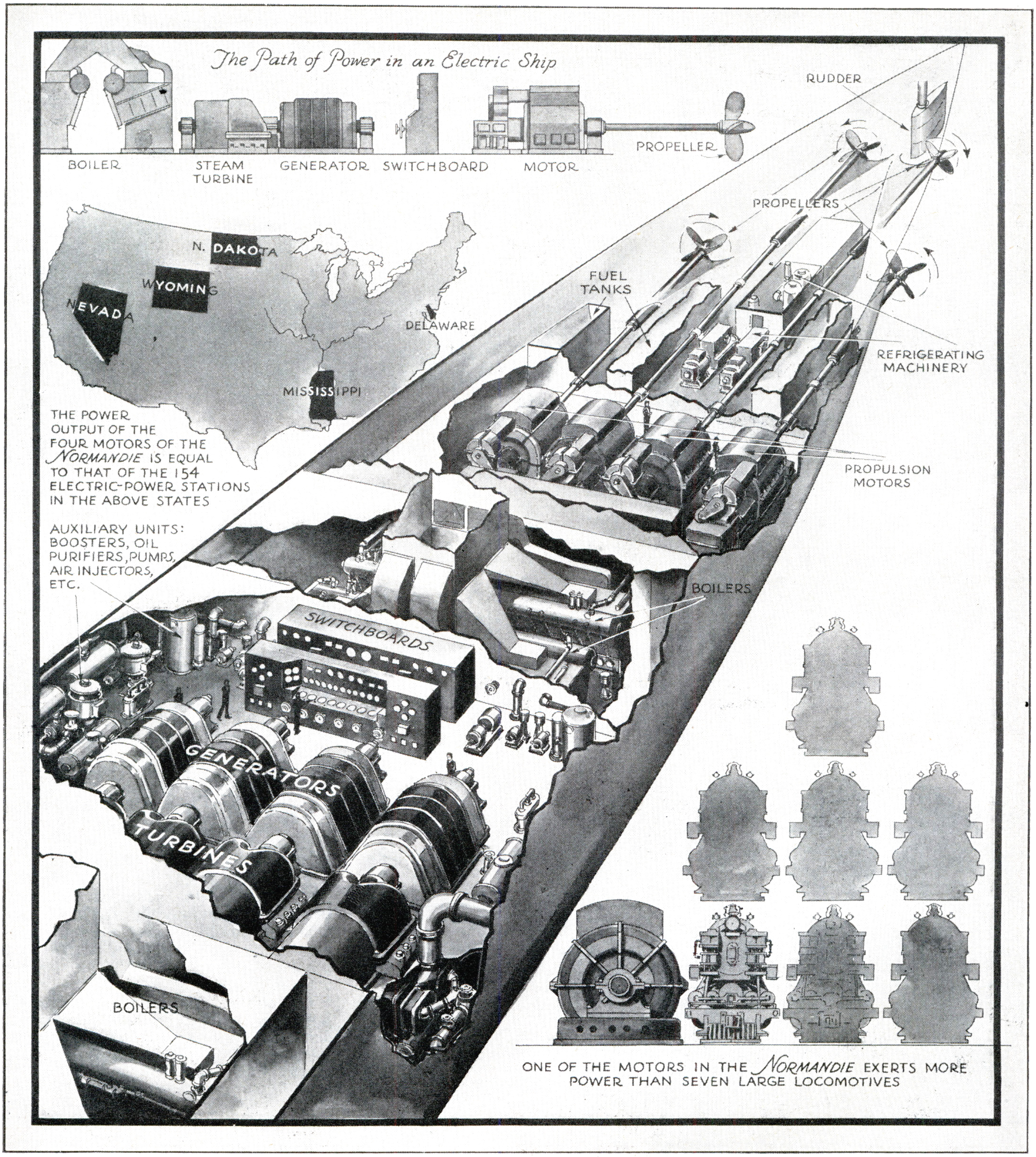
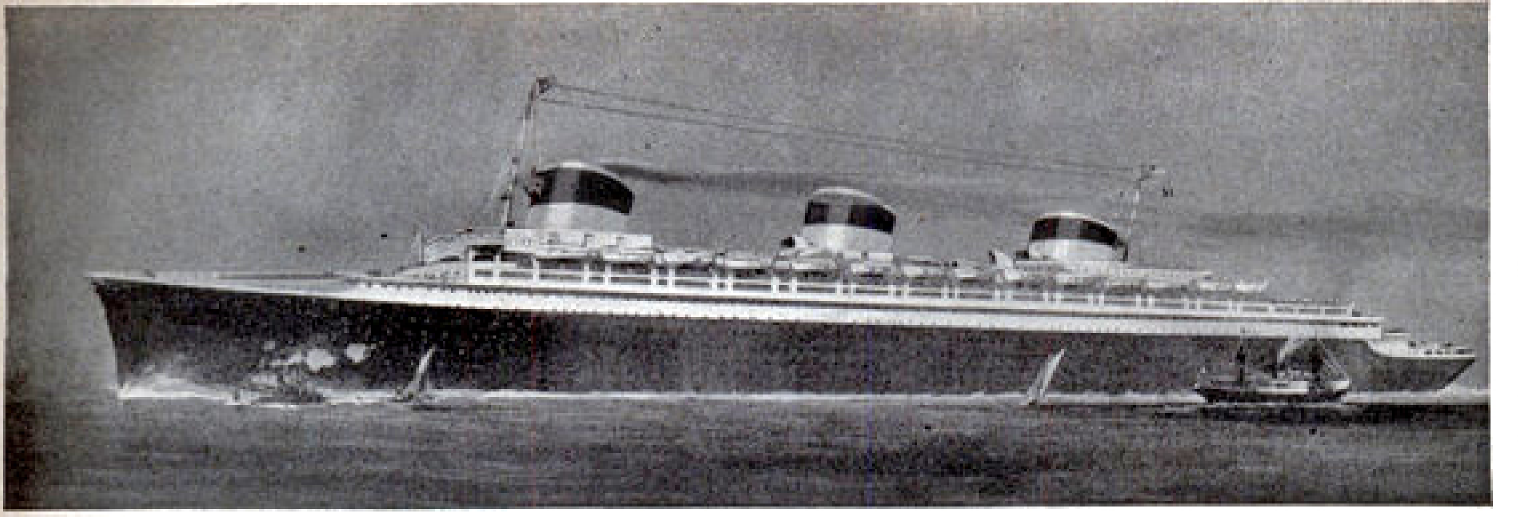


