



# Studies in Arc Welding

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DESIGN, MANUFACTURE and CONSTRUCTION



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*This book is dedicated to  
scientific progress of arc  
welding.*



**J. F. Lincoln**, president of the Lincoln Electric Co., Cleveland, Ohio, and pioneer in arc welding development, in whose honor the James F. Lincoln Arc Welding Foundation was created.

## Preface

"STUDIES in Arc Welding" assumes a place of special importance in the literature of science, education and industry. The volume's contents reflect the intensive application of the welding process during an era of world history in which the United States took up the tremendous task of arming itself and its allies for war. The book is the work, not of one person but of 113 making exhaustive studies in their own fields in which they have had long experience. The findings of these authors, who are executives, engineers, designers and officials of production, construction and maintenance, while representing vital contributions to war production, will provide the soundest possible basis for economic stabilization during the post-war period.

The 98 award papers, which comprise "Studies in Arc Welding," were selected as outstanding in the 1940-42 Progress Program. In order to make the selection, the entire group of 408 papers which received awards in the Program were considered in the light of originality, value of information and thoroughness in treatment of subject matter. The omission of any paper is not to be taken, in any sense of the word, as a reflection or criticism of the paper. This follows since in terms of interest and value all of the papers possess unquestioned merit. In the final selection, consideration had to be given to the number of papers which could be included to provide a volume of greatest value without becoming of a size impractical for easy reference.

Virtually all of the papers are reproduced in complete form, as regards both text and illustrations. A few papers which, in their original form, were too lengthy for complete reproduction, are included as comprehensive briefs without loss of pertinent text matter or illustrations. At the beginning of each paper is a brief summary of the subject matter prepared by the Jury of Award.

All papers contained herein were submitted to and approved by the United States Office of Censorship before publication. This was done to abide, in spirit and form, with the wishes of the federal government regarding such matters.

"Studies in Arc Welding" should provide a most valuable aid in furthering scientific and industrial progress and in extending the industrial, commercial, economic, and social benefits which are inherent in the welding process.

In publishing "Studies in Arc Welding," the James F. Lincoln Arc Welding Foundation, knowing the tremendous value to industry of the information contained in this book, herewith expresses its appreciation to all those who participated in the Progress Program. Without the earnestness, thoroughness and exactness with which the participants carried out their studies, this volume would not have been possible.

A. F. DAVIS and ED C. POWERS, *Editors.*

## Alphabetical List of Authors

- ALLARDT, E. W., Mechanical Engineer, Babcock and Wilcox Tube Co., Beaver Falls, Pa. Award: \$700. Title of paper: "Assembly of Five Separate Machines." See Section IX, page 756.
- AMIRIKIAN, A., Designing Engineer, Bureau of Yards and Docks, Navy Department, Washington, D. C., co-author with Captain C. A. Trexel. Joint award: \$13,700. Title of paper: "Welded Caissons for Naval Dry Docks." See Section V, page 454.
- ANDREWS, F. H., Welding Superintendent, Paterson Boiler & Tank, Inc., Paterson, N. J., co-author with Louis LaGreca. Joint award: \$500. Title of paper: "Gasoline Engine for Racing Automobile." See Section I, page 22.
- ARMOUR, W. W., Vice-President, Armour's Pattern Shop Co., Welding Engineers, Worcester, Mass. Award: \$150. Title of paper: "Welded Water Wheel Center Casing." See Section VIII, page 718.
- ARONSON, MARK, Research Engineer, United States Navy Yard, Philadelphia, Pa., co-author with Edward A. Foehl. Joint award: \$250. Title of paper: "Tilting Table for Armour Plate Production." See Section IX, page 933.
- ATKIN, WILLIAM, Naval Architect, Atkin Naval Architecture, Darien, Conn. Award: \$1,500. Title of paper: "Small Boats Arc Welded." See Section IV, page 324.
- ATKINSON, E. H., Mechanical Engineer, Fulton Metal Bed Manufacturing Co., Atlanta, Ga. Award: \$250. Title of paper: "Bed Rails and Bed Springs." See Section VI, page 526.
- AVERITT, CARL RAY, Assistant Blacksmith Foreman, Paducah, Ky. Award: \$500. Title of paper: "Fabrication of Steam Locomotive Cylinder." See Section III, page 282.
- BARRON, WALTER E., Foreman in charge of welding, Heisler Locomotive Works, Erie, Pa. Award: \$250. Title of paper: "Arc Welded Construction of 'Fireless' Locomotive." See Section III, page 201.
- BAXTER, JOE, JR., Sales Engineer, Shartle Brothers Machine Co., Middletown, Ohio. Award: \$250. Title of paper: "Arc Welding Applied to Waxing Machine." See Section IX, page 1015.
- BECKER, ERNEST R., Assistant Chief Engineer, The Liquid Carbonic Corp., Chicago, Ill. Award: \$700. Title of paper: "Bottle-Washer Redesigned for Welding." See Section IX, page 1196.
- BENEDEK, DR. ELEK K., Consulting Engineer, General Hydraulic Co., Cleveland, Ohio. Award: \$500. Title of paper: "Aircraft Propeller Blade." See Section II, page 121.
- BERKELEY, JOHN PEYTON, Chief Engineer, Berkeley Equipment Co., Corry, Pa. Award: \$500. Title of paper: "Arc Welded Motor Drives for Machine Tools." See Section IX, page 960.
- BIEDERMAN, EDWARD G., Welding Engineer, Fisher Tank Division, General Motors Corp., Flint, Mich. Award: \$150. Title of paper: "Welding of Armor Plate for Tank Production." See Section I, page 36.
- BIER, P. J., Senior Engineer, Bureau of Reclamation, Denver, Colo. Award: \$2,700. Title of paper: "Arc Welded Power Penstocks." See Section VIII, page 697.
- BIRKMEYER, PAUL J., Engineer, Western Union Telegraph Co., New York, N. Y. Award: \$2,700. Title of paper: "Welded Housings for Telegraphic Printers." See Section VI, page 531.

