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THE WATER TUBE BOILER ON ITS TRIAL.

There has recently been brought to a close a series of trials of the water tube boiler, which has attracted more attention than any event that has happened in the engineering world for many months past. We refer to the trials of the 25,000 horse power installation of Belleville boilers on the cruiser Powerful.

These trials were remarkable, not because this was by any means the first use of water tube boilers at sea, but because it was the first attempt to use them on such an enormous scale. The public has long been familiar with this type as used on torpedo boats, and of late it has been winning its way into fuller recognition on shore, where it is doing good work in the general industries, It was natural that it should meet with favor for marine, and especially naval work, where its light weight, compact form and capacity for sudden generation of power render it specially useful. In the earlier days of torpedo boat building it had the locomotive type of boiler for its competitor; but as the demand for combined lightness and power has grown, the locomotive boiler has practically disappeared from the contest and left the water tube type in possession of the field. The excellent results obtained by the French navy in fitting some of their smaller cruisers with this type have led the British Admiralty to equip their two largest cruisers, the Powerful and Terrible, entirely with the Belleville boiler. The decision was based upon the French experiences, and also upon a series of exhaustive trials in one of their own gunboats. The decision evoked a storm of criticism from experts, naval and otherwise, and it was freely predicted that the attempt would be a costly failure. The results of the recent trials, however, are reported to have been exceptionally favorable, the contract horse power, 25,000, being largely exceeded, and steam being maintained with ease and regularity.

The Belleville boilers, forty-eight in all, are divided up into eight groups—four groups of eight boilers each and four others of four boilers each, each group in its own compartment. The four latter groups are arranged side by side and fired athwartship. The other four groups are arranged for fore and aft firing. There are twelve stoking spaces, arranged with four boilers and six stokers to each space. It is found that if the men replenish the fires every four minutes by the clock, perfect uniformity of pressure can be maintained.

It has frequently been urged that the results of official trials of foreign battleships are worth very little because they are of too short duration to really test the qualities of the machinery and boilers. It must be admitted that no such charge can be made in this case, the trial tests, indeed, being of an extraordinarily severe nature, such as have never been attempted in any other navy. They included two runs at 5,000 and 18,000 horse power respectively, each of thirty hours' duration, and a final run of eight hours, the first four hours at 25,000 horse power and the remaining two at 22,000 horse power.

In the first trial the average indicated horse power was 5,008 and the coal consumption 2·07 pounds per horse power per hour. Sixteen out of the forty-eight boilers were used. In the second thirty hour trial the indicated horse power was 18,433 and the coal consumption 1·83 pounds. The four hours' full power trial was carried out on November 27. The boiler pressure was 257 pounds; the mean indicated horse power was 25,886, the maximum being 26,497; and the speed of the vessel against a head sea and wind was 21·8 knots, the distance being measured by landmarks. The coal consumption was not taken. It was estimated that in smooth water the speed would have been about 22·75 knots.

During both thirty hour runs the two furnaces of each boiler were fired alternately at intervals of four minutes. At the commencement of the full power run this was reduced to three minutes. The fires were kept at a thickness of six inches, coal being put on only in sufficient quantities to fill up the holes and hollows. The draught plates were kept three-quarters open, the air supply being controlled by varying the speed of the fans. The Belleville system is run upon the "open" as against the "closed" system of forced draught, and the fans are used primarily for ventilation. The work of the ordinary closed stokehold fan is done in a Belleville boiler plant by air compressing engines, one of which is placed in each stokehold.

It will thus be seen that the introduction of the water tube boiler has removed at a stroke all the discomforts attendant upon the old forced draught. The maximum temperature in the stokehold never exceeded 90 degrees; in the engine rooms it was 75 degrees. It is claimed, and very justly, too, that this moderate temperature will be of inestimable value when the engine and boiler room staff is called upon to endure the long continued strain of a war cruise.

