

A NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK



THE JOSHUA HENDY IRON WORKS
1906–1946
SUNNYVALE, CALIFORNIA



The American Society of Mechanical Engineers
December 14, 1978



Joshua Hendy Iron Works

DEDICATION CEREMONY
NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK
JOSHUA HENDY IRON WORKS, SUNNYVALE, CA

7:00 pm, December 14, 1978



PROGRAM

Welcome	Benjamin H. Beam, Chairman Santa Clara Valley Section, ASME
Introduction of Honored Guests	Richard Rosenberg, Vice President Region IX, ASME
ASME Landmark Program	J. J. Ermenc, Chairman, ASME National History & Heritage Committee
History of Joshua Hendy Iron Works	George F. Gayer, Chairman History & Heritage, Region IX, ASME
Presentation of Plaque	O. L. Lewis, President The American Society of Mechanical Engineers
Acceptance of Plaque	Herbert J. Cabral, General Manager Westinghouse Electric Corporation, Marine Division
Closing Remarks	Richard Rosenberg, Vice President Region IX, ASME

A tour of the Works (now Westinghouse Electric Corporation, Marine Division)
will begin at 5:45 pm, prior to the dedication ceremony.

INTRODUCTION

Early in World War II, the Joshua Hendy Iron Works adopted the slogan “What America Needs, Hendy Can Build”, but this proud slogan should have been used as early as 1906, when the first buildings were erected along newly named Hendy Avenue in Sunnyvale.

For example, this historic plant, in continuous operation since 1906, contained one of the earliest foundries and machine works in California. It was one of the primary suppliers of gold and silver mining machinery to the West, and actually to the world. Some of the early Hendy hydraulic equipment, which was considered the worldwide standard in the industry, included the Hydraulic Giant Monitor, the Hurdy Gurdy, the Tangential Water Wheel, the Hendy Ore Concentrator, the Challenge Ore Feeder, and the Hendy Hydraulic Gravel Elevator. The Panama Canal was built with the help of Hendy Giants.

The Hendy Iron Works has long been recognized as having the largest machining capabilities of any plant in the West. Many of the original buildings are still in existence and in daily use. This plant has produced

many unusual products, especially in the hydraulic field. Its production of engines for marine propulsion both in WWI and WWII was considered an outstanding contribution to national defense. The production of 252 portable “Tiny Tim” rocket launchers for the U.S. Navy in one incredible 176 hour week was featured in the *San Francisco Chronicle* and the *Reader's Digest* in 1944.

Hendy pioneered the manufacture of large machinery in the West. Either the largest or the first of their kind have been designed and built in the rambling redwood shops of Sunnyvale. On a more esthetic plane, the foundry and machine shops also produced many of the ornate arches and municipal fixtures for San Francisco, such as street lamps, hydrants, and the oriental lamp posts still fascinating the tourists in Chinatown.

This diversity of products presented a challenge that was met successfully over the years by the mechanical engineers and the other “Iron Men of Hendy”, who found out what America (and the world) needed, and went ahead and built it.



Joshua Hendy Iron Works, 1907

BIOGRAPHY OF A LANDMARK

Roots

Founder Joshua Hendy was born in England in 1822 and migrated to the United States – first to New England, where he worked as a machinist, then to Texas, and then 'round Cape Horn to California. He sailed through the Golden Gate into San Francisco Bay on the morning of September 19, 1849, the year the Gold Rush hit its peak.

Joshua, however, was not one to follow rainbows for either real or mythical pots of gold. There is no record of his having dug so much as a spoonful of earth in search of golden fortune. He saw other wealth right at hand above the ground – and within two months of his arrival in the state he had started California's first redwood lumber mill.



Horse-Drawn Boiler and Engine for Early Saw Mill

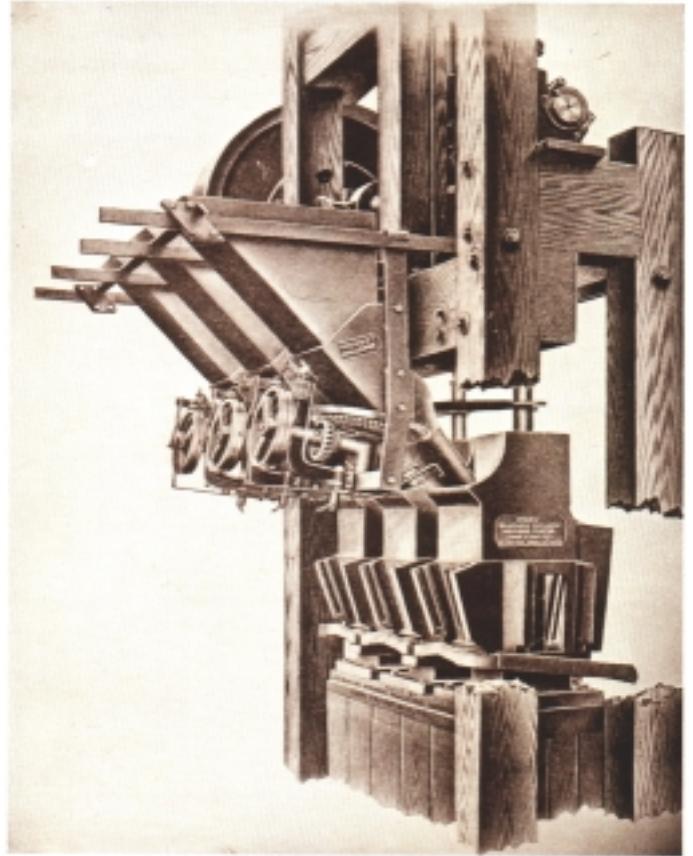
Founding of Joshua Hendy Iron Works

With typical foresight, Joshua Hendy observed and exploited the evolution of mining methods going on about him – the changing from manual placer mining, with pan and pick, to more efficient methods requiring more complicated machinery. He saw no reason why this mining machinery need be brought laboriously from the East. Consequently – in 1856 – he bought property in San Francisco, and founded the Joshua Hendy Iron Works.

