

INCLUDING  
SUPPLEMENTARY  
PAPERS



# THE AERONAUTICAL JOURNAL

JANUARY 1970

PRESIDENT'S NEW YEAR MESSAGE

SECRETARY'S NEWSLETTER

SUPPER CLUB RULES

**S. G. Hooker** THE ENGINE SCENE

**J. H. Argyris** THE IMPACT OF THE DIGITAL COMPUTER ON ENGINEERING SCIENCES  
(PART I)

**J. L. Edwards** ENGINE DEVELOPMENT IN AN OPERATORS' MARKET

TECHNICAL NOTES

**M. B. Benoy** The Determination of Solar Heating

**J. L. Stollery** A Comparison Between Some Approximate and Exact Solutions of the  
Laminar Boundary-Layer Equations

**D. G. Edwards** The Bursting Pressure of Metal Diaphragms in Square Section Shock Tubes

**Z. F. Reif** The Effect of Static Deflection on the Harmonic Resonance of a System with  
a Hardening Non-Linear Spring

THE LIBRARY

## SUPPLEMENTARY PAPERS

SYMPOSIUM ON MANAGEMENT TECHNIQUES OF GUIDED WEAPON  
DEVELOPMENT

**J. Dunham** EXPERIMENTS TOWARDS A CIRCULATION-CONTROLLED LIFTING ROTOR.  
PART I—WIND TUNNEL TESTS

27s 6d

THE ROYAL AERONAUTICAL SOCIETY

4 HAMILTON PLACE LONDON W1

# THE AERONAUTICAL JOURNAL

THE ROYAL AERONAUTICAL SOCIETY

Incorporating The Institution of Aeronautical Engineers and The Helicopter Association of Great Britain

Telephone: 01-499 3515    Telegrams: Didaskalos, London, W1

Published Monthly at 4 HAMILTON PLACE, LONDON W1V 0BQ

Subscriptions: £15 15s. 0d. per annum, post free    Single Copies: 27s. 6d.

VOLUME 74

NUMBER 709

JANUARY 1970

## CONTENTS

	Page
PRESIDENT'S NEW YEAR MESSAGE	I
SECRETARY'S NEWSLETTER	I
SUPPER CLUB RULES	II
<b>S. G. Hooker</b> THE ENGINE SCENE	1
<b>J. H. Argyris</b> THE IMPACT OF THE DIGITAL COMPUTER ON ENGINEERING SCIENCES (PART I)	13
<b>J. L. Edwards</b> ENGINE DEVELOPMENT IN AN OPERATORS' MARKET	42
TECHNICAL NOTES	
<b>M. B. Benoy</b> The Determination of Solar Heating	52
<b>J. L. Stollery</b> A Comparison Between Some Approximate and Exact Solutions of the Laminar Boundary-Layer Equations	55
<b>D. G. Edwards</b> The Bursting Pressure of Metal Diaphragms in Square Section Shock Tubes	57
<b>Z. F. Reif</b> The Effect of Static Deflection on the Harmonic Resonance of a System with a Hardening Non-Linear Spring	59
THE LIBRARY	63
<b>S U P P L E M E N T A R Y   P A P E R S</b>	
SYMPOSIUM ON MANAGEMENT TECHNIQUES OF GUIDED WEAPON DEVELOPMENT	
<b>G. W. Bridle</b> Sea Dart	69
<b>G. E. King</b> Project Management Techniques of Rapier	75
<b>P. R. Franks</b> The Management Organisation of the Martel Project	81
<b>F. Dossor</b> Management of the UK Polaris Project	85
<b>J. Dunham</b> EXPERIMENTS TOWARDS A CIRCULATION-CONTROLLED LIFTING ROTOR. PART I—WIND TUNNEL TESTS	91

*Editor:* JOAN BRUCE, BSc, CEng, AFRAeS.

*Secretary of the Society:* A. M. BALLANTYNE, OBE, TD, BSc,  
PhD, CEng, HonFCASl, FAIAA, FRAeS.

4 HAMILTON PLACE, LONDON, W1V 0BQ. Tel: 01-499 3515.

*Advertisements Only:*

H. E. SOUTHON

Magazine Advertising Ltd, 184 Fleet Street, London, EC4.

