



Figure 9. Charles E. Moore, President, Giving Noon Pep Talk
in Front of Joshua Hendy Iron Work's Band

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landscape as the quest for gold continued. In the early years, the gold dredges simply excavated the gravel and soil, passing the material through sluice boxes to separate the gold. The residue was then cast off the rear end, with the fines on the bottom and the coarse material on top. The mounds of gravel and cobbles left behind still dot the countryside. A wide belt can still be seen between Sacramento and Folsom along the American River and Highway 50. The dredges were improved later to leave the finer soil on top of the bank. This was accomplished by dumping the coarse material close behind the dredge and carrying the fines far back by belt conveyors before dumping.

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 employes were needed. Although production declined materially, it by no means stopped. The depressed business did, however, force a change in ownership to Mr. Bennerman, a German-Jewish immigrant. Old timers recall how fortunate they were to be able to keep busy on their nearby farms and orchards while they waited to be summoned back to work. When the whistle tooted vigorously during the day, they knew a new order had been received and they hurried back to the plant and their machines, ready to see what was to be done. Even during the depression years Hendy executed major orders for huge gates and valves which are still functioning in Boulder and Grand Coolee Dams and others in California. Production of all products, though limited, continued with employment standing at approximately 250 in 1940.

In November of 1940, the tremendous latent possibilities of the almost dormant plant were revealed to aggressive Charles Moore, owner of a San Francisco firm, Moore Machinery, and one of the principals of six construction companies that had banded together to build Boulder Dam. The cartel consisted of various western business men, among them Felix Kahn, K. K. Bechtel and others. Hendy Iron Works was one of Moore's customers that had threatened a suit concerning alleged failure of machinery acquired from Moore. The "Hendy Crowd" spurned Moore's customary money-back offer, insisting on being reimbursed for losses they blamed on his equipment. Moore went to Sunnyvale hoping to talk them into a more reasonable mood and out of the consequential damages. It was while walking through the old redwood buildings that the idea came to him to bid for the company. Hendy, as he was well aware, had been taken over by the Bank of California. The almost deserted shops told of the slow death overtaking the company. He knew he could buy Hendy cheap, and from his knowledge of the second-hand machine tool market, he figured to turn a quick profit by washing out the corporation and selling off the machinery possibly to the British through Lend Lease. The acquisition further appealed to him as a painless way of heading off a lawsuit he did not wish to fight.

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Back in San Francisco, Moore telephoned Felix Kahn. A small, saturnine, yet lovable man, Kahn was one of the famous brothers which included the late Albert Kahn, an industrial engineer. As Felix told it, the telephone conversation went something like this:

Moore: *"Hello, Felix. You don't know it yet, but you're going into a new business"*.

Kahn: *"Listen, Charlie, I've got enough business now"*.

Moore: *"It's a first-class proposition! We can junk it or run it, and make out fine. Let's have lunch and talk about it"*.

Kahn: *"All right, all right! But remember I am not going into a new business"*.

A few minutes later, they met at the Palace Hotel, where the "Six Companies" brass always had lunch.

As Charlie Moore told it, when he gave Felix the picture, he started to thaw.

"What do you think we could get for it?" Kahn asked, with an odd light in his eye.

"We ought to be able to sell the machinery for \$450,000," Moore replied. *"The difference between that and what we pay for the company could be straight profit"*.

Felix had really thawed. They drove down to Sunnyvale that afternoon. On the way, they stopped, at his suggestion, at the Bank of California. Kahn asked one of the officers point-blank what the bank wanted for Hendy.

"Whatever the book value is," the banker said smoothly. *"Somewhere between \$350,000 and \$360,000"*.

Without waiting for Moore, Kahn said, *"We'll take a 10-day option for \$325,000"*.

Outside in the street, Felix's twisted smile lit up his face.

"Like I said, Charlie, no new business."

Like the story of creation, according to the romanticised account, Joshua Hendy Iron Works was bought in a fifteen-minute trade with the expressed idea of converting the plant to the production of marine engines. Actually, the deal hung fire for ten days and motives were mixed. Finally, however, the purchase was completed and events moved into high gear. A tip from the Hendy sales manager, Morris Levitt, revealed that Navy Ordnance wanted the company to try its hand at producing torpedo tube mounts. The two partners

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were immediately off to Washington, and four days later, they were back with ten million dollars in Navy contracts and an additional \$1,300,000 for new facilities, including a steel-and-glass fireproof building.

