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A NEW TYPE OF GREAT LAKE ORE STEAMER.

By DAY ALLEN WILLEY.

EVER since the shipments of iron ore from the Superior ranges to American furnaces have been made on

service on fresh water, either in America or any other part of the world. Such is their draft when completely loaded, that they could not enter the ports on Lake Erie where the bulk of the ore is discharged, for the capacity of each is nearly 15,000 tons. A clearer idea of their great size can be gained by comparing

hold. The dimensions give the "Baltic" a freight capacity of 28,000 tons. Each of the four lake vessels referred to, however, will carry over 50 per cent of the tonnage of a ship the size of the "Baltic," though they are but 569 feet over all, 56 feet beam, and 31 feet depth of hold. As the vessels of the 1905 class are unloaded by such mechanical systems as the fast plant, the bridge tramway, and the Hulett shovel bucket, it would seem that the shipbuilders had reached the highest standard in the type of ore carriers; but even these steamers require more or less manual labor, since none of the mechanical unloaders will "clean up" the cargo, owing to the design of the hold. In removing the ore from one of these great floating tanks, for such they are, from five to ten per cent of the cargo usually remains. This must be shoveled into piles or "trimmed" by hand to place it in the reach of the mechanism. The time consumed in this labor equals a third of the time required to remove the entire cargo. The expense to the owners when a vessel is lying at the dock may be estimated, when it is stated that the ore carrier of the dimensions of the 1905

AN ORE STEAMER OF THE LATEST TYPE UNLOADING AT THE DOCKS.

an extensive scale, vessel builders on the Great Lakes have been trying to solve two problems. One is the construction of the largest ore carrier which can be built to enter the harbors where the ore is unloaded. The other problem is to design a vessel which can be unloaded in the least time and at a minimum expense for labor.

It is due to the consideration of these problems that the construction of steel vessels on the Great Lakes has made such remarkable progress, especially within the last decade—not only in the increase in dimensions, but also in design. In 1905 four steamers were completed for the ore-carrying service, the combined capacity of which actually equaled the total cargo capacity of the whole fleet of lake steamers which were in service twenty-five years ago. It seems almost incredible, but the later types of vessels will carry a far greater tonnage than any other craft which has been built for

them with one of the newer cargo ships constructed for transatlantic service, such as those in the fleet of the White Star Line. The "Baltic" is the largest cargo ship afloat, measuring 725 feet 9 inches over all, 75 feet in beam, and 47 feet in depth of

THE HOLD OF THE "HOOVER AND MASON," SHOWING THE TRANSVERSE ORE HOPPERS.

TWO 12,000-TON ORE STEAMERS AT THE DOCKS, DULUTH, MINN.
A NEW TYPE OF GREAT LAKE ORE STEAMER.

class averages nearly \$300 per day for wages, insurance, fuel, and other outlay, even when moored at the wharf. As this freight is transported at a lower cost than any other cargo in the world when reckoned by the ton, it is necessary to reduce operating expenses to a minimum; and as already indicated, a considerable loss is incurred when it is necessary to employ hand labor for trimming.

Apparently, however, this problem has been solved by the construction of a new type of vessel, which may be called a radical departure in marine construction. One of the craft referred to has been in service for several months, and it is claimed that it can be loaded and unloaded at a smaller cost per ton of cargo than any which has yet been placed in commission on fresh water or salt water. In designing this type of vessel four points were taken into consideration: To construct a stronger vessel without increasing the weight of the hull, to have the entire cargo accessible immediately under the hatches to grab buckets, to minimize the floor space to be cleared up, to bring up the center of gravity of the cargo as far as possible. It is obvious that by this method of construction the work of unloading by mechanical means can be greatly facilitated, but there are several other advantages, one being that the hull is greatly strengthened, since the framework of the hoppers forms transverse bulkheads, which reinforce the upper portions of the craft. The arrangement of the hoppers is a new feature, and a radical departure from the latest type of construction. It permits a return to the standard

would adhere to the plates forming the inclined sides, and that the removal of this ore would necessitate the employment of shovelers. This difficulty has been overcome in the manner of loading. The spout of the chute from the dock pockets, instead of being directed against the sides of the hopper, discharges over its center, forming a conical pile, the large pieces falling by gravity to the outside circumference of the cone and resting against the hopper sides, while the fine ore settles in the center. As the ore is unloaded these lumps slide down the inclined sides, carrying the fine ore with them.

