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PROCEEDINGS

OF THE

NATIONAL CONFERENCE

ON

FLUID POWER

SEPTEMBER 13-14-15, 1972

VOLUME XXVI

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TWENTY-EIGHTH ANNUAL MEETING



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Graduate School of Illinois Institute of Technology

IIT Center

Chicago, Illinois 60616



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NATIONAL CONFERENCE

ON

FLUID POWER

SEPTEMBER 13-14-15, 1972

VOLUME XXVI

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TWENTY-EIGHTH ANNUAL MEETING

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ANNOUNCEMENT

The National Conference on Fluid Power, formerly designated as the National Conference on Industrial Hydraulics, was organized in 1945 as a joint undertaking of the leaders in the field of industrial oil hydraulics and by the Graduate School of Illinois Institute of Technology. This one day session was so effective in answering the local need that annual conferences were instituted.

Changes in the industry and continued expansion of the technology of fluid power so progressed that in 1964 the name National Conference on Fluid Power was adopted.

Members of the Board of Governors of NCFP appreciate the support of industries involved in fluid power applications and will make every effort to present the type of conference program in the future which will merit their continued support. Recommendations for continued growth and improvement in service are solicited from industrial representatives.

P. Chiarulli, Chairman
Board of Governors

F O R E W A R D

The National Conference on Fluid Power was organized in 1945 as a joint undertaking of leaders in the field of industrial hydraulics and by the Graduate School of Illinois Institute of Technology. A conference has been held every year since then and, except for the First and Second Conferences, proceedings have been published for each Conference. This volume is Volume XXVI, the proceedings of the 28th Annual Meeting, September 13-14-15, 1972.

The purpose of the NCFP is to make available a national forum for the presentation of the latest developments and applications in the field of fluid power. The purpose of the proceedings is to record the essence of spoken words and thus extend the link between speaker and audience in time and space. A review of twenty-five volumes of proceedings would show that the Conference grew hand-in-hand with the development of fluid power over these years and, because of its flexibility was, and still is, ready to receive contributions from entirely new fields of application. Yet traditional subjects are also well represented and make the proceedings a valuable source of reference of world-wide distribution.

The sponsors of NCFP wish to express their appreciation to the many organizations and individuals who contributed to making the Conference successful. Particular thanks are due to the authors of the papers included in this volume. Their efforts and cooperation have made possible these proceedings.

William R. Smith
Executive Secretary

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PROGRAM

28TH ANNUAL MEETING

NATIONAL CONFERENCE ON FLUID POWER

SEPTEMBER 13-14-15, 1972

GROVER M. HERMANN HALL

ILLINOIS INSTITUTE OF TECHNOLOGY

WEDNESDAY, SEPTEMBER 13

8:30 A.M. -- Registration: Conference Headquarters.
Lobby, Hermann Hall

9:00 A.M. -- General Session: Auditorium

Chairman:

John A. Farris, Manager, Industrial Hydraulics Division,
Pall Corporation, and Conference Director, NCFP.

Awards:

Presentation of Hydraulics & Pneumatics Magazine
Awards, Tobi Goldoftas, Editor.

Greetings:

Chicago Chapter, Fluid Power Society, John Siedis.

9:30 A.M. -- Opening Session: Auditorium

Chairmen:

G. Wayne Hawk, Executive Vice President, Moog Inc.
and Associate Director, NCFP.
James I. Morgan, P.E., Director of Technical Services,
National Fluid Power Association, and Secretary of
ISO/TC 131.

Topics and Speakers:

INTERNATIONAL UNDERSTANDING AND INTERCHANGEABILITY --
A FLUID POWER "METRICATION" PROGRESS REPORT.

INTRODUCTION:

James I. Morgan, P.E., Director of Technical Services,
National Fluid Power Association, and Secretary of
ISO/TC 131.

PUMPS AND MOTORS,

J. Olson, Chief Application Engineer, Dynex Division,
Applied Power Industries, Chairman U.S. Pump Subcommittee.

CYLINDERS,

H. Schultz, Chief Engineer, Ortman-Miller Machine Company, Division Garlock Inc., Chairman U. S. Cylinder Subcommittee, ISO.

