TOPLEY . . . . .	115
THE ESSENTIALS IN RADAR PRESENTATION (Forum). P. HUGON . . . . .	117
A PROBABILITY DISTRIBUTION FOR A TIME-VARYING QUANTITY (Forum). D. A. LLOYD . . . . .	119
A SURVEY OF THE USE OF ASTRONOMICAL METHODS AT SEA (Forum) D. MCG. BISSETT AND J. J. EVANS . . . . .	122
THE VINLAND MAP (Forum). . . . .	124
A MODERN VIEW OF LUNAR DISTANCES. H.M. NAUTICAL ALMANAC OFFICE . . . . .	131
AN EXPERIMENT IN POLYNESIAN NAVIGATION. D. LEWIS . . . . .	154
ANALYSIS OF LONG-RANGE AIR TRAFFIC SYSTEMS SEPARATION STANDARDS—II. P. G. REICH . . . . .	169
THE PARALLEL-ROUTE SYSTEM FOR NORTH ATLANTIC SUBSONIC JET TRAFFIC. V. W. ATTWOOLL . . . . .	187
SEPARATION STANDARDS AND AIRCRAFT WANDER. R. N. LORD. . . . .	198
ADMIRAL MARCQ DE BLOND DE ST. HILAIRE. R. CH. DUVAL . . . . .	209
NAVIGATION DISPLAY FOR HIGH PERFORMANCE AIRCRAFT. W. L. POLHEMUS . . . . .	213
THE USE OF COMPUTERS IN MERCHANT SHIPS. P. HUGON . . . . .	223
MULTI-MODE WEATHER RADAR. T. G. THORNE . . . . .	235

TERRAIN CLEARANCE PROBLEMS DURING CLIMB AND DESCENT UNDER	
AIR TRAFFIC CONTROL. T. FREER . . . . .	255
THE STATISTICS OF COLLISIONS AT SEA—II. F. J. WYLIE AND D. DEACON	262
VISUAL DIRECTION INDICATION FOR SHIPS (Forum). A. WEPSTER . . . . .	265
'THE IMPACT OF RADAR ON THE RULE OF THE ROAD' (Forum). J. F. KEMP . . . . .	268
THE PAIR RULE AND THE COLLISION PROBLEM (Forum). J. GARCÍA-FRÍAS . . . . .	269
THE VINLAND MAP (Forum). R. A. SKELTON . . . . .	271
SIGHT REDUCTION TABLES FOR MARINE NAVIGATION. J. H. BLYTHE, R. L. DUNCOMBE AND D. H. SADLER . . . . .	281
A NAVIGATION CONTROL POST FOR AUTOMATED MERCHANT SHIPS C. ABRAMOWSKI . . . . .	293
INERTIAL NAVIGATION IN RELATION TO ANIMAL NAVIGATION J. S. BARLOW . . . . .	302
'THE MATHEMATICAL PRACTITIONERS OF HANOVERIAN ENGLAND' C. H. COTTER . . . . .	317
SOME ASPECTS OF S.S.T. OPERATIONS IN NON-OPTIMUM CONDITIONS P. S. COLE . . . . .	324
ANALYSIS OF LONG-RANGE AIR TRAFFIC SYSTEMS . . . . .	
SEPARATION STANDARDS—III. P. G. REICH. . . . .	331
PARALLEL-ROUTE SYSTEMS FOR SUPERSONIC TRAFFIC. V. W. ATT- WOOLL . . . . .	348
PRINCIPLES AND APPLICATIONS OF PREDICTION DISPLAY. R. BERNOTAT AND H. WIDLÖK . . . . .	361
THE TRAINING OF NAVIGATORS. A DISCUSSION . . . . .	371
LONGITUDE WITHOUT TIME (Forum). J. J. EVANS . . . . .	392
VISUAL INDICATION OF DIRECTION FOR SHIPS (Forum). G. V. PARMITER	394
THE IMPACT OF RADAR ON THE RULE OF THE ROAD (Forum) F. J. WYLIE . . . . .	395
COLLISION AVOIDANCE IN RESTRICTED VISIBILITY (Forum) J. F. WACHER . . . . .	398
THE SEPARATION OF TRAFFIC AT SEA . . . . .	411
PROGRESS IN TRAFFIC SEPARATION. L. OUDET . . . . .	451
COLLISION REGULATIONS AND THE COURTS. B. D. G. GEORGE . . . . .	458
ELECTRONICS IN THE BRITISH FISHING INDUSTRY. R. BENNETT . . . . .	466
LORAN C. C. POWELL AND A. R. WOODS . . . . .	484
MICROWAVE RADIOMETRY. C. R. DITCHFIELD . . . . .	503
A QUESTION OF NOTATION (Forum). D. H. SADLER . . . . .	522
BAD LANGUAGE (Forum). E. W. ANDERSON . . . . .	523
THE EXPONENTIAL INTEGRAL FREQUENCY DISTRIBUTION (Forum) J. B. PARKER . . . . .	526
A RADAR DISPLAY FOR COLLISION AVOIDANCE (Forum). P. C. H. CLISSOLD . . . . .	529
RECORD . . . . .	275, 401
REVIEWS . . . . .	126, 276, 403, 531

## 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.