These drawings make clear how the power is generated and applied in an electric ship, such as the huge *Normandie* which is soon to make her maiden voyage across the ocean

Drawing by
B. G. SEIELSTAD

LATEST TRIUMPHS IN Electric Ships



The *Normandie*, the world's biggest ship and the first transatlantic vessel to be fully electrified. She will be put in service next spring

Revolutionary Method of Propulsion Used in Gigantic *Normandie* May Herald Sweeping Change in Transatlantic Travel

By Kenneth M. Swezey

WHEN the 75,000-ton French liner *Normandie* starts next spring on her first voyage westward, electrical power equivalent to the combined steam powers of the *Leviathan*, the *Majestic*, and the *Ile de France*, will whirl her giant propellers. Electrical machinery will haul her ropes, raise her anchors, guide her helm. A thousand electric servants will watch over every item of comfort and safety of her 3,500 passengers and crew.

Not only will the *Normandie* be the most completely electrified ship in the world, but she will be the first electrically-driven ship to pit her might against the directly steam-driven ship in the race for transatlantic supremacy.

From the earliest days of the steamship, until about 1907, this race was waged with the help of the constantly developing reciprocating engine. Edged on by the demand for larger and faster vessels, the simple steam engine of a few hundred horsepower grew into a double-and triple-expansion engine of thousands of horsepower, until the maximum was reached in the 40,000-horsepower engines that drove the *Kaiser Wilhelm II*.

Then came the famous *Mauritania* with steam turbines, aggregating nearly 70,000 horsepower, coupled directly to her propeller shafts. Dashing across the ocean at better than twenty-seven knots, her example revolutionized shipbuilding, and turbines became thenceforth the rule for the big ships.

The 110,000-horsepower turbines of the record-breaking *Bremen* and *Europa*, and the 120,000-horsepower turbines of the *Rex*, all of which are connected to the propellers through massive reduction gears, represent the most advanced and most powerful propelling machinery entered in the race as it stands today.

With no motive but to provide greater comfort, maneuverability, and speed, the $50,000,000 *Normandie* is the first liner of the North Atlantic to challenge this long tradition. Instead of spinning her propellers directly, or through gearing, her four mammoth turbines will drive great electric generators.

The electricity from these, in turn, will drive four huge motors coupled to her propeller shafts. With from 160,000 to 200,000 electrical horsepower at the instant command of her engineers, this largest ship ever built is expected to make the crossing between Havre and New York faster than any other merchant ship that ever sailed the seas.

Engineers of the Alsthom Company, Belfort, France, in collaboration with the American General Electric Company, have been laboring for several years over the design and construction of what will be one of the largest and most nearly unique electrical systems ever built for operation on either land or sea.

