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## *Building a German Ocean-Greyhound*

### *How the Swiftest and Most Costly of All Ocean Steamships Was Built*

STETTIN, Germany, is famous for the greatest shipyards on the European continent. One visiting the Vulcan works in April of this year might have seen nine huge vessels in course of construction, seven yet on the ways, and two in the water. Of the nine ships, seven were for German companies— one of them a ship of the line for the German navy. The other two were a cruiser for Russia, and the "Yakuma," then just completed, for Japan. Of the German liners, two will be the greatest ships in the world, with a single exception, and will both have a greater speed than any other merchant ship. These splendid vessels, although intended for the Atlantic passenger service, to be fitted with a degree of luxuriousness hitherto unapproached, are all built under the requirements of the German navy. On the deck there are beds for the mounting of great guns, the rudder and screws are especially protected from the possible harm of shots, and apparatus is provided for steering below decks in case the upper works are carried away. Guns are ready at Hamburg or at Kiel, the crews are already organized; and in a fortnight, should the Empire need them, these peaceful passenger ships could be made terrible engines of war.

Two years ago there came from the Vulcan works what was then the largest and swiftest of all ocean steamships, the "Kaiser Wilhelm der Grosse." Prophets of evil predestined these ships to failure. In vain. The great success of the "Kaiser Wilhelm der Grosse" did more than any other one thing, perhaps, to establish the world fame of the German shipbuilder. Hardly had she been well tested when a still greater and still swifter ship was planned—the "Deutschland," recently in commission. The "Deutschland" is not so long nor quite so broad as the "Oceanic," so recently from the yards of the Irish builders at Belfast, but she will be next to her in size, and much swifter.

On the ways of the Vulcan works there is a long brown spine of steel, knobbed with rivets and "almost ready for the ribs. It is the keel of an unnamed ship which will be as large as the "Deutschland," and another is being planned to surpass the "Oceanic." A few years ago builders said confidently that the limit of size had been reached; now there is none who would venture to name a limit.

The time has come in shipbuilding when the addition of half a knot of speed is an epoch. The builder is so hemmed in and set about with problems that the half knots beyond twenty-two—and there are only a few twenty-two-knot merchant ships—mean a vast outlay of money, time, and skill. And yet these fractional knots are paying investments. A vessel that steams, say, 565 miles a day, while her nearest rival makes only 502 miles, will arrive in New York from Cherbourg nearly a full day ahead—and a day in the life of a man whose minutes are counted in hundreds of dollars is not to be despised.

It is probable that if a great steamship company should order a 750-foot ship, to make thirty knots an hour, the builders would take the contract—eagerly, too. But it would be in a spirit of solemnity. The steamship companies are not ready, however, to go forward so rapidly as that; the money involved is too great. Yet in the "Deutschland" they have built a

vessel 686 feet long, sixty-seven feet broad, and forty-four feet deep, with a contract speed averaging at least twenty-two knots (about twenty-six miles) an hour during the entire voyage, and with a probability of twenty-three knots or more an hour. In order to force such an enormous mass of steel, machinery, and coal through the water, the builders must of necessity construct engines such as no other ship ever had—indeed, the greatest engines in the world, either on land or on sea. It requires a 33,000 horse-power to drive the "Deutschland."

The greatest German warship, the "Kaiser Friedrich III," has only 18,000 horse-power; the "Oceanic," the greatest of ships in size, has only 27,000 horse-power; the "Campania" has 30,000 horse-power. It was therefore unknown ground that the Vulcan builders covered when they undertook to build the world's greatest engines. But there was no uncertainty about it. Indeed, in shipbuilding almost everything depends on experience. The builders knew to almost the last detail just what was necessary to the construction and operation of such enormous machinery: the strength of every bit of metal; the sizes of the parts that would give the greatest efficiency, and yet occupy the smallest space; the proper location in the ship of the vast weights of the boilers, the coal bunkers, and so on—all of these facts had been established by years of experience with smaller craft. It required the continuous work for six months of over a score of draughtsmen to make the plans, to say nothing of the greater work of the men in whose brains the beautiful lines of the ship were first traced, and who had planned the engines and solved to a nicety those wonderful problems of strains and of vibration and balance, a single mistake in which might have ruined the entire creation.