ALPHABETICAL LIST OF AUTHORS (Continued)

- BLACK, JAMES, Vice-President in Charge of Engineering, Trailer Company of America, Oakley, Cincinnati, Ohio. Award: \$500. Title of paper: "15-Ton Low-Bed Trailer Frame." See Section I, page 93.
- BLAZEY, LAWRENCE C., Secretary, Designers for Industry, Cleveland, Ohio, co-author with George B. Rogers. Joint award: \$150. Title of paper: "Arc Welding and Modern Steel Houses." See Section V, page 449.
- BOWLES, J. C., Superintendent of Equipment, the Community Traction Co., Toledo, Ohio. Award: \$250. Title of paper: "Construction of Rail Grinding Car." See Section III, page 277.
- BROOKING, WALTER J., Director of Testing and Research, R. G. LeTourneau, Inc., Peoria, Ill. Award: \$1,500. Title of paper: "Tractor Transmission Case and Frame Assembly." See Section IX, page 1022.
- BRUMMERSTEDT, EGON F., Mechanical Engineer, Petroleum Division, Foster Wheeler Corp., New York, N. Y. Award: \$700. Title of paper: "High-Temperature Vacuum Fractionating Tower." See Section IX, page 1089.
- BUERER, WAYNE, Assistant Professor, Mechanical Engineering, Mechanical Engineering Laboratory, Oklahoma Agricultural and Mechanical College, Stillwater, Okla. Award: \$700. Title of paper: "Experimental 7½-Ton Refrigeration Plant." See Section IX, page 852.
- BULGER, MARTIN, Foreman, American Airlines, LaGuardia Field, Jackson Heights, N. Y. Award: \$250. Title of paper: "Redesign of Airplane Engine Tail Pipe." See Section II, page 130.
- CANDLIN, J. E., JR., Assistant Engineer, Pullman-Standard Car Manufacturing Co., Chicago, Ill., co-author with A. M. Unger. Joint award: \$3,700. Title of paper: "Underframes for All Welded Railroad Passenger Cars." See Section III, page 252.
- CARTER, ROBERT M., Engineer, Line Maintenance Department, Stanolind Pipe Line Co., Tulsa, Okla. Award: \$500. Title of paper: "Batching Scraper for Crude Oil Pipe Lines." See Section IX, page 1104.
- CLARKE, FRED, Instructor of Welding, Moose Jaw Technical High School, Moose Jaw, Sask., Canada. Award: \$150. Title of paper: "Arc Welded Sculpture." See Section V, page 490.
- COCHRAN, VIRGIL, Assistant Superintendent, LeTourneau Co. of Georgia, Toccoa, Ga. Award: \$3,700. Title of paper: "Operating a Plant Weldery." See Section VII, page 652.
- CONABEE, R. S., Engineer, Lukenweld, Inc., Coatesville, Pa. Award: \$1,700. Title of paper: "Welded Steel in Paper-Making Machinery." See Section IX, page 979.
- DAVIS, ERNEST, Chief Engineer, The Prosperity Company, Inc., Syracuse, N. Y. Award: \$500. Title of paper: "Improved Synthetic Cleaning Machines." See Section IX, page 1277.
- DEARIE, JOHN A., Draftsman, Western Union Telegraph Co., New York, N. Y. Award: \$500. Title of paper: "Arc Welded Bicycle Racks." See Section IX, page 1183.
- DILLON, JOHN F., JR., Welding Engineer, LeTourneau Company of Georgia, Toccoa, Ga. Award: \$700. Title of paper: "Low-Cost Grading and Hauling." See Section I, page 3.
- DONALDSON, W. G., Foreman of Electrical Department, Standard Oil Co. of Indiana, Sugar Creek, Mo. Award: \$250. Title of paper: "Speedy Welding Cable Connector." See Section IX, page 777.
- DRENKARD, ADAM, JR., Engineer, Western Union Telegraph Co., New York, N. Y. Award: \$700. Title of paper: "Parts for a Receiving-Switching-Transmitting Unit." See Section IX, page 880.
- DREWES, FRED H., Welding Engineer, W. P. Thurston Co., Engineers and Contractors, Richmond, Va. Award: \$3,700. Title of paper: "Developing and Conducting a Commercial Welding or Job Shop." See Section VII, page 547.

