

ADVANCES IN INSTRUMENTATION

Vol. 37 Part 2

October 18-21, 1982

ADVANCES IN INSTRUMENTATION

VOLUME 37, Part 2

**Proceedings of the ISA International Conference
and Exhibit**

**Philadelphia, Pennsylvania
October 18-21, 1982**

Programmed By

ISA Technology Department Divisions

Analysis Instrumentation
Automatic Control Systems
Cryogenic Instrumentation

Computer Technology
Management

PUBLICATION POLICY

Technical papers may not be reproduced in any form without written permission from the Instrument Society of America. The Society reserves the exclusive right of publication in its periodicals of all papers presented at the annual ISA Conference, at ISA Symposia, and at meetings co-sponsored by ISA when the Society acts as publisher. Papers not selected for such publication will be released to authors upon request.

In any event, following oral presentation, other publications are urged to publish up to 300-word excerpts of ISA papers, provided credits are given to the author, the meeting, and the Society using the Society's name in full, rather than simply "ISA."

Reprints of articles in this publication are available on a custom printing basis at reasonable prices in quantities of 50 or more.

For further information concerning publications policy and reprint quotations, contact:

Publications Department
Instrument Society of America
67 Alexander Drive
P. O. Box 12277
Research Triangle Park
N. C. 27709
Phone: (919) 549-8411
Telex: 802 540 ISA DURM.

LIBRARY of CONGRESS CATALOG CARD NO. 56-29277

ISBN 0-87664-701-8

Copyright © INSTRUMENT SOCIETY OF AMERICA 1982

All rights reserved.

Printed in U.S.A.
By
Technical Communication Services

ACKNOWLEDGMENTS

1982 EXECUTIVE COMMITTEE

President
Louis G. Good
Systems Service Corporation

President-Elect Secretary
Leslie M. Zoss
Valparaiso University

Treasurer
Alan J. Robertson
Techline, Inc.

Past President
Darrell R. Harting
Boeing Aerospace Company

DEPARTMENT VICE PRESIDENTS

EDUCATION DEPARTMENT

Vice-President
Donald R. Gillum
Texas State Technical Institute

INDUSTRIES and SCIENCES DEPARTMENT

Vice President
Sterling Lands, II
Monsanto Company

LONG RANGE PLANNING DEPARTMENT

Vice-President
Duane E. Williams
Amoco Chemical Corporation

PUBLICATION DEPARTMENT

Vice-President
William J. Cunneen
Stone and Webster Engineering

STANDARDS and PRACTICES DEPARTMENT

Vice-President
Thomas J. Harrison
IBM Corporation

TECHNOLOGY DEPARTMENT

Vice-President
J. Lawrence Howard
Boeing Aerospace

ISA HEADQUARTERS

Glenn F. Harvey
Executive Director

FOREWORD

"Energy Instrumentation" was the theme for the ISA/82 International Conference & Exhibit held October 18 through 21 at the Philadelphia Civic Center, in Philadelphia, PA. As we proceed through the 80's with all phases of energy being uppermost in our daily lives, we find we must conserve and find alternates to the types to which we have become accustomed. As these energy sources change so also do the measurement methods and devices.

Due to the high interest in our theme we have produced this year the greatest number of technical sessions in ISA history. The program consisted of 90 sessions including 17 clinics, 7 panels, 6 tutorials, a workshop and a roundtable. More than 160 technical papers were presented and 11 of the sessions reflected directly our theme of "Energy Instrumentation". Eighteen Divisions within the Industries & Sciences Department, Technology Department, and Education Department contributed to this excellent program by sponsoring the above technical sessions. We also have a new group, Electro Optics, formed this year and they presented some very fine sessions on fiber optics, and optical instrumentation.

We are indebted to everyone, the authors, session chairmen, coordinators, reviewers, and others who made this program to be one of the finest and well attended. We are grateful for the contribution of authors from Japan, England, Canada, Australia, and Singapore who helped make it indeed an International Conference.