As in other branches of art, the shipbuilder must work within certain circumscribed limits. For instance, if he could make his vessel of any depth, he might build much larger, and there would be practically no limit to his speed—forty knots would be almost as easy as twenty-three. But he must construct his ship so that it will float into the harbors at New York and Liverpool and Hamburg, where the channels are hardly beyond thirty feet in depth. At the same time, if he would have her make a high speed, he must fit her with enormous engines; and yet if his engines are too large, his vessel will not carry enough coal to get her across the Atlantic and leave any room for passengers. If he increases breadth to make her carry a larger load—in other words, if he makes her "tubby"—he cannot drive her through the water at the required speed. On the other hand, if he makes her too long in proportion to her breadth and depth, she will break her back with the enormous weights which she carries and the thrust of her machinery. These are only a few of the difficulties with which the builder must wrestle, but they will serve to indicate faintly the delicacy and intricacy of the art—the necessity of striking just the proper proportions of depth, length, breadth, weight, so that the vessel will derive the greatest possible speed from the work of her engines.

After these problems of size and proportions are settled, there is the further difficulty of the balancing of the great ship. Here are engines and boilers weighing thousands of tons; here are bunkers which must be loaded with other thousands of tons of coal; here are hundreds of tons of other machinery, water-tanks, cargo, and so on. They must all be arranged in the long, narrow shell of the ship that she lists neither to right nor to left, and so that throughout her whole 700 feet of length, more or less, she never sinks more than a few feet deeper at one end than at the other. Then there is the problem of preventing the vibration of the propellers as nearly as may be from shaking the ship; of ventilation, and of providing strong draughts of air to the furnaces forty or fifty feet below the upper deck. Then there are other handicaps. The marine insurance companies—the Lloyds— must be placated to the last degree, for their men are on hand to watch every step in the building of the ship. She must conform, for instance, to the hundred and one rules of safety—her forward ribs must be especially strong to resist ice or collision; she must have so many pumps, so much fire-

fighting apparatus, so many water-tight compartments, and so on, else insurance cannot be obtained for her. Next, there are two governments to step in and make further regulations which must be obeyed. Few people realize with what jealousy a government watches its shipbuilders to see that proper accommodations are made for passengers and crews, and that the vessel is provided with safety appliances. The laws of Germany on this subject fill a small book, and the regulations are iron-clad, even to minute details. These provide for safety and comfort of passengers and for the possible use of the vessel as a warship. When all the German regulations are complied with, the American laws go still further, and demand hand fire-pumps, and a drifting anchor so that the ship may be steered if she loses her propellers and her rudder.

The casual visitor at a great shipbuilding establishment is rarely aware of the importance of this preliminary work in which the genius of the supreme craftsman has its keenest expression. He sees a few absorbed men in a loft, bending over desks and drawing-tables or making computations. They are not particularly impressive, especially when his eyes still see green from the light of great forges and his ears still ring with the thunder of sledges. And yet it is here that the ship is first built—finished to the last rivet in plan and blueprint before the first block of the bed is laid in place. A score of men, directed by the brains of the master engineers and designers, have created a ship in six months which will require the labor of 1,500 men for nearly two years to body forth in steel.

The River Oder at Bredow is only a narrow stream without tides or perceptible current. When we saw it first, the water was a murky brown, blotched with bits of rotten ice. Where the Vulcan works spread along its shore, the bank rises at a gentle slope, and here stands the scaffolding for seven ships. So narrow is the river that three of these cradles have been placed at a sharp angle to the water in order that when the greatest ships are launched they may not crush into the opposite bank. A ship's scaffolding at a distance resembles a gigantic basket, one end of which rests in the edge of the water, while the other reaches high up on the bank. On nearer approach the sides of this basket resolve themselves into an intricate maze of timbers of enormous proportions. Here the ship is born. The interior of the basket has been cunningly fashioned by the artificer until it follows the lines of the future vessel— a sort of huge wooden mold. At the bottom runs a long, low ridge of stout timbers, called the bed, sloping down to the water edge. This is to support the backbone or keel of the ship.