The original idea of junking the plant was forgotten. They took up the option, and Kahn decided they should have \$175,000 more working capital. Following the custom inaugurated at Boulder Dam, he called the "Six Company" representatives with offers of partnership in the new venture. Henry Kaiser put up \$37,500, giving him 7.5 percent. Four more came in at the same amount, while two others took less. Felix cut himself in for 17.5 percent. This left 35 percent, the controlling interest, for Charles Moore.

CHARLIE MOORE OF SUNNYVALE

Charlie Moore came up the ladder the hard way. His schooling stopped in the eighth grade when he went to work for the Santa Fe Railroad as an apprentice machinist. At 18 years of age, having learned his trade, he became a "boomer," the machinist's name for a drifter. For several years he "boomed" all over the United States and Mexico.

Back in Los Angeles where he started, Charlie Moore at 21 was ready to settle down. He got a job with a machine-tool company. He later aspired to become a salesman but his boss, with brutal frankness, told Charlie he didn't have the necessary education. "*I was horribly insulted*", Moore recalled many years after, "*but then I calmed down and realized that he was right*". Although sensitive about his age and great height, he entered high school and by his own account finished four-years work in one. The First World War interrupted this meteoric progress before he reached college curriculum. He enlisted in the Army the day Congress declared war.

After being mustered out a lieutenant in the Coast Artillery, Charlie Moore returned to his old job. He was soon promoted to salesman and in 1927, had the satisfaction of buying out, for \$175,000, the same company that had told him he didn't know enough to be a salesman. He supplied the final touch by renaming the company after himself. In its new owners words: "*The Moore Machinery Company is an institution out here on the coast*". An invitation to the Bohemian Club allowed him to meet his future associates. He mentioned with pride that U.S. Steel, Bethlehem and other big Eastern corporations had long bought through him the machinery they needed for their Western divisions. Moore himself became the top machinery salesman on the West Coast. This success he ascribed to "*a policy of never selling a machine that we wouldn't take back if the customer didn't like it*".

One of Moore's stockholders was Alan MacDonald of MacDonald & Kahn, a successful construction firm in San Francisco. It became one of the "Six Companies" and through MacDonald, Charlie Moore met his partner, Felix Kahn, as well as W. A. "Dad" Bechtel,

Charlie Shea, Henry Kaiser and other head men of that hard driving team. Moore managed to place machinery at Boulder Dam but he never got beyond the outer fringes of the group until the Hendy deal in November of 1940.

At 49, Charlie Moore was an impressive looking man (figure 16). Six-foot-four inches tall, he towered over most gatherings with the gulf between him and ordinary men exaggerated by his taste for loose-fitting, bright blue or green suits with Western style hats to match. A true Westerner, he loved to ride, which he did every weekend with the Santa Clara Valley Posse. He was blonde with piercing blue eyes and a jaunty, breezy manner like a man perpetually engaged in doing what he likes. "*I like people*", he was fond of saying, "*and I'm as much at home in Washington and New York as I am in San Francisco*".

A crack machine tool man, Moore served in the Office of Production Management Tool Section. In 1941, he was sent to England with the Harriman mission to study British production methods and help work schemes for more economical use of the available supply of machine tools. Charlie Moore described his mission as perhaps the only instance in recent American diplomatic history in which an envoy returned from a lend-lease country with a plus balance. The object of the trip was to relieve the demands on the American machine tool industry by inducing the British to turn back, for our own rearmament program, tools that had earlier been allocated to them. Moore not only succeeded in this, but he also talked the British into selling him a \$224,000 Craven planer and a \$150,000 gear hobber, both custom-made tools that were not available on this side of the Atlantic. These he triumphantly shipped back to Sunnyvale in what he called "reverse lend-lease". He also brought a letter from Lord Beaverbrook, which said in part, "*It is very rare for the judge not merely to acquit the prisoner, but also to give him a new outlook on life. That is what you have done*".

The Craven planer had been built for the Russian ally and was to be shipped to a factory in Vladivostock. Since the Russians were losing in that sector, the planer was unloaded at the Panama Canal and trans-shipped to California, complete with all the Russian instructions on the operating controls. Moore also picked up furniture for his office. If, as you gathered around his huge conference table, you would remark about the comfort of the colored leather, barrel-backed chairs, he would proudly tell of seeing them in Winston Churchill's office.

Many tales of great men were picked up at the "long table" in the Hendy executive dining room. One of Charlie's favorite sayings, of which he was a perfect example, was: "*Some boys have to leave school at the sixth-grade level in order to start companies that hire college graduates*". He was not adverse to progressive management and liked to tell about the man who had his Industrial Relations department install such a sophisticated aptitude test and screening system that he had to admit it was fortunate for him that he owned the company or else he could not work there.

