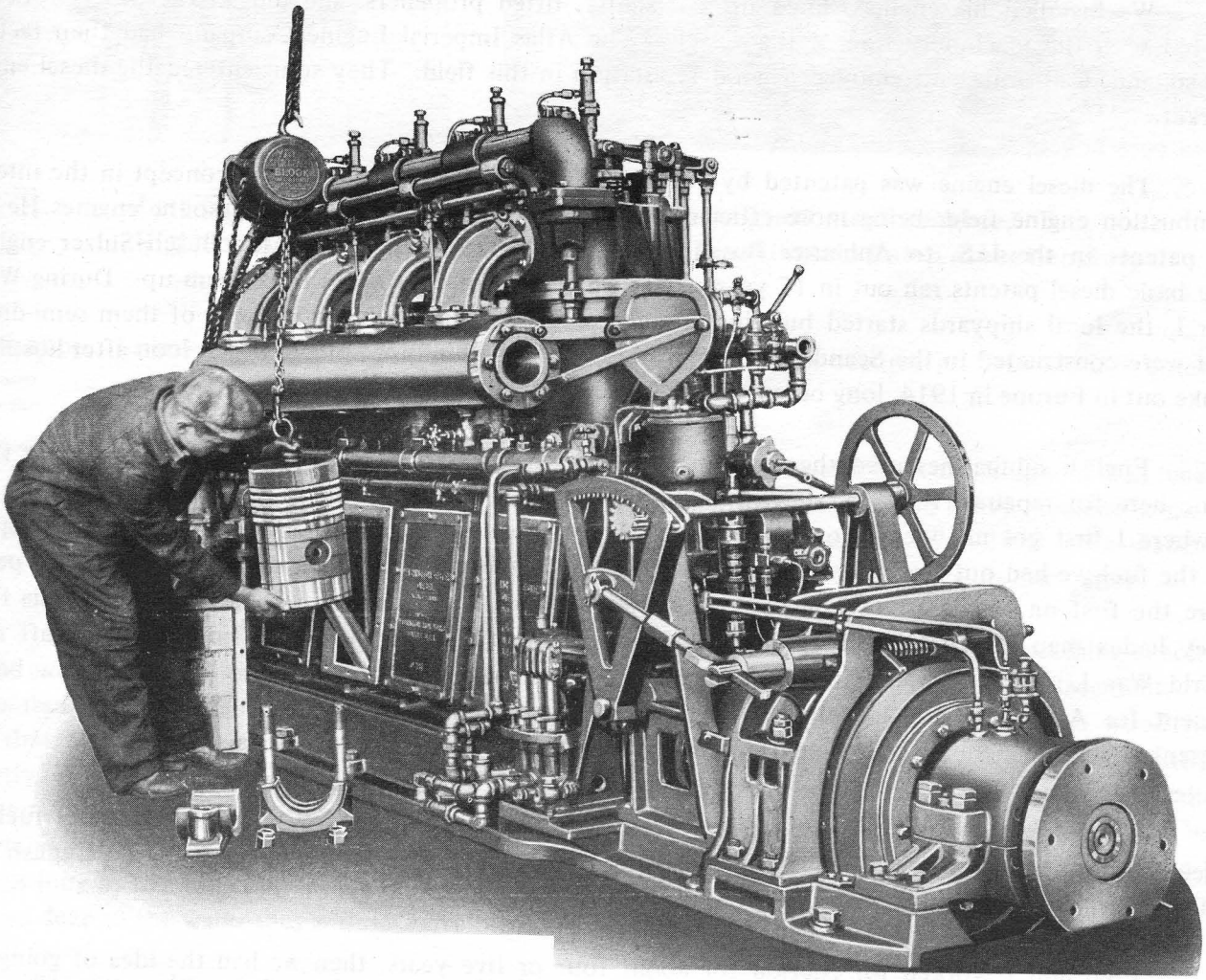
THE WASHINGTON-ESTEP DIESEL ENGINE

By Capt. Ed Shields
As told by Mr A. C. Estep

FOREWORD

Mr. A.C. Estep was the chief engineer at the Washington Iron Works where the Washington-Estep diesel engines were built. Mr. Estep now lives in the north Broadway district of Seattle as a retired engineer, both operating engineer, as he held a marine engineer's license, and professional engineer as he held a State of Washington license as mechanical engineer. His apartment is filled with memorabilia of earlier days association with internal combustion engines.



I was born out in this part of the country near Sumas, Washington. My father William Cullen Estep was a pioneer railroad civil engineer who moved around the country frequently in his work. We lived in Minneapolis several years and I finished high school there. My brother Harvey, who was two years older, and I were interested in engineering but only father worked for the railroads.

We moved to Aberdeen, South Dakota where he was building an extension to a line. I attended a normal and industrial school while we were there. I also spent considerable time working on threshing engines at that time to help finance my education.

I was married in St. Maries, Idaho in 1909. While there I owned a work boat and made good money with it. When we left I sold the boat and came out of St. Maries with quite a bit of money. Mrs. Estep and I moved to the lower Columbia River area of Washington where I got a job. My father came to Seattle again about that time for a job with the Great Northern Railway, as they were constructing a new line to Sumas, and he was involved with the location surveys. Father living in Seattle attracted me, so another move brought Mrs. Estep and me to this city.

I met another young fellow named Fred E. Kimball who was to be a lifelong associate. We worked at that time for a man named Nielson, the agent for the Atlas Imperial Gas Engine Company. Fred was 25 and I was 27 at the time of first acquaintance.

We installed his engines, lined up tail shafts, fitted propellers, and did all the other work associated with the machinery side of the vessels. The Atlas Imperial Engine Company had their factory in Oakland, California and enjoyed a good reputation in this field. They soon entered the diesel engine market.