Had he been content merely to ape his eastern competitors and to manufacture imitative products, his company, which specialized in mine equipment, would probably still have been a passable success because of the demand for that type of equipment. But the company brought out a line of machinery with so many improvements, and innovations, that it quickly became the leader in its field.

Constantly improved variations on both mining equipment and procedure were made, and many of the resulting products are still standard world-wide equipment. Among these are the Hydraulic Giant Monitor, the Hurdy Gurdy, the Tangential Water Wheel, the Hendy Ore Concentrator, the Challenge Ore Feeder, and the Hendy Hydraulic Gravel Elevator. General adoption of hydraulic mining methods kept the demand for Hendy equipment high. Business boomed and the one original shop became three. In 1891,

Joshua Hendy died and his two nephews, Sam and John Hendy, took over.



Hendy Challenge Ore Feeder & Stamp Mill



Hendy Hydraulic Giant in Action

Earthquake and Fire

San Francisco's greatest disaster, the earthquake and fire of 1906, turned the three busy Hendy shops into smoking ruins. Even the machinery, for the most part, was beyond hope of salvage. Some raw materials were rescued, as was an old fireproof vault that had been brought by Joshua Hendy around Cape Horn.



While Hendy directors were pondering the problems of rebuilding, they were approached by representatives of Sunnyvale, a new and alert little town 40 miles south of San Francisco. Sunnyvale was anxious to attract population-building industry and presented a good case to the Hendy directors. Sunnyvale offered 32 free acres, all in prune, apricot, and pear orchards, located along the Southern Pacific R.R. main line, with proximity to San Francisco Bay.

The *Sunnyvale Standard* of November 29, 1906, carried joyful headlines announcing the decision of the Hendy directors to move to the town. And before the end of the year of the fire, Hendy was Sunnyvale's chief, and perhaps only, industrial establishment. Remaining in San Francisco was a Hendy sales office – in one of the first new buildings to be erected after the fire. San Francisco contains a good many



Oriental Street Lamps in San Francisco's Chinatown

Hendy-built mementos – such as the ornamental arches that decorated Fillmore Street until a few years ago, numerous and miscellaneous municipal fixtures such as hydrants, the oriental lamp posts that still adorn the streets of Chinatown, and the machinery which operates the famous Third Street bridge.

For numerous peaceful years after the fire, Hendy continued its leadership in the mining-equipment field. In Alaska and in Western Canada and United States, widespread use was made of its Hydraulic Giants, crushers, ball mills, ore cars, and other equipment. Orders also flowed in from Russia, the Dutch East Indies, the Phillipines, China, and Japan. On many occasions Hendy equipment was used for purposes other than mining. The Panama Canal was built with the help of Hendy Hydraulic Giants and in 1921 Seattle used them to level 81 square blocks of property, taking cuts up to 112 feet.

As time went on, Hendy began to branch out more and more from its specialized lines of mining equipment. Two new lines of considerable importance were valves and gates. These were manufactured for installation on flood-control, irrigation, and power projects throughout the world.



Hendy Brochures, Circa 1911

Joshua Hendy Iron Works

ESTABLISHED 1856

Manufacturers of Mining Machinery

General Offices--75 Fremont Street, San Francisco, Cal.



WORKS--SUNNYVALE

SANTA CLARA CO., CAL.

OUR MINING AND MILLING MANUFACTURES INCLUDE

Electric Driven Hoists
 Steam Driven Hoists
 Gasoline Driven Hoists
 Hydraulic Driven Hoists
 Compressed Air Driven Hoists
 Donkey Steam Hoists
 Horse Whims
 Windlasses
 Hoisting Winches
 Steel Head Frames
 Head Frame Irons
 Dumping Irons
 Landing Chairs
 Safety Crossheads
 Bucket--Bailers
 Skips--Cages
 Ore Cars
 Turn-tables and Switches
 Mine Car Wheels
 Grizzlies
 Mucking Machines
 Saw Mills
 Timber Framers
 Belt Conveyors
 Bucket Elevators
 Stamp Mills

Chilean Mills
 Roller Mills
 Ball Mills
 Tube Mills
 Gravel Mills
 Rod Mills
 Cornish Rolls
 Grinding Pans
 Wheeler Pans
 Clean-up Pans
 Mexican Bateas
 Amalgam Barrels
 Amalgam Battery Plates
 Amalgam Safes
 Amalgam Retorts
 Sand Pumps
 Tailings Samplers
 Hydraulic Classifiers
 Jigs
 Rotary Kilns
 Complete Cyanide Plants
 Oil Flotation Plants
 Steam Stationary Engines
 Upright and Horizontal Boilers
 Ore Crushers

Ore Bin Gates
 Ore Concentrators
 Ore Samplers
 Ore Dryers
 Ore Feeders
 Ore Screens
 Wire and Metal Screens
 Stamp Battery Accessories
 Belt Tighteners
 Crawls--Chain Hoists
 Camshafts
 Chrome Steel Shoes
 Chrome Steel Dies
 Bullion Moulds
 Quicksilver Retorts
 Quicksilver Furnaces
 Hydraulic Mine Giants or Monitors
 Hydraulic Gravel Elevators
 Derricks
 Riveted Steel Pipe
 Water Wheels, Etc.
 Heavy Steel Forgings
 Heavy Machine Work