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Charlie Moore was a very thoughtful and practical man. When during the war he had difficulty getting to his barber or dentist, he brought them to the plant, complete with shop and offices for everyone to use. Hence, Drake the barber, Dr. Constine the dentist, a nurse hygienist, and Dr. Diesner were at the plant daily to care for the health of all employes.

LIBERTY SHIPS AND CORVETTES

Henry Kaiser was so busy building ships, digging gravel, and making cement in order to bring the West Coast price down to \$1.00 per bag (learning how to make steel and magnesium with aluminum was to come later) that he visited Hendy only on ceremonial occasions. But before he ever saw the plant, a casual remark he made 3,000 miles away was to put Hendy in the engine business.

One spring day in 1941, Mr. Kaiser was discussing ships with Admiral Vickery in Washington. The Admiral mentioned his grave concern over the lack of engine capacity for the Liberty program. The famous contractor said, "*Look, I've just bought a machinery plant, Admiral. Maybe I can help you*", and he referred him to Charlie Moore. Vickery grasped at this straw. There was an urgent need to establish an independent engine supplier on the West Coast.

The first order placed in March was for 12 EC-2 engines. Almost immediately, Vickery telephoned from Washington to ask Moore if he could double it. Moore replied, "*Sure, but I can tool up just as easily for a hundred.*"

Moore got the order for 112. It was a real boon for Hendy. The reciprocating engine business alone meant almost \$60 million in gross sales. But Moore and Vickery had a sharp tussle over price. The Maritime Commission's top price to a green producer for this engine was \$113,000. Moore and Kahn argued hard for this, but the Admiral finally beat them down to \$108,000, just a few tenths of a cent under 40¢ per pound.

With this order the long calm that had settled over Hendy was over. New construction overflowed onto sixty acres, swallowing the pear trees and absorbing the farm hands to work the machines. The new buildings were all of huge wooden beams of Oregon pine and Douglas fir that looked as if they would last forever. This frantic construction lasted 5 years, expanding from 146,000 to 1,250,000 square feet under roof (see figure 10). At the same time, the original 60 employees became 7,500. The capital investment grew to \$16,500,000 in the most modern machine tools, until, as Charlie Moore used to brag, "*we were the biggest and best equipped machine shop west of the Mississippi River.*"

For Moore, "*one of the great moments of my life*" was the trial run of the Liberty ship JAMES OTIS in February of 1942. The JAMES OTIS was driven by the first Hendy

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EC-2, and down in the hot, sweet-smelling oily reek of the engine room, eyeing the revolution counter and hearing the swish of the connecting rods, Charlie felt the landlubber's pride when he said, "*When it's neither so tight you can smell it nor so loose you can hear it, then you can bet a ball of wax it's a damn fine engine.*"

But for Moore, what was done with the British Vickers engines exemplified the new Hendy. To distinguish it from the others that went into noncombat vessels, he called it "the battle job." He first heard of it in October after the Navy, desperately expanding its escort vessel program, had appealed to the Maritime Commission for engines. Admiral Vickery summoned six companies, among them Hendy, to Washington and announced that he wanted them to build this engine if they could. The other companies, (Koppers, York Ice Machinery, Valley Iron Works, Diamond Iron Works, Beloit Iron Works), were all newcomers to the engine program. The Admiral presented them with photostats of the British design and waved them back to their plants.

Two days later, Moore telephoned Admiral Vickery and told him that Hendy would tackle the engine. On November 5, the go-ahead came through from the Commission. The order caught Moore short of engineers. He could spare only five from his staff, which was tied down to other jobs. However, the other companies sent in their own engineers to work with Hendy's, and by soft-soaping his friends among the big companies, including American Can and Schlage Lock in the Bay Area, he managed to borrow more men, until there were thirty-five. Hendy was the lead company in the Corvette-engine program. It was responsible for both modifying the British design, and breaking it down for production. The other companies sent their draftsmen to Sunnyvale to work on the master prints. Some 600 drawings were made of 2,000 parts. In many cases, the patternmakers didn't wait for the finished engineering drawings, but plowed ahead on rough data that was corrected as they went along. The patternmakers finished the working models January 15; the engineers' drawings were ready February 15. Three days later, the last pattern was completed. Out in the foundry, the first iron was poured into the sand pits *for the first bedplate. Nine weeks later, on April 23, the first engine was on a flat car on its way to a waiting hull (figure 11).*

Production of these engines was just 10 per month and later that was doubled, with Hendy producing half the national total. But this feat was not wholly unmarred. In breaking the engine down for fast production, Moore's engineers were free with the British design, and this made for complications. The Maritime Commission wanted the engine to be interchangeable on British, Canadian, and American Corvettes. This economical idea got lost in the rush. It became apparent that before this interchange with British and Canadian Corvettes there had to be some modification. However, no one complained, and Admiral Vickery indulgently called it "*a simple case of overenthusiasm*".