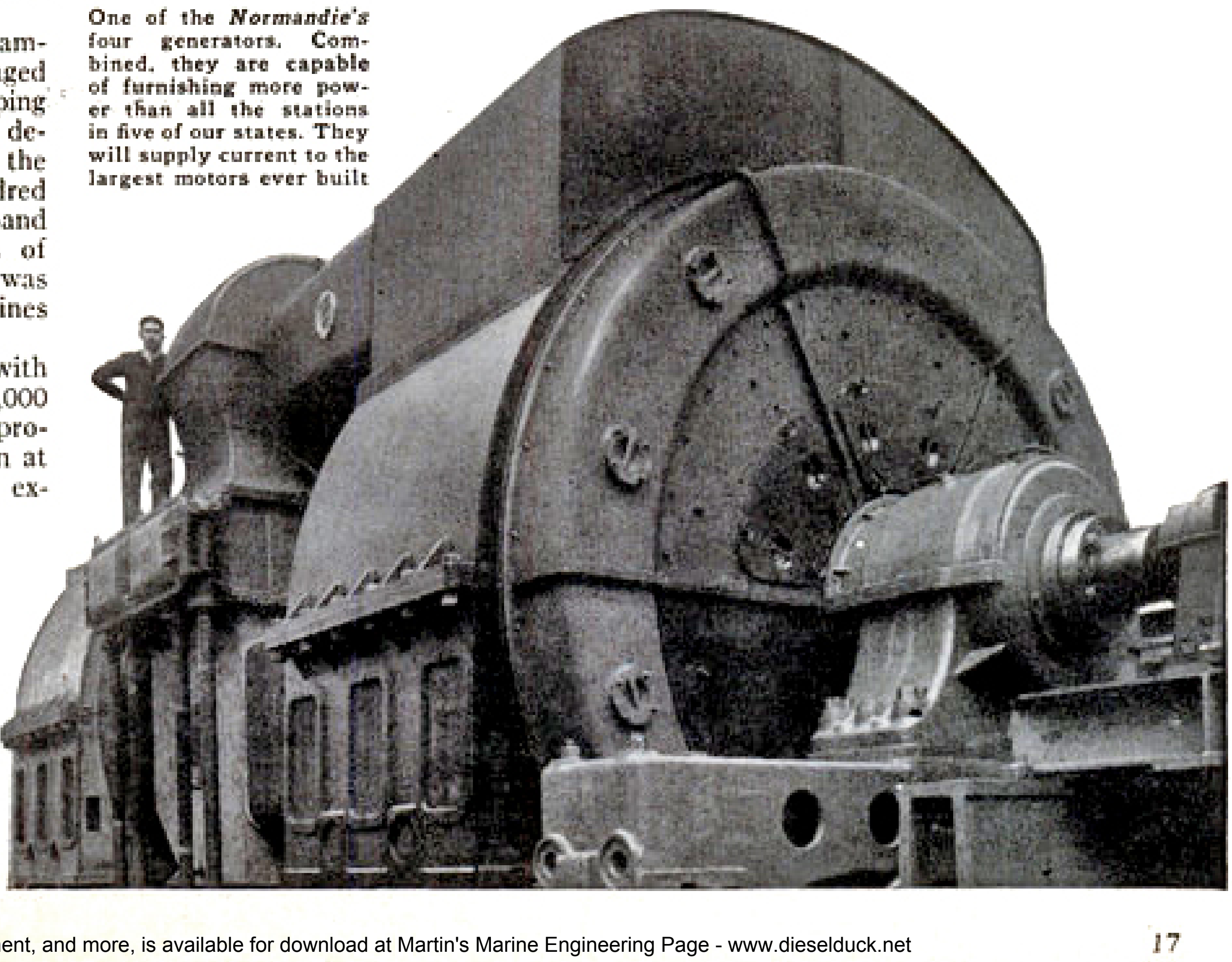
TO DRIVE this monster ship, four motors had to be built, each more than twice as powerful as any motor used for any purpose on land, and more than seven times as powerful as the most powerful steam locomotive that was ever built.

To supply these giant motors with current required a still greater feat of engineering. Running at highest speed, they necessitated a generating plant capable of producing more electricity than the combined generating capacity of the 154 power stations in the entire states of North Dakota, Mississippi, Wyoming, Nevada, and Delaware. Four huge turbo-generators, with a maximum capacity of 42,750 kilowatts each, were finally constructed to meet this demand.

