Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for scanning. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of scanning are checked below.

L'Institut a numérisé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de numérisation sont indiqués ci-dessous.

- [ ] Coloured covers / Couverture de couleur
- [ ] Covers damaged / Couverture endommagée
- [ ] Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- [ ] Cover title missing / Le titre de couverture manque
- [ ] Coloured maps / Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- [x] Bound with other material / Relié avec d'autres documents
- [ ] Only edition available / Seule édition disponible
- [x] Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- [ ] Coloured pages / Pages de couleur
- [ ] Pages damaged / Pages endommagées
- [ ] Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached / Pages détachées
- [x] Showthrough / Transparence
- [x] Quality of print varies / Qualité inégale de l'impression
- [ ] Includes supplementary materials / Comprend du matériel supplémentaire
- [ ] Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from scanning / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été numérisées.

- [x] Additional comments / Commentaires supplémentaires: Continuous pagination.

CANADIAN MAGAZINE OF Science and the Industrial Arts.

Patent Office Record.

Vol. 13. MAY, 1885. No. 5.

Communications relating to the Editorial Department should be addressed to the Managing Editor, P. O. Box 128, Montreal.

Business communications and subscriptions to be sent to the Burland Lithographic Co., Montreal.

The Editor does not hold himself responsible for opinions expressed by his correspondents.

No notice will be taken of anonymous communications.

OUR NORTH-WEST TROUBLES.

The troubles in the North-West, especially in and around the course of the great Saskatchewan river, developed very suddenly into a very serious rebellion against the governing bodies of the country and took the great bulk of the Canadian people by surprise.

The extent of the revolt, although not very large at first, caused considerable uneasiness to the authorities at Ottawa, on account of the uncertainty as to the action of the Indian tribes, and the vast amount of country to be preserved from attack and preserved in peace should a general rising take place.

Great credit is undoubtedly due to the Government at Ottawa for despatching quickly large bodies of well-equipped volunteers to the scene of action, which in a great measure prevented a general rising of many Indian tribes and saved our North-West from a great conflagration.

While going to press there is every indication that quietness and speedy settlement will be obtained, but it is more than likely that some troops will require to be stationed there for a few months before permanent peace is established and settlements made with the rebels and different Indian tribes.

We regret that a certain class in the country should have been so imprudent as to publicly demonstrate their sympathy with the rebels at a time when every effort should have been directed towards restoring peace and order, especially as it is pretty generally admitted and known that the grievances must be investigated without delay and just ones immediately set right.

There will, however, be ample time and opportunity after peace has been restored to champion the cause of the North-West half-breeds and Indians in a legal and constitutional spirit.

No doubt the Government will be bitterly attacked and blamed for the causes which led to the rebellion, and will find it difficult enough to clear their skirts; still the country will uphold them in giving ample justice to those who have remained loyal and peaceable in the midst of the turmoil, notwithstanding their grievances, while to those who have plunged the country into serious expense for war preparations, punishment, in some form or other, should be first dealt, especially to the ring leaders and heads of the rebellion.

We sincerely hope, however, that the rebels will regret the steps they have taken, and will penitently promise to never again disturb the peace of a country, in which they, as well as all of us, hope and believe has a great future, if not imperilled by lawless acts.

FIRE INSURANCE.

From the Annual Reports of the various Fire Insurance Companies believed to do business in the Dominion, it appears that the business done was not wholly without profit to many of the companies but as a general showing the business for last year was not satisfactory enough to be ranked as a safe and suitable investment.

No doubt some of the Companies have large reserves to fall back upon, but with a constant drawing on these funds with the prospects ahead for profitable business it behoves those at the helm to consider every available means whereby expenditure of every kind can be diminished.

The losses are no doubt the most serious items of expenditure and not until a more vigorous and determined effort is made outside of their branch and head office by good practical and experienced experts to examine into the condition and value, etc. of risks, will there be anything like permanent and sound improvement.

COTTON seed is the southern bonanza. There are three and a half pounds of seed to every pound of fiber. More than 4,000,000 tons are produced annually, but, notwithstanding the rapid increase in the number of mills, only about ten per cent. of the seed is crushed, the rest being largely thrown away. A ton of seed yields 35 gallons of oil, 22 pounds of cotton, and 750 pounds of cake, used for fattening cattle. The value of these products is $19. The oil is largely used for making fine soaps, and when refined properly can hardly be distinguished from olive oil, which it is superseding for many purposes.

AFGHANISTAN.

England and Russia are armed to the teeth and ready for a desperate encounter and need to be, but whether the interests at stake are sufficiently important to both countries to fight over has not been yet quite decided. The war parties in both countries would, no doubt, fight over a mere bone and the only thing to be feared is that, that Party dominates over all others in Russia and could easily force a *Casus Belli*, whereas in England the House of Commons and British Cabinet serve as a safe-guard against any precipitative course, without first having the services, consideration and consent of the English people.

The English race may be safely left with the decision of all great questions and in the future or in the past it is to be hoped the result of any action that may be taken will be for the benefit of mankind generally and the spreading of those free enlightened principles which make a people prosperous, happy and powerful.

A war with Russia is an undertaking of no ordinary moment and importance and the British Cabinet of which the Right Hon. Mr. Gladstone is the "head" may be safely counted upon to calculate the cost of such an undertaking and secure by every honourable and available means a way out of the difficulty and misunderstanding if possible at all.

Although the English press and people are bellicose in the extreme it goes beyond question that the dogs of war will be held in restraint until such times as our interests are seriously threatened.

Russia must be ill advised if she insists in menacing even indirectly the interests of the Anglo-Saxon race and incurring the responsibility of such a war which would certainly prove disastrous to her financial and social standing among the nations of the globe.

It is to be hoped that wise counsels will prevail in Russia and so prevent for the present at least what would no doubt turn out to be one of the bloodiest and severest conflicts of modern times.

INDUSTRIAL NOTES.

To prevent the cracking of the glass tubes that are connected with steam boilers to show the height of the water within it is recommended that two glass tubes be used, one within the other. The air that is confined between the two serves as a protection to the inner tube against outside cold and the outer one against the high temperature of the inner one. Both tubes are packed in the same brass couplings. But this device is hardly new.

In England there has been a great increase in the past ten years in the number of women engaged in various industries, while some entirely new classes of female labor have been created. In the civil service there are 3,215 female officers and clerks; while the municipal and other local authorities furnish employment for 3,017. There are 1,660 women engaged as missionaries, Scripture readers, and itinerant preachers, and 3,795 appears as nuns and Sisters of Charity. There are 100 female law clerks, 2,646 midwives, and 35,175 women engaged in subordinate medical service; 122,846 women are engaged in educational work. Female musicians and music mistresses number 11, 376; inn or hotel servants, 26,487; and domestic servants, 1,230,406.

ENGLAND is at the head of the mirror manufacturing industry of the world, producing 750,000 square yards annually. France produces 530,000 square yards, and Germany 340,000 square yards. In this country the principal manufactory at Lenox Furnace, Mass., produces about 110,000 square yards a year. There are other smaller manufactories in Kentucky, Indiana and Missouri.

AMERICAN CHILD AND PAUPER LABOR.

The condition of labor in this country is not always so rosy as it is painted. The annual report of the New Jersey Inspector of Factories and Workshops reveals to the public that he found 15,000 youths and children at work in 5,000 factories in that state. The average age at which they went to work was nine years, after one or two years of schooling. All of them had been accustomed to work ten hours a day, and many of them even fourteen hours. Those who had entered the shops the earliest in life were the puniest and the most ignorant. Some of them were set at work at so tender an age that they could not tell when they began. The weekly wages of the children do not average $2. The inspector has remedied a good deal of this, and sent many of the children to day and night schools.

The New York Bureau of Labor Statistics has also found a bad state of infant labor. It appears from the evidence taken at Cohoes that the little slaves of the mills there are kept at work, under their drivers, eleven hours a day, all the year round; that various subterfuges are adopted for employing children not yet in their teens; and that overseers are permitted to apply the strap to their backs, as well as to slap them. The fathers themselves, it appears from the testimony, have been turned out of the mills because the children and women can be got to work more cheaply; and so the men are described as a worthless set of do-nothings, living after a fashion on the toil of their offspring. The superintendent of one of the mills admitted: "Families come here from Ireland, and the girls are as healthy and rugged and rosy cheeked as you would ever see, and yet in two years the girls would be in consumption, and half the family would be gone in seven years." The commissioner says: "It is an established fact that parents would be unable to support their families without the wages earned by children," and that, even with this addition to the family income, a "majority of families barely manage to make both ends meet at the close of the year, while a considerable number actually find themselves in debt." We ought to let Europe alone for a while, and turn our attention to our own pauper labor.

BALANCE OF TRADE.

Ever since the Mercantile theory popularized a fallacy, there have been millions of people who never could understand "the balance of trade." A leading New England newspaper that ought to know better says that a foreign trade prosperous for us ought to leave a balance of exports over imports. This is an illustration: A and B have open accounts for one month. On the last day of the month they settle. A's bill against B is $78, and B's against A is $45. Now they will come to the conclusion that B owes A $33, and that B must either pay the balance in money or give his note for it. Foreign trade in the long run does not end this way; nor does it end in an excess of imports as others would have us believe, giving the following illustration, which is more properly an illustration of the advantage of foreign trade; An American loads a ship with a cargo of American wheat costing $100,000, and, taking it to Liverpool, sells it for $120,000, and then buying $120,000 worth of British goods, brings them to New York and sells them for $144,000. His gross profits on the two trips are $44,-000; though the "balance of trade" is $44,000 against us. The fact is neither this way nor that, in the long run, but that the exports and imports of a country *tend* to balance each other. The fallacy in the first instance lies in the failure to remember that the exporter will not bring back money so long as he can bring imports that will return a profit, as he can up to a limit, about balancing the value of the exports; and what money is left for him to bring to this country he will carry in the shape of a bill of exchange drawn against a like amount owing a foreigner in this country, and arising from a reversed transaction. In the other case, that of the $44,000 profit, it is a mistake to suppose that we will sell $100,000 worth of goods and buy $144,000 worth through many years of trade. We will not buy so much more than we sell. Theorize as you please, the fact is that exports and imports tend to balance each other.

THE English drummers, who have been heavily bitten by the depression in trade, are further exasperated by the competition of women, who, for the first time in England, now advertise and are advertised for as travelling agents for mercantile business.

THE HOOSAC TUNNEL.

I venture to say there are few, if any of your thousands of readers that have not heard of the Hoosac Tunnel, however, not many probably, have ever taken into consideration the magnitude of this great piece of engineering skill.

The Hoosac Mountain is a part of the Green Mountain range extending through the western part of Massachusetts, and until the opening of the tunnel had been a barrier between the States of Massachusetts and New York. As early as 1819 it was proposed to tunnel the mountain, but nothing of importance at the time was done. A board of commissioners was appointed by the Legislature in 1825 to select a route for a canal from Boston to the Hudson River. No unusual difficulties presented themselves to this undertaking except the tunneling of the mountain. But in 1835 the first railroad in American having been put in successful operation, the project of a canal was abandoned. The Boston & Albany Railroad was completed in 1842. This road ran over the mountains 20 miles south of the tunnel line and had grades unequaled in the history of railways, at that time; consequently the running expenses and charges were necessarily very high. In 1843 the Fitchburg Railroad was completed and that, in connection with the Vermont & Massachusetts, built three years later, formed a continuous line from Boston to Greenfield. But this did not seem to satisfy Boston capitalists, they wanted a more direct line to the West, and, to compete with the Boston & Albany, and in 1848, the Troy & Greenfield Railroad was incorporated; this was to run from Greenfield through the mountain to Williamtown, and there connect with a road for Troy, but the tunnel was the great obstacle to contend with; finally, in 1851, work was begun. It was the intention of the company at this time to cut or bore a hole through the mountain the full size of the tunnel, and a ponderous and costly boring machine was obtained for the purpose, this, with several other costly machines, was tried and proved failures. The company finding they had more of an undertaking on their hands than they had anticipated, ceased work; but in 1854 the State of Massachusetts came to their aid and voted a loan of $2,000,000 taking a mortgage on the company's property, but in 1861 the funds gave out, the work thus far having progressed slowly, and in 1862 the State foreclosed its mortgage and appointed commissions to prosecute the work, and made appropriations for the same, but after six years management by commissioners the Legislature refused to make further appropriations, and authorized the Governor to make a contract for the completion of the work. The total amount of work done by the company and State to this time, January 1869, was, east end 5,282 feet, west end 4,055 feet; west shaft sunk to grade 318 feet, and central shaft sunk to a depth of 583 feet. To accomplish this over $7,000,000 had been expended and less than one-third of the work necessary for the completion of the tunnel had been done.

A contract was made with Shauley & Co., of Montreal, to complete the work for $4,594,268, and they took hold with energy, and although great obstacles presented themselves, they, with their perseverance, overcome them. They were obliged to put in a pumping system at any expense of $80,000 to carry off the immense amount of water that flowed in. Hand drilling and the ordinary black powder was found to make slow headway with this giant; but this was the only means used prior to 1866; then drilling machines were put in operation, but they were more or less complicated, costly and proved failures. A short time afterwards the Burleigh Rock Drill Co., of Fitchburg, Mass., was organized. This company had perfected a machine which was less expensive, much lighter, easily repaired and far more effective than anything yet placed on the market. Eight of these drilling machines were kept at work constantly. With one of these machines a hole could be put down 5 feet deep in one hour. One of these machines was kept at work for a period of 90 days in the west heading, and during the time no repairs were required, and the holes drilled were equivalent to over one mile in length and two inches in diameter.

The rock through the tunnel was principally mica slate, with some veins of quartz—in some places a very hard flinty granite was found. Work was vigorously pushed at each, the west and east end openings, also the shafts, and on the afternoon of November 27, 1873, the final blast between the two headings was made, and long years of toil, untiring perseverance, with extraordinary engineering skill was crowned with success. The number of lives lost during the whole time was one hundred and thirty-six, which, when taken into consideration the magnitude of the undertaking and the large number of men employed, was compartively small, as during the construction of the Mount Cenis Tunnel one thousand lives were lost.