ALPHABETICAL LIST OF AUTHORS (Continued)

- ECKLEY, WILLIAM A., Designer, Pioneer Engineering Works, Inc., Minneapolis, Minn., co-author with Ralph W. Heer. Joint award: \$500. Title of paper: "Welding Jaw Crusher Bases." See Section IX, page 1003.
- ELDRIDGE, E. J., Draftsman, Welded Products, Pty. Ltd., Sydney, Australia, co-author with John O. Ogden. Award: \$700. Title of paper: "Fabricated Rolled Steel Machinery." See Section IX, page 725.
- ENKE, GLENN L., Assistant Chief Engineer, Utah Pomeroy Morrison, Provo, Utah. Award: \$2,700. Title of paper: "Steel and Concrete Bridges Compared." See Section V, page 362.
- EVANS, W. S., Materials and Process Engineer, Curtiss-Wright Corporation, Airplane Division, Lambert Field, St. Louis, Mo. Award: \$1,250. Title of paper: "Arc Welding of Airplane Parts." See Section II, page 159.
- FEY, REGIS F., Structural Engineer, Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. Award: \$2,700. Title of paper: "Modern Welded Blast Furnace." See Section IX, page 1112.
- FFIELD, PAUL, Materials Engineer, Bethlehem Steel Co., Quincy, Mass., co-author with Carlton G. Lutts. Joint award: \$500. Title of paper: "Welding of Finished-Machined Casting." See Section IX, page 805.
- FISHER, C. DONALD, Designer and Draftsman, Sprout, Waldron and Co., Muncy, Pa. Award: \$500. Title of paper: "Special Duty Steel Plate Fan." See Section IX, page 870.
- FITCH, JAMES W., Automotive Engineer, Kenworth Motor Truck Corp., Seattle, Wash. Award: \$1,500. Title of paper: "Streamlined Fire Truck." See Section I, page 54.
- FITCH, T. S., President, Composite Steels, Inc., Washington, Pa., co-author with L. W. Townsend. Joint award: \$500. Title of paper: "Carbon Arc Welding in Production of Clad Steels." See Section IX, page 1131.
- FOEHL, EDWARD A., Naval Architect, United States Navy Yard, Philadelphia, Pa. Co-author with Mark Aronson; see above.
- GERSTACKER, WILLIAM G., Development Engineer, Union Metal Manufacturing Co., Canton, Ohio. Award: \$500. Title of paper: "Welded Design of Tapered Tube Booms for Cargo Ships." See Section IX, page 847.
- GRAVES, GEORGE J., President, Graves & Son Boiler & Mfg. Co., Inc., Jamestown, N. Y. Award: \$250. Title of paper: "De Luxe House Trailer." See Section I, page 102.
- GRUVER, JOHN H., Designer, Addressograph-Multigraph Corporation, Euclid, Ohio. Award: \$500. Title of paper: "Special Check Writing Machine." See Section IX, page 896.
- HARRIS, LEMUEL J., Manufacturing Foreman, Holland Furnace Co., Holland, Mich. Award: \$250. Title of paper: "Redesign of Oil-Gas Furnace." See Section IX, page 1189.
- HAUPT, WALTER H., Mechanical Engineer, Kelley Koett Manufacturing Co., Covington, Ky. Award: \$700. Title of paper: "Base of Tilting Fluoroscope." See Section IX, page 951.
- HAWKINS, GEORGE W., Consulting Engineer, Anderson Nichols Associates, Boston and New York. Award: \$2,500. Title of paper: "Quantity Production of Cargo Carriers." See Section IV, page 305.
- HEER, RALPH W., Assistant Chief Engineer, Pioneer Engineering Works, Inc., Minneapolis, Minn. Co-author with William A. Eckley; see above.
- HOLMES, RICHARD H., Production Design Engineer, Curtis Aircraft Co., Buffalo, N. Y. Award: \$700. Title of paper: "Arc Welded Tubular Aircraft Jigs." See Section IX, page 919.
- HRUSKA, JOHN H., Chief Inspector, Electro-Motive Division, General Motors, LaGrange, Ill. Award: \$1,700. Title of paper: "Arc Welded Diesel Electric Freight Locomotive." See Section III, page 181.