PORT, FITTINGS, TUBE, HOSE ASSEMBLIES,

T. Graffy, General Manager, Airmatic Valve/Beckett Harcum, Division Componetrol Company, Division of I-T-E Imperial Corporation, Chairman U.S. Port and Fittings Committee ISO.

FLUIDS AND FILTERS,

E. Kirnbauer, Corporate Consultant-Contamination, Pall Corporation, Head U.S. Fluid and Filter Delegation ISO.

SEALING DEVICES,

H. Flock, Assistant to Corporation President/FPG, Garlock Inc., Chairman U.S. Seals Committee ISO.

COMPONENT TEST METHODS,

J. Johnson, Professor, Fluid Power Institute, Milwaukee School of Engineering, Chairman U.S. Component Testing Subcommittee ISO.

FLUID POWER SYSTEMS,

A. Roberts, Director of Engineering, Vickers Division, Chairman U.S. Installation and Systems Committee ISO.

CONTROLS,

Z. J. Lansky, Vice President-Technical Director, Industrial Group, Parker Hannifin Corporation, Chairman U.S. Fluid Power Committee ISO.

OVERVIEW OF U.S. PARTICIPATION,

Z. J. Lansky, Chairman U.S. Fluid Power Committee, ISO.

12:15 P.M. -- Luncheon Session -- Ballroom

Chairman:

John A. Farris, Manager, Industrial Hydraulics Division, Pall Corporation, and Conference Director, NCFP.

Topic and Speaker:

FLUID POWER AND THE PATENT OFFICE,
Irwin Charles Cohen, United States Patent Examiner,
U.S. Patent Office.

AFTERNOON TECHNICAL SESSIONS

2:00 P.M. -- PRODUCTION HYDRAULICS -- S. E. LOUNGE

Chairmen:

John J. Pippenger, President, Hydraulic Products, Inc.
Larry L. Boulden, Associate Editor, Machine Design
Magazine, Penton Publishing Company.

Topics and Speakers:

PRECISION APPLICATION OF HYDRAULIC MOTORS ON SPECIAL
PRODUCTION MACHINERY,
Nelson Stayton, Hydraulics Manager, Planet Products
Corporation.

THE METHODS OF MODULAR MANIFOLDING,
Thomas C. Frankenfield, Regional Sales Manager,
The Rexroth Corporation.

2:00 P.M. -- MOBILE HYDRAULICS -- BALLROOM

Chairmen:

William B. Norick, Program Manager-Hydraulics,
Caterpillar Tractor Co.
Glenn E. Stewart, Chief Engineer, Fluid Power Section,
Components - Engineering, Construction Machinery
Division, Allis-Chalmers Manufacturing Company.

Topics and Speakers:

THE MODERN EXCAVATOR AND HIGH PRESSURE HYDRAULICS,
Noel Alain, Poclain Hydraulics, France.

HIGH PRESSURE HYDRAULICS ON EUROPEAN EXCAVATORS,
Hans Dieter Knoelker, Linde Hydraulics, West Germany.

EVOLUTION OF AMERICAN HYDRAULIC EXCAVATOR SYSTEMS,
J. A. Jones, Hydraulic Engineer, Harnishfeger
Corporation.

2:00 P.M. -- SEALS AND PACKINGS -- MEZZANINE

Chairmen:

Charles F. Fisher, Jr., Associate Professor,
Mechanical and Aerospace Engineering Department,
The University of Tennessee.
W. D. Ross, Ford Motor Company, Transmission and
Chassis Division.

Topics and Speakers:

EXPERIMENTAL EVALUATION OF ROTARY SHAFT SEALS FOR USE IN ORGANIC RANKINE CYCLE ENGINES,
L. DiNanno, Development Engineer, Thermo Electron Corporation, and T. LeFeuvre, Assistant Professor, Mechanical Engineering Department, University of Ottawa.

