ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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THE JAPANESE BATTLESHIP "SHIKISHIMA" was launched by the Thames Iron Works & Shipbuilding Co. on Nov. 1. This will be one of the most powerful warships afloat when completed. Her dimensions are: Length over all, 438 ft.; length between perpendiculars, 400 ft.; extreme beam, 75 ft. 6 ins.; depth, 45 ft. 2½ ins.; draft on 14,750 tons displacement, 27 ft. 3 ins. She will have a complete water-line belt of Harveyized nickel-steel armor 8 ft. 2 ins. deep and tapering in thickness from 9 ins. amidships to 4 ins. at the ends; above this is a 6-in. belt between the barbettes, extending to the main deck. The barbettes are 14 ins. thick, and the cross bulkheads, 12 ins. The engines are to develop 14,500 I. HP., and drive the ship at a speed of 18¼ knots. As armament she will carry four 12-in. guns in two barbettes; 14 6-in. rapid-fire guns; 20 12-pdr. rapid-fires; 8 3-pdr. rapid-fires; 4 2½-pdr. rapid-fires; 8 Maxim guns, and 5 18-in. torpedo tubes, 4 of the latter under water. Her coal capacity, however, is only given as 700 tons.

THE CRUISER "MARIA TERESA," abandoned in a storm on her way from Cuba to Norfolk, is now aground on Cat Island, in the Bahamas. The water is up to her between-decks, she has a list towards the damaged side, and is dismantled. Meanwhile the wrecking company's boats have gone to inspect her, and a court of inquiry is to be held to determine if her abandonment was justifiable. Later information gives little hope of her final rescue. The hull is badly strained and the engines and boilers seem to be immovably fixed upon the rocks of the reef.

THE DESIGNS FOR THE FOUR NEW MONITORS for which Congress appropriated $5,000,000 at its last session are to be materially changed as the result of recent action by the Navy Department. The prices at which the contracts for the vessels were awarded left so large a margin that it has been decided to build bigger and better vessels. The principal features of the old and new designs are compared as follows:

	Old.	New.
Displacement, tons	2,700	4,000
Coal capacity, tons	200	400
Main battery	2 12-in.	4 10-in.
Horse-power	2,400	3,200
Draft	12 ft. 6 ins.	14 ft. 6 ins.

The speed in the new designs will be 12 knots, as in the old.

THE LIFE OF MODERN NAVAL GUNS is commented upon by Com. Charles O'Neil, Chief of the Bureau of Ordnance in the Navy Department. The popular idea was that a heavy naval gun was out of service and dangerous after 100 rounds had been fired from it with service ammunition. As a matter of fact, in the war with Spain, some of our 12 and 13-in. guns have been fired 300 times, and are yet as sound as when they left the factory, and are free from serious impairment by erosion by gases. Of the smaller pieces, some have been fired 600 and 900 times, and they are still perfectly sound and are not eroded to any extent. The use of cordite hastens the erosion of the gun, but in the British Navy the gun is built with a core, which can be bored out and replaced when too much worn. Commodore O'Neil says that most of the guns now in use in our navy will only be withdrawn when they become obsolete; he thinks there is little danger of their being worn out in service.

MACHINE GUNS, says General Joseph Wheeler, proved their efficiency and value in the San Juan fight. The four guns used in the battery commanded by Lieut. John H. Parker, of the 13th U. S. Invantry, were the regulation Gatling model of 1895, firing regulation Krag-Jorgensen cartridges at the rate of 400 shots per minute each. He lost one-third of his men but drove the Spaniards from their trenches; and, at 1,500 yards, drove the gunners from a 6.4-inch Spanish gun which was trained upon them. This is probably the first time in warfare that a field gun of that caliber was silenced by machine gun fire. The Spaniards left their heavy gun loaded and admit a loss of 50 men in trying to fire that last charge. From July 4 to July 11 two Colt rapid-fire guns and a dynamite gun, throwing 4½ lbs. of explosive gelatine, were added to the Gatling battery. The dynamite gun fire had the effect of driving the enemy from his trenches and the machine gun played havoc with the fleeing men. Gen. Wheeler advocates the creation of an individual arm of the service to be known as the Gatling Gun Corps.

THE REPORT OF THE CHIEF OF ORDNANCE, General Flagler, for the last fiscal year, deals lightly with the late war with Spain. The expenditures of the Ordnance Department for the year were $29,858,783. From April to August the Department produced 250,000 sets of infantry equipments and 26,000 sets of horse equipments; and it met all the demands made upon it for small-arm ammunition. In answer to the criticism on the 45-caliber Springfield rifle used by many of our regiments, General Flagler says that while the single-fire Springfield was not so good as the magazine 30-caliber rifle, it was by no means as inferior as asserted. It fully met all the demands of an active campaign; the chief objection being the use of black powder in the cartridges. Smokeless powder is now being supplied for the Springfield rifle. General Flagler points out, as one of the lessons of the war, that 100,000 stands of arms should be procured at once, and the factories at Springfield and Rock Island should be equipped for turning out 2,500 stands per day; field and siege guns and equipments for an army of 500,000 men should also be held in reserve, as six months' time would be thus saved in an emergency.

EXPERIMENTS WITH FLYING MACHINES, for use in war, are to be conducted by the Board of Ordnance and Fortifications, and the sum of $25,000 has been appropriated for this purpose. The experiments will be carried out by General Greely, of the Signal Corps.

THE U. S. ARMY, IN THE WAR WITH SPAIN, reports Adj.-Gen. H. C. Corbin to the Secretary of War, numbered as follows: At the breaking out of the war the regular army consisted of 2,143 officers and 26,040 enlisted men. Under war legislation this number was increased to 2,332 officers and 56,365 enlisted men, including 5,365 men of the hospital corps. Regular army officers, to the number of 387, were appointed to different grades in the volunteer army. At its highest point the volunteer army numbered 8,785 officers and 207,244 enlisted men; in August, 1898. The aggregate strength of the whole army was thus 11,108 officers and 263,609 enlisted men. The casualties of the war were: 23 officers killed, 113 wounded; 257 enlisted men killed, 1,464 wounded. The total deaths from wounds and disease, to Oct. 3, were 107 officers and 2,803 enlisted men; or a little over 9 per 1,000 for the officers and 10 per 1,000 for the enlisted men.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Nov. 15, near Trenton, Ont., on the Grand Trunk Ry., as the result of a misplaced switch. The Montreal express, west bound for Toronto, took the switch and ran head on into an east-bound freight. The accident caused the death of 12 persons and seriously injured as many more.

A SERIOUS RAILWAY ACCIDENT occurred Nov. 10 on the Lehigh Valley R. R., near Wilkesbarre, Pa., as the result of a failure of the brakes. According to accounts the Buffalo express had orders to stop at a siding on the Wilkesbarre mountain to let an express from New York pass. On approaching the switch the brakes of the Buffalo express failed to hold the train, and it ran past the siding and collided with the approaching New York express. Five trainmen were killed and four injured. Newspaper reports state that the failure of the brake was due to an accumulation of wet leaves upon the rails.

A SALT WATER FIRE PROTECTION SERVICE has been established in Boston for a limited area. A line of pipe has been laid to a point near the post-office and a number of hydrants placed on it. Pumping is done by an engine on a fireboat. This, it is hoped, is the beginning of a comprehensive system of independent fire protection for the business district of the city. Such a system has been advocated for a number of years.

CARBIDE OF CALCIUM AND ACETYLENE GAS are not favorably looked upon by the Boston Manufacturers' Mutual Insurance Co. Its circular for October contains a "Caution" from which we extract the following:

> The purpose of this caution is to call upon each and all of our members not to make use either of carbide of calcium or of acetylene gas without full advisement and consultation at the time the proposed application is to be made. It may happen that the uses of these materials may be made safe. At present they are not deemed so. Therefore, the introduction of either, without the consent of the underwriters, would make an alteration in the condition of the risk not contemplated in the original contract.

A new method of lighting by kerosene oil is also mentioned in the circular, without giving its name, "because there are elements of merit in the process," and it is suggested that no new method of lighting be permitted even for experiment, without consultation with the insurance company.

THE COOLGARDIE STEEL PIPE LINE, in Western Australia, will be constructed by G. & C. Hoskins, of Sydney, and Mephan Fergusson, of Melbourne and Perth. There will be 328 miles of 30-in. steel pipe, with longitudinal joints made under patents owned by Mr. Fergusson, presumably after the plan described in our issue of June 9, 1898, as employed on the Adelaide water-works. The total contract price is about $4,990,000, or $350,000 less than the engineer's estimate. The plans for this work, which includes a storage reservoir and a pumping plant to deliver 5,000,000 gallons of water a day through the pipe line, were made by Mr. Chas. G. O'Connor, M. Inst. C. E., Perth, Western Australia. The work was described in our issue of Feb. 10, 1898, and the pipe line was discussed editorially in our issue of Feb. 17 and Oct. 13, 1898.

THE PURCHASE OF THE WATER-WORKS of the eight companies supplying London is recommended by the water committee of the County Council, providing parliamentary authority can be obtained. Early possession is advised, the price to be paid the companies to be determined by arbitration. Authority is also desired to connect the systems of the several companies, in order to prevent a repetition of the recent water famine in East London. The committee also recommends that parliamentary sanction be asked for introducing a new supply from Wales at an estimated cost of some $80,000,000. It states that the drouth of the last season proves that the late Royal Commission on Metropolitan Water Supply over-estimated the yield of the Thames and Lea and therefore were wrong in assuming that those streams would be sufficient to supply the Metropolis until 1931, at least without an unwarranted expense for storage. A second Royal Commission is now investigating the subject of a metropolitan water supply.

THE DAY-LABOR PLAN of carrying out municipal work, practiced of late by the London County Council, is reviewed by an earnest friend of the system, Mr. J. W. Martin, in "Municipal Affairs," for September. The cause leading the council to adopt this system, according to Mr. Martin, was a combination of contractors to maintain high prices in order to break down the wage-rules established by the council. These rules are termed by Mr. John Burns "the Magna Charta of Labor." They provided for trade union wages for all skilled labor and for a minimum of 12 cts. an hour for unskilled labor, whether employed by the council or by contractors. The trade union wages were already paid by many London employers, so in this particular the council merely placed itself in line with numerous private concerns. The rate of 12 cts. an hour for unskilled labor, Mr. Martin says, was above the market rate, but how much above he does not state. A while ago the moderates achieved considerable control in the council, and succeeded in "starving" the works department, but now the progressives are strongly in the ascendency, and Mr. Martin states the department is in danger of being overfed. The London "Contract Journal," we have observed, is opposed to the works department of the council, which has charge of all the work not done by contract.

SEWAGE DISPOSAL in nearly all the coast towns of England is by the discharge of the crude sewage into the tidal water, but generally with some storage during rising tides. Thus, of 36 towns, only 6 have any system of purification, 3 of these employing chemical precipitation, and the other 3 sedimentation, or screening. Of the 25 towns reporting some storage, this is effected in tanks only in 9 cases, the other instances being the use of enlarged sewers near the outlet, or simple backing up of the sewage in the main sewers by the tides. The above information is taken from a paper read at The Sanitary Institute, by Mr. H. Bertram Nichols, Assoc. M. Inst. C. E., and published in the London "Contract Journal."

THE METRIC SYSTEM is being considered by the Danish Diet, with a view of substituting it for the confusing Danish system of weights and measures. The general opinion is that the metric system will be adopted and the law establishing it will at once go into effect.

THE GOODWIN DUMP CAR.

The great amount of work being done by railways in the improvement of their lines, by means of widening banks and cuts, reducing grades, ballasting, filling trestles, etc., which involves the handling and dumping of large quantities of material, has led to the introduction of various types of dump cars, designed to effect facility and economy in the handling and dumping of this material. We have from time to time described a number of these cars, and the work which they perform, and in the present article we describe the most recent type of the Goodwin car, which has been used on some extensive works.

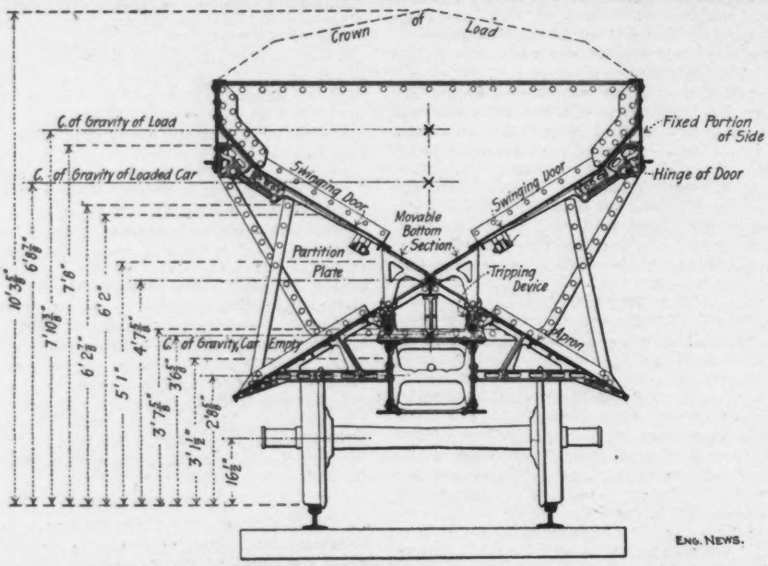


FIG. 1. CROSS SECTION OF GOODWIN DUMP CAR (SIDE DUMP ONLY).

Fig. 2. Car in Running Position.

Fig. 3. Cars Dumped at Side.

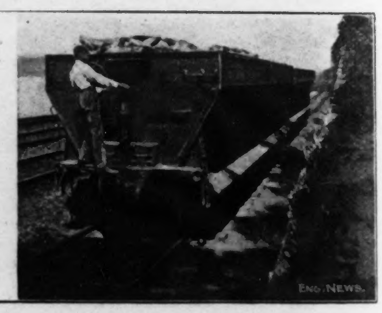


Fig. 4. Ready to Dump by Hand.

THE GOODWIN DUMP CAR. Goodwin Car Co., New York City, Builders.

This car was first patented in 1872 by Mr. John M. Goodwin, and has since been greatly improved on the lines of modern car construction. A four-wheel car of this design, built of iron, and having a capacity of 30,000 lbs., was exhibited at the Columbian Exposition, 1893, and in the past few years new and larger cars have been introduced. These cars are built by the Goodwin Car Co., 96 Fifth Ave., New York (and with a western office at 115 Dearborn St., Chicago), and we are indebted to that company for photographs and particulars of these latest cars.

The Goodwin dump car, as now built, is constructed entirely of steel and malleable iron, and will discharge the whole or a part of its contents between the rails or on either side of the track. There are two plate-girder sills, 21 ins. apart, c. to c., these girders being 18 ins. deep at the middle and 9¼ ins. at the ends. From each sill extends an inclined floor or apron, which serves to deliver the charge clear of the track and of the axle boxes. The space between the sills is left clear for dumping the load between the rails. The ends and end sills are supported by the plate girders, and the ends are connected by top side plates 18 ins. deep. A middle transverse bulkhead divides the car body into two compartments, which can be dumped independently. The bottom of the hopper or body is composed of swinging doors on each side, hinged at the top and inclined inward at a flat angle. These doors do not meet when closed, but rest on two narrow central movable sections on each side of a longitudinal shaft, about 15 ins. above the sills. By turning the shaft, one or other of these narrow sections is made to incline downward towards the apron instead of upwards, thus releasing the door on that side, which will then swing out to a vertical position, while the load slides under it and over the apron. The aprons are hinged on a line nearly over the wheels, and in order to dump between the rails, the inner portion is swung up and out, so that when the door is released it strikes against the raised apron, and the contents of the body fall between the sills. Some of the cars, however, are made to dump only at the sides, and these have no movable section to the aprons. The dumping and closing devices may be operated by compressed air or by hand power, and are under control, so that the load may be discharged slowly or rapidly, as desired, and while the train is in motion.

Fig. 5. Dumping Stone Ballast from Goodwin Cars, Illinois Central R. R.

The cars are mainly used for ballasting and filling, but are claimed to be suitable for carrying grain, coal, coke, ore, and other bulk freight. For grain service, an adjustable steel top is fitted, while for carrying coke a steel railing or crate is attached to increase the height of the fixed sides. These cars have been used for ballasting and filling on the New York Central R. R., the Pennsylvania R. R., the Lehigh Valley R. R., and the New York, New Haven & Hartford R. R., and on the lake front work of the Illinois Central R. R., at Chicago. They have been used for trestle filling in New York harbor by the U. S. Government, and on numerous large contracts for filling by different contractors, including the Globe Construction Co., of Cincinnati. Some of them are now in use on the excavation work for the great Jerome Park reservoir for the water supply of New York.

Fig. 1 is a cross-section of a side-dumping car, showing the positions of its center of gravity when loaded and unloaded. Fig. 2 is a view of a side and center-dumping car in position for carrying the load. In this view, A is the fixed portion and B the pivoted portion of the apron, C is the opening for dumping between the sills, D is the middle bulkhead, E the fixed portion of the top, and F F the swinging doors (pivoted below the sides E) which form the bottom. At the end may be seen the horizontal wheel for dumping the car by hand, while to the right of this is the air pipe and cock for dumping the car by air pressure. Fig. 3 shows the car after its load has been dumped from one side, the swinging doors now hanging vertically. Fig. 4 is an end view of the car, with the man ready to dump the load by hand. Fig. 5 shows the car in use for ballasting on the Illinois Central R. R. The broken stone ballast is being dumped while the train is running at a speed of eight miles per hour.

The cars are mounted on diamond-frame trucks of special design, having steel bolsters, and are fitted with hand and air brakes. They have also the Williams M. C. B. couplers, and a special design of draft rigging with double springs.

The principal dimensions of the cars are:

Length over end sills	35 ft. 11 ins.
Width over all	8 " 10 "
Height, rail to top of sill	3 " 6 "
Height, rail to top of car	8 " 6 "
Wheelbase, truck	5 " 0 "
Wheelbase, total	28 " 9 "
Wheels, cast-iron, 600 lbs.	2 " 9 "
Journals	4¼ × 8 ins. or 5 × 9 "
Carrying capacity	80,000 lbs., or 125,000 lbs.
Cubic capacity (with load crowned 10 ins.)	28.8 cu. yds.
Cubic capacity with top crates	37.0 "

STEAM OMNIBUSES OR STAGES for use in London are proposed by the London Steam Omnibus Co., which is now inviting subscriptions for its stock. The De Dion & Bouton system is to be employed, which system has been successful in some of the motor carriage trials in France. Coke or petroleum may be used for fuel. One omnibus has been put in use for experimental service, and is said to show great economy over the two-horse omnibuses which are so extensively used in London. The same company also proposes to operate similar vehicles on country roads and for long suburban routes, using either the De Dion & Bouton, the Panhard & Levassor or the Daimler (petroleum motor) systems. The cost of operation per month, including wages, cleaning, licenses, and all expenses, is estimated at $160 for the horse omnibus, $127 for the steam omnibus, and $99 for the petroleum omnibus; the cost for the two latter being 73% and 62% of that for the former. It seems very doubtful, however, whether the time has yet arrived for a business sufficient to give satisfactory financial returns.

PORTABLE PNEUMATIC RIVETERS IN SHIP-BUILDING.

At the recent New York meeting of the Society of Naval Architects and Marine Engineers, Mr. W. I. Babcock, Manager of the Chicago Shipbuilding Co., read a paper on the above subject. This company is equipped to drive every rivet in a ship by power machines, operated by unskilled labor; and Mr. Babcock gives a history of the development of portable riveting machines in shipbuilding at his company's works.

A beginning was made with a stationary steam riveter, with a horizontal ram and a 5-ft. gap, and it was used for such pieces of work as could be brought to the machine and handled by a chain hoist working on an overhead trolley. This riveter has driven 1,800 rivets in 10 hours, at a cost not exceeding ½ ct. apiece, or a saving of 2¼ cts. over the labor scale rate for driving such rivets by hand.

For the first portable machines, compressed air was used, as it was feared that the severe climate might interfere with hydraulic power. Moreover, the air-power could also be used for calking and chipping hammers and drills or reamers, and an air-compressing plant was a necessity anyhow. Compression bow riveters, such as are used in bridge shops, were first tried; but they were too light for the work and too difficult to handle about a ship. In 1896, some experimental rivets were driven with an ordinary pneumatic calking hammer, at the works of the Lassig Bridge and Iron Co., in Chicago. This was tried in the shipyard and the method was found to be feasible; but the blows of the hammer were so heavy and continuous that it was impossible to "hold-on" the rivets by the ordinary hand hammer, which was fairly jarred off the rivet-heads. A pneumatic "holder-on" was then devised, of simple construction. It was simply a cylinder, into which air was admitted and then forced out a piston with a cup to go over the rivet-head; by screwing a piece of pipe to this device it was easy to obtain a bearing, or resistance for this cylinder among the longitudinals in the double bottom of lake steamers.

The next step was to connect the hammer and holder-on by a horse-shoe frame, as shown in Fig. 1. A variation in the device is to mount the hammer itself as a piston in a cylinder, to which air is admitted to force out the hammer as the point of the rivet is beaten down. A plain die is used on the other side, and this die can be small enough to go into contracted places. As arranged for various depths of gap, these machines weigh as follows: 9 ins., 83 lbs.; 51½ ins., 160 lbs.; 70 ins., 220 lbs. In the larger machines the bow is made of a piece of wrought-iron pipe.

These machines do better work than hand riveting. In the first place, it requires constant watchfulness, in hand work, to prevent the men from knocking the head over at once, instead of striking the first blows exactly in line with the axis of the rivet and properly filling the rivet hole. With the machine, the blows of the hammer are naturally in line and they are so rapid that "plugging" is accomplished before the point is formed As the machine work is quicker, the driving is completed before the rivet has lost its heat and the contraction afterwards draws everything firmly together and strengthens the joint by f iction between its parts. Then in a ship, there are many places where there is not sufficient space to swing a hammer, or where the rivet can only be gotten at from one side. In these places hand riveting is never what it should be; while these considerations do not affect the machine.

In deck, tank and outside shell rivets, with countersunk flush points, a machine with a separate pneumatic holder-on is employed; and three men and a heater-boy will drive from 800 to 1,000 of these rivets in a working day. In the case of bulkhead rivets, with full or button point, the combined hammer and holder-on can be fastened to the end of a beam which slides loosely on a central supporting stud bolted to the bulkhead, with an adjustable stud-bolt at the other end of the beam governing the distance of the hammer-die from the rivet-point; and thus a number of rivets may be reached at one setting. The pneumatic holder-on may be similarly mounted on the other side of the bulkhead. For flush-pointed rivets a very different arrangement is required. As in hand-work, the varying thicknesses of plating, liners, butt-straps, frame flanges, etc., and the amount of countersink in the plate, make it impossible to gage the length of rivet under the head that will exactly fill flush to the plate surface. Here the hand method is practically followed; the rivet is beaten down with surplus metal crowded off to one side; this metal is then chipped off by hand or by a pneumatic chipping chisel, and the rivet is properly finished on the point. To do this, some freedom of motion must be given to the hammer, so that it is possible to incline its axis, to properly crowd the metal to one side and facilitate chipping. For this purpose hammers are mounted on gimbals; or, so mounted in a frame that while the die is held in position against the rivet the lower end may be given a rotary motion; or, the hammer may be mounted on trunnions and the beam carrying it turned on its own axis and moved forward and back longitudinally. Mr. Babcock thinks the second method not so good as gimbals, and he had never tried the third.

Still another method of driving countersunk flush rivets is to fasten the hammer immovably to the end of the beam, as in the bulkhead riveter; and the flat-faced die has a central 3-16-in. hole drilled in it. When the rivet is beaten down some of the hot metal enters the hole and the result is a projectng teat on the rivet-head, with the remainder of the surplus metal flattened out equally on all sides. This surplus metal is removed by a face milling tool, which also has a central hole fitting over the teat and holding the tool in position. The milling tool is driven by a pneumatic drill, and after the point of the rivet is milled down flush with the plate the teat is easily cut off by the blow of a hand hammer or a cold chisel. This rivet is not, however, quite "shipshape" in finish, and it is difficult to get a milling tool of the right shape to properly cut it. In the yard of the Chicago Shipbuilding Co. the first method described is alone used, as the most satisfactory.

For bottom rivets the beam is hung by a bolt through its center, on which it rotates, to a trolley running inside of a slotted pipe bolted to the bottom of the ship; this enables the operator to reach many rivets at one setting.

For side riveting the machine is attached to a counterweighted horizontal pipe, hung from pulleys above inside of flat iron guides bolted to the ship's sides. For the bilges the hammer beam is again a horizontal pipe fastened to a double frame which fits the bilge and travels on trolleys above and below.

Mr. Babcock says that it is the unanimous opinion of the hull inspectors that the machine rivets are first-class in every respect, and make better and tighter work than those driven by hand. Adding cost of air, repairs, etc., the saving is from 1 to 2 cts. per rivet over piece-work prices for hand-riveting, and averages 1¼ cts. This means a saving of from $4,000 to $5,000, over hand-work, in an ordinary 4,000-ton lake steamer. An important advantage is that unskilled labor can, with these riveters, successfully replace skilled labor of a class hitherto regarded as indispensable, and correspondingly troublesome with regard to strikes, etc.

THE FIREPROOFING OF WOOD FOR THE NEW UNITED STATES BATTLESHIPS.