ALPHABETICAL LIST OF AUTHORS (Continued)

- JACKSON, J. O., Chief Engineer, Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. Award: \$3,700. Title of paper: "Liquefied Gas Storage Containers." See Section VIII, page 667.
- JACOBSON, E. W., Design Engineer, Gulf Research and Development Company, Pittsburgh, Pa., co-author with F. F. Vewsaw. Joint award: \$250. Title of paper: "Wheel Mounting for Racing Automobile." See Section I, page 62.
- KNERR, H. S., Lt. Junior Grade, U. S. Navy, Navy Yard, Portsmouth, N. H. Award: \$500. Title of paper: "Welded Steel Boat Design." See Section IV, page 333.
- LAGRECA, LOUIS, Owner, LaGreca Machine Co., Paterson, N. J. Co-author with F. H. Andrews; see above.
- LEBERT, H. A., Inspector, United Airlines Transport Corporation, Cheyenne, Wyo., co-author with S. B. Willoughby. Joint award: \$2,500. Title of paper: "Arc Welding Airplane Boilers." See Section II, page 148.
- LOVE, J. R., Manager and Engineer, Love Tractor, Inc., Eau Claire, Mich. Award: \$500. Title of paper: "One-Piece Design of Farm Sprayer." See Section IX, page 1163.
- LUTTS, CARLTON G., Materials Engineer, Navy Yard, Boston, Mass. Co-author with Paul Ffield; see above.
- MARQUARDSEN, R. P. V., Structural Designer, The Sanitary District of Chicago, Chicago, Ill. Award: \$250. Title of paper: "Efficiently Rigid Arc Welded Connections." See Section V, page 350.
- MARTIN, P. W., Secretary and Chief Engineer, Smalley General Co., Bay City, Mich. Award: \$250. Title of paper: "Bed for Milling Propeller Blades." See Section IX, page 746.
- MCCLELLAN, CLARENCE, Director of Welding, McClellan & Sons Super Service Station, Menomonie, Wis. Award: \$2,700. Title of paper: "Organization of Garage or Service Station for Arc Welding." See Section VII, page 601.
- MCGEE, WILLIAM A., Mechanical Engineer, The New York Central Railroad Co., Cleveland, Ohio. Award: \$100. Title of paper: "Ali Arc Welded Steam Line." See Section VIII, page 721.
- MCKAY, S. R., McKay Engineering Company, Cleveland, Ohio. Award: \$250. Title of paper: "Steel Framing for Residences." See Section V, page 435.
- MIDNIGHT, STANLEY A., Assistant Chief Draftsman, American Ship Building Co., Cleveland, Ohio. Award: \$3,700. Title of paper: "Hidden Advantages of Arc Welded Ship Construction." See Section IV, page 289.
- MILLER, DR. JOHN L., Chief Metallurgist, Gun-Mount Division, The Firestone Tire and Rubber Co., Akron, Ohio. Award: \$11,200. Title of paper: "Redesigned 40 MM. Anti-Aircraft Gun Carriage." See Section IX, page 1248.
- MONSON, HUGH T., Plant Engineer, The Euclid Road Machinery Co., Euclid, Ohio. Award: \$700. Title of paper: "Downdraft Ventilation for Welding Shop." See Section IX, page 900.
- MORK, GEORGE W., Engineer, Bucyrus-Erie Company, South Milwaukee, Wis., co-author with Howard Squires. Joint award: \$500. Title of paper: "Redesign of Main Frames for Tractor Bullgrader." See Section IX, page 1080.
- MOYER, ROBERT E., JR., Vice-President in charge of Engineering, Heilman Boiler Works, Allentown, Pa. Award: \$100. Title of paper: "The Drumless Boiler." See Section VIII, page 693.
- MULLER, JOHN F., Sales Engineer, The American Pulley Company, Philadelphia, Pa., co-author with Gonzalo C. Munoz. Joint award: \$1,300. Title of paper: "Arc Welded Suspension for Air Conditioning System." See Section III, page 262.
- MUNOZ, GONZALO C., Secretary-Treasurer, The American Pulley Company, Philadelphia, Pa. Co-author with John F. Muller; see above.
- NIEDERHOFF, A. E., Senior Engineer of Design, U. S. Army Engineers, Portland, Ore. Award: \$500. Title of paper: "Thoughtful Welding of Machine Parts." See Section IX, page 913.

