A NATIONAL
HISTORIC
MECHANICAL
ENGINEERING
LANDMARK

The C-E All Welded Test Boiler Drum

Chattanooga, Tennessee

May 2, 1980

CHATTANOOGA WALDEN CLUB
LUNCHEON PROGRAM
1:00 P.M., May 2, 1980

Welcome	Mr. H. M. Winterson President Power Systems Group Combustion Engineering, Inc.
ASME Landmark Program	Professor J. J. Ermenc Chairman, ASME National History & Heritage Committee
C-E First Welded Steam Drum Commemoratives	Mr. D. E. Lyons Vice President Fossil Power Systems Division Combustion Engineering, Inc.

DEDICATION CEREMONY
NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK
COMBUSTION ENGINEERING FIRST WELDED STEAM DRUM
May 2, 1980, 2:30 P.M.
C-E CHATTANOOGA METALLURGICAL AND
MATERIALS LABORATORY

PROGRAM

Welcome	Dr. Reginald I. Vachon Vice President, Region XI ASME
Introduction of Honored Guests	Dr. Ronald B. Cox, P.E. Chairman, Chattanooga Section ASME
Remarks	The Honorable Charles A. Rose Mayor, City of Chattanooga
	The Honorable Dalton Roberts Hamilton County Executive
	The Honorable Gene Roberts Commissioner, Department of Safety State of Tennessee
Dedication Speaker	The Honorable Marilyn L. Bouquard Congresswoman 3rd District, Tennessee
Plaque Presentation	Dr. S. Peter Kezios Past President ASME
Acceptance	Mr. D. E. Lyons, Vice President Fossil Power Systems Division Combustion Engineering, Inc.
Closing Remarks and Invitation to Tour the Metallurgical Lab	Mr. R. E. Lorentz, Jr. Director, Metallurgical and Materials Laboratory Combustion Engineering, Inc.

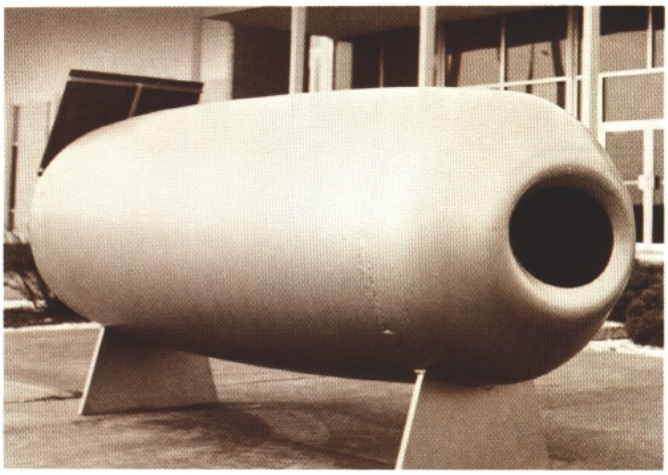
INTRODUCTION

The bronze plaque commemorating the C-E fusion welded boiler drum as a national historic Engineering Landmark reads as follows:

"This fusion-welded drum, tested during 1930, was the first in a series tested at Combustion Engineering, Inc., which led to the industrial acceptance of welding for the fabrication of boiler drums.

Welding, in replacing riveting for steam power plants, permitted increased efficiencies through higher working pressures and temperatures, and fabrication of larger units of improved safety. Welding then was rapidly extended to fabrication using alloys optimum for pressure vessel and structural application for all types of service."

The American Society of Mechanical Engineers



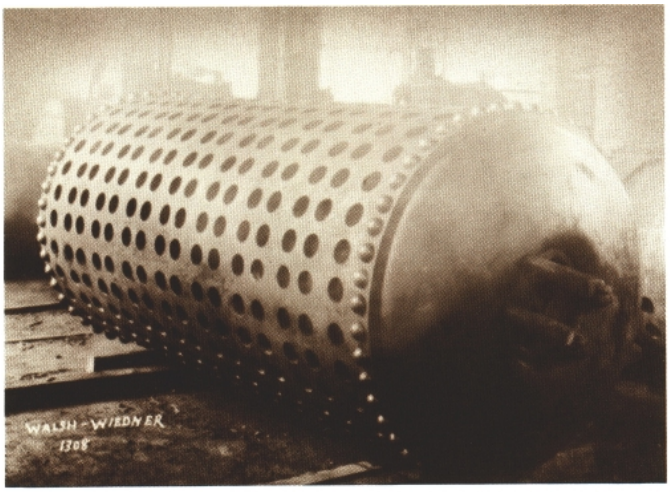
This first welded boiler drum by Combustion Engineering was tested to destruction on May 2, 1930.

HISTORY OF A LANDMARK

Until the late 1920s, pressure vessels for boiler service were assembled by riveting. The process of welding as applied to this industry simply did not exist. Under thermal and mechanical expansion, the crevice inherent in riveted construction leaked. Also, at very high pressures, the crevice was a place of corrosion concentration. Both of these conditions posed serious safety problems and demanded that other methods of construction should be investigated.

Faced with this problem, the industry had two alternatives: The first was to use metal forgings, but they were very expensive. The second was to improve safety, and to allow larger and more efficient units by experimenting with welding—a technique that had yet to be fully perfected and accepted for pressure vessel construction.

Rivets in these pre- 1930 boiler drums were driven by hydraulic pressure.



THE WELDED DRUM

It was about this time that the Hedges-Walsh-Weidner Boiler Company, a wholly owned subsidiary of Combustion Engineering Co., came into the picture. They had already in the late 1920s begun welding and testing boiler plate material coupons in Chattanooga. A program to hydrostatically test welded boiler drum vessels on an experimental basis was started.

Since the use of coated electrodes for electric arc fusion welding was in its infancy, much of the early work carried out here in developing and perfecting these electrodes was extremely important—both to the success of the

company's testing programs at that time and to the future of welding for high pressure, high temperature applications.