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Felix Kahn attributed the company's fine record with hurry-up jobs largely to Charlie Moore's astute knowledge of machine-shop practice. "*There isn't a tool on the floor,*" Felix said admiringly, "*that Charlie couldn't operate himself*". Indeed, during the first desperate months, it was not unusual for President Moore, while inspecting the shop, to peel off his coat, step up to a milling machine or lathe, and show a "thirty-day wonder" how a "boomer" would handle a tool.

The years of tramping down the oil-stained alleys of West Coast machine shops paid off for Moore. When he started to recruit labor in the spring of 1941, reliable toolmakers and shop foremen were scarcer than turret lathes. But Moore knew dozens from Seattle to San Diego. In luring them to Sunnyvale, he quieted his own conscience - if not those of their former employers - with the reasoning that they would contribute more to the war effort at Hendy. This argument won him his thirty-three year old plant manager and production chief, Harry Gunnetti, who had been a machine-shop superintendent for Nordstrom Valve Company in Oakland. Percy Williams came, and Bob Mann sold the Mann Manufacturing Company (famous for the Ruxel Axle) to help Charlie. Joe Bracco, Bob Jefferies and many other master mechanics from around the Bay Area flocked to Sunnyvale under Moore's magnetic attraction to build up one of the most capable manufacturing staffs ever assembled.

Moore's intimate knowledge of the machine tool situation, reinforced by his tour of duty with OPM, allowed him to make the best use of secondhand tools. Admiral Vickery told with awe what he saw on his first visit to Sunnyvale a month or so after Moore received his first contract. "*Charlie didn't beat his brains out trying to get priorities for brand-new equipment. He went into the secondhand market. The day I was there, there were twenty-five freight cars lined up on the siding full of secondhand tools*".

To assume from this that Hendy was mostly equipped with worn-out tools held together with baling wire would be a mistake. On the contrary, the impression left with a visitor was of an eye-filling expanse of shiny new tools. Moore appraised these at over 10 million: "*more dollars worth*", he would say, "*than I used to sell in five years on the entire West Coast*". In fact, Moore was so successful in buying and selling these that he repeated it again for Hendy after the war, reselling the equipment to others, and even went into the tool rebuilding business in San Jose after the War, restoring used tools to first-class shape with new paint, power, and controls.

What Moore called the "New Hendy Method" was really just a further refinement of the familiar process of breaking down a complicated job. Hendy went in heavily for dozens of small machines rigged for a simple repetitive task, and for set-up plates on which the work was laid out, aligned, or clamped before it was brought to the tool. The tooling for the reciprocating engine alone cost about \$1 million.

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Under the old method, just machining an EC-2 cylinder was a two-weeks job. It was done with a horizontal boring mill, which cost \$75,000, by a man who had served a four-year apprenticeship. In the new method the work was done with three machines, a few set-up plates, and half a dozen men who had learned their jobs in two weeks. Operating time: one day. Similarly, the assembly time of a crankshaft was cut from one week to one hour. These and other tricks enabled Hendy to cut the final assembly time on an EC-2 engine from 4,500 to 1,800 man hours and to become the nation's fastest producer. Hendy went on to build 754 of them in 3-1/2 years (see figure 12). But like Kaiser on his ships, Hendy was not the cheapest. General Machinery of Hamilton, Ohio, first in the program, worked its price down to \$90,000 per engine. The average for all producers was \$96,000. Hendy's price was just under \$100,000, so above average. But as Moore explained, "*We gave the Country the most engines of the highest quality, but we couldn't do that at the cheapest price.*" After all, time was of the essence and renegotiation would take away any excess profits anyway.

ROCKET LAUNCHERS

One instance of the super war effort of the Iron Men of Hendy came on an afternoon late in December of 1943 and was recorded on records playable on the All Wave Radio-Phonograph combination in the main office. At four o'clock on a Thursday, the telephone rang in the office of Gene Elkus, Superintendent of the "Navy Shop". Elkus reached for the phone - and didn't get home until eight days later!

