WHEN COAL OIL JOHNNY GOES TO SEA.

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The fast clipper ship was built of wood and propelled by sails. We had the timber to build that type of ship and the ingenuity to apply wind power and beat the world in speed. Those were the days of the Yankee clipper ships, and from Revolutionary times until 1861 we carried from 60 to 90 per cent of our own world trade.

Then came iron and steel ships, with steam power. Great Britain led all countries in pig-iron production—the whole world output in 1860 was less than 8,000,000 tons, against 50,000,000 tons for the United States this year. As for steam, Emerson said then: "Steam is an Englishman." John Bull took first place in the new kind of shipping. The proportion of American trade carried in American ships steadily ran down to less than 10 per cent at the outbreak of the world war.

To-day we are about to see another revolutionary advance in merchant ships, and the United States will again have some advantage—if we back natural resources with national ingenuity.

Petroleum is the coming factor in shipping. It will be used under boilers to raise steam. Better yet, it will propel internal-combustion engines of the Diesel type—the motor ship. We have an advantage in our large output of petroleum—65 per cent of the world's output. And we are handiest to Mexico's supplies, now nearly 8 per cent of the world production, with remarkable possibilities for increase, and two types of crude oil that are peculiarly suited to marine use.

In making a learned academic forecast of America's new merchant marine a German professor recently said: "In trading with other maritime powers it is right and proper that a nation should carry in its own ships at least 50 per cent of its world commerce."

A NEW ERA IN SHIPPING.

With petroleum, the motor ship, and American inventive genius and energy, we have reasonable prospects of again carrying our own exports and imports on this Germanic basis of fifty-fifty; but we must not rely upon natural advantages. Coal Oil Johnny will not do the work alone; we must put brains into the job—brains to the utmost.

Petroleum is about to effect a transformation in world shipping much more remarkable than that which was wrought by steam. The possibilities are fascinating. Both the oil-burning and the motor ship remove handicaps under which the merchant navies of the world have been steadily degenerating. They reduce operating costs, increase range and flexibility, overcome certain international political handicaps in shipping, and improve the living standards and morale of those who go down to the sea in ships.

Land transportation in practically all countries has been developed to a point where competition is regarded as wasteful. Competition probably played a useful part in days when railroads were being built: but, once laid down, it was agreed that competition in railroad operation, with its losses and bankruptcies, worked public damage. So for a generation the nations have been bringing their railroads under wise control for common welfare.

On the ocean, however, the nations have let competition run pretty much unchecked. After building their merchant fleets it might have been wise to work out some plan of international regulation. But, instead, they have fought each other on lines reminding one of our old railroad rate wars. They have used railroads, port privileges, bunkering stations, and other auxiliaries to give their own ships the best of it and let the other fellow's ships have the worst.

They have done little to overcome by teamwork the violent fluctuations in ocean tonnage, rates, and profit. They have fought each other on a rate basis with very little fundamental knowledge of shipping costs. And the general result has been to make shipping a risky business for the investor and a thankless job for the seaman, and to run the world into a great crisis, with a shipping plant that proved inadequate and antiquated.

But the world has undoubtedly learned its lesson during the past four years. Peace will find it building bigger merchant fleets on modern lines. Petroleum will give new mechanical advantages and help to bring order into ocean transportation. If international wisdom can be applied to operation and wasteful competition eliminated, shipping may enter a new renaissance.

When Coal Oil Johnny steps aboard a merchant ship and takes charge of the engine room the transformation is great. The comparatively few shipping managers who have operated with petroleum will tell you that it is like switching from the one-hoss shay to a high-powered racing car.

Take the advantages found in the oil-burning ship with steam engines over the coal burner. There is a reduction in the number of men needed in the boiler room, first of all.

Some months before the *Lusitania* sailed on her last tragic voyage American petroleum experts examined her boilers and coal bunkers to make suggestions for converting her into an oil burner. They found this entirely feasible, and estimated that her fireroom force could be reduced 90 per cent by the change—that is, 1 man out of 10 would be needed. It has been said that the *Lusitania* started on her last voyage short of firemen, and that because she was running with only 70 per cent steam efficiency the submarine was able to torpedo her. Had she been running at full efficiency with coal, or been fitted for oil burning, she might, perhaps, have escaped.

ADVANTAGES OF OIL.

Next comes reduction in bunker space, with an increase in cargo space. A ton of oil takes 5 cubic feet less space than a ton of coal, and gives 80 per cent steaming efficiency against 65 per cent for coal.