- NORTHROP, JOHN K.**, President, Northrop Aircraft, Inc., Hawthorne, Calif., co-author with Vladimir H. Pavlecka. Joint award: \$3,700. Title of paper: "Arc Welding of Magnesium Aircraft Structures." See Section II, page 132.
- OGDEN, JOHN O.**, General Manager and Director, Welded Products, Pty. Ltd., Sydney, Australia. Co-author with E. J. Eldridge; see above.
- PAVLECKA, VLADIMIR H.**, Chief of Research, Northrop Aircraft, Inc., Hawthorne, Calif. Co-author with John K. Northrop; see above.
- PETERSON, H. B.**, American Can Company, San Francisco, Calif. Award: \$500. Title of paper: "Arc Welding in Automatic Can-Testing Machine." See Section IX, page 1203.
- PRIEST, H. MALCOLM**, Engineer, U. S. Steel Corp., Subsidiaries, Pittsburgh, Pa. Award: \$2,700. Title of paper: "Welded Design of 250-Ton Flat Car." See Section III, page 228.
- REISS, ERNEST**, General Manager and Partner, The Art Chrome Company of America, Boston, Mass. Award: \$3,700. Title of paper: "Arc Welding of Plated Tubular Furniture." See Section VI, page 507.
- RENN, ALAN C.**, Assistant Foreman in Charge of Arc Welding, Vultee Aircraft, Inc., Vultee Field Division, Vultee Field, Calif. Award: \$100. Title of paper: "Arc Welded Tubular Fuselage." See Section II, page 178.
- RIORDAN, JOHN M.**, Chief Engineer, Bonnar-Vawter Fanform Co., Cleveland, Ohio. Award: \$500. Title of paper: "Collating Machine of Improved Design." See Section IX, page 1244.
- ROGER, JOHN P.**, Plant Engineer, The Babcock and Wilcox Co., Barberton, Ohio. Award: \$150. Title of paper: "Welding a Locomotive Boiler." See Section III, page 214.
- ROGERS, GEORGE B.**, General Contractor, Lakewood, Ohio. Co-author with Lawrence C. Blazey; see above.
- ROSSMANN, PETER F.**, Chief of Miscellaneous Developments Research, Research Laboratory, Curtiss-Wright Corporation, Airplane Division, Buffalo, N. Y. Joint award: \$1,500. Title of paper: "Welding Aircraft Engine Mounts Economically." See Section II, page 111.
- RUTTEN, WALTER**, Partner and Factory Superintendent, Railoc Company, Plainfield, Ill. Award: \$250. Title of paper: "Production Machine for Domed Silo Roofs." See Section IX, page 764.
- SALK, CLIFFORD A.**, Carman, Great Northern Railway, St. Cloud Shops, St. Cloud, Minn., co-author with Ray F. Theisen. Joint award: \$250. Title of paper: "Arc Welded Conversion of Tenders Into Tank Cars." See Section III, page 247.
- SAXE, VAN RENSSELAER P.**, Consulting Engineer, Baltimore, Md. Award: \$700. Title of paper: "Welded Airplane Hangar." See Section V, page 343.
- SCHeyer, EMANUEL**, Assistant Designing Engineer, Designs Division, Board of Transportation, New York, N. Y. Award: \$1,500. Title of paper: "Welded Steel Bents for Subways." See Section V, page 470.
- SHEFELTON, W. E.**, Production Manager, R. D. Cole Manufacturing Co., Newnan, Ga. Award: \$500. Title of paper: "Welded Lining of Horizontal Processing Tanks." See Section IX, page 1225.
- SHIMKIN, B. M.**, Master Science Civil Engineer and Civil Engineer and Associate Bridge Designer Engineer, Bridge Department of State of California, Sacramento, Calif. Award: \$250. Title of paper: "Trusses for Swing Bridge." See Section V, page 414.
- SIMPSON, HOWARD W.**, Chief Engineer, Detroit Harvester Co., Detroit, Mich. Award: \$700. Title of paper: "Arc Welding in the Manufacture of Mowers." See Section IX, page 1145.
- SLAGHT, W. W.**, Chief Engineer, Cleveland Steel Products Corp., Cleveland, Ohio. Award: \$250. Title of paper: "Universal Joint Drive Shafts." See Section I, page 24.