The voice of a high-ranking naval officer in Washington D. C. cracked tensely over the wire: "*Elkus? Got a job for you people. We want 252 portable rocket launchers in a hurry. Need two by next Wednesday for a test and the others by Thursday midnight. WE NEED THEM WORSE THAN ANYTHING WE HAVE EVER ASKED FOR.*" Portable rocket launchers, at that time on the "secret" list, have a firepower comparable to heavy artillery. Operated electrically and adaptable to all types of mobile equipment they could be used on landing barges to give each assault wave its own frontline artillery. The Navy official told Gene Elkus that the weapons would be in use a few hours after completion; the invasion date had already been set. Three times he repeated his plea, "*WE NEED THESE WORSE THAN ANYTHING WE HAVE EVER ASKED FOR.*"

Gene took swift mental stock: 252 units to build in 176 hours. Blue prints? Hundred miles away. Material? Not one pound in the shop producing 21-inch quadruple torpedo mounts at a fantastic rate, and 50 tons were needed. Manpower? Scarcely half of the 310 specially skilled men required were on the Hendy payroll. Worse yet, they had never done a job like this. Most were already building steam turbines or Liberty engines. Elkus called in his department heads and laid it on the line as only he could do. Priority clearances on materials? Traphagen, Production Manager remarked, "*It will take four days just to slash through red tape.*" Said Huff, Navy Purchasing Agent, "*We'll get the stuff!*"

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The purchasing department geared to Navy procurement got it: 50 tons weeded out of as many war plants scattered around the San Francisco Bay Area. Everyone cooperated. Key skilled men were yanked out of nearby Marin shipyards, San Jose welding outfits, Kaiser Cement and Magnesium plants, etc.

At dawn on Friday, a Navy plane roared away from Moffett Field with a Hendy engineer and a Naval inspector. They were back by 10:00 p.m., clutching blueprints and technical data.

At 8:00 a.m. Saturday, a truck arrived with a working model. By 3:00 p.m., the materials were on the stock pile. A plane was kept on alert ready to fly anywhere in the nation for any specially needed tool. Motorcyclists stood by to run short errands. For a Christmas Holiday weekend, the entire plant was electrified. By 7:00 p.m. Saturday, men were cutting metals for prefabrication. By 11:00 p.m. Saturday, two pilot models were finished. At 6:30 a.m. Tuesday, a complete assembly line was clanking. Blue clusters of flame bloomed at the welding rods like agitated cornflowers; over the sputtering tufts bent the hooded leather-jacketed welders. Cranes swung their burdens crazily overhead; air grinders screamed like sea gulls; men at the assembly line yelled for more, more, more parts.

They tossed out the time clock and in its place tacked up a calendar. Men forgot about shifts. There was no quitting time, no starting time. A man carried on until he was ready to drop, then dunked his head in cold water and carried on some more. Job definition meant nothing. Top production and office men pitched in during their off hours. "*Here, Bud, give me a hand,*" a welder would shout, and white-collar men jumped. On a monthly salary, they didn't draw a dime for overtime. Even the Naval inspectors donned overalls. Bob Bleibler, superintendent on the graveyard shift in the Naval Ordnance Division, had once been a welder. He heard about the emergency job at 2:00 a.m., and phoned his wife to bring down his old welding outfit. At the close of his own shift, Bleibler pulled on his togs and worked on through the day, grabbed two hours of sleep that night and went back for more.

Then there was the top supervisor who stood on the concrete floor for 38 hours, his feet swelling so that he had to cut off his shoes.

The long, sleepless hours began to tell. Eyes became bloodshot, beards sprouted, faces caked up with grime and sweat. But there was no letup. Throughout the plan, there was whispered talk of the "super dupers" that were being built. Everyone itched to lend a hand. Office girls, after their own day's task, carried coffee to the men, ignoring the strict California law limiting feminine working hours. Nurses, ordinarily off duty at four o'clock, stayed on until midnight. Though it was the hottest job Hendy ever handled, the safety record was remarkable: not one disabling accident.

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Wives brought down shaving outfits and changes of clothing. A few minutes out to shave made them feel as good as an hour's nap. A quick sponge bath in the washroom and clean underwear made do for a night's sleep. When a man became so exhausted he saw nothing but a blur, he flopped on a cot in one of the executive offices or curled up in a car in the parking lot for an hour.

By this time, the men found it hard to relax; the terrific pace was beginning to tell. What was the spark that drove the men on?

A welder pushed the hood back off his dirt-caked face, and answered that question by saying, "*This is my chance to get in a foxhole.*" A young 4-F father put it this way: "*Thank God, I can tell my kids I did something, even if I wasn't in uniform.*"

At 6:00 p.m. Wednesday, the rafters suddenly vibrated with shouting. A Hendy truck rolled out of the yard, bound for the Navy's China Lake testing grounds with the first two completed weapons. But even before it was out of sight, the shouting died and the tumult of feverish work began again.