THE TEST

Progress in this area continued until finally on May 2, 1930 an historic occasion took place—the first of a series of the company's boiler drums that had been assembled by welding was hydrostatically tested to destruction, and with significant results. To begin with, this first welded vessel had been fabricated from rolled shell plate one inch thick, purchased to ASTM standards of 55,000 psi tensile strength for firebox boiler plate.

The heads were formed in the shape of a dish from 1½ inch thick plate material made to the same specifications as the cylindrical shell. One head was blank. The other had a 12 × 16 inch oval manway opening sealed by a standard manway cover. The shell cylinder had a 34 inch inside diameter. There was a distance of 72 inches between the head weld seams.

The overall length of the drum was 98 inches—a small but historic start. A single longitudinal seam weld joined the edges of the rolled shell. Two girth seam welds joined the heads to the shell. Flux coated metal electrodes produced by C-E were used for welding. Samples of the weld joint had been tested and found satisfactory prior to testing the vessel.

The vessel itself was mounted on a laboratory test stand. Dial indicators measured the extent of two dimensional strains as hydrostatic pressure was applied.

This historic recording shows C-E's first all welded boiler drum in the shop where it was tested to destruction.

A forerunner of today's larger models, this 550 ton flanging press was used to form heads for early C-E boilers.

SUCCESS AT 3250 PSIG

Based on tentative design calculations which were then proposed for the ASME Code, the safe working pressure for this pressure vessel was calculated to be 517 psig. It is doubtful anyone at that time realized just how much more it would actually withstand under test.

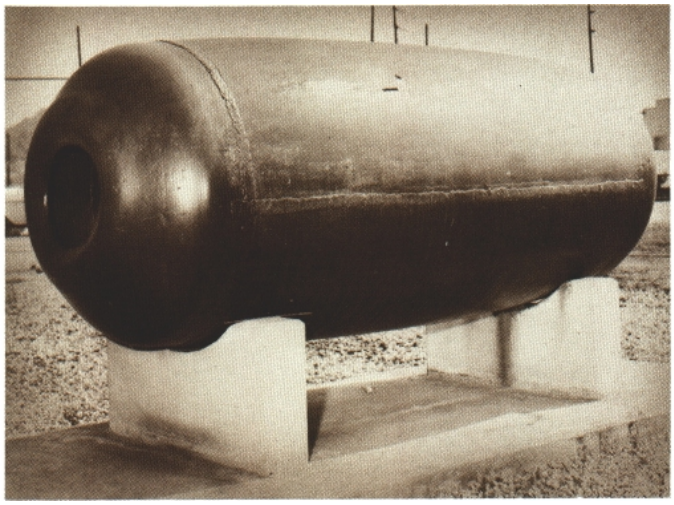
A test pressure of 3250 psig was reached. As the test vessel expanded under hydraulic pressure, the flanged-in manway bulged, causing a leak that prevented further testing. Nevertheless, the test was a success. It proved conclusively that these welded joints were 100% efficient and could withstand pressures more than six times those considered safe.

At pressures more than six times those calculated to be within safe limits, this first welded test unit was so deformed at 3250 psig that it leaked and could no longer hold more pressure.

INDUSTRY RECOGNITION

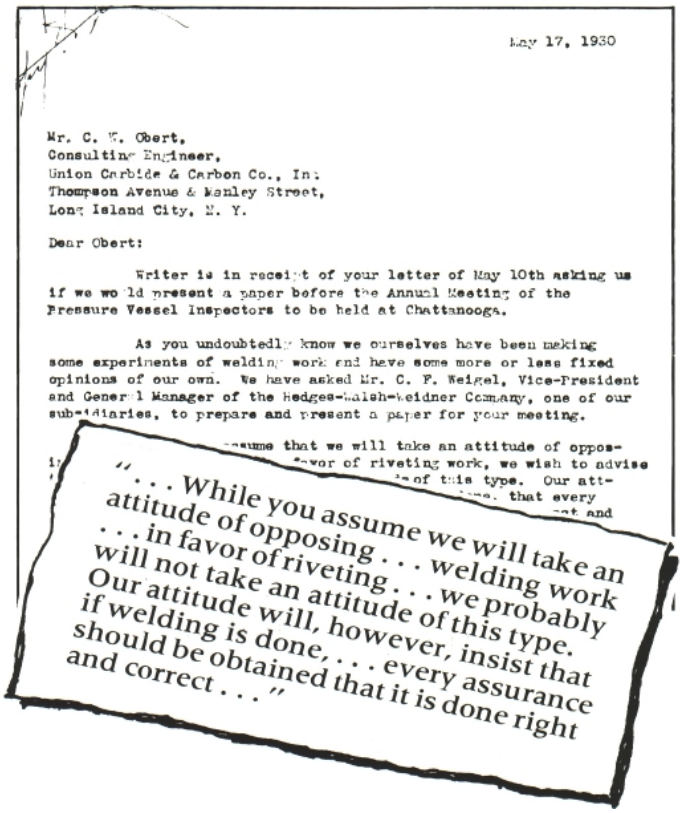
After the first successful C-E test, follow up work and interest in welding continued in earnest. Coincidentally, an opportunity to share these developments with the boiler industry presented itself at just about the same time. On May 10, 1930, some eight days after this first successful test, C-E officials in New York City received a letter from Mr. C. W. Obert, a consulting engineer at Union Carbide and Carbon Co., Inc., an official of the American Welding Society and the honorary secretary of the ASME Boiler Code Committee.

In his letter to A. C. Weigel, the manager of C-E's boiler department, Obert requested that C-E participate in the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors. He asked C-E to prepare a paper on the subject of welding. Perhaps not



being completely familiar with some of the test results C-E had achieved just eight days earlier, Obert wrote, "May I inquire if you will be willing to be represented at this symposium . . . and will be prepared to criticize the proposed (fusion welding code) specifications prepared by the National Board? It is my understanding that you would not. be in favor of the use of such fusion welded drums for the construction of power boilers, although of course, if you have any favorable comments to offer, they will be in order at that time."