We hope these proceedings will contribute to your professional growth and may they become a useful tool in the accomplishment of those professional endeavors.

George W. McGee
Program Chairman

TABLE OF CONTENTS

ISA/82 Philadelphia

PART I

701	LONG-WAVE ACOUSTIC FLOWMETER, J. E. Potzick and B. Robertson, National Bureau of Standards	1
702	INSTRUMENTATION TO IMPROVE RELIABILITY OF TURBO-MACHINERY, Robert S. Adamski, Exxon Chemical Americas	15
703	INSTRUMENTATION R&D FOR THE GAS INDUSTRY, Sami Atallah, Raymond A. Day and L. L. Altpeter, Jr., Gas Research Institute	29
704	USER DEVELOPED ENHANCEMENTS OF A TURNKEY COMPUTERIZED DRAFTING SYSTEM, Roger H. Volk and Eugene J. Lapointe, Monsanto Company	37
705	COMPUTER AIDED DESIGN AND DRAFTING FOR INSTRUMENTATION AND CONTROL ASPECTS OF ENGINEERING PROJECTS, E. C. Whidden, J. C. Townend and R. L. Bell, Monenco Computing Services	45
706	VIDEO INSTRUMENT CONTROL, Andrew Lippman, Massachusetts Institute of Technology	57
707	COMPUTER AIDED DESIGN AND DRAFTING, Randall W. Dear, Brown & Root, Inc.	67
708	DESIGNING THE PIPING SYSTEM FOR USE OF VARIABLE AREA FLOW MEASUREMENT, Charles E. Fees, Fischer & Porter Co.	87
709	DESIGNER APPRENTICESHIP: A UNIQUE APPROACH TO IN-HOUSE TRAINING, Warren E. Robinson, Fluor Engineers and Constructors.....	97
710	CONTROL CENTERS - FROM SPEC TO JOB SITE, Richard W. Borut, M. W. Kellogg Company	109
711	RECENT APPLICATION OF UNIQUE NONINVASIVE DOPPLER TRANSDUCERS FOR FLOW MEASUREMENTS, James D. Baird, Dynasonics, Inc.	127
715	CALIBRATION OF LARGE PROCESS WEIGHING SYSTEMS, James J. Pinto, Hardy Scales, Inc.....	137
719	ENERGY MANAGEMENT - COMPUTER, Ronald D. Wells, Hubinger Company.....	145
725	COMPUTER INTEGRATED CONTROL, Theodore J. Williams, Purdue Laboratory for Applied Industrial Control	167
726	DEVELOPMENT OF ON-LINE WALL THICKNESS GAGE FOR SEAMLESS STEEL TUBES, Yutaka Funyu and Tadashi Okumura, Kawasaki Steel Corp.; Asao Monno, Fuji Electric Company	191
728	PATTERN RECOGNITION, R. K. Aggarwal and B. R. Suresh, Honeywell Systems and Research Center.....	199
729	THE INLAND STEEL COMPANY UTILITIES DISPATCH SYSTEM Mark S. Borowiak and Spiros P. Arethas, Inland Steel Co.	217