Tel: 01-242 0434/5.

*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.*

PRINTED BY THE LEWES PRESS WIGHTMAN & CO. LTD., LEWES, SUSSEX, ENGLAND, AND PUBLISHED  
BY THE ROYAL AERONAUTICAL SOCIETY, 4 HAMILTON PLACE, LONDON, W1V 0BQ, ENGLAND.

# DIVISIONS AND BRANCHES OF THE ROYAL AERONAUTICAL SOCIETY

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

*President: P. S. LANGFORD, FRAeS. Hon. Secretary: B. A. J. SCOLLES, AFRAeS, 191 Royal Parade, Parkville, Victoria 3052.*

## **Rhodesia** *Branches at: Bulawayo, Gwelo and Salisbury.*

*Hon. President: Sir HUMPHREY GIBBS, KCMG, OBE. President: G. A. FORD, AFRAeS. Hon. Secretary: Sqn. Ldr. D. Butler, P.O. Box 3759, Salisbury, Rhodesia.*

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

*President: T. T. N. COLERIDGE, FRAeS. Hon. Secretary: A. A. HOFFMAN, ARAeS, New Zealand National Airways Corp'n, P.O. Box 96, Wellington.*

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

*President: M. S. HUNT, AFRAeS. Hon. Secretary: Cmdt. F. W. CARNELL, AFRAeS, 11 Staal Road, Valhalla, Pretoria Dist.*

## **Bedford**

*President: F. O'HARA, FRAeS.  
Chairman: D. LEAN, AF, AFRAeS.  
Hon. Secretary: J. B. BERRY, AFRAeS,  
Aircraft Research Association, Manton  
Lane, Bedford. Tel: Bedford 67701.*

## **Belfast**

*President: P. F. FOREMAN, FRAeS.  
Chairman: J. H. McCLEAN, AFRAeS.  
Hon. Secretary: T. E. MORRISON, AFRAeS,  
Dept. of Mechanical Engineering College  
of Technology, College Square East,  
Belfast BT1 6DJ. Tel: Belfast 27244.*

## **Birmingham and Wolverhampton**

*President: L. W. J. NEWMAN, FRAeS.  
Chairman: R. F. HOLDNALL, ARAeS.  
Hon. Secretary: I. B. CRIPPS, AFRAeS,  
H. M. Hobson Ltd, Fordhouses, Wolver-  
hampton, Staffs. Tel: Fordhouses 2381.*

## **Boscombe Down**

*President: Air Cdre. C. D. A. BROWNE, DFC.  
Chairman: G. MACLAREN HUMPHREYS,  
MBE, FRAeS.  
Hon. Secretary: Flt. Lt. A. A. CLARK,  
E. Squadron, A & AEE, Boscombe Down,  
Amesbury, Salisbury, Wilts. Tel: Ames-  
bury 3331.*

## **Bristol**

*President: D. ROWLEY, FRAeS.  
Chairman: T. P. FROST, FRAeS.  
Hon. Secretary: R. HARDING, BAC Ltd,  
Filton, Bristol. Tel: Bristol 693831.*

## **Brough**

*President: Capt. E. D. G. LEWIN, CB, CBE,  
DSO, AFRAeS.  
Chairman: K. ESSEX-CROSBY, FRAeS.  
Hon. Secretary: A. D. HOWARTH, ARAeS,  
c/o Hawker Siddeley Aviation Ltd,  
Brough, Yorkshire. Tel: Brough 667121*

## **Cambridge**

*President: Professor W. A. MAIR, FRAeS.  
Chairman: R. O. GATES, FRAeS.  
Hon. Secretary: D. J. COLE, Marshall of  
Cambridge (Engineering) Ltd, The Air-  
port, Cambridge. Tel: Cambridge 56291.*

## **Chester**

*President: K. G. HANCOCK, FRAeS.  
Chairman: H. STRAWSON, AFRAeS.  
Hon. Secretary: V. W. CLARKSON, ARAeS,  
Hawker Siddeley Aviation Ltd, Broughton,  
Chester. Tel: Chester 24646.*