The last hour before the deadline on Thursday, was like the seconds before the final gun of a big game with only two yards to go for a touchdown. Two hundred and fifty-one of the "super dupers" were finished. Only one more was needed to fill the Navy's order. Three crews working on three separate units began a race for the honor of completing "THE ONE". Workers from all parts of the plant crowded around, rooting the teams on. One minute before midnight, a great cheer swelled! The last weapon was completed. Lift-truck operators honked their horns. Machinists clanked metal on metal. Teary-eyed superintendents hugged begrimed and teary-eyed workers.

Charley Moore expected to find that the week's goings-on had affected Hendy's regular production schedule, for throughout the plant attention had been directed to this special job, and the holiday season was at hand. He found that production had indeed been affected. The output of Liberty Ship engines jumped that month from 32 to a record 35.

Just before dawn on Friday, Elkus went up to his office to finish his report. He grinned at the motto on the wall which read: "The difficult things can be done right away; the impossible will take a little longer".

TURBINES

When the Iron Men of Hendy started to build steam turbines all in steel, there were many doubters and some miscalculations. In December of 1942, at the docks of the Consolidated Steel Corporation in Wilmington near Los Angeles, were twenty-odd C-1 cargo ships with strange big holes gaping in their sides. These were to accept the turbines that had

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failed to come when the hulls were ready for them. Like Bath Iron Works with destroyer machinery of a more recent date, the shipbuilders were wild. They said these motionless ships had given them a terrible and undeserving black eye; and, to put the blame where they thought it belonged, they hung signs on the hulls saying in effect, "These ships are waiting for Hendy turbines."

In the face of this, Charlie Moore argued stoutly that Hendy was only two weeks late with its first turbine, and that everything was fine. But the contrast of his optimism with the discouraging reports from other sources is strangely reminiscent of the baffling contradictions that once surrounded the turbine program.

The fact is that Admiral Vickery had brought Hendy into the turbine program as a dark horse. In July of 1941, he foresaw that his Consolidated hulls would start coming off the ways in May of 1942, and he was crazy for turbines. They were beginning to come fast: three ship launchings in one day at Consolidated, Cal Ship, and Wilmington. Westinghouse, which also designed turbines, refused to promise delivery earlier than November of that year. But out at Sunnyvale, while Moore was away on his mission to England, Henry Kaiser and Felix Kahn promised the Admiral he could have two turbines a month beginning in June. On the strength of the reciprocating engine production performance and this generous promise, Vickery cancelled the Westinghouse contract.

It appeared that Kaiser and Kahn did not consult either the production department or Charlie Moore. "*I came back from England in December,*" Moore recalled, "*to find myself in the turbine business.*" A quick look convinced him that the promise was impossible, and he informed the Maritime Commission he could not start deliveries before October.

As the summer came on, tempers were beginning to wear thin. President Alden Roach of Consolidated was prodding Vickery, who was prodding Moore, who was finally forced to admit he could not meet the revised schedule unaided. In desperation, Moore asked Westinghouse to cut the gears for the first three turbines — in some respects the hardest part of the job. "*Without regard to cost,*" he said, "*the blanks and gears were shipped by express all the way across the country and back. This alone cost us \$2600 more in freight charges*".

Hendy did not wait to test the finished Westinghouse gears in the first Hendy case. Case and gears were shipped separately to Wilmington and assembled onboard ship. After four decades of humbling experience with marine propulsion, Westinghouse engineers expected plenty of trouble. But the gears meshed beautifully and the alignment was perfect. This was no surprise to Charlie Moore. Westinghouse, however, put it down to beginner's luck.

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Luck did not hold out on all Consolidated units, but many of Hendy's troubles were of the sort one would expect of green hands. Only a dozen of the first 300 or 400 workers recruited from the prune orchards for the turbine plant had ever seen a turbine. Neither had the superintendent, "Manny" Aflague, who had been a master mechanic for American Car & Foundry (Brill of Philadelphia), nor the chief inspector, Al Freeborn (who had been with Cadillac). Westinghouse invited the two to come East to study its methods. For a couple of months, while Hendy was tooling up, they camped at the South Philadelphia works. Back in Sunnyvale, they tried to communicate to the farm hands, fruit pickers, and clerks the reverence for high tolerance that had been instilled in them.

Another source of difficulty, and for a long time an irremovable bottleneck, was in the gear-cutting department. The reduction gears that in steps reduce the 6000 RPM's of the H.P. and 5000 RPM's of the L.P. turbine to the 90 RPM's of the C-1 propeller must be true within a few ten-thousandths of an inch (see figure 13). Otherwise, teeth meshing at about 11,000 feet per minute could cause a rough action that is unacceptable for several reasons. The transmission becomes inefficient, and the noise produced can be picked up by submarine listening devices much farther than the propeller beat.

