



DECEMBER 1974

THE
aeronautical
JOURNAL



THE ROYAL AERONAUTICAL SOCIETY

DIVISIONS AND BRANCHES OF

THE ROYAL AERONAUTICAL SOCIETY

Australia Branches at: Canberra, Sydney, Melbourne and Adelaide.

President: W. ISBISTER, FRAeS. Hon. Secretary: B. A. SCOLES, AFRAeS, 191 Royal Parade, Parkville, Victoria 3052.

Rhodesia Branches at: Bulawayo, Gwelo and Salisbury.

Hon. President: Sir HUMPHREY GIBBS, KCMG, President: G. PULLAN, ARAeS, Hon. Secretary: G. A. FORD, FRAeS, P.O. Box 3759, Salisbury.

New Zealand Branches at: Auckland, Wellington, Palmerston North, Christchurch and Hamilton.

President: T. R. PIKE, AFRAeS. Hon. Secretary: R. L. WILLIAMS, New Zealand National Airways Corp'n, P.O. Box 96, Wellington.

Southern Africa Branches at: Johannesburg, Pretoria, Cape Western and Durban.

President: Wg Cdr N. F. HARRISON. Hon. Secretary: Col F. W. CARNELL, FRAeS, 11 Staal Road, Valhalla, Pretoria District.

Bedford

President: D. E. MORRIS.

Chairman: F. A. SPURR, FRAeS.

Hon. Secretary: P. G. PUGH, AFRAeS, 25 Cody Road, Clapham, Bedford.

Belfast

President: P. F. FOREMAN, CBE, FRAeS.

Chairman: T. E. MORRISON, AFRAeS.

Hon. Secretary: W. K. DAY, AFRAeS, Technical Building, Short Bros & Harland Ltd, Airport Road, Belfast BT3 9DZ. Tel: 0232 58444. Ex. 243.

Birmingham and Wolverhampton

President: S. R. TYLER, FRAeS.

Chairman: I. B. CRIPPS, AFRAeS.

Hon. Secretary: D. E. HAMMOND, AFRAeS, 6 Beech Gardens, Sucking Green Lane, Codsall, Nr. Wolverhampton.

Boscombe Down

President: Air Cdre. A. D. DICK, CBE, AFC, MA, RAF.

Chairman: H. W. TURNER, CEng, AFRAeS. Hon. Secretary: T. J. HOWARD, AFRAeS, A & AEE, Boscombe Down Amesbury, Salisbury, Wilts. Tel: 098 02 3331. Ex. 2483.

Bristol

President: L. HAWORTH, OBE, FRS, FRAeS.

Chairman: N. H. WOOD, AFRAeS.

Hon. Secretary: Dr. R. K. NANGIA, AFRAeS, Aerodynamics Dept., British Aircraft Corp'n, Filton, Bristol. Tel: 0272 693831. Ex. 464.

Brough

President: G. W. CARR, AFRAeS.

Chairman: P. ASHWORTH, AFRAeS.

Hon. Secretary: R. MELLING, CEng, AFRAeS, c/o Hawker Siddeley Aviation Ltd, Brough, HU15 1EQ. Tel: 0482 667121, Ex. 311.

Cambridge

President: Professor W. A. MAIR, CBE, FRAeS.

Chairman: N. A. J. HARRY, FRAeS.

Hon. Secretary: G. T. ATKINS, AFRAeS, Marshall of Cambridge (Engineering) Ltd, Newmarket Road, Cambridge. Tel: 0223 61133.

Chester

President: J. GARSTON, AFRAeS.

Chairman: V. W. CLARKSON, AFRAeS.

Hon. Secretary: P. C. GIBBONS, Hawker Siddeley Aviation Ltd, Broughton, Chester. Tel: 0244 24646.

Christchurch

President: P. S. MACGREGOR, MBE, FRAeS.

Chairman: G. B. HUSTINGS, AFRAeS.

Hon. Secretary: E. L. HUTCHINGS, AFRAeS, BAC Ltd, Bournemouth (Hurn) Airport, Christchurch, Hants. Tel: 020-16 3201, Ex. 127.

Coventry

President: C. BAYLY, FRAeS.

Chairman: J. L. EDWARDS, FRAeS.