THEN came the problems of lighting, heating, cooling, ventilating, cooking, running, elevators, operating winches and capstans, of providing current for hundreds of miscellaneous electrical devices needed for the safety and comfort of a great superliner. No modern hotel on land, no community, could boast such extensive electrification as had been planned for this ship. Merely to supply these auxiliaries, six additional turbo-generators, totalling 18,000 electrical horsepower, had to be included in the plans.

When the *Normandie* is ready for her first crossing, she will represent not only the triumph of the electric ship but also the most complex and complete utilization of electricity for human service in existence today. *(Continued on page 108)*

One of the *Normandie's* four generators. Combined, they are capable of furnishing more power than all the stations in five of our states. They will supply current to the largest motors ever built



New Triumphs of Transatlantic Electric Ships

(Continued from page 17)

To see at first hand some of the wonders of this latest trend in merchant shipbuilding, the writer recently made a tour of inspection of the turbo-electric *Queen of Bermuda*, the most modern and luxurious electric liner in present service.

Under the guidance of engineers and electricians, I saw propellers being put through their motions, gyro-compasses spinning, water-tight doors clanging shut in response to distant signals, cargo being hoisted, food steaming in giant ovens, the great rudder responding to invisible impulses from the bridge. The maze of steam piping of the steamship of a few years ago was conspicuously absent. Wherever there was light or heat, or work being done, or delicate devices operating for the ship's safety, electricity, conducted through copper wires, was in command and doing all the work.

IT happened that my visit was on the morning of sailing, when deck officers and engineers were preparing to give the motors a turn-over, to make certain that the propelling machinery was in perfect order.

Before an immaculately groomed main switchboard, deep in the engine room, the chief electrician and the staff chief engineer, with several white-overalled assistants, stood waiting at attention. Suddenly, over the soft purring of idling turbines, came the clanging of the bridge telegraph: port outboard propeller—slow—ahead!

Immediately an assistant had answered the signal, an electrician was slowing turning one of the two large nickled wheels which, through an intricate automatic relay system, control the entire operation of the turbines and propelling motors. In a matter of several seconds, turbines had been speeded, the port outboard motor slowly turned over, and a signal returned to the bridge that the operation had been completed.

In rapid succession, the telegraph clanged orders for each of the four propellers. Smoothly and rapidly, the orders were carried out. By a slight throw of a smaller wheel, the propellers could be put into reverse. So simple was the manipulation of the machinery of this electric ship, that complete control of her 19,000 horsepower could, in an emergency, be accomplished by a single man operating the controls.

I was soon to find out, however, that the marvellous electrical service of the ship did not end with the driving equipment. Electricity was functioning everywhere.

In the engine rooms, electric oil pumps, ballast pumps, bilge pumps, water pumps, stand ready for instant duty. Water-tight doors in the bulkheads are opened and shut by electricity. Huge electric blowers keep these rooms constantly at a comfortable temperature. Hydro-electric steering gear smoothly maneuver the rudder. While all the ship's refuse is digested and expelled under the water by an electric sewerage system that insures sanitary conditions.

TIME throughout the ship is told by electricity, food is cooked, cabins heated and cooled, perishables refrigerated, clothing and linens laundered. Electric cranes, capstans, and winches haul lines and anchors and lift luggage. Lifeboats are raised on electrically-operated davits. An automatic fire alarm system flashes instant warning of excess heat in any part of the ship, and electric fire-fighting equipment is immediately available to quell a possible blaze.

Besides the usual radio telegraph and telephone apparatus and radio compass, the electrical equipment of this new ship is finally completed with a gyroscopic compass, electric bridge telegraph, electric fathometer, electric log, and the very latest electric eye of Macneil which is capable of detecting objects through miles of fog.

Strangely enough, the electric ship, which is now being brought to such a high state of perfection by European shipbuilders, was pioneered by American engineers and first proved practical by the United States Navy and Coast Guard. Nikola Tesla, inventor of the motors which make electric drive possible, was one of its first strong advocates. William LeRoy Emmet and Eskil Berg, engineers of the General Electric Company, went far to make the electric ship a reality.

THE first argument of these men was speed reduction between turbine and propeller. For highest efficiency, turbines had to be designed for speeds ranging from about 1,000 to 3,000 revolutions per minute. Propellers, on the other hand, wasted power extravagantly when whirling at more than, say, 300 revolutions. By coupling the ship's turbines to electric generators, and then conducting this power through copper wires to motors connected to the propeller shafts, any speed ratio desired could be easily attained, and both propellers and turbines could be operated at maximum efficiency.

But this was not the only talking point of the pioneers. Mechanical gearing had already been developed which could perform this service with less weight and at less initial cost. Electric drive, they insisted, possessed a number of other advantages which could not be matched by any other type of ship-propelling equipment in existence. One was rapid reversing of the propellers, at the mere throw of a switch. With ordinary turbine drive, reversing was a complicated feat requiring a transfer of steam from the ahead turbines to special astern turbines.