In one of the cradles the keel pieces of a new warship had just been laid. A crew of riveters were at work fastening the vertical keel pieces to the horizontal keel. Imagine a machine as tall as a man and having the shape of your thumb and finger when fashioned in the form of a C. A boy at a hand forge throws a bursting red rivet. Another workman seizes it with tongs and drops it into a hole in the ship's spine. There is a shout and a quick signal; the giant thumb and finger of the machine close in and come deliberately together, one at each end of the rivet. There is no sound; but when the machine opens again and draws away, the lower end of that rod of iron, as thick as a man's two thumbs, has been crushed like so much putty into a rounded head. This rivet shrinks in cooling, and draws the beams of steel together until they are like one solid piece. And that is the daily work of the pneumatic riveting machine.

The ribs of the ship come from the mills in long, straight, L-shaped beams which must be bent to the delicate curves of the ship’s body. A wide iron floor, full of equidistant holes; a furnace sixty-five feet long—of a length great enough to hold and heat the ship's longest rib; a force of workmen waiting for the furnace door to open—that is where the ribs are shaped. The master workman has pegged out the curve of a rib by fitting iron pins in the holes of the floor. When the signal is given, the furnace door bursts open, emitting a blinding glare of light and fervid heat. A single dark figure, black against the glow, grapples with huge pincers

in the furnace mouth; the workmen, but a moment before standing inert and lax of muscle, now bend their shoulders to a hawser, and the bar of metal, so hot that its edges bear no definite outline, is dragged forth. With infinite deftness and fearlessness, with swiftness and yet without hurry, this flaming bar is crowded against the pegs of the curve, the workmen smiting it with hammers, driving other pegs, straining at levers, and smiting again. Once the steel wrinkled in bending like a blotting pad, as if reluctant to submit. In two minutes' time a simple L of iron had become a ship's rib. curving in the shape of the hull, and ready, except for rivet holes, for service.

In ways just as fascinating the steel plates which are to form the skin of the ship are fashioned. Here is a pair of enormous rollers of steel, like the rollers of a laundress's wringer. Between them a plate of steel as large as two dining tables is fed, leaving part of it sticking straight out. Just at the proper moment a third roller rises from below, pushed upward by the resistless force of hydraulic pressure. When it reaches the plate, we start back, expecting to see the cold steel snap like glass; but, instead, it bends upward as easily as though it were pasteboard, until it is almost L-shaped. Then the noiseless but mighty roller that has done the work slips back again.

Around the head of each cradle at the Vulcan yards there is a cluster of machines covered with umbrella-like canopies of corrugated iron. There are thick, saw-like shears that trim the steel plates, three-quarters of an inch thick, as a little girl would snip the corners of a bit of calico cloth. Other machines there are that bore endless numbers of rivet holes in beams, girders, and plates; others countersink these holes; still others level off the edges of the plates, and then a huge crane lifts them over into the scaffolding, dangles them, though they weigh ten tons each, just where they are to be placed, and the workmen fit and fasten them in.

One year from the time that the keel of the "Deutschland" was laid, her hull was finished. It loomed huge and brown through the scaffolding which still protected and supported it, and it was ready to take the sea. In January, 1900, the Emperor came up from Berlin with a brilliant guard of officers. Count von Bulow pulled the silken cord, champagne was spattered on the great ship's stern, and she shot forward into the water. This shell of steel weighed upward of 9,200 tons, and had cost all of a million and a quarter of dollars. There were yet to be added the engines and the fittings, which would bring her total weight to over 16,500 tons, and her total cost to over $3,000,000.

In a great shipyard one tool stands supreme in importance over all others. It goes by the highly expressive title of "shear-legs," a kind of crane. From the top hangs heavy chain tackle which will lift a hundred tons—200,000 pounds—as easily as a boy would pick up a penny. And this is the way all of the heavy interior fittings— the engines, pumps, boilers, stacks, masts, and so on—are placed in the ship.