Gear cutting is, therefore, a fussy and exasperatingly slow operation. Gear hobbors must be housed in air-conditioned rooms on massive foundations insulated against shock. The vibration of a passing train can be disastrous. Furthermore, once a cut is started, it cannot be stopped until it is finished. Therefore, special D.C. motors with storage battery backup that will come on automatically in case of power failure are necessary.

Even under these pampered circumstances, the \$150,000 tool that Moore brought back from England took seventeen days to cut 594 teeth in the bull wheel of the C-1 reduction gears. It could not be hurried and the whole shop output was governed by the painstaking slowness of its rounds. This MUIR hobber later proved to be so slow and inaccurate that it was first relegated to rough cutting and finally to the Cast Iron Dump. "Reverse lend lease" in this case had backfired.

Gear hobbors take a year to construct, and because additional ones were not to be had soon enough, Charlie Moore arranged with Gould & Eberhardt, the toolmaker, to build several at Hendy. Two of these were capable of cutting gears up to 15 feet in diameter and had double heads so that rough and finish cuts could be cut simultaneously, halving the time! (See figure 14.) The gear cutting capacity was soon built up to five gear units a month.

At this point, Charlie Moore said, "*I'm practically there now!*" refusing to be downcast just because Hendy was four units behind schedule. Moreover, his confidence was shared by the Maritime Commission and Westinghouse. In April, the company delivered the first all-Hendy turbine, built from the ground up at Sunnyvale. Another major crisis was safely behind.

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The first order of twenty-four was completed in October. Production then swung to 48 8500-HP Westinghouse-designed C-3 turbines. These were for the long-range, 17-knot C-3 ships, which were combination passenger/cargo carriers, somewhat bigger (12,600 dead weight tons) than the Victories. A modified C-2 turbine of 6000 shaft horsepower was planned for the Victory Ships, but the closing of the war curtailed this program.

In the first year of the turbine program (November 1940 to November 1941), the dollar value of Hendy deliveries was about \$3 million. In the second, between \$25 and \$30 million. The third year, it rose to \$60 million; in the fourth Hendy joined the blue-chip corporations grossing \$100 million or more (see table 1 and table 2). Being a privately held corporation, Hendy published no financial statement, but Mr. Moore had a Westener's willingness to talk, and said that for the second year, Hendy's profits were just over \$4 million before taxes and renegotiation. They took away about \$2,200,000 and \$1,300,000, respectively, leaving the company a net profit of only \$500,000. This was not all that bad considering most of the investment was someone else's. The Maritime Commission owned about \$11 million worth of facilities at Hendy. The Navy had \$1,300,000 worth of machinery, carefully marked with metal tags showing serial numbers and ownership. Charts of the buildings showed who financed and built them, down to the crane trolleys and power distribution wiring.

While Charlie Moore often bragged about offers to buy Hendy for millions, he set up a Post War Planning group. Instead of selling, he continued to buy. Hendy paid \$3,200,000 for the old firm of Crocker-Wheeler. A. A. Browne, Assistant to the President, had accompanied Moore to Ampere, New Jersey, to visit Crocker-Wheeler, and check on their production schedule of 250 KW. D C Generators for Geared Lighting sets for cargo vessels. The evening after the plant inspection, when they were leaving their hotel in New York City and walking down the street to dinner, Charlie said to Al suddenly, "*Why don't we buy that Crocker-Wheeler outfit and do our own electrical work? They are a first-class manufacturer; we would not have to worry anymore where our motors and generators are coming from.*"

Al replied, "*Do you think they would sell?*"

"*Sure, why not,?*" said Moore. "*Let's go over and make them an offer in the morning.*"

They did, and with the Maritime Commission's encouragement to make West Coast shipbuilding as nearly self-sustaining as possible, other acquisitions followed. Hendy paid \$2,500,000 for the Pomona Pump Company, which had plants in Pomona and Torrance, California. One of the best in the deep well pump business, they had been manufacturing pumps for Hendy. Al Browne managed the Pomona operation for a time, until finally their excellent engineering department under Perry Brown, Chief Engineer, was moved to Sunnyvale to consolidate engineering efforts. Morris Levitt, Hendy's Sales

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Manager, who said he knew nothing of the electrical business, and proved it did not matter, managed Crocker-Wheeler for a time. He was followed by Captain Almey, and then Charlie Butcher, who had been Manager of the Westinghouse Plant in Emeryville. The St. Louis and Torrance plants of the Hydral Company, which also made pumps and were famous for their "little chief", were absorbed with an eye to covering the entire pump field, including some patents and development picked up for the oil-well industry. The Hendy air- or gas-operated deep oil-well pump was successful and very efficient because of the air lift of the exhaust into the upward oil stream.