To one not acquainted with the principal and details of engineering it will be difficult for them to understand how a tunnel five miles long could be worked from either end—also from two shafts—so accurately that the holes projected should meet with a deviation of only 9·16 of an inch in an advance into the mountain of 10,000 feet. This is less than 1·16 of an inch to the thousand. This has never been approached on similar works in a point of engineering accuracy. Some special and patented devices, entirely new, were used for this purpose.

The total cost of the tunnel was $17,000,000, which is much more than a similar work would cost at this day, after years of engineering experience in tunneling, which was in its infancy when this work was begun. Above the tunnel are two summits with a wide valley between; the west summit is 1,718 ft. above the tunnel; the east summit is 1,429 ft. above the tunnel. Here we have a tunnel four and three-fourth miles in length through a solid mass of rock rising 1,718 feet. The reader may obtain a comprehensive idea of the immense amount of work necessary to accomplish this great undertaking, from the fact that over two million tons of rock was excavated and over 500,000 pound of nitro-glycerine used. Total length of tunnel 25,081 feet, or nearly five miles; width, 24 feet; heighth, 20 feet. There was 7,573 feet of brick arching required. The first train of cars that passed through the tunnel was on February 9, 1875. First through freight train from the West—24 cars—passed through April 3rd, 1875, over the Fitchburg Railroad. The first passenger train from Boston to Troy passed through October 13th, 1875.

The direct line East through the tunnel is the Fitchburg Railroad, known as the Hoosac Tunnel Line, and runs from Boston to North Adams. This road is equipped with steel rails, double track nearly the entire length of its line. The old wooden bridges have been replaced with iron structures and its passenger, drawing-room and sleeping coaches are built in a style of magnificence not excelled by any road in the country. These cars are run through between St. Louis, Chicago and Boston, over the West Shore and Hoosac Tunnel & Western. The traveling public will find the Hoosac Tunnel line well equipped with every convenience money can procure that will aid in the comfort and safety of its patrons. The Troy & Boston Railroad, running from Troy to North Adams, is the only line connecting with the New York Central Railroad in connection with the Hoosac Tunnel line. Niagara Falls is a wonder of nature; the Hoosac Tunnel is a wonder of engineering skill—both must be seen to be appreciated. Travelers wishing to avail themselves of the most picturesque scenery in New England and enjoy a ride through the world-renowned Hoosac Tunnel, will find tickets on sale at all stations reading *viâ* this line.—*Ex.*

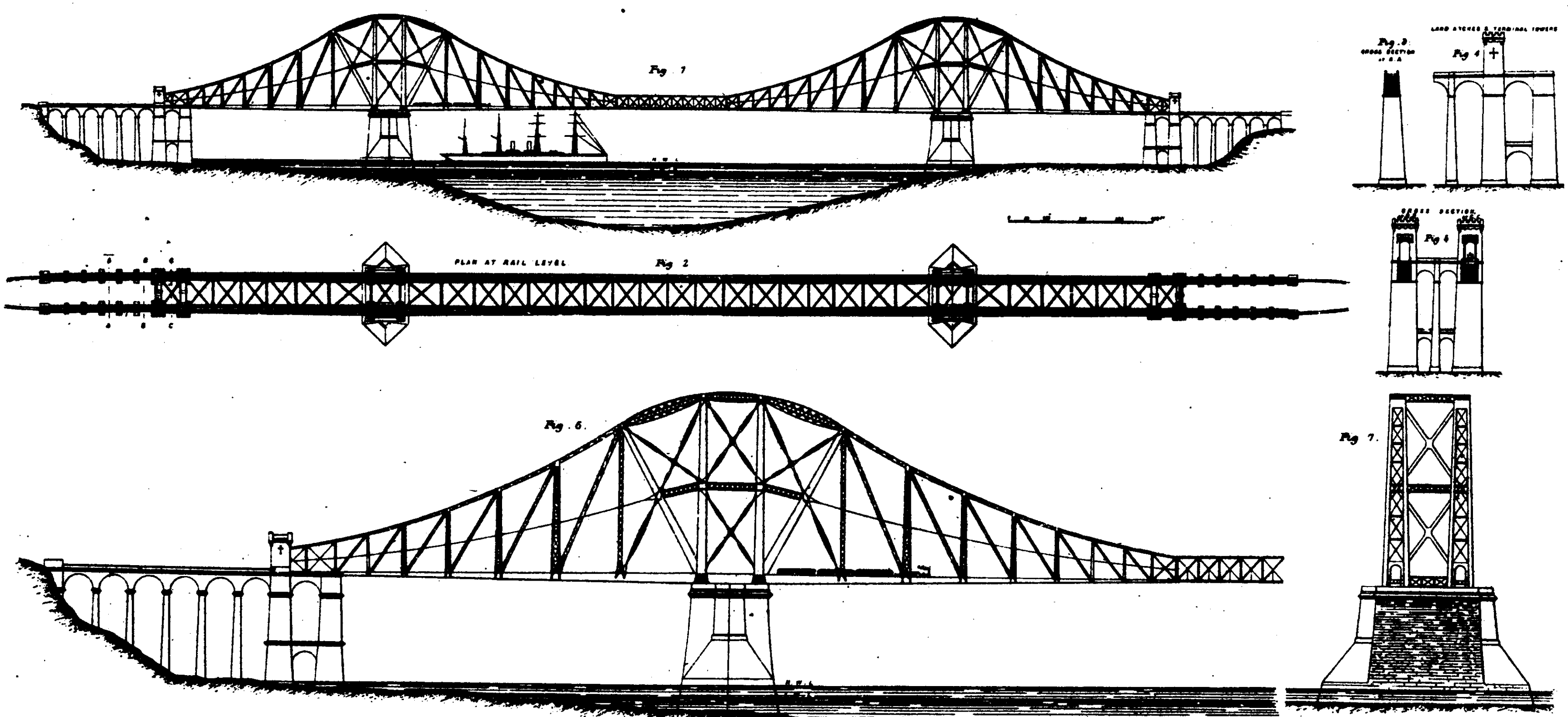
SPLITTING A BANK NOTE.

The remarkable operation of splitting in two the paper on which a bank note was printed was accomplished by a Kentucky counterfeiter. The two sheets made were nearly transparent. He made a plate of copper and brass, a little larger than the bill, and spread one of the sheets on top of it. With a steel tracing pencil of his own manufacture he engraved through the sheet its exact counterpart on the plate. The other half was engraved on a different plate in a similar manner, and then he was ready for printing his spurious money. This method of workmanship looks very simple, but it is the first time it had been done by a counterfeiter, as it is said to be almost impossible to split the bill. However true this reported difficulty may be, it is generally an easy matter to split a sheet of paper. Paste a piece of strong cloth to each side of the paper to be split. When dry, violently pull the two pieces asunder, when part of the sheet will be found to have adhered to the one and part to the other. When the paste is softened in water the paper can be removed from the cloth.

THE manufacture of artificial ivory from bones and scraps of sheepskin is a new industry.

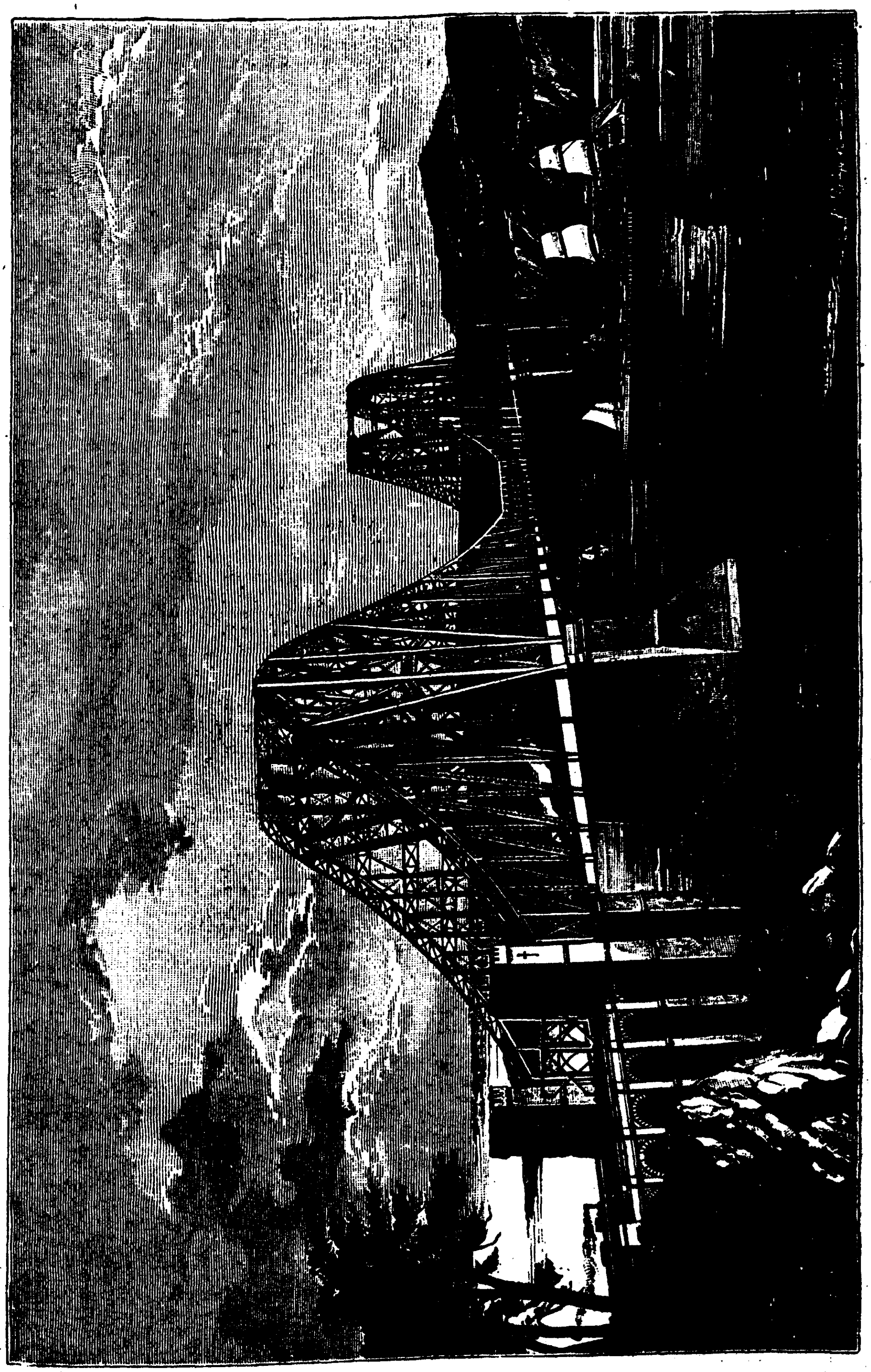
Cryolite, a mineral which is of great value in the potash manufacture, has been discovered in the Yellowstone Park. Heretofore it has been obtained only in Greenland.

PROPOSED BRIDGE AT QUEBEC.



PRINCIPAL DIMENSIONS.

Total Length of Bridge including Land Arches	3400 ft.
" " Steel Superstructure	2800 "
Width of Steel Superstructure	108 "
Length of Channel Span, Centre to Centre of Piers	1550 "
Length of Channel Span, in the Clear	1442 "
Clear Height of Channel Span, above High Water	150 "
Maximum Depth of Cantilever, at Piers ...	258 "
Wind Pressure Assumed, per square foot ...	56 lb.
Maximum Stress in Steel Members, per sq. in.	7.5 tons
" " Members of Wind Bracing	5.0 "



PROPOSED BRIDGE AT QUEBEC.

BRITISH NAVY.

AN ACCOUNT OF ITS STRENGTH AND CHARACTER.

Thirty years ago it was a very easy matter to determine the exact force of a navy, and compare it with that of another nation. The fighting fleets of all nations consisted of line of battle ships and frigates, and the vessels of the same class in every fleet were substantially alike, so that the tonnage and number of guns carried by any ship formed sufficient data to enable any expert to make an estimate of her force. All this has been changed since the introduction of the ironclad, which, while it has thrown all unarmoured vessels out of the fighting line of battle, has established no standard of comparison by which the strength of a navy can be absolutely determined. All ironclads yet built are in the nature of experiments, and must remain so until in some great war the best ships of European nations are pitted against each other.

The British fleet has for more than a century been the strongest in the world, this maritime superiority being looked upon as absolutely necessary to the maintenance of the Empire, with its numerous colonies. On many occasions the alarm has been raised that France was threatening the naval powers of England, but such alarms have never stood the test of actual trial, although they have generally served the purpose of inducing Parliament to vote larger sums for the navy. The cost of the British navy has varied greatly at different periods. In 1814 the expenditure upon it was $93,000,000; in 1854 the expenditure was only $33,000,000. The Crimean war put it up to close upon $100,000,000 in 1856, after which there was a fall to a little more than half that figure. Last year the British naval expenditure was about $55,000,000; this year it will be considerably larger, but how much can only be determined when the accounts are closed. The number of vessels in the British navy, including 72 gunboats, is 475, of which 75 are ironclads, of the latter from 30 to 35 being usually in commis sion. The total number of ships in commission, including depot vessels, store ships, and training ships, is 240. Of these from 110 to 120 may be termed the active fleet, which is always at sea patrolling the coasts of the world. This fleet is divided into nine squadrons, viz:—The Channel, Mediterranean, North America and West Indies, Pacific, China, East Indies, Australia, Cape and West Africa, and south-east coast of America.

THE VARIOUS SQUADRONS.