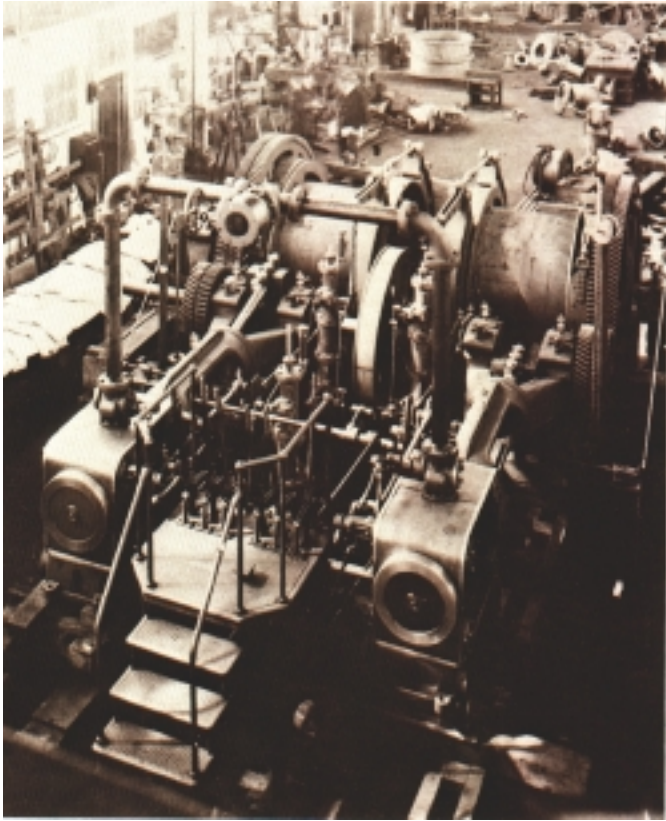
FOR HYDRAULIC POWER, IRRIGATION AND WATER STORAGE

Needle Nozzle Valves--Butterfly Valves--Low and High Pressure Gate Valves--Riveted Steel Pipe and Fittings
 Heavy Cast-iron Pipe and Fittings--Water Wheels--Reservoir Gates--Sluice Gates

FOR ELEVATING, HOISTING, ETC

Steam and Electric Hoisting Engines--Traveling Cranes--Jib Cranes--Stitt-leg Derricks--Guy Derricks--Derrick Irons

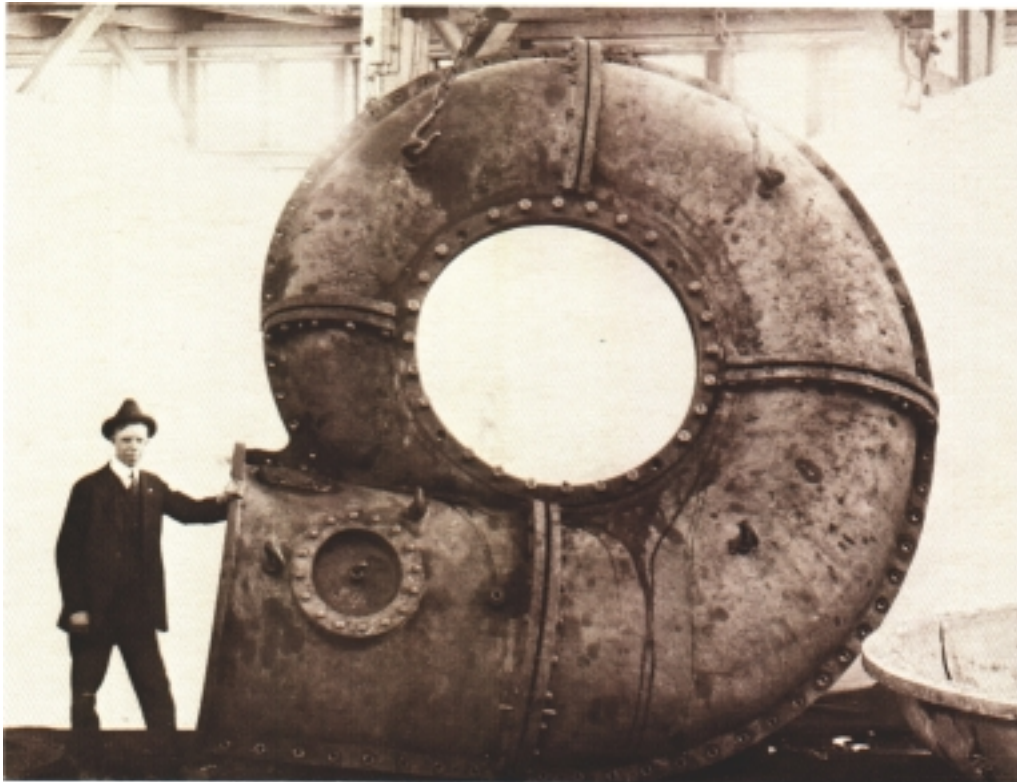
SECTIONALLY BUILT MACHINERY of the above for animal transportation.