Some idea of the saving of weight which is made by the use of this type of boiler as against the ordinary Scotch boiler may be gathered from the fact that the Powerful can carry a coal supply of over 3,000 tons. On the other hand it must be borne in mind that the consumption of coal per horse power is higher for the water tube than for the common type of boiler. It is a common occurrence for a Scotch boiler to show a consumption of less than 1·5 pounds per horse power hour, and it was only the other day that, chancing to step aboard a tramp steamer and inquire as to her coal consumption, the engineer promptly responded by handing us the cards of the voyage just ended, which showed a consumption of 1·4 pounds. So that in considering the merits of the Belleville boiler as regards saving of weight, we must remember that if the weight of boiler per horse power is less, the weight of coal per horse power is greater.

Warships, however, are not run for economy. The value of this type of boiler lies in its power to generate high pressure steam rapidly and in great volume for a considerable length of time in response to an emergency call, such as will continually be made in active service. The trials just concluded prove that all these conditions can be fulfilled with an installation of the unprecedented capacity (for water tube boilers) of 25,000 horse power.

A RETROSPECT OF THE YEAR 1896.

It will be pardonable to take a rapid glance at the international affairs of the past year, before entering into a detailed recapitulation of the scientific achievements which have marked its progress; and, as a journal devoted to the arts of peace, we note with deep satisfaction that whereas the opening of the year was marked by a widespread international distrust and jealousy, and the gathering of ominous war clouds, its close finds the political sky growing clear, a more reasonable temper of tolerance and forbearance manifesting itself, and, with the exception of three widely separated corners of the earth, a prevailing and apparently long to be continued peace established. With the Venezuelan scare replaced by the prospect of a permanent peace tribunal; with England, France and Russia united in the effort to bring about reforms in the East; with the Boer government promising concessions to the foreign element in the Transvaal; with a satisfactory treaty concluded between Italy and Abyssinia and the hostages returned—the prospects of peace are certainly brighter now than they were in the opening days of the year which has just drawn to a close. The three existing wars are attendant on the struggle of Spain to hold what she has in Cuba and the Philippines, and of England to reconquer the Soudan.

It is encouraging to note that in the industrial world there is evidence of a marked revival of trade, which has been felt in every quarter of the globe, and in this respect is as widespread as the gradual depression which commenced in 1891. We were the last nation to feel the decline, and we have been among the last to show signs of recovery. With the opening of the year, however, we may congratulate ourselves that trade is thoroughly convalescent, and there is every reason to look for a prosperity which will be permanent, because it is more gradual in its return, and comes in a natural course. One of the most notable events of the year has been the astonishing development of Japan, whose victory over her traditional enemy seems to have awoke in her a spirit of aggressive ambition, which is showing itself in her evident determination to take her place as one of the leading nations of the world.

It was hoped when the Chinese statesman and ambassador, Li Hung Chang, made his tour through the western world at the time of the coronation of the Czar of Russia, that his return to China would be marked by a similar activity in the ancient empire. There is little doubt but what Li Hung Chang himself was earnestly in favor of introducing modern improvements and industries. The tidings, however, that soon after his arrival he had been again degraded shows that the conservative party is yet all powerful. The awakening of China seems to be indefinitely postponed.

The most notable event in the field of engineering was the opening of the river Danube to navigation. This event formed part of the millennial festivities in Hungary, and as such took rank with the great exposition at Buda-Pesth. The undertaking was intrusted to Hungary by the treaty of Berlin, 1878, and work was commenced in 1890 and completed on the last day of 1895. The blasting operations covered a distance of sixty miles, and involved the removal of 1,635,000 cubic yards of material, 915,600 of which were excavated under water. Nine thousand workmen were continuously employed and the total cost was $10,000,000. Previous to the opening of the Iron Gates five feet was the limit of draught for river steamers for a large part of the year. The canal now affords an unobstructed outlet from Vienna to the sea for boats drawing ten feet of water. The Nicaraguan Canal Company states in its annual report to the Secretary of the Interior that no work has been done since August, 1893. Its rival, the Panama Canal, is almost equally inert, a small force being employed merely to fulfill charter obligations. It is with pleasure we turn to the Chicago Drainage Canal, which is being pushed with commendable energy. Apart from its magnitude, this work is remarkable for the magnificent excavating machinery which it has called into existence and the novel methods of handling material which are employed. The pre-