The Channel Squadron, which guards the sea and straits between England and France, consists at present of six ironclads, only one of which—the Neptune—is a war ship of the first class. The other five are fine, handsome, powerful sea-going ships, but a little out of date as regards armour and armament. Besides them there are twelve other ironclads in commission on the British coast guarding their respective stations vigilantly. The Mediterranean squadron numbers 16 vessels, of which 7 are ironclads. All of the latter are very powerful ships, and two of them are the best in the British navy. The North America and West Indies Squadron numbers 12 vessels, one of them—the Northampton—a large cruising ironclad, rated as a third class ship, but heavily armed and well suited for the service in which she is engaged. Four of the squadron are powerful unarmoured frigates, and the remainder small vessels. There are 9 ships in the Pacific Squadron, 21 in the China Squadron, 10 in the East India Squadron, 8 at the Cape and West Coast of Africa, 5 on the Australian coast, besides 3 or 4 surveying vessels and 4 on the south-east coast of America. The Pacific, China, and Australian Squadrons have each an ironclad, the flagship of the latter being the Nelson, a sister ship to the Northampton, which is on our own coast. The Audacious, of the China, and Livingstone, of the Pacific, are also sister ships, less powerful than the Northampton, but good cruising vessels. Besides these ironclads there is one permanently stationed at Melbourne, two at Bombay, one at Hong Kong, and one, in addition to two armoured gunboats, at Bermuda. This fleet is manned by 45,000 seamen and 12,500 marines, and about 25,000 men are employed in the dockyards, exclusive of many thousands employed in private yards on contract work for the Government. The naval reserve, consisting of men in the merchant service who are liable to be called upon in case of war, numbers 20,000 seamen.

THE INFLEXIBLE.

The Inflexible is the largest and most powerful ship of the British navy, and, leaving out of account Italy's four huge ironclads, which have never yet been tested, is the most formidable war ship in the world. It may be instructive to compare her with the Duke of Wellington, England's most powerful ship just thirty years ago:—

	Displacement Tonnage.	Horse-power.	Guns.
Duke of Wellington........	6,071	1,999	131
Inflexible................	11,800	8,000	4

The largest guns mounted on the Duke of Wellington were 68 pounders, and, as she carried but few of that size, the weight of her whole broadside would not exceed 2,000 pounds. Each of the four guns of the Inflexible carries a shot that weighs 1,700 pounds, and all four can be fired at once and in the same direction. The Inflexible's guns are rifled; those of the Duke of Wellington's were of the old-fashioned cast-iron pattern, and would make no more impression on a modern ironclad than a shower of hail.

No ship which carries heavy armour can bear the weight of sufficient metal to protect her in every part, and to this fact is due the peculiarities in the construction of the Inflexible. The vessel is simply an armoured citadel, with unprotected ends lying beneath the surface of the water to keep her afloat. Although 320 feet in length, the armour protected portion in the centre extends only 110 feet, but as the Inflexible is 75 feet wide the citadel thus inclosed is of generous dimensions. It rises 10 feet above the surface of the water and is 6 feet 5 inches below it; but as the vessel is sunk by water ballast a foot in going into action, the protection beneath the surface of the water is increased to that extent. This castle is protected by 24 inches of iron, in two sections, of 12 inches each, backed by iron girders and filled in with teak. Inside of all is the double skin of the vessel. Within this citadel are the engines, boiler, and all the vital parts of the ship. Rising above it are two turrets—not in line, as in most ships, but placed *en echelon* at the opposite corners of the citadel, so that the guns, which are placed side by side in turrets, in pairs, can be fired all four together, ahead or astern, or toward either beam, and in pairs to any other point of the compass. The interior diameter of the turrets is 28 feet, and their armour is similar to that of the citadel itself. The gun ports are 11 feet above the surface of the water when the ship is in trim for going into action, and the guns can be depressed so as to strike an enemy below the waterline. The turrets are worked by hydraulic power, and all the operations of loading the guns are performed in the same way. They weigh, as already stated, 80 tons each, and carry a bolt or shot that weighs 1,700 pounds. The armour-shelter, for the protection of the officer who is manœuvring the ship, is in the form of a cross and plated with 12 inch iron. The submerged portion of the ship, which lies fore and aft of the citadel, is some 7 feet beneath the surface of the water, and is divided into innumerable water-tight compartments, filled with cork. It is covered with 3 inches of armour on its submerged deck, so that no shot striking downward could penetrate it. Above this is built a superstructure, rising twenty feet above the water, for the accommodation of the officers and men, the whole of which might be shot away in action without impairing the power of the ship in the smallest degree. Even if the submerged hull shoule be penetrated, the citadel would still float. The Inflexible has a powerful ram, and carries a Whitehead torpedo apparatus. She draws 25½ feet of water, is provided with twin screws, and has a speed of 14 knots an hour. She can carry enough coal to take her across the Atlantic and back. This vessel cost $4,000,000, and 350 officers and men is her complement.

AJAX AND AGAMEMNON.

These two ships are exact reproductions of the Inflexible in every respect except size. They are 40 feet shorter, 14 feet narrower, and draw 23½ feet of water. Their displacement is 8,500 tons, and their speed 13 knots. In these vessels the citadel is 104 feet long, and the armour upon it 18 inches thick. The armoured deck over the submerged hull is 6 feet below the water level, and the height of the citadel above the water is 9½ feet. The turrets are arranged in the same manner as those of the Inflexible, and they are armed with four 38 ton guns carrying a 750 pound shot. Each of these ships also carries two 6 inch rifled breechloaders.

DEVASTATION, THUNDERER, DREADNOUGHT.

These three vessels are of the same class, although they differ in minor points of detail, and be described as mastless monitors. The Devastation is 255 feet long, 62 feet wide, and draws 26 feet of water. Her hull, engines, boiler, and magazines are protected by 12 inches of armour at the sides, and her deck by three inches. She has two turrets, plated with 14-inch armour, and carries in them four 35 ton guns, capable of sending a projectile weighing 700 pounds. These turrets are inclosed in a central armed citadel, the deck in front of it being given up wholly to the waves in rough weather, but a narrow deck-house, running between the two turrets, is so opened out at the top as to form a spacious hurricane deck, 24 feet above the water. The Devastation has a speed of nearly 14 knots, and can carry 1,600 tons of coal—enough to take her a distance of 9,000 miles. She is a very handy vessel, and can make a complete circle at full speed in a diameter of 339 yards in 4 min. 34 sec. An interesting comparison has been made between the Devastation and the Monarch to show the progress that has been made in ironclad shipbuilding in three years. The Devastation carries twice as heavy armour as the Monarch, and would go twice as far. The guns of the Devastation would pierce the Monarch at a distance of 2¾ miles, while the armour of the Devastation could not be pierced by the Monarch's guns at any range beyond 200 yards. The devastation can be worked by a crew of from 250 to 300 men, while the Monarch requires 700 men. Finally, the Monarch cost $2,390,000, while the cost of the Devastation was only $1,600,000.

The Thunderer is similar to the Devastation in every respect except that here four guns are of 38 tons and are worked by hydraulic machinery. She is about half a knot slower than the Devastation, her speed being 13½.

The Dreadnought, on the other hand, is more than half a knot faster than the Devastation, and is a bigger ship, being about 1,500 tons larger. She carries heavier armour on her sides (14 inch. instead of 12 inch.), and her armament, like that of the Thundrer, is four 38 ton guns.

COLUSSUS AND EDINBURGH.

These two ships, which were launched in 1882, and are now about to be placed in commission, are like the inflexible, but of different dimensions. The latter, with a length of 320 feet, and a width of 75 feet, so that it was difficult to obtain much speed without a great waste of power. The new ships are 325 feet long, and only 68 feet wide, and their displacement is 9,150 tons. They are very fast, the Colussus having a speed of 16½ and the Edinburgh of 16 knots. Their armour is 18 inches thick and steel faced, and they each carry four 43 ton guns in their turrets and four 6 inch breechloaders. The 43 ton guns are also breechloaders, and greatly superior to the 35 and 38 ton guns with which the Devastation and Dreadnought are armed.

THE BARBETTE SHIPS.

The French have for some time past been building what are termed barbette ships, that is, ships in which the guns are mounted *en barbette* in open fixed turrets. The English adopted this principle in the Temeraire, which was launched in 1876, but modified it so that the guns in the turrets could be loaded under cover, and only appear above them when about to be fired. The English have built or rather are building six additional shipson the barbette plan, two of which—the Collingwood and the Rodney—are already launched, three more to be launched this year and one next year. The four still on the stocks are the Howe, Benbow, Camberdown, and Anson. All these ships, as regards the arrangement of their hull and central armed citadel, are similar to the Inflexible. They are all very fast, their speed being 16 knots or more, and they carry steel faced armour 18 inches thick. The Collingwood is armed with four 43 ton breech loaders and six 4 ton guns. The Rodney, Rowe, Camberdown, and Anson will each be armed with four 63-ton guns, while the Benbow will have two enormous guns, each of 110 tons weight, sending a shot that will weigh about a ton and a quarter. All these vessels are regarded as ironclads of the first class, inferior only to the Inflexible. The latter, it should be stated, although at present only provided with 80-ton guns, can carry guns double that weight in her turrets, should ever guns of that size be made.

RIGGED TURRET SHIPS.

All the turret ships described above are unrigged vessels, depending on steam power alone. The Inflexible, indeed, has two short masts and carries a couple of thousand yards of canvas, but this is merely a piece of equipment, to be thrown aside at once in case of an engagement. The only fully rigged turret ships in the British Navy are the Monarch and Neptune. The former vessel will be remembered as the ship that brought the body of the philanthropist, George Peabody to this country. She has a displacement of 8,3000 tons, can steam 15 knots, and carries four 25 ton and two 12 ton guns. Her armour is comparatively thin, being only 8 inches at the water line and 10 inches at the port holes of the two turrets. The Neptune is 1,000 tons larger and has 12 inch armour on the water line and 13 on her turrets. She is also far more heavily armed than the Monarch, carrying four 38 ton guns. In a recent Admiralty return she is rated as an ironclad of the first class, but why that should be the case, when the Ajax and Agamemnon with armour six inches thicker and equally heavy guns, are only classed as second rates, is not easy to understand. The Neptune has a speed of 14 knots. She was originally built for Brazil, but was purchased by the British Government in 1878 for $3,200,000.

RAMS.

All British ironclads are provided with facilities for ramming their antagonists, but in vessels like the Hotspur and Rupert the armament is made subordinate to this feature. The Hotspur, launched in 1870, was the first real coast service vessel constructed for the British Navy. She is comparatively small —4,000 tons displacement—and has armour 11 inches thick on the water line and 8½ on her turret, in which she carries two 25 ton guns. Her armour is compound, one-third steel and two-thirds iron, and her speed is 12½ knots.

The Rupert is 1,400 tons larger than the Hotspur, and carries 12 inch armour. Her speed is 13 knots, and in her turrets are two 25 ton guns. In this vessel, as in the Hotspur, the ram stands 10 feet in front of the bow and 8 feet below the water line.

The Conqueror, which has just been put in commission for the first time, is an improved Rupert of 6,200 tons displacement, and with 12 inch steel-faced armour. The turret is inclosed in a citadel, as in the Inflexible, and in it are two 43 ton guns. This ship has a speed of 17 knots, so that she is the fastest ironclad afloat and the most powerful single turret ship yet built.

The Glatton is 5,000 tons displacement, has 14 inches of armour on her water line, and carries in her turret two 25 ton guns, which send a shot weighing 600 pounds. She is provided with a fish torpedo apparatus. Although a ram, she was built with a special view of attacking fortresses. This vessel, it will be remembered, was tested some years ago by being fired at by the Hotspur, at the Point Blank range, with her 25 ton guns, the trial being favorable to the efficiency of the Glatton

COAST SERVICE IRONCLADS.

The rams above described, with the exception, perhaps, of the Conqueror, may be classed as coast service vessels, but there are six other to which the term specially applies. The Bellisle and Oricon are each of about 5,000 tons displacement and carry 12 inch armour. They have a central octagon battery 60 feet in length and are each armen with four 25-ton guns. They draw less than 20 feet of water.

The Cyclops, Gorgon, Hecate, and Hydra are smaller ships, of 3,500 tons displacement and a speed of only 10 knots. They are belted with 20-inch armour at the water line and carry two turrets in the central breastwork. The armament of each vesis four 18-ton guns. They draw only 15½ feet of water, and of course could go into the shallow harbours of an enemy where a large ironclad could not venture.