Double-Drum Mine Hoist, 1913



Twenty Ton Flywheel, 1916



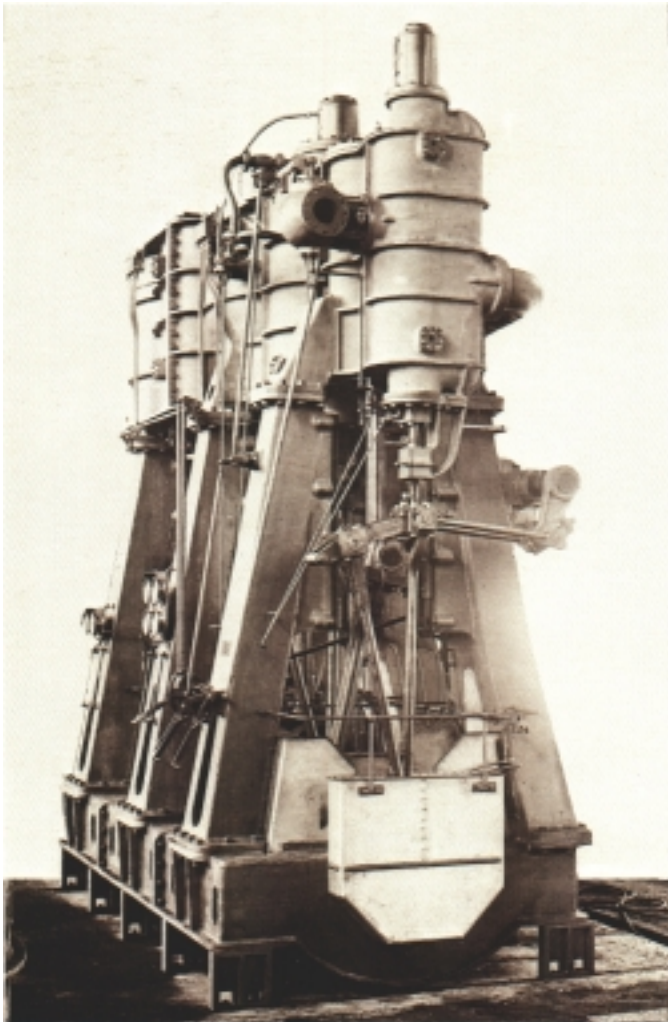
Centrifugal Pump, 48 Inch, 1917

First Marine Engines

Hendy's marine propulsion engines were produced to power the cargo vessels of World War I. The engines were the 125-ton "up-and-downers" – 2,900-hp, triple-expansion, reciprocating, steam engines, essentially the same type as the EC-2 engines used to power Liberty ships for World War II. During the 25 months of this first war program, Hendy produced 11 of the huge engines. (World War II, 25 months: 500 such engines.)



Hendy Machine Shop, 1919

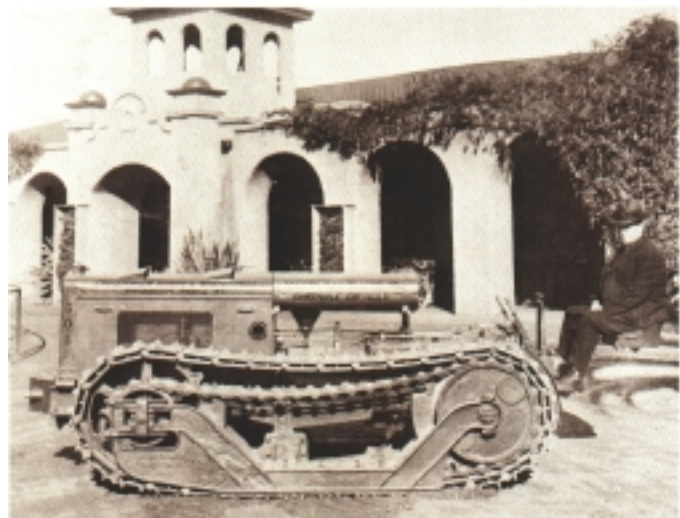


WWI Marine Engine, 2900 HP, 1918

Precision methods of machining, so necessary to mass production, had not yet been developed for the big units and, consequently "cut-and-try" methods were used. For that period, producing 11 such engines was indeed a notable achievement.



Valve & Manifold Assembly, 1919

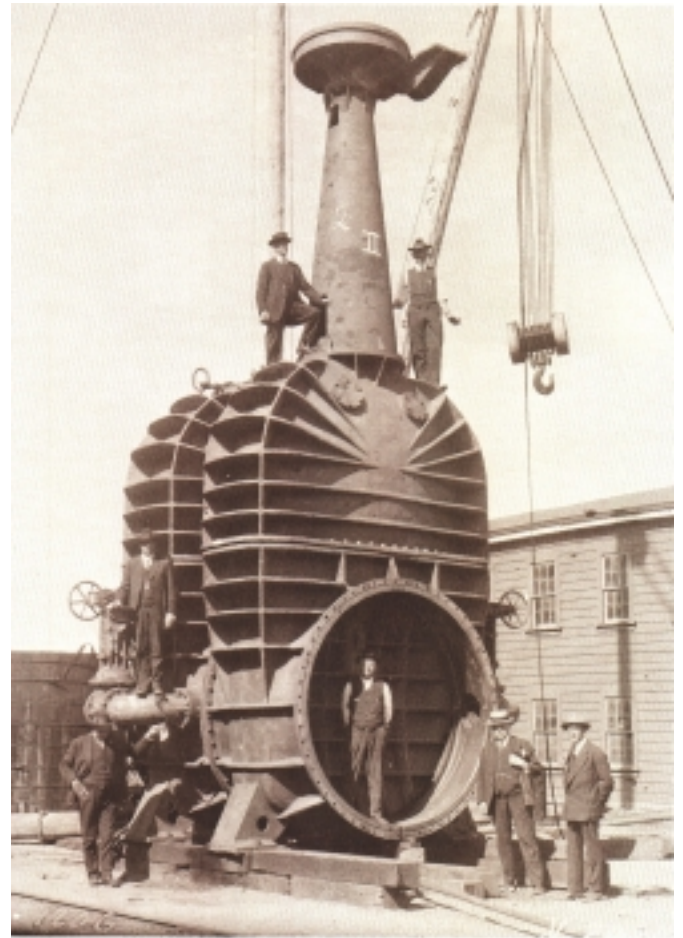


Hendy Stutes Mar Tractor, 1920

After the war, Hendy returned to its own standard lines, occasionally adding new ones, such as the tractor that was produced for a time, the Hendy Auto-crane, a

freight car puller, water wheels and turbines, parts for dredges and diesel engines, and a variety of custom-built equipment and parts.