The diesel engine was patented by Rudolph Diesel in Germany as a new concept in the interval combustion engine field, being more efficient and safer than the then-common gasoline engines. He sold his patents in the U.S. to Anheuser Busch of St. Louis, where they built the Busch-Sulzer engines. The basic diesel patents ran out in 17 years, after which alot of companies took them up. During World War I, the local shipyards started building wooden ships here and installed in some of them semi-diesels that were constructed in the Scandinavian countries. This shipbuilding splurge began soon after hostilities broke out in Europe in 1914, long before the U.S. became involved.

English submarines used the German patent in their engines, and during the war some of them came here for repairs. Fred and I went on some of those submarines and looked the ships over. This is where I first got my ideas about diesel engines. European semi-diesel engines would not run properly on the fuel we had out here. The asphalt base of the California fuel was the problem. The Atlas people were the first on this coast to build a reliable diesel engine, and their engines could use California fuels. They had a man named George Adkin, who had worked in England, who now joined their staff after World War I. Prior to that Atlas had built only gas engines for fishing vessels and small tow boats. Except for Atlas, the diesel engine was not locally manufactured, and the ones from the east often presented the problem of lack of parts or agents who could repair the machines.

The early English engines got away from the idea of air injection, wherein the diesel fuel was injected into the cylinders by a jet of high-pressure air. Atlas followed along with the English idea on the principle of a high pressure oil spray into each cylinder.

Fred and I worked for Nielson for about four or five years, then we had the idea of going into business for ourselves. Father told us that the Great Northern Railway owned property along the south shore of the ship canal, and were about to sell some of the waterfront. This was the time the Lake Washington Ship Canal and the Hiram M. Chittenden Locks were being completed. The Port of Seattle was establishing the Fisherman's Dock where boats could moor in fresh water. Lots were to be drawn for some of the land, so Fred and I signed up and succeeded in getting a 20 year lease at the head of the Port of Seattle dock, for a minimum rate. We got first bid and a prime site on the west side of the Ballard Bridge on the south side of the canal. This is the site where the Fishing Vessel Owners Marine Ways Incorporated is located. We built a one story structure, purchased good machinery, and opened our

Left picture: Tug R. P. ELMORE with original steam engine.
Right picture: Tug ELMORE with new Washington-Estep diesel engine.

repair shop. I used my profits from the St. Maries deal for that. This occured prior to the U.S. entering the war.

The shop became very active during the war, as the Meachim and Babcock Shipyard was located just west of us. Estep and Kimball, as our shop was known, did most of the heavy machine work for the shipyard, when they built several Ferris-type wood freightboats during 1916-1918. We made tail shafts, fitted propellers, and did other heavy work, as the shipyard did not have its own shop.

After the end of the war, there were many steam towboats whose engines were becoming obsolete, tired, and in need of either extensive repair work such as new boilers, etc; or total replacement. The steam boiler had a life considerably shorter than the engines, especially when burning slab wood from logs that had been stored in salt water or low grade, high sulphur coal. Tubes required replacement frequently, a cracked tube was a common occurance, and a plug was often the answer to the immediate problem. Fire boxes had to be rebricked often as they burned out. The low grade coal that was used was very dirty and inefficient. Ashes were all over the vessels, although the owners had little care for this, as long as the tug could pull a string of logs. Most of the tugs when fully loaded with water and coal were so deep in the water they did not have the necessary freeboard to go out to the ocean.

The fishing fleet of large steam-powered vessels was fading out for economic reasons. The smaller fishing vessels, as purse seiners, trollers, and the like were using gas engines. Engine room explosions on these vessels were well known, being the fear of all fishermen. Hence the pressure was being felt for a new engine with improved efficiency, safety, cleanliness, and reduced weight. This would also mean higher pay loads, and in the case of the steamers a considerable reduction in the size of crew, as the highly trained engineers and firemen were not required on the diesels. At that time there was also no requirement to have a license as diesel engineer whereas for steam this was mandatory on tugs and passenger boats.

Atlas, as I have said, got into the diesel market followed by the Union Iron Works of Oakland. There were other companies that manufactured semi-diesels, known as the hot bulb type. Fairbanks Morse were a leader in this design with their well known C-O engine. The hot bulb was just that; a separate hot bulb within each cylinder that was always hot enough to ignite the fuel. Before the engine could be started this hot bulb had to be heated, usually with a hand held gasoline blowtorch.

I decided that I could improve on those early engines and make a profit. I had worked up some drawings for a few new ideas. Fred and I bought a heavy-duty two cylinder gas engine, and rebuilt it using my blueprints. I used to work Saturdays and Sundays on that first sample diesel engine. We removed the cylinders which were 12 inch inside diameter and made new ones with only nine inch diameter, because the higher pressures and greater strain from the diesel system would have placed too much strain on the gas engine crank shaft and bearings. We made completely new cylinders, cylinder heads and pistons, along with a new revised fuel system. The old gas manifold with vaporizer was replaced with a free breather and a high pressure injection nozzle. We had it running before the patents were granted for my high pressure injection nozzle, air valves in the manifold for starting, and five other items.

This first engine was started with compressed air, the force of the air being used to rotate the crankshaft. I had constructed a special flapper valve in the intake manifold which allowed compressed air to be introduced there, thence into the individual cylinders at the proper instant by means of the regular intake valves. This eliminated the need for separate air start valves in the cylinder head as on the Atlas. Once the engine began firing on its own, the compressed air was shut off, the flapper valve opened to the outside, and the engine continued to run.