730	LIQUID CENTRE AND HOT CENTRE ROLLING OF INGOTS USING ON-LINE COMPUTER CONTROL, J. R. Cook and T. R. Dishun, Armco, Inc.	235
731	SENSOR DEVELOPMENT INITIATIVES BY THE STEEL INDUSTRY, Roger L. Whiteley, Bethlehem Steel Corporation	251
732	ON-LINE INSPECTION OF STEEL STRIP FOR SURFACE DEFECTS, Jack B. Morgan, Allegheny Ludlum Steel Corp.	257
733	STATUS ON THE DEVELOPMENT OF A SENSOR FOR THE MEASUREMENT OF INTERNAL TEMPERATURE DISTRIBUTIONS IN HOT BODIES OF STEEL, Robert G. Watson, Republic Steel Corporation	267
734	AISI TASK UNIT 3-4: DEMONSTRATION OF AN AUTOMATIC SYSTEM FOR DETECTION OF PIPE AND GROSS POROSITY IN HOT STEEL BILLETS, BLOOMS, OR SLABS, C. D. Rogers, U.S. Steel Corporation	275
735	RAPID IN-PROCESS ANALYSIS OF MOLTEN METAL — A CRITICAL STEELMAKING NEED, Fred A. Achey, Bethlehem Steel Corporation	287
736	INFRARED THERMOMETRY FOR LOW EMISSIVITY METALS, Michael J. Haugh, Kaiser Aluminum & Chemical Corporation	295
737	HIGH TEMPERATURE EDDY CURRENT MEASUREMENT AND ANALYSIS, J. P. Wallace, D. C. Kunerth and R. M. Siegfried, Casting Analysis Corporation; T. L. VanderWert, Laserdyne Corporation	309
738	AUTOMATED INSPECTION OF HOT STEEL SLABS, Erik T. Tromborg and Gerald D. Hunter, Honeywell, Inc.	323
740	CONTROL DESIGN FOR AN INTEGRATED GASIFICATION COMBINED CYCLE, Anami S. Patel, General Electric Company	339
742	GASIFIER INSTRUMENTATION NEEDS, John E. McDaniel, Electric Power Research Institute	343
745	BALANCING BOILER INPUTS TO ENERGY DEMAND — ONE OF THE BASIC CONSIDERATIONS IN THE DESIGN OF CONTROLS FOR DRUM TYPE BOILERS, Richard H. Morse, Leeds & Northrup Company	349
746	THE CALCULATION OF HEAT EXCHANGER GAINS BY THE EFFECTIVENESS — NTU METHODS, Mark Rothstein, P.E.	361
747	BOILER CONTROL MODERNIZATION USING TODAY'S TECHNOLOGY, Lamar Pond, Honeywell, Inc.; Charlie Hein, Southern Indiana Gas & Electric Company	367
755	MEASURING AND MODELING ENERGY CONSUMPTION OF TEXTILE PROCESSES, Y. Isaac Szmuiłowicz, Gary N. Mock and Perry L. Grady, N. C. State University	371
756	A MODERN APPROACH TO CONTROLLING DYE MACHINES IN THE TEXTILE INDUSTRY, Clifford T. Johnson, Bailey Controls Company	379
757	ENERGY MANAGEMENT APPLICATIONS IN TEXTILES, Phil Hudson, Southern Bell Telephone	385

760	COMPUTER CONTROL OF AIR NITRIFICATION, Harry A. Fertik and Christopher Lutman, EMA, Inc.; Robert Werner, Washington Suburban Sanitary Commission	403
761	SUPERVISORY CONTROL AND DATA ACQUISITION OF WATER DISTRIBUTION SYSTEMS — AN OVERVIEW, Alan R. Dewey, ECC, Inc.	415
762	VIRGINIA BEACH, VIRGINIA WATER CONTROL CENTER — AN OVERVIEW AND UPDATE, Jack L. Thompson and Walter G. Miles, Wiley & Wilson	427
763	A COMPUTER-ASSISTED CONTROL SYSTEM FOR WATER DISTRIBUTION AS IMPLEMENTED FOR THE SUFFOLK COUNTY WATER AUTHORITY, Robert V. Wertz, Suffolk County Water Authority; John B. Trevor, III, Coldspring Instrument Corp.	437
764	COMPUTER CONTROL SCHEME OF WATER DISTRIBUTION NETWORK, Shin'ichiro Miyaoka, Motohisa Funabashi, Teruo Takagi, Fumito Shinomiya, Tohru Ohto and Shigeyuki Shimauchi, Hitachi, Ltd.	447
769	START-UP EXPERIENCES WITH PROGRAMMABLE CONTROLLERS, Thomas Langer and Howard I. Last, Malcolm Pirnie, Inc.	461
770	MICROPROCESSOR — CONTROLLED AUTOMATIC FILTER BACKWASH, Ernest R. Coppock, III, New Haven Water Co.	465
772	CONSIDERING MICROCOMPUTERS AND PROGRAMMABLE CONTROLLERS FOR USE IN A WATER TREATMENT PLANT, Francis W. Bailey, Jr. and Jack Chadowitz, Metcalf & Eddy, Inc.	471
774	LOW COST DATE LOGGER SOLVES METERING STATION BILL DATA REQUIREMENT, John Crossley, Greater Lawrence Sanitary District; Richard H. Eastman, Kaye Instruments, Inc.	477
775	USING DISTRIBUTED COMPUTERS IN TELEMETRY AND DATA TRANSMISSION, Graham D. Bogel, Bristol Babcock, Inc.	479
776	DIGITAL SUPERVISORY CONTROL AND MONITORING SYSTEM USING UHF RADIO FOR CITY OF FT. LAUDERDALE, FLORIDA, E. F. Morey and R. J. Glass, The Turbitrol Company; Allen B. Roberts and R. L. Nielsen, City of Ft. Lauderdale	491
777	A TELEMETRY-DISTRIBUTED CONTROL SYSTEM MANAGEMENT HYBRID, Jack Chadowitz, Metcalf & Eddy, Inc.	503