Business hummed along smoothly until the 1929 depression. Most manufacturers suffered, particularly those engaged in producing heavy equipment, and the Joshua Hendy Iron Works was no exception. Less and less business was recorded on the company books, and fewer and fewer employes were needed. Although production declined materially, it by no means stopped. During the depression years, Hendy executed major orders for many huge gates and valves, now functioning in Boulder and Grand Coulee dams, as well as several others. And limited, but consistent, production of all the major products continued.



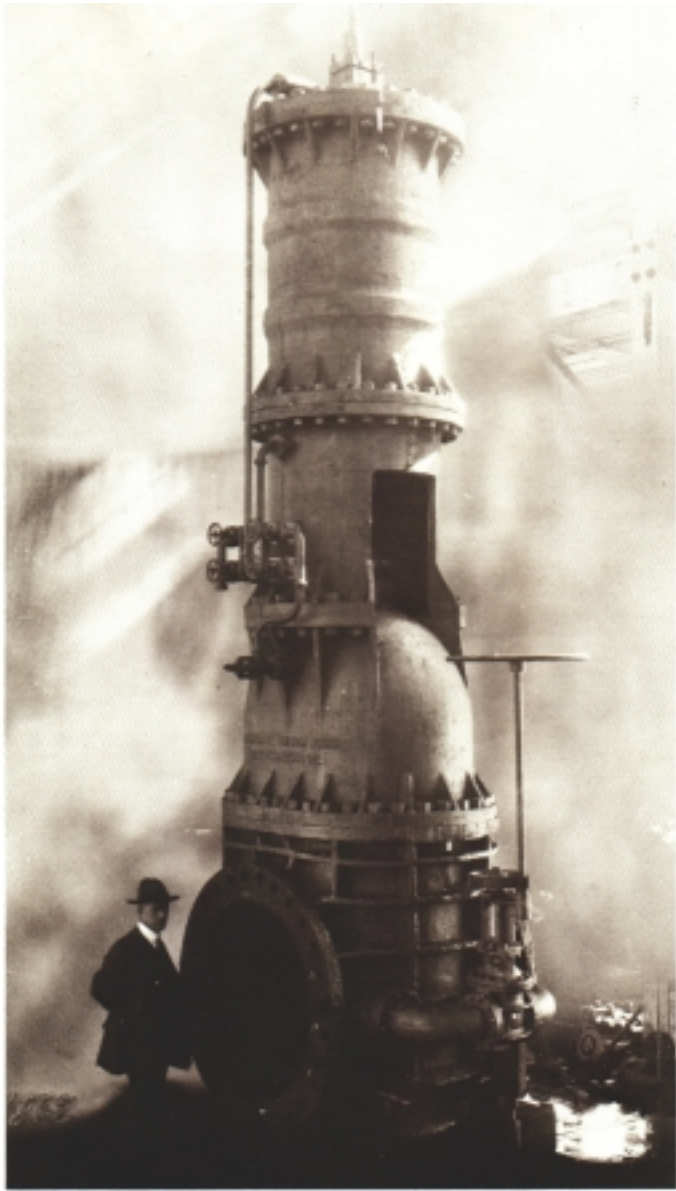
Twin Gate Valve, 96 Inches, 1920



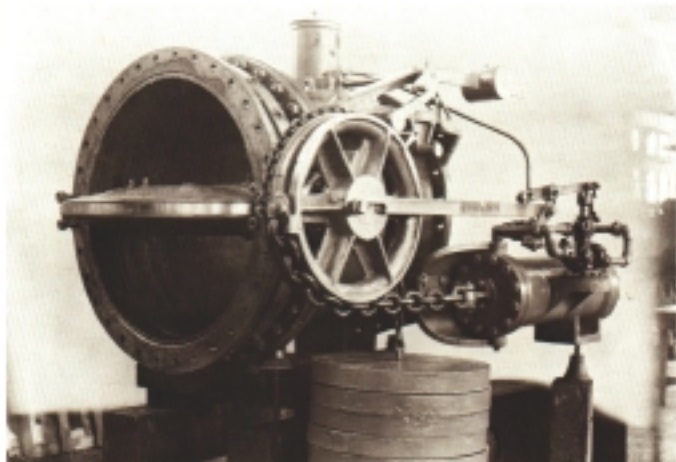
Street Lamps Built by Hendy, 1921



Hendy Gears Ready To Go, 1924



Cast Steel Gate Valve, 1921



Butterfly Valve, 36 Inches, 1932

Under New Mangement

In November of 1940 the tremendous latent possibilities of the almost dormant plant were revealed. Aggressive Charles E. Moore, backed by a group of western business men — among whom were Felix Kahn, K. K. Bechtel, Henry J. Kaiser, and others — took over the ownership. This group, originally called the “Six Companies,” had teamed together to build Boulder Dam, and the name stuck with them for each new venture. Immediately, the plant went into high gear. In 24 months, the plant expanded from 65,000 to nearly a million square feet and from 60 employees to 11,500. Products manufactured varied from small precision parts to a third of all the engines built in the United States for Liberty ships, corvette engines, main propulsion steam turbines, Navy torpedo-tube mounts, and others.

Hendy’s amazing growth — its transition from a quiet to a giant industry — resulted from a successful dovetailing of the new management’s dynamic business methods and its development of unusual manufacturing procedures. The program of building the EC-2 engines for Liberty ships illustrates how this combination was the key to record-breaking speed. Here is the story.