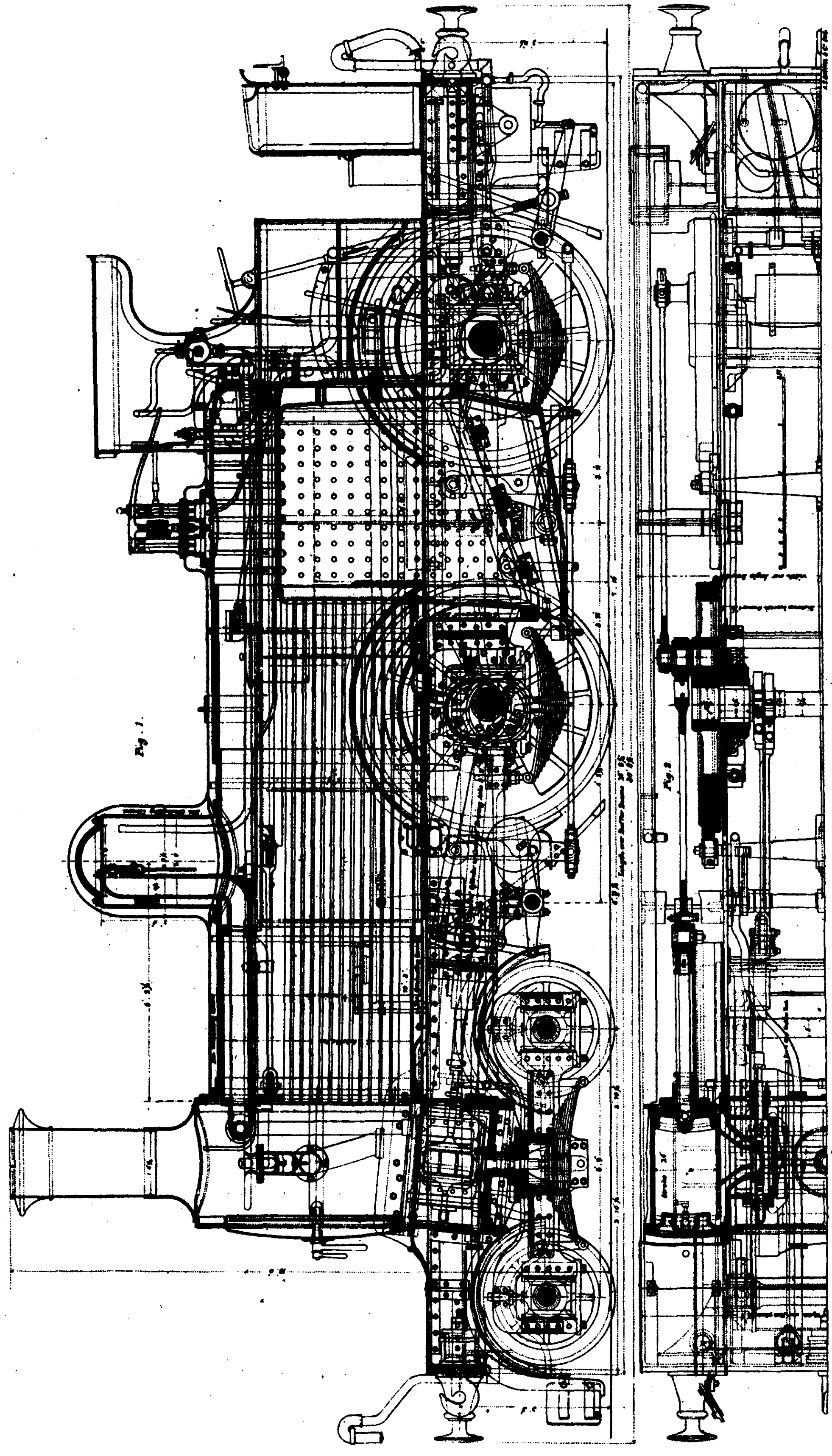
HARBOUR PROTECTORS.

Three of these—the Magdala, Abyssinia, and Cerebus, were built especially for colonial defence. The first two are at Bombay and the last at Bermuda. They are double turret ships belted with 10-inch armour and carry four 18-ton guns. Their exposed sides are only three feet in height, their docks are shell proof, and they can steam 11 knots.

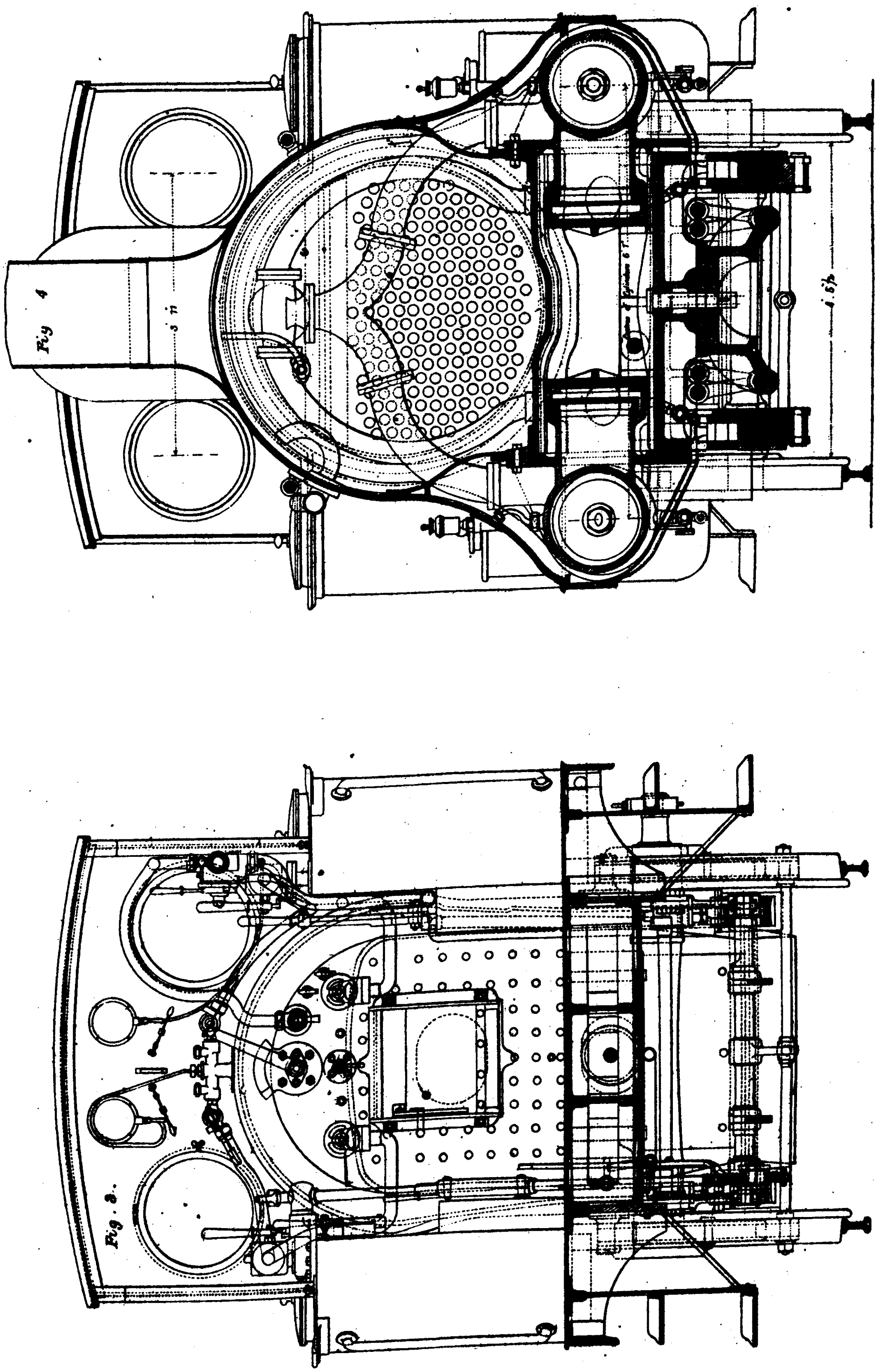
The Scorpion, stationed at Bermuda, and the Minerva, at Hong Kong, were built by the Lairds for the Southern Confederacy in 1863, but purchased by the Brstish Government. They were intended for cruisers, but are only fit for harbour defence. Their armour is only 5 inches thick and they each carry four 12-ton guns.

IRONCLAD OCEAN CRUISERS.

There are fifteen ships of this class in the British navy in addition to the Monarch and Neptune which have already been



TANK LOCOMOTIVE.



TANK LOCOMOTIVE.

described. Two of these—the Imperieuse and Warspite—are barbette ships and were built expressly for the purpose of pursuing and destroying the "commerce destroyers" of other nations. They carry 10 inches of steel-faced armour, have an armament of four 18 ton and six 4 ton guns, and have a speed of 16 knots. To attain this speed they have engines of enormous power—8,000 horse to 7,400 tons of displacement. It would be difficult for any unarmoured cruiser, however speedy, to get away from these vessels, especially in a rough sea, for the heavy ironclad would keep her speed much better than a light vessel.

The Temeraire is a cruiser of 8,500 tons displacement, with 11 inch armour and a speed of 14½ knots. She combines both the barbette and broadside principles and carries her guns in two tiers, the upper being in fixed turrets, open at the top. Her armament is four 25 ton and four 18 ton guns.

The Alexandra is the largest of the central battery ships, her displacement being 9,500 and her speed 15 knots. She carries her guns on two decks and has an all round fire. Her armour is 12 inches think on the water line and her armament is two 25 and ten 18 ton guns.

The Hercules and Sultan are ships of the same class, being smaller, being about 7,000 tons displacement, with 9 inch armour. The Hercules has a speed of nearly 15 knots, and is armed with eight 18 ton and six 12 ton guns. The Sultan carries eight 18 ton guns and four 12 ton guns, and her speed is 14 knots. The Superb, purchased from the Turks, a similar vessel but larger—9,000 tons displacement—with 12 inch armour and an armament of sixteen 18 ton guns, Her speed is 13 knots.

The Nelson and Northampton are sister ships of 7,600 tons displacement, with 9 inch armour, carrying four 18 ton and eight 12 ton guns on broadside. The Nelson has a speed of 14 and the Northampton of 13½ knots. The Shannon, a belted cruiser with 9 inch armour, is smaller and carries two 18 and seven 12 ton guns.

The Audicious, Invincible, Iron Duke, Swiftsure, and Triumph are all of the same class, and nearly the same size—from 6,000 to 7,000 tons displacement. They have 8 inch armour and carry on broadside ten 12 ton guns and four 64 pounders. Their speed is from 13 to 14 knots. The whole of the 15 ships under this heading are fully rigged and fit to cruise in any part of the world,

OLD FASHIONED SHIPS.

There is still on the British Navy lists 14 ironclads of a class that is considered obsolete, useful cruising ships, but unfit to cope with modern ironclads in line of battle. Their armour varies in thickness from 4½ to 6 inches and their speed from 13 to 15½ knots. None of them carry guns heavier than 12 tons. Half a dozen of them are at present in commission as coast guards, and no doubt they would do good service as cruisers in case of war. The Agincourt, for instance, with her 10,500 tons displacement, 15½ knots speed, clad in 5½ inch armour, and armed with seventeen 12 ton guns, would be a very ugly customer for a hostile unarmoured cruiser to have following her. These vessels, however, are essentially out of date, and need not be specified further than to say that the list includes such well known ships as the Warrior, Black Prince, Minotaur, Achilles, Northumberland, and Bellerophon. The last will be remembered as the flagship on the North American station a few years ago.

UNARMOURED CRUISERS.

The British Navy contains a large number of swift unarmoured cruisers, with a speed varying from 14 to 18½ knots. They are all built of iron or steel, sheathed on the inside with wood. The largest of these are the Inconstant, Shah, and Raleigh, with nearly 6,000 tons displacement, the first two with a speed of 16½ knots. The Iris, 18½ knots, and Mercury, 18⅝ knots, are, however, the fastest vessels in the British Navy, or in the war fleets of the world. In them everything has been sacrificed to speed, their armament being only ten 64 pounders. The Iris, with a displacement of 3,750 tons, has engines of 7,330 horse-power. There is, however, one feature in connection with vessels of this type which detracts seriously from their efficiency. They have to be built with considerable beam so as to carry sail, and as a result of this require engines of enormous power to drive them. The following statement of the dimensions of the Iris as compared with two well known ocean steamships will illustrate this difficulty :—

	Length. Feet.	Beam. Feet.
Iris	300	46
City of Berlin	520	41
Servia	530	52

While the length of the Iris is only 6½ times her beam, that of the Servia is more than 10 times her beam, and of the City of Berlin nearly 12 times. Beside this disadvantage in form and size, the Iris has to carry with her and drag through the air the masts and rigging of a large ship. Unless in an absolutely dead calm, a fast passenger steamer could easily escape from the swiftest armed crusier by running up the wind. In anything of a sea the cruiser would have no chance whatever, for the long narrow passenger steamer would slip easily through waves that would bury up and beat back the shorter and broader ship of war. Hence the best cruisers in the time of war as "commerce destroyers" will be passenger steamers that have been strengthened to carry guns. The Iris, running at full speed, would exhaust her supply of coal in five days, whereas a passenger steamer should carry enough to take her across the Atlantic and back at a racing pace.—*Brooklyn Eagle.*

LARGE PER CENTS.

We notice in one of our exchanges, very recently, an article which treats quite too concisely for the fact and the importance of it, of the stunning recommendations furnished by people with regard to the use of certain steam appliances. The writer of that article reflects very strongly, but very truly, upon the almost infamous practice of some steam users as well as steam engineers, who are always ready to sign a certificate stating that the use of so-and so's patent ash-barrel cleaner, or whatever else it may be, has saved by careful noting of effects for three months exactly thirty-one per cent. of the fuel used. Or that some other fellow gives a certificate that so-and-so's patent soft soap has removed all the scale and sediment of every kind and description, and has also removed one ton of coal per day, making thirteen, fourteen or seventeen per cent. less coal than used before. The writer then goes on to show what all practical engineers know full well, that as a rule several changes are made as well as the particular one referred to, or possibly a change in coal might make the whole difference of eight or ten per cent. without the slightest exaggeration or misconstruction of the fact. The fault to which this gentleman alludes, and he does it very truthfully too, is one which is no particular credit to engineers, superintendents or agents, and such a certificate should be received for exactly what it is worth. We might inquire into all the facts, whether the engineer in a certain case had not perhaps been paid a commission, not only upon the particular attachment used, but perhaps upon any other which had been influenced through or by him ; or, that the manufacturer had received a large discount for the attaching of the appliance about which he wrote. It is rather a curious statement, but nevertheless true, and it is equally as true that such a state of affairs should not be allowed to exist. It only brings it down to the fact that men who really do this kind of business are robbing themselves of credit and their own reputation, while at the same time they are doing an injustice, not only to their employers, but also to every one who comes in contact with them in a business way.

There seems to be room for a decided change in these particulars, and there is no good reason why it should not occur very soon. These large percentages only prove the correctness of our oft-repeated assertion that, if a combination of these percentages had any approximation to the truth, our steam-engine users would be running with no fuel at all, and a handsome margin left. But the trouble in these percentages do not work, and they not only do not work, but they do work a power of mischief, dissatisfaction, extra expense, loss of time, annoyance, etc., while occasionally one may make a reasonable saving, and in that way influence the introduction of many others. Taken altogether it is a practice which should be stopped. Engineers should be forbidden to sign any such misleading articles, and if they did do it, should be promptly dismissed from their places and sent back among the knownothings, where they belong.—*Manufacturer's Gazette.*

THE telephone has been introduced in New Zealand, Van Diemen's Land, and Formosa. In Borneo the natives call it the "hell talker."

SIMPSON'S TIMBER DRY DOCKS.