Another advantage was the possibility of cruising at slow speeds, when desirable, with merely a half or a quarter of the turbo-generating plant in operation, reserving the entire plant for extreme bursts of speed. A factor of economy in ordinary runs, this advantage might prove vital in case of a turbine breakdown at sea. Instead of dragging a dead propeller through the water, the disabled turbine could be completely shut down and all the propeller motors operated from the remaining turbines.

Despite the theoretical advantages, this type of propulsion was persistently turned down by both merchant and naval shipbuilders until 1913, in which year the U. S. naval collier *Jupiter* was equipped with a 6,600-horsepower plant as an experiment. The *Jupiter* proved so economical and trouble-free in her trials that five years later electric drive was chosen for the great dreadnaught *New Mexico*, and subsequently for every first line battleship of the United States that has been constructed since.

BY 1927, with the commissioning of the giant aircraft carriers *Saratoga* and *Lexington*, the United States Navy could boast electrically-driven ships faster and more powerful than any other large ships in the world.

Adding to the remarkable experience of the Navy that electric ships were unusually rugged, easily handled, and could be built to stupendous powers, the Coast Guard introduced an innovation which was to revolutionize the whole trend in design.

Although Captain Q. B. Newman, then chief of engineering, was certain that for the strenuous and hazardous duties of Coast Guard cutters, electric drive was superior to all others, he was confident that properly designed synchronous motors could spin the propellers more efficiently than the induction motors used by the Navy. Synchronous motors were lighter and cheaper for a given horsepower. His decision to have synchronous drive installed in the little cutters *Tampa*, *Haida*, *Mojave*, and *Modoc*, which were put into service in 1921, set an example which has been followed by the present fleet of electric merchant ships.

The first important vessel of this fleet was the palatial, 20,000-ton *California*, of the Panama Pacific line, put into service in January, 1928. By the beginning of the next year, two sister ships, the *Virginia* and the *Pennsylvania*, were operating on the same run and also electrically powered.

Inspired by the success of these ships, Great Britain built the *Viceroy of India*, which introduced electric service to the long run between England, India, and Australia. In the succeeding five years came the *Morro Castle* and the *Oriente*, the *President Coolidge* and *President Hoover*, the *Strathnavar* and *Strathaird*, and finally the new *Monarch of Bermuda* and *Queen of Bermuda*. At the present writing, the electric ship total has climbed to more than 1,200,000 horsepower.

The electrification of the *Normandie* comes as a climax to a meteoric development. Electric drive was chosen for most of the present ships because of some peculiarity of their runs, such as the necessity for long periods of slow speed cruising, or tortuous channels through which extreme maneuvering qualities are essential. The fact that the largest ship in the world has chosen this means of propulsion merely for achieving greater speed, comfort, and reliability across the Atlantic may signify the beginning of a major revolution in shipbuilding.

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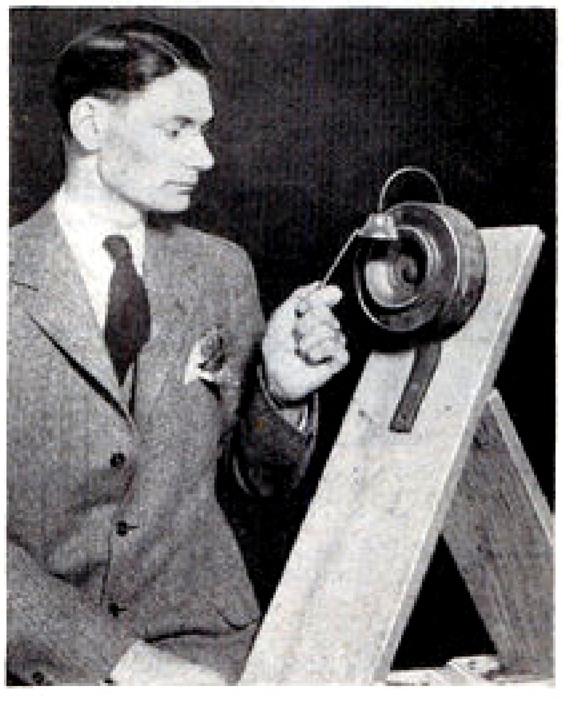
First Telephone Used to Help Escaping Slaves



America's oldest telephone, pictured here, was used before the Civil War by abolitionists who helped negroes escape. It consisted of a wire attached between drumlike boxes containing diaphragms. A ringing bell announced that a message was to be sent.