Weigel then wrote back to Obert, "As you undoubtedly know, we . . . have been working on some experiments of welding work and have some more or less fixed opinions of our own . . . While you assume we will take an attitude of opposing . . . welding work . . . in favor of riveting . . . we probably will not take an attitude of this type. Our attitude will, however, insist that if welding is done, . . . every assurance should be obtained that it is done right and correct and, . . . we are not in favor of welding . . . unless proper precautions are made to insure good welding work."



May 17, 1930

Mr. C. W. Obert,
Consulting Engineer,
Union Carbide & Carbon Co., Inc.
Thompson Avenue & Manley Street,
Long Island City, N. Y.

Dear Obert:

Writer is in receipt of your letter of May 10th asking us if we would present a paper before the Annual Meeting of the Pressure Vessel Inspectors to be held at Chattanooga.

As you undoubtedly know we ourselves have been making some experiments of welding work and have some more or less fixed opinions of our own. We have asked Mr. C. F. Weigel, Vice-President and General Manager of the Hedges-Walsh-Weidner Company, one of our subsidiaries, to prepare and present a paper for your meeting.

...sume that we will take an attitude of oppos-
...vor of riveting work, we wish to advise
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"... While you assume we will take an attitude of opposing ... welding work ... in favor of riveting ... we probably will not take an attitude of this type. Our attitude will, however, insist that if welding is done, ... every assurance should be obtained that it is done right and correct ..."

C-E's first expression of support for welded boiler construction was pointed out in this letter to an ASME official.

THE FIRST TECHNICAL PAPER

A. J. Moses, shop superintendent of Hedges-Walsh-Wiedner in Chattanooga, was chosen to prepare this important paper. It was Moses' early involvement in welding development that led to the decision.

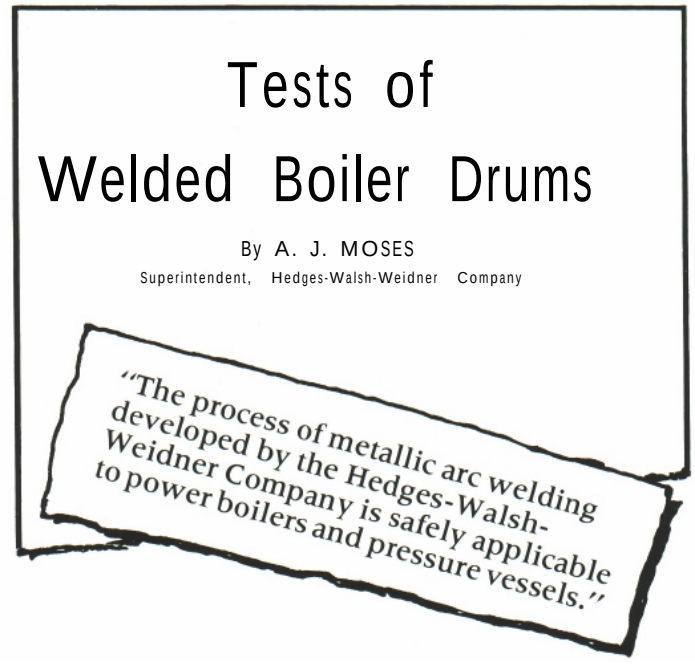
As planned, the presentation was made to the National Board Of Boiler and Pressure Vessel Inspectors in June, 1930. In addition to discussing his views on the proposed requirements and codes, Moses took it a step further. He incorporated C-E suggestions for "having a special licensed shop for building welded boiler drums and that the inspector passing them (be required) to stand a special examination."

Welding as a viable alternative to riveting of boiler drums was starting to take shape and form. Over the next several months, additional tests of welded boiler drums were conducted.

C-E'S COMMITMENT TO WELDED CONSTRUCTION

In November, 1930, Moses wrote another paper that was published in Combustion magazine, entitled, "Tests of Welded Boiler Drums." In it he fully described the details of the test work conducted during those prior months and concluded that while further tests were contemplated, "The process of metallic arc welding developed by the Hedges-Walsh-Weidner Company is safely applicable to power boilers and pressure vessels. It has met all the requirements of the proposed ASME Code without exception in numerous welded coupon tests and in two demonstrations with full size drums."

C-E had opened the door and committed itself to this emerging technology.



Tests of

Welded Boiler Drums

By A. J. MOSES

Superintendent, Hedges-Walsh-Weidner Company

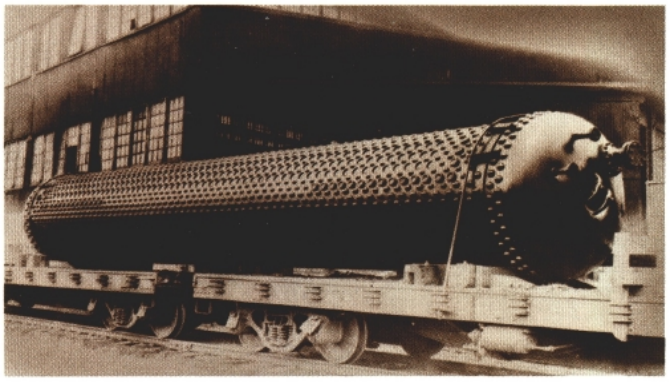
"The process of metallic arc welding developed by the Hedges-Walsh-Weidner Company is safely applicable to power boilers and pressure vessels."

Boiler welding as a viable alternative to riveting began to take shape and form with the first related technical paper on the subject by A. J. Moses.