Although the use of timber is so universal in America, yet it will come as a surprise to most of our readers to learn that it is extensively used in the construction of dry docks, and that these structures are much preferred to those built of granite. That wooden docks should cost 30 to 50 per cent. less than those of stone will be readily understood, but until the nature of the North American climate is taken into consideration it will not be realised that they are infinitely cheaper in maintenance. The alternation, however, from hot summers to hard winters proves exceedingly trying to the joints of stone docks, and it requires constant repairs to keep them tight. The alternate contraction and expansion rapidly separate the cement from the granite and afford ingress for water, which on freezing effects a rapid disintegration of the courses. In 1882 there were but four granite docks completed in the United States, and one was being constructed by the Government in the harbor of San Francisco. At the same date there were ten wooden Simpson docks, so named after the inventor. Three of the stone docks were built by the Government; the fourth, which was the result of private enterprise at San Francisco, has had its exposed surface covered with wood, and that in a locality where the winters are mild.

Some of the principal advantages which the Simpson docks have been found to possess over stone docks, as usually constructed, are greater accessibility, better facilities for shoring and repairing vessels, better distribution of light and air, dryness, and greater safety and comfort to the workmen in freezing weather. The greater slope given to the sides and heads of these docks, and the low narrow altars used, furnishes safe and easy means of access for workmen to the floor of the dock, direct from any part of the coping, and also affords much greater facilities for easily and quickly repairing, receiving, and shoring up vessels in dock, conducting the work of repairs, etc. This feature also gives more light upon the ships' bottoms, and the use of wood for floorings and altars is preferable to stone in winter, when the adhesion of ice and snow will be less upon the wood, and the discomfort of the damp chilling air inseparable from the use of stone docks when filled with frost, is largely obviated. Careful investigation shows that extensive repairs and renewals to well-built timber docks are not necessary until after twenty years' service, and then only to the parts above the tide water; also that the piles, floor and keel timbers, sills and abutments, and the timbering generally below low-water line of the oldest Simpson docks, are still in use and in a good state of preservation, and although the exposed timbers are more or less worn from constant use, and all are deeply water-stained, they are substantially as sound and serviceable as when put in twenty-eight or thirty years ago.

The method of constructing these docks will be seen from our engravings. These views represent two different docks, built by Messrs. J. E. Simpson and Co.; the unfinished one is at Baltimore, and the completed example is the Erie Basin, Brooklyn. The former is 470 ft. long on the top, 437 ft. at the bottom, the width on the top of the body being 113 ft., and at the bottom 45 ft. The contract price was $375,500, and the time of building twelve months. Nearly the whole area of the dock was covered with water and near the gate to a depth of 10 ft. or 12 ft. Below the mud at the bottom of this water was a hard clay. The Erie dock is of the following dimensions:

	ft.
Length over all on coping	540
" inside of caisson when an outer abutment	510
Length inside of caisson when on inner abutment	490
Width on top in body	124
" floor "	52
" " at entrance	46
" top "	100
Depth of gate sill below coping	27
" " " high water	22

The dock, together with an adjoining one of larger dimensions, is built upon spruce foundations throughout, the floor foundation piles being driven in rows spaced 3 ft. from centres transversely, and about 4 ft. 8 in. longitudinally, upon which are fitted and secured heavy transverse floor timbers of yellow pine, covered with spruce planking to form the floor, and carrying the keel blocks, the latter being additionally supported by four rows of piles driven under these floor timbers, and capped with yellow pine timbers along the axis of the dock. The heads of the piles along the keelway are also inclosed in a continuous bed of Portland cement concrete. Open box drains are provided at each side of the keeling beneath the floor timbers, leading to the drainage culverts at the head of each dock. The sides and heads of the docks are built with a slope of about 45 deg., the altars to high water level are built of yellow pine timber, 9 in. rise and 10 in. tread, and are bolted to side brace timbers, which are supported by piles, and abut upon the ends of the floor timbers. The altars are carefully filled in behind with clay puddle as the sides are built up, and from the level of high water to the top of coping the sides are built of concrete *en masse*, faced with Hoope's artificial stone, the altars being continued of the same material to the coping level. The keel blocks are placed upon every floor timber, and the bilge blocks of the usual form, sliding upon oak bearers, upon every other floor timber. Lines of close sheet piling of tongued plank inclose the floor of the dock, and also extend entirely around the dock outside of the coping, and across the entrance of the outer end of the apron, and at each abutment, forming cut-offs to exclude the tide water, etc. An iron caisson, used to close the dock, is made with sloping ends corresponding substantially with the slope of the side walls in the body of the dock. This bears against the sill and solid timber abutments the whole length of its keel and stem, no grooves being used. Each dock has two gate sills and abutments, the outer being to allow repairs to the inner.

A timber dock, constructed under the superintendence of Mr. Simpson, who is now 73 years of age, was opened at St. John's Newfoundland, on December 15 of last year. The following are the dimensions:

	ft.	in.
Greatest length on coping, head to outer gate sill	610	10
Greatest length on floor, head to outer gate sill	569	6
Greatest width of body on coping	132	6
" " " floor	49	10
Least width of entrance, inner abutment, on coping	84	9
Least width of entrance, inner abutment, on floor	52	9

Greatest draught of water over inner gate sill, high water, spring tide, 25 ft.

This dock is located at Riverhead, in the harbour of St. Johns, and is similar in shape and construction to the wooden graving docks in Brooklyn, Philadelphia and Baltimore.

It is built upon spruce pile foundations, except the floor, which rests upon a bed of Portland cement concrete, varying from 2½ ft. in thickness at the head to about 6 ft. at the entrance. The concrete floor foundation itself rests upon a glacial deposit of compacted slaty gravel immediately overlying the bed rock.

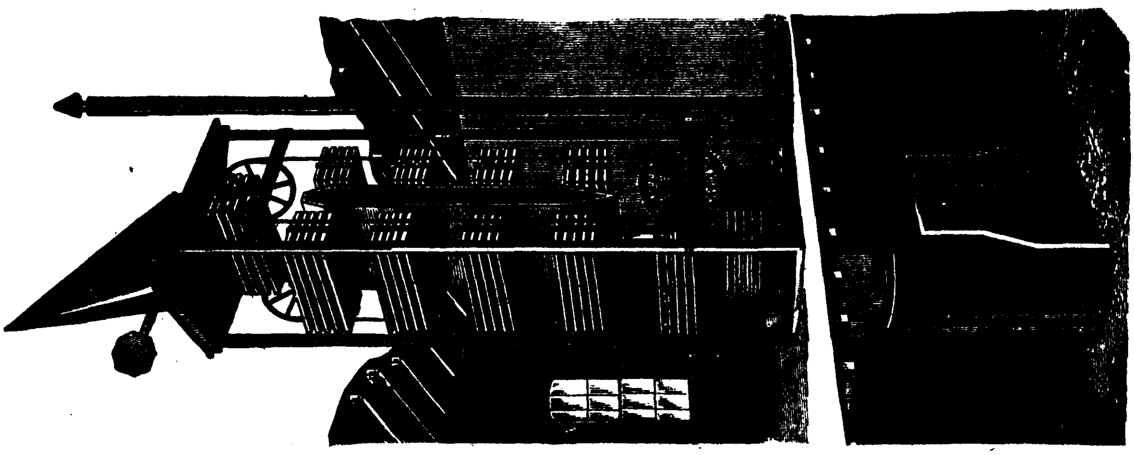
It would appear that this dock has been constructed with great despatch, the contract having been made March 17, 1883, subject to the Legislature passing an Act authorizing the Government to ratify and confirm the same, which act was duly passed, April 21, 1883. The site provided by the Government was only partially bare at low water, and a portion of it was occupied with pile wharves, etc. The contractors arrived on the ground May 9, 1883, and the first pile was driven May 28th. On December 24th, following, all outside work was suspended for the winter until April 24, 1884, when it was resumed, and the inclosed site first pumped dry ready for excavation, which began the following day.

The entrance works were completed on November 28th following, and water first admitted to the dock on the 29th; the caisson was floated and set in place at the outer abutment November 30th, and the dock first pumped out December 2nd. —*Eng.*

The list of goods canned has been enlarged by a company in St. Louis, which has begun canning eggs. A factory has been erected, and is now in operation, where they will can 1,000,000 dozen annually. The eggs are put through some sort of a process by which the yolks and white are separated from the shells, and the substance is then dried and canned. One teaspoonful is said to be equal to one egg, and it is warranted to keep fresh for three years.

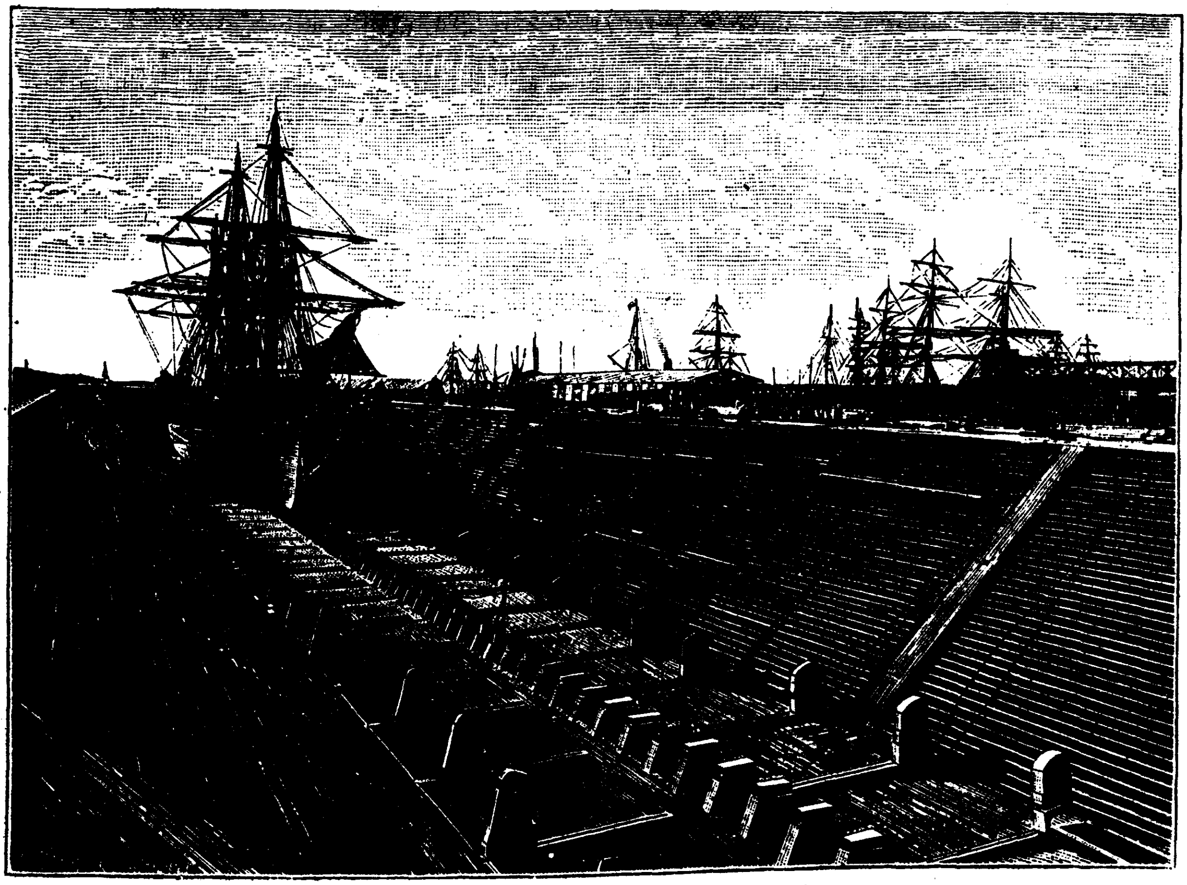
TIMBER DRY DOCK.

TIMBER DRY DOCK AT BALTIMORE, MARYLAND, U.S.A.

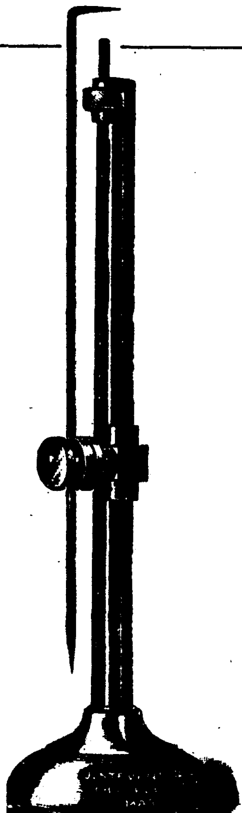


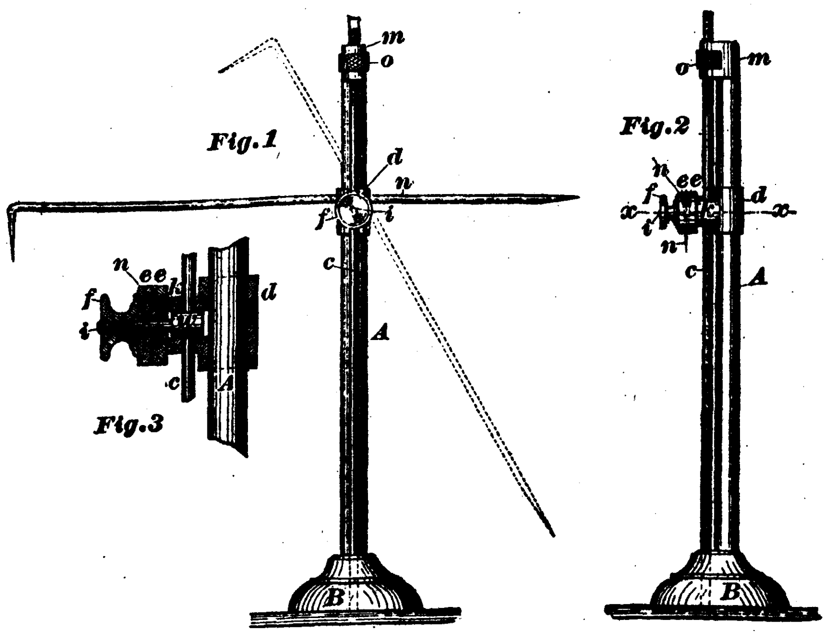
WILLIAMS' EVAPORATOR FOR DRYING FRUITS, ETC.