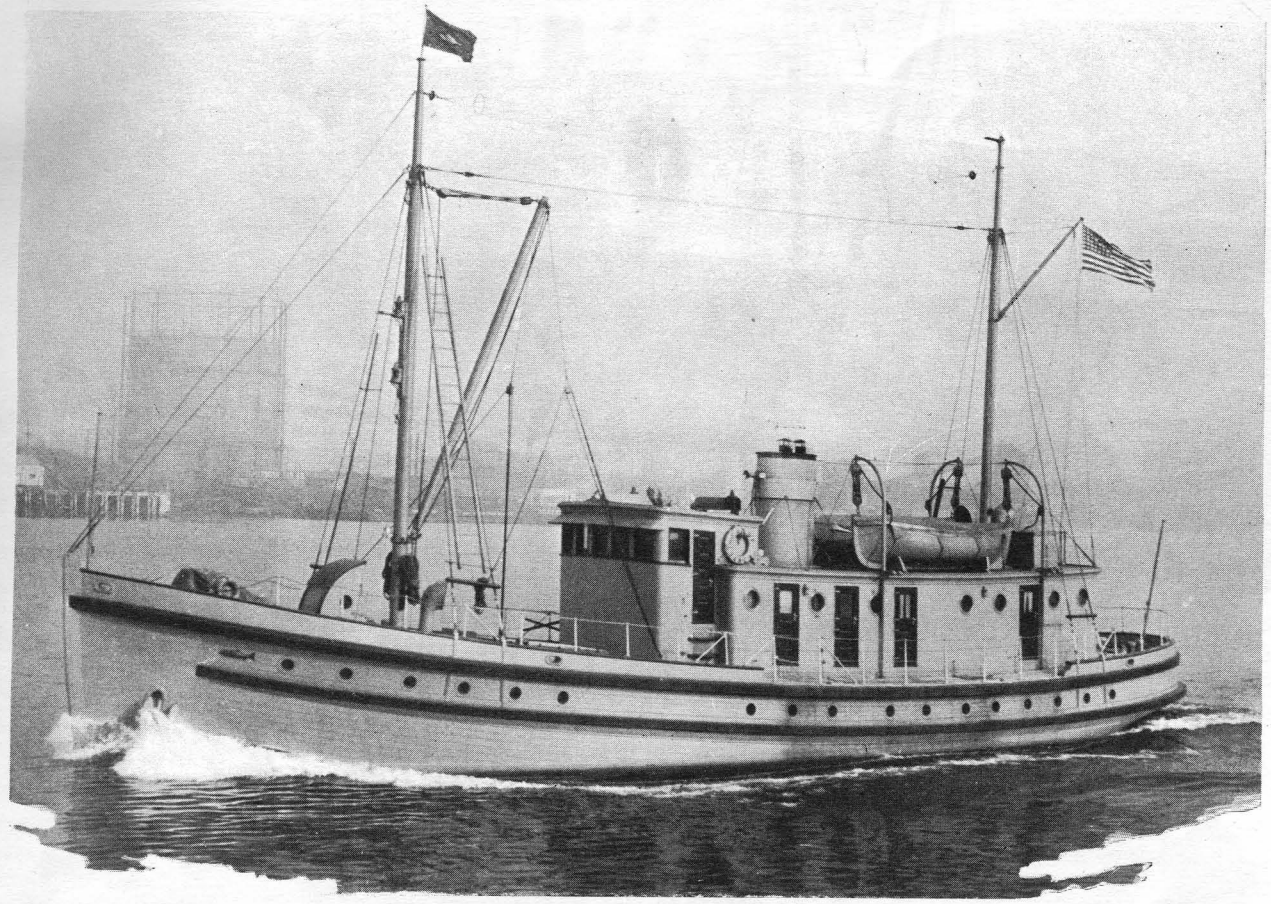
Frank and John Frink and their dad, John, of the Washington Iron Works in Seattle became interested in our work and this trial engine. They had a yacht and saw my engine running in our shop at the Fisherman's Dock. They tried to purchase my patents but I refused to sell. They did hire me though on a ten-year contract, from 1921 to 1931.

I went to work for them and the Washington Estep diesel engines began to roll off the production lines. After I left them in 1931, they dropped my name, continueing to make the engines as the Washington diesel. They paid me a royalty of $1.00 per horsepower for all engines built while I was there. They kept my chief designer after I left and continued to use my patents. Washington Iron Works had been manufacturing logging engines and continued this work along with the diesel engines, as these were only a small part of the total output of the shop.