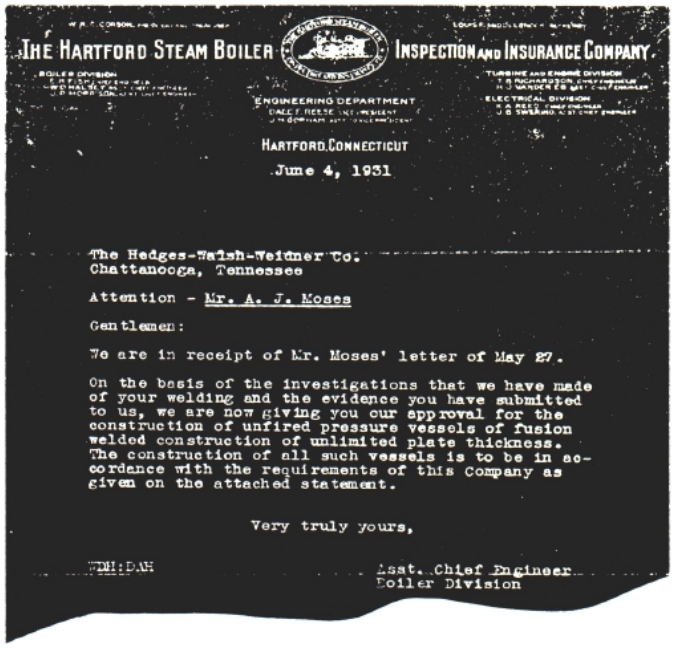
ASME CODE ACCEPTANCE

By 1931, the entire boiler industry was engaged in the development of welding processes for pressure vessels. In June of that year, an industry milestone was reached when the ASME Code Committee adopted new rules approving the use of welding for boiler drum construction. The rules also established requirements for x-ray testing the weld seams and for stress relieving welded vessels.

A jump ahead of the game, C-E had already installed large industrial X-ray equipment and a large stress relieving furnace. In fact, on June 22, 1931, the company shipped to the Fisher Body Division of General Motors Corporation what is believed to be the first commercial land boiler fabricated to these ASME Code welding requirements. By June 4, 1931, the Hartford Steam Boiler Inspection and Insurance Company had given C-E approval to go ahead with construction of unfired pressure vessels of fusion welded construction.



This drum, believed to be the first unit built to ASME Code welding rules, was shipped to Fisher Body Division of General Motors on June 22, 1931.



THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

ENGINEERING DEPARTMENT

HARTFORD, CONNECTICUT

June 4, 1931

The Hedges-Walsh-Weidner Co.
Chattanooga, Tennessee

Attention - Mr. A. J. Moses

Gentlemen:

We are in receipt of Mr. Moses' letter of May 27.

On the basis of the investigations that we have made of your welding and the evidence you have submitted to us, we are now giving you our approval for the construction of unfired pressure vessels of fusion welded construction of unlimited plate thickness. The construction of all such vessels is to be in accordance with the requirements of this Company as given on the attached statement.

Very truly yours,

WDH:DAH

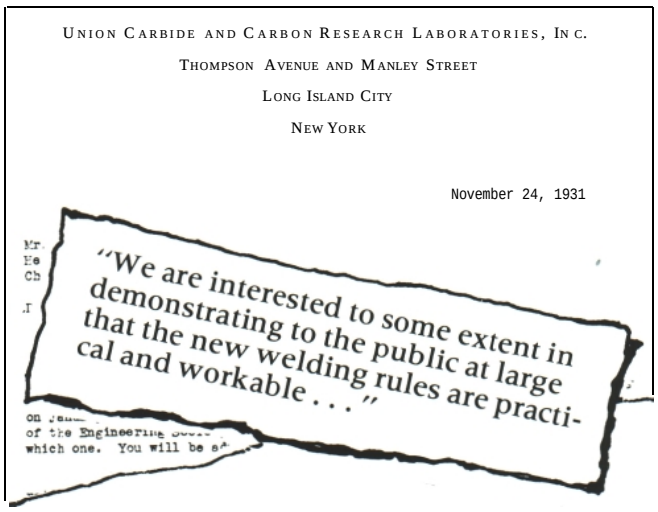
Asst. Chief Engineer
Boiler Division

Approval from the Hartford Steam Boiler Insurance Company to go ahead with welded construction on unfired pressure vessels opened the door for C-E.

HOLDING THE LINE ON CODES

While C-E was able to move ahead in welded pressure vessel technology, some boiler manufacturers were apparently having difficulty meeting the requirements of the new rules to the ASME Code. In November, 1931, C. W. Obert requested that A. J. Moses prepare another paper—this one for a joint meeting of ASME and the American Welding Society. Obert said in the letter, "We are interested to some extent in demonstrating to the public at large that the new welding rules are practical and workable and that they do not involve an impossible set of conditions as some of the boiler manufacturers have claimed. Anything you can do to assist us in emphasizing this fact will be greatly appreciated."

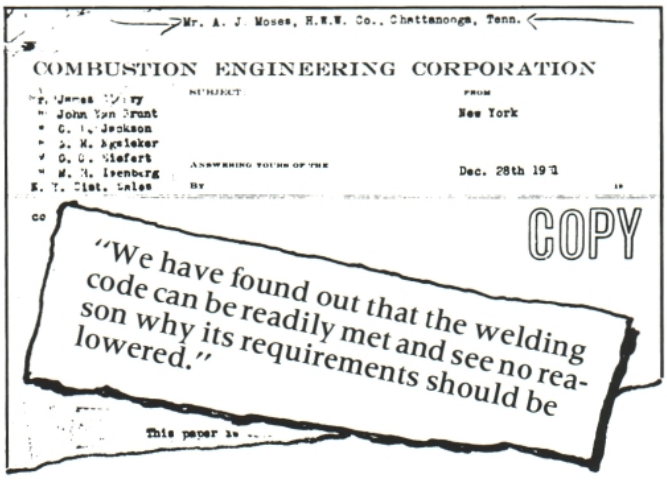
C-E backed up this request 100% when A. C. Weigel of C-E wrote in a memo to corporate management, "We understand that quite a number of the manufacturers are having troubles meeting the requirements of the new ASME Code and are objecting strenuously to the specifications. In our opinion this is due to their lack of having developed the art to the extent necessary. We have found out that the welding code can be readily met and see no reason why its requirements should be lowered. It is our intention that this paper shall support the Code committee and our stand along these lines."