Engines for War

Admiral Emory S. Land, chairman of the U.S. Maritime Commission, heard that the Hendy plant — which had manufactured ship engines during World War I — had been rejuvenated, and might be able to supply some of the steam reciprocating engines needed for a projected cargo fleet of 1,600 ships (eventually 2,500 ships). After placing one order for twelve engines, Admiral Land called Moore from Washington to ask if Hendy could build another twelve. Moore said, most emphatically, Hendy could build another twelve. Said Moore, “It’s just as easy to tool up for a hundred.” They settled for a contract of 118.

One hundred and eighteen engines — each weighing about 137 tons and standing 24.5 feet high — a total of about 16,160 tons of finished machinery! In England, single engines of the same type were taking

four to six months to build by conventional, piece-by-piece methods. To say the least, Hendy's position as contractor to supply ship engines at the outset of the program was not without its interesting implications. Clearly, something unusual had to be done.



But Moore had not jumped into this program unprepared. He believed he could do to 137-ton engines what Ford had done to the automobile. Always before, marine engines of such size had been problems of tedious assembly – of careful machining of each part to fit into a specific engine. If they could be put on an assembly line like automobiles, if the machining could be so standardized and precise that no such individual fitting was necessary, a tremendous saving of time would result.

This, however, was easier said than done. Where were the many necessary machine tools to be obtained? And where would Hendy find the skilled machinists to do such exacting work? Moore attacked these problems with characteristic vigor.

Through his knowledge of machine-tool businesses and business men, he obtained an astonishing number of new tools. Where new tools were unobtainable, he converted used models that would do the work. For a

start he took anything that would produce. He even put to work a relic that had helped machine the Monitor, during the Civil War. And, where certain tools – old or new – could not be found, he and Hendy engineers designed and built them. One problem being solved . . . more followed.

Skilled machinists don't get that way over night. Nor are they abundant, particularly in time of war production. Moore found the answer to this bottleneck by combining jigs, fixtures, and specially adapted machine tools. A unique production procedure was followed whereby large parts were painstakingly fastened to "set-up" plates by highly skilled workers, in such a manner that alignment of the "set-up" plate on a machine tool automatically aligned the work. The jigs, fixtures, and special tools turned once-laborious jobs into simple, repetitive operations that workmen of less skill could handle, and the "set-up" plate procedure still further reduced the need for skilled machinists.

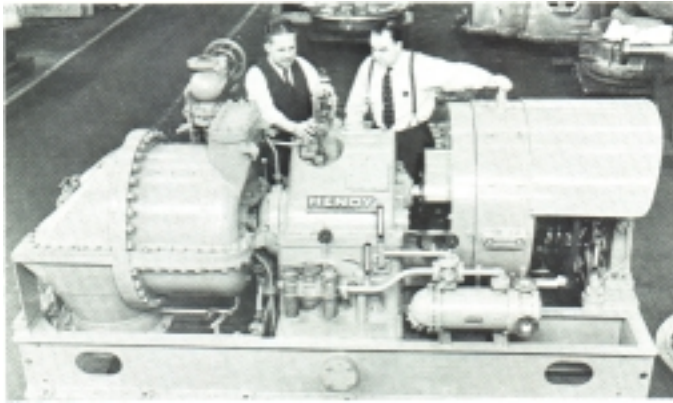
Every known device (and some hitherto unknown) that could aid production was invoked. A materials-procurement organization was created and went into action, a production-control system was established, manufacturing procedures were systematized, and new facilities were built. The upshot of all this activity was that Hendy did produce the 118 engines – and then went on producing. By March, 1945, more than 750 engines had been delivered.



Celebrating A New Record, 1945

Other Maritime or Navy Programs

Among the many programs on which Hendy worked were main propulsion steam turbines for ships, turbo-generators of several different types, turbine-drive reduction gears, diesel engines, ships' line-shafting torpedo-tube mounts, and rocket launchers.