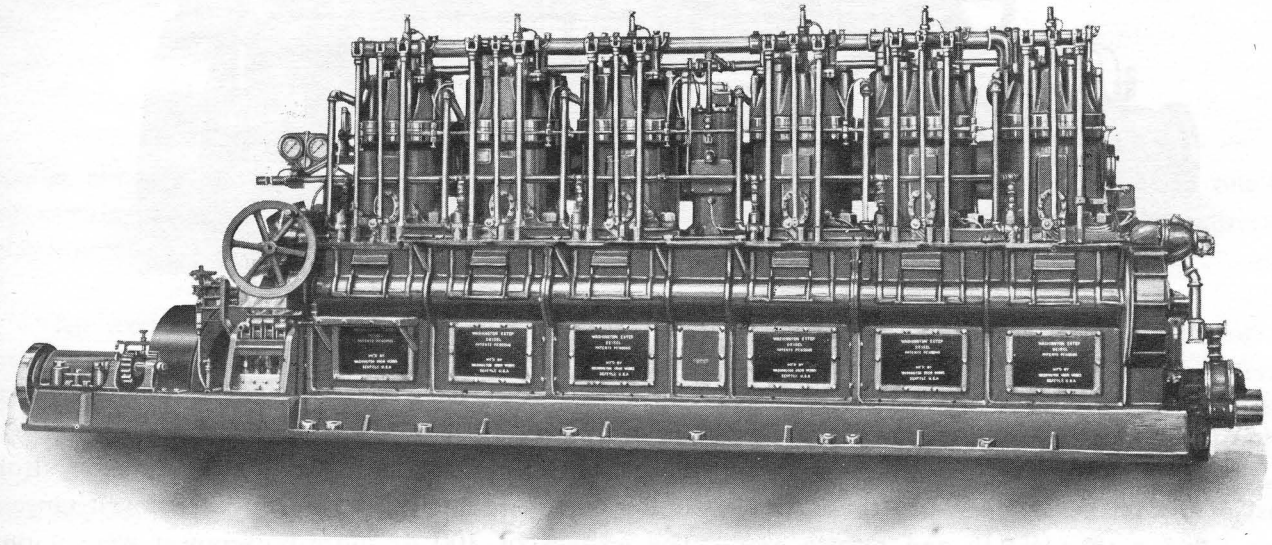
The first Washington Estep diesel was installed in the old steam tug ELMORE, owned by the American Tow Boat Company of Everett. She was built as the R.P. ELMORE, a steam cannery tender for the Elmore Canning Company on the lower Columbia River. After the new engine was installed in 1923, the ELMORE became the first unit of the towboat firm. We called the engine 110 horsepower, but in truth it was about 150 horsepower. She towed for them for many years and earned us a good reputation. This vessel is still in service as the KIKET of the Puget Sound Freight Lines, although the engine has been replaced.

All of the engines built at the Washington Iron Works had cylinder liners that could be removed and replaced. They also had intake and exhaust valves in individual cages, so if a valve was giving trouble it was comparatively easy to stop the engine, remove the one valve and cage, and replace it with a spare. You did not have to remove the cylinder head or drain the cooling water out. This was a great feature

as valve trouble was common, especially from burned and leaking valves. Every vessel carried at least one spare complete intake and exhaust valve with cage. The removed parts could then be either repaired on the run or if badly damaged they were sent to the shop while the boat continued to run.