ALPHABETICAL LIST OF AUTHORS (Continued)

- SLYGH, EDWARD J., Campbell-Lowrie-Lautermilch Corp., Chicago, Ill. Award: \$700. Title of paper: "T-Beams for Residences." See Section V, page 426.
- SMITH, S. ARNOLD, Chief Engineer, The Whitlock Manufacturing Co., Hartford, Conn. Award: \$1,300. Title of paper: "Design and Production of Heat Exchangers." See Section VIII, page 678.
- SPENCER, ELDRIDGE T., Architect, San Francisco, Calif. Award: \$1,500. Title of paper: "Pipe-Frame Office Chair." See Section VI, page 538.
- SQUIRES, HOWARD, Manufacturing Engineer, Bucyrus-Erie Company, South Milwaukee, Wis. Co-author with George W. Mork; see above.
- STANLEY, RICHARD W., Design Engineer, American Viscose Corp., Marcus Hook, Pa. Award: \$700. Title of paper: "Redesign of Rayon Processing Machine." See Section IX, page 1211.
- STONE, HERBERT, Assistant Works Manager, Markham and Co., Ltd., Chesterfield, England. Award: \$1,500. Title of paper: "Large Water Turbine Installations." See Section IX, page 783.
- STORATZ, G. J., Assistant Chief Engineer, The Heil Co., Milwaukee, Wis. Award: \$3,700. Title of paper: "High-Speed Dirt Movers." See Section I, page 70.
- STREITHOFF, C. PERRY, Structural Division Engineer, Engineering Works Division, Dravo Corporation, Pittsburgh, Pa., Award: \$1,700. Title of paper: "Welded Revolving Cranes." See Section IX, page 815.
- THEISEN, RAY F., Welder, Great Northern Railway, St. Cloud Shops, St. Cloud, Minn. Co-author with Clifford A. Salk; see above.
- TOWNSEND, L. W., Vice-President, Composite Steels, Inc., Washington, Pa. Co-author with T. S. Fitch; see above.
- TREXEL, CAPTAIN C. A., Director of Planning and Design, Bureau of Yards and Docks, Navy Department, Washington, D. C. Co-author with A. Amirikian; see above.
- UNGER, A. M., Plant Engineer, Pullman-Standard Car Manufacturing Co., Chicago, Ill. Co-author with J. E. Candlin; see above.
- VERSAW, F. F., Shop Superintendent, Gulf Research and Development Company, Pittsburgh, Pa. Co-author with E. W. Jacobson; see above.
- WAGNER, D. F., Chief Engineer, Wentworth & Irwin, Inc., Portland, Ore. Award: \$1,500. Title of paper: "Arc Welding in Bus Construction." See Section I, page 27.
- WEAVER, ELVERTON W., Consulting Design Engineer, Towmotor Co., Cleveland, Ohio. Award: \$2,700. Title of paper: "Small-Truck for Loading Freight Cars." See Section I, page 45.
- WEIDNER, VICTOR PAUL, Engineer, Western Union Telegraph Company, New York, N. Y. Award: \$250. Title of paper: "Welded Display Holder for Printed Matter." See Section VI, page 543.
- WHITTAKER, LLOYD A., Chief Engineer, Thomson National Press Co., Franklin, Mass. Award: \$700. Title of paper: "Arc Welding in Press Machinery." See Section IX, page 1232.
- WILLIS, JOHN F., Engineer of Bridge Design, Connecticut State Highway Department, Hartford, Conn. Award: \$1,300. Title of paper: "Welded Grade Separation Structure." See Section V, page 376.
- WILLOUGHBY, S. B., Arc Welder, United Airlines Transport Corporation, Cheyenne, Wyo. Co-author with H. A. Lebert; see above.
- WOODARD, JOSEPH H., Co-owner and Plant Manager, Lee L. Woodard Sons, Owosso, Mich. Award: \$1,300. Title of paper: "Wrought Iron Furniture Manufacturing." See Section VI, page 518.
- WOLFE, GEORGE F., Chief Plant Engineer, Engineering Works Division, Dravo Corporation, Neville Island, Pittsburgh, Pa. Award \$2500. Title of paper: "Straight Line Mass Production Methods Speed the Defense Program." See Section VII, page 627.

# The James F. Lincoln Arc Welding Foundation

**T**HE James F. Lincoln Arc Welding Foundation has been widely acknowledged as an important aid to industry through its contributions to industrial, economic and social progress.

Through its Award Programs, the Foundation has stimulated and is stimulating widespread interest in the possibilities of the electric arc welding process as applied to industrial manufacture, fabrication, construction and maintenance work.

Valuable information contained in the award papers has been widely disseminated to stimulate and intensify the use of the electric arc process. Dissemination of this important information is accomplished through publication of abstracts of papers in literally hundreds of magazines; publication of the most outstanding papers in complete form in magazines; and publication of the books, "Arc Welding in Design, Manufacture and Construction," containing 109 of the outstanding papers from the 1937-38 Award Program and the present volume "Studies in Arc Welding," containing 98 of the most significant award studies in the 1940-42 program.