liminary operations connected with the great Simplon Tunnel through the Alps are under way, and the fact that this monumental work is being undertaken conjointly by the Italian and Swiss governments is a pledge of its vigorous prosecution. In this country we have seen the completion of the great dry dock at Port Orchard, 675 feet long, and a similar structure at the Brooklyn Navy Yard, with a length of 670 feet, is within measurable distance of completion. Work has been carried on without interruption on the Croton River Dam, and this massive structure is, therefore, nearer completion by one more out of the total thirteen years that will have been consumed in its erection. Work has been commenced during the year on the new East River Suspension Bridge, New York. This structure will rank as the second longest railroad span in the world, the clear length between towers being 1,600 feet. It will carry six lines of railroad track, two roadways, and two footwalks, and will in every way, except that of beauty, eclipse the existing New York and Brooklyn Bridge. Mention should be made of the completion of the great Cascade Locks on the Columbia River, Oregon, whereby a vast area of the interior of the State is opened up to river navigation, of the progress of the great lock at the new Imperial Harbor of Bremerhaven, and of the extensive works at Barry Docks, England.

In the wide field of transportation, the most notable undertaking is of course the great Siberian Railway. Work has been pushed so vigorously that the line will soon reach Irkutsk, an event which will mark the completion of the entire western, and a large part of the transcontinental, line. At the present rate of construction, the line can be completed in 1898. Considerable activity is being shown in railroad building in Southeastern Africa, and the Congo Railroad is about half completed. In the United States, 1,803 miles only were built last year, a small figure in comparison with those of previous years; but it must be borne in mind that a vast amount of work has been done in the improvement of roadbed and rolling stock. The past year has not been marked by any such spectacular railroad runs as distinguished its predecessor; but there has been a tendency to accelerate the running speed of the average train. This has been rendered possible by the improved condition of the track and the ever increasing weight and power of the engines. The favorite type of locomotive for fast passenger traffic, if we may judge from the recent examples, has cylinders 19 to 20 inches diameter by 24 to 26 inches stroke; 180 to 200 pounds of steam; drivers, 6½ to 7 feet in diameter, and about 2,000 square feet of heating surface.

Electric traction has continued to make steady progress during the year. Its ultimate application to the trunk railroads has been brought a step nearer by the excellent results obtained during the year on the Nantasket branch of the New Haven road, which have been so good that the company has determined to lay a third rail on other branches of its system. Of the attempt to apply electric traction to the main lines by the builders of the Heilmann locomotive, it can only be said that if it proves to be successful, it will be in flat contradiction to the commonly accepted principles of the conversion of energy. The company claims to have been so encouraged by results that they are building larger and much more powerful machines. The successful operation of the Lenox Avenue underground trolley lines in New York City during the snows of last winter, and the determination of the company to put in the same system on forty miles of their horse car lines brings the day a little nearer when overhead wires will be abolished from our streets. The year has seen the opening of the Buda-Pesth electric underground road in Europe, and in this country the Boston Electrical Subway has progressed favorably. The deep underground electric railways of London have proved so successful that several new schemes are in progress and proposed. The Snaefell Mountain Railway in the Isle of Man has scored a brilliant success for electric traction, in sharp contrast to its unfortunate contemporary across the channel in North Wales, the Mount Snowdon steam rack railway. Much interest attaches to the line opened this year at Lugano, Switzerland, where the three-phase system receives its first application to traction. The cars carry a double trolley and the rails are utilized as one conductor. Limits of space prevent a detailed reference to the ever increasing applications of electric power, chief among which is the transmission from Niagara to Buffalo. Suffice it to say that the year has seen its further extension in the shape of electric locomotives for mining and general yard work, its extended application to elevators, motor carriages, the manipulation of warship appliances, artillery, to various household uses and a multitude of other purposes.

Compressed air, notwithstanding the loss of power inseparable from its compression and expansion, has come to the front this year, especially in this country, where the Hardie and Hoadley patents for railway motors have been extensively tested on the streets of New York City. Both of these attempt to overcome the loss by a system of heating the air previous to its admission to the cylinders. The Hardie motor has given such satisfaction that it is shortly to be applied experimentally to the elevated railroads in this city. Compressed air has also undergone a successful test on the United States monitor Terror, where it is applied to the manipulation of the turrets.