TABLE OF CONTENTS ISA/82 Philadelphia

Part II

801	NUCLEAR QUALIFICATION OF INSTRUMENTATION AND ITS BENEFITS TO OTHER INDUSTRIES, R. D. Adams and C. C. Comins, The Foxboro Company	511
803	USE OF GAS CHROMATOGRAPHS AT THE FORT LEWIS SRC PILOT PLANT, Carl D. Ackerman, Consultant.....	521
804	CHROMATOGRAPHIC ANALYSIS OF CHEMICALS DERIVED FROM COAL CARBONIZATION, Dan P. Manka, Consultant	531
806	EVALUATION OF INFRARED AND PHOTOIONIZATION DETECTORS IN THE CHARACTERIZATION OF COMPLEX MIXTURES, Joel A. Yancey, Standard Oil Company	547
810	A SEQUENTIAL PREDICTIVE STRATEGY FOR DIGITAL PROCESS CONTROL, Lin S. Tung, Monsanto Company	559
811	THE DESIGN OF INDUSTRIALLY USEFUL ADAPTIVE CONTROLLERS, Edgar H. Bristol, The Foxboro Company.....	569
812	PULP MILL PRODUCTION CONTROL — THEORY AND EXPERIENCES OF A MILL-WIDE APPROACH, Hans Sigvardsson and Olof Strandell, ASEA Industrial Systems, Inc.	583
813	CONTROL AND INSTRUMENT FEATURES OF AN ENERGY OPTIMIZATION SYSTEM, J. D. Robnett, Du Pont Company	591
814	AN OVERVIEW OF DISTRIBUTED PROCESS CONTROL AND MOTOR CONTROL WITH A MASTER COMPUTER, William R. Hodson, Leeds & Northrup Company	605
815	MICROPROCESSOR BASED DISTRIBUTED CONTROL SYSTEM WITH SPLIT ARCHITECTURE, Keisuke Takada, Akihiro Uyetani and David W. Fable, Toshiba Corporation	617
816	A SELF-TUNING CONTROLLER, H. S. Hoopes, W. M. Hawk, Jr. and R. C. Lewis, Leeds & Northrup Company	627
817	PRIMARY AUTOMATION CONTROLLER (PAC) FOR TRUE DISTRIBUTED CONTROL, Charles E. Stires, Inconix Corp.	653
818	COMPUTERIZED BATCH PROCESS MANAGEMENT, William M. Franey and L. VanDerJagt, Taylor Instrument Co.	669
819	BATCH CONTROL METHODOLOGY, K. Kumar Gidwani, Honeywell	681
820	EMERGING BATCH CONTROL SYSTEMS, S. Bansal, Polaroid Corporation	693
821	DEVELOPING A BATCH PROCESS COMPUTER CONTROL LANGUAGE, John C. Ward and Michael R. Scalera, Setpoint, Inc.	713
830	CRYOGENIC THERMOMETRY & INSTRUMENTATION FOR THE EARLY 1980's, Warren G. Pierce and David J. Bartos, Lake Shore Cryotronics, Inc.	721
831	VALVE DESIGN FOR CRYOGENIC SERVICE, Michael E. Miles, Jamesbury Corporation	735