The terrible experience of at least two of the Spanish cruisers in the naval battle off Santiago added to the destruction by fire of the Chinese vessels in the battle of the Yalu River, in the Chinese-Japanese war has, as many of our readers are aware, brought about the decision to construct our new battleships with fireproof or non-inflammable wood. This order applies to the first-class battleships "Maine," "Missouri" and "Ohio," and is a direct reversal of the policy previously determined upon, which was to use the material for interior construction only, as the result of the experience in peace service with the monitor "Miantonomoh" and the gunboats "Helena," "Newport," "Vicksburg," "Wheeling," "Princeton," "Wilmington," "Nashville," "Marietta" and "Annapolis," all of which were finished with fireproof wood at the time of their construction in 1895-7. The objections raised to the use of fireproof wood on these vessels were briefly as follows: Fireproof wood is heavier, much harder to work, and not so strong as the untreated material; the contained chemicals corrode metals, which come into contact with the wood, prevent the wood from taking paint, and injure clothes kept in drawers made of it. These objections were investigated in 1897 by a board of naval officers, which sustained them in a majority report to the Navy Department, and also advised that the use of fireproof wood on war ships should be abandoned. In a minority report, however, Chief Naval Constructor Hichborn, of the Board of Investigation,

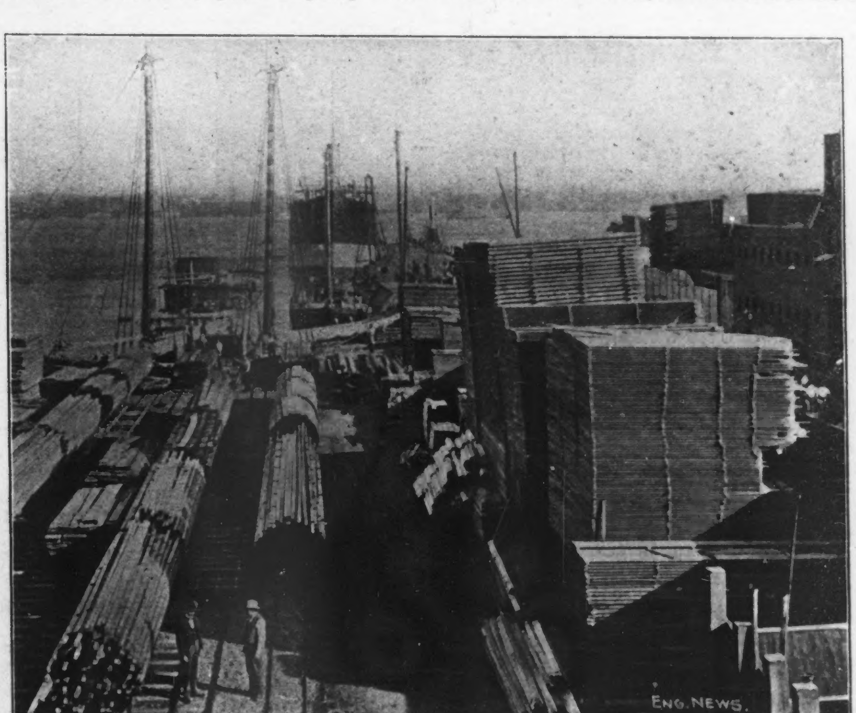


FIG. 1.—YARDS SHOWING LUMBER IN STORAGE AND LOADED ON CARS READY FOR FIRE-PROOFING.
Electric Fireproofing Co., New York, N. Y.

took a contrary position, claiming that the objections raised were not warranted by facts and urging the great value of non-inflammable wood fittings and finishing in time of battle as compared with such minor objections as really existed. The question rested in abeyance until the fight at Santiago showed that if war ships are to resist successfully heavy fire from modern batteries it is of the greatest importance that any woodwork about the superstructure should be made non-inflammable.

The employment of fireproof wood on so extensive scale as is contemplated in the recent orders of the naval authorities is sufficient to make a description of the method of its preparation of interest to engineers, and we have collected from various sources such information of practical interest as is available concerning both the process of fireproofing and the actual fireproofness, durability, strength, etc., of the wood after undergoing this process. It is also apparent that if fireproof wood shall prove to be what it is claimed to be, viz.: non-inflammable, with its strength and durability and the various other qualities of the natural material uninjured, naval construction is evidently only one of many fields of usefulness. In timber construction generally, and in fireproof building construction particularly, the advantages of such a material are many.

Turning now to the process which is employed for fireproofing wood for United States war vessels, it can be described in a general way as resembling very much the process of creosoting timber to preserve it from decay. The timber to be treated is placed in an air-tight cylinder and enveloped in an atmosphere surcharged with aqueous vapor at a temperature of from 110° to 200° F., until its pores or cells are opened. The moisture is then evaporated from the wood by creating a vacuum in the cylinder. When the evaporation is completed the cylinder is filled with the fireproofing solution consisting of phosphate of ammonia and sulphate of ammonia, with, in some cases, other chemicals, and pressure is applied to force the solution into the pores of the wood. After this saturation the wood is thoroughly kiln-dried at a temperature of from 85° to 125° F., which solidifies the chemicals contained in the pores. More complete details of the process and of the plant used to conduct it will be given further on, but right here it will make some features of the work more clear if we consider another phase.

The end which is sought in fireproofing wood is not merely to render it non-inflammable, but to do this without injuring its structural and decorative qualities. To preserve the strength, elasticity and life of the wood its cellular structure must not be broken down or injured in the process of filling the cells or pores with the fireproofing liquid. This requires a thorough knowledge of the age, texture, condition, etc., of each kind of wood treated, for all of these things affect the strength and toughness of the fibers, and, therefore, their resistance to injury. To fill the pores of a crooked-grained, gnarled piece of oak with the fireproofing solution is an entirely different task, for example, than filling pores of a straight-grained stick of white pine; the quantity of solution required is different, the pressure necessary to force it into the wood is different, and the preliminary processes of saturation and evaporation likewise differ.

The first work in the process of fireproofing wood, therefore, is to sort the timber according to its various natural and acquired characteristics. This being done, it is put through the successive treatments of saturation, evaporation, impregnation and kiln-drying with such particular characteristics of manipulation as previous experiment and experience have determined to be necessary to secure the best results for wood of its kind and condition. It will be seen at once that the success of fireproofing wood depends largely upon the intimate knowledge of woods and experience in their treatment which the operator possesses.

The plant at which the fireproofing of wood for the new battleships is being done is located on the East River front, between 19th and 20th Sts., in New York city, and is owned by the Electric Fireproofing Co., which controls the process. Figs. 1, 2 and 3 are views of the plant. Fig. 1 shows the yard for the storage and shipment of lumber, with a number of charges of treated and untreated material loaded on the cars ready for further processes; Fig. 2 is a view inside the plant showing one of the cylinders, the solution tank above it, the steam and other piping, and other apparatus, and Fig. 3 is a nearer view of the front ends of the two cylinders showing the construction of the covers or doors.

FIG. 2.—INTERIOR OF WOOD FIREPROOFING PLANT, SHOWING CYLINDERS, WITH SOLUTION TANK OVERHEAD, AND THE PIPING SYSTEM.

FIG. 3.—INTERIOR OF WOOD FIREPROOFING PLANT, SHOWING CYLINDER HEADS AND COVERS.

The cylinders are 105 ft. long and about 7 ft. in diameter, and hold when filled about 15,000 ft. B. M. of timber. The material of the cylinders is steel ¾-in. thick. Referring to Fig. 4, a, a, are rails upon which the cars loaded with lumber are run into the cylinders. Below the trucks and the bodies of the cars when they are in the cylinder is the steam coil d, d, which runs the whole length of the cylinder. Adjacent to these coil pipes is an apertured pipe e also running the full length of the cylinder. This pipe e brings steam to the cylinder and the apertures in it increase in size from the points of entrance of the steam so as to deliver the same quantity of fluid at all points. The pipe e connects with a pipe f, which leads outside of the cylinder to a T-coupling g, to which a pipe h is connected on one side. This pipe h leads from the pressure pump and serves to bring liquid to the cylinder from the pump. A pipe i connects to the opposite side of the T and serves to admit steam to the cylinder through pipes f and e at the appropriate time and to exhaust the same therefrom. This pipe has a number of branch pipes k, l, the source of the steam supply being connected to l and k being the exhaust pipe.

The mud drum B of the cylinder is connected to the cross coupling C by the arm m, the opposite arm n being a vent to clear the mud drum. Connected to the arm m' of the cross coupling is a pipe D, which is provided with a valve d' and leads to the bottom of the tank containing the fireproofing solution, and connected to the opposite arm n' is the pipe F which serves to return the unused liquid from the cylinder to the supply tank. Along the top of the cylinder are a number of pressers G, which, when screwed down upon the top of the lumber, hold it firmly in place.

The method of operation is then as follows: the lumber being in the cylinder and the cover firmly closed, a depth of 3 ins. to 6 ins. of water is introduced; all the valves except those in the steam pipe are closed, and steam at low pressure is introduced by means of the pipes l, i, g, f and e and through the water into the cylinder. This process continues for from one to eight hours, the temperature being maintained from 110° to 200° F., depending upon the kind of wood being treated and is very important, its purpose being to open the pores of the wood and fill them with moisture. Aqueous vapor at a low temperature is employed. If live or dry steam at a high temperature is used it has been found that the wood is discolored, and its elasticity and tensile strength are reduced. Moreover, the action of the heat is to seal rather than to open the pores of the wood, forming an impenetrable outer shell to the timber, and preventing the introduction of the fireproofing fluid. The mild action of the aqueous vapor, on the contrary, opens up the pores of the wood like a sponge.

The process of saturation being completed, that of evaporation is begun by gradually inducing a vacuum in the cylinder to exhaust the moisture from the pores of the wood, and leave them open for the entrance of the fireproofing fluid. This vacuum is broken about every three hours to allow the accumulated moisture to be drawn off from the cylinder, and it is kept up until the lumber is dried. When the work of evaporation is finished a final vacuum of from 20 ins. to 28 ins. is induced in the cylinder, and the fireproofing solution is then admitted to the cylinder from the tank above it. Care is taken to have the temperatures of the timber and of the solution the same, as this facilitates the impregnation. The fluid is allowed to fill the cylinder completely, and at first the pressure is only that due to the head of the liquid and to the vacuum. Finally, however, the liquid is shut off from the tank, and the pressure pump is started, forcing liquid into the cylinder through the pipe k. Gradually the wood takes up the fireproofing solution, and when the gages show that it has absorbed all it can hold, the remaining liquid is drawn off.

The final step is to kiln dry the treated timber. This is done slowly at a low temperature, not more than 125° F. Particular importance is claimed for this low temperature process of drying. Greater heat, it is asserted, tends to make the wood brittle and to discolor it, while temperatures of from 85° to 125° F. preserves all the elasticity and life of the natural material. Except for the low temperatures employed, the process of kiln drying presents no differences from the process ordinarily used.

The process of fireproofing wood as conducted by the Electric Fireproofing Co. is perhaps sufficiently described in the preceding paragraphs. At the present time the company is treating regularly the following timbers: Mahogany, cherry, butternut, walnut, red oak, sycamore, maple, birch, pine, ash, spruce, elm and white wood. The charge of fireproofing is the same for all kinds of wood, $50 per M. ft. B. M., exclusive of the final kiln drying. The company either furnishes the wood fireproofed at the usual market price plus $50 per 1,000 ft., or will fireproof wood furnished by others to order.

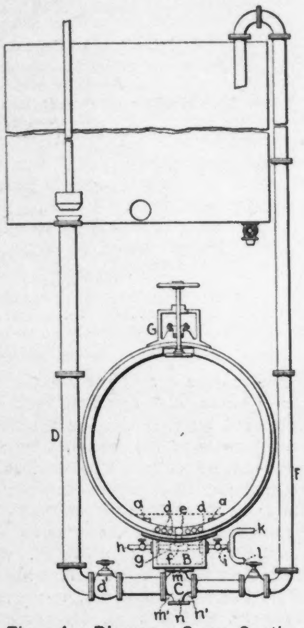


Fig. 4.—Diagram Cross-Section of Cylinder and Solution Tank Illustrating Operation.

Although generally spoken of as fireproof, wood which has undergone the process described is more correctly described as non-inflammable. When exposed to flame the wood chars, and will, if the flame be continued, be completely carbonized. Non-inflammable, however, is pretty certainly obtained. Shavings and splinters of the treated wood held in an alcohol flame will char, but will not catch fire nor retain the flame when removed; in fact, the glowing coal on the charred wood almost immediately goes out upon removing the source of heat. Small test buildings built of the treated wood and having kindling saturated with oil piled inside and around them, have been fired in New York (Eng. News, Aug. 29, 1895) and in London, and have shown almost as perfect non-inflammability. The standard for fireproof wood adapted by the United States Navy Department, and to which all the treated wood supplied for the new battleships conforms, is that, "when dry and subjected to heat of 600° F., it will remain non-inflammable and absolutely safe against spread of fire from point of contact."

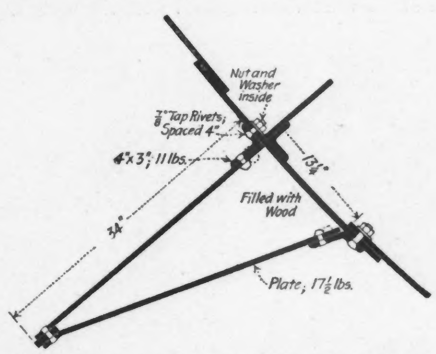
The fireproofing material contained in the wood is solid and non-volatile, and the fireproof quality of the wood is, therefore, claimed to be permanent. Even by long continued soaking, it is stated, the fireproofing material is not injured or withdrawn. The material is also claimed to have no injurious action upon paint or varnish, or upon nails driven into or hardware attached to the woods, provided it is thoroughly dried. It, however, makes the treated wood slightly darker than its natural color. The treated wood is also harder and somewhat heavier, and as a consequence is harder to work, but by a proper tempering of the tools this difficulty is easily overcome. In respect to the strength of wood which has been fireproofed, we find records of tests made in the laboratory of Stevens Institute, Hoboken, N. J., and at the Watertown Arsenal. In the Stevens Institute tests of both Oregon pine and yellow pine showed a loss of from 2.4% to 12.6% in transverse strength by being fireproofed. White pine, however, showed an increase of 7% by being fireproofed. In compressive strength both white and yellow pine showed a loss due to fireproofing of from 6.4% to 9.2%. In tension, however, white pine and yellow pine showed gains in strength of 19.6% and 24.2%, respectively. In tests made at the Watertown Arsenal for transverse strength both white pine and white wood showed a gain from fireproofing. These results do not agree very well, because, it is stated, of the difference in degree of heat applied in the kiln drying, which is a matter easily corrected, but they show generally that the wood is rendered somewhat more brittle by the fireproofing treatment. It is pointed out that these tests were made some time ago, and it is stated that the recent improvements in the process of fireproofing have corrected many of the former objections.

In conclusion it may be stated that so far as we have been able to ascertain, the Electric Fireproofing Co., illustrations of whose plant we present herewith, and its offspring the British Non-Inflammable Wood Co., are the only concerns which now manufacture non-inflammable wood on a marketable scale.

BILGE KEELS AND ROLLING EXPERIMENTS.

At the sixth general meeting of the Society of Naval Architects and Engineers, held in New York last week, Asst. Naval Constructor Lawrence Spear, U. S. N., presented a paper with the above title. He stated that the original designs for the battleships "Oregon," "Indiana" and "Massachusetts" called for bilge keels about 30 ins. deep; but to facilitate docking these keels were omitted in building. This omission was at the time in line with the best foreign practice, and theoretical considerations led to an underestimation of the steadying effect of bilge keels of any practical dimensions as applied to slow-moving ships of large displacement and inertia.

But while these ships were nearing completion foreign practice, and, especially, that of England, underwent a change, as the result of comparisons of sister battleships with and without keels. Experience with the "Oregon" class at sea showed that some steadying influence was necessary;



Section of Bilge Keel Fitted to U. S. Battleship "Oregon."

though the maximum inclination of the "Oregon" herself never exceeded about 22°, under a long, low swell. Bilge keels were put on the "Oregon" in January, 1898. These keels had a maximum depth of 34 ins. near the ends, tapering to 14 ins. amidships. The comparison in rolling effect, with and without keels, is shown in the following table:

	Keels, Without.	Keels, With.
Date of trial	Dec. 30, 1897.	Feb. 17, '98.
Draft, forward	22 ft. 9½ ins.	22 ft. 9 ins.
" aft	23 " 8½ "	23 " 8 "
" mean	23 " 3 "	23 " 2½"
Displacement, tons	9,810	9,790
Metacentric height, feet	3	3
Mean period, single swing, secs.	7.6	7.83
Weight of coal, tons	115	50
Weight of ammunition, tons	26.7	26.7
Bilge keels, number	0	2
Length		207 ft. 6 ins.
Greatest depth		34 "
Least depth		14 "
Total area		830 sq. ft.
Effective radius,		34.4 ft.

Except as above stated, conditions were alike in both cases. At slack water, and practically no current, with ship moored and without keels, 350 men running across the deck caused an inclinaton of about 7° from the vertical; with 200 men acting in conjunction with the 8-in. turrets, an inclination of nearly 6° was reached. Without bilge keels the rolling was practically isochronous within the range of experiments. With bilge keels, the period for single swing decreased slightly with the amplitude of roll. As measured by the radius of gyration, the period without keels was 7.6, and that with keels, 7.83, a difference of a little over 3%.

The results of the observations were plotted as "curves of declining angles" and "curves of extinction," and these were compared with corresponding curves for the first-class English battleship "Revenge," in light condition. It is noted that the "Oregon," starting at an inclination of 6°, required, without keels, 60 swings to reduce this inclination to 2°; while with keels the corresponding extinction required only 10 swings. For the "Revenge" the corresponding figures were 45 and 8. Taking the extinction value of the "Oregon," without bilge keels, as unity, the curves gave the following results at an inclination of 5° from the vertical:

"Oregon," light, no keels	1.0
"Revenge," light, no keels	1.32
"Oregon," light, with keels	7.36
"Revenge," light, with keels	8.18

The "Oregon's" loss of range per swing with this inclination is thus over seven times greater with keels than without; and this figure holds approximately true for any other angle within the range of experiments. In the case of the "Oregon," the same forces that would produce an unresisted roll of 20° would only produce one of 6° with the keels in place. In the case of the "Revenge" these figures were about 18° and 6°; or, broadly speaking, the roll, with keels, under identical conditions, would only be one-third as great as without them.

Generally speaking, it appears to be pretty well established that the entinction work done by keels may be divided under these three main heads: (1) Increased wave-making resistance; (2) disturbance of natural stream line motions about the ship; (3) direct resistance of plain surfaces of keels. As yet we have no data on which to base a quantitative division of the total resistance under these three heads; but it can be easily shown that the third is a comparatively small factor. Constructor Spear then mathematically stated, on the assumption of the late Mr. Froude, that 1.6 lbs. per sq. ft. is the resistance of the keel harmonically oscillating at a mean speed of 1 ft. per second, that the direct resistance of the keel is responsible for but a small part of the work done in steadying the vessel. As the third effect is practically unsolvable, with the data at hand, it is recommended that tank experiments be made so that naval architects may later obtain some emperical formulae sufficiently accurate for general design.

While service conditions prevented fuller trials of the "Oregon," the English experiments proved, what was to be expected, that the bilge keels had an increased effect when the ship was under way, and that the steering qualities were improved and tactical dimensions were decreased by the addition of keels.

STANDARDIZED CAST-IRON DRILLINGS FOR ANALYSIS.

The Committee appointed by the American Foundrymen's Association to establish a Bureau for the distribution of uniform standardized drillings, has issued a circular saying that it is now able to distribute a range of samples that it is felt will meet the indorsement of managers and chemists employed in all branches of the iron industry, pertaining to the making or use of pig iron.

The standardized samples now ready for distribution cover the following determinations: Silicon, sulphur, manganese and phosphorus, one each of a low, medium and high range; total carbon and graphite, one determination each; titanium, three determinations; in all, 17 determinations, made on four samples.

The samples are designated as A, B, C and D. Sample A, which has been ground to pass a 40-mesh sieve, gives one total carbon and one graphite. Sample B gives a low silicon, a medium sulphur, a low manganese, a phosphorus within the Bessemer limit, and a titanium. This has been passed through a 20-mesh sieve. Sample C gives a medium silicon, high sulphur, medium manganese, medium phosphorus and a titanium. This has also passed a 20-mesh sieve. Sample D gives a high silicon, low sulphur, high manganese, high phosphorus, and a titanium, and has passed through a 40-mesh sieve.

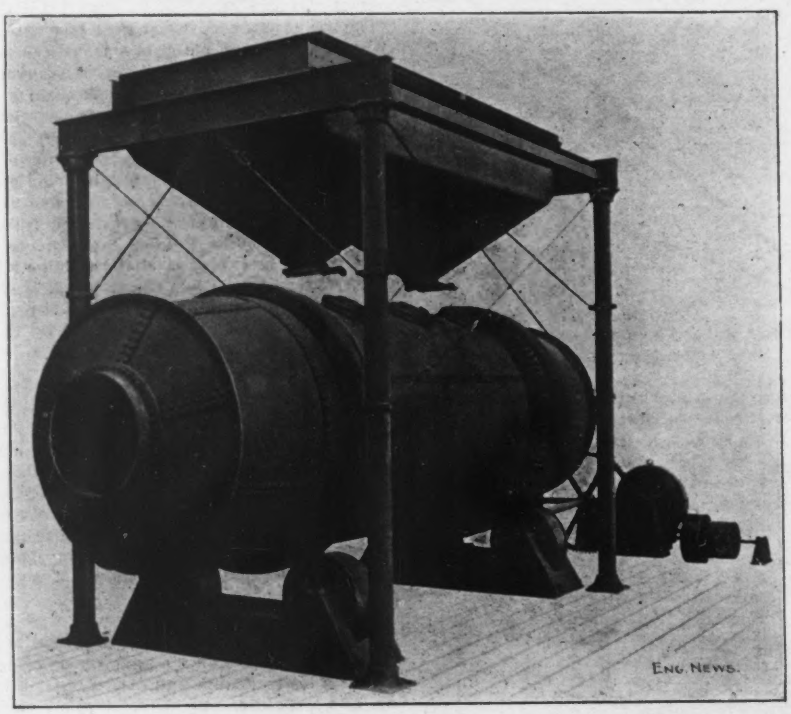
The drillings were obtained from castings made after the plan described by Mr. West in his paper before the Pittsburg Foundrymen's Association, June, 1898. The drillings were prepared under the supervision of Prof. C. H. Benjamin, and the standardizing under that of Prof. A. W. Smith, both of the Case School of Applied Science, Cleveland. The chemists engaged in standardizing the four samples are Messrs. Booth, Garrett & Blair, Philadelphia; Prof. A. W. Smith, and Cremer & Bicknell, Cleveland, O., and Andrew S McCreath, Harrisburg, Pa.

The standards are sold at the price of $5.00 per lb., and in no instance will less than 1 lb. be sold. The samples are packed in bottles, holding one-third of a pound and delivered in cases holding three or four bottles, according to the desires of a subscriber. One pound of the samples should furnish enough material for 36 complete analyses, or at least 200 separate determinations. The analyses of the samples, A, B, C and D will be sent separately by mail, so that they may be placed upon bottles or kept private, as desired by the subscriber.

About 35 leading laboratories have already subscribed for samples. Orders for samples may be sent to any member of the following committee: Thos. D. West, Chairman, Sharpsville, Pa.; Dr. R. Moldenke, 48th St. and A. V. Ry., Pittsburg, Pa.; James Scott, Lucy Furnace, Pittsburg, Pa.; P. W. Gates, Gates Iron Works, Chicago, Ill.; E. H. Putnam, "The Foundry," Detroit, Mich.

ROTARY FURNACES FOR ROASTING ORES.

The accompanying cut represents one of six large Bruckner rotary furnaces for treating ore, which are probably the largest ever built. Each furnace is 28 ft. long and 8 ft. 6 ins. diameter, with an end opening of 3 ft. 4 ins. diameter. Its capacity is about 20 tons of ore. Around the shell are two circular bearings or roller paths, which rest upon four 34-in. rollers in the bed-plates. Lateral motion is prevented by having one pair of the rollers made with double flanges. The total weight, including the charge, which is carried by the rollers, is 101,000 lbs. An iron frame supports two hoppers, and the furnace has three doors in the shell. Two of these are for receiving the charge from the hoppers, while the third is to facilitate the discharge of the roasted ore.



20-TON ROTARY ROASTING FURNACE. Gates Iron Works, Builders, Chicago, Ill.

The furnace is revolved by a pinion gearing with a circular rack attached to the shell. The pinion is carried by one of the bed-plates and is driven by a spur gear and worm-wheel and worm-shaft, the latter being on the shaft of the belt pulleys. Two belts are used, one for high speed and the other for low speed. The furnace makes about one revolution per hour while roasting and six per hour when discharging. Six of these furnaces have recently been built for the Canadian Smelting Works, at Trail, B. C., by the Gates Iron Works, of Chicago, and we are indebted to the builders for the above information respecting them.

ELECTRIC POWER IN THE NEW PRINTING PLANT OF THE W. B. CONKEY CO., HAMMOND, IND.

The recent removal of the large printing plant of the W. B. Conkey Co., from Chicago, Ill., and its re-establishment in new buildings at Hammond, Ind., has given the opportunity for one of the most comprehensive applications in this country of electricity to the work of a printing house. This new plant is fully described in a paper read before the Chicago Electrical Association, on Nov. 4, 1898, by Mr. Geo. A. Damon, and we abstract from that paper the following facts of general interest.

The reasons which first of all led to the removal of the firm's plant from the city to the suburbs was the saving which it was found could be effected in many ways. In the city taxes were necessarily high, and the insurance rates large on such property. Another great disadvantage of the city plant was the cost and delay of cartage through the congested city streets to and from the railway depots. The necessity of artificial lighting, and, also, the fact that the power transmission as established was expensive, were also important factors in deciding the change of location. To secure adequate natural light, in fact, especial attention was given to the design of the new building.

The plant at Hammond, as finally erected, consists of a single story building, 520 x 450 ft. The roof is of the weaving shed or saw tooth type, and all its windows are glazed with frosted glass and are placed at an angle looking toward the north. Every 29 ft. of roof space provides 11 ft. of light. Owing to the angle of the roof the direct rays of sun are kept out of the building, which is thus lighted by the soft reflected rays from the northern sky. The entire roof is built up of light structural steelwork resting upon cast-iron columns spaced 29 ft. c. to c. one way, and 16 ft. c. to c. in the other direction. The height of the trusses above the floor is 12 ft.

