SCIENTIFIC AMERICAN
ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year, for the United States, Canada, or Mexico........$3.00
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) ....$3.00 a year
Scientific American Supplement (Established 1876)............. 5.00 "
American Homes and Gardens..................................... 3.00 "
Scientific American Export Edition (Established 1878).......... 3.00 "
The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, FEBRUARY 2, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE ENGLISH CHANNEL TUNNEL SCHEME.

When the British Parliament, a quarter of a century ago, voted down with a ringing "no" the scheme for building a tunnel beneath the channel from Dover to Calais, it was thought that the question had been settled for all time. Some pertinacious promoter, however, undiscouraged by the outspoken sentiment of that day, has now laid another bill before the House of Commons, in which the franchise then denied is again prayed for. Whether this latest Channel bill will meet with more favor, it is impossible to foretell. Although sentiment against the plan is not lacking, we fancy that the British public is this time disposed to lend a more willing ear to arguments in favor of the tunnel.

The question is undoubtedly one of grave political importance to Englishmen. A Channel tunnel will impair, if it will not destroy, a splendid isolation enforced by geographical situation. Accordingly, we find that the objections which were urged one-quarter of a century ago against an artificial union of France and England are again raised. A scientific committee, to which the matter of properly guarding the British terminal was referred in 1882, was decidedly pessimistic in its report. They questioned the possibility of preventing the capture of the British end of the tunnel by a bold company of French adventurers. Even the most elaborate and diabolically ingenious devices for checking an onslaught, devices which seem almost ridiculously romantic, were considered inadequate, for the reason that at the last moment the hand which was to set them in motion might fail. Among other things, the committee advised that the tunnel should not emerge within any fortification, but that its exit, as well as the airshafts and pumping apparatus, should be commanded by the advance works of a fortress, besides being within effective range from the sea. Means of closing the tunnel by a portcullis, and still more wonderful, of discharging poisonous gases into it, were recommended. Temporary demolition of the land portion of the tunnel by means of mining was still another conception. Sluices that should allow the tunnel to be temporarily flooded, and mines which should tear open the walls, were other defenses seriously contemplated. Finally, after having considered every possible safeguard, the committee concluded that "it would be presumptuous to place absolute reliance upon even the most comprehensive and complete arrangements which can be devised with the view of rendering the tunnel absolutely useless to an enemy in every imaginable contingency."

The naval view of the matter was saner, although likewise discouraging. Admiral Sir John Hay thought it not unlikely that the tunnel might be seized by surprise in the absence of the Channel fleet, and that a force of 16,000 men could be thrown very quickly upon the English coasts at a time when it would not be likely to find a sufficiently well-trained, well-equipped army to oppose it.

Englishmen are prone to regard the building of the tunnel as an enterprise which would redound largely to the benefit of their hereditary enemy. France is a great land power, an armed nation with nothing whatever to fear from invasion from over the sea. The addition of another railway terminating within her borders endangers by no appreciable extent her present position. Even assuming that an English expedition might capture Calais, and that 150,000 British soldiers were projected into France, it is a question if they could vanquish a standing army composed of trained soldiers.

Dismissing these political considerations, and passing for a moment to the engineering features of the contemplated work, it must be urged that the configuration of the bottom of the strait is most felicitous for the execution of the enterprise. The course selected presents a relatively plane surface, or at all events very gentle slopes. The depth of the Channel nowhere reaches 200 feet upon the selected line from England to France. For several miles out from the English coast it is not 100 feet deep; and the greatest depth is, roughly speaking, about two-thirds of the way across to France, and there its maximum is 186 feet.

Of the various plans which have been proposed for connecting England and France, that which was advanced some twelve years ago by Sir Edward J. Reed ought to commend itself strongly to civil engineers. He proposed a double tube of steel plate, to be constructed in sections of 300 feet, and to be hermetically sealed at the ends, and towed to the place of submersion. Each section was to be attached by one of its extremities to a huge caisson designed to form at the bottom of the water a very low pier for its support. The tube sections were to be sunk from scows. The plan, it will be observed, is substantially the same in principle as that since adopted for the construction of the tunnels under the Seine River in Paris, under the Harlem River in New York, and under the Detroit River in Michigan.

Should the Channel tunnel ever be constructed, its form may ultimately be such as that proposed by Sir Edward Reed. Moreover, it would overcome the objections of British naval men. For a length of no less than 3,160 feet Reed's tubular railway would be exposed to direct fire of the guns of ships between the high-water and low-water limit. Any breach or hole made in it below high-water mark would admit the sea at the next tide to the whole interior.

The problems involved are neither novel nor intrinsically very difficult. The most serious obstacles to be encountered are the raising of an amount of capital that must of necessity be enormous, the opposition of shipping interests, and the difference in gage between French and English railways. The capital cost is necessarily enormous. To ship goods from London to the continent or from Paris to London without breaking bulk would clearly be an impossibility. The tunnel would therefore offer merely a more rapid means of communication between British and French towns.

QUICK-STEAMING MARINE BOILERS.

There is over half a million horse-power in cruisers, battleships, and lesser arms of the service in the United States navy. Any one of the smaller vessels may be swinging idly at her anchor, with cold boilers, and in ten minutes from notification get under way, and be off upon her mission. It seems incredible to those who have business upon the great waters that a huge warship can be got under way in about the time that it takes to hitch up a two-horse team when the horses and their driver are on the spot ready for business, but it is an actual fact, as shown by the following official figures.