UNION CARBIDE AND CARBON RESEARCH LABORATORIES, INC.
THOMPSON AVENUE AND MANLEY STREET
LONG ISLAND CITY
NEW YORK

November 24, 1931

"We are interested to some extent in demonstrating to the public at large that the new welding rules are practical and workable . . ."

In November, 1931, C-E was asked to prepare a paper on our experiences showing that proposed ASME welding codes were both practical and workable.


Mr. A. J. Moses, H.W.W. Co., Chattanooga, Tenn.

COMBUSTION ENGINEERING CORPORATION

John Van Brunt
C. T. Jackson
S. M. Applebee
O. O. Siefert
M. M. Isenberg

New York

Dec. 28th 19

COPY

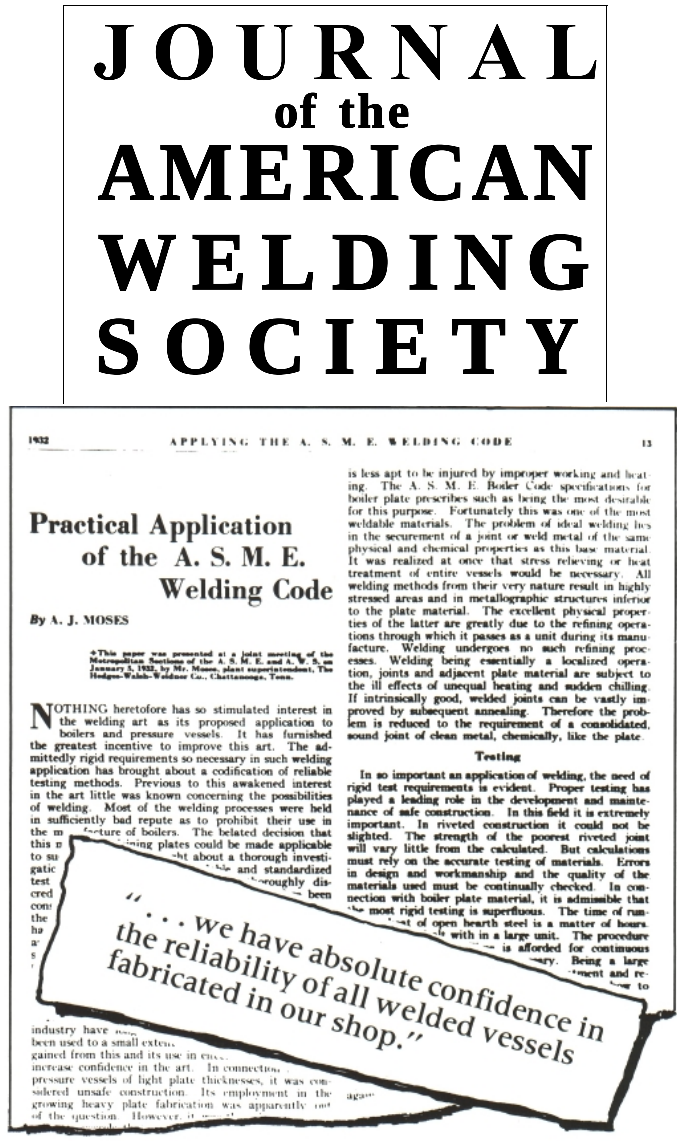
"We have found out that the welding code can be readily met and see no reason why its requirements should be lowered."

From the beginning Combustion Engineering's position on welding was to maintain the highest standards and codes.

FUSION WELDING HERE TO STAY

When Moses presented the paper on January 5, 1932, there was no doubt where C-E stood. His summary paragraph said it all. “By adhering to grade 1 testing specifications (of the ASME Code) we have absolute confidence in the reliability of all welded vessels fabricated in our shop.”

As a result of testing that first boiler drum to destruction on May 2, 1930, C-E had made a substantial contribution to the acceptance of fusion welding in pressure vessels—a step that led to the eventual adoption of a set of rules in the ASME Code of 1931.



JOURNAL of the AMERICAN WELDING SOCIETY

1932 APPLYING THE A. S. M. E. WELDING CODE 13

Practical Application of the A. S. M. E. Welding Code

By A. J. MOSES

*This paper was presented at a joint meeting of the Metropolitan Sections of the A. S. M. E. and A. W. S. on January 5, 1932, by Mr. Moses, plant superintendent, The Hedges-Walsh-Weidner Co., Chattanooga, Tenn.

NOTHING heretofore has so stimulated interest in the welding art as its proposed application to boilers and pressure vessels. It has furnished the greatest incentive to improve this art. The admittedly rigid requirements so necessary in such welding application has brought about a codification of reliable testing methods. Previous to this awakened interest in the art little was known concerning the possibilities of welding. Most of the welding processes were held in sufficiently bad repute as to prohibit their use in the m... ...ture of boilers. The belated decision that this ... ...ing plates could be made applicable ...

...is less apt to be injured by improper working and heating. The A. S. M. E. Boiler Code specifications for boiler plate prescribes such as being the most desirable for this purpose. Fortunately this was one of the most weldable materials. The problem of ideal welding lies in the securement of a joint or weld metal of the same physical and chemical properties as this base material. It was realized at once that stress relieving or heat treatment of entire vessels would be necessary. All welding methods from their very nature result in highly stressed areas and in metallographic structures inferior to the plate material. The excellent physical properties of the latter are greatly due to the refining operations through which it passes as a unit during its manufacture. Welding undergoes no such refining processes. Welding being essentially a localized operation, joints and adjacent plate material are subject to the ill effects of unequal heating and sudden chilling. If intrinsically good, welded joints can be vastly improved by subsequent annealing. Therefore the problem is reduced to the requirement of a consolidated, sound joint of clean metal, chemically, like the plate.

Testing

In so important an application of welding, the need of rigid test requirements is evident. Proper testing has played a leading role in the development and maintenance of safe construction. In this field it is extremely important. In riveted construction it could not be slighted. The strength of the poorest riveted joint will vary little from the calculated. But calculations must rely on the accurate testing of materials. Errors in design and workmanship and the quality of the materials used must be continually checked. In connection with boiler plate material, it is admissible that the most rigid testing is superfluous. The time of run... ...of open hearth steel is a matter of hours...