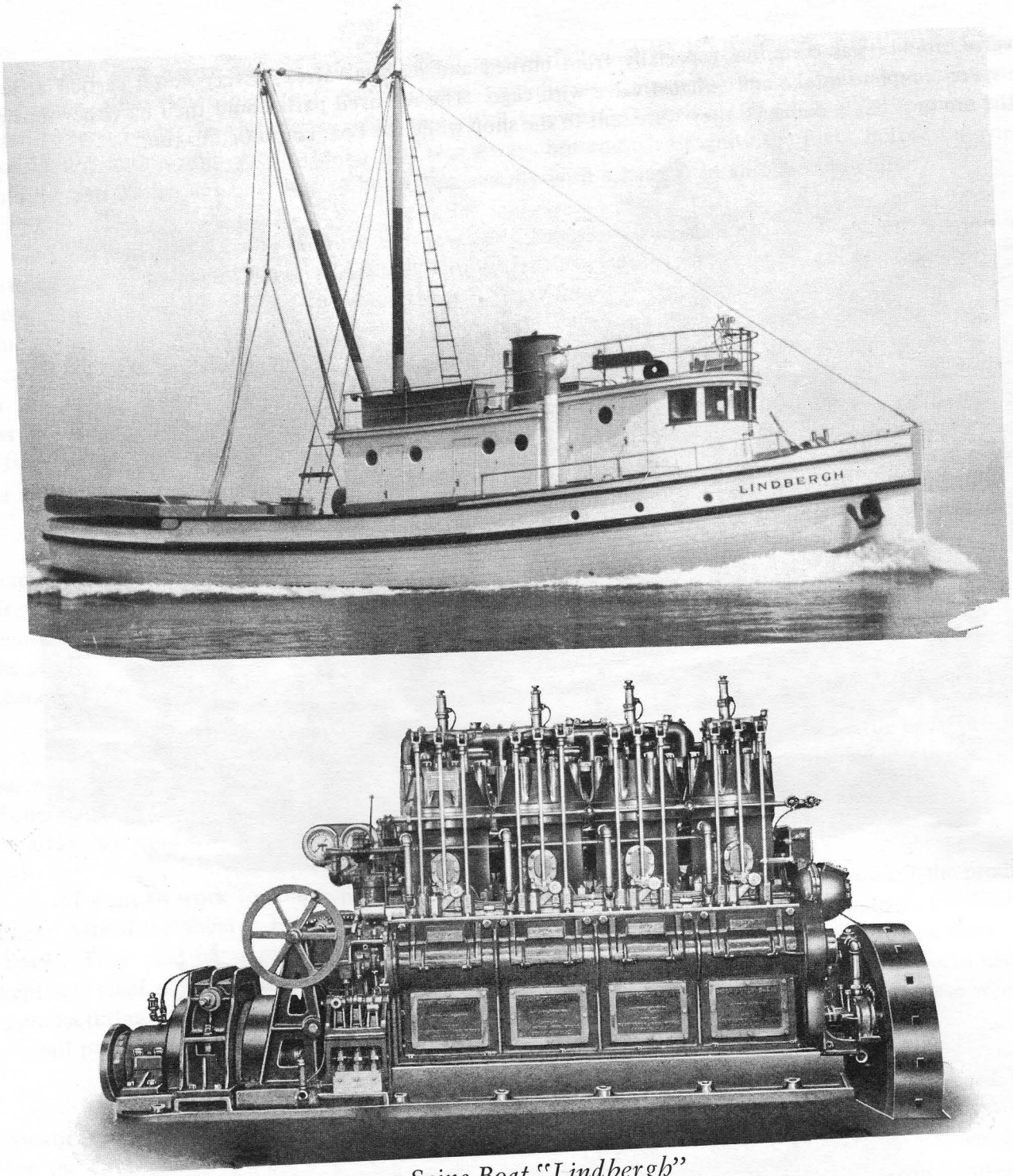


U. S. Bureau of Fisheries Patrol Boat "Crane"



POWER UNIT

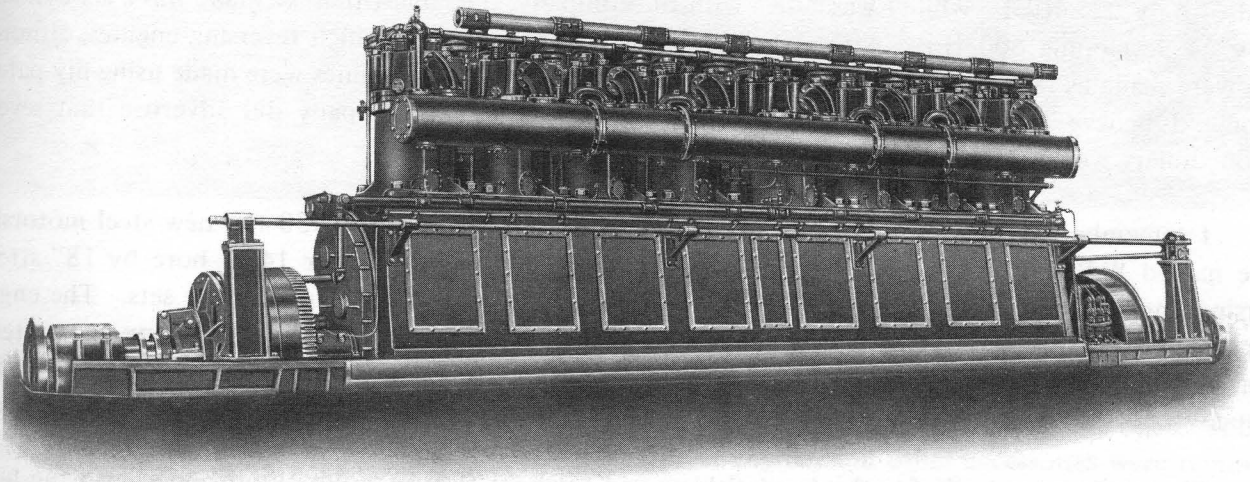
200 H. P. 6 Cylinder 10" x 12½" Washington Direct Reversing Diesel



Seine Boat "Lindbergh"
Powered with 4 Cylinder, 180 H. P. WASHINGTON DIESEL

We made engines in a wide assortment of sizes, as we made several sizes of cylinders and also varied the number of cylinders. This allowed for uniformity of manufacture. The smallest was 7 by 10 up to 18 by 24 inches, (numbers represent the cylinder diameter and the length of piston stroke). Most of the smaller engines, like those for the fishing fleet were in the 100 to 250 horsepower range and were fitted with a clutch and reverse gear. The engines of 300 or more horsepower were normally of the reversing type, that is the engine itself was run in the opposite direction with no need for a clutch, the engine being connected directly to the propeller. On these engines when the engine started, the

Ferry "Bainbridge"



800 H. P. 8 Cylinder 17" x 24"—190-200 R. P. M.
Driving From Either End Through Clutches

propeller also started, and if it was necessary to warm up the engine before leaving the dock, one had to be certain the mooring lines were in good order. These engines could run equally well in either direction of rotation of crank shaft; all that was required was a second set of cams to operate the valves.

An exception to this general rule was the engines installed in the three ferries built for the Kitsap County Transportation Company, the KITSAP, BAINBRIDGE, and VASHON. These ferries were constructed at the Lake Washington Shipyard in Houghton (now part of Kirkland). The engines for these ferries were unique, as each engine had two clutches, one at each end. Neither clutch had a reverse gear. Either clutch could be engaged, depending on the order from the captain via the engine room telegraph. The clutch at the end to be the stern of the ferry was engaged while the one at the other end was disengaged. Hence the propeller at the end of the ferry that was the bow at that time was allowed to rotate freely or to windmill. No power was applied to the bow propeller. This is not the case with present double-end ferries. The engines in these ferries were most successful and were never

replaced although the ferries were operated for over 40 years. The ferry KITSAP was sold to the State of Oregon for service on the Astoria-Megler run. After the bridge was built the vessel was converted to a floating cannery and lost while being towed to Alaska, no fault of the engine. The BAINBRIDGE was in use in British Columbia until 1966. The VASHON, the last of the three to be constructed, slid down the ways in 1930 and is still in daily use by the Washington State Ferries, a life of 47 years on the original engine.