The United States steamer "Cincinnati" has eight boilers of the water-tube type which, when tested for efficiency of steam raising, gave the following results: Fires started at 9.40; in five minutes steam formed; in six minutes the gage showed 25 pounds pressure; in 7 minutes the gage showed 35 pounds; in half a minute more the pressure had jumped to 45 pounds; in the next half minute it gained 10 pounds more; in 9 minutes from starting fires with cold water in the boiler the pressure was 65 pounds, and the pressure rose every thirty seconds 10 pounds, until at ten minutes and forty-five seconds from starting fires the gage showed 115 pounds; in eleven minutes and a half the pressure was 155 pounds per square inch, ample to get under way and handle ship as required. In twelve minutes and forty seconds there were 215 pounds per square inch on the gage, and the vessel was free to go wherever she listed at full speed. Now, if this boiler had been of the old tank type, shell boiler, it would have taken two hours to attain the same result, not infrequently more. The boilers mentioned are very large, holding about 50 tons of water, more or less, according to the height of it in the water glass, but notwithstanding this fact the entire contents were raised to working pressure in the time stated. Concerning this feature in the practical handling of naval vessels, Admiral George W. Melville said, in a report after the war with Spain for the rehabilitation of Cuba: "It would have been of the greatest advantage during the blockade of Santiago to have had boilers capable of raising steam in less than half an hour. Coal need not have been used to keep all the boilers under steam all the while. The 'Massachusetts' might have shared the glories of the fight if she had been fitted with water-tube boilers. The 'Indiana' would have kept up with the 'Oregon' and 'Texas,' the 'New York' would have developed at least three knots more speed, and the navy would have been spared a controversy. I think the 'Colon' would not have got so far as she did, but we did not have water-tube boilers." The pertinency of Admiral Melville's remarks applies equally as well to merchant vessels, for in cases where ships have to remain a long time in dock, say for ten hours and more, taking off or getting in freight, the necessity of banking fires would be dispensed with; the fires being drawn and fresh ones started at a few minutes' notice. It must be noted that while modern marine boilers of the type alluded to steam rapidly, they are not injured in any way, or even forced to obtain the desired results.

This is not an innovation—the installation of water-tube boilers in naval ships; the first employment of them dates back nearly half a century, in fact to the "San Jacinto," of the year 1858-59. This vessel carried the Martin vertical water-tube boiler, which was an hermaphrodite boiler, being externally very much like the fire-tube boiler of the period, in that it had a shell, braces, and water bottom, the water tubes taking the place of a crown sheet over the furnace, and extending into a steam space above. The products of combustion circulated around and between the tubes, emerged into an uptake as usual. But, although strenuous efforts were made by those interested to establish the favorable performance of this type of water-tube boiler, it was very unsatisfactory, both in naval and merchant ships. The tubes were of solid-drawn brass, 2 inches external diameter by 13 wire gage, but they soon became choked solid with stony saline accretions, which stopped evaporation to such an extent that they were useless as steam generators. The steamers "Fulton" and "Arago" of the old Havre line had these water-tube boilers. Old sailors can recall their limping into port with five and six pounds of steam, scarcely enough to get home with. Compare this performance with that of the modern water-tube boiler, which has no shell, no water-bottom, no braces or staybolts, carries twenty times the steam pressure that its prototype of half a century ago did, and can stand continuous service during the circumnavigation of the globe without repairs of any moment. The "Chicago," of the United States navy, which has eight water-tube boilers, spent the winter and spring of 1899 in active service on the Atlantic coast; then made a trip around Africa, returning to New York *via* South America, stopping *en route* at Rio Janeiro, a total distance of 35,000 miles, and on arrival was sent at once to Buenos Ayres, the boilers requiring no repairs. A performance like this is ample reason for equipping naval ships with water-tube boilers.

Not very many years ago, less than a quarter of a century, it required a good deal of persuasion to induce users to listen to arguments in favor of water-tube boilers; but now, although fire-tube boilers are by no means out of use, the water-tube type pushes them hard for manufacturing purposes at least. Boilers of both classes, however, have been so greatly improved, that there is no comparison possible between the splendid generators of the present and those of two decades ago. One great factor in the improvement has been the character of the metal employed in their construction. For an unreliable, variable quality of iron, steel has been substituted, with the result that pressures have been increased and the life of boilers generally prolonged. Another advance has been made in the character of the workmanship, by no means the least of the causes leading to the regeneration of steam boilers of the period. The wonderful metal now available for the boiler maker deserves more than a passing notice. When, by the aid of hydraulic presses, we can make this sheet steel flow into all sorts of shapes and corrugations without the development of a single check, crack, or craze in a whole shipload of it; when we recall that in the past we had to flog our boiler plates slowly and painfully into the former, or over it, thankful if we escaped disaster, the splendid quality of the present-day product is realized.

It is now possible, because of the metal and the means, to bend sheets one and one-half inches thick to a circle of fifteen feet in diameter as easily as we used to bend quarter-inch iron.

SPONTANEOUS IGNITION OF COAL.

The old hypothesis suggested by Liebig, according to which the spontaneous inflammation of coal is due to the oxidation of the pyrites, can no longer be maintained. Spontaneous ignition, as pointed out by Dr. Heideprim (Welt der Technik), would seem rather to be attributable to a direct oxidation of the carbon. In fact, carbon when heated has been found eagerly to absorb oxygen from the air, and this heating effect can be increased until ignition occurs. The part played by moisture in the process has not yet been determined. The physical conditions of the carbon (hardness, size, etc.) are other factors influencing the process. In connection with a recent investigation of three hundred cases of self-ignition, all kinds of mineral coal apart from anthracite were examined. In most cases the ignited coal was ordinary coal, and less frequently nut coal or coal dust. The higher the layers, the more readily will self-ignition take place. An efficient ventilation by channels in the coal layers and the thermometrical recording of temperatures by long thermometers inserted in the coal have been found to be good preventive measures, while the only available means of extinguishing such fires has been found to be a transfer of the coal and simultaneous flooding.