This works out to about 40 per cent saving in bunker space, which is made available for cargo in a freighter. Moreover, there is a saving in quarters for the crew, because an oil-burning ship carries fewer men. Estimates for the *Mauretania* give a fireroom force of 27 men for oil burning, as against 312 needed to burn coal.

Oil-burning vessels will make from 10 to 20 per cent more mileage than coal burners. There is better control of steaming, because fires can be started and stopped instantly, steam raised quickly, and time in port saved through the greater ease of taking on oil as contrasted with coal. Coaling is always a dirty job and tedious, whereas oil is simply pumped into the double bottoms quickly and without fuss or muss.

There are other advantages: Oil is often cheaper than coal in actual dollars—prices vary widely, of course. Oil does not deteriorate in storage like coal. Oil eliminates the fire risk from spontaneous combustion in coal, and is not subject to the danger of shifting in rough weather at sea. Oil eliminates ashes and ash conveyors, smoke, and soot, and the necessity for frequently painting a ship. Oil reduces the expense of grate repairs, corrosion of boiler plates, fuel-handling devices afloat and ashore.

Even more remarkable, however, is the increase in radius of ship operation and the possibility for planning profitable voyages without handicaps imposed by coaling. The coal-burning ship must stop frequently for fuel. Her nationality may put her at a disadvantage where foreign bunkering stations are used. At the best, coal-bunkering stations in other countries have always involved political complications. Even with the magnificient bunkering facilities afforded British ships, there are various parts of the world where the coal burner must steam a considerable distance, with little or no cargo, simply to take on coal—a well-recognized operating handicap.

But the oil burner has a radius of from two to three times that of the coal burner. Fast passenger liners burning oil for steam could almost make the round trip from New York to Europe and back, taking most of their oil on this side; and with freight steamers running at slower speeds, and burning less oil to the mile, it would be possible for them to go half round the world.

Coal Oil Johnny can give almost any coal-burning steamer seven-league sea boots by a few simple changes in equipment—the installation of oil burners under the boilers and the conversion of coal bunkers or double bottoms into oil tanks.

But even that is only half his potential efficiency. Look a little farther ahead and design your ship to run with internal-combustion engines of the Diesel type, and he can double the efficiency.

The motor ship will operate on about half as much oil as the oil-burning steamer. Its engine-room force is reduced still more—from one to three men are sufficient; and there are no stokers, for the motor ship's mechanical staff is made up of skilled men. A Danish motor liner, the *Fiona*, recently went clear around the globe, making a voyage of 32,000 miles, with only one engineer.

The largest motor ship yet built, the *Glenapp* recently made her trial trip in Scotland. She is 10,000 tons dead-weight, with two sets of Diesel engines, 6,600 horsepower. It is estimated she can make from 12 to 14 knots an hour and run from London to Australia and back more than half way without replenishing fuel—that is, going by way of the Suez Canal, she could take oil in the Persian Gulf and run back there without replenishing; while by the Panama route she would take oil in the Mexican Gulf.

This means that, with the world's merchant fleets equipped entirely as motor ships, from 80 to 90 per cent of the bunkering stations around the globe could be abolished; ships would require fuel only about twice in going around the world—or at an average of every six weeks. There need be no isolated fuel stations; oil would be taken on only where ships called for cargo or passengers.

THE ECONOMY OF OIL.

Anyone who has made a voyage through the Tropics will find it interesting to contrast this sort of ship with his recollections of coaling incidents. If his voyage was through the Suez Canal to Australia or India, for instance, he remembers the terrific heat and how only Chinese coolies can stand the temperature of the fire hold; and how the ship was coaled at Port Said by hundreds of women carrying baskets of fuel. Neither the motor ship nor the oil-burning steamer requires coaling. The engine room of a motor ship need be little warmer than the deck in the Tropics; and, besides, there is probably only one man attending the engines, and he is not performing hard manual labor nor is he in dirty surroundings.

The boiler room of an oil-burning steamer can be 25° cooler than if coal were burned under the same boilers. For most of the heat in a fire hold comes from opening the furnace doors to throw in coal. There are no furnace doors when oil is burned. With coal, heat escapes every time the furnace door is opened and is lost for steam-making purposes. With oil, there is no furnace door to open and all the heat is used for steam making.