RELATIONSHIP OF SHAFT FINISH TO HIGH PRESSURE LIP SEALS (ROTARY APPLICATIONS,)
Edward A. Wheelock, Product Sales Manager, Oil Seal Division, Crane Packing Company.

LEAKAGE AND FRICTIONAL CHARACTERISTICS OF LARGE DIAMETER LABYRINTH SEALS,
E. Bilgen, Senior Project Engineer, and
A. C. Akgungor, Research Engineer,
Dominion Engineering Works Limited.

2:00 P.M. -- HIGH PRESSURE ENGINEERING -- AUDITORIUM

Chairmen:

Edward J. LeMay, P.E., Department of the Army, Materials and Mechanics Research Center.
George Z. Libertiny, Senior Research Engineer, Advanced Testing Methods Department, Ford Motor Company.

Topics and Speakers:

THE ROLE OF FRACTURE TOUGHNESS AND RESIDUAL STRESSES IN THE FATIGUE AND FRACTURE BEHAVIOR OF LARGE THICK-WALLED PRESSURE VESSELS,
Thomas E. Davidson, Albert N. Reiner, and
Joseph F. Throop, Benet Weapons Laboratory, Watervliet Arsenal.

FATIGUE CRACK GROWTH IN THICK-WALLED CYLINDERS,
Joseph F. Throop, Benet Weapons Laboratory, Watervliet Arsenal.

STRESS ANALYSIS OF THE "SELF-SEALING" TYPE PISTON HEAD BY THE FINITE-ELEMENT METHOD,
Takeshi Kanda, Research Engineer, Yasuhisa Sawada, Research Engineer, Kazuo Yasunami, Director of Science and Engineering, Technical Consultant, Kobe Steel, Ltd.

DEVELOPMENT OF A 70,000 PSI INTENSIFIER,
M. T. Kardoes, Senior Project Engineer, and
R. F. McArthur, Manager, Product Engineering, KOBE, Inc.

THE DEVELOPMENT OF A HIGH PRESSURE DIAPHRAGM
COMPRESSOR,

Syed M. M. Afzal, Assistant Chief Engineer and Stress
Analyst, Pressure Products Industries,
A Division of Duriron Company.

HIGH PRESSURE FLUID CIRCUITS AND CONTROL,

Donald E. Witkin, Director of Engineering and
Research, National Forge Company.

THURSDAY, SEPTEMBER 14

MORNING TECHNICAL SESSIONS

8:30 A.M. -- Registration: Conference Headquarters,
Lobby, Hermann Hall

9:30 A.M. -- HYDRAULIC SERVO SYSTEMS -- BALLROOM

Chairmen:

Lee R. Herndon, Jr., President, Vega Servo-Control Inc.
George Younkin, P.E., Giddings & Lewis Machine Tool Co.

Topics and Speakers:

THE FRICTIONAL RESISTANCE CHARACTERISTICS OF
HYDROSTATICALLY-LUBRICATED SLIDEWAY BEARING SYSTEMS,
H. C. Rippel, Principal Engineer, Friction and
Lubrication Laboratory, The Franklin Institute
Research Laboratories.

A SURVEY OF HYDROSTATIC BEARING DESIGNS FOR MACHINE
TOOL GUIDEWAYS,

P. Chaudhuri, Research Assistant,
N. H. Beachley, Associate Professor, and
J. G. Bollinger, Professor,
The University of Wisconsin.

ANALOG COMPUTER SIMULATION TECHNIQUES FOR ANALYSIS OF
A MACHINE TOOL HYDRAULIC DRIVE.

John J. Schachte, Senior Mechanical Engineer,
Kearney & Trecker Corporation, and
J. G. Bollinger, Professor, The University of Wisconsin.

9:30 A.M. -- FLUID LOGIC -- MEZZANINE

Chairman:

Frank D. Yeaple, Associate Editor, Product Engineering
Magazine, A Morgan-Grampian Publication.

Topics and Speakers:

INTRODUCTION: FOUR KINDS OF LOGIC,

Frank D. Yeaple, Associate Editor, Product Engineering
Magazine, A Morgan-Grampian Publication.