The motor car, or horseless carriage, has attracted more attention this year than any other device in the field of mechanical engineering, always of course excepting the bicycle. Our columns have kept the public well informed, both by cuts and descriptive matter, of the progress of the industry. The record of the year proves that the motor car has come to stay, and gives cause to believe that it will enjoy a popularity second only to that of the bicycle itself, and a commercial utility far greater. The greatest performance of the year was that of the winning machine in the Paris-Marseilles race, which covered 1073 miles at an average speed of over 15 miles per hour. In this country we have had the Cosmopolitan race on Decoration Day and the track race at the Providence State Fair. The way has been opened for the new industry in England by the repeal of the antiquated laws restricting the use of motors on common roads. In the inaugural parade (so called, it was really a race) the winning car made a speed of over 20 miles per hour for the whole journey from London to Brighton. At present the oil motors are in almost undisputed possession of the field; but there is every reason to expect that when the steam engineers have had time to develop a suitable form of engine and boiler, this supremacy will be disputed.

The bicycle still continues to enjoy an enormous popularity. It has undergone little or no organic change this year in its construction; the diamond frame, chain-driven machine continuing to be the practically universal type. There is a tendency to raise the gear from 66½ to 74 or even 80. The tendency to study the comfort of the rider is seen in the great attention which has been paid to the production of a comfortable saddle, built on so-called "hygienic" principles. The single tube tire appears to be displacing the double tube; and the weight of the average machine remains at about 23 pounds.

The close of the year 1896 sees no abatement in the craze for naval shipbuilding which has taken possession of the nations. England, France and Russia continue to make enormous expenditures on their fleets, and Germany, on a smaller scale, is maintaining her activity of the last few years. Speaking generally of the designs, there is a tendency to sacrifice armor to armament and speed. This is very noticeable in the latest battleships of the English navy, known as the new Renown class, which, with a displacement of nearly 13,000 tons, will have only eight inches of armor on the sides, six inches on the bulkheads and ten inches on the turrets. On the other hand, they will carry nearly 2,000 tons of coal and steam about nineteen knots. It will thus be seen that the dividing line between battleship and armored cruiser is gradually disappearing. One of the most sensational events of the year was the speed attained by the torpedo boat destroyers Desperate, of the British navy, and Forban, of the French navy, both of which exceeded thirty-one knots an hour. The naval progress of the United States during the past year has been altogether unprecedented. The most notable fact is the completion of that powerful trio of battleships, the Indiana, Massachusetts and Oregon, which are universally conceded to be the most powerful fighting machines afloat. Each of them considerably exceeded the contract speed at its trial, the Oregon touching seventeen knots an hour. The Brooklyn was nearly two knots ahead of its trial speed of twenty knots, and this vessel also enjoys the distinction of being the most effective ship of her class afloat. The monitors Monadnock and Terror, the ram Katahdin, and the torpedo boat Ericsson have also been accepted. In naval strength, the United States have now moved up to sixth place, and they will eventually be ahead of Germany on the list, if the present activity continues.

We have so recently illustrated the recent developments of shot and armor that it is sufficient to say that the year closes with the Harveyized reforged nickel steel plate and the compressed fluid steel solid shot of American manufacture still in the lead.

In the merchant marine it is gratifying to record that the American liner St. Paul has captured the record from Southampton to New York, her time on two successive trips being 6 days 2 hours and 24 minutes, and 6 days and 31 minutes, her speed on the latter trip being 21·08 knots per hour. This result from a ship which was designed for only 20 knots is a distinct tribute to the skill of the shipbuilders. Mention must be made in this connection of the placing of orders by the Japanese government with Messrs. Cramps and with the Union Iron Works for two fast cruisers. It is the first event of its kind, and full of promise for the future. Speaking generally, there has been a tendency the past year to build cargo steamers of unprecedented size, huge carrying capacity and moderate speed, the Pennsylvania, the next largest ship to the Great Eastern, and rivaling her in size, being a case in point. The German yards have two vessels in hand for the Atlantic mail service which are to surpass the Lucania, the Frederick the Great being 20 feet longer on the waterline and several hundred tons greater displacement. The world is watching curiously for the trial trip of the Bazin roller ship.