Two tramp steamers of the same tonnage leave New York for Santos, Brazil, calling at other ports on the way. One of them burns coal and the other is an oil-burning steamer. The coal burner makes the voyage in 24 days and 8 hours, while the oil burner makes it in 21 days and 13 hours—a saving of nearly 3 days, due to the fact that she runs 1 knot more an hour than the coal burner, owing to steadier steam pressure and greater speed secured with oil fuel. The coal burner needs 27 tons of coal daily, or 657 tons for the voyage. The oil burner needs 16.7 tons of fuel daily or 359 tons for the voyage. A coal burner carries nine firemen and trimmers; the oil burner only three.

In normal times oil fuel for such a voyage might be either a little cheaper or a little dearer than coal. Suppose coal and oil cost the same. There will be a saving of $300 in firemen's wages for the oil burner and 700 dead-weight tons of bunker space for carrying cargo; which figures, at $5 a ton, earn $3,500 on the voyage. So the oil burner yields $3,800 more to her owners and a saving of three days in time. On a year's operation the oil burner would probably make at least two voyages more than the coal burner, and these would be clear profit, except for fuel cost and port charges.

Two ships of the same tonnage went around the world, leaving Europe, rounding Cape Horn, touching at San Francisco, thence crossing the Pacific and going through the Suez Canal. One was a coal-burning steamer and the other a motor ship. The steamer stopped for coal 14 times and burnt 8,500 tons on the voyage. The motor ship burned 1,446 tons of oil and had capacity for carrying 1,250 tons; so she might have gone nearly the whole voyage, starting with full tanks—actually she left Europe with 820 tons, and bunkered twice—in San Francisco and the Persian Gulf—but turned an honest penny by using some of the tank capacity to carry an oil cargo from one port to another.

The steamer made the voyage in 300 days; the motor ship in 236 days. The steamer carried 7,500 tons of cargo; the motor ship 8,500 tons. The cost of coal—normal times—was $41,275, and the cost of oil for the motor ship was $12,940—a saving of nearly 70 per cent. The coal burner carried 14 stokers; the motor ship none. The motor ship carried an engine-room force of 13 men as against 19 for the coal burner. So there was a saving in fuel amounting to 70 per cent, a saving in time of more than 20 per cent, and an increase in cargo of nearly 15 per cent.

These figures become most significant when reduced to terms of early operating costs. Suppose each ship cost $1,000,000. The motor ship saved $28,335 on fuel alone in eight months. That amounts to about 4 per cent annual interest on the entire investment in the ship.

And this is only a comparison of dollars on a coal-burning ship and a motor ship running on an old-fashioned coal burner's schedule. The coal burner spent 183 days at sea and 117 days in port. The motor ship spent 140 days at sea and 96 days in port. Because the world's cargo business is still organized on wasteful lines, with slow turn-round in port, the motor ship dwadled away more than three months in port; whereas, with cargo facilities organized on a motor-ship basis, her greater radius and flexibility in operation would have made it possible to save much of this time. If the maritime world can tackle this one item of waste after the war, it may go far toward paying off the world's war debt.

And the cost sheets do not show that other great item of betterment—morale in the ship's crew.

THE MORALE OF SAILORS.

The world's shipping before the war had got into such desperate straits in morale that the men who go down to the sea in ships were seldom able to marry and maintain families. There are some British figures that show this condition in a striking way. About 60,000 British seamen living in the United Kingdom come under the health-insurance law. This law provides a maternity benefit when a child is born in a seaman's family. With a birth rate of about 25 children annually, which is a general average, 60,000 seamen, if married, should claim 3,000 maternity benefits yearly.

Actually, less than 800 maternity benefits a year are said to have been paid to British merchant seamen's families in normal times; and this is said to indicate a world-wide condition among merchant sailors. It shows one of the world's essential industries disintegrating through blind competition, and in my opinion the remedy must be some form of international system, if not control, and a building up of wages, skill, and morale which will give the seaman a home and a family, like the railroader or machinist.

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With the motor ship we can have an entirely new era in ocean transportation. It calls for skill and effects economies that will yield good wages; and its flexibility and speed should facilitate rearrangement of the world's shipping routes, so the seaman may get home more frequently and have a home worth getting to.

The motor ship is here. But it still needs development and application. Thus far it has been built chiefly in small-tonnage freighters running at moderate speed. These have been highly successful economically; but there are still certain shortcomings in machinery and organization to be dealt with.

The Diesel engine must be freed of some defects that have appeared under the stress of ocean voyages, and must also be built in larger units to furnish greater horsepower for bigger ships running at higher speed. The problems are now entirely questions of engineering, and American ingenuity should prove adequate to develop the fast motor liner for passenger traffic.