832	LIQUID HELIUM, ITS AVAILABILITY AND EFFECT ON CRYOGENIC SYSTEMS OVER THE NEXT DECADE, David L. Swartz, Cryosystems, Inc.	747
835	ON-LINE OPERATOR TRAINING SIMULATOR INTEGRATED IN A CAT CRACKER DISTRIBUTED MICROPROCESSOR CONTROL SYSTEM, P. Sommelet, Shell Francaise; J. C. Presenti, Controle Bailey	751
836	COMPUTER APPLICATIONS IN INSTRUMENTATION FOR CHEMICAL ANALYSIS, T. P. Wampler, S. A. Liebman and E. J. Levy, Chemical Data Systems, Inc.	755
837	THE DESIGN OF A MAN-MACHINE INTERFACE FOR PROGRAMMABLE CONTROLLERS, Karl H. Brackhaus, Dynapro Systems, Inc.	759
838	BATCH AUTOMATION — A HISTORICAL PERSPECTIVE, John P. Schratz, Johnson Controls, Inc.	767
839	ROASTING COFFEE WITH A PROGRAMMABLE CONTROLLER, Paul Kafer, General Foods Corporation	775
840	MODULAR STRUCTURING OF BATCH CONTROL LOGIC, Asish Ghosh, The Foxboro Company	783
841	THE APPLICATION OF COMPUTER SYSTEMS IN REFINERY OIL MOVEMENTS OPERATION, Robert S. Czech, Exxon Research and Engineering Company	797
842	TOUCH SENSITIVE GRAPHICS TERMINAL APPLIED TO PROCESS CONTROL, Scott I. Bennion and James P. Creager, Westinghouse Hanford Company; Robert D. VanHouten, Boeing Computer Services	823
843	A NEW TOOL FOR PANELLESS OPERATION, Hiroo Okuhara, Akihiro Uyetani and Lewis Smith, Toshiba Corporation	833
846	A GENERAL PURPOSE SCHEME FOR IMPLEMENTING INTELLIGENT BATCH DEVICES, William T. Shaw, EMC Controls, Inc.	843
847	INTERUNIT SYNCHRONIZATION IN BATCH SYSTEMS, Howard P. Rosenof, The Foxboro Company	863
849	FINANCIAL MODELS FOR JUSTIFICATION OF COMPUTER SYSTEMS, Ivan Erickson and John R. Purvis, III, Texas Instruments	879
850	MICROPROCESSORS: SELECTING THE "RIGHT SYSTEM" FOR YOUR MEASUREMENT/CONTROL APPLICATION, P. Y. Keskar, Merck & Co., Inc.	891
851	TWO VIEWS OF "TOTAL SYSTEM" PRODUCT ANALYSIS, Dennis M. Smith, Honeywell, Inc.	903
852	A BASIC LANGUAGE COMMUNICATIONS LINK FOR PROCESS CONTROL, W. H. MacIntosh and W. J. Barnett, Daniel International Corporation	915
853	CCTV: A DATA WAY APPLICATION AT DUPONT SABINE RIVER WORKS, Randolph S. Knipp, E. I. du Pont de Nemours	921
855	ENGINEERING USES OF PERSONAL MICRO-COMPUTERS, Charles G. Laspe, Honeywell, Inc.	927