The Foundation's first award program was inaugurated early in 1937 and terminated with payment of \$200,000 in September, 1938. A total of 382 awards were made ranging from \$101.75 to \$13,941.33.

The second study program, the \$200,000 Industrial Progress Award Program, was sponsored during the period from January 1940 to June 1942. It terminated in October 1942 with the payment of \$200,000 in 408 awards which range from \$50 to \$13,700.

By its study programs, the Foundation has called widespread attention to the many inherent advantages of arc welding and has stimulated the use of this process with pronounced benefits. For example, in the 1940-42 program it was shown that a possible annual saving of \$1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man hours of labor, was available by utilization of this modern process.

The Foundation more recently sponsored a \$6,750 Engineering Undergraduate Award and Scholarship Program to stimulate study of the arc welding process by engineering students. This program was announced December 1st, 1942 and closed April 1st, 1943.

## Why the Foundation Was Created

Regarding the creation of The James F. Lincoln Arc Welding Foundation in 1936, Mr. J. C. Lincoln, chairman of the board of directors of The Lincoln Electric Co., the founder, made the following statement which is quoted from the original deed of trust.

"Since the dawn of recorded time, man has struggled constantly to improve his conditions. Coping with many obstacles, he has developed great skill and ingenuity. Applied through the years, these talents have rewarded man with luxuries of which his ancestors never dreamed—the telephone, the radio, the automobile, the airplane, the railroad, the steamship, the skyscraper, the gigantic bridge—these modern wonders and many others are the products of man's skill and ingenuity.

"Recent years have seen the origin and development of an ingenious process which has great economic, social and commercial significance to mankind. That process is arc welding.

"It is, therefore, our belief that by encouraging and stimulating scientific interest in and study of arc welding, still greater benefits will result from man's skill and ingenuity. To this end, The Lincoln Electric Co. announces that it has created, in honor of its president, 'The James F. Lincoln Arc Welding Foundation'."

The Lincoln Electric Company  
J. C. LINCOLN,  
Chairman of the Board of Directors

## Object and Purpose of the Foundation

"The object and purpose of The James F. Lincoln Arc Welding Foundation is to encourage and stimulate scientific interest in, and scientific study, research and education in respect of, the development of the arc welding industry through advance in the knowledge of design and practical application of the arc welding process, and to provide for the payment of awards, by prizes, to those persons who by reason of the excellence of their papers upon said subject may be selected in the manner herein provided as most worthy to receive such awards."

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# The \$200,000 Industrial Progress Award Program

The 1940-42 Progress Program was the second activity of The James F. Lincoln Arc Welding Foundation to encourage scientific progress of arc welding. It offered 458 awards.

The following information regarding awards is quoted from the Rules and Conditions governing participation in the Program:

"The 458 awards are grouped as follows:

"184 Divisional Awards:—1st, 2nd, 3rd and 4th awards of \$700, \$500, \$250 and \$150 respectively, in each of 46 Divisions.

"48 Classificational Awards:—1st, 2nd, 3rd and 4th awards of \$3,000, \$2,000, \$1,000 and \$800 respectively, in each of 12 Classifications.

"3 Main Program Awards:—1st, 2nd and 3rd awards of \$10,000, \$7,500 and \$5,000 respectively.

"223 Additional Awards for Honorable Mention:—Awards of \$100 each for 223 papers which do not share in any other award but which, in the opinion of the Jury of Award, deserve Honorable Mention. These 223 awards may be made for papers in any of the Divisions.

"The 184 Divisional Awards will be determined first. Then, from the papers receiving the 1st, 2nd, 3rd and 4th Divisional Awards in each Division of a particular Classification, papers will be selected to receive the 1st, 2nd, 3rd and 4th Classificational Awards of the particular Classification, repeating the process for each Classification. From the Classificational award papers, papers will be selected to receive the 1st, 2nd and 3rd Main Program Awards. After the Divisional, Classificational and Main Program Awards have been determined, papers will be selected to receive the Honorable Mention Awards.

"For the paper selected as the best of all papers submitted, a 1st Grand Award of \$13,700 will be made, composed of \$700 as 1st Divisional Award, \$3,000 as a 1st Classificational Award and \$10,000 as 1st Main Program Award.

## Subject Matter of Papers in the \$200,000 Industrial Progress Award Program

The following definitions of subject matter for papers in the Progress Program are quoted from the Rules and Conditions of the Foundation governing participation:

"Papers are to be on the subject, *progress made by application of arc welding between January 1st, 1940, and June 1st, 1942.* The paper shall cover progress on but one of the following points:

## INDUSTRIAL PROGRESS AWARD PROGRAM

“(a) Redesign and manufacture or construction of an existing machine, structure, building, manufactured or fabricated product of ferrous or non-ferrous metals, within the limits of the rules hereinafter prescribed, which was previously made in some other way and redesigned so that arc welding may be applied, in whole or in part, to its manufacture, fabrication or construction.