This type of engine was invented by Dr. Rudolf Diesel, a Bavarian engineer. The difference between an automobile engine and a Diesel engine is, generally, that all the fuel in an automobile engine cylinder is burnt at once, while in a Diesel engine it is burnt gradually, and so gives power more like the steam engine. Air is compressed in Diesel cylinders under great pressure, and then the fuel, consisting of crude petroleum or other heavy oils, is forced into the compressed air by greater outside pressure. This raises the temperature for the air in the cylinder and turns the oil into a gas.

THE DIESEL TYPE OF ENGINE.

The pressures in a Diesel engine are so much greater than those in a gas engine that when Dr. Diesel placed his first engine on the test block, in 1893, it exploded and nearly killed the inventor, not being sufficiently heavy in construction.

The Diesel engine has been widely applied in Europe for stationary power plants. But its application to ships has been difficult. This requires engines of very heavy construction; and as the mechanism for the gradual introduction of the fuel into the compressed air in the cylinders is intricate, the motor ship involves valve problems of its own.

The Scandinavians have made the greatest progress in motor ships, and the most successful Diesel engines on the ocean to-day are built by the Danes, Swedes, and Hollanders, or under their patents. We have built some motor ships, as have the British also. But certain difficulties, to be overcome by wider experience in designing the engines and operating the ships, have retarded the development of this type. However, there are now prospects of active development for the motor ship in both this country and Great Britain.

The British, especially, are very much interested in this new type of ocean ship, and their splendid technical achievements in naval vessels during the war have given them new methods and a splendid new shipbuilding industry, which will be of great benefit in restoring the British merchant marine as soon as peace returns.

And that is as it should be and what every broad-minded American will rejoice to see: for the British merchant marine, no less than the British Navy, has played a leading part in keeping the world free.

If the world should turn during the next 10 years from coal to fuel oil, and from steam to the motor ship, the question of petroleum supplies will become important .

At present the largest marine consumption of petroleum in the world is probably that of the United States Navy, estimated at 5,000,000 barrels yearly under war conditions. This quantity would not go far in operating an American merchant marine of 25,000,000 tons. Data upon which to figure consumption for such a fleet, with types of passenger and cargo ships running at various speeds and in various classes of service, are not yet very ample. But engineers have adopted a rough-and-ready ratio, estimating 1 ton of oil yearly to a ton of dead-weight shipping, where the fuel is burned for steam, and half a ton yearly for motor ships.

On this basis the American merchant marine alone would require 150,000,000 barrels yearly for steam, or 75,000,000 barrels for motor ships. The world's ocean tonnage was 50,000,000 tons before the war, and under the improvement and cheapening in transportation, made possible through petroleum, might increase to 75,000,000 tons within the next five or ten years, this estimate including our own merchant marine.

Thus, for 75,000,000 tons of motor ships there would be required yearly somewhere between 200,000,000 and 250,000,000 barrels of crude oil. This is approximately half of the world's total present production, and more than 80 per cent of our own production.

Where is the oil to come from?

Fortunately nature has stored supplies in the earth for precisely this situation. Mexican petroleum is peculiarly suited for marine use. In the district round Tampico, which has been the scene of petroleum development for the past 18 years, there are two types of crude oil taken from opposite sides of the Panuco River, which runs through Tampico and divides the district. The northern type of oil is a heavy crude oil that can not be refined but is suitable for burning to make steam. The southern type of oil is lighter. When refined this yields about 12 per cent of crude gasoline and is suited for Diesel engines.

No such oil field has yet been located in any other part of the world. The Tampico district now has about 50 wells in production, with an estimated capacity of 1,500,000 barrels daily—more than twice as much oil as would be needed to operate the world's merchant fleets and navies.

It is true that Mexico at present produces only from 50,000,000 to 60,000,000 barrels yearly; but this represents simply the quantity that can be handled in available pipe lines and tank steamers.

THE PETROLEUM AGE.

The Tampico district is less than 150 miles long and 50 miles wide; but it lies over enormous reservoirs of oil and is considered but part of a general oil region 1,600 miles long and from 75 to 100 miles wide. Prospectors have also found promising oil indications in Guatemala, Venezuela, Colombia, Ecuador, and other parts of Latin America.