856	TWO AND THREE DIMENSIONAL GRAPHICS FOR ENGINEERS USING A LOW-COST MICROCOMPUTER, K. C. Ng and Y. F. Chen, National University of Singapore	943
858	INDUSTRIAL UTILITIES MANAGEMENT SYSTEMS — CAN THEY BE JUSTIFIED, Charles G. Laspe, Honeywell, Inc.	955
862	HIGHLY RELIABLE DISTRIBUTED CONTROL SYSTEM WITH CUSTOM LSIs, Nobuhiro Hayada, Norihiko Sugimoto, Jinichi Sakurai and Tetsuo Suehiro, Hitachi, Ltd.....	977
863	MICROCOMPUTER DATA ACQUISITION FOR A SOLAR/WIND HYBRID ELECTRICAL ENERGY SYSTEM, Reinhold M. W. Strnat and Louis I. Boehman, University of Dayton; Wayne S. Bishop, Air Force Wright Aeronautical Labs	985
864	FIBRE OPTICS IN INDUSTRY, M. P. Klaassen, Polysar Limited	993
865	AUTOMATING COAL GASIFICATION SYSTEMS BY USING PROCESS CONTROL COMPUTERS, John B. McDaniel and C. R. Stewart, Honeywell, Inc.....	1005
868	A REVIEW OF TECHNIQUES FOR ACHIEVING HIGH RELIABILITY IN HARDWARE AND SOFTWARE, John H. Wensley, August Systems, Inc.	1023
875	WHY NOT BE AN ADAPTIVE MANAGER, Frederick A. Meier, Bechtel Canada Limited	1033
876	TECHNICAL RECRUITING THROUGH SYSTEMATIC SELECTION, James M. Cialdella, Stearns-Roger Engineering Corp	1037
878	DEVELOPING AN INSTRUMENT ENGINEER, Donald H. Olson, M. W. Kellogg Company	1041
879	"THE VIEW FROM OVER YOUR DONKEY" (CAREER DEVELOPMENT AND DECISION MAKING), Dennis Walsh, Dennis Walsh and Associates; Donald K. Wright, Brown & Root, Inc.	1047

TABLE OF CONTENTS

ISA/82 Philadelphia

Part III

881	AIR ELIMINATION TECHNIQUES FOR ACCURATE LIQUID MEASUREMENT, Jack R. Chester, Emerson Electric Company	1053
882	TURBINE METERS FOR LIQUID MEASUREMENT, Barry A. Ellison, Emerson Electric Company	1065
883	GAS FLOW MEASUREMENT BY VORTEX FLOWMETER, Yoshio Fukai, Ichizoh Itoh, Kenichi Yoshioka and Akira Ohya, Yokogawa Electric Works; Charles M. Flora, Yokogawa Corporation of America	1075
885	ENERGY SAVING OPERATION FOR WATER SERVICE PUMPS Ken-ichi Kurotani, Fuji Facom Corporation; Kiyoshi Kasama, Fuji Electric Co., Ltd.	1087
886	INTERFACING TO VARIABLE SPEED MOTOR CONTROLLERS, Curtis R. Wasko, Robicon Corporation	1097
887	COMPACT PROVER, Edward J. Dahn, Emerson Electric Co.	1105
888	A NEW CONCEPT IN MAGNETIC FLOWMETER DESIGN, Raymond C. Mills, Jr. and Elmer D. Mannherz, Fischer & Porter Co	1115
889	TWO WIRE TOTALIZER WITH INDICATION AND SQUARE ROOT EXTRACTION, Herbert A. Shauger, Fischer & Porter Co.	1131
890	AN ELECTRONIC-PNEUMATIC TEMPERATURE CONTROLLER, Gordon Kramer and Lynn Whitehead, Fisher Controls International	1149
891	HPSLC — HIGH PERFORMANCE SINGLE LOOP CONTROL, A. Salim and P. S. Zagar, Bristol Babcock, Inc.....	1153
892	USE OF HIGH GAIN PNEUMATIC AMPLIFIER IN COMMON FUNCTION PNEUMATIC INSTRUMENTS, Robert H. Batey, Brandt Industries, Inc.	1171
893	MAGNETIC FLOWMETER DEVELOPMENT, Frank D. Banta, Emerson Electric Company	1183
894	POSITIVE DISPLACEMENT LIQUID METERS, R. Gary Barnes, Emerson Electric Company	1197
895	A VORTEX FLOWMETER WITH 2 ACTIVE VORTEX GENERATORS, Peter J. Herzl, Fischer & Porter Co.	1205
896	INTELLIGENT MAN-MACHINE INTERFACE KEY TO HIGH PERFORMANCE SINGLE-LOOP CONTROL, Neil D. Johnson, Bristol Babcock, Inc.	1217
897	PRACTICAL IMPLÉMENTATION OF ADVANCED PROCESS CONTROL, R. Rammler and M. Togneri, Powell Process Systems, Inc.	1235
898	A DISTRIBUTED PROGRAMMABLE CONTROLLER SYSTEM FOR BATCH CONTROL, Gary R. Larsen, Eastman Kodak Co.	1243
899	CONTRACTOR HANDLING OF ENGINEERING FOR DISTRIBUTED CONTROL SYSTEM — EVOLUTION OR REVOLUTION, Trevor C. Haines and Frederick A. Meier, Bechtel Canada Ltd.	1251