## **Christchurch**

*President: E. W. J. GRAY, FRAeS.  
Chairman: D. E. CAILES, AFRAeS.  
Hon. Secretary: A. L. RUCKLEY, AFRAeS,  
BAC Ltd, Design Office, Bournemouth  
(Hurn) Airport, Christchurch, Hants. Tel:  
Northbourne 3201.*

## **Coventry**

*President: R. W. F. FARTHING, FRAeS.  
Chairman: R. A. FIELD, ARAeS.  
Hon. Secretary: J. KIRKLAND, ARAeS,  
Dunlop Aviation Division, Design Dept,  
Holbrook Lane, Foleshill, Coventry. Tel:  
Coventry 88733.*

## **Cranwell**

*President: Air Vice-Marshal T. N. STACK,  
CB, CVO, CBE, AFC.  
Chairman: Wg. Cdr. J. SANDFORD, AFRAeS.  
Hon. Secretary: F. A. BRISTOW, AFRAeS,  
Dept of Engineering, RAF College, Cran-  
well, Sleaford, Lincs. Tel: Cranwell 201.*

## **Derby**

*President: Sir DENNING PEARSON,  
HonFRAeS.  
Chairman: S. L. BRAGG, FRAeS.  
Hon. Secretary: J. R. COWNIE, AFRAeS,  
Rolls-Royce Ltd, Derby, DE2 8BJ. Tel:  
Derby 42424.*

## **Dublin**

*President: Capt. J. C. KELLY-ROGERS, OBE,  
FRAeS.  
Chairman: A. J. WALLS, FRAeS.  
Hon. Secretary: Dr. K. J. HOLDEN, AFRAeS,  
Irish Helicopters Ltd, 3a Clyde Road,  
Ballsbridge, Dublin.*

## **Glasgow**

*President: Dr. A. W. BABISTER, AFRAeS.  
Chairman: G. M. ADDISON, AFRAeS.  
Hon. Secretary: T. K. BLACK, 43 Partickhill  
Road, Glasgow, W1.*

## **Gloucester and Cheltenham**

*President: Sir GEORGE DOWTY, HonFRAeS.  
Chairman: D. L. BROWN, FRAeS.  
Hon. Secretary: R. W. WHITE, AFRAeS, c/o  
Smiths Industries Ltd, Bishops Cleeve,  
Cheltenham, Glos. Tel: Bishops Cleeve  
3333.*

## **Halton**

*President: Air Vice-Marshal J. H. HUNTER-  
TOD, OBE, FRAeS.  
Chairman: Gp. Capt. M. F. HATTON, OBE,  
AFRAeS.  
Hon. Secretary: Flt. Lt. C. R. MILES,  
Officers' Mess, RAF Halton, Bucks. Tel:  
Wendover 2241.*

## **Hatfield**

*President: Sir HARRY BROADHURST.  
Chairman: G. R. WILKINSON.  
Hon. Secretary: G. B. EVANS, FRAeS,  
Drawing Office, Hawker Siddeley Aviation  
Ltd, Hatfield, Herts. Tel: Hatfield 2345.*

## **Isle of Wight**

*President: L. BODDINGTON, CEB, FRAeS.  
Chairman: D. J. HARDY, AFRAeS.  
Hon. Secretary: H. A. POOK, AFRAeS,  
British Hovercraft Corporation Ltd, East  
Cowes, Isle of Wight. Tel: Cowes 4121.*

## **London Airport**

*President: C. ABELL, OBE, FRAeS.  
Chairman: F. J. LOW, ARAeS.  
Hon. Secretary: N. BROWN, ARAeS, Tech-  
nical Publications, Technical Block A,  
G.3, BOAC, PO Box 10, Hounslow,  
Middlesex. Tel: Skyport 5511.*

## **Loughborough**

*President: Professor K. L. C. LEGG, FRAeS.  
Chairman: Dr. K. B. AYERS, FRAeS.  
Hon. Secretary: F. G. MACCABEE, AFRAeS,  
56 Holywell Drive, Loughborough, Leics.*