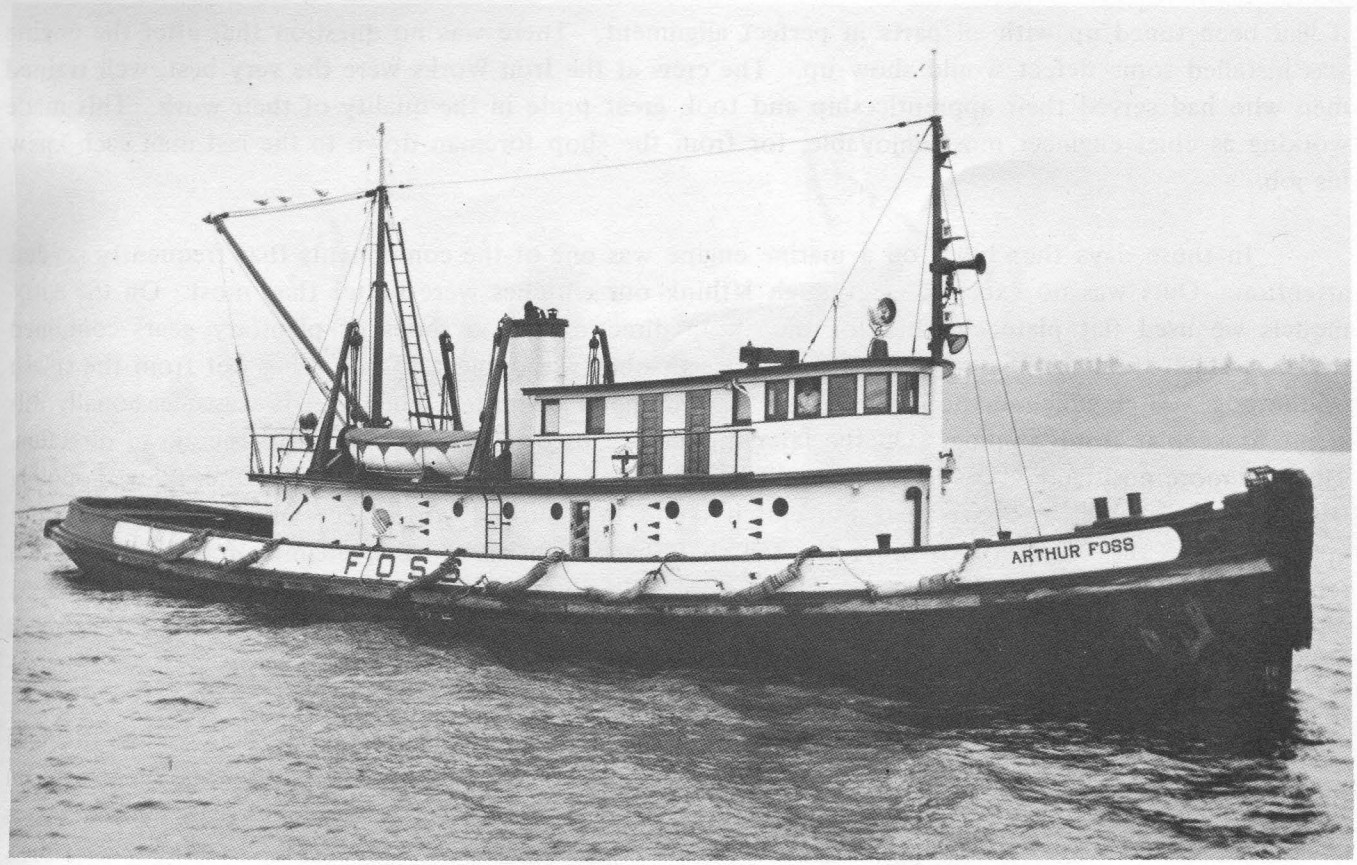
Some of the early Atlas reversing engines had an arrangement called the "suck and blow" system. When the engine reversed direction the intake valves and manifold became the exhaust side and the exhaust side became the intake. Both the exhaust pipe and the intake were extended up the stack. Each pipe would alternately be the intake hence the name "suck", and when operating in opposite direction it would be the exhaust when the name "blow" applied. This system was soon discarded for the more conventional one with the two sets of valve cams. The Atlas engines were always good reliable machines.

The Washington Estep engine was a slow turning machine. Our engines in the larger sizes of 350 H.P. and over were rated to deliver their horsepower at 250 RPM, while the engines smaller than 250 H.P. were generally rated at 300 RPM. We also made some engines for tow boats that had a rated speed of only 225 RPM. While I was active with the company, the largest that we made was a six cylinder, 18 by 24 developing 600 H.P. After I left they made a few 18 by 24 inch reversing engines, although none were made as large as 1000 H.P. I do not remember how many engines were made using my patent although I believe the number to be between 300 and 400. The company did advertise that several million dollars worth of engines were built.

I remember one set of right and left hand engines we made for a 1950 ton new steel motorship to be named W.B. FOSHAY. We made this pair of 560 H.P. eight cylinder 14½" bore by 18" stroke reversing engines to operate at 225-250 RPM. We also built two 50 K.W. generating sets. The engine room was one of the finest I have ever seen in a vessel of this size. The Foshay Company encountered financial problems and were not able to operate the vessel; it was taken over by Northland Transportation Company and the name changed to NORTHLAND. The vessel served her owners well for over 20 years.

The engines we built for the local fishing and towboat fleet were usually dropped into the hulls with the sheer legs (crane) at the Fisherman's Dock while the larger machines being too heavy for this sheer legs were hoisted aboard with the Port of Seattle sheer legs at pier 91. These were the only hoisting devices available other than at the shipyards and it seemed the cost of going to a shipyard was more than most of the owners felt they could afford, especially when the owners were going to do their own work of completing the installation.

The Washington Estep engines when fitted with a clutch and marine reverse gear were ideal for the halibut schooners. When hauling the set halibut lines, the captain had to regulate the speed of the vessel with the speed the crew on deck were hauling in the set or ground line. Constant changing of engine speed was required especially during inclement weather. The clutch was in and out every minute or two. These vessels had engine controls in the pilot house, so the captain could operate the clutch with a small air valve and the speed with other levers. The use of an engine that had to be started and stopped for each speed change was out of the question. On these halibut boats the captain was usually the owner or had a large share of ownership and he took good care of the machine, for his living depended on it. Should the engine break down on the grounds it meant the end of the trip and a loss of money. There even might be a tow bill to port. Our engines were very dependable and enjoyed the best reputation with the fleet which brought in many new orders.