“. . . we have absolute confidence in the reliability of all welded vessels fabricated in our shop.”

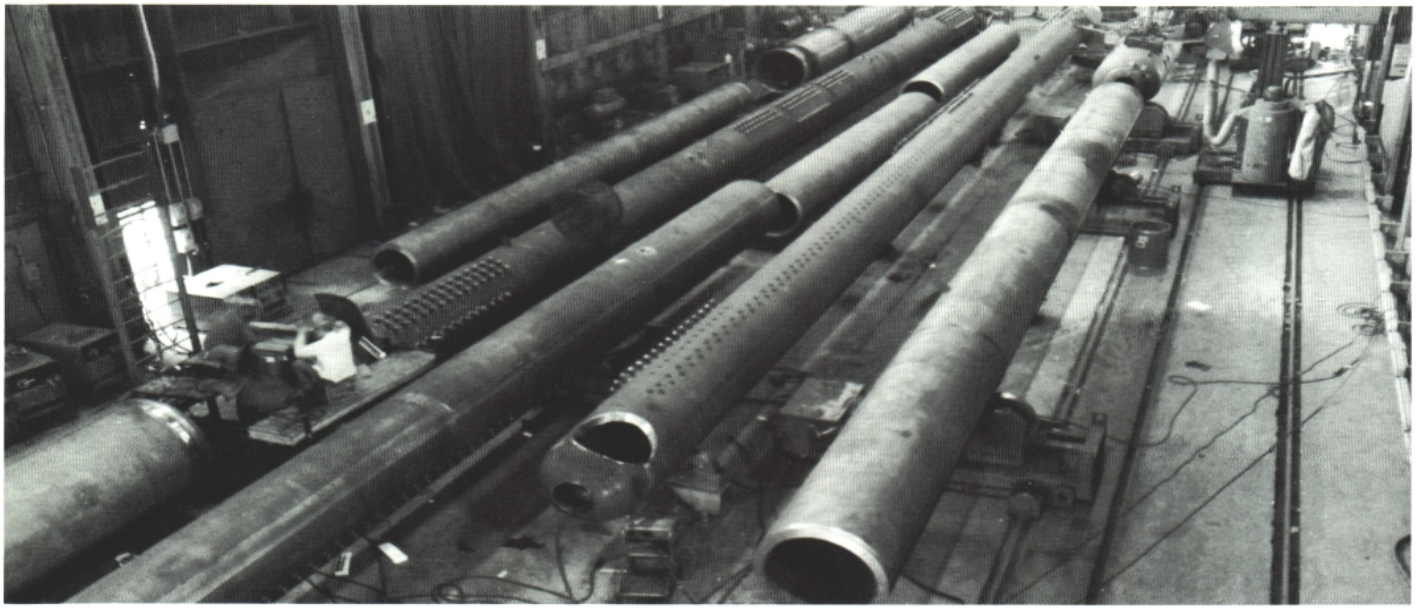
A. J. Moses pointed out in this 1932 technical paper, published later in the Journal of the American Welding Society, that the company had absolute confidence in its welded pressure vessel fabrication.

MODERN TECHNOLOGY

C-E's involvement in pressure vessel welding has continued over the years. Today, in the Chattanooga manufacturing facilities, welding processes have been developed to a very high order of sophistication.

Early in the proposal stage of a contract, welding engineering is used to address many of the pertinent fabrication questions and to develop the necessary welding procedures.

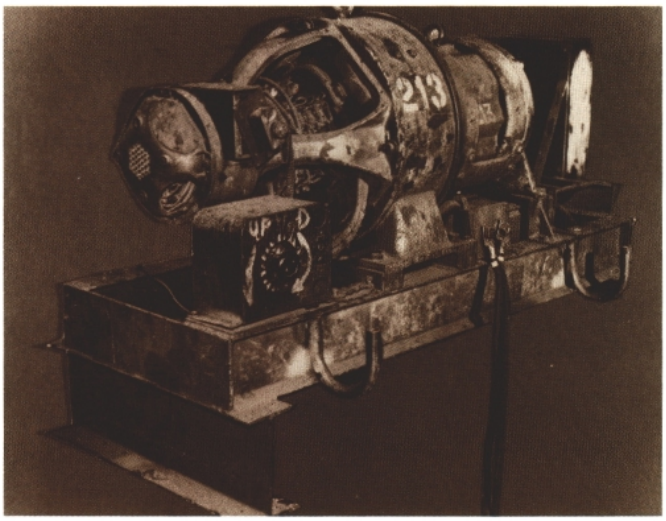
A comparison between shop facilities in the 1920s and today, shows the degree of sophistication modern welding fabrication technology has reached.



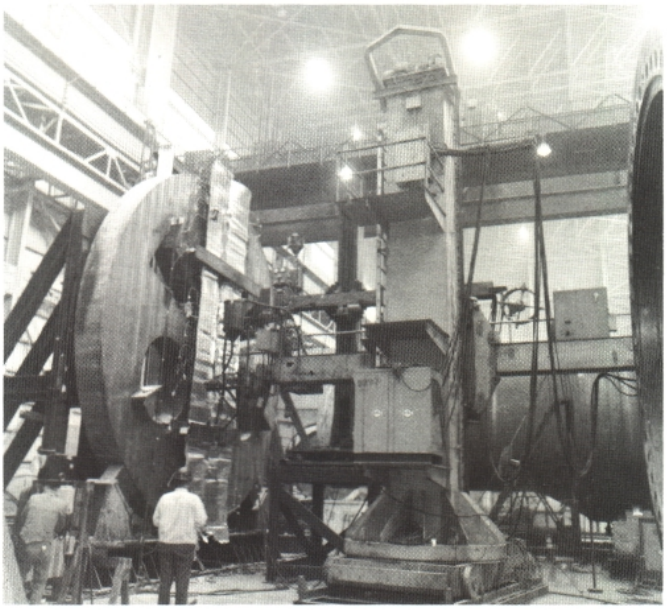
Welding shop support units follow the procedures, teach new methods and monitor shop conformance. Each year approximately 1200 C-E welders undergo training, skill upgrading and qualifying tests in virtually every type and technique of welding; submerged arc, gas metal arc, gas tungston arc, electroslag, resistance and induction pressure welding.