With Captain Albers, to whom fell the honor of taking the "Deutschland" on her first voyage, we went up the broad plank gangway which led from the river bank to the promenade deck of the vessel. Fifteen hundred men were there at work on her, hammering, sawing, planing, fitting, and yet so huge was she that the force seemed small, and there were areas where not a man was to be seen.

These men of the Vulcan works possess their own peculiar interest to the American visitor. They are not quite so foreign as he expects; he sees the strong cousinship of sweat and grime and strength. But for a little more, perhaps, of stoop and stolidity, a little more of patience in their faces, these might be the men of an American shop. There is work done here by strength of shoulder, heaving and hammering and lifting, that in America would be done by steam or electricity; and yet as long as human muscle is cheaper than steam, so long will it be employed. In dress, the German workmen strongly resemble the American, except in their shoes, many of which are heelless, with their wooden soles, the clacking of which on cobble

pavement and iron flooring gives a distinctive and unaccustomed sound to the works. There is also the unfamiliar German blue blouse, falling from a yoke at the shoulders and hanging loose around the waist, which some of the workmen wear. The German works longer hours and earns much less money than the American; but while food commodities are higher for the most part in Germany than in the United States, he lives much more cheaply than the American because he is willing to live on poorer fare and in homelier quarters. He does not, as a rule, save money, for he must have his beer and his lottery ticket; but he pays regularly to the Sterbekasse (death-cashier), so that he may be buried decently when he dies. And yet he is industrious, skillful, painstaking, and even duly ambitious.

One is impressed with the comfort which the German workman gets from his meals; indeed, he seems to be eating all the time. Before he leaves home in the morning he has black coffee and rye bread. At eight o'clock he stops work for a few minutes for more black coffee and a few thick slices of rye bread with sausage or cheese. And then comes the long nooning of an hour and a half. That is a sight to dwell upon—when the thousands of workmen pour from the Vulcan yards at noon. For fifteen minutes before the whistle sounds, plump and comely women in short skirts, boys and girls and old men, have been gathering with, baskets and bottles; and at the striking of the hour they all rush forward into the yards and are swallowed up in the outward current of men. A little later the men may be seen sitting along the sunny sides of neighboring buildings, each with a woman beside him, eating his rye bread, in silence for the most part, and yet with contentment. Again at four o'clock in the afternoon the whistle blows, and the men set their little blue pots in the edge of the forges and bring out a thick slice of bread covered with lard. This pause of fifteen minutes is called vespers; and the sudden lull of the clangor of the great works, the quiet, and the comfort of the men sitting thus at the close of the day, recall our own meaning of the word vespers. At night, after reaching home, there is a fifth meal of coffee, smoked fish, rye bread, and possibly a bit of cheese; and after that, if there are pfennigs left, beer. It is eleven hours or more of work, and after that the deadness of sleep; then work again, for there are always many mouths to feed in a German family.

The space over the "Deutschland's" engines still gaped wide open at the time of our first visit, suggesting from the upper deck an enormous grimy pit. The cylinders for the main engines were still open at the top, the largest being nearly nine feet in diameter, with a weight of forty-five tons, larger than the funnels of many a large steamer. Having gone down three stories of decks, we descended a ladder fully sixty feet long into the depths of the vessel. One may read indefinitely the cold figures relating to the size of the engines and boilers in an ocean steamer, and still he will not realize their greatness. But let him get down, pigmy-like, among the machinery itself, and look up into one of the great twin engines, and he will receive an impression of size and power such as he will never forget, especially if he visits this greatest of all engines. There are 128 cylinders in the engines, and the ship has nearly a third of a mile of railroad track for carrying her coal from the bunkers to the furnaces.

It was interesting to hear Captain Albers explain how the great ship was balanced—the engine just aft of amidship, boilers forward, fresh water in great tanks on each side just balancing each other, coal in the bunkers around the boilers, so that in case of war the enemy's shot could not pierce to the ship's vitals—and how water could be let in from the sea to this or that compartment to balance the coal burned away. This was all interesting, but we felt more deeply impressed by the strange, cold, dark, resounding hole in the extreme stern and at the bottom of the great ship, which we reached through a door in a steel wall. Here in silence, and almost without human attention, works the mighty rudder arm of the ship. It travels in a cogged quadrant, and it is so big that the engine which runs it is perched on top of it, and rides back and forth as the rudder answers the touch of the steersman's finger on the bridge, a fifth of a mile away.