To-day there are about 50 companies operating or holding oil lands in the Tampico district, with storage tanks and pipe lines to get the oil down to the ocean. Mexicans have not been active in developing this region because their political troubles have been acute during the chief period of Tampico development.

Political unrest in Mexico is still a serious handicap to oil production, the construction of new pipe lines and port facilities, and the investment of additional capital by outside operating companies. But by the time the world's improved merchant fleets are ready for the transformation of petroleum, it is to be hoped that Mexico will have worked out political stability. The petroleum lies beneath her soil. Its efficient use means not only wealth to her but benefit to all nations.

Within the next generation, and perhaps the next decade, the world seems certain to enter a new era—the petroleum age. Oil will be widely used for industrial power and heating all over the globe. Already there is a marked diversion to oil fuel in industrial centers along the Atlantic seaboard.

It is estimated, roughly, that one man can produce 300 tons of coal yearly, while the same man might produce 7,000 tons of oil. This great multiplication of human power is a benefit that will irresistibly make its own way, and, besides greater results for men's work, there are the additional advantages of clean industrial towns, more agreeable working conditions, better morale, and better living all round.

It is so very much worth while to bring the world into this petroleum age that development of new oil resources all over the globe will be one of the chief activities of peace. The world needs Mexico's petroleum for its growth and comfort. Under the earth in the Tampico district are resources capable of influencing the history of the world.

Out of the lessons of international adjustment and teamwork taught the nations by war they will unquestionably find methods of making the Mexican oil supply available to mankind—methods which will not only be entirely fair to the Mexican people but which will bring them stability, growth, and prosperity.

Photo Mexican Petroleum Company.

"AFTER"—Boiler room of banana ship "Metapan" after conversion for burning crude petroleum to make steam—one fireman on duty each shift at clean, comfortable work.

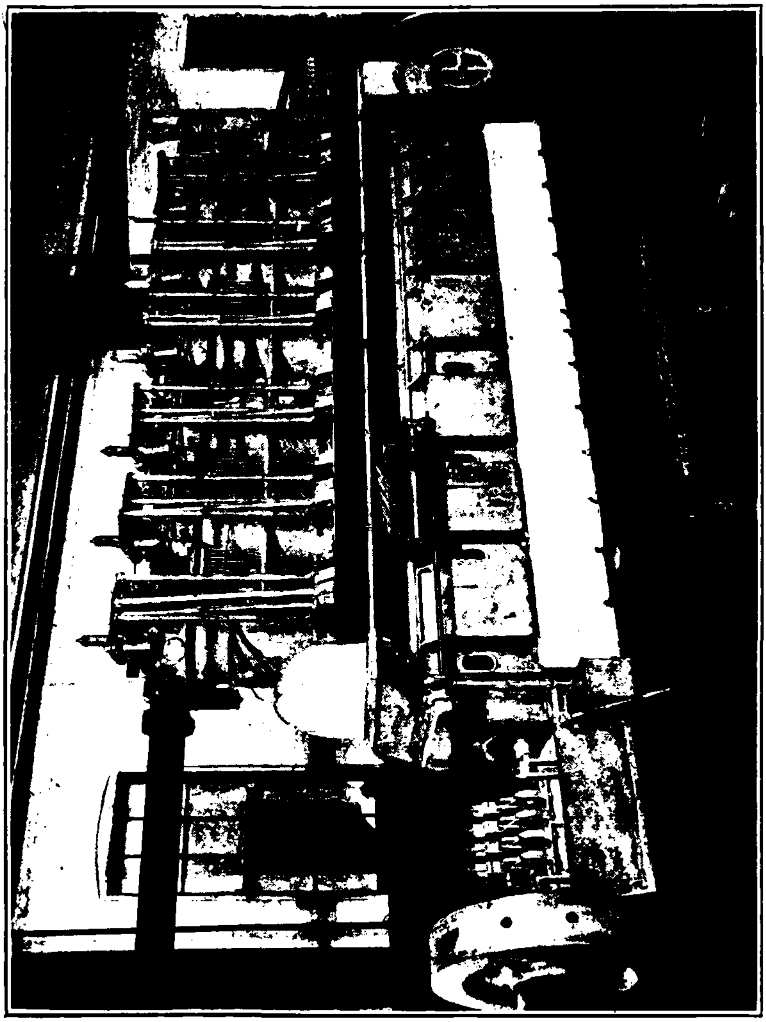

Photo McIntosh & Seymour Corporation.

How motor ship engines look on the test block. This engine was operated 30 days without stop at full load and speed as a test.

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