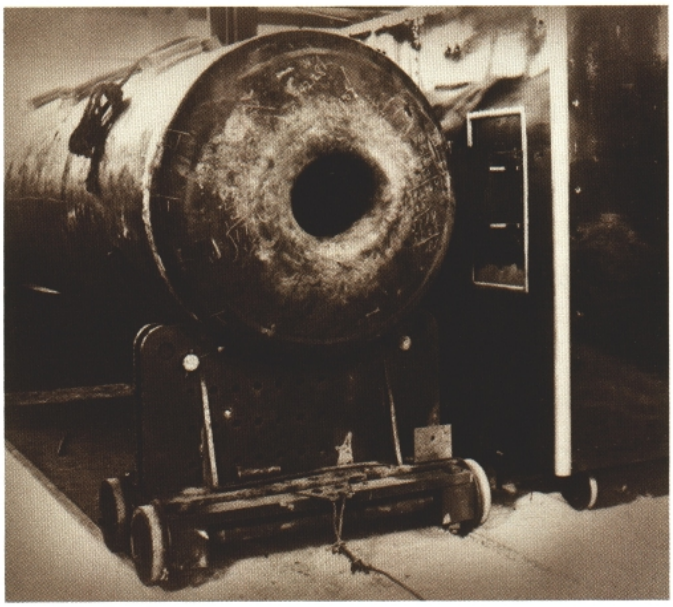
Many of the welding controls, power supplies and automatic welding equipment used are developed by C-E's metallurgical laboratory and welding engineering department. Even techniques for various types of strip cladding have been developed to the highest degree in C-E's Chattanooga facility.

Today, many of the high precision, high pressure, high temperature vessels used in the electric utility, chemical, petroleum and other process industries, are fabricated at this multi-million dollar complex occupying 143 acres and nearly four million square feet of manufacturing space in Chattanooga, Tennessee—birthplace of C-E's first all welded steam drum for modern pressure vessel boiler applications.

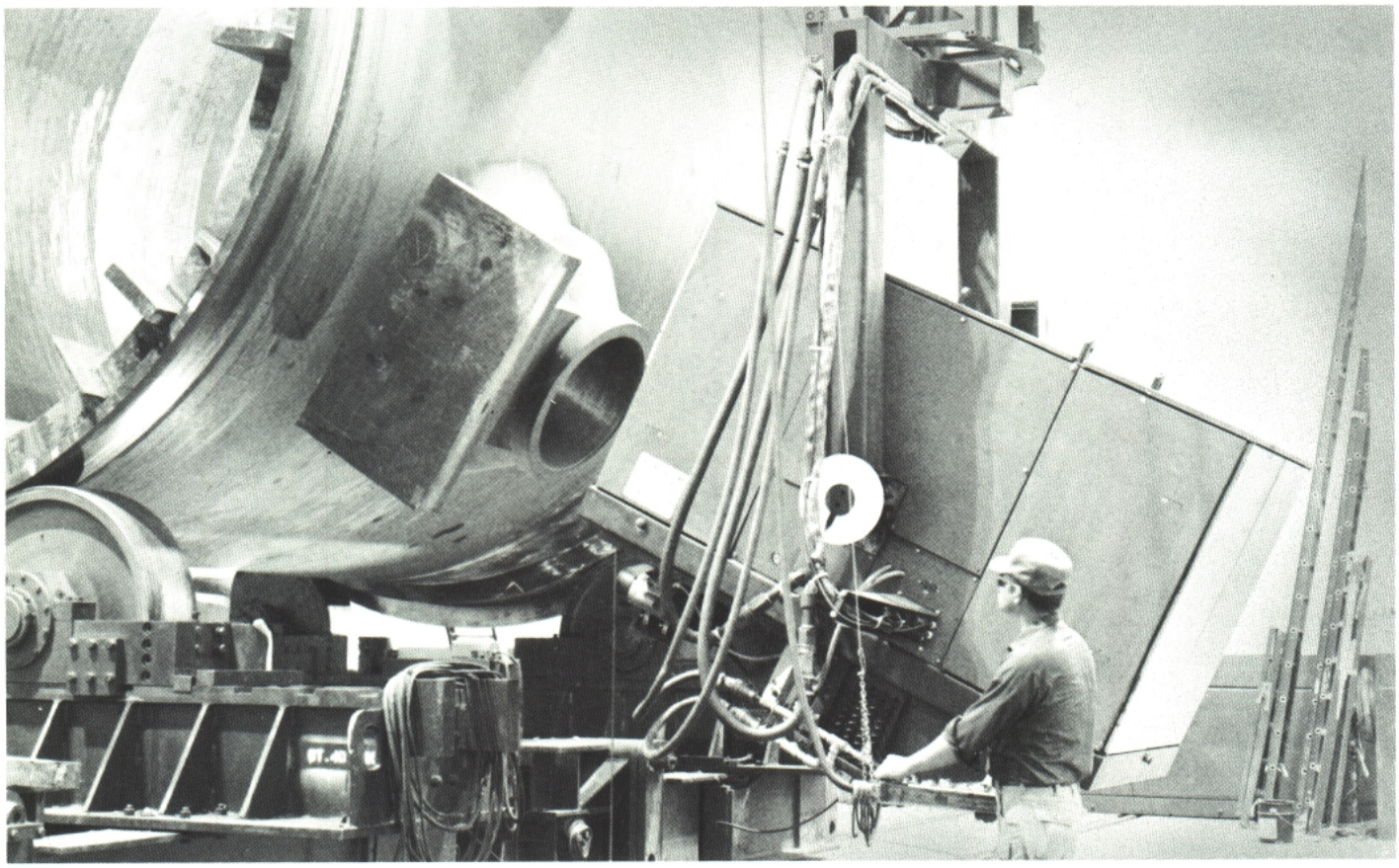


Arc welding techniques and machining have come a long way since this equipment was first used in the 1930s.





