

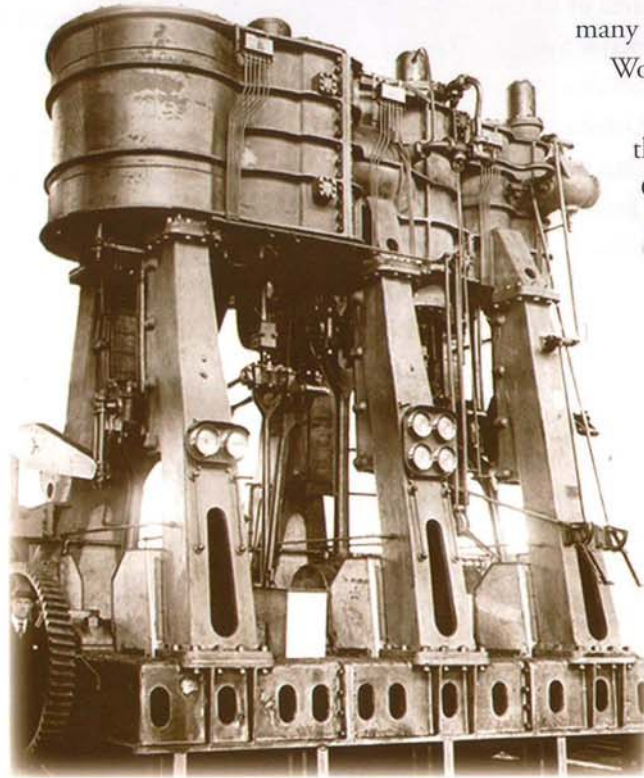
A blue-tinted photograph of a large, domed building with arched windows. In the foreground, a worker wearing a hard hat and a safety vest is kneeling on the ground, possibly working on a large wheel or piece of machinery. The overall scene is set against a dark, textured background.

NORTHROP GRUMMAN'S CENTURY IN SUNNYVALE

GENERATIONS
of **ACHIEVEMENT**

Defense of the United States and her Allies during World Wars I and II

Hendy's first marine propulsion engines were produced to power the cargo vessels of World War I. The engines were the 125-ton "Up-and-Downers", 2900-hp triple-expansion, reciprocating steam engines, which were essentially the same type as the EC-2 engines later used to power Liberty ships in World War II. During the first 25 months of the war Hendy produced 11 of the large engines, running shifts of 500 men during the day, and another 400 men at night. When compared with the Hendy's World War II record of producing 500 such engines in 25 months, it should be noted that precision methods of machining, so necessary to mass production, had not yet been developed for the big units and, consequently, "cut-and-try" processes were used. For the 1917-18 period, producing 11 such engines was indeed a notable achievement. Even though Hendy added over 200 feet to the east end of the 660 foot long main machining and assembly shop (now Bldg. 11) for this project, very often the pieces to be assembled were so large that the work had to be done outside. In addition to the engine program,



The 11 reciprocating steam engines built by Hendy to power World War I cargo vessels were essentially the same as the EC-2 Engines produced for Liberty Ships during World War II

many marine valves and fittings were also produced during World War I, along with some deck machinery.

In November of 1940 the tremendous potential of the almost dormant Hendy plant was 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 of the Hendy plant. This group, originally called the "Six Companies", had teamed together to build Boulder Dam, and the name stuck with them for each new venture. Moore, owner of Moore Machinery Company, the top machine tool sales agency on the West Coast, became Hendy's President. Immediately, the ailing company went into high gear. In 24 months, the plant expanded from 65,000 to nearly 1,000,000 square feet under roof and from 250 employees to 11,500, in large part to meet the emerging demands for World War II.

The first defense contract obtained by Moore was from the Naval Ordnance Department for \$10,000,000 worth of quintuple torpedo mount tubes in late 1940, with an additional \$1,300,000 for new facilities, including the plant's first all steel-and-glass