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. 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 plant during the War, built at Sunnyvale, and tested at Hawthorne. Hendy designed and built a reduction gear for the test cell at Hawthorne, and made tentative designs for the Wing aircraft gears. Ten gas turbines designed to develop 5000 HP for this application were later built.

The Northrop-Hendy Corporation was composed of men from two organizations with Jack Northrop as president, Max Sherritt, assistant to Charles Moore, as a director, and Art Phelan as chief Hawthorne engineer. Most notable on the project was Theodore Von Karmen, aerodynamist. Under him, Dr. Duncan Rannie produced a compressor with an efficiency no one outside could believe.

In order to enter more directly into jet propulsion, Hendy proposed and received an Air Force contract to build 50 turbine wheels. This consisted mainly of developing an integral shaft rotor disk and welded-on high-alloy blades with the object of increasing the reliability and operation time for such parts. Previous equipment had been limited to between 30 and 100 hours.

For the turbine program Hendy also attracted Dr. Mark Benson, German inventor of the Benson boiler. Parts were available to build one of his critical pressure boilers, an alternative to the Bessler flash-type boilers on the turbine test floor, which were capable of operating up to 1000 psi and 1000°F. He spent most of his time, however, studying demineralization of boiler feed water, so the wonderful boiler was never built. Benson would spend hours expounding upon how pure boiler feed water should be made.

Also, Hendy proposed gas turbine propulsion for cargo vessels. When the Maritime Commission turned a deaf ear to the proposal, Hendy feigned a Russian delegation. Two of our engineers of Russian descent, namely Seva Guins and Edward Soomil, posed as customers and spoke Russian to each other, putting on a very convincing show that fooled

Admiral Vickery for an hour or so. When Charlie Moore's mirth finally gave the whole thing away, everyone roared with laughter.

Hendy did design and build several Hendy 2000 KW package steam power plants sold by Peter Loftus of Pittsburgh to war-torn Russia. Theoretically, they could be assembled with boiler, condenser, and Crocker-Wheeler generator in any open building or shed in 24 hours. This was a forerunner of the Westinghouse 5000 KW package power plant, 25 of which Sunnyvale later produced for domestic and foreign use in Mexico and Australia.

When the trans-Arabian Pipeline was being built, Hendy worked with Bechtel and Standard Oil of San Francisco to build a couple of 1000 HP gas turbines to drive oil pumps for Aramco. These were not combustion gas turbines, but driven by expansion of high pressure trap gas. Later, some combustion was added when the bearings were burning out in the top half from "ice" (frozen hydrocarbons in the expansion exhaust) rubbing the bottom of the turbine rotors in the case. The addition of a combination gas heater kept the ice from forming, and no more bearing replacements were needed.

During this time Arabs often visited Sunnyvale. King Iben Saud, a great friend of Earl English, Vice President of Bechtel, wanted two things. One was a railroad of his own and the other was a power plant for his capitol at Riyadh. The latter was designed and built at Sunnyvale. To replace the 15 KW Diesel lighting set which lit the Palace, i.e. harem, at Riyadh, Hendy built a 2000-KW diesel electric plant with Crocker-Wheeler DC generators and four Hendy diesel engines. The building, coolers, etc., were all part of the project, but both Carl Engstrom and George Gayer declined to erect the machinery after hearing from Earl English about the German diesel engineer who had lost his hands as punishment when the lights once went out in the King's palace.

POST-WAR YEARS

During the war, California Shipbuilding Corporation, second largest shipyard in the country, built 467 ships worth some one billion dollars. Shortly after V-J day, Cal Ship's payroll dropped to 800 from its wartime peak of 42,500. Its 14 ways were sold for lumber. Cal Ship's President John A. McCone and Board Chairman Stephen Bechtel found themselves heading a company reportedly worth \$14,000,000, most of it in cash. (What a cash position!) But Cal Ship had nothing to make, so McCone and Bechtel wanted to find a use for their cash. They found the answer in the Joshua Hendy Iron Works, largest machinery maker on the West Coast.

California's famed "Six Companies", which built Boulder Dam and owned Cal Ship, owned a controlling interest in Hendy. They decided it was time to own it all. So they bought out the 25% interest of Hendy President Charles E. Moore, who had other business interests and no taste for the strike which had shut Hendy down for several months. In