Comparing the first 175,000 volt x-ray equipment with today's 13 Mev unit shows the progress that has been made in the last 50 years.



Over 143 acres and nearly four million square feet of manufacturing space make this Chattanooga plant one of the largest facilities of its kind.

The C-E metallurgical laboratory in Chattanooga is devoted to the study and testing of materials and research to develop processes to improve C-E products.

National Historic Mechanical Engineering Landmark Program

In September 1971 the ASME Council reactivated the Society's History and Heritage program with the formation of a National History and Heritage Committee. The overall objective of the Committee is to promote a general awareness of our technical heritage among both engineers and the general public. A charge given the Committee is to gather data on all works and artifacts with a mechanical engineering connection which are historically significant to the profession—an ambitious goal, and one achieved largely through the volunteer efforts of the Section and Division History and Heritage Committees and interested ASME members.

Accordingly, two major programs are carried out by the Sections and Divisions under the direction of the National Committee: 1) a listing of industrial operations and related mechanical engineering artifacts in local Historic Engineering Records; and 2) a National Historic Mechanical Engineering Landmark program. The former is a record of detailed studies of sites in each local area; the latter is a demarcation of local sites which are of national significance—people or events which have contributed to the general development of civilization.

In addition, the Society cooperates with the Smithsonian Institution in a joint project which provides contributions of historical material to the National Museum of History and Technology in Washington, D.C. The Institution's permanent exhibition of mechanical engineering memorabilia is under the direction of a curator, who also serves as an ex officio member of the ASME National History and Heritage Committee.

The Fusion Welded Drum is the forty-second landmark to be designated since the program began in 1973. The others are:

Ferries and Cliff House Cable Railway Power House, San Francisco, CA
Leavitt Pumping Engine, Chestnut Hill Pumping Station, Brookline, MA
A. B. Wood Low-Head High-Volume Screw Pump, New Orleans, LA
Portsmouth-Kittery Naval Shipbuilding Activity, Portsmouth, NH
102-inch Boyden Hydraulic Turbines, Cohoes, NY
5000 KW Vertical Curtis Steam Turbine-Generator, Schenectady, NY
Saugus Iron Works, Saugus, MA
Pioneer Oil Refinery, Newhall, CA
Chesapeake & Delaware Canal, Scoop Wheel and Engines, Chesapeake City, MD
U.S.S. Texas, Reciprocating Steam Engines, Houston, TX
Childs-Irving Hydro Plant, Irving, AZ
Hanford B-Nuclear Reactor, Hanford, WA
First Air Conditioning, Magma Copper Mine, Superior, AZ
Manitou and Pike's Peak Cog Railway, Colorado Springs, CO
Edgar Steam-Electric Station, Weymouth, MA
Mt. Washington Cog Railway, Mt. Washington, NH
Folsom Power House #1, Folsom, CA
Crawler Transporters of Launch Complex 39, J.F.K. Space Center, FL
Fairmont Water Works, Philadelphia, PA
U.S.S. Olympia, Vertical Reciprocating Steam Engines, Philadelphia, PA
5 Ton "Pit-Cast" Jib Crane, Birmingham, AL
State Line Generating Unit #1, Hammond, IN
Pratt Institute Power Generating Plant, Brooklyn, NY
Monongahela Incline, Pittsburgh, PA
Duquesne Incline, Pittsburgh, PA
Great Falls Raceway and Power System, Paterson, NJ
Vulcan Street Power Plant, Appleton, WI
Wilkinson Mill, Pawtucket, RI
New York City Subway System, New York, NY
Baltimore & Ohio Railroad, Balttmore, MD
Ringwood Manor Iron Complex, Ringwood, NJ
Joshua Hendy Iron Works, Sunnyvale. CA
Hacienda La Esperanza Sugar Mill Steam Engine, Manati, PR
RL-10 Liquid-Hydrogen Rocket Engine, West Palm Beach, FL
A.O. Smith Automated Chassis Frame Factory, Milwaukee, WI
Reaction-Type Hydraulic Turbine, Morris Canal, Stewartsville, NJ
Experimental Breeder Reactor 1 (EBR-1), Idaho Falls, Idaho
Drake Oil Well, Titusville, PA
Springfield Armory, Springfield, MA
East Wells (Oneida Street) Power Plant, Milwaukee, WI
Watkins Woolen Mill, Lawson, MO

Acknowledgements

The Chattanooga Section of The American Society of Mechanical Engineers gratefully acknowledges the efforts of all who cooperated on the landmark dedication of the C-E All Welded Test Boiler Drum, Chattanooga, Tennessee.

The American Society of Mechanical Engineers

Dr. Donald N. Zwiep	President
Dr. S. Peter Kezios	past-president
Reginald I. Vachon	Vice President Region XI
Bobby L. Green, Chairman	H&H, Region XI
Dr. Rogers B. Finch	Executive Director and Secretary

The ASME National History & Heritage Committee

Prof. J. J. Ermenc	Chairman
Dr. R. Carson Dalzell	Secretary
Prof. R. S. Hartenberg	
Robert M. Vogel	Smithsonian Institution
Carron Garvin-Donohue	ASME Staff Director of Operations
Jill Birghenthal	Administrator

The ASME Chattanooga Section—Executive Board

Dr. R. B. Cox	Chairman
G. S. Myers	
George Riddle	
Clem Schonoff	
George Campbell	H&H Chattanooga Section

Combustion Engineering, Inc.

Active and Retired Officials and Employees
Chattanooga, Tennessee
Stamford and Windsor, Connecticut
Ottawa, Canada