Hon. Secretary: A. J. EAGLES, 30 Lupton Ave, Coventry, CV3 5BQ. Tel: Work—0203 452152, Ex. 3608, Home—0203 415412.

Cranwell

President: Air Vice Marshal R. D. AUSTEN-SMITH, DFC.

Chairman: Wg. Cdr. C. B. STRIBLING.

MBE, AFRAeS.

Hon. Secretary: F. A. BRISTOW, AFRAeS, Dept of Engineering, RAF College, Cranwell, Stamford, Lincs. Tel: 040 06 201.

Derby

President: D. A. HEAD, AFRAeS.

Chairman: A. D. JACKSON, FRAeS.

Hon. Secretary: C. HORNBLLOWER, Grad. RAeS, Rolls-Royce (1971) Ltd, Derby, DE2 8BJ. Tel: 0332 42424, Ex. 254.

Dublin

President: Capt. J. C. KELLY-ROGERS, OBE, FRAeS.

Chairman: R. W. O. SULLIVAN, FRAeS.

Hon. Secretary: S. J. P. LYTTLE, AFRAeS, Astra, Pinelawn, Newtonpark Ave, Blackrock, Co. Dublin. Tel: Dublin 896311.

Glasgow

President: Dr. A. W. BABISTER, AFRAeS.

Chairman: J. SACHARIN, AFRAeS.

Hon. Secretary: T. K. BLACK, 43 Partick-Hill Road, Glasgow, G11 5BY. Tel: 041 221 9000 Ex. 2410; 041 334 7193 (Home).

Gloucester and Cheltenham

President: R. F. HUNT, FRAeS.

Chairman: K. BEST, AFRAeS.

Hon. Secretary: R. W. WHITE, AFRAeS, c/o Smiths Industries Ltd, Bishops Cleeve, Cheltenham, Glos. Tel: 024-267 3333.

Halton

President: Air Cdre. B. HAMILTON, OBE, DFC, AFC.

Chairman: Gp Capt. E. E. LAKE, AFRAeS.

Hon. Secretary: Fit. Lt. A. J. GILCHRIST, Grad. RAeS, Basic Studies Wing, No. 1 School of Technical Training, RAF Halton, Bucks. HP22 5PG. Tel: 0296 623535, Ex. 369.

Hatfield

President: Sir HARRY BROADHURST.

Chairman: C. F. BETHWAITE, FRAeS.

Hon. Secretary: G. B. EVANS, FRAeS, Drawing Office, Hawker Siddeley Aviation Ltd, Hatfield, Herts. Tel: 30 62345.

Isle of Wight

President: Sir CHRISTOPHER HARTLEY, KCB, GBE, DFC, AFC.

Chairman: R. L. WHEELER, AFRAeS.

Hon. Secretary: D. L. GOODMAN, AFRAeS, British Hovercraft Corporation Ltd, East Cowes, Isle of Wight. Tel: 098-382 4121.

London Airport

President: C. ABELL, OBE, FRAeS.

Chairman: E. R. MAJOR, FRAeS.

Hon. Secretary: D. S. FORSYTH, ARAeS, 3 Mole Abbey Gdns, West Molesey, Surrey. Tel: Office 759 3131, Ex. 4755, Home 979 7588.

Loughborough

President: Professor K. L. C. LEGG, FRAeS.

Chairman: F. G. MACCABEE, AFRAeS, 56 Holywell Drive, Loughborough, Leics.

Luton and Stevenage

President: G. R. JEFFERSON, CBE, FRAeS.

Chairman: A. C. SOUTHGATE, FRAeS.

Hon. Secretary: D. A. GIBBS, McAlpine Aviation, Luton Airport, Beds. Tel: 0582 34182.

Manchester

President: C. E. FIELDING, OBE, FRAeS.

Chairman: G. A. WHITEHEAD, CBE, FRAeS.

Hon. Secretary: L. R. BALTHAZAR, AFRAeS, Hawker Siddeley Aviation Ltd, Woodford, Cheshire. Tel: 061 439 5050. Ex. 52.

Preston

President: F. E. ROE, FRAeS.

Chairman: A. C. BOSWELL, AFRAeS.