## **Luton and Stevenage**

*President: J. E. RIDGWAY.  
Chairman: Dr. W. F. HILTON, FRAeS.  
Hon. Secretary: D. B. COLLINS, ARAeS,  
English Electric Co. Ltd, Special Pro-  
ducts Group, The Airport, Luton, Beds.  
Tel: Luton 31441.*

## **Manchester**

*President: C. E. FIELDING, OBE, FRAeS.  
Chairman: G. A. WHITEHEAD, CBE, FRAeS.  
Hon. Secretary: J. A. E. WATERFALL, 137  
Walton Road, Sale, Cheshire. Tel:  
061 962 1695.*

## **Merthyr and Treforest**

*President: G. W. MOORE.  
Chairman: E. R. CHAYTOR, AFRAeS.  
Hon. Secretary: Dr. G. O. FORESTER,  
AFRAeS, Chief of Research, Teddington  
Aircraft Controls Ltd, Cefn Coed, Merthyr  
Tydfil, South Wales. Tel: Merthyr Tydfil  
3261.*

## **Preston**

*President: F. D. CROWE, FRAeS.  
Chairman: F. E. ROE, FRAeS.  
Hon. Secretary: L. A. WILLOTT, AFRAeS,  
BAC Ltd, Preston Division, Warton  
Aerodrome, Preston, Lancashire. Tel:  
Freckleton 531.*

## **Prestwick**

*President: R. McINTYRE, FRAeS.  
Chairman: J. LOGAN, AF.  
Hon. Secretary: J. FISHER, Scottish Aviation  
Ltd, Design Office, Prestwick Airport,  
Ayrshire. Tel: Prestwick 79888.*

## **Reading**

*President: E. N. MOBBS.  
Chairman: J. T. APPLEBY, FRAeS.  
Hon. Secretary: K. O. SCOTT, AFRAeS,  
M.L. Aviation Co Ltd, White Waltham,  
Maidenhead, Berks. Tel: Littlewick  
Green 3361.*

## **Southampton**

*President: A. N. CLIFTON, FRAeS.  
Chairman: D. C. EVANS, AFC.  
Hon. Secretary: P. W. FORTESCUE, AFRAeS,  
Dept. of Aeronautics and Astronautics,  
The University, Southampton. Tel: South-  
ampton 56331.*

## **Southend**

*President: J. R. BATT, ARAeS.  
Chairman: K. A. COLE, AFRAeS.  
Hon. Secretary: Mrs. M. SOLMAN, Stress  
Office, Aviation Traders (Eng) Ltd,  
Southend Airport, Essex. Tel: Southend  
49471.*

## **Swindon**

*President: W. GILLESPIE, AFRAeS.  
Chairman: E. J. DAVIS, AFRAeS.  
Hon. Secretary: G. N. GINGELL, AFRAeS,  
Vickers Ltd, South Marston, Swindon,  
Wilts. Tel: Stratton St. Margaret 3241.*

## **Weybridge**

*President: Sir GEORGE EDWARDS, CBE,  
FRS, HonFRAeS.  
Chairman: N. W. BOORER, FRAeS.  
Hon. Secretary: A. M. DOBSON, AFRAeS,  
BAC Ltd, Weybridge Division, Weybridge,  
Surrey. Tel: Weybridge 45555.*

## **Yeovil**

*President: E. C. WHEELDON, CBE, FRAeS.  
Chairman: Dr. G. S. HISLOP, FRAeS.  
Hon. Secretary: F. N. R. BALLAM, ARAeS,  
Westland Aircraft Ltd, Yeovil, Somerset.  
Tel: Yeovil 5222.*

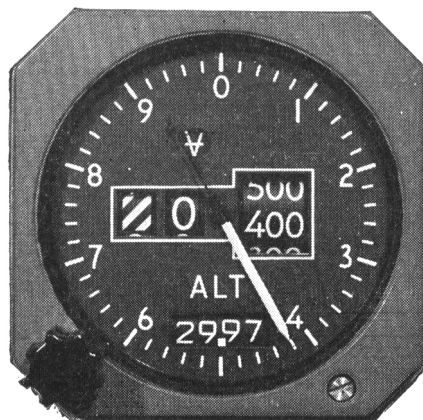
JANUARY 1970

# Mechanical C/P Encoding Altimeter from Smiths Industries

**A** programme of continuous development in the field of aircraft instrumentation has led to the recent introduction by Smiths Industries Aviation Division of a number of sophisticated new designs.