TIMBER DRY DOCK.



TIMBER DRY DOCK, ERIE BASIN, N.Y., U.S.A.





STEVENS SURFACE GUAGE.

EVAPORATOR FOR DRYING FRUIT, ETC.

The Williams evaporator, herewith illustrated, is designed for the drying of fruit, vegetables, etc., and while being simple in construction, easy to handle, and continuous in operation, there is no danger of overdrying or burning the fruit.

The evaporator consists of a vertical trunk about 32 feet high, 5 feet 1 inch wide, and 5 feet 8 inches deep, divided by a partial partition into two evaporating flues, through which the fruit to be dried is slowly passed. At the top and bottom of the trunk are shafts, each of which carries two wheels; the upper and lower wheels are connected with endless chains formed with projecting pins, from which light frames are suspended.

Between the frames filled with trays are spaces of about 15 inches, forming a number of air chambers at certain intervals in the flues. On two sides of the trunk are doors conveniently located for putting in and taking out the trays. The heaters require no masonry, and either wood or coal may be used as fuel. By means of a damper the heat may be thrown into either or both flues at will, and the operator is enabled to control the heat as occasion may require.

The trays containing the green fruit are inserted through a small door, about 4 feet above the furnace, and passed downwardly directly over it, thus heating the fruit rapidly to as great a degree as it will bear without materially changing its color. When first put in, the degree of heat may be very high without danger, since the fruit is cool and contains all its original moisture, and the hot air surrounding it is free from vapor, and will not penetrate and scald the fruit as moist air would. It then rises gradually through the hottest flue, the hot air being thrown under the trays by deflectors on the inside of the walls of the flue; the heated air and vapor pass off at the top. While rising, the greater degree of heat the outside of the fruit received while passing over the heater diffuses itself through the fruit; and while descending the other flue to the operator, the drier fruit, preceeding the moist, enters the increasing heat, and arriving at the door is removed by the operator, who inserts another tray of green in its place, thus making the operation continuous. The fruit, having been dried in the least possible time, and having been uninjured by scorching or cooking, retains its original color and flavor. The construction of this apparatus enables the operator to evaporate, at the same time, different kinds of fruit which require more or less time and heat.

The principle governing the construction and operation of this evaporator is sound; by first exposing the green fruit to a high, dry heat and passing it slowly to a lower temperature, and then in its downward passage through the second flue subjecting it to a dry, heated current moving upward, the fruit is not so apt to be injured as in the case of its exposure in a moist atmosphere from which it passes into an intense heat.

The capacity of the evaporator described above is 150 bushels of apples or 200 baskets of peeled peaches in 24 hours. Letters of recommendation received by the manufacturer, Mr. S. E. Sprout, of Muncy, Pa., who should be addressed for further particulars, while highly indorsing the evaporator, state that it will appreciably exceed the guaranteed capacity if properly run.—*Ex.*

STEVENS' NEW "EXACT" SURFACE GAUGE.

This gauge was patented in September last and is made by J. Stevens & Co., of Chicopee Falls, Mass. It is claimed to be superior to all others in its quick and fine adjusting powers, and especially in the grasp of its pointer. This, tightening on to one of the rods, and moving only with it instead of sliding upon it as others do, is held perfectly firm in all of its adjustments.

In this tool the post *A*, is rigidly fastened to the base *B*, in the usual manner. At the top of the post is the nut guide *m*, for nut *O*. The adjusting rod *c*, is guided at the top in a hole through *m*, and at the bottom in a hole in the base *B*. By means of the nut *O*, the rod and attached parts can be ajusted vertically. The support *d*, is made with a branch *k*, through which the rod *e*, passes. This branch is recessed to receive the cylindrical head *w*, of clamp screw *i*. The rod *c*, passes through head *w*, and branch *k*. The pointer *n*, is held between two clamps, *e*, *e*, as clearly represented. This permits turning the pointer and clamps on the screw *i*, and of binding the whole by means of nut *f*.

It will be understood that the mechanism carrying the pointer can, when the nut *f* is loosed, be readily moved up or down the post, that when the nut *f* is tightened, it clamps this mechanism to the rod *c*, but that by turning nut *O*, the pointer can be adjusted a short distance up or down to bring it to the exact position required, after it is otherwise securely clamped. The advantages of providing for this adjustment will be apparent to those accustomed to use such tools. By having a hole drilled in the base, it is also adapted to a Depth Gauge and various others purposes.

The small size has a height of eight inches and will scratch weight inches side ways and 13 inches high. The large size will scratch 10½ inches sideways, and 18 inches high.—*Ex.*

PUMPING MACHINERY.

We give a perspective view, and an elevation and a plan of a set of horizontal double force pumps shown at the late Turin Exhibition, by Messrs. Bosisio, Larini, Nathan, and Co., of Milan. They are designed to deliver 1000 tons of water per hour with a head of 200 ft., and are of the type usually employed on the Continent for water works.—*Eng.*

THE CABLE RAILWAY IN CINCINNATI.

As in large cities, there are thousands of people doing business in this city who reside in the suburbs, and must consequently go back and forth each day. The demand for quick transit as well as better accommodations than those furnished by horse cars has brought matters to such a point that Cincinnati will at last have a cable railway. The practicability of building and maintaining a cable rod has for the past few years been agitated, and now the Street Railroad Company has taken the matter in hand and all the necessary arrangements are said to have been completed.

Cincinnati is the third city in the United States to adopt cable railways. The cable will run from Knowlton's corner in Cumminsville, where the street car turn table is at present, to the stables on Spring Grove avenue. From the stables it will extend along the street car route to Twelfth street, then down Race to Front street, and back again over the same route to Cumminsville.

The engine which will supply the motive power to the cable will be placed in the spring Grove avenue stables. Contracts have been let for the engine, and it will be completed in about two months. The Lumber has been contracted for, the quantity being 400,000 feet. About 40,000 pounds of iron work will be required. This material will be ready for use about the middle or latter part of April, and the work of laying the tunnel between the tracks will be at once begun, and as with the laying of the stringers there will be no interference with the usual every day traffic. The whole of the work will be finished and the cable put in operation by the middle of June.

The object of changing from horse to cable railway is, of course, to save money. It is claimed that it costs $138,820 per annum to run a horse car line of three miles, and but $88,246 to run a cable line of equal length. It is further asserted that the largest item of expense in the latter is the cable itself, whose life now extends to but a year and a half. The cable is worn out by the constant gripping and ungripping. To overcome the inertia of the car when at rest is a great strain on the rope, and this, with the friction from slipping, wears it out in a very short time. A Cincinnati inventor claims that he has made a grip that almost entirely overcomes the objectionable friction, by giving the car a gradual start, and that this will let the cable live at least three years. If his arrangement is practicable, Cincinnati can have the cheapest cable road in America.

There are many benefits to be derived from the cable system by the public. A single grip car can easily serve to draw three passenger cars, and when travel is heavy the number of cars can be increased without any trouble until every one can be supplied with a seat. This fact alone will greatly popularize the cable road. Again, the cable will be run at a rate of twelve miles an hour, and, when possible, the speed of the cars can be increased to that extent.—*Ex.*

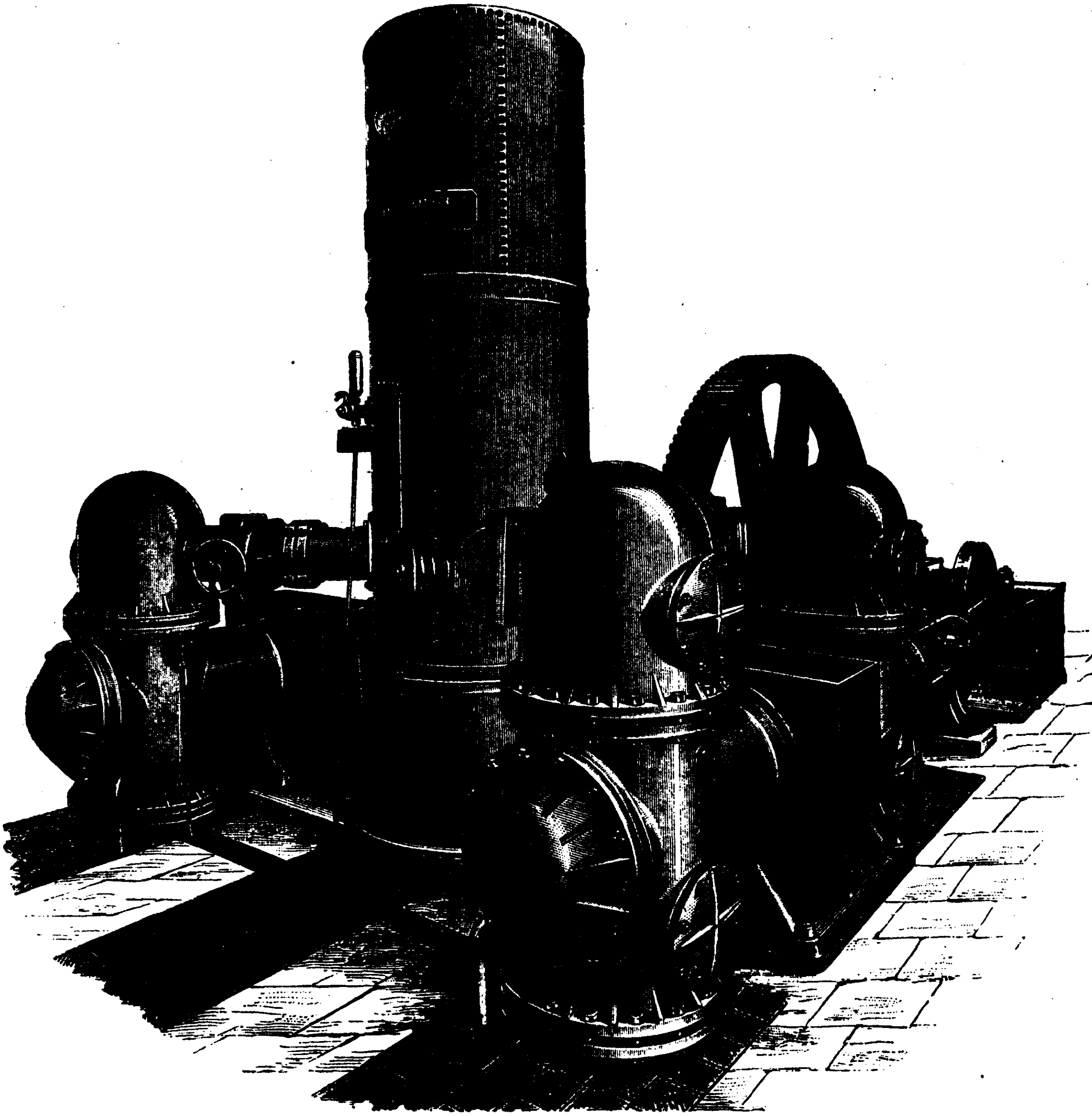
THE CONSTRUCTION OF LOCOMOTIVES.

At the meeting of the Institution of Civil Engineers, held on Tuesday, March 9, Sir Frederick J. Bramwell, F. R. S., President, in the chair, the paper read was on "The Construction of Locomotive engines, and some Results of their Working on the London, Brighton, and South Coast Railway," by William Stroudley, M. Inst. C.E.