The generator plant consists of two engines and three 100 K-W. 225-volt generators connected on the Arnold system, described in Engineering News of Jan. 26 and Aug. 28, 1898. The power is conveyed to 95 motors distributed as follows:

	HP.
Electrotype Foundry.	
17 Motors, belted or geared to dovetailing machine, trimmers, planers, roughers, saws, routers, black leaders, molding machines, beveling machines, blowers and jig saws	21
1 Direct-connected to electroplating dynamo	10
Bindery.	
15 Belted to shafting driving folders, book-covering machines, trimmers, sewers, wire-stitchers, sewing machines, case makers, embossers, rounding and backing machines	52
2 Direct-connected to shafting driving cutters and smashers	10
8 Individual motors belted to knife-grinders, tying machines and gluing machines	18.5
Stock Room.	
2 Belted to shafting driving cutting machines, rotary board cutters, grinding machines, sizing machines and bevelers	6
Heating Apparatus.	
1 Belted to blower fan to heat office	12
Machine Shop.	
1 Belted to line-shaft driving machine tools	10
Composing Room.	
1 Belted to shaft driving type-setting and distributing machines	3
Press Room.	
6 Belted to job presses, ink grinders and bronzing machines	5.5
41 Directly attached to presses	173
Total horse-power of motors installed	321

The motors are of the Lundell type. Each motor is made with one field coil, which is entirely protected by the form of the field casting. The armature is of the ironclad type with removable form-wound coils. The motors have a steady neutral point of commutation, and do not spark under sudden changes of load. The motors directly attached to the presses and shafting are multipolar, narrow in width, with a relatively large circumference of field frames. The commutator, like the armature, is narrow and of large diameter, with a large number of bars.

Besides the improvement in lighting, ventilation and cleanliness, and the advantages of a more perfect control of the various machines, the new plant has exhibited a notable saving in fuel. Mr. Damon in his paper states that the result of the operation of the new plant is that only about one-third of the amount of coal is burned that was required before the move was made. A part of this saving, he says, however, must be attributed to the design of the power plant, with its modern equipment, so that just how much economy has been gained by the operation of the purely electrical part of the plant cannot be definitely determined.

The Corliss engine was furnished by the Atlas Engine Co.; the motors, by the Sprague Electric Co.; the motor, controllers and starting boxes by the Cutler-Hammer Mfg. Co., and the switchboard and wiring by the Western Electric Co. Mr. George C. Nimmons was the architect of the building, and Mr. Bion J. Arnold, M. Inst. C. E., was Consulting Electrical and Mechanical Engineer.

TEST OF THE BULKHEAD SEPARATING THE ENGINE ROOMS OF THE BATTLESHIP "ILLINOIS."*

By J. J. Woodward, M. Soc. N. A. & M. E.†

The specifications for the U. S. battleships "Kearsarge," "Kentucky," and "Illinois" require all watertight compartments to be tested by filling the compartments with water under a head; and the most important bulkheads, whose strength it was desired to test in this manner by actual water pressure, were the center-line longitudinal bulkheads existing between the engine rooms and fire rooms on the vessels in question. These bulkheads were all of large size, and the head of water directed to be used for the test was 5 ft. greater than the normal load water-line of the ship. This corresponded to a water level during test of 28 ft. 6 ins. above the keel. The bulkheads were all of approximately the same depth, namely, 23 ft. 5⅞ ins., and they were very strongly supported on all sides, being limited at their bottom by the inner bottom of the ship, and at their top by a heavy protective deck, which was formed by two thicknesses of ½-in. steel plating and an upper thickness of 1¾ ins., all three riveted together in

*Abstract of paper read at the sixth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 10 and 11, 1898.
†Naval Constructor, U. S. N., Newport News, Va.

an efficient manner. The ends of the bulkheads were also well supported by complete transverse bulkheads extending across the ship.

As all the work had been carefully inspected during construction for general workmanship (which was found to be entirely satisfactory), and the principal point it was desired to determine was whether the scantlings of the bulkheads, as built, were ample for the work they had to perform, it was considered that if one bulkhead was tested and shown to be entirely satisfactory, that the other bulkheads would be considered as satisfactory, subject to passing a test with hose, for local defects in calking. As the length of the bulkheads separating the engine rooms was greater than those separating the fire rooms, and were consequently of the greatest area, since all of them had the same depth, the bulkhead separating the two engine rooms on the "Illinois" was chosen for the test for strength.

The volume of one engine room being such that to have filled it with water would have resulted in a possible injury to the general structure of the vessel which, at that time, was on the blocks of the building slip, it was decided to make the test by building in the port engine room a wooden cofferdam, placed about 3 ft. 9 ins. from the center-line bulkhead under test, the cofferdam being made of 5-in. plank. In this manner the weight of water necessary for the test was reduced to a very moderate amount, and it may be remarked in passing, there was no difficulty (with the exception of a slight amount of leakage, which occurred during the first test, on account of a defect in calking the plank), keeping up the pressure desired for the tests. It should be stated further that the water level of 28 ft. 6 ins. above the keel, required for the full test, was obtained by means of a small stand-pipe connecting with the water space within the cofferdam, through a circular hole in the protective deck. The bulkhead was subjected to three series of tests by filling the space between the cofferdam and the bulkhead with water, and carefully measuring the deflection on all stiffeners corresponding to different heads of water.

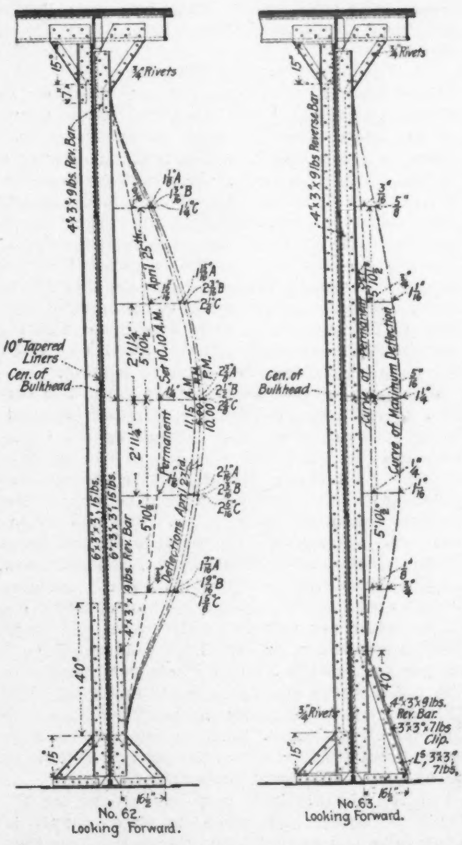
First Test.—Before the test, the actual shape of the bulkhead was carefully determined by measuring on each stiffener the distance from a vertical reference plan parallel to the center-line of the ship, these measurements being taken at three points, respectively, 5 ft. 10 ins., 11 ft. 8 ins., and 17 ft. 6 ins. above the top of the inner bottom plating, the measurements being taken on the side opposite the cofferdam, so that corresponding measurements could be made after the space between the cofferdam and the bulkhead was filled to different water levels

On beginning to fill the cofferdam space with water, no appreciable deflection could be noticed until the head of water had reached a height of 8 ft. above the inner bottom plating. At that height, however, a slight deflection was measured, and the filling of the cofferdam space then proceeded with, the water levels being maintained constant for heads of water corresponding to the heights of 12 ft. 9 ins., 16 ft., 18 ft., 20 ft. and 22 ft. above the inner bottom, measured as described, for such lengths of time as permitted the three measurements on each stiffener to be taken for the deflection corresponding to such heads of water. These intermediate water levels correspond, approximately, if we add the depth of the inner bottom space, to the 15 ft., 19 ft. 3 ins., 23 ft. 3 ins, and 25 ft. 3 ins. water-lines of the ship.

A careful examination of the behavior of the bulkhead while under test, showed that up to a head of 18 ft. the deflection increased very regularly, and, as well as could be judged, the material forming the center-line bulkhead had not, up to the head of 18 ft., been strained beyond its elastic limit. Between the heads of water of 18 and 20 ft. the deflections increased much more rapidly, and, as well as could be judged, the elastic limit of the material was passed somewhere between these two points. Between heads of water of 20 and 22 ft., the deflections of the stiffeners increased very rapidly indeed, though up to the latter head no leak showed at any of the butts or seams, although a few drops of water went through four or five rivets. Just as the water level reached the head of 22 ft., the lower brackets of the Z-bar stiffeners connecting them to the inner bottom plating buckled badly, as did also the brackets at the upper end of the stiffeners, where connected to the beams of the protective deck. The buckling of both upper and lower bracket plates decreased rapidly for the stiffeners near the ends of the bulkhead. At this head also the local deflection of the plating between the stiffeners was observed, and found to be very small, the maximum deflection in 4 ft. being ¼-in.; it, of course, being understood that the deflection referred to is that caused by the bellying of the plate between the Z-bar stiffeners, and is therefore more properly defined as the difference in the total deflection of the plating at such points situated midway between stiffeners and the corresponding deflection of the stiffeners themselves.

On attempting to increase the head of water above 22 ft., it was found that on reaching a head of 22 ft. 4 ins. the maximum deflection of the stiffeners increased very rapidly; the increase due to the 4 ins. additional head of water, and also the time element of the test, had resulted in an increase of maximum deflection from 2 13-16 ins. to 3⅝ ins. Under these circumstances and in view of the buckling of the lower brackets of the stiffeners, the test of the bulkhead was discontinued at this point, it being manifest that it could not stand a pressure due to the full head of water required by the specifications.

After the water had been entirely run out of the cofferdam, the deflections of the various stiffeners of the bulkhead were measured, and the stiffeners and brackets on the opposite side of the bulkhead, which had been in the cofferdam space and so could not be examined during the progress of the test, were then carefully inspected, and it was found that no rivets had been sheared, and the bracket plates remained perfectly plane, and, as far as could be determined, had not been permanently deformed. The heel, however, of the 3 ins. × 3 ins., 7-lb. angle clips connecting these brackets to the inner bottom plating were drawn away from the plating at the outboard ends of the clips to the extent of nearly 3-16-in. at the



Figs. 1 and 2.—Sketches Showing Results of Tests of Water-Tight Bulkheads on U. S. Battleship "Illinois" to Determine Their Resistance to Deflection.

maximum, which occurred about midway of the bulkhead, and decreased to zero for the brackets of the two stiffeners which were adjacent to the ends. A study of the curves of deflection of the stiffeners is especially interesting as showing the marked influence of the support received from the transverse bulkheads in relieving the stiffeners next to them from strain. Thus, under a head of water of 22 ft., the maximum deflection of the forward end stiffener is approximately 1 3-16 ins., and the after end stiffener deflected 1½ ins., whereas the stiffeners in the central portion of the bulkhead deflected 2 11-16 ins.

Second Test.—In the second test the bulkhead was stiffened by re-enforcing the bracket plates at the upper and lower ends of the stiffeners with a 4-in. × 3-in., 9-lb. reverse-bar on the opposite side of the outer flange of the Z-bar stiffener (Fig. 1). The object of this test was clearly to demonstrate that the cause of the first failure of the bulkhead had been the want of strength of the stiffeners themselves, and not that of the brackets connecting the Z-bars to the inner bottom plating and the protective deck. The failure of the lower brackets had undoubtedly been the determining cause of the rapidly increasing deflection of the bulkhead at the time the testing was suspended during the first test, and it was desired to establish beyond doubt that additional strength was required for the stiffeners themselves, and that satisfactory strength of bulkhead could not be obtained by simply increasing the strength of the gussets themselves. The ship's main drain and other piping prevented the size of the brackets being increased at all on the starboard side of the vessel and, for this test, they were kept of the same size as in the previous test, but stiffened as described. The general method of conducting the test was similar to that previously followed, except that deflections of the stiffeners were measured at five points in the height of every stiffener.

Up to a head of 8 ft. above the inner bottom, the deflections were inappreciable. After that head, deflections were recorded with heads of 12 ft. 9 ins., 16 ft., 18 ft., 20 ft., 22 ft., 22 ft. 6 ins., 23 ft., 23 ft. 5⅝ ins., 24 ft., 24 ft. 6 ins., and 25 ft. 2⅝ ins., the latter height corresponding to a head of 5 ft. above the normal load water-line. At the latter head of water three records of the deflections of the bulkhead were taken; the first of these records was taken as soon as this head of water was reached, at 11.15 a. m.; the second one at 5 p. m., and the third at 10 p. m. Forty-five hours after the bulkhead was relieved from water pressure, a record of its permanent set was taken.

An examination of the records of this test shows the same general conditions as in the first test, in so far as concerns the influence of the transverse bulkheads upon the deflection of the stiffeners at the ends of the bulkhead under test, but that the additional stiffening given the brackets had been sufficient to prevent their buckling during the test; moreover, when the brackets in the port engine room were examined it was found that there was no measurable deformation of either bracket plates or angles as had previously been the case. In view, however, of the fact that under the pressure required by the specifications, namely, of a head of water of 5 ft. above the normal load water-line, the deflection of the bulkhead constantly increased with the length of time it was under test, it was evident that the stiffeners were strained beyond their elastic limit, and it was therefore decided materially to increase their strength. This was done by carrying a 4-in. × 3-in., 9-lb. reverse-bar for the full length of the stiffener, and of the brackets at both head and heel; and, in addition, by adding for the lower bracket a second clip for securing the bracket plate to the inner bottom plating, also a short reverse clip on the edge of the bracket plates, so that the strength of the new end connections would be proportioned to the strength of the reinforced stiffener.

Third Test.—The test was conducted in the same manner as the previous series. Up to a head of 12 ft. 9 ins. no deflections were observed. Above that head, deflections were recorded for 16 ft., 18 ft., 20 ft., 22 ft., 24 ft., and 25 ft. 2⅝ ins. At the maximum head of 25 ft. 2⅝ ins., or 5 ft. above the normal load water-line, three sets of measurements of deflections of the stiffeners were taken; the first of these records was taken as soon as the maximum head of water was reached at 1 p. m.; the second at 5.30 p. m., and the third at 10 p. m., the maximum head of water being maintained continuously until the last measurement was taken. Each of these records gave the same deflection for the stiffeners; in other words, the deflection of the bulkhead did not increase at all in nine hours, while under the test head of water called for by the specifications. The results of this final test may, therefore, be summarized as follows:

(1) There was no appreciable increase of deflection under the maximum head of 25 ft. 2⅝ ins. with a lapse of time of nine hours.

(2) The maximum deflection observed on any stiffener was 1¼ ins., and the maximum permanent set, measured twelve hours after the bulkhead was relieved of water pressure, was 5-16 of an inch.

(3) The maximum deflection of the bulkhead plating between stiffeners, observed during the test, was ⅝ of an inch, and after the test there was a corresponding permanent set of about ⅛ of an inch.

(4) The stiffener brackets in the starboard engine room showed no signs of buckling during the test. After the water had been pumped out of the cofferdam space, the brackets in the port engine room were examined and were found to be in perfect condition, no permanent deformation of any kind having occurred for either the bracket plates or the angles.

It was therefore decided that the strength of the bulkhead, as finally stiffened (Fig. 2), was thoroughly satisfactory, and the remaining nine similar bulkheads on the "Kearsarge," "Kentucky" and "Illinois" were reinforced in a similar manner.

The observation of the actual test, together with other similar experience, leads me to express my belief, first, that for bulkheads in which general strength to prevent collapse and not absolute water-tightness, is required, a wider spacing than the usual 30 ins. spacing is permissible, and that this increase may extend to as much as 4 ft., it being, of course, understood that the strength of the stiffener bars are suitably increased; secondly, that in bulkheads in which the length is great relative to the depth, if subjected to considerable heads of water pressure, better results will be obtained if one or more deep belt stiffeners are worked in connection with intermediate stiffeners of moderate weight, rather than that all the stiffeners should be uniform depth and strength; it being, of course, understood that the spacing of all stiffeners here referred to may be as much as 4 ft. between any two of them. Such a general arrangement of stiffeners can be made lighter for a given strength than with a uniform spacing and weight of stiffeners, such as exists in the center-line bulkhead whose tests have been described.

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The Navy Department has done well in revising and improving the plans for the four new monitors ordered at the last session of Congress. It would do still better if it should induce Congress to repeal this appropriation and allow the $5,000,000 to be used for some type of vessels which would be a real addition to our naval strength. The fact is that the monitor is an obsolete type of warship; and it is ridiculous for the United States to continue their construction. In the appropriation bill by which their construction was authorized, they were referred to as "harbor-defence vessels"; and it is conceivable that in the smooth waters of a harbor, a monitor might give a good account of itself in a naval engagement. But naval battles are no longer fought in harbors and are little likely to be in the future. There was a period when the construction of harbor-defence vessels was appropriate. That was when the range of naval ordnance was so small that the defences of a harbor were placed in the harbor itself. At a later date, too, the rapid advance in the power of guns made all the old-time masonry forts obsolete, and it was necessary to meet ship with ship for purposes of defence. Now, however, the invention of the high-powered rifled mortar and the disappearing gun carriage and the perfection of systems of submarine mines have entirely revolutionized the science of naval attack. Nearly all the important harbors of the world are to-day absolutely impregnable. Modern naval vessels are powerless against modern land fortifications. Warships are designed, therefore, only to attack the vessels of an enemy, and that attack must be made in the open sea, not in the smooth waters of a harbor.

Of what use, then, is the monitor? Our naval officers found by experience in the recent war—what they knew before—that the monitors were worse than useless to take part in fleet actions. On the long voyage of Sampson's squadron to Porto Rico and back, the monitors of the fleet held the other vessels back, and were generally more of a nuisance than all the rest of the fleet combined. The only thing left for the monitor to do, then, is to operate independently; but in this field, too, it is equally ineffective. It can neither catch any vessel which it can whip or run away from any of superior force. It offers a shining mark for torpedo boats, since it has too little secondary battery to make the attack of such vessels dangerous, and its slow speed makes it a good mark. Finally, it is so unsteady that good shooting from its guns is practically impossible in a seaway; its low free-board and quick roll subject it to peril at every storm, and life upon it at sea is constant misery for officers and crew. In view of all these well-known facts, it ought to be possible to secure a repeal of the law ordering the construction of these vessels. The taxpayers of the country will have no objection to seeing $5,000,000 come back to the treasury; or, if it is desired to use it for the increase of the navy, let us at least build vessels of modern type, instead of vessels which are obsolete before they are begun.

The present agitation over the effect of the Chicago drainage canal upon the water supply of St. Louis would be more impressive if there were not reasons for believing that it is prompted, to some extent, by other than sanitary considerations, and if those city officials most directly responsible for the purity of the water supply and the welfare of the city were not either silent or very convervative in their comments on the subject. It seems rather late in the day to demand a national investigation of this matter, now that so many millions have been spent and the work is so nearly done. There have been similar attempts before, but they came to nothing.

Whatever the real merits of the case, it is certain that Chicago is only one of many cities already polluting the water flowing by St. Louis, and that the latter city does not call in question its own conduct in discharging its sewage into the same stream, for the benefit of Memphis, New Orleans and other cities below. The new drainage canal will undoubtedly result in sending more of the Chicago sewage towards St. Louis than now goes in that direction, but it will greatly increase the dilution. The law requires a flow of 20,000 cu ft. of water per minute in the canal for every 100,000 population, or over 1,800 gallons per capita per day, so the sewage starts out more than 300 miles above St. Louis with much dilution. This dilution is gradually increased as Illinois is traversed. Before St. Louis is reached the Mississippi and Missouri dwarf the original volume of sewage to insignificant proportions.

But for all this it is perfectly proper for St. Louis to inquire how much its water supply is going to be endangered by any disease germs that may survive the conflict for life during the long journey from Chicago. The reduction in the original number of disease germs will be immense, since they die, rather than multiply, out of their natural element, and will be deposited along the bed and banks of the stream for more than 300 miles; there, too, to succumb to adverse influences. The number that may finally reach the St. Louis intake will be scattered through hundreds of times the original volume of the water that conveys them. It is quite probable, though we do not pretend to have definite information, that towns of comparatively insignificant size, not far above St. Louis, will endanger its water supply more than the discharge of the Chicago drainage canal, while if the latter is to be feared far greater danger has existed for years from the sewage of Chicago, St. Paul, Minneapolis, Omaha, Kansas City, and scores of smaller places in the Mississippi drainage area.

Settling basins and filter beds were recommended for St. Louis by the late Mr. Jas. Kirkwood, some thirty years ago. Certainly, if they were needed then they would be of far greater value now. The settling basins were provided and they have been included, on a larger scale, in the new works for St. Louis. Studies for filtration have also been prosecuted there for some years past, and doubtless a filter plant will be installed inside of five or ten years. In any event, St. Louis should not rely too much on national action, which is likely to be slow, at best, so great is the inertia to be overcome in all attempts at national sanitary legislation. When they feel that the proper time has arrived, we believe the city officials of St. Louis will come forward with plans to fully protect the water supply. To many outsiders it seems as though the time had already arrived.

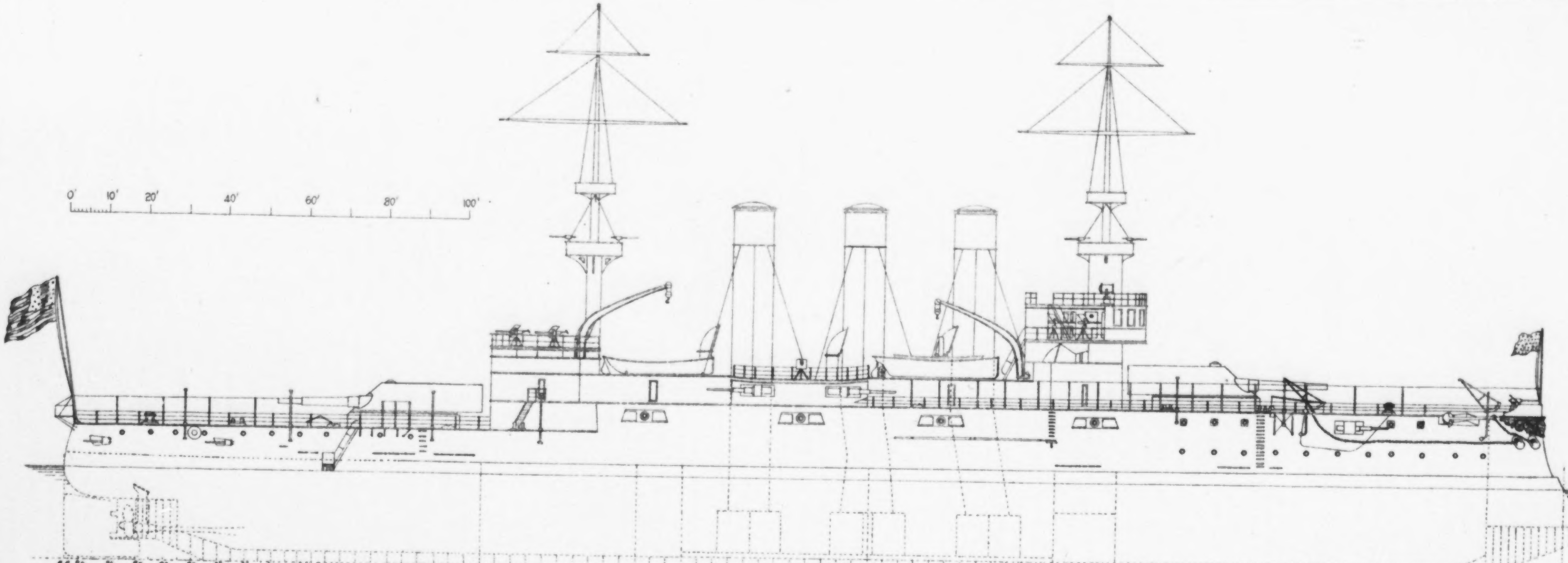
Elsewhere in this issue is given a brief abstract of a paper describing a recent application of electricity to factory operation which clearly shows some of the advantages to be derived by substituting individual electric motors for the usual array of shafts, pulleys and dust-disturbing belts.

The plant in question is that of a large Chicago printing establishment, which has recently been moved to Hammond, Ind., where an entirely new plant has been erected. This was built from plans which, with one important exception, seem to have been prepared with unusual care, so far as we can judge from a somewhat cursory examination. The one exception referred to is the placing in one enormous building, under a single roof covering a space of about 218,000 sq. ft., all the departments of a great manufacturing plant. So far as we can ascertain from the published descriptions and illustrations of this building, there is nothing whatever to prevent a fire starting in any part of this great room from sweeping over every part of it, destroying the entire plant and very likely proceeding with such rapidity as to give many of the operatives no time to escape.

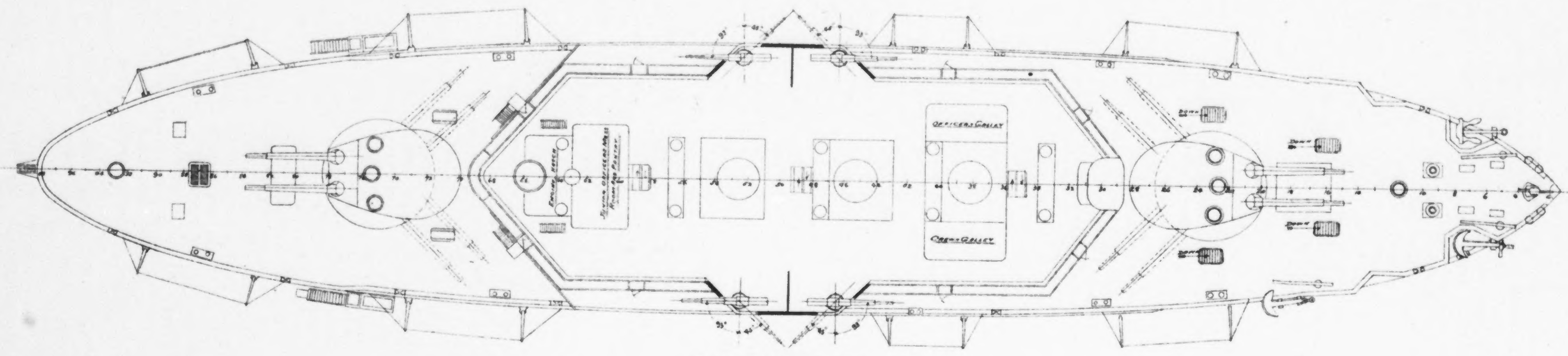
We call attention to this, not for the purpose of criticising this particular manufactory, which may, perhaps, have safeguards against the spread of fire of which we are not informed, as to emphasize the fact that very few factory buildings are planned with equal attention to all the different details that should be considered in the design. The chances are that the proprietor has one particular thing into his mind as the thing of all importance, and other matters receive minor consideration. For example, in the W. B. Conkey plant, referred to above, the matter of securing the best possible light seems to have been the controlling consideration. To obtain this, the saw-tooth or weaving shed roof has been adopted, notwithstanding the well-known objections to it in a climate of heavy showfalls; and the entire plant has been placed on the ground floor, and in a single building. The fire risk that is involved in this we have already alluded to; and it is also apparent that the maintenance account for keeping in repair this great area of roof will amount in a few years to a large figure. By making the structures two stories instead of one story in height, and placing the various departments in separate buildings connected by covered runways, the roof area and the ground floor area subject to rapid decay would have been nearly halved, the lighting might have been made almost equally good, communication between different departments might have been made equally easy, and the danger of a total fire loss of the whole plant might have been greatly reduced.