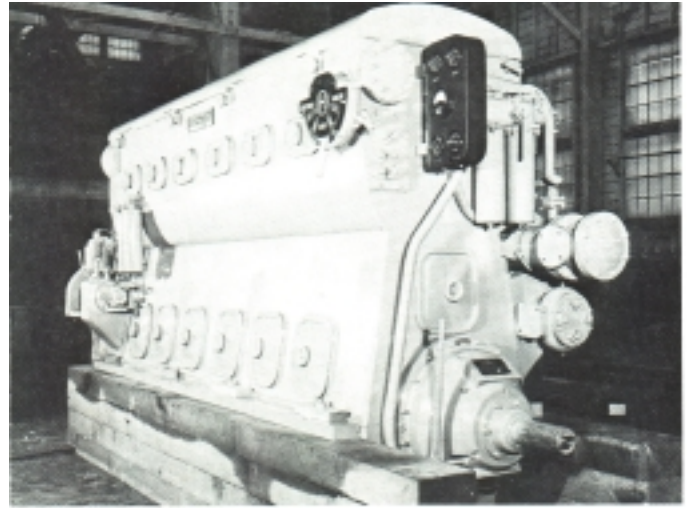


Buckingham & Ewing with First Hendy-Designed T-G Set, 1945

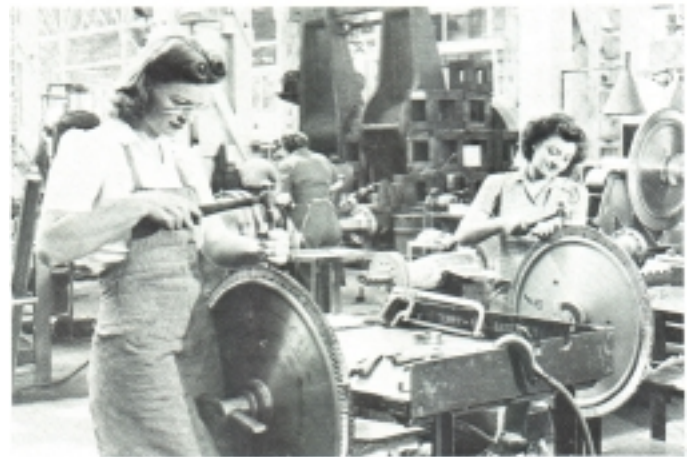
The manufacturing of turbines is a program of particular interest, for prior to Hendy's entrance into the field, no turbines had ever been built in the entire western half of the United States. Turbine building had been exclusively an eastern manufacturing art, and at that, only a half dozen or so firms anywhere in the country had the necessary facilities. This is understandable – because specialized and expensive machinery is required, and workmanship must be of the highest order. A modern turbine must have the precision of a fine watch, plus the stamina of a locomotive.

However, the Maritime Commission needed more turbines than existing national facilities could possibly produce. Hendy took the job, to the accompaniment of pessimistic predictions by outsiders who direly stated that Hendy would never get much beyond the state of acquiring facilities. But Hendy, despite all odds, plowed straight through the whole program involving plant building, machine and material procurement, engineering, production and delivery. And soon Hendy-built turbines ranging from 4000 hp to 9000 hp were installed in cargo ships delivering goods to every world port and outpost.

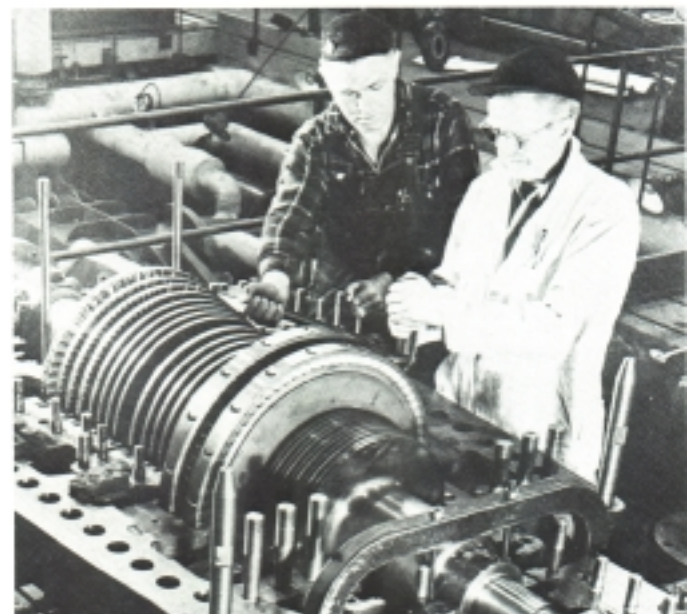
It is interesting to note that in WWII Hendy was manufacturing Westinghouse-designed ship propulsion turbines and reduction gears, pioneered by George Westinghouse in 1911.



Hendy Diesel, 1945



Hendy's "Rosie the Riveter", 1945



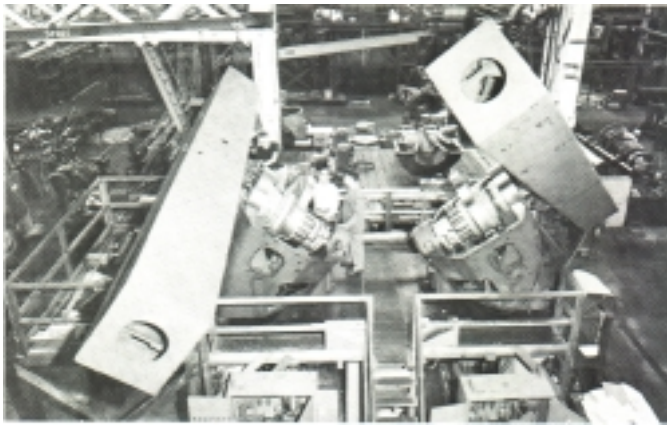
C-1 High Pressure Turbine, 1945



Hendy Becomes Westinghouse

In 1947, the Westinghouse Electric Corporation purchased the Joshua Hendy Iron Works to provide a western source of equipment for electric utilities. The machinery and capabilities well suited the needs, and the plant was soon producing steam turbines for power generation, transformers, switchgear, motors, and even portable and wall-type electric heaters.

During the transition period, the plant developed and produced a 3-inch, 70-caliber, rapid fire anti-aircraft gun for the U.S. Navy. The effort was started under Hendy and completed under Westinghouse management. Also during this period, this Sunnyvale plant built a giant multicolor, high-speed press so that TIME magazine could print a west coast edition.



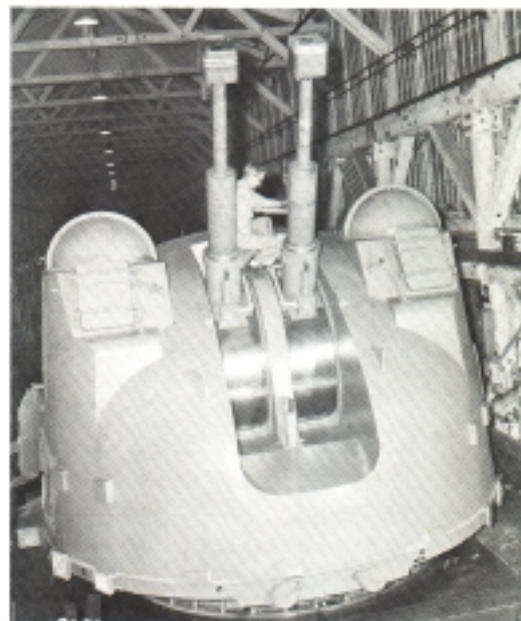
Coronagraphs

For the field of aerodynamic research Sunnyvale has supplied many wind tunnel compressors, the most spectacular being the axial flow compressors for the transonic and supersonic sections of the propulsion wind tunnel at the U.S. Air Force Arnold Engineering Development Center in Tullahoma, Tennessee. The multi-stage compressors are located in separate tunnels with a common drive system. The combined drive is believed to constitute the largest piece of rotating equipment ever built, requiring 216,000 horsepower for operation. At present, Sunnyvale is producing twelve compressors for the Aeropropulsion Systems Test Facility, also in Tullahoma.