“(b) New design and manufacture or construction of a machine, structure, building, manufactured or fabricated product of ferrous or nonferrous metals, within the limits of the rules hereinafter prescribed, which was not previously made but which has been designed in whole or in part for the use of arc welding, the description to show how a useful result, which was impractical with other methods of construction, or could be better done by arc welding, is accomplished.

“(c) Organizing, developing and conducting a welding service. The welding service to be described in the papers may be conducted by Commercial Welders or Job Shops (G-1), Garages or Service Stations (G-2), Commercial Welderies (I-1), or Plant Welderies (I-2).

“(d) Developing, planning and performing maintenance or repair work with arc welding. The maintenance or repair work to be described in the papers may be Plant and Construction machinery and mechanical equipment of all kinds; also mobile equipment such as fleets of trucks, buses and taxicabs (L-1); or Structures and other structural applications of arc welding in maintenance (L-2), such as pipe lines, railroad tracks, bridge strengthening, and other such work, not covered under L-1.

“Note that the machine, structure, building, manufactured or fabricated product under (a) or (b) may be designed either in whole or in part for the use of arc welding.

“To qualify as to subject matter, the welding service as in (c) and the maintenance work as in (d), within the period January 1, 1940, to June 1, 1942, must have been either:

- (1), planned and put into practice within the period;
- or (2), put into practice within the period as result of plans made prior to the period.

Papers of otherwise equal merit will be preferentially rated in the above order.

### Requirements As to Submission of Papers

- “1. Paper shall be submitted in two copies, one signed, the other unsigned.
- “2. Each copy shall be enclosed in a separate sealed envelope.
- “3. **THE SIGNED COPY:**—The signed copy shall have the following information written on the cover or title page and on the outside of the envelope in which it is enclosed:

Name, address and signature of the author, or authors.

Name and address of company with which author is connected.

Relationship between the author, or authors, and the company or concern.

Classification of the paper, as for example A-1, C-4, J-6, K-7, L-2, etc., depending upon the nature of the subject matter.

Name of individual or individuals to whom award check is to be made payable, and address of individual to whom it is to be mailed, if award is made for the paper.

A statement that data on the three Factors of Judgment are given in the paper.

A statement that cost data are given.

A statement that the work treated in the paper was carried on within the period—January 1st, 1940 to June 1st, 1942.

If paper may not be published, a statement to that effect.

If product, structure, or work used as subject is patented, a statement to that effect giving the full name and address of the person, or persons, from whom information regarding the patent is to be obtained.

- "4. THE UNSIGNED COPY:—The unsigned copy shall have the following information written on the cover sheet and on the outside of the envelope in which it is enclosed:

Classification of the paper, as A-1, C-4, J-6, etc.

NOTE: On this unsigned copy of the paper and envelope no name or data other than classification are to be given.

- "5. The two separate sealed envelopes, one containing the signed and the other the unsigned copy of the paper, are to be placed together in a large envelope, postage prepaid, and addressed: 'Secretary, The James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, Ohio,' and mailed, postmarked not later than midnight June 1st, 1942, and received in Cleveland not later than midnight July 1st, 1942. Upon receipt thereof in Cleveland, the sender will be notified by mail.

"*Confidential Handling of Papers*—When received by the Secretary, the envelope in which both copies of the paper are enclosed will be opened and immediately the same identifying number will be given to the envelope containing the signed paper and the envelope containing the unsigned paper. The envelope containing the signed paper will be retained by the Secretary unopened and confidential. The envelope containing the unsigned paper, with the number identifying the author, and the classification and division for which the paper is entered, will be delivered, unopened, to the Jury of Award, with other contesting papers, at the close of the Program.

"The object will be to keep each paper confidential, without disclosure, until the Jury of Award considers the identified but unsigned paper. When the award papers are selected by the Jury of Award, proper certificate thereof will be made to the Foundation and then each award paper will be identified with its original paper on file with the Secretary."

Only papers contained in envelopes postmarked not later than June 1, 1942, and received in Cleveland not later than July 1, 1942, were accepted.

By letter of July 28, 1942, the Jury of Award of The James F. Lincoln Arc Welding Foundation certified to the Secretary its decisions concerning papers submitted in the Progress Program. The certification of papers, (See page xxv), was by number in accordance with the Rules of Award.

Upon receipt of the Jury's report, the Secretary and Assistant Secretary of the Foundation, identified the authors of the award-winning papers by reference to the various records.