Tug ARTHUR FOSS

Generally the engine orders were from the shipyard building a new vessel or doing a major reconstruction. For the fishing industry most of the new owners would plunk down the cash for the engine at the time of order. We also sold many engines for towboats to replace the old open exposed crankshaft triple-expansion steam engines. The old boilers, engine, and other accessories were removed, leaving a large engine room in which to install the new diesel. Fuel tanks were replaced or cleaned of all the sludge from the bunker fuel and made ready for new service. When completed the boat was entirely different; it had a clean engine room, fewer crew resulting in better accomodations for the new crew, far less weight, and the big advantage of lower fuel bills.

Foss Launch and Tug Company were one of those repowering old tugs. One of these was the tug WALLOWA, constructed at Portland in 1889, repowered in 1934 with a 700 H.P. six cylinder Washington diesel, and operated by Foss until the mid 1960's. At the time of her repowering she was renamed ARTHUR FOSS. This vessel was typical of many.

Washington Iron Works had its own foundry, where all the cylinders, cylinder heads, engine frames, and other parts were cast. I remember how they used to fill the electric furnace with the proper selection of scrap iron, which was melted and then poured into the sand molds. The crank shafts were forged by Isaacson Iron Works and delivered in the rough form, the shaft having been turned down somewhat to assure there were no defects. Washington Iron Works could generally manufacture and deliver an engine in 60 to 75 days after the order was placed. Each engine was set up on the test block at the factory and run to prove itself. It had to produce the proper horsepower and when it left the factory

it had been tuned up with all parts in perfect alignment. There was no question that after the engine was installed some defect would show up. The crew at the Iron Works were the very best, well trained men who had served their apprenticeship and took great pride in the quality of their work. This made working as chief engineer most enjoyable, for from the shop foreman down to the last man each knew his job.

In those days the clutch on a marine engine was one of the components that frequently needed attention. Ours was no exception, although I think our clutches were better than most. On the early models we used flat plate clutches for the ahead direction and a series of planitary gears contained within a steel drum for the reverse. The entire assembly was subject to becoming wet from the splash of the bilge water which did nt add anything towards good operation. When wet it was occasionally difficult to keep it from slipping. On the later models we used a V cone clutch for the ahead direction. This was more positive and gave very little difficulty. Most engines had a bolted together flange coupling between engine and clutch, so that the clutch could be removed when necessary for repair without need to move the engine or to shove the tail shaft back. On some other engines it was necessary to remove the intermediate shaft to get room to open up the clutch. Our last engines had a press fit between clutch and crank shaft, but even with this we had sufficient clearance that the clutch could be removed without disturbing anything else.

I obtained a Chief Engineer license from the Steamboat Inspectors so I could go on the trial trip of each vessel as the official chief engineer. The insurance companies required this license be on the vessel when operating. While the shipyard and the Iron Works mechanics and crews had engineers licenses, it was good to know I did not have to take second place in authority to them at these times.

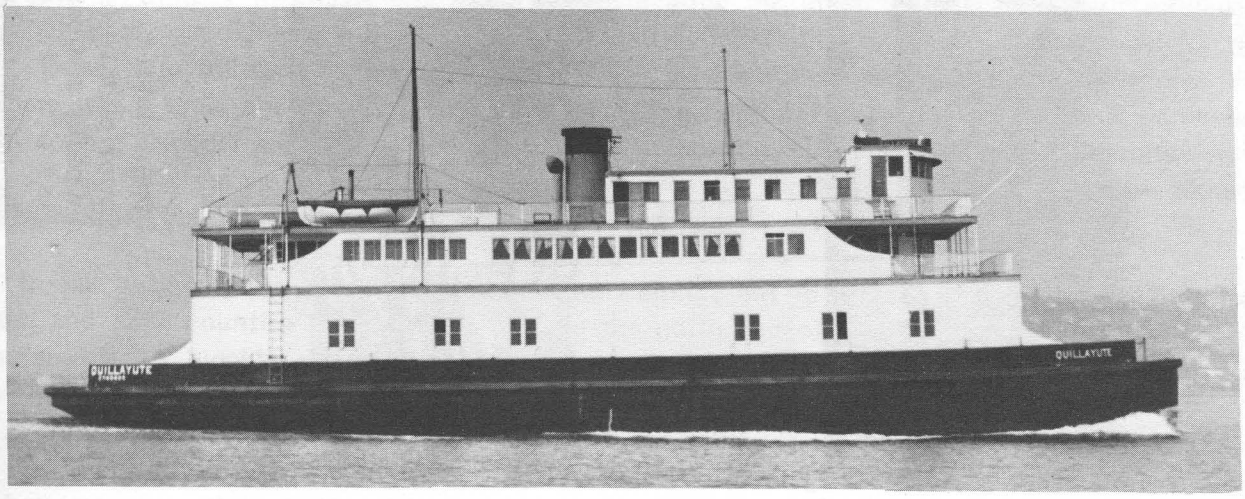
Washington engines were sold all over the country. Some were sold for towboats in New York. We had an agent in Baltimore who sold many. We also made many for use in Mississippi River towboats. At that time there was a series of sternwheel steam tugs being converted to diesel and we got our share of the business. One engine was sold and installed in the San Francisco ferry GOLDEN CITY (formerly AVEN J. HANFORD). This ferry was involved in a collision with the steamer NEWPORT and sunk as a result on April 24, 1927. The ferry had operated only two days with the new engine. The hull drifted out through the Golden Gate before sinking and was never recovered.

I left the Washington Iron Works in 1931 with full intention to go back working with Fred Kimball. While I was away, he had sold the shop at the Fisherman's Dock and opened up a new shop at the south end of Lake Union. That summer Fred was involved in a freak accident that cost him his life. He had just bought a new car and was under it making some adjustment when someone monkeyed with the jack and dropped the auto on him. He never recovered from the injuries. One of the Seattle banks was going to find me another partner but never did, so I sold the machinery to the Western Boat Building Company in Tacoma.