Hon. Secretary: B. W. JAMES, AFRAeS, BAC Military Div., Strand Road, Preston, Lancs. Tel: 0772 54722.

Prestwick

President: R. McINTYRE, FRAeS.

Chairman: I. OSGERBY-BISHOP, AFRAeS.

Hon. Secretary: P. BERRY, AFRAeS, 9 Carclue Crescent, Ayr. Tel: 0292 42747.

Reading

President: E. N. MOBBS.

Chairman: J. T. APPLEBY, FRAeS.

Hon. Secretary: A. G. FOSKETT, AFRAeS, M.L. Aviation Co Ltd, White Waltham Aerodrome, Berks. Tel: 062-882 3361.

Southampton

President: A. N. CLIFTON, MBE, FRAeS.

Chairman: A. McKAY, AFRAeS.

Hon. Secretary: Dr. M. JUDD, AFRAeS, Dept. of Aeronautics and Astronautics, The University, Southampton SO9 5NH. Tel: 0703 559122.

Southend

President: J. R. BATT, AFRAeS.

Chairman: A. J. BROOKE-WALDER, AFRAeS.

Hon. Secretary: Wg. Cdr. E. F. PRICE, ARAeS, 147 Johnstone Road, Southend-on-Sea, Essex, SS1 3NG. Tel: 070-258 7090.

Swindon

President: W. GILLESPIE, AFRAeS.

Chairman: G. N. GINGELL, AFRAeS.

Hon. Secretary: F. G. T. QUINNEY, AFRAeS, BAC Ltd, Flight Test Centre, Fairford. Tel: 0285 5731.

Weybridge

President: Sir GEORGE EDWARDS, OM, CBE, FRS, HonFRAeS.

Chairman: N. W. BOORER, FRAeS.

Hon. Secretary: A. M. DOBSON, AFRAeS, BAC Ltd, Commercial Aircraft Division, Weybridge, Surrey. Tel: 97 45555, Ex. 509.

Yeovil

President: Dr. G. S. HISLOP, FRAeS.

Chairman: Dr. J. P. JONES, FRAeS.

Hon. Secretary: K. DAMON, Production Controller, MCD, Westland Aircraft Ltd, Yeovil, Somerset. Tel: 0935 5222 Ex. 352.

VOLUME 78
NUMBER 768
DECEMBER 1974

THE **aeronautical** JOURNAL

*Incorporating The Institution of Aeronautical Engineers and
The Helicopter Association of Great Britain*
Published Monthly

contents

*Editor: G. R. Wrixon, ARAeS,
TEng(CEI).
Assistant Editors:
Jay Wolff, David Scallan.*

*Secretary of the Society:
E. M. J. Schaffter, MA, CEng,
AFRAeS
4 Hamilton Place, London
W1V 0BQ. Tel: 01-499 3515.
Telegrams: Didaskalos, London, W1*

*Reproduction of any of the papers
published in this journal is not
permitted without the written
consent of the Editor.*

*None of the papers or paragraphs
must be taken as expressing the
opinion of the Council unless
otherwise stated.*

*Advertisements:
John G. Newman,
Wheelwrights, Dormansland,
Lingfield, Surrey RH7 8PS.
Tel: Lingfield (STD 0342)
832603.*

*Printed by
Lewes Press Ltd.,
Lewes, Sussex, England.*

*Subscriptions: £20 per annum,
post free.*

*Single copies, including back
numbers: £1.75.*

*Published by
The Royal Aeronautical Society,
4 Hamilton Place,
London W1V 0BQ, England.*

Cover picture:

The Rockwell International B-1, without doubt one of the most expensive aeroplanes yet built, faces many stringent tests on both the engineering and political fronts before any production order can be expected, in spite of it being priority number one for the USAF. Dr. Flax, president of the US Institute for Defense Analysis, drew attention to the trend in aerospace expenditure to increase on any new and advanced project at a rate faster than the nation's gross national product when he presented the 63rd Wilbur and Orville Wright Memorial Lecture earlier this month.