To extend our nation's scientific frontiers in space, the Sunnyvale plant has since produced special radio and optical telescope equipment. Sunnyvale built two

coronagraphs (solar telescopes) for tracking the sun and photographing it at specific intervals. Their accuracy is equivalent to keeping a penny in sharp focus at a distance of 13 miles, as it rolls along at 300 feet per minute. One coronagraph is installed in Colorado and the other in New Mexico. A 130-foot diameter radio telescope, weighing over 941,000 pounds, capable of extremely accurate tracking, was built for Cal Tech's Owens Valley Radio Observatory. A telescope mount, including the 40-ton polar axis shaft and digital drive system was built for the McDonald Observatory, University of Texas. Mountings for the 80-inch heliostat, 60-inch primary mirror, and 48-inch mirror were furnished for the Kitt Peak National Observatory near Tucson, Arizona.

Since 1956, the Westinghouse Missile Launching & Handling (ML&H) Department at Sunnyvale has been actively engaged in the evolutionary design, development, testing, manufacture, and installation of more than 1,300 missile launch tubes and their associated shock isolation systems, missile eject systems, and control systems. To support these programs, Sunnyvale has conducted more than 2,355 development test launches. The Marine Division (as it is now known) is prime contractor to the U.S. Navy for the missile launching and handling systems for Polaris/Poseidon/Trident submarines.



Navy Anti-Aircraft Gun

Acknowledgments

The Santa Clara Valley Section of the American Society of Mechanical Engineers gratefully acknowledges the efforts of all who cooperated to make the dedication of the Joshua Hendy Iron Works a success.

The American Society of Mechanical Engineers

O.L. Lewis	President, 1978-1979
Richard Rosenberg	Vice President, Region IX
George F. Gayer	Chairman, History & Heritage, Region IX
Dr. Rogers B. Finch	Executive Director & Secretary
F. Wendell Beichley	Field Services Director, Regions VIII & IX

Westinghouse Electric Corporation, Marine Division

Herbert J. Cabral	General Manager
T. F. Raess	Manager, Engineering Operations

The ASME National History & Heritage Committee

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Donald F. Hanson	Secretary
Robert F. Pratt	Treasurer
R. Michael Hunt	Chairman, History & Heritage

The Brochure

This brochure was compiled and edited by Marvin B. Bellis, and designed by Anthony Passarelli, both of the Westinghouse Marine Division. It was published by the Marine Division. The majority of copy in the landmark brochure was developed from the following sources:

- This is Hendy* — brochure published by Hendy Iron Works in 1946
- Iron Men of Hendy* — Hendy house organ 1942 - 1946
- Reader's Digest*, June 1944
- Western Machinery and Steel World* - 1944
- The research notes of Mr. George Gayer
- The Hendy archives of Mr. Ted Raess

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 technological 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 History and Heritage Committees and interested ASME members.

Accordingly, two major programs are carried out by the Sections 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 mankind.

In addition, the Society cooperates with the Smithsonian Institution on a joint project which provides contributions of historical material to the U.S. 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 Joshua Hendy Iron Works is the thirty-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	5 Ton "Pit-Cast" Jib Crane, Birmingham, AL
Leavitt Pumping Engine, Chestnut Hill Pumping Station, Brookline, MA	State Line Generating Unit #1, Hammond, IN
A.B. Wood Low-Head High-Volume Screw Pump, New Orleans, LA	Pratt Institute Power Generating Plant, Brooklyn, NY
Portsmouth-Kittery Naval Shipbuilding Activity, Portsmouth, NH	Monongahela Incline, Pittsburgh, PA
102-inch Boyden Hydraulic Turbines, Cohoes, NY	Duquesne Incline, Pittsburgh, PA
5000 KW Vertical Curtis Steam Turbine-Generator, Schenectady, NY	Great Falls Raceway and Power System, Patterson, NJ
Saugus Iron Works, Saugus, MA	Vulcan Street Power Plant, Appleton, WI
Pioneer Oil Refinery, Newhall, CA	Wilkinson Mill, Pawtucket, RI
Chesapeake & Delaware Canal, Scoop Wheel and Engines, Chesapeake City, MD	New York City Subway System, New York, NY
U.S.S. Texas, Reciprocating Steam Engines, Houston, TX	Baltimore & Ohio Railroad, Baltimore, MD
Childs-Irving Hydro Plant, Irving, AZ	Ringwood Manor Iron Complex, Ringwood, NJ
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, NH	
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	
Fairmount Water Works, Philadelphia, PA	
U.S.S. Olympia, Vertical Reciprocating Steam Engines, Philadelphia, PA	



The Men Who Developed the First Marine Reduction Gear

GEORGE WESTINGHOUSE
President, The Westinghouse Companies
President, American Society of Mechanical Engineers

1909

REAR ADMIRAL GEORGE W. MELVILLE
Ex-Engineer-in-Chief, U.S. Navy

JOHN H. MACALPINE, M.I.N.A