The geographical world has welcomed home this year from Arctic exploration Dr. Nansen, who failed to drift across the North Pole, but penetrated to latitude 86 degrees 14 minutes, which is 2 degrees and 50 minutes further north than ever before attained. The Jackson-Harmsworth expedition has mapped out an extensive area of Franz Josef Land, and Lieutenant Peary has returned safely from his annual Arctic trip. The voyage of Mr. Borchgrevink to Antarctic regions and his earnest representations are likely to result in one or more well equipped expeditions.

Archæology has reaped a rich harvest as the result of the year's explorations. M. De Morgan's discoveries at Dashur in Egypt, the excavations of Dr. Richardson in Corinth and Herr Dorpfeld at Athens, the finding of Trajan's Ship of State in Lake Nemi, and lastly the splendid results of American investigation in Babylonia are only some of the operations of a particularly successful year.

The field of aeronautics is poorer by the loss of Lilienthal, who died a martyr's death, victim of his devotion to science. The most remarkable performances of the year have been those of Prof. Langley's aerodrome, which, carrying its own fuel and water, has soared and returned to earth, and also flown 1,500 yards in a horizontal direction, without losing its equilibrium or receiving any damage. The feat of human flight has been successfully accomplished for varying distances by inventors who have followed in the steps of Lilienthal, who was the first to accomplish it successfully. Experiments in kite flying have been industriously prosecuted at the Blue Hills Observatory, Boston, and this quondam pastime is likely to be turned to good meteorological account.

By far the most dramatic event in the world of science occurred when the year was yet but a few days old. On January 4, at the celebration of the semi-centennial of the founding of the Berlin Physical Society, Prof. Roentgen announced his discovery of what are now universally known as the X rays. A certain form of vacuum tube was shown to be capable of giving out rays which could penetrate opaque substances, and the public incredulity was quickly dissipated when X ray photographs began to fill the columns of the illustrated press. Following close upon the announcement came the fluoroscope, which enabled the effect of the rays to be seen directly by the eye. If no other event than this one had to be chronicled, the year just closed would stand out as one of the most famous in the history of Science.

The Pyro-Metol Developer.

BY JEX BARDWELL.

Some weeks ago I had a call to do a little street photography. The day was very far from bemg suitable for snap shot work, but it had to be done then or not at all. It had been raining, so that the atmosphere was clear, but there was very little light. The lens I used will work at *f*/4, but in order to get better distance I used the stop *f*/8. It was with some fear that I entered my dark room to develop the plates, but I had the satisfaction of having them turn out all right. I attribute my success to a modified pyro or pyro-metol developer which I have employed for some time past with general satisfaction. Those who have a little time to spare, and who are fond of trying a new thing once in awhile, will possibly find these few notes of interest. In the following formula No. 1 is for use when it is desired to produce a strong negative; No. 2 is a milder form of the same; No. 3 is the usual alkali solution:

No. 1.

Water	8 ounces
Metol	18 grains
Sulphite of sodium (cryst.)	360 "
Pyro	22 "
Bromide of potassium	4 "
Citric acid	24 "

No. 2.

Water	8 ounces
Metol	18 grains
Sulphite of sodium (cryst.)	360 "
Pyro	22 "

No. 3.

Water	8 ounces
Carbonate of potassium	1 "

For use, take one part of No. 1 (or No. 2 according to the kind of negative desired) to one part of No. 3, and add one part of water.

I find that the above quantity of sulphite gives a slight tint which produces an excellent printing negative, but if you desire a gray negative you can get it by increasing the quantity of sulphite. I think those who try it will like it. I have had better results with this formula, both under skylight and landscape, than with any developer I have ever used. You can modify the printing qualities of your negative to almost any extent by increasing or decreasing the quantity of sulphite.—Wilson's Photographic Magazine.