900	RETROFITTING AN EXISTING PLANT WITH A DISTRIBUTED CONTROL SYSTEM, F. P. Bader, Moore Products Co.	1271
901	CONTROL VALVE AND PROCESS STABILITY, Gayle E. Barb, Bechtel Petroleum, Inc.	1277
902	HOW TO ESTIMATE AERODYNAMIC VALVE THROTTLING NOISE: A FRESH LOOK, Hans D. Baumann, H.D. Baumann Assoc., Ltd.	1299
903	THE EFFECTS OF NON-IDEAL GASES ON VALVE SIZING, Allen C. Fagerlund and Richard J. Winkler, Fisher Controls International, Inc.	1323
904	AN INTELLIGENT RECORDER: AN ELEMENT OF HIGH PERFORMANCE SINGLE LOOP CONTROL, John N. Raven and John M. O'Neil, Bristol Babcock, Inc.	1335
906	AN AUTO-TUNING PID CONTROLLER, Kazutaka Nagakawa and Takashi Shigemasa, Toshiba Corporation; Yoshitomo Hanakuma, Idemitsu Petrochemical Corporation Limited	1353
908	ELASTOMERS FOR CAVITATION DAMAGE RESISTANCE, Robert C. Sanderson, Fisher Controls International, Inc.	1363
909	THE INDUSTRIAL DETECTION AND EVALUATION OF CONTROL VALVE CAVITATION, Marc L. Riveland, Fisher Controls International, Inc.	1371
910	THE DETERMINATION OF MINIMUM BYPASS FLOWS FOR BOILER FEED PUMP SYSTEMS, W. Stanley Tinney, Target Technology, Ltd.	1387
911	CENTRIFUGAL PUMP RECIRCULATION SYSTEMS, Peter P. Van Blarcom, Yarway Corporation	1397
912	DISPLACER OPERATED LEVEL CONTROLS FOR TANK SPILL PREVENTION, Frank Webb, Emerson Electric Company....	1405
916	DIGITAL EXTENSIONS OF THE MODIFIED SMITH PREDICTORS, C. C. Hang and Q. Y. Tham, National University of Singapore	1413
917	RELIABILITY IN BATCH CONTROL PROCESSES, John H. Wensley, August Systems, Inc.	1423
918	OPTIMIZATION METHODS IN NATURAL GAS TRANSMISSION, Abdul Baqui, Northwest Pipeline Corporation	1437
919	ENERGY SAVINGS THROUGH ADVANCED CENTRIFUGAL COMPRESSOR PERFORMANCE CONTROL, R. Rammler, Powell Process Systems, Inc.	1445
920	ENERGY SAVINGS THROUGH ADVANCED CONTROL OF SOAKING PITS, Roman Rammler, Powell Process Systems, Inc.; Mark Urda, Synergy Systems, Inc.	1455
922	APPLICATIONS OF REGULATING VALVES IN THE POLLUTION CONTROL FIELD, Robert N. Adams and William A. De Chiara, Sonic Development Corporation	1461
923	REGULATING VALVES — ADVANCES IN THE STATE OF THE ART, Paul L. Ochs and Jeffrey Kasoff, Kaye & MacDonald, Inc.	1471
924	THE USE OF WET STEAM ACCUMULATORS AND PRESSURE REGULATING VALVES, Marvin H. Cunningham, Tri Manufacturing and Sales Company	1477