Hydraulic Giant
circa 1860



Stamp Mill
circa 1906



Steam Engines
circa 1918



EC2 Engines
circa 1942



Our Own
"Rosie the Riveter"
circa 1943



Anti-aircraft Guns
circa 1947



Polaris A-1
Missile Fire
circa 1960



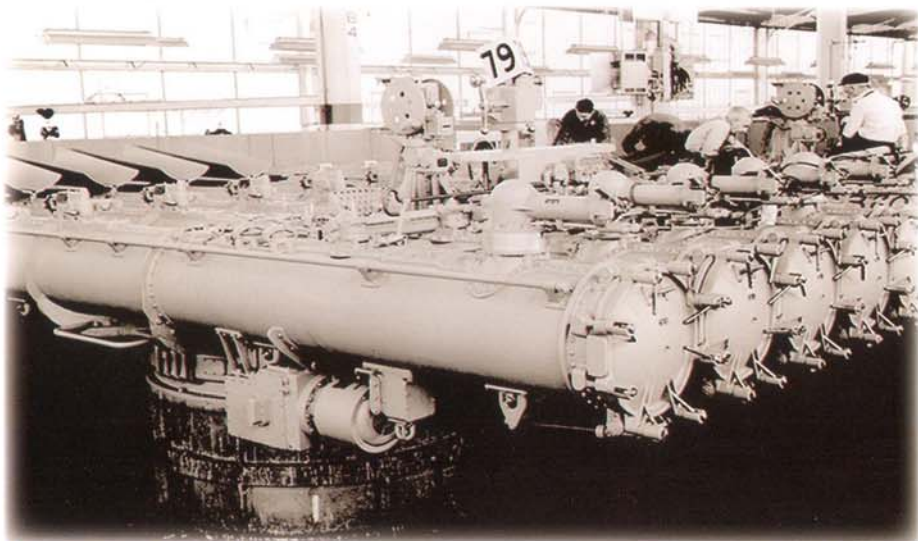
"Sky Ear"
Radio
Telescope
circa 1965



Solar
Telescope
Mountings
circa 1965



Underwater
Missile
Launch
Trident I (C4)
circa 1970



Hendy's first order for torpedo mounts was received in 1940. A total of 380 quintuple torpedo mounts were manufactured in a shop hastily built in the middle of an orchard

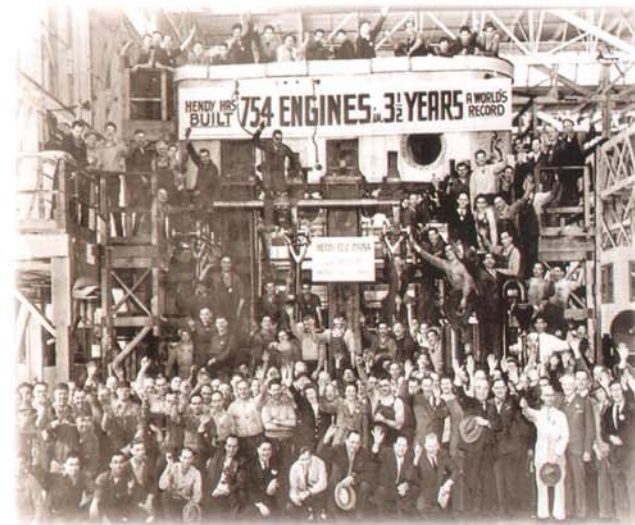
fireproof building (now Bldg. 81). An adjacent two-story administrative office for this program was also built (now Bldg. 82). With contract extensions, a total of 380 units were delivered by the time this job ended.

By far the largest World War II program for Hendy was the EC-2 3-cylinder triple-expansion reciprocating steam engine, designed to power a projected fleet of 1,600 "Liberty" cargo ships. The Liberty fleet, eventually expanded to 2,500 vessels, was created to provide supplies to our fighting forces in Europe and Asia, as well as to serve as a life-line to the embattled British Isles. Many of the Liberty ships were built at local yards, including California Shipbuilding Company in Richmond, also owned by the "Six Companies", and Marin Shipbuilding Company in Sausalito. Among the 457 Liberty ships built by Cal Ship and powered by Hendy EC-2 engines were the "George Westinghouse" and the "Joshua Hendy".

Nearly identical to the 11 engines built by Hendy in World War I, the EC-2 produced 2500 HP, weighed 137 tons, and stood 24-1/2 feet high. With the placing by the U.S. Maritime Commission of the first order for 12 EC-2 engines in March, 1941, the long calm that had settled over Hendy was ended. Almost immediately came another order for 112 more engines and Hendy's amazing growth was off and running.

The building of the EC-2 illustrates how a successful combination of the new management's dynamic business methods and its development of innovative manufacturing procedures was the key to record-breaking speed. At that time, single engines of the same type were taking 4 to 6 months to build by conventional piece-by-piece methods, but Moore believed he could do to 137-ton engines what Ford had done to the automobile. Marine engines of such size always had problems of tedious assembly and careful machining of each part to fit into a specific engine. If they could be put on an assembly line like automobiles, and if the machining could be so standardized and precise that no such individual fitting was necessary, a tremendous amount of time could be saved.