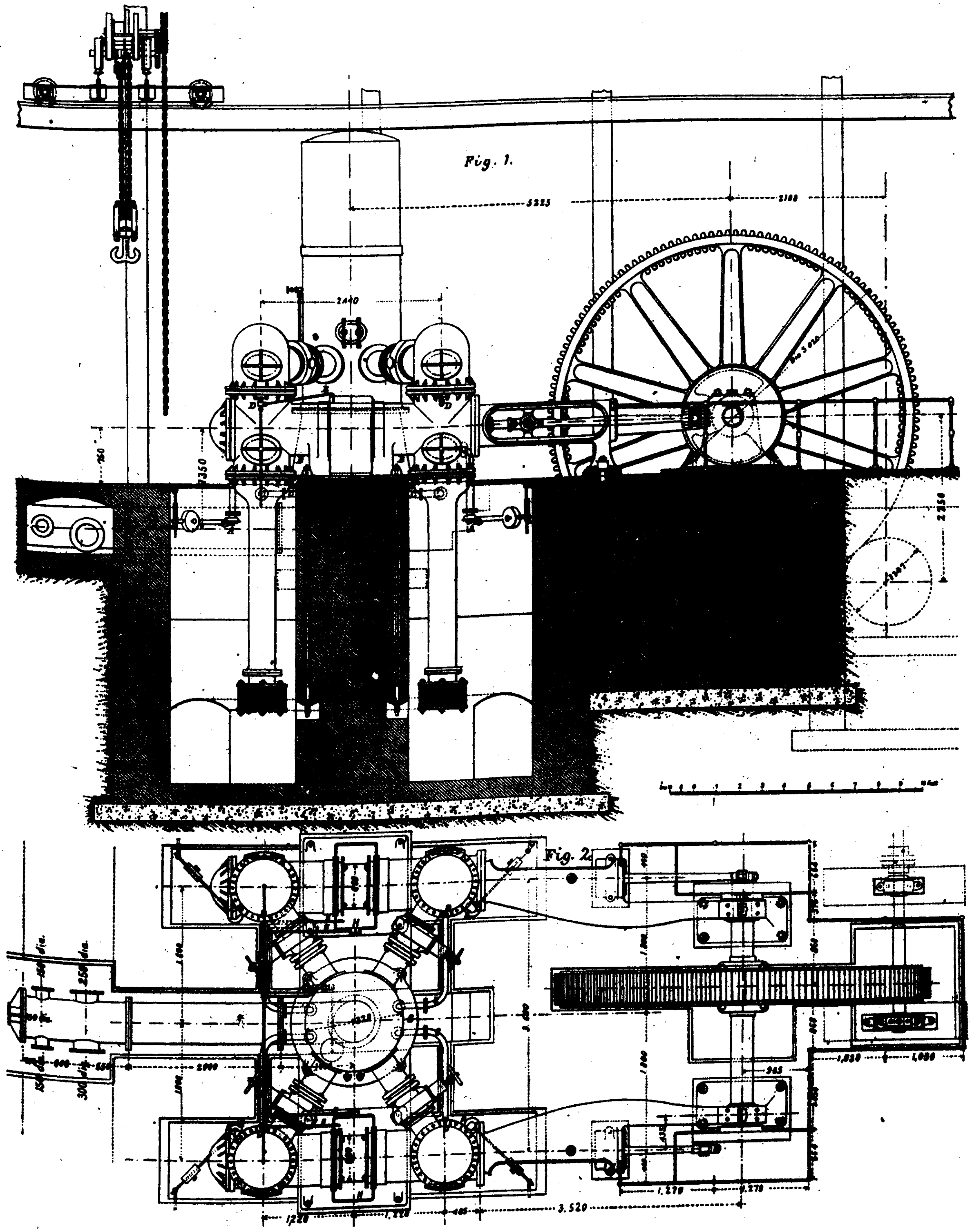
The author, on his appointment to the London, Brighton, and South Coast Railway, in 1870, had to consider what kind of locomotive engine and rolling stock would best meet the requirements of the service, as, owing to the great increase and complication of the lines and traffic, the original primitive engines and rolling stock were not able to do so. He, therefore, in the same year, designed a large goods engine, class "C," arranging the details so that they would enable him to construct the several classes illustrated, all the principal parts being interchangeable. Having had long experience with both outside and inside cylinder engines, he adopted inside cylinders, but placed the crank-pins for the outside rods on the same side of the axle as the inside crank, the outside pin, however, having a shorter stroke; and he thus obtained the advantages of both systems. He adopted the method of putting the coupled wheels in front, instead of at the back as usual, which permitted the use of small trailing wheels, lightly weighted, and a short outside coupling rod for the fast running engines, and also a much larger boiler than could be obtained when the coupled wheels were at the back. The author adopted a somewhat high centre of gravity, believing that it made the engine travel more easily upon the road, and more safely at high speeds; the slight rolling motion, caused by the irregularities of the road, having a much less disturbing influence than the violent lateral oscillation peculiar to engines with a low centre of gravity. The high centre of gravity also threw the greatest weight upon the outside or guiding wheel when passing round curves; and this relieved the inner wheels, and enabled them to slip readily. The author used six wheels in preference to a bogie for these engines, to avoid complication and unnecessary weight. The engines were very light for their power. Several springs were used for the middle axle, and these had a greater range than the end ones for the same weight. The two cylinders of the large engines were cast in one piece, with the valves placed below, giving lightness, closeness of centres, and easy exhaust and steam passages. The crank-axle was the only disadvantage left in an inside cylinder, inside-framed engine, and, when this was of good proportions, it offered but a small objection. Owing, however, to the narrow gauge of the rails in this country, the crank-axle could not be made so strong as it ought to be, or there would be no reason why a crank-axle should break. When the flanges of the driving wheels were turned down thin, so as to avoid the side-shock given by crossings and check-rails there only remained the strain of the steam upon the pistons to cause breakage; the action of this was precisely the same as the methods used by the late Sir William Fairbairn in testing to destruction the model tube for the Menai Bridge, by letting a heavy weight rest upon it suddenly at frequent intervals. The deflection, if sufficient, caused a crack at the weakest place, which gradually extended until fracture took place. This was precisely what occurred in the axle; the crack invariably commencing on the side of the axle opposite to that to which the steam was applied.

The author, after thirty years' experience, believed that the separate parts of locomotives, including tires, axles, piston rods, side rods, bolts, cotters, and carriage and waggon axles, broke from the same cause; they did not break when carefully designed, and made with proper materials and workmanship. As the crank axle could not be made of the proper strength, it was well to consider how to avoid, as far as possible, risk of accident by its failure. By making the axle-boxes and horn-blocks deep and strong giving large flat surfaces against the boss of the wheel and the outside of the crank arm, the driving wheel was kept in position after the axle was broken, if the fracture occurred in the usual place, namely, through the inside web near the crank-pin, or through the centre part where it joined the inside web. An axle, broken in this manner, would run safely over any part of the road, except at a through crossing, where the guiding rail was lost, and the flange was liable to take the wrong side of the next point; this, however, had not happened in the author's experience. The author had always hooped the larger cranks, and had for some time hooped every new crank in the same proportion as adopted on the Great Northern Railway, thus reducing the risk to a minimum. The engines had been arranged that part of the exhaust steam might be turned into the tender or tanks, so that the feed water might be heated. This was a special advantage in a tank engine, by increasing the total quantity of water; it also kept the water supply of greater purity, and it relieved the boiler of a certain amount of duty in heating the water from the ordinary temperature to that which feed water required. The feed pumps had been designed to meet the requirements of pumping hot feed water. The proportions of the valve gear gave an admission of 78 per cent. of steam in full gear, which could be reduced to 12 per cent. with excellent results; and as at high speeds the steam was never exhausted, the temperature of the cylinder was maintained, and as much steam was locked up in the cylinders as raised the pressure at the end of the stroke to near that in the steam chest. This made the engine run very smoothly at high speeds, and turned what would otherwise be an extravagant coal burner into an economical machine. And for the same reason the compounding of fast passenger or frequent stopping locomotives was not likely to show much, if any, economy over a well-designed, simple engine. The case was different, however, in heavy goods engines, working with a late cut-off most of the time, and where the conditions approximated closely to those of a land or marine engine with a constant load. The back pressure observed in the diagrams of the high-speed locomotives was not therefore a defect, but an advantage, and the author accordingly used small steam ports and short travel of slide valve. These remarks as to back pressure did not apply to the pressure in the exhaust pipes, where it should be as small as possible, but only to the back pressure in the cylinder. The latter was greatest at high speeds, when a small volume of steam was passing through the cylinders, and small power was required, and least when working full power with the smallest expansion. All the passenger engines and many of the goods engines were fitted with the Westinghouse automatic air brake, as were also the whole of the carriages. The brake gave entire satisfaction and complete control of the trains. The author took considerable pains with the fittings and details when it was first introduced, and arranged the gear for the engines, so that the brake acted upon each wheel independently, allowing the springs freedom to act; or it acted upon the front of all the wheels, as in the tank engines, the brake of which was moved by hand as well as by the air pressure. The Westinghouse air pump has been fitted with a plunger at the bottom end of the rod, 1¾ in. in diameter, and this pumped water into the boilers of the goods engines when they were in sidings or were delayed by signals. For the express and large goods engines, the greatest possible amount of heating surface had been provided; the firebox was capacious, with small tubes of considerable length in proportion to their diameter, little or no flame being generated with the coal used, and a very small amount of soot. The fuel which was found cheapest to consume in this locality, was smokeless coal from South Wales, mixed with a small quantity of bituminous coal from Derbyshire. The boilers were made of the best Yorkshire iron, with plates having planed edges; holes were drilled after the plates had been bent; the joints were butt-joints, and they were hand rivetted. The construction of the ash-pan and its dampers, perforated plates, water supply and the arrangement of firebars, brick arch, firedoor and deflector, were shown. The indicator diagrams, taken by one of the Crosby Steam Gauge Valve Company's indicators, at various speeds, and under varying conditions of gradient, afforded a fair idea of the working capabilities of these engines, the economical value of which was best shown by quoting the consumption of fuel for the half-year ending the 30th of June, 1884, when the average of the whole of the engines on this line was 29.74 lb. per engine mile, including the coal used in raising steam. A great number of careful tests had been made of the amount of coal required to raise steam in the engines from cold water, and also from the partially heated water when the boiler had not been emptied, and this amounted on an average to about 3 lb. per mile run. Some doubt had been expressed as to the value of heating feed water by the exhaust steam. The author, therefore, had a number of tests made with the ordinary heating apparatus removed, and water fed to the boilers by the feed pumps, and in one series by a Borland's injector. The amount of power required to work the pumps was inappreciable, and the heated feed water brought about reduction in the consumption of fuel to the extent of over 2½ lb. per train-mile. It had also been found that heating the feed water by direct contact of the steam did not, on this railway, injuriously affect the boiler plates. With a view to ascertain what was

PUMPING MACHINERY.



PUMPING MACHINERY.



the amount of power required to haul a train from Brighton to London, a complete set of forty-nine diagrams was taken from the engine Gladstone, working an express train of twenty-three vehicles, the total weight of train and engine being 335 tons 14 cwt. A section of the line was given, and clearly illustrated the result, giving the horse-power at about every mile, the speed, and the gradient. The temperature of the gases in the smokebox was taken at frequent intervals; also the degree of vacuum in the firebox and in the smokebox, and the quantity of water used out of the tender. To the latter had to be added the water condensed from the exhaust, which, from experiments, the author estimated at 20 per cent. This gave an evaporation of 12.95 lb. of water per 1 lb. of coal, and 1 lb. of coal would convey one ton weight of the train 13½ miles, at an average speed of 43.38 miles per hour, over the Brighton Railway, the rate of consumption being 2.03 lb. of coal per horse-power per hour.—*Eng.*

LABOR IN EUROPE.

THE POOREST FOOD AND WAGES ON WHICH AN AMERICAN WORKINGMAN WOULD STARVE—TOILING FOR THE BREATH OF LIFE.

The wages, cost of living, habits, manner of life, school systems and special privileges in America are familiar to all readers, but they are better appreciated by comparison with similar conditions in other countries. The recent letter of Secretary Frelinghuysen to Congress furnishes much information upon the subject of labor and the minor conditions which surround it, and from this are selected some pictures showing the condition of the working classes in England, Germany and other portions of Europe. Comparing England with the United States, it appears that bricklayers and masons in Chicago are paid very nearly three times the wages; plasterers nearly four times; slaters, three times; carpenters, twice; cabinetmakers nearly twice; cigarmakers, nearly three times; draymen, teamsters and car-drivers nearly twice; laborers, porters, etc., more than twice; telegraph operators and printers, twice and a half; stevedores, twice and a fourth; engravers, three times; tailors, twice; and bookbinders more than twice the wages paid to similar trades and occupations in London.

In the tables comparing the cost of the necessaries of life, it is shown that bacon sells for about the same in London; ham, about 50 per cent. higher; beef, 25 per cent. higher; mutton, 25 per cent. higher; sugar, for less; tea and coffee, a little higher; butter, for a trifle more; rice, for less; flour for less; bread, 30 per cent. less; oatmeal, for more; rice, for a little less; potatoes, for a little less than the same articles can be purchased in Chicago and New York.

The consul at Birmingham cites two extreme cases to illustrate the manner of living of the best and poorest paid. The first is that of a brushmaker, with a wife and four children. The husband earns from $7.20 to $8.40 per week, and with the aid of his wife and children, who all work, the total income is estimated at $583 per annum, which, according to his own statement, is expended as follows: rent of house, three rooms, $44.22; clothing for family, $97.20; food, $328.52; school tax for one child, $3.15; trades union, $20.40; doctor's bill, $24.30; total, $417.80. Breakfast, bread and tea and butter, or bread and bacon; dinner, fish or meat, vegetables and beer, tea, bread and butter; supper, bread and cheese and beer. Saves no money; falls back on his club or trades union in emergencies. The second is a female tackmaker, who tells the following story; "I get paid by the thousand; the card price is 17 cents per thousand, but I am glad to take the work at 14½ cents, it is so hard to get. I work four days per week and make $1.16. My husband is a gardener at the college hard by, and earns 17 shillings per week, but works very long hours; our total income is $275.89 per year. Have a brother a nailmaker; himself and his wife both work at the trade, and earn about fourteen shillings per week, or $171.88 per annum; after paying rent and fuel for the forge they have $2.43 per week for food and fuel; their food consists of what they call bread and butter, but I call it 'bread and scrape,' with a bit of bacon at times; they hardly ever see fresh meat; I do not think the children get enough to eat." The consul at Bremen estimates the number of females employed there in industrial establishments at 28,000. The average wages of adult females are $2.18 per week of 69 hours. Girls from 12 to 14 years of age are now permitted to be employed more than six hours per day, while those from 14 to 16 can be employed only eight hours. The wages of workingmen in this district average about as follows: Bricklayers, $3.64; plumbers, $3.68; gas-fitters, blacksmiths and coopers, $3.93; carpenters and butchers, $3.80 each per week of 66 hours; tailors, $4.29 for 72 hours, and brickmakers $4.61 for 84 hours. Telegraph operators receive $6.50, machinists $5, compositors, $5, and pressmen $4.74. Male farm hands receive, with board and lodging, $49.98 per annum, and female farm hands $29.75. The prices of food per pound are as follows: Wheat flour, 4 cents; butter 34 cents; beans, 4 cents; potatoes, 4-5 cent; cheese, 11 to 26 cents; sausage, 23 cents; beef 24 cents; veal, 15 cents; mutton, 17 cents; pork, 16½ cents; bacon, 17 cents; coffee (green) 38 cents, and roasted, 42 cents. By careful observation, estimates and interviews the consul shows how a workingman's family of seven persons lives on the wages earned, $3.57 per week. Some of the principal items are 56 pounds of potatoes, 45 cents; 21 pounds of bread, 45 cents; coal, 14 cents; meat, including bacon and sausage, 35 cents; rent, 42 cents; clothing, 33 cents, or $17.16 per year.

From the statements of several consuls the following are condensed: A laborer in Berlin, 41 years old, works in a coal yard and earns about $123 per year, although this sum is uncertain. The expenses of himself and family are $186, of which $77 is paid for rent, $24 for clothing and $51 for food. His wife is obliged to do all sorts of work—washing, scrubbing, etc.—and the eldest daughter, 15 years old, assists. Besides, they raise potatoes, their chief living, on land rented from Berlin magistrates at $2.14 per year.