925	APPLICATIONS OF INSTRUMENTATION TO THE TEST & CONTROL OF A WIND TURBINE, Peter Kaiteris and Erik Eriksen, Grumman Aerospace Corporation	1485
926	PLANT INSTRUMENTATION FOR PETROLEUM RECOVERY FROM THE TAR SANDS, J. R. (Bob) Connell, Syncrude Canada Ltd.	1493
927	INSTRUMENTATION OF THE BROOKHAVEN NATURAL THERMAL STORAGE HOUSE, H. T. Ghaffari and R. J. Jones, Brookhaven National Laboratory	1505
928	EVALUATION OF O-2 AND CO MONITORING SYSTEMS FOR COMBUSTION CONTROLS, C. Presser, H. G. Semerjian and M. Juberts, National Bureau of Standards.....	1515
931	IN SITU MICROPROCESSOR BASED CO, OXYGEN AND OPACITY STACK EMISSION MONITORING TECHNIQUES FOR IMPROVING THE COMBUSTION EFFICIENCY OF INDUSTRIAL FUEL-BURNING EQUIPMENT, Robert C. Molloy, Dynatron, Inc.	1537
941	A SOFTWARE FAULT TOLERANT DATA ACQUISITION SYSTEM FOR REENTRY VEHICLE TESTING, Jorge Lopez, Walter D. Downing, Jr., and Bryan D. Winn, Southwest Research Institute	1545
942	KALMAN MILEAGE PREDICTOR-MONITOR, Jerry J. Lobdill, Tracor, Inc.	1555
943	USING AN OPTICAL HIGHWAY FOR DISTRIBUTED ARCHITECTURE OF INDUSTRIAL CONTROL SYSTEMS, Samuel M. Herb, Leeds & Northrup Company	1565
944	MICROCOMPUTERS IN SOLAR ENERGY RESEARCH: THREE CASE HISTORIES, J. Michael Callahan and David R. Jackson, The University of Connecticut.....	1571
945	A SIMULATION MODEL OF A FLAT PLATE SOLAR ENERGY CONTROL SYSTEM, George E. Mobus	1585
946	SUBCRITICAL FLIGHT FLUTTER TESTING, Charlie D. Turner, North Carolina State University	1591
951	THE PRECISION ERROR IN TEMPERATURE FOR SEVERAL COMMERCIAL FIXED POINT BATHS, R. P. Benedict, Westinghouse Electric Corporation	1607
954	PRECISION HUMIDITY MEASUREMENT, John C. Harding, Jr., General Eastern Instruments Corporation	1617
955	RMS — A DISTRIBUTED, SMART, WIRE REPLACEMENT SYSTEM FOR THREE NUCLEAR POWER PLANTS, William F. Trover, Teledyne Controls Company	1631
956	INTRINSIC SAFETY: PREVENTION NOT CURE, Robin Garside, Safety Technology Limited.....	1645
971	SENSING WITH OPTICAL FIBERS: AN EMERGING TECHNOLOGY, Albert R. Tebo, Electro-Optical Systems Design	1655
972	FIBER OPTIC SENSORS IN INDUSTRIAL APPLICATIONS: AN OVERVIEW, David A. Krohn, EO Tec Corporation	1673
975	THE IBM HOLOGRAPHIC SUPERMARKET SCANNER, LeRoy D. Dickson, IBM Communication Products Division	1685

- 978 CHOOSING COMPONENTS FOR INDUSTRIAL FIBER
OPTIC SYSTEMS, Jeff D. Montgomery, Electronicast Corporation 1691
- 979 DISTRIBUTED CONTROL USING FIBER OPTIC DATA
HIGHWAY, Paul M. Blaiklock, Leeds & Northrup Company 1697