The textile manufactories are almost the only ones in the country which have come to fully appreciate the fact that in the matter of fire protection an ounce of prevention is worth a pound of cure, and that the time to prevent the destruction of a plant by conflagration is when it is first laid down on the drawing board. In other manufacturing industries far too little attention is paid to planning for fire protection, the owner or superintendent generally sees to it that the arrangements for communication and transport throughout the plant suit his ideas and leaves the rest to the architect. In nine cases out of ten the architect is a local man, who has never made any special study of the requirements for heating, lighting, fire protection, etc., in factory buildings. Under these circumstances it is not strange that money is wasted in some directions and squandered in others, and that poor light, defective and uneconomical heating facilities and standing invitations for the spread of fire are far too common, even among those modern factory plants which are pointed to with pride by their owners as models of good construction.

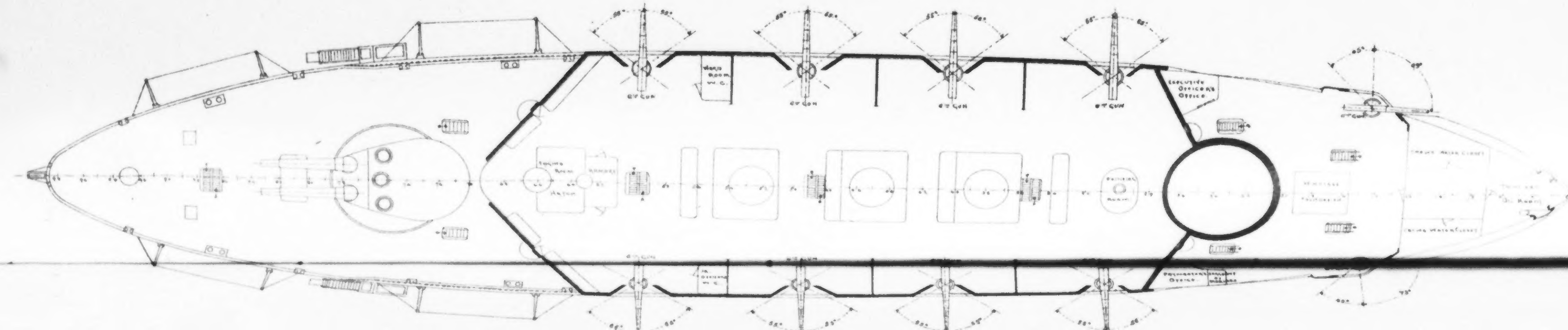
The excellent form of annual report of water-works systems adopted years ago by the New England Water-Works Association, and used by quite a number of works in and out of New England ever since, seems to have been overlooked

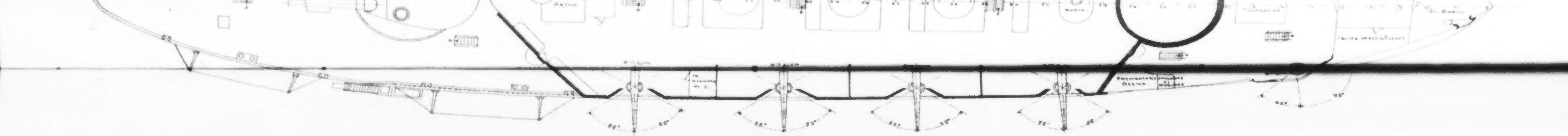


SIDE ELEVATION.



PLAN OF UPPER DECK.





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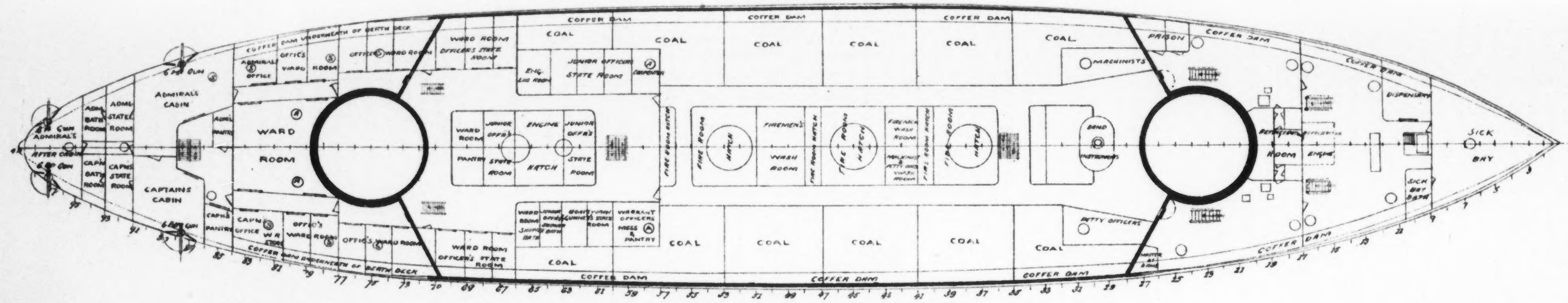
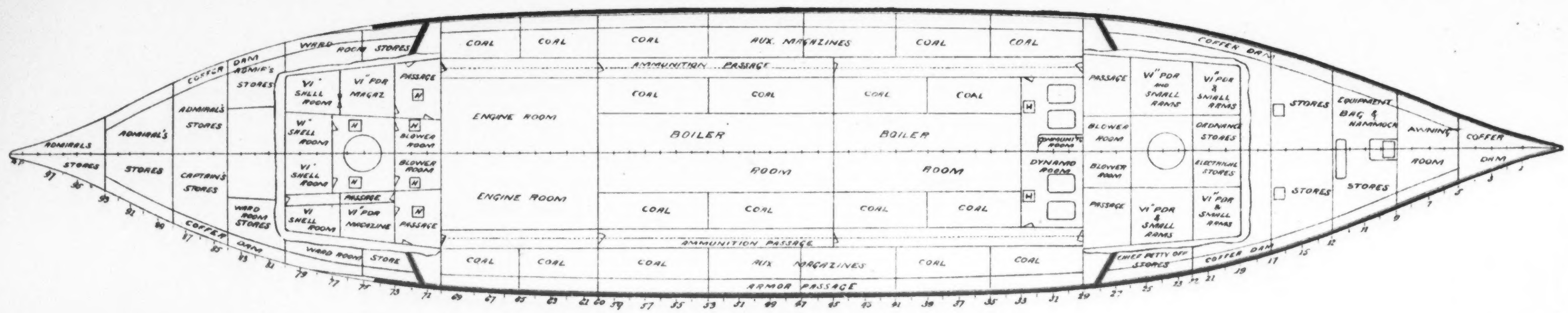


PLAN OF BERTH AND PROTECTIVE DECKS.



PLAN OF SPLINTER DECK AND ENDS OF PROTECTIVE DECK.

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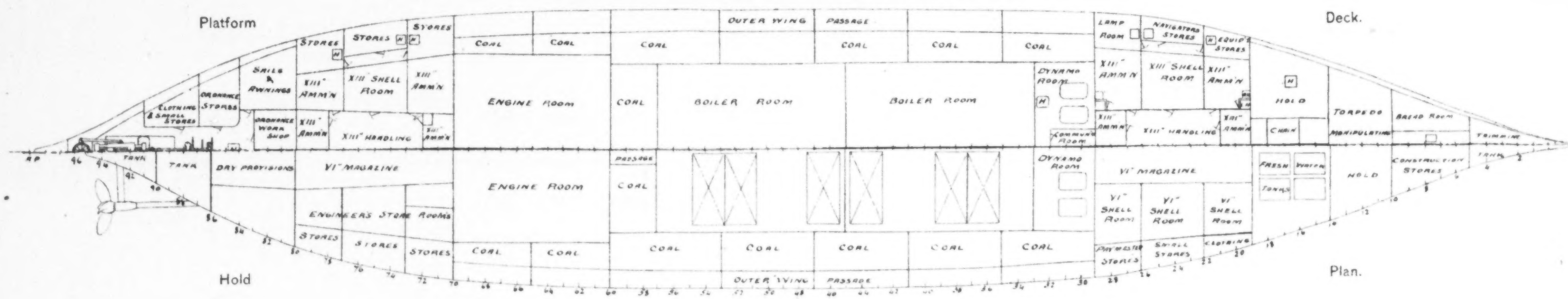

Hold

Plan.

HALF PLANS OF PLATFORM DECK AND HOLD.

PLANS FOR THE NEW U. S. BATTLESHIP "MAINE."

(Reproduced from Drawings Accompanying Paper by Philip Hichborn, Chief Constructor U. S. N. Read before the Society of Naval Architects and Marine Engineers.)

CHAS. HART, LITH., 36 VESEY ST., N. Y.

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in the discussion of forms for such reports at the recent meeting of the American Society of Municipal Improvements. The proposed new form appears to be a good one. Perhaps it contains some valuable features not included in the old one, but probably more would have been gained by bringing the old one to the attention of the association and recommending its adoption. Without an actual count of items it appears that the new form is longer than the old one. Many of the water-works using the New England form do so only after abbreviation. Until the compilation of municipal statistics under a uniform system is made compulsory, and entrusted to competent central administration, all attempts at uniformity should proceed along simple and easy lines, and the aim should be to increase the use of such existing forms, as are meritorious and well-established, rather than to secure the adoption of new ones.

THE NEW RAILWAY CONSTRUCTION OF 1898.

The steady decrease in railway construction in the United States which followed the "boom" years of 1886 to 1888, seems to have reached its lowest point in the figures of 1895, and to be now turning into a slow and healthy increase. The best available information indicates that the mileage of new railway line completed during the twelve months of the calendar year now drawing to a close will not fall far short of 3,000 miles. In 1895, according to Poor's Manual, 1,603 miles of new railway were built; in 1896, 1,668 miles, and in 1897, the greatly increased total of 2,094 miles. With 3,000 miles of new road, the year 1898 will present the largest figures of new construction since 1892, when 4,419 miles were built.

A general survey of the new work of 1898, shows the South and Southwest to have been the fields of greatest activity, while in the New England states, with one exception, construction has been almost nil. Important individual lines have been built in Maine, Pennsylvania, North Carolina and California, but it is the states of Alabama, Texas, Louisiana, Arkansas, Oklahoma, Missouri and Minnesota, all essentially Southern and Southwestern states, with one exception, which exhibit the longest lines and the greatest aggregate mileage of new road. Canada and Mexico have both added somewhat to their railway mileage during the year. Most of the new Canadian work has been done in the far western provinces, and the most notable single line is doubtless the new extension of the Canadian Pacific Ry. through the Crow's Nest Pass of the Rocky Mountains (Eng. News, March 10, 1898), to reach the rich Kootenay mining districts. The wilderness opened up by this line is exceeded only by that penetrated by the new narrow gage line to the Klondike, by which Alaska for the first time adds her quota to the new railway construction of the United States.

It may be of interest at this time to describe some of the more prominent of the new lines of 1898, using as a guide our weekly railway construction news columns, about one-half of the items in which are edited from official communications, and are, therefore, quite certainly accurate. It is not our intention to discuss the numerous more or less doubtful projects or such lines as have advanced no further than the surveys or grading. A number of these projected lines will doubtless be built, some of them, perhaps, before the close of another year, but this will depend entirely upon the financial backing which their promoters may succeed in securing.

One of the largest and most important pieces of work on this year's list of new construction is the Allegheny & Western Ry., which is to be an extension of the Buffalo, Rochester & Pittsburg R. R. From the old terminus of the main line at Punxsutawney, the new line will run to New Castle, via Adrian and Butler, Pa., a distance of 98 miles. Work is now well under way between Punxsutawney and Butler, and its farther extension to New Castle is projected in time to run trains over the entire route by next June. On this first section to Butler, a tunnel 2,317 ft. in length has just been finished, having taken five months to complete; track-laying has been commenced, and good progress is being made on the bridge, with a total length of 1,500 ft., which is to be built across the Allegheny River at Mosgrove. Excavation is progressing on a deep cut at Lyons farm, containing over 250,000 cu. yds. of material, and grading is active all along the stretch of six miles, from this cut to the Allegheny River, which is said to be one of the heaviest pieces of railway work in this country. Two steel viaducts will be built within 1½ miles of Adrian, one having a maximum height of 95 ft., and the other of 102 ft. At the "Devil's Gulch," one mile east of Adrian, there will be a steel culvert with a fall of more than 40 ft.; over this culvert there is an embankment 100 ft. high. In constructing this line the maximum grade employed is 1 per cent., compensated for curvature, and the rails used weigh 100 lbs. to the yard. The tunnel excavation and much of the grading and trackwork are being done by the Pennsylvania Construction Co., of Curwensville, Pa., under the supervision of Mr. J. M. Floesch, of Kittanning, Pa., as chief engineer.

Closely connected with the new Allegheny & Western R. R. is the Cleveland & New Castle extension of the Lake Erie & Western R. R., from Cuyahoga Falls to Youngstown, O., and thence to New Castle, Pa., a distance of about 80 miles. Contracts for the construction of this road were let in August in two sections, to Streeter & Co., of Chicago, for the portion between Akron and Niles, and to Ryan & McDonald, of New York, for the portion between Niles and New Castle. By means of the Allegheny & Western and this extension, the Brice system proposes to establish a new trunk line between Chicago and New York. The chief engineer of the Cleveland & New Castle extension is Mr. J. H. Pirkey, of Youngstown, O.

The Washington County R. R., in Maine, is also a project of considerable magnitude. This is an entirely independent line which, when completed, will connect Ellsworth and Calais, via Machias, Me., a distance of 116 miles. The work is being carried on in two sections, one of which, from Ellsworth to East Machias, a distance of 60 miles, has been mostly ballasted, while the other, extending to Calais, is being graded. Construction began about a year ago, and it was expected to open the first section for operation by Nov. 1, 1898. The company has acquired the St. Croix & Penobscot R. R., a short line running out of Calais, and it will also build a new branch from a point near Calais to Eastport. Besides opening up a new timber section in Maine, the line will make important connections with the Maine Central R. R. at Ellsworth, and with the Canadian Pacific Ry. and other Canadian railways at Calais. The promoters of the enterpirse are Mr. George A. Curran, of Calais; and Mr. J. P. McDonald, of Knoxville, Tenn.; while Washington county assisted to the extent of $200,000 in bonds. Mr. William Barclay Parsons, of New York, was the chief engineer.

Two large railway extensions that have been completed this year are the Fosston branch of the Great Northern Ry., and the Kulm branch of the Minneapolis, St. Paul & Sault Ste. Marie Ry. The former line extends from Fosston to Deer River, Minn., and is 98 miles in length, and by means of the Duluth, Superior & Western Ry., which has recently been purchased, and another extension of 28 miles from Cloquet to the Nemadji River Bridge, this branch will gain an entrance into Duluth for the Great Northern Ry. and provide a continuous line through northern Minnesota. Work was completed about the first of September. The Kulm branch, which was opened for traffic on October 17, runs from Kulm, in Le Moure county, to Hebard, Emmons county, N. Dak., a distance of 77 miles, where a junction will be made with the old grade of the Aberdeen, Bismarck & Northwestern Ry., which was partly graded in 1887 from Aberdeen, S. Dak., to Bismarck, N. Dak. The prime object of these two extensions is to accommodate the grain traffic from the Northwest to the Great Lake ports and the eastern seaboard.

In the southwest, one of the longest extensions is the St. Louis & Oklahoma City branch of the St. Louis & San Francisco Ry. The route is from Sapulpa, Ind. Ter., to Oklahoma City, via Stroud, Chandler and Wellston, a distance of 103½ miles. The contract to construct the line was let last February to Messrs. Johnston Bros. & Faught, of St. Elmo., Ill., who in turn sub-let the work to about a dozen contractors. On Aug. 1 our official reports showed that most of the grading has been completed, and about 75 miles of track laid. Mr. J. F. Hinckley, of Sapulpa, Ind. Ter., is the Chief Engineer.

The El Paso & Northeastern Ry. is another southwestern project well advanced towards completion. Starting from El Paso, Tex., on the Southern Pacific Ry., the line takes a northeasterly direction through a thinly settled region of New Mexico to White Oaks, at which place a junction is expected to be made with a projected extension of the Pecos Valley R. R. from Roswell. Of the entire distance of 165 miles, 86 miles are now ready for operation; work on the main line has stopped temporarily, it is stated, pending the construction of a 16-mile branch to timber lands across the route. Messrs. George S. Good & Co., of Lock Haven, Pa., received the contract for the work last December. The financiering of the project had not been entirely settled on October 1. The New Mexico Railway & Coal Co., of New York, which owns extensive coal mines in Arizona, is chiefly interested in this railway. Mr. H. A. Sumner, of El Paso, is chief engineer.

In California the most important work of the year is, doubtless, the final completion of arrangements which will insure the entrance of a new trans-continental railway into San Francisco, which city, notwithstanding the competition of its younger rivals in Southern California, and in Oregon and Washington, still remains the chief distributing center for the Pacific coast. All classes in California have long been restive under the monopoly of rail transportation in the state which the Southern Pacific Co. has long held, and the outcome was the building of the San Francisco & San Joaquin Valley Ry. in 1895, '6 and '7, extending from Stockton, on the Sacramento River, where steamer communication with San Francisco exists, southward about 235 miles through the most fertile farming section of California. During the present year the extension of the line from Stockton to San Francisco has been undertaken, and is now nearing completion, and arrangements have been completed by which the Atchison, Topeka & Santa Fe Co. acquires control of the road, and thus secures the entrance to San Francisco which it has for some time desired. To connect its present line with the new road, the Atchison will have to build an extension from its present terminus at Mojave to Bakersfield, or else secure trackage rights from the Southern Pacific for the use of its road between the two places.

The heaviest work on the Stockton-San Francisco extension is the "Franklin" tunnel, over a mile in length, now being driven through the Contra Costa Hills, 30 miles from San Francisco. Work is being carried on from both ends through a hard indurated clay, somewhat approaching slate, and considerable timbering is required throughout. Foley Bros. & Muir, of St. Paul, Minn., were awarded the contract in last February, and it was estimated that about 17 months would be required to complete the work.

The most important new line constructed in Canada is without doubt the extension of the Canadian Pacific Ry., by the construction of the Crow's Nest Pass and the Columbia & Western (Eng. News, March 10, 1898). Most of the track has now been laid on the Crow's Nest Pass line, from Lethbridge, N. W. Ter., to Nelson, B. C., at Kootenay Lake, a total distance of 287 miles. From Nelson to Midway a line is now in operation which will connect the new line with the Columbia & Western, now being built westward 105 miles. The completion of this latter line, and of a proposed branch from Midway to Penticton, and thence to Hope, will provide another transcontinental route much shorter than the present main line, which makes a long detour to the north.

The construction in this locality is of an extremely varied nature. The first 80 miles of the Crow's Nest Pass runs through what is called a prairie country, but it requires some heavy grading and much bridge work. On the next 25 miles the line reaches the summit of the Rockies, and there is considerable rock work. From the summit westward for 16 miles the work is also heavy, and includes two tunnels and a half-dozen bridges. The next 37 miles consists of earth and rock work, with a great deal of heavy clearing, and two 100-ft. bridges. Elk River is crossed by a three-span bridge, each span being 150 ft. long, and from here to the East Kootenay River and Wardner, about 23½ miles, the earthwork is again heavy, and three more bridges are required. From Wardner to Cranbrook, 23½ miles, the line passes through a park-like country, with the exception of five miles through the Isidores Canyon, where heavy rock excavation is again required. Thence to Moyie Lake, and along its east shore more difficulties are met with, requiring another 500-ft. tunnel, and then, after crossing the Moyie River and following the valleys for about 24 miles, another 35-mile section is reached requiring considerable excavation and trestle working. In this work the maximum grades are only 1%, and the maximum curvature, 12°. The manager of construction has been Mr. M. J. Haney, of Toronto, with headquarters at MacLeod, Alberta, N. W. Ter.

Turning now to a somewhat more general consideration of the geographical distribution of new railway construction, we find in the New England and the Middle Atlantic states a noticeable dearth of new work, other than that of the Washington County and the Allegheny & Western lines, already described. About 15 miles of new track have been laid in New York from Moira to the St. Lawrence River, by the New York & Ottawa Ry. This same company, however, has about 53 miles of new line on the Ontario side of the river, between Cornwall and Ottawa. In Pennsylvania several new branches and short extensions have been built to coal and timber districts. Such a line is the so-called Clearfield Southern, from Belsena Mills to Clearfield Bridge.

In the South Atlantic States, there are 40 miles of new work on the Richmond, Petersburg & Carolina Ry., and 22 miles on the Norfolk, Virginia Beach & Southern, in Virginia. The contract for constructing the Little Coal River Ry., a coal line 50 miles in length to be built in West Virginia, has been awarded, and in North Carolina, there has been about 125 miles of new track actually laid, with more to follow, on the Cape Fear & Northern, the Raleigh & Cape Fear, the North Carolina Midland, the Aberdeen & Ashboro, and the Carolina & Northwestern Rys. Extensions have also been built by the Carolina Midland Ry., in South Carolina; the Southern Ry., in Georgia, and to the Atlantic, Valdosta & Western Ry., in Florida.

In the Central Northern states most of the work has been in Ohio and Michigan on the Detroit & Lima Northern Ry., and its feeders. The building in the Gulf and Mississippi states has been more active. About 150 miles of track has thus far been laid in Alabama alone, with good prospects of more to follow before the close of the year. Among other lines being extended are the Alabama & Tombigbee, the Mobile, Jacksonville & Kansas City, and the Mobile & Ohio railways, which latter has completed its important connection between Jackson, Miss., and Birmingham, Ala., a distance of 167 miles, although most of the work of construction was carried on in 1897. The Yazoo Delta Ry., in Mississippi, has also been extended about 35 miles, and over 100 miles of track has been laid in Louisiana on the Louisiana & Northwestern, the Louisiana & Arkansas, the Southern Pacific and other lines.

In the southwest some of the railways which have added new mileage are the Kansas City, Osceola & Southern, from Osceola to Bolivia, 38 miles, in Missouri; the Arkansas, Louisiana & Southern, the Little River Valley and the Mississippi, Hamburg & Western Rys., in Arkansas, and the Colorado Valley, Chicago, Rock Island & Texas, and the Guadaloupe Valley railways, in Texas, which built in all about 150 miles. In Kansas extensions were built to the Kansas & Southeast, and the Hutchinson & Southern; in Colorado, to the Denver & Rio Grande and to the Golden Circle; in New Mexico, to the Pecos Valley, and in Oklahoma, to the Choctaw, Oklahoma & Gulf and other railways.

Of the Northwestern States, Minnesota has the greatest mileage of new track to its credit, viz., 175 miles, most of which is on the Great Northern Ry. In the other states of this section, extensions have been built to the Duluth, Mississippi River & Northern, the Muscatine, North and South, the Brainerd & Northern Minnesota, the Duluth & Northern Minnesota, the Gaylord & Ruby Valley branch of the Northern Pacific, and the Wyoming & Missouri River lines.

The work in the Pacific States, other than that on the San Francisco & San Joaquin Valley, which is most worthy of notice, is the 58-mile extension of the Gila Valley, Globe & Northern, from Geronimo to Globe, Ariz., a 17-mile extension of the Columbia Southern Ry., in Oregon, and the Union, Cove & Valley Ry., in Oregon. In Canada the only other company than the Canadian Pacific which has had important new extensions built is the Coast Ry., of Nova Scotia, which is being extended from Yarmouth towards Halifax.

In Mexico much important work has recently been done. President Diaz, in his annual message, delivered in the last part of September, states that since April the Mexican railway systems have increased by more than 314 kilometers (195 miles), of which 60 kilometers belong to the Mexican, Cuernavaca & Pacific; 60 to the Mexican Central, between Jiminez and Parral, which was later on completed for the whole distance of 89 kilometers on October 9; 40 to the Mexican National; 25 to the Mexican International on its branch between Reata and Monterey; and the remainder to other lines. Since this report, ten miles of track have also been laid on the proposed Chihuahua & Pacific Ry., which is being built by New York capitalists from Chihuahua to the Pacific coast, via. Guerrero, a distance of 600 kilometers (372.6 miles).

LETTERS TO THE EDITOR.

The Advantages of Blower Systems for Drying Materials.

Sir: The letter of Mr. E. L. Ballard, in your issue of Nov. 3, regarding the use of blowing fans instead of steam pipes for drying tobacco, attracted our attention, and as your comment on it seemed to imply that heat was necessary the same with as without the fan, and the subject is one that should interest every one who has to do with drying brick, lumber, starch, leather, tobacco, etc., we wish to add to the remarks already made.

The drying of any substance is simply the absorption from it of a portion of its moisture by means of a dryer surrounding medium. The natural method of drying is by placing the substance in the air and allowing the moisture to be absorbed by the air. The proportion of moisture absorbed will depend either on the amount of moisture already in the air or on the quantity of air present. Now, the amount of moisture that the air is capable of absorbing increases with its temperature, and the quantity of air depends on the size of the room relative to the amount of moisture in the article to be dried or on the current of air that passes by, absorbing and carrying off moisture as it goes.

Man soon learned that drying was facilitated by heat, and until within a few years the commonly recognized method of hastening drying has been by heating the air by steam pipes or otherwise, and thus increasing the capacity of a given volume of air to absorb moisture. A blowing fan accomplishes the same object by increasing the volume of air passing by the article to be dried and at the same time allows of better regulation.