Through his knowledge of the machine-tool business, Moore obtained an astonishing number of



Hendy delivered a record 754 EC-2 steam engines to power one-third of all WWII Liberty Cargo Ships afloat



Turbine Generators
Trident Sub
circa 1970



Peacekeeper
Missile Launch
System
circa 1982



Rail Garrison
circa 1980's



Electromagnetic
Launch
1980's



Intercooled Recuperated
Gas Turbine Engine
(ICR)
1990's



Virginia class
Propulsion/Power
circa 1995



Turbine Generator
Sets circa 1960's -
present



Multiple All Up Round
Canister
circa 2003



KEI
Interceptor
Launcher
circa 2005



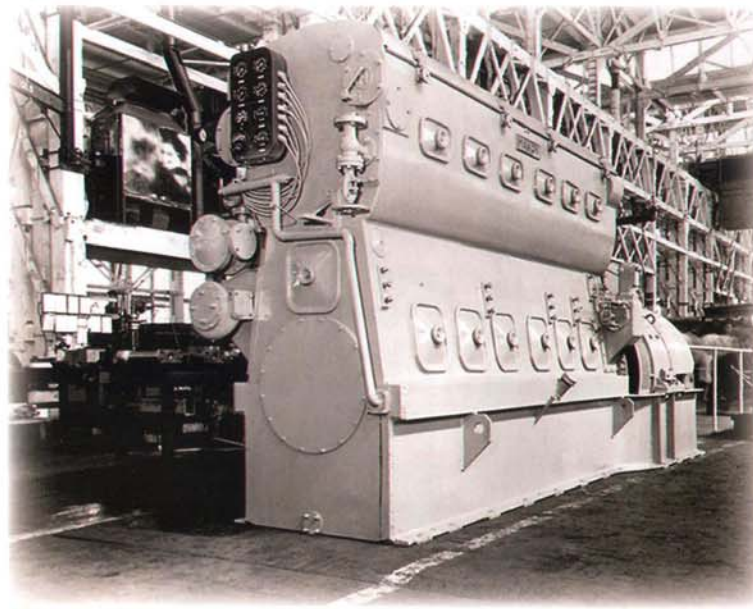
new tools. Where new tools were unobtainable, he converted used models that would do the work. Where certain tools, old or new, could not be found, he and Hendy engineers designed and built them.

Skilled machinists in sufficient numbers were not abundant, particularly in time of war production. Moore solved this problem by combining jigs, fixtures, and specially-adapted machine tools in such a way that once-laborious jobs performed by skilled machinists were turned into simple repetitive operations that workers of less skill could handle.

Every known and improvised device that could increase production was invoked. A materials procurement organization was created and went into action, a production-control system was established, manufacturing procedures were systemized, and new facilities were built.

The upshot of all this activity was that Hendy completed the 112 engines and continued producing these engines for the next three and one half years. At the end of the program in March, 1945, a world's record of 754 engines, for a third of all Liberty ships afloat, had been set. This was an extraordinary achievement that helped beat the German U-boat blockade and save the British.

Hendy's success with the EC-2 program quickly led to an order for 101 engines to power British, Canadian, and American Corvette-class Naval escort ships. These were 4-cylinder triple-expansion steam engines built to a British design. The initial delivery rate of 10 units a month was later doubled.



Marine propulsion diesel engines made by Hendy were sound, trouble-free, and long-lasting

In December of 1942 Hendy was called upon by the Maritime Commission to provide steam turbine and reduction gear sets for powering C-1 class cargo ships. More turbines were required than existing national manufacturers could possibly produce. However, Hendy accepted the challenge and set about providing the additional facilities to do the job. The C-1 turbines were built under license to their designer, Westinghouse, who had pioneered marine steam propulsion in 1911. With the help of experienced Westinghouse employees who came onto Hendy's payroll, 110 units were delivered on the C-1 and following C-3 and C-4 programs.

Other products delivered for the war effort included Hendy-designed 6- and 8-cylinder medium-speed diesel engines of up to 450 HP, and steam turbine generators with outputs up to 2500 kw.

Ordnance products manufactured to government specifications included "Little Buster" and "Tiny Tim" rockets, shells for 16-inch guns, and 5-inch portable rocket launchers.