The “Deutschland” may be said to be twenty-one ships in one. In passing up the vessel from stern to stem, we crept through numerous gangways of steel, the doors of which could be instantly closed, and so screwed on rubber battens as to be impervious to both water and air. In case of an accident at sea, two men spring instantly to each of these doors and close them fast; and the ship, a moment before a single great apartment, becomes twenty-one separate rooms, having no connection below decks. If one, or two, or even five of these compartments fill with water, the ship will still float with the buoyancy of those remaining. And each compartment has its own pumps and its own means of escape for passengers, so that even though there is a yawning hole in the ship’s bottom, she may yet sail safely into port. The “Deutschland” also has two bottoms. The real bottom of the ship lies from four to eight feet beneath the false bottom; both are almost equally strong, so that if a hidden reef bursts through the outer plates, there will still remain a firm, dry inner bottom to keep out the water. This wide space—it might be called the subbasement of the vessel—has also its own separate compartments into which water can be let at will to balance the ship if she does not ride evenly.

After the ship’s engine s and boilers, perhaps the most impressive pieces of mechanism are the shafts, which reach from the engine out through the stern of the vessel, where they drive the propellers. In many respects, also, these shafts are the most difficult of any part of the ship to produce. They are made of a special, high-priced nickel steel. Each of them is 215 feet long—longer than many good-sized ships, and twice as large around as a man’s body. They must needs have strength to drive such a weight of steel through the water at such a speed. Each bears on its tip end outside the ship a screw propeller of manganese bronze, each blade of which weighs four and one-half tons. They are the work of that great German, Herr Krupp of Essen, and they represent the acme of the art of steel-making. Upon its arrival from the mills, the shaft is in five parts, and it looks rough and coarse. But the workmen at the Vulcan fit the pieces one by one into an enormous lathe, and plane them down as a cabinet-maker would turn the leg of a chair. We saw such a lathe at work, and picked up fine shavings of nickel steel, curled and strong as a clock spring.

Such a vessel as the “Deutschland” would have been an impossibility a few years ago, not only for mechanical reasons, but because she could not have been made to pay. The “Deutschland” carries no freight and almost no express. She is wholly a passenger and mail steamer; and she is now a possibility because people are richer, and every year more of them travel back and forth between Europe and America. And to make such a speed as that indicated for the “Deutschland” means that so much room is required by the power-producing machinery and coal that there really is not any space for a large cargo. But for her purpose—that of carrying 1750 passengers across the Atlantic in the least possible space of time and with the greatest luxury — the “Deutschland” is the perfection of the shipbuilder’s art.

Some few facts about the new ship may help to a realization of what a great modern ocean liner really is, and how absolutely complete she must be made in every particular. The “Deutschland,” for instance, has a complete refrigerating plant, four hospitals, a safety deposit vault for the immense quantities of gold and silver which pass between the banks of Europe and America, light kitchens, a complete post-office with German and American clerks, thirty electrical motors, thirty-six pumps, most of them of American and English make, no fewer than seventy-two steam engines, a complete drug store, a complete fire department, with pumps, hose, and other fire-fighting machinery, a library, 2,600 electric lights, two barber shops, room for an orchestra and brass band, a telegraph system, a telephone system, a complete printing establishment, a photographic dark-room, a cigar store, an electric fire-alarm system, and a special refrigerator for flowers. And she is one of the two great foreign liners having four funnels; the other is the “Kaiser Wilhelm der Grosse.” That is the way that these two leviathans may be known from all other ships. She also has the usual

two masts. They look stubby enough when mounted on her vast bulk, and yet they are so tall that the “Deutschland” could not get under the Brooklyn Bridge at New York, and so large around that while they are building, a man lies inside of them driving rivets. When we last saw the “Deutschland,” great dabs of red and white chalk marks covered her steel sides from stem to stem. Some German workman, with feeling for the monster on whom he had so long been toiling, had scrawled in big letters, “Gluck auf”—“Good luck!”