Any drying, to be successful, must begin slowly and be hastened only when the inside of the article has become partly dry, in order to prevent cracking the surface or staining it by the coloring matter in the water dried out of it. If the surface of the article is made dryer than the normal air in which it is to be used, it becomes "dead" and brittle and will never regain its natural elastic condition. Overdrying is much more apt to occur if done by heat than by a fan with air at normal temperature. Some thick articles like brick or lumber may require a certain degree of heat to start the moisture from the inside toward the surface, but thinner articles, like leather or tobacco, keep their elastic qualities better if dried at a low temperature, and this can only be done in all conditions of the atmosphere without moulding by a fan.

The secret of successful drying lies in the ability of the man who does it, not in the method. Some form of hygrometer is almost a necessity in the beginning, as the whole process of successful drying depends on the relative humidity of the air, or its substitute, regulation of quantity. In commercial drying, where the quantity of material to be dried is always placed in a comparatively small room, it is necessary to use heat or a fan to prevent moulding, but the principal consideration is time, and the intelligent use of a fan will do the drying in about half the time that would be needed with heat only, and leave the material in better condition.

Yours truly,

Given & Aldrich,

Civil and Mechanical Engineers.

Birmingham, Ala., Nov. 8, 1898.

Automatic Couplers for Air Brake Hose.

Sir: In your issue of Oct. 27, in discussing the merits of automatic air hose couplers, you say that "automatic car couplers were introduced largely to illiminate the danger to life and limb incident to coupling moving cars by hand, but the brake hose cannot be coupled until the cars are already coupled, and are very rarely coupled up while the cars are in motion in the yard." As a man having experience, I will endeavor to show you wherein you err, and that automatic hose couplers are not as unimportant as your article would indicate. To make a coupling with the old link and pin coupler was not much of a feat for an experienced man. In fact, good railway men would prefer them to the present mixture of types. Of course, when we get automatic car couplers universally introduced, this feature will be overcome. The facts are that the "protection of life and limb" is only incidentally an issue in the introduction of the automatic car coupler. Every trainman, however, looks forward with joy to the time when automatic car couplers will be the only couplers in use, and they also appreciate the fact that the danger of car coupling will be greatly eliminated when that time arrives, and do not so very much care what the motive may be for the improvement. However, to return to the air hose coupler, it may be imagined by those not actively engaged in the train service that air hose are not coupled or uncoupled while cars are moving. This, however, is a mistake, and I will endeavor to show you the necessity of improvement along this line, if the lives of human beings are worth an effort to save.

It is a fact that many lives are lost yearly by trainmen in making hose couplings, and any automatic arrangement that can be utilized will be hailed with delight by the writer. Five trainmen make a trip when cars are coupled and uncoupled without coupling and uncoupling hose when cars are moving. I have in my mind now two co-employees who were killed outright, one in coupling and the other in uncoupling hose. The one killed while coupling was doing so while the train was being made up in the yard, and in order to have the "air" ready to inspect when the train was "thumbs up." While making the coupling a "cut" of cars struck and caught him, drew him under and killed him. The other was uncoupling hose while the train was moving, and was caught by the wheel on the truck of the following car, drawn under and killed. Trainmen follow this practice to expedite the work, and as a rule they are the men who worked at railroading before air brakes came into use, consequently it seems to take so long and to consume so much unnecessary time to wait for cars to come to a stop before coupling and uncoupling hose, when compared with previous work when the automatic brakeman was unknown. For instance, you are switching a train, hose all coupled and train pipe charged, and you want to cut off one or more cars. You swing in with a foot on each brake beam, shut off the angle cocks, and reach down and lift up on the hose until it becomes uncoupled. Then all you have to do is to pull the pin and there you are, i. e., if you don't slip and fall under, then, there you are any way. You may say that this is unnecessary risk, but when the chief dispatcher is asking, "what is delaying you?" or "why don't you get out? You are laying out No. 150," or some other question familiar to "old timers," all kinds of schemes are resorted to in order to hasten the work and avoid a "jacking up," which is not pleasant. And this coupling and uncoupling of air hose is one of the schemes most commonly resorted to. So "all hail" to the automatic hose coupler.

"Sivart."

Grand Junction, Colo, Nov. 5, 1898.

The Engineers' Work in the Santiago Campaign.

Sir: I was gratified to find in the Oct. 13 number of the Engineering News a valuable article by Mr. Chibas relative to the work of the engineers in the Santiago Campaign, accompanied by a well-done and useful map reduced from the official information showing the position of the troops in the vicinity of Santiago. I also note with satisfaction your editorial comment. As a matter of fact, much injustice has been done by some newspaper writers and others in commenting upon the practical work of the Santiago campaign, for the reason that the actual situation was hardly at all understood by others than those of the military authorities more immediately responsible for the execution of the military plans.

The Santiago campaign was a particularly rough, and, in a sense, hazardous enterprise, in a tropical region, meagerly known as to topographic details, at the sickly season, and with troops which, while they possessed mental and physical attributes of a high order and an admirable discipline, were ill prepared to meet the special difficulties of locality and climate. It was practically a race between the physical endurance and military spirit of the men and the destructive malarial influences that were lying in wait for them. It resolved itself into a question of time. Had full preparations for landing and movement, such as wharf and railroad, wagon road and bridge construction, been practicable, as in fact it was not, it would still have been entirely inexpedient to lose time on them. The work indicated would have taken at least a month under the most favorable circumstances, and the immediate consequence of this delay in completing the military enterprise would have been that the army would have been on its back prior to the surrender instead of after, and in all probability we should not have accomplished our results at all. In fact, the disembarkation of the troops was accomplished within 48 hours; and sufficient horses and mules to serve the immediate purpose, together with three days' rations, were put on shore in another day; and this included the transfer and disembarkation of 3,000 Cubans in addition to our own forces It will be admitted, I presume, after looking at the matter broadly, that the results sought in the campaign were in every sense thoroughly attained, and this after all is the main object of a military enterprise, and minor matters must be waived in the presence of an urgent military exigency.

For the comparatively rough engineering that was required, General Shafter had at his disposition his Corps Engineer, Colonel Derby, regularly assigned to him, and two companies of engineers in addition, including eight engineer officers with several others detailed at various headquarters, and these gentlemen performed in the fullest measure all the engineering work that was practicable or expedient, including the multiplied reconnoissance work, which, to great extent, was conducted under maximum topographical difficulties, and often under fire in the immediate presence of the enemy.

My own direct connection with this work, involving these minor details, was therefore unnecessary, and I was given command of a brigade at the front, where General Shafter believed that I could he of greater service to him. This enabled me to give personal attention to the military engineering proper, namely, the laying out and construction of the investing trenches, by which, in fact, the ultimate surrender of the Spanish army was finally compelled.

I state this in view of the paragraph below the middle of the third column on page 227 of Mr. Chibas' interesting and valuable article, in which he states that the trenches in the Santiago campaign were not laid out by the engineers, but were constructed by the troops of the line, under the direction of their own officers. While this is perfectly correct, it might lead to a misapprehension, because it so happened that my brigade held the extreme right, and I was specially charged by the division commander, General Lawton, with the designing and construction of the entrenchments.

I enclose you a copy of your map, which I have been glad to use as a matter of official record, a duplicate having been sent to the Adjutant-General and to the Chief of Engineers. On this map I have made certain corrections and additions.

First: Adding the position on the left of my line at Caney of the 2d Battalion of the 22d Infantry, one of the regiments in my brigade, occupying an extremely important point where it was enabled to completely cut off the retreat of the Spaniards by commanding the only possible means of exit by road.

Second: By adding the position occupied by General Sanchez's troops on the west side of the bay, across the Cobre Road. General Sanchez was under my orders and stationed in connection with my brigade.

Third: Showing the several positions (4 in number) occupied and entrenched by my brigade. A portion of the entrenchments between positions 1 and 2, and all of the entrenchments between positions 3 and 4, were also prescribed by me, and, to a considerable extent, executed by Cubans under my direction.

These matters are of interest to yourselves and to others as matters of engineering history and record, for which reason I have taken the liberty of communicating with you on the subject, and sending you the corrected chart, which is enclosed.

Yours very truly,
William Ludlow,
Major-General, U. S. A.

Army Building, New York, Nov. 4, 1898.

(As it is practically impossible to reproduce and correct the maps published in our issue of Oct 13, we here attempt to verbally indicate the corrections and additions made by Gen. Ludlow, reference being made to the maps as published: In the first map, showing conditions on July 1, the position of the 2nd Bat., 22nd Infantry, at Caney, is changed to a point on the road leading from Caney to San Miguel. The camp of the 1st Brigade, 2nd Division, on June 30, is also shown on the Siboney road, at the south tributary to the Rio Seco, just east of La Reconda. On the map of July 14, the following additions are made: The headquarters of the Cuban General Sanchez are shown at Dos Caminos, on the Cobre Road, leading out of Santiago, and his troops occupied the point on this road marked "cemetery." Gen. Ludlow also indicates the four successive positions occupied by the 1st Brigade, 2d Division, on the dates named, as follows: (1) July 2 and 3, at San Juan Hill; (2) July 4 to 7, near position on map, marked by " Light U. S. Battery, 4 guns, Col. Theaker"; (3) July 8 to 10, at position marked or 12 I, field battery 71,"; (4) July 11 and Aug. 13, northwest of Santiago, with right wing resting on the "cemetery," and left wing extending to and including the 2d Mass. Regt.—Ed.)

Notes and Queries.

Apropos of the recent discussion in these columns of the relative resistance to corrosion of iron and steel, a correspondent writes that plumbers prefer iron to steel for underground or enclosed work, and states that iron stovepipes outlast those of steel by several years.

In publishing an abstract of the paper of Mr. A. L. Adams, M. Am. Soc. C. E., on "Wood Stave-Pipe," in our issue of Oct. 27, an error in numbering figures 1 and 2, in the paper as it appeared in the Transactions of the American Society of Civil Engineers, was reproduced in this journal. These figures should be transposed, and Fig. 1 should be Fig. 2, and Fig. 2 should be Fig. 1.

CONCRETE AND STEEL FLOORS FOR THE PETIT PALAIS DES BEAUX ARTS; PARIS EXPOSITION.

In the article with the above caption printed on p. 302 of our last issue, the illustration of the beam system of construction (Fig. 2) was accidentally omitted. We therefore insert it here and refer our readers to the second column of p. 302 in our preceding issue for a description of the construction. It may also be noted here that in the fourth paragraph of the article as printed, in stating the requirements of the test, it should have read that the "deflection" must not exceed 1-800th of the span, instead of the "rise."

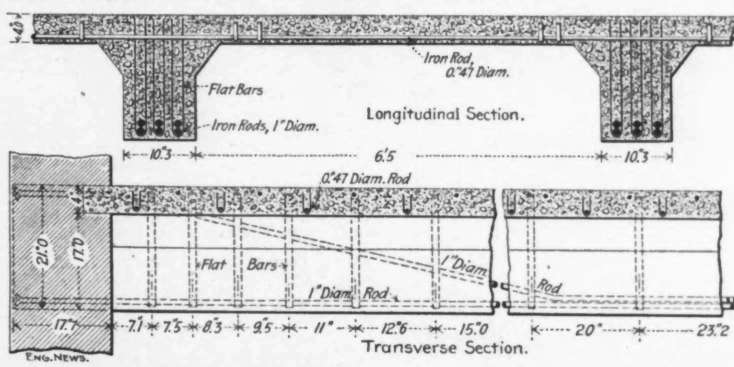


FIG. 2.—HENNEBICQUE BEAM SYSTEM OF STEEL AND CONCRETE FLOOR CONSTRUCTION FOR THE PETIT PALAIS DES BEAUX-ARTS FOR THE PARIS EXPOSITION OF 1900.

NOTES FROM THE ENGINEERING SCHOOLS.

University of Illinois.—A visit to the Engineering Department of the University was made on Nov. 11 by a large number of the members of the Western Society of Engineers and other visitors, including several of the trustees of the University. The party came by a special train on the Illinois Central R. R., arriving at 1 p. m., and leaving again at 6.30 p. m. At the engineering building the visitors were received by President Draper and the staff of professors, and luncheon was served in the physics laboratory.

The party was conducted through the building and then through the woodworking shops, machine shops, electrical and mechanical engineering laboratories, laboratory of applied mechanics, the new central boiler-house for the heating plant, and finally to the new library building, which was designed by Prof. Ricker, Dean of the College of Engineering, and one of the earliest graduates of the university.

The party was conducted by President Draper, assisted by Professors Baker, Breckenridge, Pence and others. After a tour of inspection, the party assembled in the physics lecture room, and brief speeches were made by the President, and by Messrs. L. P. Morehouse, Richard Price Morgan, R. W. Hunt, Isham Randolph, H. W. Parkhurst and Prof. I. O. Baker.

Massachusetts Institute of Technology.—The new building just erected for the use of the Institute will be called the Pierce Building, in honor of the late Hon. Henry L. Pierce. Mr. Pierce was a member of the Corporation from 1885 until the time of his death. He was a leader in a line of business making large demands on science; and he always expressed a keen interest in the Institute, its ideas and work, as shown by visits and suggestions, and by his frequent and liberal gifts. His various benefactions amount to $770,000 to Oct. 31, 1898.

The circular of the Lowell Free Courses in the Institute of Technology is now ready for circulation. Among the timely courses given are: "The Structure and Strength of Ships," by Prof. Peabody; "The Computation of Earth Work," by Prof. Allen; "Sanitary Science and the Public Health," by Prof. Sedgwick; "Mechanism and Gearing," by Prof. Merrill; "English Composition," by Prof. Bates; and the usual mathematical courses and electrical testing laboratory exercises by Prof. Laws.

University of Nebraska.—The north wing of a new building, known as "Mechanic Arts Hall," has been dedicated with appropriate exercises, including addresses by President Chaplain and by Morgan Brooks, the recently-appointed professor of electrical engineering. The building is of brick, plain, but substantial, and cost a little over $30,000. It will require at least $60,000 more to complete it as planned.

Prof. O. V. P. Stout, head of the civil engineering department, who has been engaged throughout the summer and fall in constructing a flume and power station for the Ingold Placer Mining Co., of Boulder, Colo., is now at his place in the University. Adjunct-Prof. Geo. R. Chatburn has had charge of the department during his absence.

THE NEW U. S. BATTLESHIP "MAINE."

(With two-page plate.)

At the annual meeting of the Society of Naval Architects and Marine Engineers, held in New York last week, a paper was presented by Commodore Philip Hichborn, Chief of the Bureau of Construction and Repair, U. S. N., on "Designs of the New Vessels for the U. S. Navy." We reprint that portion of it relating to the three new battleships, recently placed under contract, in full below, and have reproduced upon our inset sheet the drawing of the new "Maine," which accompanied Commodore Hichborn's paper:

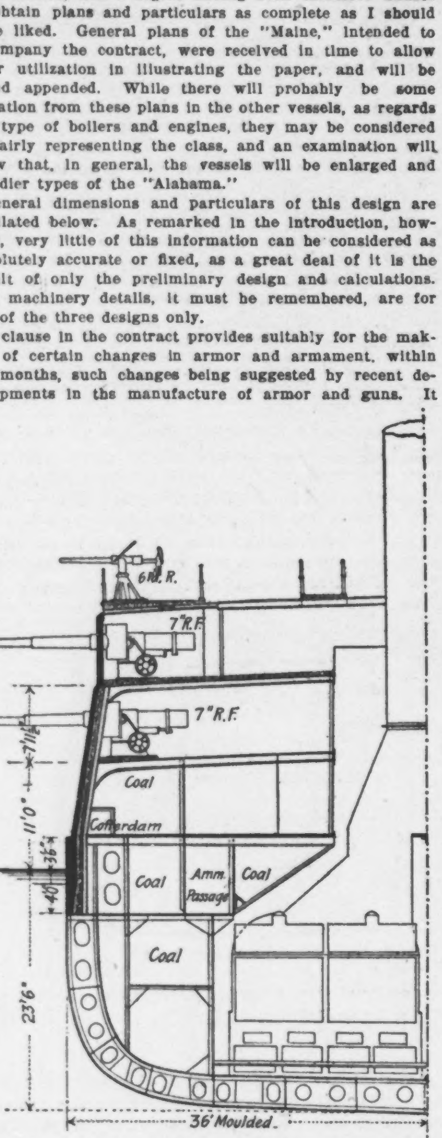
Believing that the "Alabama" class represented an efficient type, the Department, in issuing circulars and plans for the three battleships appropriated for, concluded practically to duplicate that class as regards size, speed, armament, etc. It was decided, however, to invite bidders to submit their own designs, offering preference—other things being equal—to bids guaranteeing the highest rate of speed and greatest coal endurance, without exceeding the total weight of engines, boilers and coal, or the space allowed therefor, as provided in the Department's plans and specifications.

The result was highly satisfactory. The designs submitted, after some revision, provided, in effect, an 18-knot vessel 20 ft. longer and of 1,000 tons greater displacement, but in other respects conforming to the original plans and specifications, excepting, of course, the changes in design of boilers and engines to meet the additional requirements of power on the weight allowed.

The preliminary acceptance of these propositions had to be followed by a revision of plans and specifications before any contract could be drawn. At the time of preparing my paper this work was still in the hands of the builders, and I regret having been therefore unable to obtain plans and particulars as complete as I should have liked. General plans of the "Maine," intended to accompany the contract, were received in time to allow their utilization in illustrating the paper, and will be found appended. While there will probably be some variation from these plans in the other vessels, as regards the type of boilers and engines, they may be considered as fairly representing the class, and an examination will show that, in general, the vessels will be enlarged and speedier types of the "Alabama."

General dimensions and particulars of this design are tabulated below. As remarked in the introduction, however, very little of this information can be considered as absolutely accurate or fixed, as a great deal of it is the result of only the preliminary design and calculations. The machinery details, it must be remembered, are for one of the three designs only.

A clause in the contract provides suitably for the making of certain changes in armor and armament, within six months, such changes being suggested by recent developments in the manufacture of armor and guns. It



Half Cross-Section Amidships of New U. S. Battleship "Maine."

is believed, for instance, that a reduction of at least 25% in the thickness of heavy armor can be made when treated by the Krupp process, without lowering its efficiency in resisting penetration. This will be found suggested in the design here presented, although the matter is not definitely settled at this time. The latest type of 12-in. gun, with smokeless powder giving a muzzle velocity of 3,000 ft. per second, is believed equal if not superior to the 13-in. guns of our present battleships. England is limiting the size of her heaviest guns to 12-in., and other European navies are installing nothing larger. This change to 12-in. guns is therefore to be expected in the designs in question, and the number of 6-in. guns will, of course, be increased as a consequence—probably to 16. The secondary battery provided in the "Maine" design has been increased over that of the "Alabama" class, on account of increase in the length of the vessel. The number of 6-pdr. guns stated may also be changed somewhat.

One very important improvement in the new battleships will be the installation of under-water torpedo tubes. There will be two of these submerged tubes in a single compartment fitted up for the storage of eight 17-ft. torpedoes and appliances for handling and operating the same. The war heads will be conveniently stowed in a separate compartment. We have been rather tardy in adopting the submerged discharge for torpedoes, but the matter has been made the subject of considerable study and some experiment, so that it is to be hoped that our first attempt at this difficult installation will be more successful than some of the early efforts of European designers in this connection.

It is interesting to note, under the schedule of weights given below, which represents the vessel in trial condition, in which she is to attain a speed of 18 knots, the relatively large amount of coal, ammunition and stores to be carried on trial. The total coal bunker capacity is also very large, it being fixed at 2,000 tons. This, of course, involves the closest possible stowage, and the figures cannot therefore be compared with those based on loose stowage, as given out for our previous battleships. It will also be seen by comparison between the estimated collective I. HP. and the total heating surface of the boilers, that the number of square feet of heating surface per horse-power is over 3.6. These figures, of course, are only estimates as yet.

Considered as a whole, however, the "new designs" for battleships—with the slightly lengthened hull and general arrangement of the "Alabama" class, with the immense addition in engine power, and with the improved armor and armament likely to be fitted—certainly embody the very best features known to naval science. It is of special importance that the improvements in design have been accomplished with practically no sacrifice in draft, in which respect these ships will have an advantage of from 18 ins. to 2 ft. over vessels of their same class and size in Europe. The fact that the contract price for hull and machinery for the "Maine" class will exceed by less than 10% that of the "Alabama" class speaks well indeed for the progress of the shipbuilding art in this country. The contract time, furthermore, has been reduced.

Dimensions and Particulars.

Hull.

Length on load water-line	388 ft.
Length over all	393 " 9 ins.
Breadth, molded....72 ft.; extreme....	72 " 2½ "
Freeboard, forward	20 "
Freeboard, aft..13 ft. 3 ins.; amidship..	20 " 3½ "
Mean draft, with 1,000 tons coal and all stores and ammunition	23 " 10¼ "
Corresponding displacement (trial)	12,500 tons.
Speed per hour in knots	18
Area amidship section	1,637 sq. ft.
Area load water plane	21,000 " "
Tons per inch immersion	52
Moment to alter trim 1 in	1,050 ft. tons.
Wetted surface	35,572 sq. ft.
Mean draft, with all provisions, stores, ammunition, and 2,000 tons of coal on board	25 ft. 6 ins.
Corresponding displacement	13,500 tons.
Metacentric height (at 25 ft. 6 in. draft).	4.20 ft.
Range of stability at same	68°
Maximum righting arm	2 ft. 5 ins.
Maximum righting moment	32,535 ft. tons.
Angle of maximum righting arm	36°

Armament.

Main battery	4 13-in. B. L. R., 14 6-in. R. F.
Secondary battery— 20 6-pdr. R. F., 6 1-pdr. R. F., 4 Gatlings, 1 field gun.	
Height of guns above 23 ft. 10¼ in. L. W. L.:	
Axis of forward 13-in. guns	26 ft. 1½ ins.
Axis of after 13-in. guns	18 " 7½ "
Axis of 6-in. guns, main deck	15 "
Axis of 6-in. guns, upper deck	22 " 4½ ins.

Thickness of Armor.

Water-line belt, amidships:		
To 1 ft. below 23 ft. 6 in. L. W. L.		12 ins.
Bottom		8½ "
Height above 23 ft. 6 in. load line	3 ft.	6 "
Total depth of belt	7 "	6 "
Side armor above main belt		5½ "
Superstructure armor		6 "
Turret armor (13-in. gun)	17 and	15 "
Barbette armor	15 "	10 "
Protective deck armor	2¾ to	4 "
Conning tower armor		10 "

General Schedule of Weights.

Hull and fittings	4,836 tons.
Armor and bolts	2,933 "
Protective deck armor	600 "
Armament and ammunition	1,058 "
Machinery, with water	1,396 "
Equipment	199 "
Outfit and stores	478 "
Coal	1,000 "
Total	12,500 tons.

Machinery.

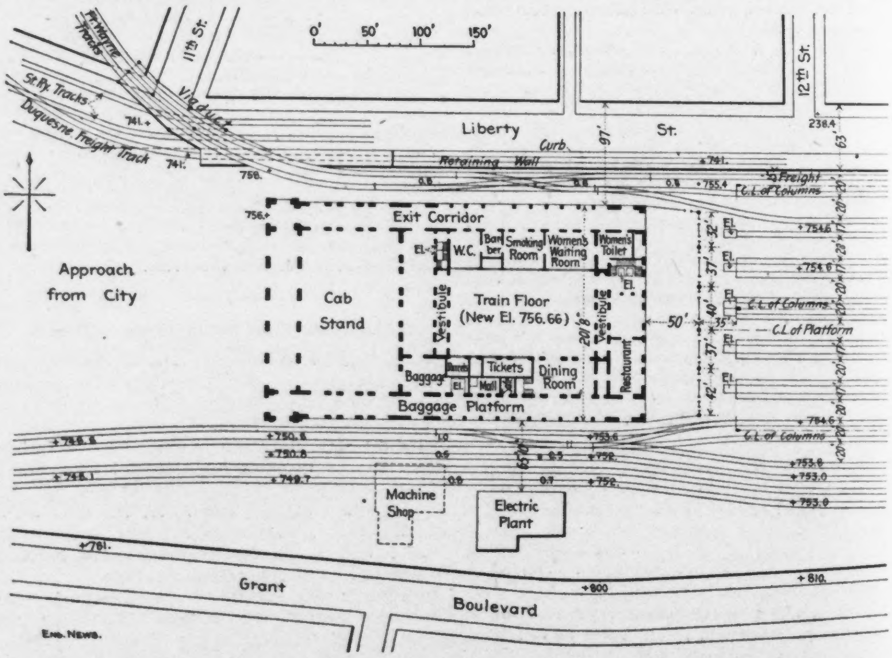
Vertical, inverted cylinder, direct-acting, triple expansion engines, in two water-tight compartments:	
Collective I. HP. of propelling, air-pump, and circulating-pump engines.	16,000
No. of revolutions at this power	126
Cylinder diams., ins	38½, 59 and 92
Length of stroke, ins	42
Cooling surface, main condenser	9,600 sq. ft.
Cooling surface, auxiliary condenser	800 " "

Boilers.—24 Niclausse water-tube type, in three groups of 8 boilers each. Each group is subdivided by the center line bulkhead. Each boiler will have 15 elements of 24 tubes, the whole number of elements being 360 and the number of the tubes 8,640.

Total heating surface	58,104 sq. ft.
Total grate surface	1,353 " "
Working pressure (gage) lbs. per. sq. in.	250

NEW STATION OF THE PENNSYLVANIA R. R. AT PITTSBURG, PA.

The Pennsylvania R. R. has for several years past been expending vast sums of money upon the improvement of its road and its terminals, and is now about to undertake the reconstruction of its Pittsburg terminals at a cost of probably over $1,500,000. This work will include the elevation of its tracks through the city, and the construction of a handsome new station on the site of the present station. We show a general plan of the new arrangement, from which it will be seen that there are to be both through and stub tracks, the station building having tracks on three sides, with the street approach on the other side. The main floor of the new station will be about 12 ft. above that of the present structure, and the elevations of the different tracks, etc., are marked upon the plan. The Pennsylvania R. R. proper comes in at the east end of the station. The Pittsburg, Fort Wayne & Chicago Ry. comes in from the northwest, crossing the Allegheny



GENERAL PLAN OF NEW TERMINAL AND STATION FOR THE PENNSYLVANIA R. R. AT PITTSBURG, PA.

Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer D. H. Burnham, Architect.

River. The Pittsburg, Cincinnati, Chicago & St. Louis Ry. comes in from the southwest, crossing the Monongahela River.

On the Liberty St. side will be two through tracks of the Pittsburg, Fort Wayne & Chicago Ry., brought in on a curve from 10th St. and the Allegheny River bridge. These tracks cross Liberty St. by a viaduct. One of them will be a freight track, outside the trainshed. The other will run through the trainshed, and will also connect with another passenger track. A double crossover will facilitate train movements. There will be a retaining wall along Liberty St., the street level being 14.4 ft. below that of the tracks. The Duquesne freight track will remain at the street level, being separated from the roadway by a curve, and will cross the tracks of the street railway just beyond the station.

On the Grant Boulevard side of the station will be four through tracks, two of which will be entirely independent of the station tracks, while the other two will connect with two of the station tracks by means of crossovers. This side of the station is against the slope of the hill, Grant Boulevard being from 30 to 55 ft. above the tracks. On this side of the building will be the electric power station.

The trainshed will be 550 ft. long and 225 ft. wide c. to c., of the outer lines of columns. It will cover twelve tracks, and six platforms, each of the latter being 20 ft. wide. There will be three through tracks and nine stub tracks in the trainshed, with baggage elevators at the ends of the latter. A transverse platform 85 ft. wide extends from the headhouse to the ends of the tracks, for the full width of the building, and at 50 ft. from the headhouse is an iron fence with gates. This forms a 50-ft. concourse to effect a distribution of the crowds and serve as an auxiliary to the waiting room.

The station proper or main building, will be about 360 ft. long and 201 ft. 8 ins. wide, with a height of four stories in the main portion, 235 x 155 ft. At the city approach, and extending the full width of the building, will be a covered way about 25 ft. wide, opening into a carriage concourse, 90 x 150 ft., beyond which is a vestibule containing entrances to the main waiting hall and to the baggage room. In the center of the main building will be a grand hall or waiting room, 135 x 80 ft., with a vestibule at each end, one opening upon the street entrance and the other upon the main platform or concourse. On one side of this hall will be the railway and sleeping-car ticket offices, parcel room, dining room, restaurant, mail room and baggage room. Beyond these will be a covered baggage platform about 20 ft. wide. On the other side of the main hall will be the smoking-room, women's room, toilet rooms and barber shop, outside of which will be a corridor 20 ft. wide for passengers going from the trains to the street. In each side of the building will be stairways and elevators communicating with the several floors.

While this general interior arrangement is a very common one, it seems to us to be open to serious objection in that it makes the waiting room the main thoroughfare to the trains and the principal place for the transaction of business. Passengers who are waiting for trains are, therefore, continually disturbed by the noise and bustle, and while there is a separate waiting room for women, there will be apparently no place where men who are sick, weak or weary can rest in quiet. It seems to us that it would have been better to make this great hall narrower, with ticket, parcel and news rooms opening upon it, and with waiting rooms separate from it. This general arrangement has been adopted in some stations, notably in the Park Square station at Boston, much to the comfort and convenience of the traveling public.

The approach will be a broad space paved with asphalt, and it is proposed to run branch tracks from the street railway on Liberty St. up to one side of the station.

The entire planning of the new terminal system, with its station and track elevation, has been done under the direction of Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer of the Pennsylvania R. R., to whom we are indebted for the plan and the view of the building. The architectural design was prepared by Mr. D. H. Burnham, of Chicago.

The stations and trainsheds of the Pennsylvania R. R. at Jersey City and Philadelphia have been described and illustrated in our issues of Dec. 27, 1890; Sept. 26, and Oct. 3, 1891; Oct. 6 and 13, 1892, and June 1 and 8, 1893.

A CHAIR OF MUNICIPAL ENGINEERING and a lectureship of municipal hygiene has been established at University College, London, under provisions made by that eminent sanitarian, the late Sir Edwin Chadwick. Prof. Osbert Chadwick, M. Inst. C. E., son of the founder, remarked during the exercises accompanying the ceremony, that the title of sanitary engineer has been appropriated by the plumber and glazier, making the title, municipal engineer, necessary as a substitute.

THE CIVIL SERVICE EXAMINATION to select two electrical engineers, announced on page 289 of our last issue, has been cancelled by the Civil Service Commission. Hereafter the subject of electrical engineering will be optional in junior civil engineer examinations for the Engineer Department at Large (War Department), so that persons qualified as electrical engineers may have an opportunity to have their qualifications tested. The junior civil engineer examination will be given next spring. Applications and information in regard thereto may be obtained after Jan. 15, 1899.

THE LAKE SUPERIOR & MICHIGAN CANAL CO. is being incorporated at Lansing, Mich., and surveys are being made. The chief promoters are Messrs. D. C. Dennison, A. H. Parker and C. W. Parker, all of Chicago. They hope to utilize a glacial valley occupied by a series of swamps, and estimate the cost of the canal at about $4,000,000. But Mr. L. E. Cooley says that the best topographical maps show a divide between the two lakes about 300 ft. high; and it would not pay to lock over this divide, even if water were available—which he doubts.

THE TENNESSEE RIVER IMPROVEMENT ASSOCIATION will hold its annual meeting at Chattanooga, on Nov. 23; General Joseph Wheeler is President, and will preside.

TWO CAST-IRON LIGHT-HOUSES are to be erected on the Norwegian coast, at Okso and Utvar. Each will be 85.28 ft. high and 27.22 ft. in largest outside diameter, tapering to 14.76 ft. at the top. Besides a basement ring, each will be made of 16 sectional rings of cast-iron bolted together; the plates will be 30 mm., or 1⅛ ins. thick at the bottom, and for other courses 1.1 ins. The rings have inside flanges, 12 plates to the circle.

NEW OCEAN STEAMER TRACKS, for North Atlantic vessels, have been adopted by the steamship managers, as the result of a recent conference in London. Two, instead of three tracks, as at present, were decided upon. From Jan. 15 to Aug. 14 the west-bound track will be from Fastnet, or Bishop's Rock, on the great circle course, to the crossing of meridian 47° W., in latitude 42° N.; thence, by either rhumb line or great circle, to a position southward of Nantucket lightship; thence to Fire Island, when bound for New York; or to the Five Fathom Bank South lightship when bound for Philadelphia. From Aug. 15 to Jan. 14, the westward course would cross meridian 49° W., in latitude 43° N. The eastward course, at all seasons of the year, would cross meridian 70° W., at latitude 40° 10′ N. From this crossing, from Jan. 15 to Aug. 23, the course would cross meridian 47° W., in latitude 41° N., to Fastnet, or to Bishop's Rock. From Aug. 24 to Jan. 14, the latter course would cross meridian 60° W., in latitude 42° N.; thence by rhumb line to cross meridian 45° W., in latitude 46° 30′ N.; thence to Fastnet or to Bishop's Rock, as the course lies for the Irish or the English Channel. All of the steamship lines agree to this arrangement.

MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The 6th annual meeting of this society was held Nov. 10-11, at the House of the American Society of Mechanical Engineers, in New York city.

At 10.30 a. m. President Clement A. Griscom called the meeting to order, and Secretary Francis T. Bowles read his report, which also included the financial status of the society. He stated that 50 applications for membership had been received, and that there was a balance of $7,000 in the society's treasury. The list of candidates presented by the Council was passed upon by acclamation, after which the officers for the past year were re-elected, Mr. G. W. Dickie, of the Union Iron Works, being substituted for the late John F. Parkhurst, as member of the Council. Following this, Mr. Griscom, the president, read a brief address, in the course of which he said:

The past year has been one of exceptional interest to the members of the society. The laurels won on the decks of the warships built in the shipyards of the United States have electrified the world, and the marvelous victories gained reflect credit which can well be shared by our gallant naval officers with the designers and builders of the ships, which they commanded.

The demands made by the government in the war with Spain for colliers, water boats, troopships, hospital ships, supply vessels, guard boats, blockading vessels, scout and cruisers largely exceeded the supply found in our merchant marine. The navy purchased about 110 vessels of various classes, and the War Department chartered and purchased about 100 important steamships, and these 200 vessels, ranging in size from yachts to ocean liners, were fitted for war purposes with incredible despatch, and upon the whole in a most effective manner.

An enormous public interest has been awakened in the performance of this so-called "Auxiliary Navy," and the practical lesson the country has received from the late war leads me to repeat what I had the honor of saying to you in 1894.

It should be understood that a modern naval force, with all its multitude of equipment, arms, munitions and accessories, cannot be produced on the spur of the moment, but is the product of naval architects, steel makers, and a host of others whose skill can only be obtained by experience. It must not be overlooked that the personal element in warfare as in peace is an all-powerful one, sometimes predominating, sometimes secondary, but always of the greatest importance, and, therefore, an adequate navy is necessary, not only for the actual representation of power and force, but also to secure to our officers and men that superior nautical training only to be obtained by such continued experience at sea as made heroes of Hull, Decatur and Farragut.

The full development of a naval force, however, is not possible unless the growth of the merchant marine has kept pace with the naval development. The words of Sir Nathaniel Barnaby, "No nation can maintain an efficient navy without a prosperous commercial marine to support it," has still the force of an axiom. It should not be overlooked that, in time of war, the conversion of fast mail steamers into armed cruisers is generally recognized among all maritime nations as a most formidable means of offence or defence for any country so fortunate as to possess them; moreover, to provide for the expansion of naval personnel rendered necessary in time of war, there must be a well-trained merchant marine to draw upon, and those nations which have not encouraged shipbuilding and shipowning in times of peace must inevitably suffer from their shortsighted and narrow policy when confronted with a powerful hostile fleet.

It is not too hopeful to predict that one of the results of the war, resulting in the acquisition of distant insular territory, will exercise a marked effect upon our shipbuilding industry; indeed, it may be the turning point from which this nation may commence to regain its once proud position as a shipbuilding, shipowning and seafaring people; and it is very happy testimony to your skill as naval architects and marine engineers that several orders have already come from foreign nations for warships of the first class and it is well known that foreign shipbuilders and capitalists have commenced seriously to examine with interest the advantages of this country for shipbuilding.

The reading of papers began with one by Mr. Arthur B. Cassidy, entitled, "The Standard Navy Boats." This paper briefly reviewed the various types of small boats, such as dories, whale boats, surf boats and the like, and then described the several types of steam launches and boats now adopted by the United States Navy Department as standard for use on all naval vessels.

In the design of these boats the four essentials in order of importance are: Safety, weight, comfort and speed. Just how these requirements are met was fully explained, as were also a number of constructional details. Two tables were included; one, giving the maximum number of men, weight of provisions and water and freeboard, when loaded of the standard described; and the other giving the sail area, area of load water line, etc., for the same boats. These figures range from 64 men, 640 lbs. of provisions and 505 sq. ft. of sail for the 33-ft. launches, to 10 men, 100 lbs. of provisions, and 126 sq. ft. of sail for the 18-ft. dinghies. The statement was also made that at present there were in use in the navy 1,000 boats of all classes, the life of any one of which would not average more than 10 years. Accompanying the paper were 21 plates giving the constructional details of a number of designs of each type of boat mentioned, and 16 full-page half tones, taken from actual boats.

The discussion was introduced by Mr. H. De B. Parsons, who asked what the author's experience with folding boats had been. Such boats were used by foreign navies, and also by the merchant marine. Mr. W. P. Stephens remarked that the area of sail provided appeared small, and it seemed to him could be increased with material advantage.

Capt. J. W. Miller also considered an increased sailing power desirable, and he suggested the use of a centerboard with suitable stiffening. His experience with 12 boats used in connection with the New York naval militia convinced him that the boats now used were not good sailers.

Col. E. A. Stevens asked if metal boats had been tried by the navy. He also understood that cypress planking was at one time used, but that it had been abandoned, and wanted to know why.

Lieut. W. P. White mentioned a report of a board appointed to investigate the question of small boats which was published in the "Proceedings of the Naval Institute." He considered that the rig of these boats needed attention. It was unnecessary to adopt small sails for safety since safety depended largely upon the handling and not upon sail area.

Mr. John G. Tawresey said that there were so many conflicting elements to be provided for in the design of these boats that it was difficult to suit all. Injuries in stowage, hoisting and lowering, and the blast of guns all tended to shorten the life of boats. At present he had charge of the largest boat shop in the navy, and he was therefore in a position to appreciate the excellence of the present type. Metal boats had been tried in the navy and abandoned. Centerboards were not used because of the additional weight and the infrequent need of sailing close to the wind. It must be remembered that these boats are not intended for sailing craft. The present designs suited three out of four officers.

Secretary Bowles said the present boats were the outcome of an enormous amount of experience and were a compromise between the builder and the user, whose ideas were naturally somewhat antagonistic.

The second paper, by Assistant Naval Constructor Lawrence Spear, U. S. N., entitled "Bilge Keels and Rolling Experiments, U. S. S. 'Oregon,'" was then read by Prof. W. F. Durand. It is abstracted separately on another page of this issue. The discussion was opened by Mr. J. G. Tawresey, who said that the arguments advanced for abandoning the bilge keel did not meet the approval of practical men. That the reduction of rolling was due to wave making by the bilge keels there could be little doubt, and it is well known that the best method of creating model waves was by oscillating a plane. He considered that the bilge keels did not disturb to any extent the natural wave lines of the vessel.

Prof. W. F. Durand read a discussion of the paper, calling attention to the difference in results obtained by the use of present formulas and the actual values obtained by the test described. The bilge keel was not a plane, and the formulae at present in use were very unsatisfactory.

Secretary Bowles stated that a few years ago bilge keels were placed on all of the large vessels of the navy. Recently, for various reasons, several battleships had been built and launched without these keels, with the result that these vessels were not really safe, and it was necessary that keels be put upon them. He ventured to say that in the future no battleships would be built without bilge keels.

Asst. Naval Constructor R. M. Watt mentioned that the "Massachusetts," was keeled in 16½ working days at the Brooklyn Navy Yard, under Mr. Bowles.

The next paper, "Portable Pneumatic Riveters in Shipbuilding," was then read by its author, Mr. W. I. Babcock, President of the Chicago Shipbuilding Co. This paper is abstracted elsewhere in this issue.

Mr. T. F. Newman said he had used pneumatic percussion riveters in connection with the construction of vessels for the revenue marine service, and the government inspectors passed such work readily. Where it was necessary to mill rivets, as in the case of shell riveting, he had found the saving only about 25%.

Mr. John Platt called attention to the methods of hydraulic riveting used in England, and remarked that he was surprised to find people still using blows instead of steady pressure here. He thought that large rivets could not be driven by percussion riveters. The Holland & Wolff works use an immense crane which spans the vessel. Pendant from this crane are six 40 to 50-ton riveters, which are used to rivet framing, etc. In England and Ireland hydraulic riveters are extensively employed. To prevent freezing crude glycerine was used in proportions of ⅓ glycerine to ⅔ water. He had no doubt, however, but that for small work percussion riveting was satisfactory.

Mr. Tawresey believed percussion riveters could do all sorts of riveting in a rapid and satisfactory manner. The noise was, of course, disagreeable and had a bad effect on all concerned, possibly increasing costs slightly.

Mr. L. R. Pomeroy asked what were the limitations of percussion riveting. He knew several locomotive builders had tried pneumatic riveters and had later given them up because they could not get steam tight joints with them.

Mr. Babcock, in answering the various statements and questions, said that he had closed 1-in. rivets, but he knew of several cases where rivets up to 1¼ ins. had been set with the same style of hammer that he used. This need not be the limit, however, as it was simply a question of sizes of hammers. The air-pressure at the end of the hose should not be less than 100 lbs., and they were now putting in machinery which would give 125 lbs. He preferred pneumatic to hydraulic riveting, because of its simplicity and general applicability. The Harlan & Wolff traveling crane is very heavy, and only of use for only certain kinds of work. He admitted that the noise of percussion riveters was objectionable, but said that there was practically no limit to their use, it being almost as easy to operate a 10-ft. gap as a 4-ft. one.

In one vessel recently riveted up by hand 51,306 shell rivets were used, each costing 3.99 cts. In another instance 74,493 shell rivets were placed by the percussion riveter, mounted upon the frame described in the paper, and cost 2.96 cts. per rivet. In response to a question, he stated that as far as he could see there was no reason why long rivets could not be driven in this way.

Afternoon Session.

Immediately after calling the meeting to order, the President introduced Capt. Wm. H. Jaques, who presented a series of stereopticon views of foreign submarine boats, and the American boat "Holland."

The regular programme was resumed by Secretary Bowles reading a paper by G. W. Dickie, entitled, "Torpedo Boat Destroyers for Sea Service, with Special Reference to the Conditions that Prevail on the Pacific." In this the author said:

A torpedo-boat destroyer must possess other qualities than those necessary for the destruction of torpedo boats. The destroyer must be a sea-going vessel, able to remain at sea with the fleet to which she is attached or to make independent voyages.

The work of the torpedo-boat destroyer is to prevent the torpedo-boat attack, and is, therefore, performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo-boat. She must, therefore, possess speed equal to that of the torpedo boat; a battery powerful enough to destroy her; sea-going qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be an ideal torpedo-boat destroyer.

It cannot be said that the present type of torpedo-boat destroyer comes near meeting these requirements. Quite a large number of destroyers now meet the requirements in the matter of speed, if required for a short time only, in smooth water, and if she is in good order; but the one quality of speed has been made paramount to all other qualities to such an extent that the full speed can only be reached when the conditions are such that the sea-going qualities can be neglected.

The great distances between harbors on the Pacific Coast and the almost universal condition of rough water along the coast from Point Conception in the south to Cape Flattery on the north, with only one place of refuge, renders it necessary that any vessel for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound must have good sea-going qualities and be able to remain outside in all conditions of weather.

The qualities necessary for this service are not possessed in any degree by the present type of torpedo-boat destroyer. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel. They have needed extra care, both in watching the weather, taking advantage of every shelter that lies in the way.

The 420-ton destroyers lately ordered by our government are a decided improvement in this class of vessel, but we do not think they are fitted even yet to meet the special conditions of service on the Pacific.

The annexation of the Hawaiian Islands requires a much greater radius of action for such a vessel, and, we think, a different treatment. In fact, we maintain that if 30 knots or over is aimed at as the supreme speed, a sufficiently staunch sea-going vessel cannot be produced in the present state of the art, and that the present so-called 30-knot torpedo-boat destroyers have not, in fact, the speed with which they are credited as being available when required.

If these boats and their machinery were made more substantial, so that their full power could be exerted at any time and without risk, and the hull stand a moderate sea without danger, the 30-knot boat, by reason of the extra displacement, would drop to about 27 knots; yet we venture to assert that such a boat, ordered to reach a point at sea, say 100 miles distant, in the shortest possible time, would reach the objective point in less time than the regulation 30-knot boat that is said to get a horse-power in 50 lbs. weight of machinery. A large proportion of naval vessels rated at high speeds, especially those over 20 knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy-engined, 16- or 17-knot boat may outstrip them in a fight.

Mr. Dickie then outlined plans for a destroyer of 640 tons displacement and 7,000 I. HP. with a maximum speed of 25 knots and a sustained sea speed of 15 to 20 knots. He provided an armament of six 6-pdrs., two 4-in. rapid-fire guns and two submerged torpedo tubes aft of the engine room. He believed such a boat would show better speed under regular service conditions than any of the so-called 30-knot torpedo-boat destroyers, and for sea-worthiness, habitability, or fighting capacity would far outrank them.

The discussion of this paper was opened by Mr. Platt, who took exception to the use of the term "Torpedo-boat Destroyer." The craft described should properly be called a "Torpedo Cruiser." The boat outlined by the author possessed many desirable features, but he saw no reason for limiting the speed to such a low figure. He had been present at the test of an English destroyer of 300 tons, which had made 27 knots in a rough sea and against the wind or 32 with the wind. Such a boat would easily make 30 knots in moderate weather. Further, in English practice, it was customary to limit other matters, such as coal consumption, the maximum at present allowed being 2½ lbs. per horse-power.

In answer to a question by Mr. Stevenson Taylor, Mr. Platt stated that speed ratings were obtained, in the case of such boats, by averaging 6 runs over a measured mile between points. During these runs the turns of the screw were accurately determined, and thus data obtained from which the speed can be obtained at any time by knowing the turns of the screw.

In connection with this discussion the first topical question "The Utility of Torpedo Boats and Has the Submarine Boat a Place," was introduced, and Mr. Bowles read a letter from an officer who had commanded torpedo boats during the recent war. The opinion seemed to be that the torpedo boat was of great utility, but that a lack of drill and an insufficient complement of officers and men, accustomed to the handling of such boats, had made them of considerably less service than they might otherwise have been. The systematizing and standardizing of boats and equipment and the careful selection and drilling of the crews was strongly advocated.

Lieut. A. P. Niblack, in a letter, compared our torpedo boat system with the careful and complete methods of foreign countries, and regretted that the custom of hauling the boats out of the water was being adopted here.

A letter from Lieut.-Commander Kimball, who commanded the torpedo-boat division of the North Atlantic Station during the recent war advocated the submarine boat. He stated that if it be admitted that the torpedo is of use, then the submarine boat which is no more than a torpedo with a human mind directing its movements in place of the usual automatic devices, would be of far more service. If trenches and mines are useful or necessary on land, it was quite as essential to take advantage of the protection afforded by the water. The submarine boat is the only kind of inexpensive boat that can move up close to an enemy. Such a boat with a crew of five men could attack land batteries and enter harbors. It could make blockades ineffective, destroying mines, etc.

Capt. John Lowe spoke in favor of the submarine boat, and pointed out how much time, money and anxiety would have been saved had the United States had such a boat at Santiago. He believed that the future would see submarine despatch boats, gunboats, and observation boats.

Assistant Naval Constructor R. M. Watt, who had had charge of the repairs of the torpedo boats sent to the New York Navy Yard, considered the "Morris" the ideal type of torpedo boat, operating from a base. He favored only one type of torpedo boat, about 100 tons, and would then at once jump to vessels of 400 to 500 tons, building a vessel about as outlined in Mr. Dickie's paper for service as a scout or despatch boat. Mr. C. D. Mosher did not think the time had come for standardizing torpedo boats. The speed and power for a given displacement were yearly increasing, and we must have as high speeds as our enemy. Handling had a great deal to do with the poor showing of our boats. At present experiments were being conducted in England by Mr. Parsons, which, if successful, might revolutionize torpedo-boat construction.

Mr. J. G. Tawresey spoke as an unbeliever in torpedo boats. He admitted their moral effect, but based his views largely upon the fact that at present there were no indications that torpedo attacks would be successful. He would not be afraid of torpedo boats in the open sea. He was of the opinion that torpedo boats were entirely too light for any sort of sea service. Under special conditions they might be dangerous antagonists, but conditions must be taken just as they exist when the chance to fight occurs. So far, they had been used simply as dispatch boats and not with the best of success. They should not in any case be used for any other than the designed purpose.

Mr. F. L. Du Bosque favored the standardization of torpedo boats so that a man, when ordered from one to another, could at once perform his special duties properly. Water tube boilers on some torpedo boats had proven a success, and there was no inherent reason why all should not prove successful, if properly handled. The great trouble was that the boilers on a torpedo boat were used spasmodically.

Mr. John C. Kafer considered the construction of torpedo boats faulty. They never did what was expected of them, and the speeds credited to them were not reached in actual service. He did not favor any boat that could only keep up its speed from three to five minutes.

Mr. R. M. Watt called attention to the fact that in a torpedo-boat attack it was contemplated to have, say, half a dozen boats start from different directions. In the Battle of Manila two improvised torpedo boats started from 4,000 yds., and one of them succeeded in getting within 1,200 ft.

Mr. Stephenson Taylor considered the trouble due largely to the make up of the crews, most of them being men not familiar with the tools they were using. The "Scorpion," for instance, gave no trouble until taken by the government.

Mr. Bowles explained that the service of a yacht under ordinary conditions and the conditions imposed upon the converted yachts employed in Cuban waters was entirely different. Most of the vessels on the blockade were forced to use salt water at times in the boilers.

Mr. F. Meriam Wheeler then read a paper, entitled "Econmoy Test of a Unique Form of Feed Pump," which will be abstracted in a later issue of Engineering News.

In discussing this paper Lieut. Walter M. McFarland, Engineer Corps, said that it must be remembered that the service of engines in the merchant marine and in naval vessels was entirely different. In the former they were started up and ran continuously for 6 or 7 days, while in the latter they might be started or stopped every five minutes. Hence it was that the converted vessels gave so much trouble. It was, therefore, necessary to have the various pumps separate from the main engines and leave the engines free to propel the vessel alone. Whatever form of pump was adopted must be designed with an idea of saving weight and economizing coal.

November 11.—Morning.

This session began with the reading of a paper, entitled "The Steam Yacht as a Naval Auxiliary," by Mr. W. P. Stephens.

The work of reconstruction which has been under way in the United States Navy for the past 15 years has been limited almost entirely to the strictly fighting arm of the service—the battleships, cruisers and torpedo craft. Indispensable as they are, these of themselves do not constitute a perfect navy, in fact they are of comparatively little use without a large attendant fleet of auxiliary craft; transports, colliers, water boats, repair ships, supply ships, hospital ships, and small craft for various uses.

The condition of the Navy at the outbreak of hostilities between the United States and Spain may be briefly summed up as strong in its personnel, comparatively strong in fighting vessels, guns and armor; and absolutely unprovided with auxiliaries of all kinds. Of all the urgent work demanded both ashore and afloat, nothing was more immediate and pressing than the creation of an efficient fleet of auxiliaries.