In the "Hoover and Mason" the hoppers form the tank top of the ship's water bottom, which is another departure from the more recent double-hull construction on the Great Lakes. The deck is supported by beams resting on the ridges of the hoppers. These come midway between the hatches and extend the full width of the ship, but from their location they do not interfere with the cargo in any way. Beams on either side of the hatches run continuously fore and aft of the ship, forming an excellent stiffening of the top chord of the truss formed by the sides of the vessel. The frames or ribs, instead of continuing unbroken into the water bottom, stop at the hopper tank top, to which they are attached, and continue again at a point inside the hopper. This design was necessary to secure absolutely tight construction of the water tank, and has not reduced the general strength of the ship's construction.

Since the vessel was launched, she has carried on a

though it is doubtful if any of larger dimensions will be built on the Great Lakes, owing to the depth of water in the ship canals and in the harbors of the unloading ports.

It is interesting in this connection to note the rapid expansion of vessel building on the Great Lakes despite the large fleet which has been completed in the last ten years. During the last fiscal year, no less than 204 steamers and barges, aggregating 265,271 tons, were built on the lakes—63 per cent of the total marine construction of the United States during this period. In seven shipyards on June 30th there were planned or under way 32 vessels, aggregating 175,000 tons.

THE GREATEST ALTITUDES ATTAINED BY UNMANNED SOUNDING BALLOONS.

By DR. A. WAGNER.

SINCE the year 1900, in pursuance of an international agreement, balloons have been sent up monthly from most of the principal meteorological stations in Europe, for the purpose of investigating the conditions and phenomena of the atmosphere. Information of especial value has been obtained through "sounding balloons." These are small unmanned India rubber balloons, which are filled with hydrogen and carry instruments which automatically record air pressure, temperature, and relative humidity. The pressure, from which the height attained can be computed, is registered by a Bourdon tube, the temperature by the bending of a thin bar made by soldering together strips of two metals having very different coefficients of expansion, the relative humidity by the increase in volume by a hygroscopic mass of hair.

Most of these unmanned balloons attained heights between 6 and 10 miles, and a few ascended more than 15 miles. The greatest elevation, 18 miles, was reached by a balloon set free near Brussels, on November 5th, 1908. At this great elevation the air pressure was only $\frac{2}{5}$ inch, so that only $\frac{1}{76}$ of the mass of the atmosphere lay above the balloon. The balloon made a horizontal journey of 50 miles in 113 minutes.

As this ascension furnished a typical record of temperatures and humidity it will be described in detail. The temperature, which was 40 deg. F. at the earth's surface, decreased irregularly until a height of about 2 miles was reached. Below this level two reversals of the usual law of temperature were registered. The temperature rose from 39.6 deg. F. at an elevation of 623 feet to 42.6 deg. F. at 1,115 feet, and from 25.9 deg. F. at 4,986 feet to 34.2 deg. F. at 6,560 feet. Such inversions are of frequent occurrence in the lower atmospheric strata which are subject to terrestrial influences. In clear, calm nights an increase of temperature upward is found immediately above the earth's surface, owing to the effect of radiation in cooling that surface and the air in contact with it. A similar inversion often occurs above extensive and compact cloud layers.

Above the height of 2 miles the temperature falls very regularly as the elevation increases. In the ascension here cited, the thermometer registered 26.2 deg. F. at 1.9 miles, 6.1 deg. F. at 3.1 miles, —33.2 deg. F. at 5 miles, and —61.6 deg. F. at 6.2 miles. The lowest temperature, —89.7 deg. F., was encountered at a height of 8 miles. The height of the level of minimum temperature varies, according to the weather and the time of the year, from 5 to 8.7 miles, the minimum temperature itself from —40 deg. F. to —94 deg. F. Above 8 miles, in this ascension, the temperature increased very gradually with the elevation, becoming —84.6 deg. F. at 9.3 miles, —80.7 deg. F. at 12.4 miles, —80.5 deg. F. at 15.5 miles, and —80.3 deg. F. at the maximum elevation of 18 miles. A similar gradual increase of temperature upward is recorded by every balloon that reaches the great heights. No universally accepted explanation of this "permanent inversion" or "isothermal zone" has yet been given. It is probably caused by radiation of heat from the earth.