After Fred died I worked for several engine companies in various capacities, generally as chief engineer. The Kahlenberg Engine Company in Two Rivers, Wisconsin was one of these where I worked as chief engineer during World War II. Kahlenberg built a medium-speed totally enclosed engine. This was even cleaner than the Washington and much lighter for the same horsepower. Then it was back with the Atlas people in their Chicago office, my first marine engine builders, where I was now the chief engineer instead of the mechanic down in the bilge aligning up those gas engines. I stayed there a few years, then returned to Seattle where I retired.

Ferry VASHON

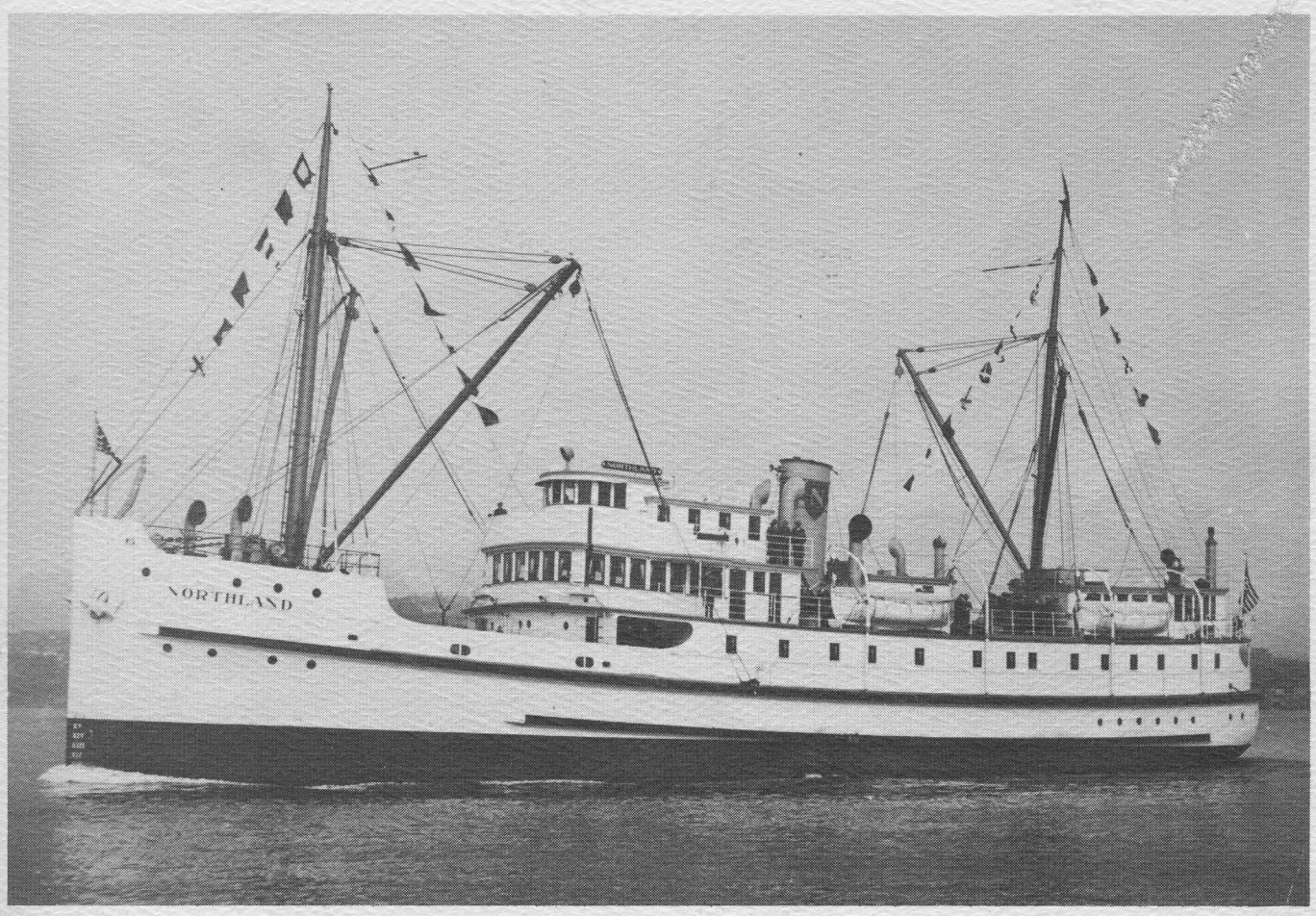
During my life I manufactured engines for 25 years and was in the marine engine business in one form or another for nearly 50 years. They have been most enjoyable. I think however, the greatest pleasure of all occured every time I went out on the trial trip when one of my new engines was put through its paces for the first time. What a thrill! When I went down in the engine room and looked along the line of cylinder heads I could see all those rocker arms, rocking forth and back as they opened and closed the valves with perfect timing. And then in the pilot house out in Puget Sound where we would plow up a white frothy furrow. Other vessels passed by, also powered with engines from our factory. It was wonderful to say to myself "I designed those machines."



The End.

MARCH 1978

THE SEA CHEST



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CONTENTS

COVERS

Front: NORTHLAND (W.B.FOSHAY)

Back: Schr. C.S.HOLMES

Both photos courtesy Joe Williamson.

THE PUGET SOUND MARITIME HISTORICAL SOCIETY

Membership in the Society is open to anyone interested in maritime history. Membership is solicited, and inquiries should be addressed to: The Puget Sound Maritime Historical Society, 2161 E. Hamlin St., Seattle, Washington 98112. Monthly meetings are held September through June on the first Wednesday of the month. Meeting place and programs are announced to members by mail. Membership is $12.00 per year. THE SEA CHEST is free to members, however, additional or back copies may be obtained, while they last, at $3.00 per copy.

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