The possibilities of the yacht fleet at the present time for conversion to war uses were, even from a theoretic standpoint, far from promising. Many of the vessels were ill-fitted in model for real service at sea; there was a lack of displacement for the added weights of armament and ammunition, of berthing space for crew, of bunker space, and suitable locations for magazines. The nominal speed, in many cases low in itself, was not realized even in smooth water, and in a sea there was a serious loss of the average working speed. There was no protection, no distilling apparatus; the capacity of the water tanks was generally inadequate, and the decks were not designed to withstand the shock of guns. The draught as a rule was greater than was necessary or desirable. The nature and extent of these defects were fully realized at the outset, but under the circumstances there was no other course but to take the yachts as they were and to make the best of them. All things considered, they have done their work quite as well as was to be expected; they have served a certain necessary purpose, and they were capable of doing even more had it been required of them. The work of the yachts, their success and failures taken together, with the work of other small craft, such as tugs, lighthouse tenders, etc., impressed into the same service, seems to indicate the desirability of the creation of a new type of small auxiliary not at present recognized on the Navy List. The speed may be placed at not over 18 knots. This, however, is not to be measured by the conventional yacht standard by which an 18-knot steam yacht takes the wash of a good 12-knot tug, but means a reasonable approach to the designed speed under ordinary service conditions at sea, and the ability to keep with the fleet even in bad weather. The model should possess seagoing qualities of the highest class; the draught should be limited to 11 or even 10 ft., as a maximum; the construction should be durable, with ample scantling both to carry the armament and to insure a long life with ordinary care in laying up; the engines should be strong and reliable, the bunker space as large as possible, and, as deck and side protection will probably be impracticable, especial attention should be given to the water-line protection of machinery and magazines through their location and the disposition of the bunkers.

The intended uses of this class call for three sizes: for sea work, as despatch boats and tenders, and for picket duty, vessels of not over 800 tons displacement. The next size to be of about 400 tons displacement. The third size, for harbor patrol service, to be of about 200 tons. A speed of 15 knots would suffice for this service, but they should be capable of towing a vessel out of possible danger.

In the discussion, Capt. Jacob W. Miller said: Although we were fighting a nation in the late war which did not make a second line of defense necessary, the yachts did not meet the conditions required. The yachts were purchased at maximum prices, and we could have got boats better fitted for the work if the same money had been expended some years ago. Yet the pick of the yachts in the United States were taken. None of the yachts could do over 10 knots continuously for 24 hours. There was not sufficient breathing space for the crew on converted yachts, and they were not rough and ready enough. Boats for harbor work must be strong enough to permit running up alongside of sailing vessels that are drifting in mine fields. Converted yachts were serviceable in very few particulars. He did not favor three types of such vessels, and considered two quite sufficient, one for inner patrol work, and one for outer.

Mr. J. G. Tawresey, who was a member of the Auxiliary Cruiser Board, said: The orders given to the Board was to select vessels that would act as "eyes to the fleet." We had to take such vessels as were available. As fighters they were makeshifts, filled with objectionable features. For one thing, they were tinder boxes. I want to emphasize the fact that we cannot improvise a navy from yachts and tugs. There was a very useful field for such a boat as suggested by the author, and the design presented would, he thought, quite fill the want.

Mr. John Platt called attention to the fact that no fast gunboats had been built in this country. A speed of only 18 knots for a vessel of 850 tons was very low, as it was quite possible to get 22 knots. The British Government had built a large number of torpedo gunboats with speeds ranging from 18 to 22 knots.

Mr. Bowles felt that there was a decided need of such a boat as was described in the paper, but a speed of 16 knots, provided it could be kept up, was sufficient. Referring to the lack of crew space on the converted yachts, Mr. Bowles said that as all the naval militia wanted to see service, the boats were often over-crewed. He favored only one size of boat, because experience had shown that the wrong size was always around when an emergency arose.

Lieut. W. P. White considered the inshore patrol or mine-field protection to be a function of such sea-going tugs as the government could impress, and it was out of the question to maintain a fleet of small boats for this purpose. The armoring of scout boats to any extent was inadvisable. In time of peace the various vessels should carry more than their war complement, so that in emergencies the extra men could at once man auxiliary or new vessels. The manning of vessels with entire naval militia crews was, he thought, poor policy, and it was far better to send them out as part of the regular crew of vessels in service. Battleships were of the first importance, and hence money should first be put into their construction, leaving despatch boats, etc., until later.

Mr. W. P. Stephens, in closing the discussion, said he did not mean to insist upon three classes. There might only be two classes, the larger being represented by the boat designed by Mr. Dickie. Lower speeds should be used and engines and other apparatus employed which could be successfully operated by inexperienced men.

In the absence of Chief Constructor Philip Hichborn, the Secretary read the opening paragraph of his paper on "Designs of the New Vessels for the U. S. Navy." That portion of the paper pertaining to the new battleships is given elsewhere in this issue. In speaking of monitors, torpedo boats, etc., Mr. Hichborn said:

Since our last meeting, practically every type of vessel the government possesses has been put to the test in engagements with the enemy. There is no record, so far as I know, of the failure of any vessel to fulfil all expectations. The wonderful success attending these naval engagements has impressed the country at large with the value of, and the necessity for, an efficient Navy. Congress responded to this sentiment promptly and liberally, and within the past 6 weeks contracts have been made for 3 additional battleships, 4 coast-defence monitors, 16 torpedo-boat destroyers, and 12 torpedo boats. A full ship-rigged sailing vessel was also authorized as a practice ship for the Naval Academy, and is already under way.

Monitors.—In appropriating for four coast-defence monitors, Congress did not contemplate providing vessels equal in size to the double-turreted monitors now in commission, the cost of hull and machinery being limited to $1,250,000.

The bill provided that the vessels should have either one or two turrets, and it was found advisable to develop the design on the basis of a single turret mounting a pair of 12-in. guns. The trial speed is specified as 12 knots.

The paper then briefly outlined some of the important features of this type of monitor, but the information given is now of little value since within the last few days the Department has decided to use double turreted monitors carrying four 10-in. guns.

Torpedo Boats and Destroyers.—The portion of the appropriation bill providing for these vessels authorized the construction of "16 torpedo-boat destroyers of about 400 tons displacement," and of "12 torpedo boats of about 150 tons displacement," all to have "the highest practicable speed." The designs prepared in the Department for the destroyers cannot be referred to any particular type. The midship section approximates to the oval form largely adopted by the French. The sections toward the stern are original, though resembling somewhat the form given by Thorneycroft to his twin rudder boats of some years ago. In addition to coal abreast the machinery, there will be the protection of 12½-lb. nickel-steel plate over a portion of the deck and on the sheer strake. The forward conning tower is of ½-in. nickel-steel plates. The vessels carry a battery of two 12-lb. and five 6-lb. guns, with two long torpedo tubes, mounted on the midship line.

In both the torpedo boats and destroyers, the wood has been required to be fire-proofed and its use reduced to a minimum. The vessels will be lighted throughout by electricity and fitted with searchlights. Special attention will be paid to adequate ventilation, and every comfort and convenience consistent with the type will be supplied.

The Secretary suggested that the question of the utility of monitors be discussed in connection with the discussion on the paper just read.

Capt. William C. Wise said:

It is my belief that the "Puritan" is the finest fighting ship in the United States Navy to-day. She could battle with a whole fleet. With 20 "Puritans" we could defend the whole coast.

Prof. Cecil H. Peabody discussed briefly the disposition of armor on monitors and battleships. He did not favor standardization of battleships and torpedo-boats beyond those built at any one time, since standards at times interfered with progress.

Col. E. A. Stevens asked if the conditions during the battle of Santiago were normal enough to permit the records of hits given the Spanish vessels being used for future design. If so, it would seem that such heavy armor was unnecessary for the large shells did not seem to hit.

Afternoon Session.

At the afternoon session the first paper presented was "Methods of Securing Watertight Work," by Assistant Naval Constructor H. G. Smith, U.S.N. The paper referred especially to ship construction, but as some portions of it are of general interest to all designers of riveted work, we shall abstract it in a future issue.

To facilitate discussion, since the general subjects were the same, the next paper, "Tests of the Strength of a Longitudinal Bulkhead Separating Two Engine Rooms," was then read by its author, Naval Constructor J. J. Woodward, U.S.N. This paper is abstracted on another page of this issue.

In discussing the papers, Naval Constructor J. G. Tawresey said that there should only be one kind of bulkhead—a strong and absolutely water-tight one. Historically there might have been two classes, the tight and the leaky, but in the future only the tight should be accepted. It must not be understood that the navy alone found leaks, for they were just as troublesome in the merchant marine. He considered that a good deal of the blame for leaky bulkheads could be laid to the draftsmen.

Professor Peabody considered the experiments described in the papers just read, as very important. He thought the Navy Department should conduct a series of experiments and put the data obtained in form so that it could be used for future design.

Mr. T. F. Newman saw no reason why bulkheads and ship's bottoms could not be made absolutely tight. On the Great Lakes they managed to secure such tight work that in many instances where the outer plating of the double bottom of vessels carrying grain had been injured, not more than 30 or 40 bushels of grain would be damaged, owing to the tight inner bottom

Mr. John C. Kafer thought that bulkheads were made to keep out the bulk of the water, and except in tank steamers, there was no need of builders going to great trouble to stop every little leak, provided the bulkheads were strong enough to stand the strain.

Col. E. A. Stevens asked what conditions were imposed in the United States service. In the British service he understood that the stiffeners must be strong enough to stand all strains without depending upon the sheeting.

In reply Mr. R. M. Watt read a letter showing how the stiffeners and bulkheads were calculated for the "Texas," and a comparison of the bulkheads of a number of United States vessels.

Mr. Bowles objected to placing 50% of the blame for leaky bulkheads upon the draftsman. The trouble was that after a bulkhead was made tight it was drilled full of holes by the machinists and electricians.

Mr. J. J. Woodward objected to any plan of bulkhead bracing that would weaken the protective deck, and said that where there was a conflict between the fighting strength of a vessel and a small amount of leakage, the latter should be disregarded. In response to a question, Mr. Smith said that in the test of the double bottom of the "Brooklyn" the time and labor of five men was required constantly for 14 months.

Owing to the short time remaining, the paper of Mr. Walter A. Post, on "An Electrically Operated 150-Ton Revolving Derrick," was read by title only. This paper will be abstracted in a later issue of Engineering News.

The last paper of the meeting, "Stability of a Battleship Under Damaged Conditions," was read by its author, Prof. C. H. Peabody. This was a report of a series of tests made with a small wooden model representing a battleship with its superstructure removed. The model, with inclining apparatus in place, was ballasted so that it floated at the proper water line, and so that it had the proper metacentric height. Then blocks, representing the parts or compartments laid open to the sea, were cut out and lead weights were fastened in place to compensate for the wood removed. Then various measurements were made to determine the initial stability and the stability at various angles of heel. The facts developed were illustrated by a series of diagrams, and a number of curves. Discussing the paper, Mr. Woodward suggested that in an actual battleship the superstructure could be made to assist in keeping the vessel afloat. Professor Peabody considered that the many openings in the superstructure would prevent its adding to the buoyancy of the vessel, should it start to capsize.

The discussion of the following topics was then taken up:

First.—Under the circumstances of the blockade at Santiago, which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?

Second.—Can you give any data as to the cost in coal of maintaining the engines and boilers in readiness for immediate service?

Mr. John C. Kafer read a letter from Chief Engineer Milligan, of the "Oregon," which stated that the fires on the "Oregon" were spread thin. There being from 24 to 27 tons of coal burned per day. The "Iowa" used banked fires. Mr. Kafer considered banked fires more economical, but not so advantageous for quick steam making, as keeping them spread.

Lieut. Walter M. McFarland presented some figures showing the coal consumption on the "Indiana," "Massachusetts," "Oregon," and "Iowa." These were in part:

	Tons.		Lbs.	
"Indiana"......	34.7	per day, or	7.21	per sq.ft. grate per hr.
"Iowa".........	35.16	" "	5.2	" "
"Massachusetts"	29.4	" "	6.5	" "
"Oregon".......	24.91	" "	4.35	" "

Note.—The "Iowa," "Massachusetts," and "Oregon" had spread fires.

This was, therefore, an indication that spread fires were also more economical, and there could be no question about the enormous tactical advantage.

Mr. Lewis Nixon presented a resolution to the effect that papers be invited on the subject of "Life Saving at Sea" and that two such papers be selected and printed in next year's "Proceedings." Motions thanking the various officers were passed, after which the final adjournment was taken.

In the evening fully 200 members and guests assembled at Delmonico's to participate in the annual banquet, which proved quite as successful as the business meetings had been. President Clement A. Griscom acted as toastmaster and the following is the list of toasts:

"The President of the United States;" "Our Navy; It Has Justified Its Existence and Glorified the Nation," Harvey D. Goulder; "Our Commercial Marine, Its Development and Extension is a National Necessity," Hon. George F. Edmunds; "The Naval Militia," Capt. J. W. Miller; "Naval Architecture," Lewis Nixon; "Marine Architecture," Lieut. Walter M. McFarland; "Our Manufacturers," Theo. C. Search. Personal toasts were: Charles H. Haswell, Charles Ward, William H. Webb.

On Saturday the members of the society enjoyed an excursion to South Bethlehem, Pa., through the courtesy of the Bethlehem Iron Co. The party, to the number of about 100, boarded two special cars provided by the Bethlehem Company, and attached to the regular Lehigh Valley Express, which left Jersey City at 8.20 Saturday morning. Immediately upon arriving at South Bethlehem the special cars were run into the yard of the Bethlehem Iron Works, and the entire party was transferred to a train of flat cars provided with seats. On this observation train the inspection of the works was made.

Starting at one end of the property, which is just one are not intended for sailing craft. The present designs suited three out of four officers.

Secretary Bowles said the present boats were the outcome of an enormous amount of experience and were a compromise between the builder and the user, whose ideas were naturally somewhat antagonistic.

The second paper, by Assistant Naval Constructor Lawrence Spear, U. S. N., entitled "Bilge Keels and Rolling Experiments, U. S. S. 'Oregon,'" was then read by Prof. W. F. Durand. It is abstracted separately on another page of this issue. The discussion was opened by Mr. J. G. Tawresey, who said that the arguments advanced for abandoning the bilge keel did not meet the approval of practical men. That the reduction of rolling was due to wave making by the bilge keels there could be little doubt, and it is well known that the best method of creating model waves was by oscillating a plane. He considered that the bilge keels did not disturb to any extent the natural wave lines of the vessel.

Prof. W. F. Durand read a discussion of the paper, calling attention to the difference in results obtained by the use of present formulas and the actual values obtained by the test described. The bilge keel was not a plane, and the formulae at present in use were very unsatisfactory.

Secretary Bowles stated that a few years ago bilge keels were placed on all of the large vessels of the navy. Recently, for various reasons, several battleships had been built and launched without these keels, with the result that these vessels were not really safe, and it was necessary that keels be put upon them. He ventured to say that in the future no battleships would be built without bilge keels.

Asst. Naval Constructor R. M. Watt mentioned that the "Massachusetts," was keeled in 16½ working days at the Brooklyn Navy Yard, under Mr. Bowles.

The next paper, "Portable Pneumatic Riveters in Shipbuilding," was then read by its author, Mr. W. I. Babcock, President of the Chicago Shipbuilding Co. This paper is abstracted elsewhere in this issue.

Mr. T. F. Newman said he had used pneumatic percussion riveters in connection with the construction of vessels for the revenue marine service, and the government inspectors passed such work readily. Where it was necessary to mill rivets, as in the case of shell riveting, he had found the saving only about 25%.

Mr. John Platt called attention to the methods of hydraulic riveting used in England, and remarked that he was surprised to find people still using blows instead of steady pressure here. He thought that large rivets could not be driven by percussion riveters. The Holland & Wolff works use an immense crane which spans the vessel. Pendant from this crane are six 40 to 50-ton riveters, which are used to rivet framing, etc. In England and Ireland hydraulic riveters are extensively employed. To prevent freezing crude glycerine was used in proportions of ⅓ glycerine to ⅔ water. He had no doubt, however, but that for small work percussion riveting was satisfactory.

Mr. Tawresey believed percussion riveters could do all sorts of riveting in a rapid and satisfactory manner. The noise was, of course, disagreeable and had a bad effect on all concerned, possibly increasing costs slightly.

Mr. L. R. Pomeroy asked what were the limitations of percussion riveting. He knew several locomotive builders had tried pneumatic riveters and bad later given them up because they could not get steam tight joints with them.

Mr. Babcock, in answering the various statements and questions, said that he had closed 1-in. rivets, but he knew of several cases where rivets up to 1¼ ins. had been set with the same style of hammer that he used. This need not be the limit, however, as it was simply a question of sizes of hammers. The air-pressure at the end of the hose should not be less than 100 lbs., and they were now putting in machinery which would give 125 lbs. He preferred pneumatic to hydraulic riveting, because of its simplicity and general applicability. The Harlan & Wolff traveling crane is very heavy, and only of use for only certain kinds of work. He admitted that the noise of percussion riveters was objectionable, but said that there was practically no limit to their use, it being almost as easy to operate a 10-ft. gap as a 4-ft. one.

In one vessel recently riveted up by hand 51,306 shell rivets were used, each costing 3.99 cts. In another instance 74,493 shell rivets were placed by the percussion riveter, mounted upon the frame described in the paper, and cost 2.96 cts. per rivet. In response to a question, he stated that as far as he could see there was no reason why long rivets could not be driven in this way.

Afternoon Session.

Immediately after calling the meeting to order, the President introduced Capt. Wm. H. Jaques, who presented a series of stereopticon views of foreign submarine boats, and the American boat "Holland."

The regular programme was resumed by Secretary Bowles reading a paper by G. W. Dickie, entitled, "Torpedo Boat Destroyers for Sea Service, with Special Reference to the Conditions that Prevail on the Pacific." In this the author said:

A torpedo-boat destroyer must possess other qualities than those necessary for the destruction of torpedo boats. The destroyer must be a sea-going vessel, able to remain at sea with the fleet to which she is attached or to make independent voyages.

The work of the torpedo-boat destroyer is to prevent the torpedo-boat attack, and is, therefore, performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo-boat. She must, therefore, possess speed equal to that of the torpedo boat; a battery powerful enough to destroy her; sea-going qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be an ideal torpedo-boat destroyer.

It cannot be said that the present type of torpedo-boat destroyer comes near meeting these requirements. Quite a large number of destroyers now meet the requirements in the matter of speed, if required for a short time only, in smooth water, and if she is in good order; but the one quality of speed has been made paramount to all other qualities to such an extent that the full speed can only be reached when the conditions are such that the sea-going qualities can be neglected.

The great distance between harbors on the Pacific Coast and the almost universal condition of rough water along the coast from Point Conception in the south to Cape Flattery on the north, with only one place of refuge, renders it necessary that any vessel for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound must have good sea-going qualities and be able to remain outside in all conditions of weather.

The qualities necessary for this service are not possessed in any degree by the present type of torpedo-boat destroyer. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel. They have needed extra care, both in watching the weather, taking advantage of every shelter that lies in the way.

The 420-ton destroyers lately ordered by our government are a decided improvement in this class of vessel, but we do not think they are fitted even yet to meet the special conditions of service on the Pacific.

The annexation of the Hawaiian Islands requires a much greater radius of action for such a vessel, and, we think, a different treatment. In fact, we maintain that if 30 knots or over is aimed at as the supreme speed, a sufficiently staunch sea-going vessel cannot be produced in the present state of the art, and that the present so-called 30-knot torpedo-boat destroyers have not, in fact, the speed with which they are credited as being available when required.

If these boats and their machinery were made more substantial, so that their full power could be exerted at any time and without risk, and the hull stand a moderate sea without danger, the 30-knot boat, by reason of the extra displacement, would drop to about 27 knots; yet we venture to assert that such a boat, ordered to reach a point at sea, say 100 miles distant, in the shortest possible time, would reach the objective point in less time than the regulation 30-knot boat that is said to get a horse-power in 50 lbs. weight of machinery. A large proportion of naval vessels rated at high speeds, especially those over 20 knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy-engined, 16- or 17-knot boat may outstrip them in a fight.

Mr. Dickie then outlined plans for a destroyer of 640 tons displacement and 7,000 I. HP. with a maximum speed of 25 knots and a sustained sea speed of 15 to 20 knots. He provided an armament of six 6-pdrs., two 4-in. rapid-fire guns and two submerged torpedo tubes aft of the engine room. He believed such a boat would show better speed under regular service conditions than any of the so-called 30-knot torpedo-boat destroyers, and for sea-worthiness, habitability, or fighting capacity would far outrank them.

The discussion of this paper was opened by Mr. Platt, who took exception to the use of the term "Torpedo-boat Destroyer." The craft described should properly be called a "Torpedo Cruiser." The boat outlined by the author possessed many desirable features, but he saw no reason for limiting the speed to such a low figure. He had been present at the test of an English destroyer of 300 tons, which had made 27 knots in a rough sea and against the wind or 32 with the wind. Such a boat would easily make 30 knots in moderate weather. Further, in English practice, it was customary to limit other matters, such as coal consumption, the maximum at present allowed being 2½ lbs. per horse-power.

In answer to a question by Mr. Stevenson Taylor, Mr. Platt stated that speed ratings were obtained, in the case of such boats, by averaging 6 runs over a measured mile between points. During these runs the turns of the screw were accurately determined, and thus data obtained from which the speed can be obtained at any time by knowing the turns of the screw.

In connection with this discussion the first topical question "The Utility of Torpedo Boats and Has the Submarine Boat a Place," was introduced, and Mr. Bowles read a letter from an officer who had commanded torpedo boats during the recent war. The opinion seemed to be that the torpedo boat was of great utility, but that a lack of drill and an insufficient complement of officers and men, accustomed to the handling of such boats, had made them of considerably less service than they might otherwise have been. The systematizing and standardizing of boats and equipment and the careful selection and drilling of the crews was strongly advocated.

Lieut. A. P. Niblack, in a letter, compared our torpedo boat system with the careful and complete methods of foreign countries, and regretted that the custom of hauling the boats out of the water was being adopted here.

A letter from Lieut.-Commander Kimball, who commanded the torpedo-boat division of the North Atlantic Station during the recent war advocated the submarine boat. He stated that if it be admitted that the torpedo is of use, then the submarine boat which is no more than a torpedo with a human mind directing its movements in place of the usual automatic devices, would be of far more service. If trenches and mines are useful or necessary on land, it was quite as essential to take advantage of the protection afforded by the water. The submarine boat is the only kind of inexpensive boat that can move up close to an enemy. Such a boat with a crew of five men could attack land batteries and enter harbors. It could make blockades ineffective, destroying mines, etc.

Capt. John Lowe spoke in favor of the submarine boat, and pointed out how much time, money and anxiety would have been saved had the United States had such a boat at Santiago. He believed that the future would see submarine despatch boats, gunboats, and observation boats.

Assistant Naval Constructor R. M. Watt, who had had charge of the repairs of the torpedo boats sent to the New York Navy Yard, considered the "Morris" the ideal type of torpedo boat, operating from a base. He favored only one type of torpedo boat, about 100 tons, and would then at once jump to vessels of 400 to 500 tons, building a vessel about as outlined in Mr. Dickie's paper for service as a scout or despatch boat. Mr. C. D. Mosher did not think the time had come for standardizing torpedo boats. The speed and power for a given displacement were yearly increasing, and we must have as high speeds as our enemy. Handling had a great deal to do with the poor showing of our boats. At present experiments were being conducted in England by Mr. Parsons, which, if successful, might revolutionize torpedo-boat construction.

Mr. J. G. Tawresey spoke as an unbeliever in torpedo boats. He admitted their moral effect, but based his views largely upon the fact that at present there were no indications that torpedo attacks would be successful. He would not be afraid of torpedo boats in the open sea. He was of the opinion that torpedo boats were entirely too light for any sort of sea service. Under special conditions they might be dangerous antagonists, but conditions must be taken just as they exist when the chance to fight occurs. So far, they had been used simply as dispatch boats and not with the best of success. They should not in any case be used for any other than the designed purpose.

Mr. F. L. Du Bosque favored the standardization of torpedo boats so that a man, when ordered from one to another, could at once perform his special duties properly. Water tube boilers on some torpedo boats had proven a success, and there was no inherent reason why all should not prove successful, if properly handled. The great trouble was that the boilers on a torpedo boat were used spasmodically.

Mr. John C. Kafer considered the construction of torpedo boats faulty. They never did what was expected of them, and the speeds credited to them were not reached in actual service. He did not favor any boat that could only keep up its speed from three to five minutes.

Mr. R. M. Watt called attention to the fact that in a torpedo-boat attack it was contemplated to have, say, half a dozen boats start from different directions. In the Battle of Manila two improvised torpedo boats started from 4,000 yds., and one of them succeeded in getting within 1,200 ft.

Mr. Stephenson Taylor considered the trouble due largely to the make up of the crews, most of them being men not familiar with the tools they were using. The "Scorpion," for instance, gave no trouble until taken by the government.

Mr. Bowles explained that the service of a yacht under ordinary conditions and the conditions imposed upon the converted yachts employed in Cuban waters was entirely different. Most of the vessels on the blockade were forced to use salt water at times in the boilers.

Mr. F. Meriam Wheeler then read a paper, entitled "Economy Test of a Unique Form of Feed Pump," which will be abstracted in a later issue of Engineering News.

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This session began with the reading of a paper, entitled "The Steam Yacht as a Naval Auxiliary," by Mr. W. P. Stephens.

The work of reconstruction which has been under way in the United States Navy for the past 15 years has been limited almost entirely to the strictly fighting arm of the service—the battleships, cruisers and torpedo craft. Indispensable as they are, these of themselves do not constitute a perfect navy, in fact they are of comparatively little use without a large attendant fleet of auxiliary craft; transports, colliers, water boats, repair ships, supply ships, hospital ships, and small craft for various uses.

The condition of the Navy at the outbreak of hostilities between the United States and Spain may be briefly summed up as strong in its personnel; comparatively strong in fighting vessels, guns and armor; and absolutely unprovided with auxiliaries of all kinds. Of all the urgent work demanded both ashore and afloat, nothing was more immediate and pressing than the creation of an efficient fleet of auxiliaries.