One of these, the Mechanical Counter/Pointer Altimeter, the 800 series, incorporates a 5-figure readout of altitude by means of counter drums which are driven without servo assistance—a major advance made possible by the development of a unique and more powerful capsule assembly. And the latest version has an optical digital encoder for height reporting to ARINC 548/549.

The five-digit presentation includes zeroes as part of the moving display, obviating the ambiguity that can otherwise occur with two- or even three-digit counter/pointer altimeters. Variants are available with either single or twin baroscales and integral lighting is standard. These altimeters conform to TSO C10b, and TSO C88.



The Pilot's Selector has been designed for solid mounting and carries the switches needed by the pilot to engage the Autostabiliser in the pitch and/or yaw modes. The unit is housed in a 2 ATI case conforming to ARINC 408, and electrical connections are made through a 19 pin connector.

## Smiths Industries—the power monitors.

Engine temperature and speed monitoring, temperature and speed control, overspeed protection and engine life recording are typical functions performed by the engine

equipment offered by Smiths Industries. We have more than 15 years' experience in



the design and manufacture of such accessories for many different types of gas turbine.

Monitoring and control equipment includes multi-function units for engines as advanced as the 3-shaft gas turbine. On the less sophisticated side, units have been produced for such applications as A.P.U.'s and booster engines, where the

engine is unattended, with no flight deck instrumentation other than warning lights.

Details of the existing range of Smiths engine equipment, and of the resources and enterprise that can be applied to new projects, are readily available from us.

## Capacitance fuel gauging systems—made to measure

During the past 20 years Smiths Industries have designed and manufactured fuel gauging systems for more than 50 types of fixed and rotating wing aircraft.

A recent innovation is the Type 8 system, which features micro-electronics and printed circuit boards, while retaining the flexibility of design and application that distinguished the earlier systems. A significant reduction in size has been achieved without loss of reliability, and the introduction of modular construction has simplified servicing.

A typical gauging system consists of a number of probes in the tank, and a fuel-contents amplifier/indicator.

Type 8 tank probes are self-compensating and each system is individually tailored to the airframe constructor's

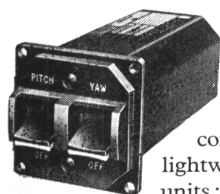
requirements, so that the highest practical level of accuracy can be provided for a given aircraft/altitude relationship. Additionally a total fuel contents summation indicator is available and fuel management facilities can be provided.



## Autostabilisation for Jaguar

An advanced technology autostabiliser system by Smiths Industries is specified for the BAC

Jaguar. The system, designed to augment the stability of high performance aircraft in both pitch and yaw, consists of only two lightweight compact units: the Pilot's

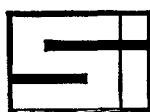


Selector and the Computer.

Incorporated in the Computer are two Smiths Series 400 Rate Gyroscopes for measurement of pitch and yaw rates and a manometric unit for gain scheduling as a function of airspeed and altitude throughout the flight envelope. The electronic assembly forms a separate unit within the computer case.

The outputs from the Computer drive three electro-hydraulic servo actuators, one in yaw and two in pitch.

The Computer power supply is 115V 400Hz.



**SMITHS INDUSTRIES LIMITED**  
AVIATION DIVISION

Head Office: Kelvin House, Wembley, Middlesex. Telephone: 01-452 3333. Telex 25366

# If you've got high hopes.

We provide the kind of service that helps to break records.

And here are two satisfied customers to prove it.

We fuelled the Royal Air Force's Hawker Siddeley 'Harrier' jump-jet when it streaked across the Atlantic in 6 hrs. 11 mins. 57 secs.

And Wing Commander Wallis called us in when he took the gyroplane altitude record in 1968.

You'll find Shell-Mex and B.P. at over 70 airfields in the U.K. Backed by the finest research and quality control going.

Ask for it. As you can see, you'll be in good company.



SHELL-MEX AND B.P. LTD. Operators in the U.K. of the Shell and the BP Aviation Services.

*Photograph: Crown copyright*