Dr. A. H. Flax

AERONAUTICS—A STUDY IN TECHNOLOGICAL AND ECONOMIC GROWTH AND FORM

537

D. R. Stanniland

THE EFFECT OF DEFLECTING FLAPS ON STRIKE/FIGHTER AIRCRAFT WING DESIGN

553

TECHNICAL NOTES

D. R. Smart, K. F. Gill, J. M. Gething and J. A. Holt

Dynamic analysis of flexible space vehicles having uncoupled control axes

560

M. Holland

Pure bending of beams having initial curvature

570

R. V. Williams and F. M. Burrows

Movement of a line vortex pair downstream of a circular cylinder in potential flow

573

Library, Reviews, Additions and Reports

579

Index

The Royal Aeronautical Society

FOUNDED 1866

INCORPORATED BY ROYAL CHARTER 1949

Patron: HER MAJESTY THE QUEEN

COUNCIL

President: B. P. LAIGHT, OBE, MSc, CEng, MIMechE, FRAeS

President-Elect: AIR MARSHAL SIR CHARLES PRINGLE, KBE, MA, CEng, FRAeS

Vice-Presidents:

C. ABELL, OBE, FSLAET, CEng, FRAeS
G. R. JEFFERSON, CBE, HonBSc, CEng, FRAeS
H. DAVIES, CB, MSc, CEng, FRAeS

Past Presidents:

S. D. DAVIES, CBE, BSc(Eng), CEng, FRAeS
K. G. WILKINSON, HonDSc, BSc, DIC, FCGI, CEng, FCIT, FRAeS
DR. G. S. HISLOP, PhD, BSc, ARCST, CEng, FRAeS

Members:

AIR CDRE F. R. BANKS, CB, OBE, HonCGIA, CEng, HonFAIAA, HonFRAeS,
RAF (Ret'd)
CAPTAIN E. C. BEARD, CBE, CEng, FIMechE, FRAeS, RN (Ret'd)
M. J. BRENNAN, BSc, CEng, FIMechE, FRAeS
F. R. J. BRITTEN, CBE, CEng, AFRAeS
D. G. BROWN, BSc, DIC, CEng, FRAeS
CAPTAIN E. M. BROWN, CBE, DSO, AFC, FRAeS, RN (Ret'd) (*Chairman, Rotorcraft
Section*)
PROF. L. F. CRABTREE, BSc, DIC, PhD, CEng, AFAIAA, FRAeS
M. G. FARLEY, CEng, FIMechE, MBIM, FRAeS
D. J. FARRAR, OBE, MA, CEng, FRAeS
WG. CDR. N. F. HARRISON, AFRAeS, (*President, Southern Africa Division*)
AIR VICE-MARSHAL F. S. HAZLEWOOD, CB, CBE, AFC, FRAeS
DR. W. F. HILTON, PhD, DSc, CEng, AFAIAA, FRAeS
W. ISBISTER, BSc, BE, CEng, FRAeS (*President, Australian Division*)
AIR CDRE J. R. MORGAN, OBE, BSc(Eng), CEng, FIMechE, FRAeS, RAF (Ret'd)
G. M. MOSS, MSc, CEng, AFRAeS
DR. E. S. MOULT, CBE, BSc, CEng, FIMechE, FRAeS
AIR CDRE F. C. PADFIELD, BSc, CEng, AFRAeS, (*Chairman, Astronautics and
Guided Flight Section*)
G. K. C. PARDOE, BSc(Eng), DLC, CEng, FBIS, FRAeS
T. R. PIKE, AFRAeS (*President, New Zealand Division*)
R. P. PROBERT, Esq, CB, MA, CEng, FRAeS
H. RADNITZ, CEng, AFRAeS, (*President, Rhodesia Division*)
J. T. STAMPER, MA, CEng, FRAeS
DR. A. M. THOMPSON, PhD, BSc(Eng), GradRAeS
G. T. WANSBROUGH-WHITE, ARAeS
G. E. WELLER, BTech, GradRAeS (*Chairman, Graduates' and Students' Section*)
H. ZEFFERT, CEng, FIEE, FRAeS

Officers:

Hon. Treasurer: C. F. HUGHESDON, AFC, FRAeS
Solicitor: L. A. WINGFIELD, MC, DFC (*Hon Companion*)
Secretary: E. M. J. SCHAFFTER, MA, CEng, AFRAeS