PNEUMATIC MOVING PART LOGIC-ATTACHED METHOD,
R. L. Culbertson, Sales Manager, Control Systems,
The Aro Corporation.

SEQUENCE CONTROL CIRCUITS USING PNEUMATIC MOVING
PART LOGIC,
Peter C. Huff, President, Dynamco, Air Controls Division

FLUIDIC CONTROL TECHNIQUE FOR AIR-OPERATED DRILLING
FIXTURE,
John A. Enright, Fluidic Products Division,
Johnson Service Company.

SOLID STATE LOGIC METHOD OF CONTROL,
Frank D. Yeaple, Associate Editor, Product Engineering
Magazine, A Morgan-Grampian Publication.

9:30 A.M. -- HYDROSTATICS -- S. W. LOUNGE

Chairman:

R. W. Henke, P.E., Fluid Power Consultants International

Topics and Speakers:

HIGH PRESSURE HYDRAULICS -- KEY TO NEW TRANSMISSION
DESIGN,
William A. Ross, Chief Engineer, New Products and
Joseph E. Louis, Section Manager, Basic Development,
Sundstrand Hydro-Transmission.

HYDRAULIC POWERED DRIVE WHEEL,
Glen A. Johnson, Hydraulics Engineer, John Deere
Waterloo Tractor Works and Henry D. Kadavy, Staff
Engineer, John Deere OEM Sales Department.

NEW APPLICATIONS FOR MOBILE HYDROSTATICS,
Joseph N. Mazur, Director of Engineering, Linde
Hydraulics Corporation.

9:30 A.M. -- HOSES AND FITTINGS -- AUDITORIUM

Chairmen:

Fred T. Johnson, Assistant Chief Engineer,
Anchor Coupling Co. Inc., and Irving D. Press,
Vice President-Research, Resistoflex Corporation.

Topics and Speakers:

MECHANICAL JOINING -- AN IMPROVED METHOD OF JOINING
TUBULAR ELEMENTS TO FLANGES OR FITTINGS FOR INDUSTRIAL
AND AIRCRAFT USE,
R. G. Pleiman, Plant Manager, Wiedeke Plant,
Elliott Company, and Harvey R. Nickerson, Research
Manager, Resistoflex Corporation.

A NEW JOINING PROCESS FOR FABRICATED HYDRAULIC COMPONENTS,

John Zotos, Associate Professor, Mechanical Engineering Department, Northeastern University and Theodore J. Morin, Executive Vice President, Thermo Magnetics, Inc.

RECOVERABLE DISTORTION THROUGH CRYSTALLINE DEFORMATION IN METAL,

Clyde A. Lofdahl, Eastern Regional Manager, Metals Division, Raychem Corporation.

12:15 P.M. -- Luncheon Session -- Ballroom

Chairman:

G. Wayne Hawk, Executive Vice President, Moog Inc. and Associate Director, NCFP.

Topic and Speaker:

HOW TO UNDERSTAND AND APPLY TECHNICAL CREATIVITY, George Whittington, Managing Editor, Assembly Engineering Magazine.

AFTERNOON TECHNICAL SESSIONS

2:00 P.M. -- PUMPS AND MOTORS -- BALLROOM

Chairmen:

J. Wesley Broome, Vice President of Engineering, Racine Hydraulics, Rex Fluid Power Group.
Tobi Goldoftas, Editor, Hydraulics & Pneumatics Magazine.

Topics and Speakers:

DISPOSAL AND SALVAGE OF WASTE HYDRAULIC FLUIDS, J. A. Johnston, Manager, Facilities Engineering, Stamping Division, and R. E. Rich, Waste Treatment Specialist, United States Automotive Manufacturing Group, Chrysler Corporation.

HYDRAULIC FLUIDS AND POLLUTION,

W. H. Millett, General Product Manager, E. F. Houghton & Co.

SOME ASPECTS OF PRE-COMPRESSION VARIATIONS AND THE EFFECTS ON PUMP NOISE,

Brian E. J. Bishopp, Regional Sales Manager, Rex Fluid Power Group, Racine Hydraulics.