The relative humidity in the lower strata, in which the clouds are chiefly found, varies greatly with the weather, but at elevations exceeding 2 miles the air is nearly always very dry. In the ascension here described the relative humidity was 100 per cent at the earth's surface and 96 per cent at a height of 4,920 feet, which probably marked the upper boundary of the clouds. Thence it fell to 43 per cent at $1\frac{1}{4}$ miles and to 28 per cent at about 2 miles, and thereafter remained nearly constant up to the maximum height where it was 26 per cent.

In these balloon experiments the winds are studied by following the flight of the balloon with a theodolite and taking readings of altitude and azimuth at intervals. From these observations in combination with the records of the instruments attached to the balloon, the co-ordinates of the balloon's position at any instant can be computed and, consequently, as the balloon moves with the wind, the direction and velocity of the air current at any height can be determined.—Umschau.

BUILDING A BIG CARGO STEAMER, SHOWING THE BOTTOM HULL PLATES AND THE ANGLE FRAMEWORK ATTACHED TO THE KEEL.

hatch covers, for it is unnecessary to use the patent coverings requisite in the 12-foot centered boats. The arch construction of deck support has also been replaced by deck beams.

The "Hoover and Mason," which is the vessel illustrated in the accompanying photographs, is not as large as the vessels of the 1905 fleet referred to. Her dimensions are as follows: 524 feet over all, 504 feet keel, 54 feet beam, and 30 feet molded depth. The power equipment consists of a quadruple-expansion engine with cylinder diameters of 18, 27, 40, and 42 inches by 62-inch stroke, and Niclausse water-tube boilers, 9 by 13 feet, providing steam at 250 pounds pressure, with induced draft and chain grates. The hoppers are 24 feet wide at the top and 6 feet 9 inches at the bottom and have a height of 13 feet. The center of each is directly underneath the center of the hatch opening. The hoppers are built of steel plates, the bottom plates being $\frac{5}{8}$ inch in thickness to withstand the drop of the ore in loading, and are bent up at the sides, greatly adding to the strength of the general construction. The width of the flat portion of the hopper bottom was governed by the size of the largest shovels or grab buckets at the unloading docks. The angle of the sides of the hoppers is such as to incline the cargo to the center of each hopper, and make it easily accessible to the operation of the grab buckets. False plates from the shell of the ship run inboard between transverse hopper sides, completing the hopper.

One of the points made against the practicability of the transverse hopper construction was that the ore

single trip nearly 10,000 tons of cargo, the actual quantity being 9,841 tons. Owing to the design of the hold and its accessibility, the actual cost of unloading this quantity of material was but \$70—about seven mills per ton. Nowhere has such a record for the economical transfer of cargo been made.

The total tonnage of ore transferred by water from the Superior ranges during 1906 aggregated nearly 40 million tons. During 1905 the total quantity was 35 million tons. The United States Steel Corporation, in taking possession of the Hill ore deposits and other beds in the Superior region, has agreed to increase the tonnage mined year by year until during 1917 it will take out 8,250,000 tons, compared with 1,500,000 tons in 1907. Therefore, a fleet of vessels of sufficient capacity to carry at least 50 million tons during the season of navigation must be provided to transport the ore for this corporation and the other ore smelters. The expense of unloading this enormous quantity can be appreciated. Even estimating it at the minimum figures quoted, it would amount to no less than \$3,500,000. Consequently, the importance of having vessels which can be completely unloaded by mechanical methods is apparent. The "Hoover and Mason," it is understood, was constructed largely as an experiment, to determine if this model would be an improvement on the other types of craft in service. In all probability, a fleet of cargo carriers of this design, but of much larger capacity, will be built as a result of its performances; for steamers carrying as large a tonnage as the 1905 class can readily be constructed after this design, al-