Another development, this time a product of the newly organized Northrop-Hendy Corporation, was the Turbodyne, a prop-jet gas turbine. This was originally a Navy contract with Northrop, who approached Hendy to do the manufacturing. Jack Northrop intended to put the final units in his Flying Wing aircraft. The first small-wing model had an early Westinghouse jet in it. Five Turbodyne engines were built to develop 1500 hp. These were designed at Northrop's Hawthorne, California plant during the war, built at Sunnyvale, and tested at Hawthorne. Hendy designed and built a reduction gear for the test cell at Hawthorne,



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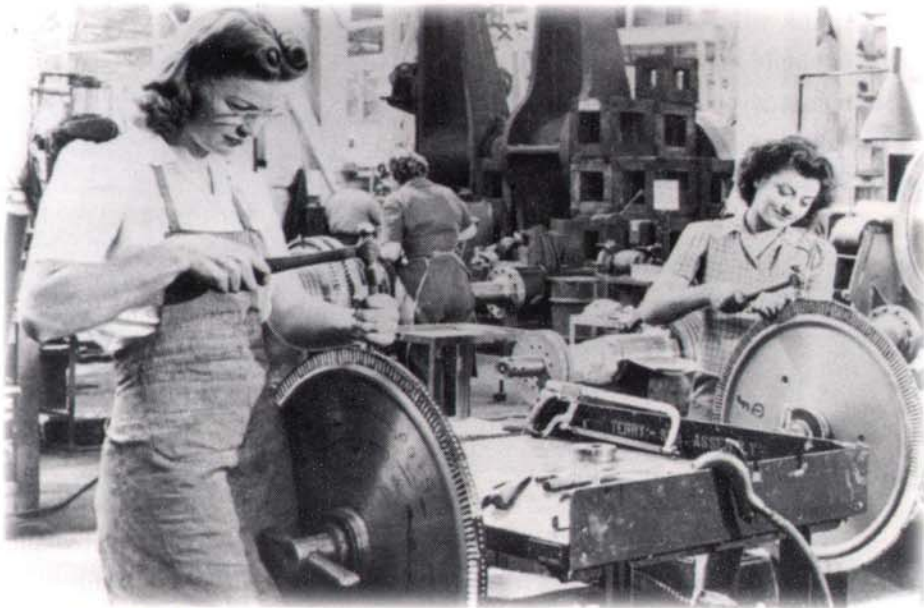
"Sky Ear"
Radio
Telescope
circa 1965



Solar
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Mountings
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Underwater
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A turbine blade shroud is riveted by Hendy's own "Rosie the Riveter," one of about 4,000 women who worked at the plant in the 1940s, supporting the war effort

and developed designs for the Flying Wing aircraft gears. Ten gas turbines designed to develop 5000 hp for this application were later built.

Hendy's final major defense contract came from the Navy after the end of hostilities. It was for twenty-five 70 Mark 37 anti-aircraft gun mounts. The design of this sophisticated fast-loading, rapid-firing weapons system was carried out by Hendy engineers sequestered on the Stanford University campus, and manufacturing was completed by Westinghouse after the change of ownership.

In July, 1942, a monthly employee magazine titled "Iron Men of Hendy" made its first appearance. The catch phrase quickly caught on, although it failed to recognize the fact that the Joshua Hendy Iron Works was a pioneer in the

women-in-the-workplace movement. With so many able-bodied men leaving for the armed forces, factory jobs were waiting to be filled. While women's jobs had customarily been limited to office and administrative tasks, Hendy offered them new opportunities as machinists, assembly technicians, forklift drivers, security guards, and the like. The icon of "Rosie the Riveter" became popular, and the number of women in the Hendy work force rose to 4,000. Although the name of the magazine didn't change (there was also a "Song of the Iron Men"), later company brochures referred to Iron Men **and** Women of Hendy.

To ease the tedium of around-the-clock work shifts and long hours with few days off, Hendy held regularly scheduled Saturday noontime rallies to boost morale. These all-employee events featured music by the Hendy band, entertainment by talented employees as well as outside professionals, and pep talks by armed forces enlisted men and officers, customers, and public officials. In February, 1943, Senator Harry S. Truman, then Chairman of the Armed Services Committee, visited the plant and addressed the employees. Hendy received many commendations for its war effort, including the Army-Navy "E" flag and the Maritime Commission "M" flag for high production achievement.

By producing high quality machinery to seemingly impossible schedules, once again, the men and women of the Sunnyside plant met the challenge supporting the U.S. and her Allies in their time of need.



Senator Harry S. Truman addresses employees at Sunnyside plant in 1943



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