The possibilities of the yacht fleet at the present time for conversion to war uses were, even from a theoretic standpoint, far from promising. Many of the vessels were ill-fitted in model for real service at sea; there was a lack of displacement for the added weights of armament and ammunition, of berthing space for crew, of bunker space, and suitable locations for magazines. The nominal speed, in many cases low in itself, was not realized even in smooth water, and in a sea there was a serious loss of the average working speed. There was no protection, no distilling apparatus; the capacity of the water tanks was generally inadequate, and the decks were not designed to withstand the shock of guns. The draught as a rule was greater than was necessary or desirable. The nature and extent of these defects were fully realized at the outset, but under the circumstances there was no other course but to take the yachts as they were and to make the best of them. All things considered, they have done their work quite as well as was to be expected; they have served a certain necessary purpose, and they were capable of doing even more had it been required of them. The work of the yachts, their success and failures taken together, with the work of other small craft, such as tugs, lighthouse tenders, etc., impressed into the same service, seems to indicate the desirability of the creation of a new type of small auxiliary not at present recognized on the Navy List. The speed may be placed at not over 18 knots. This, however, is not to be measured by the conventional yacht standard by which an 18-knot steam yacht takes the wash of a good 12-knot tug, but means a reasonable approach to the designed speed under ordinary service conditions at sea, and the ability to keep with the fleet even in bad weather. The model should possess seagoing qualities of the highest class; the draught should be limited to 11 or even 10 ft., as a maximum; the construction should be durable, with ample scantling both to carry the armament and to insure a long life with ordinary care in laying up; the engines should be strong and reliable, the bunker space as large as possible, and, as deck and side protection will probably be impracticable, especial attention should be given to the water-line protection of machinery and magazines through their location and the disposition of the bunkers.

The intended uses of this class call for three sizes: for sea work, as despatch boats and tenders, and for picket duty, vessels of not over 800 tons displacement. The next size to be of about 400 tons displacement. The third size, for harbor patrol service, to be of about 200 tons. A speed of 15 knots would suffice for this service, but they should be capable of towing a vessel out of possible danger.

In the discussion, Capt. Jacob W. Miller said: Although we were fighting a nation in the late war which did not make a second line of defense necessary, the yachts did not meet the conditions required. The yachts were purchased at maximum prices, and we could have got boats better fitted for the work if the same money had been expended some years ago. Yet the pick of the yachts in the United States were taken. None of the yachts could do over 10 knots continuously for 24 hours. There was not sufficient breathing space for the crew on converted yachts, and they were not rough and ready enough. Boats for harbor work must be strong enough to permit running up alongside of sailing vessels that are drifting in mine fields. Converted yachts were serviceable in very few particulars. He did not favor three types of such vessels, and considered two quite sufficient, one for inner patrol work, and one for outer.

Mr. J. G. Tawresey, who was a member of the Auxiliary Cruiser Board, said: The orders given to the Board was to select vessels that would act as "eyes to the fleet." We had to take such vessels as were available. As fighters they were makeshifts, filled with objectionable features. For one thing, they were tinder boxes. I want to emphasize the fact that we cannot improvise a navy from yachts and tugs. There was a very useful field for such a boat as suggested by the author, and the design presented would, he thought, quite fill the want.

Mr. John Platt called attention to the fact that no fast gunboats had been built in this country. A speed of only 18 knots for a vessel of 850 tons was very low, as it was quite possible to get 22 knots. The British Government had built a large number of torpedo gunboats with speeds ranging from 18 to 22 knots.

Mr. Bowles felt that there was a decided need of such a boat as was described in the paper, but a speed of 16 knots, provided it could be kept up, was sufficient. Referring to the lack of crew space on the converted yachts, Mr. Bowles said that as all the naval militia wanted to see service, the boats were often over-crewed. He favored only one size of boat, because experience had shown that the wrong size was always around when an emergency arose.

Lieut. W. P. White considered the inshore patrol or mine-field protection to be a function of such sea-going tugs as the government could impress, and it was out of the question to maintain a fleet of small boats for this purpose. The armoring of scout boats to any extent was inadvisable. In time of peace the various vessels should carry more than their war complement, so that in emergencies the extra men could at once man auxiliary or new vessels. The manning of vessels with entire naval militia crews was, he thought, poor policy, and it was far better to send them out as part of the regular crew of vessels in service. Battleships were of the first importance, and hence money should first be put into their construction, leaving despatch boats, etc., until later.

Mr. W. P. Stephens, in closing the discussion, said he did not mean to insist upon three classes. There might only be two classes, the larger being represented by the boat designed by Mr. Dickie. Lower speeds should be used and engines and other apparatus employed which could be successfully operated by inexperienced men.

In the absence of Chief Constructor Philip Hichborn, the Secretary read the opening paragraph of his paper on "Designs of the New Vessels for the U. S. Navy." That portion of the paper pertaining to the new battleships is given elsewhere in this issue. In speaking of monitors, torpedo boats, etc., Mr. Hichborn said:

Since our last meeting, practically every type of vessel the government possesses has been put to the test in engagements with the enemy. There is no record, so far as I know, of the failure of any vessel to fulfil all expectations. The wonderful success attending these naval engagements has impressed the country at large with the value of, and the necessity for, an efficient Navy. Congress responded to this sentiment promptly and liberally, and within the past 6 weeks contracts have been made for 3 additional battleships, 4 coast-defence monitors, 16 torpedo-boat destroyers, and 12 torpedo boats. A full ship-rigged sailing vessel was also authorized as a practice ship for the Naval Academy, and is already under way.

Monitors.—In appropriating for four coast-defence monitors, Congress did not contemplate providing vessels equal in size to the double-turreted monitors now in commission, the cost of hull and machinery being limited to $1,250,000.

The bill provided that the vessels should have either one or two turrets, and it was found advisable to develop the design on the basis of a single turret mounting a pair of 12-in. guns. The trial speed is specified as 12 knots.

The paper then briefly outlined some of the important features of this type of monitor, but the information given is now of little value since within the last few days the Department has decided to use double turreted monitors carrying four 10-in. guns.

Torpedo Boats and Destroyers.—The portion of the appropriation bill providing for these vessels authorized the construction of "16 torpedo-boat destroyers of about 400 tons displacement," and of "12 torpedo boats of about 150 tons displacement," all to have "the highest practicable speed." The designs prepared in the Department for the destroyers cannot be referred to any particular type. The midship section approximates to the oval form largely adopted by the French. The sections toward the stern are original, though resembling somewhat the form given by Thorneycroft to his twin rudder boats of some years ago. In addition to coal abreast the machinery, there will be the protection of 12½-lb. nickel-steel plate over a portion of the deck and on the sheer strake. The forward conning tower is of ½-in. nickel-steel plates. The vessels carry a battery of two 12-lb. and five 6-lb. guns, with two long torpedo tubes, mounted on the midship line.

In both the torpedo boats and destroyers, the wood has been required to be fire-proofed and its use reduced to a minimum. The vessels will be lighted throughout by electricity and fitted with searchlights. Special attention will be paid to adequate ventilation, and every comfort and convenience consistent with the type will be supplied.

The Secretary suggested that the question of the utility of monitors be discussed in connection with the discussion on the paper just read.

Capt. William C. Wise said:

It is my belief that the "Puritan" is the finest fighting ship in the United States Navy to-day. She could battle with a whole fleet. With 20 "Puritans" we could defend the whole coast.

Prof. Cecil H. Peabody discussed briefly the disposition of armor on monitors and battleships. He did not favor standardization of battleships and torpedo-boats beyond those built at any one time, since standards at times interfered with progress.

Col. E. A. Stevens asked if the conditions during the battle of Santiago were normal enough to permit the records of hits given the Spanish vessels being used for future design. If so, it would seem that such heavy armor was unnecessary for the large shells did not seem to hit.

Afternoon Session.

At the afternoon session the first paper presented was "Methods of Securing Watertight Work," by Assistant Naval Constructor H. G. Smith, U.S.N. The paper referred especially to ship construction, but as some portions of it are of general interest to all designers of riveted work, we shall abstract it in a future issue.

To facilitate discussion, since the general subjects were the same, the next paper, "Tests of the Strength of a Longitudinal Bulkhead Separating Two Engine Rooms," was then read by its author, Naval Constructor J. J. Woodward, U.S.N. This paper is abstracted on another page of this issue.

In discussing the papers, Naval Constructor J. G. Tawresey said that there should only be one kind of bulkhead—a strong and absolutely water-tight one. Historically there might have been two classes, the tight and the leaky, but in the future only the tight should be accepted. It must not be understood that the navy alone found leaks, for they were just as troublesome in the merchant marine. He considered that a good deal of the blame for leaky bulkheads could be laid to the draftsmen.

Professor Peabody considered the experiments described in the papers just read, as very important. He thought the Navy Department should conduct a series of experiments and put the data obtained in form so that it could be used for future design.

Mr. T. F. Newman saw no reason why bulkheads and ship's bottoms could not be made absolutely tight. On the Great Lakes they managed to secure such tight work that in many instances where the outer plating of the double bottom of vessels carrying grain had been injured, not more than 30 or 40 bushels of grain would be damaged, owing to the tight inner bottom

Mr. John C. Kafer thought that bulkheads were made to keep out the bulk of the water, and except in tank steamers, there was no need of builders going to great trouble to stop every little leak, provided the bulkheads were strong enough to stand the strain.

Col. E. A. Stevens asked what conditions were imposed in the United States service. In the British service he understood that the stiffeners must be strong enough to stand all strains without depending upon the sheeting.

In reply Mr. R. M. Watt read a letter showing how the stiffeners and bulkheads were calculated for the "Texas," and a comparison of the bulkheads of a number of United States vessels.

Mr. Bowles objected to placing 50% of the blame for leaky bulkheads upon the draftsman. The trouble was that after a bulkhead was made tight it was drilled full of holes by the machinists and electricians.

Mr. J. J. Woodward objected to any plan of bulkhead bracing that would weaken the protective deck, and said that where there was a conflict between the fighting strength of a vessel and a small amount of leakage, the latter should be disregarded. In response to a question, Mr. Smith said that in the test of the double bottom of the "Brooklyn" the time and labor of five men was required constantly for 14 months.

Owing to the short time remaining, the paper of Mr. Walter A. Post, on "An Electrically Operated 150-Ton Revolving Derrick," was read by title only. This paper will be abstracted in a later issue of Engineering News.

The last paper of the meeting, "Stability of a Battleship Under Damaged Conditions," was read by its author, Prof. C. H. Peabody. This was a report of a series of tests made with a small wooden model representing a battleship with its superstructure removed. The model, with inclining apparatus in place, was ballasted so that it floated at the proper water line, and so that it had the proper metacentric height. Then blocks, representing the parts or compartments laid open to the sea, were cut out and lead weights were fastened in place to compensate for the wood removed. Then various measurements were made to determine the initial stability and the stability at various angles of heel. The facts developed were illustrated by a series of diagrams, and a number of curves. Discussing the paper, Mr. Woodward suggested that in an actual battleship the superstructure could be made to assist in keeping the vessel afloat. Professor Peabody considered that the many openings in the superstructure would prevent its adding to the buoyancy of the vessel, should it start to capsize.

The discussion of the following topics was then taken up:

First.—Under the circumstances of the blockade at Santiago, which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?

Second.—Can you give any data as to the cost in coal of maintaining the engines and boilers in readiness for immediate service?

Mr. John C. Kafer read a letter from Chief Engineer Milligan, of the "Oregon," which stated that the fires on the "Oregon" were spread thin. There being from 24 to 27 tons of coal burned per day. The "Iowa" used banked fires. Mr. Kafer considered banked fires more economical, but not so advantageous for quick steam making, as keeping them spread.

Lieut. Walter M. McFarland presented some figures showing the coal consumption on the "Indiana," "Massachusetts," "Oregon," and "Iowa." These were in part:

	Tons.		Lbs.
"Indiana"......	34.7 per day, or		7.21 per sq. ft. grate per hr.
"Iowa".........	35.16	" "	5.2 " "
"Massachusetts"	29.4	" "	6.5 " "
"Oregon".......	24.91	" "	4.35 " "

Note.—The "Iowa," "Massachusetts," and "Oregon" had spread fires.

This was, therefore, an indication that spread fires were also more economical, and there could be no question about the enormous tactical advantage.

Mr. Lewis Nixon presented a resolution to the effect that papers be invited on the subject of "Life Saving at Sea," and that two such papers be selected and printed in next year's "Proceedings." Motions thanking the various officers were passed, after which the final adjournment was taken.

In the evening fully 200 members and guests assembled at Delmonico's to participate in the annual banquet, which proved quite as successful as the business meetings had been. President Clement A. Griscom acted as toastmaster and the following is the list of toasts:

"The President of the United States;" "Our Navy; It Has Justified Its Existence and Glorified the Nation," Harvey D. Goulder; "Our Commercial Marine, Its Development and Extension is a National Necessity," Hon. George F. Edmunds; "The Naval Militia," Capt. J. W. Miller; "Naval Architecture," Lewis Nixon; "Marine Architecture," Lieut. Walter M. McFarland; "Our Manufacturers," Theo. C. Search. Personal toasts were: Charles H. Haswell, Charles Ward, William H. Webb.

On Saturday the members of the society enjoyed an excursion to South Bethlehem, Pa., through the courtesy of the Bethlehem Iron Co. The party, to the number of about 100, boarded two special cars provided by the Bethlehem Company, and attached to the regular Lehigh Valley Express, which left Jersey City at 8.20 Saturday morning. Immediately upon arriving at South Bethlehem the special cars were run into the yard of the Bethlehem Iron Works, and the entire party was transferred to a train of flat cars provided with seats. On this observation train the inspection of the works was made.

Starting at one end of the property, which is just one mile long, the party was taken past the scrap pile, where waste pieces of armor plate, stubs of ingots, etc., are stored for possible future use, into the forge shop, a building about 1,900 ft. long. In the main portion of this great building is a 5,000-ton Whitworth hydraulic forge, which was at work upon a steel jacket for a 12-in. coast defense gun. The wonderful power of this press, its quiet operation, the accuracy of its work and the skill with which its many movements were controlled by the few operators, was a revelation to many present.

Further on the powerful pumps necessary to give the 2,250 lbs. per sq. in. needed for the press were seen. A smaller press, 1,300 tons, but of the same type, was also in operation cutting off the end of a good-sized ingot. Continuing, the observation train and party passed the line of open-hearth furnaces, with capacities of 30 to 50 tons, and came to a halt beside the ingot casting pit, where the fluid compressed ingots, for gun forgings, engine shafts and the like, are made. This consisted of a pit about 20 ft. deep, in the center of which stands a 9,000-ton vertical hydraulic press. Fortunately for the visitors, an ingot was just being cast, so the whole operation could be seen by all. At one side of the great press stood a cylindrical flask built up of heavy cast-steel sections, bolted together and lined with refractory material. Over this a ladle holding about 15 tons of molten steel was run and the vent in its bottom opened, allowing a jet of liquid steel about 2 ins. in diameter to flow out and gradually fill up the vertical flask. When sufficiently filled, the flask, with its liquid steel contents, was slid over and centered under the hydraulic press and the pressure of 9,000 tons was gradually applied. Under the influence of this pressure, which is allowed to remain for six hours, the metal is compressed and the possibility of injury by air or gas bubbles is largely removed.

The next shop visited was the machine shop, where gun work was in progress. This building is 1,400 ft. long, and is filled with enormous planers, boring mills and other heavy machinery, most of which was engaged upon disappearing gun carriages for coast defense guns, and upon large size guns and mortars and a variety of engine shafts.

In another shop, devoted to armor plate work, the party was fortunate enough to see the great 13,000-ton press forging an armor plate. In this shop also the immense 125-ton steam hammer, now abandoned, stands as a monument to past methods and modern improvements.

Next the visitors were conducted to the department where common plates are Harveyized. A steel plate about 8 × 10 ft., intended for a large vault, was withdrawn from the furnace and placed over a large vat. A system of perforated pipes was swung over the plate, and when the proper temperature was reached water was turned on. In summer it is necessary to use ice water to ensure a proper chill, but at this season of the year ordinary river water is suitable.

The next move was to the tempering building, where engine shafts, gun tubes and long or thin pieces likely to bend and temper unevenly in a horizontal position are supported vertically in a gas blast furnace. The party arrived just in time to see a jacket for a 12-in. gun lifted from the heater, shifted over and rapidly lowered into a large cylindrical tank of oil, where it was to remain for from 5 to 6 hours. As the red-hot tube, fully 20 ins. in diameter and 20 ft. long, dropped into the oil there was next to no flame, and when once immersed only a small amount of smoke escaped from the oil surface.

In the armor plate trimming shop, the next one inspected, great slabs of steel armor, some flat and others curved, were having their edges beveled or squared up in planing machines. Such plates as had been hardened could only be planed down to the hardened surface, and emery wheels, either automatic or mounted upon flexible shafts for hand use, were employed to finish the hard edges. Plates as yet unhardened were being sawed, the saws consisting of steel disks some 4 or 5 ft. in diameter, with a series of separate cutting tools mounted around their circumferences. These saws advanced at the rate of about 4 ins. per hour, a rather lively rate, considering the fact that they were sawing tough steel from 12 to 14 ins. thick.

By this time the calls of the inner man were heard, and those in charge piloted the party to the office, where things to eat and drink were served and disposed of without stint, not, however, being served on armor plate. After a full inspection and realization of this department the special cars were again boarded and a quick return was made to New York, where the party disbanded, after a most instructive and delightful day.

BOOK REVIEWS.

Note:—In the review of the new edition of Johnson's "Engineering Contracts and Specifications" in our last issue the price of the book was, by an error, printed as $3.50. It should have been $3.00, which is a reduction of $1 from the price at which the first edition was sold.

COMMERCIAL RELATIONS OF THE UNITED STATES WITH FOREIGN COUNTRIES DURING THE YEARS 1896 AND 1897.—In two volumes. Vol. I. issued from the Bureau of Foreign Commerce, Department of State, Washington. Cloth; 9 × 5¾ ins.; pp. 1,283.

The introduction of this book proposes to show that the "international isolation" of the United States, so far as industry and commerce are concerned, is made a thing of the past by the logic of the change in economic conditions. We are now a competitor in the world-wide struggle for trade, and can no longer afford to disregard international rivalries. The report then commences the detailed review of the world's commerce, based upon data chiefly obtained from our consular agents. This volume deals with Europe, Africa, America, Asia, Australasia and Polynesia. The report covers character and amount of exports and imports, finances, trade conditions, transportation systems in many cases, and a vast mount of information useful to the American exporter.

CALCUL DES CONDUITES D'EAU.—Par Georges Davies, Conducteur au service des Eaux de Paris, Licencie es-sciences. Encyclopedie Scientifique des Aide-Memoire. Paris: Gauthier-Villars & Sons. Paper; 7½ × 4½ ins.; pp. 194; illustrated. Paper, 2.50 francs; boards, 3 francs.

The author commences his work by a discussion of the theory of the flow of water in pipes or conduits, under different conditions; gives the formulas of Prony and Darcy and recommends the employment of the latter under the conditions stated; he also notes the formulas of Weisbach, Ganguillet and Kutter, M. A. Franck, Manning, Unwin and Lampe. Succeeding chapters discuss conduits with reservoirs, variable diameters, distribution from various points on the pipe line, and miscellaneous questions arising in the supply and control of water in pipes. His final chapter treats of the study of distribution systems, arrangement of pipes, discharge, diameters and loss of head, syphons, etc. He closes with a number of tables of coefficient velocities, discharge, etc., as deduced from Darcy, Maurice Levy and Flamant. The work is chiefly theoretical and mathematical, with a few actual examples noted. The author does not enter into the details of practice in the form of pipes, valves and general appliances in pipe distribution.

STREET RAILWAY ROADBED. By Mason D. Pratt, Assoc. M. Am. Soc. C. E., and C. A. Alden, Assoc. M. Am. Soc. C. E. Street Railway Publishing Co., New York. Cloth, 6 × 9 ins.; pp. 135; 157 illustrations; $2.

As stated in the preface, the subject matter of this book is largely made up from contributions of the authors to the "Street Railway Journal," "Engineering News" and the Proceedings of the Am. Soc. C. E. About one-third of the book is given up to a historical review and a consideration of what governs the shape of rails. In this portion are some 50 line cuts representing sections of rails and angle plates showing the gradual increase in web depth and the changes of form of head and base. There are also about 30 cuts under the title of "What Governs the Shape of Rails," and the T-rail as adapted to street railways is also considered. This is followed by a discussion of track fastenings and joints, curves, special work and guard rails. The remainder of the volume is devoted to a discussion of the advantages of spiral curves, in connection with which is given a series of tables and formulas and remarks on the design of special work. The last chapter consists of a set of skeleton specifications for street railway tracks.

Considering the book as a whole we feel compelled to criticise it in several points. For instance, in the chapter on joints, cast joints and electric welded joints are barely touched upon, while "bonding," a very important matter where electric roads are concerned, is not even mentioned. We find no mention either of the recent practice of laying rails directly upon longitudinal concrete footings and discarding the use of ties. Aside from several such defects the information contained under the various headings mentioned will doubtless be of considerable assistance to those having to design or construct street railways. The principal value of the book rests in the chapters on curves and the design of special work.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES, issued by the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn. Leather; 6 × 3¾ ins.; pp. 196. $1.25.

Of the many metric conversion tables issued, this is by far the best and most convenient that has ever come to our notice. The actual work of calculating the tables and reading the proof has been done by Mr. A. D. Risteen, Associate Editor of "The Locomotive" and late of the computing division of the U. S. Coast and Geodetic Survey. This in itself is a guarantee of the care and accuracy with which the task has been performed. The history of the meter is given in full, together with a general discussion of the units derived from the meter. Then follows a table of metric units, the U. S. equivalent and the logarithm to be applied in working from this data. A full list of the tables inserted in this handbook is as follows: The units reaching 100 in each case and two tables being given under each head from metric to U. S. standards and from U. S. to metric; centimeters to inches; meters to feet; meters to yards; kilometers to miles; square centimeters to square inches; square meters to square feet; square meters to square yards; square kilometers to square miles; hectares to acres; cubic centimeters to cubic inches; cubic meters to cubic feet; cubic meters to cubic yards; cubic kilometers to cubic miles; cubic centimeters to U. S. fluid ounces; liters to U. S. liquid quarts; liters to U. S. gallons; liters to British liquid quarts; liters to British gallons; liters to U. S. dry quarts; cubic meters (sterea) to U. S. bushel; grammes to grains; grammes to avoirdupois pounds; kilograms to avoirdupois pounds; grammes to troy ounces; kilograms to troy pounds; milliers to short tons; kilograms per square meter to pounds per square foot; kilograms per square centimeter to pounds per square inch; kilogram-meters to foot-pounds; calories to British heat units; calories to foot pounds; force de chevaux to horse-power; grammes in a cubic centimeter to ounces in a cubic inch; kilograms in a cubic meter to pounds in a cubic foot; milliers in a cubic meter to short tons in a cubic yard, milligrams in a liter to grains in a U. S. gallon; comparison of Centigrade and Fahrenheit thermometers. This list, better than a page of comments, conveys an idea of the useful range and application of the tables. The equivalents in both metric and U. S. measurements, are carried out to three places of decimals in the regular tables, and to six or even eight places, in the special table of metric equivalents. Though the tabular numbers run only to 100 the equivalents of any number can be readily obtained, as explained in the chapter on "The Use of the Tables." The great usefulness of this little book has already been proven in the short time it has been in this office.

THE HEAT EFFICIENCY OF STEAM BOILERS; Land, Marine, and Locomotive. With Tests and Experiments on Different Types, Heating Value of Fuels, Analyses of Gases, Evaporation and Suggestions for Testing Boilers. By Bryan Donkin, M. Inst. C. E. With numerous tables, plates and illustrations. London: Charles Griffin & Co., Ltd. Philadelphia: J. Lippincott Co. Cloth; 8vo.; pp. 311.

The author of this book says in his preface that he has had frequent opportunity during the last 25 years of making tests on steam boilers, and that as his tables of results increased it might prove useful as a collection of facts, if thrown into the shape of a book. To his own tests he has added those of many other experimenters, and he has thus "thrown" together in tabular form the figures of no less that 425 experiments in English and other boilers. We quote the following from the preface:

> It is mainly by collating and comparing a large number of reliable tests, that the principles governing combustion and efficiency in different types of boilers can be determined. The author hopes, therefore, that his contribution to the heat question, by breaking comparatively new ground, will lead the way, and incite others to make more complete collections of careful boiler experiments, the only mode in which the subject can be thoroughly and practically studied.

We hope that Mr. Donkin's book will "incite others" to do nothing of the kind, and that his "collection" will remain for many years to come the most extensive collection in existence. It is one thing to have a mania for making collections and quite another to have the faculty of studying the collection after it is made. Mr. Donkin is a good collector and tabulator, but his study of the collection, as far as we can judge from the book, is meager and unimportant. The tables occupy 100 pages; the chapter on discussion of the trials and conclusions only six. The most important conclusion drawn is the following:

> The efficiencies vary, even in the same type of boiler, owing to very different working conditions. Thus in Cornish, externally fired, they ranged from almost the highest, 81.7% to 53%. Again, Lancashire, internally fired, show, under favorable conditions, an efficiency of nearly 80%, while they also give the lowest, viz., 42%.

This conclusion is important but it is not at all new, for the author quotes from Mr. Barrus's book on "Boiler Tests," published in this country several years ago a practically identical conclusion as follows:

> The general conclusion as to economy of different types of boilers depends much more upon their proportions and upon the conditions under which they work than upon their type With suitable proportions and favorable conditions the various types give substantially the same economic results.

An interesting statement concerning air supply to the coal on the grate is as follows:

> The only right method of testing the efficiency of a given grate with a given coal and draught is to analyze the gases of combustion and thus to ascertain the percentage of air in excess or the reverse. If too much has been admitted to the grate the bars should be arranged nearer together; if too little they should be spaced out further apart.

We venture to say that there is not a boiler user in Great Britain who is likely to follow Mr. Donkin's advice in this particular and that Mr. Donkin himself would not follow it if he were in charge of a boiler. What he or any one else would be most likely to do, if his analysis of the gases showed that too much air was passing through the fire, would be to increase the thickness of the bed of coal on the grates, and to take extra care that there were no "air-holes" in the fire.

Besides the tables of tests and the very brief statement of conclusions drawn from them the book contains a fair compilation of information on classification of types of boilers, on fire grates, on mechanical stokers, on feed water brakes, superheaters, feed pumps, etc.; discussions on combustion, on the transmission of heat through boiler plates, on smoke prevention; descriptions of testing apparatus; notes for making boiler tests, etc. An appendix contains illustrations of all the principal forms of ancient and modern boilers. On the whole the book is a valuable collection of interesting facts concerning steam boilers, although it is far from being as good a treatise on steam boiler efficiency as we should expect from the author.