An intelligent young silk weaver of Crefeld, 29 years of age, who has worked at the trade since he was 14 years of age, an expert in his business and consequently having a choice of work, informed the consul that by working from thirteen to fifteen hours per day at his loom he could earn $3 37 per week. Very few weavers, he said, could earn this wage, eight to ten marks—about $2—per week being the average wages earned by the weavers of Crefeld. Being a single man he was able to get along on his wages.

In Silesia a family of five persons lives on the following amount of provisions per month; Rye flour, 78 pounds; wheat flour, 52 pounds; beef 2¾ pounds; bacon, 7½ pounds; butter, 3 pounds; potatoes, 3½ bushels; milk, 10 quarts. Total value, $8.29.

Cotton mill wages are shown to be $6.48 for overseer and $5.94 for foreman of weaving; $3.09 for man weaver, $2.76 for woman weaver, $1.12 for child bobbin winder, $6.60 for foreman of spinning, $5.40 for packer of spindles, $4.50 for conductor of self-acting looms, $3,39 for tender of spindle frames; $2.37 for draw-frame tender. These are for weeks of from sixty-six to seventy-eight hours. The wages in foundries, for weeks of 72 hours, are from $5.40 for forgemen and first puddlers to $1.02 for laborers. The highest wages set down for foremen is $8.33 per week.

The food of the Dutch working people is mainly potatoes, vegetables, beans and peas. With the exception of horse flesh, fresh meat is a rarity. One of the most prosperous masons, who earns $236 per year when times are good, describes the bill of fare for himself, wife and two children as follows: Breakfast, coffee, bread and butter; dinner, potatoes with fat, sometimes vegetables; supper, same as breakfast; Sunday dinner, beef or pork. In Amsterdam a schedule of wages is given, from which are taken the following prices: Engravers, $8 per week (the highest named); brewers, distillers and printers, $6; school teachers, $6.40; telegraph operators, $5.40; tailors, $5; all others from $2.80 to $4.80.

Most French laborers live in a manner similar to the following: "In the morning before going to work, a piece of bread and two cents' worth of brandy; at breakfast, bread crumbed into a basin of coffee; for dinner, a piece of bread and cheese, or an apple, and a gill of red wine; for supper, a piece of bread and a little sausage, or oftener only a herring and a cup of coffee. A meat and vegetable meal is indulged in only on Sunday." The following example, taken from one of the manufacturing centres, is given as a sample of the life of the employed classes: A mechanic in a woollen mill; 42 years of age; has a wife and two children; earns 77 cents per day, which is 10 to 20 per cent. more than is earned by general workmen; works 12 hours per day; exercises the strictest economy in order to get along, although he is better fixed than most workingmen; his wife works in the mill also, and earns 48½ cents per day; works every day in the year, Sundays included, which yields a wage of $251.78; his wife works 305 days in the year, which yields a wage of $147.16, a united wage earning of $428.94. Family expenses. Rent, $38.60 ; clothing. $63.69 ; food and fuel, $315.75 ; personal tax, 48 cents ; society dues, $4.83 ; balance for incidentals, $5.59 ; total, $428.94. Meals : A cup of coffee and a piece of bread for breakfast ; dinner, soup, made from salt pork or horseflesh, or cheap beef, and vegetables and bread ; supper, bread and potatoes, and what is left of the dinner."

The consul at Berne gives the following case of a shoemaker as illustrative of the condition of workmen in Switzerland ; "A shoemaker, 37 years old, has a wife and two children. By working long hours can earn seventy-eight cents per day ; usual hours, ten to twelve ; earns fifty-eight cents per day ; his wife works at washing and sewing and earns twenty-nine cents per day when she can get work ; could not support his family otherwise ; total annual income, from $193 to $242. Expenses—rent of room in second story, $34.74 ; clothing, $28.95 ; food and fuel (thirty-five cents per day), $123.28 ; income and residence tax, $1.16 ; dues to aid societies, $2.32 ; school books, doctor bills and incidentals, $9.65 ; total expenses, $200.10. Breakfast, coffee, bread and potatoes ; dinner, soup, sometimes meat, but mostly food prepared of flour ; afternoon, bread and beer ; supper, bread, potatoes and coffee. Can save nothing." A silk weaver of Basle, who had a wife and a daughter, estimated the total income of a family at $328 per year, and another stated that coffee and bread three times a day constituted the bill of fare for his family, although when times were good they indulged in a little meat occasionally. The rates of female wages in Switzerland, per week of sixty-five hours, are set down as follows : Weavers, $3.86 ; warpers, $2.89 ; spoolers, $1.93 ; hands on rough work for watches, $2.58 ; on jewels, $4.92 ; on hands, $3.48 ; on dials, $6.06 ; on springs, $4.63 ; and on finishing, $2.58. In the Saint Gall district the farmers pay male laborers at the rate of $1.74 per week, and female laborers 96 cents per week, with board and lodging, which are considered highly advantageous terms. For these rates farm laborers work from daylight to dark, often late at night, and during certain hours of Sundays and holidays.

The reports which have been received from Italy indicate that the working classes are patient, economical, sober, industrious, tractable and trustworthy. Their wage rates are the lowest in Europe, and that they are able to economize, and are happy and contented is probably largely due to a favoring climate. An erroneous opinion prevails in the United States in regard to macaroni being the staple food of the working class of Italy ; it is in reality only purchasable by the comparatively well-to-do. Fresh meat is seldom eaten, even by the skilled mechanic. Vegetables and fruit, however, are at times so plentiful as to be accessible to the poorest. The average hours of work are thirteen in the summer, and ten and a half in the winter.

Four representative families were taken by the consul at Copenhagen to present a fair average for the wages and manner of living for the workingmen of Denmark. He found that the first family earned $189, spent $183.60 to live, and saved $4.40 ; the second earned $214, spent $210.40, and saved $3.60 ; the third earned $240, spent $227.80, and saved $12.20 ; the fourth earned $268, spent $254.60, and saved $13.40. More than half the population live exclusively by agriculture.

Wages throughout Russia are much lower than those which rule in continental Europe. The general condition of the working classes is one of poverty and want. As a rule, they do not and cannot save anything. As a sample of the wages and living of mechanics in St. Petersburg, the following story of a metal turner's experience is given : "Aged 45 ; has a wife and two children ; earns seventy-two cents per day of eleven hours ; his wife earns $2.40 per month sewing ; total income, $254 per year, estimating on full time. Expenses—Rent, $34.56 ; food, $190 ; clothing, $24 ; taxes, $2.40 ; sundries, $3.44 ; total annual expenses, $254. It is not probable that the average workman can make full time throughout a year, and therefore the above estimates must be regulated accordingly." In bookbinding establishments women receive from $2.50 to $3 per month. In paper-box factories, girls earn $1 per week ; girls engaged in printing labels, $5 per month, holidays deducted. Retouchers in photographic establishments earn from $15 to $17.50 per month. In toilet soap and perfume factories girls earn from 90 cents to $1.50 per week. Chair polishers in furniture factories receive 37½ cents per day. Women laboring in tanneries receive 15 cents for ten hours' labor. Women engaged in house and shop work, living in the premises, work generally from early morning until late at night, going to bed at 12 o'clock and getting up at 6 o'clock in the morning.

ENGINES OF THE "COTENTIN."

The compound surface condensing engines which we illustrate are those of the Cotentin, built by Messrs. Green, of Blackwall, under the superintendence of Messrs. J. Thompson and Son, of London. They were constructed by Messrs. Wilson and Co., Vauxhall Iron Works, London, and their peculiarity consists in the cylinders, which are 15 in. and 25 in. diameter by 18 in. stroke, being fitted with Payton and Wilson's Circular balanced and double-ported slide valves, operated by Joy's valve gear.

Fig. 1, which is an end elevation, shows the low-pressure cylinder and valve in section. Fig. 2 is a side elevation, showing the valve chests without their covers, the valve being drawn in position in the low-pressure but not in the high-pressure cylinder. Fig. 3 is a plan, except as regards the cylinders which are in section. Fig. 4 and 5 illustrate the inside faces of the covers of the valve chests, and Fig. 6 is a section to a larger scale of the valve and chest shown in Fig. 1.

The valve of each cylinder is circular in form, and is constructed of two rings alike on their outer faces, but jointed together so as to act as one ring, the thickness of which is a little less than the distance between the cylinder port face and the inside face of the valve chest cover.

The cover of the valve chest is provided with a port face, having ports with passages leading to the ends of the cylinder exactly similar to and opposite those in the cylinder port face. The valve is driven by a valve-rod connected to a circular hoop, within which the valve fits with sufficient freedom to allow of its turning within it, should it have any tendency to do so. As the valve is moved backwards and forwards by the valve-rod, it necessarily opens and closes two ports simultaneously at each reciprocation, and acts as a double-ported valve, thus permitting of the width of the ports and the travel of the valve being reduced to one-half the usual dimensions. The steam from the boiler is first admitted to the interior of the valve, from which it passes to the cylinder ; it is then exhausted on the exterior of the valve into the valve chest, which acts as a receiver. As the width of the face of each part of the valve is only that of a port with the required lap added, it has no back upon which steam can press so as to keep it upon its seat when entirely covering a port. A flange is therefor formed on the interior of each part of the valve for this purpose, and its area is determined by the width of the ports. With the exception of these flanges the valve has no surfaces subject to steam pressure ; it is therefore completely balanced in itself, and is entirely free from the rings, plates, or other appliances usually used to produce a similar result.

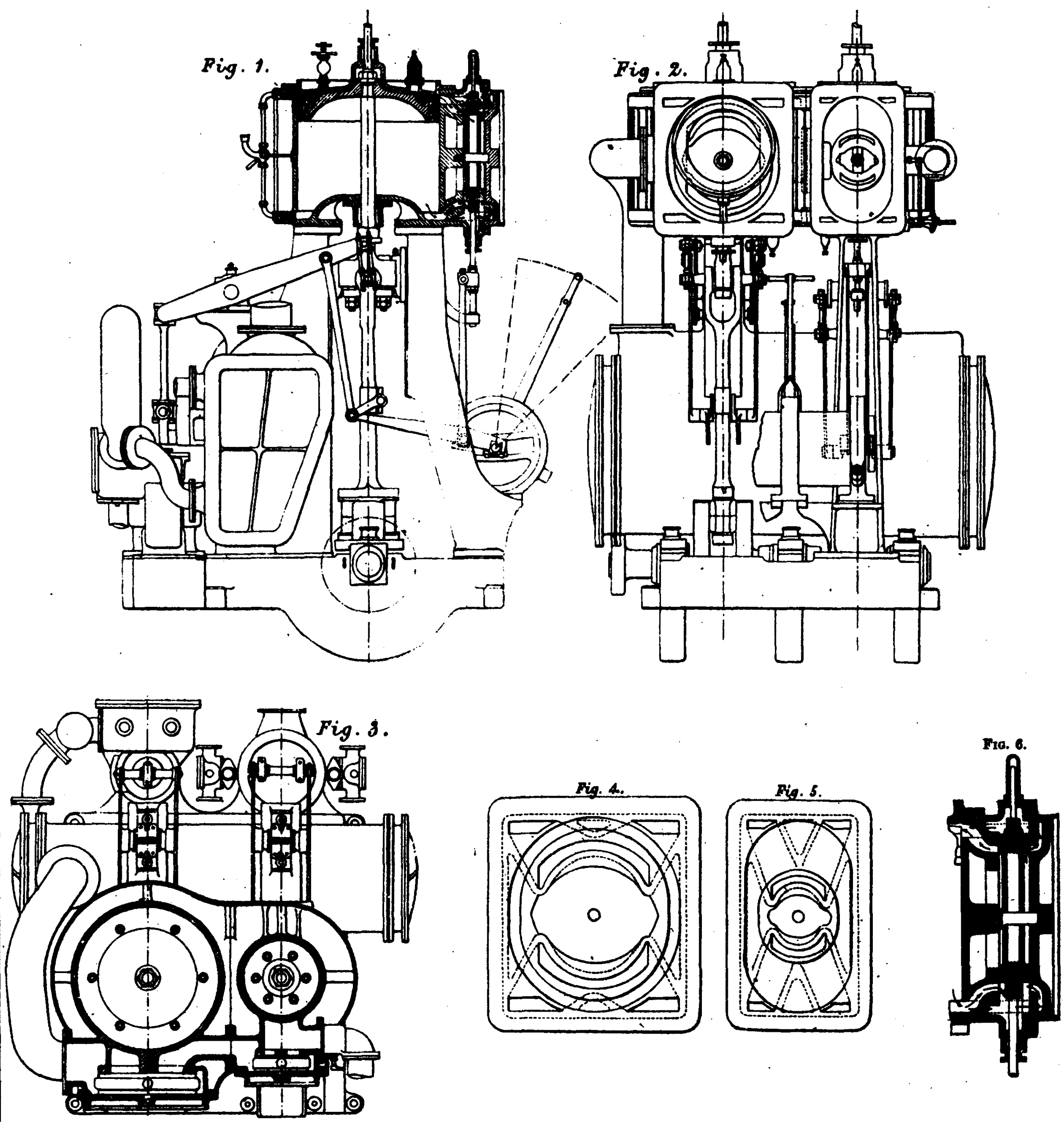
The spiral springs shown in the drawing are only used to keep the two parts of the valve expanded and in contact with their port faces when steam is turned off ; the efficient action of the valve does not therefore in any way depend upon them, such contact being maintained, when running, by the pressure of steam upon the flanges inside the valve.

The joint where the two parts of the valve meet is made entirely steam-tight by means of a thin strip of sheet brass sprung over it inside the valve, and having the pressure of the steam on the back of it. The steady pin shown is used to centre the cover, and insure the coincidence of the opposing ports, and the curves given to the edges of the ports are such that they are identical with the edges of the valve at the moment the ports are opening or closing.

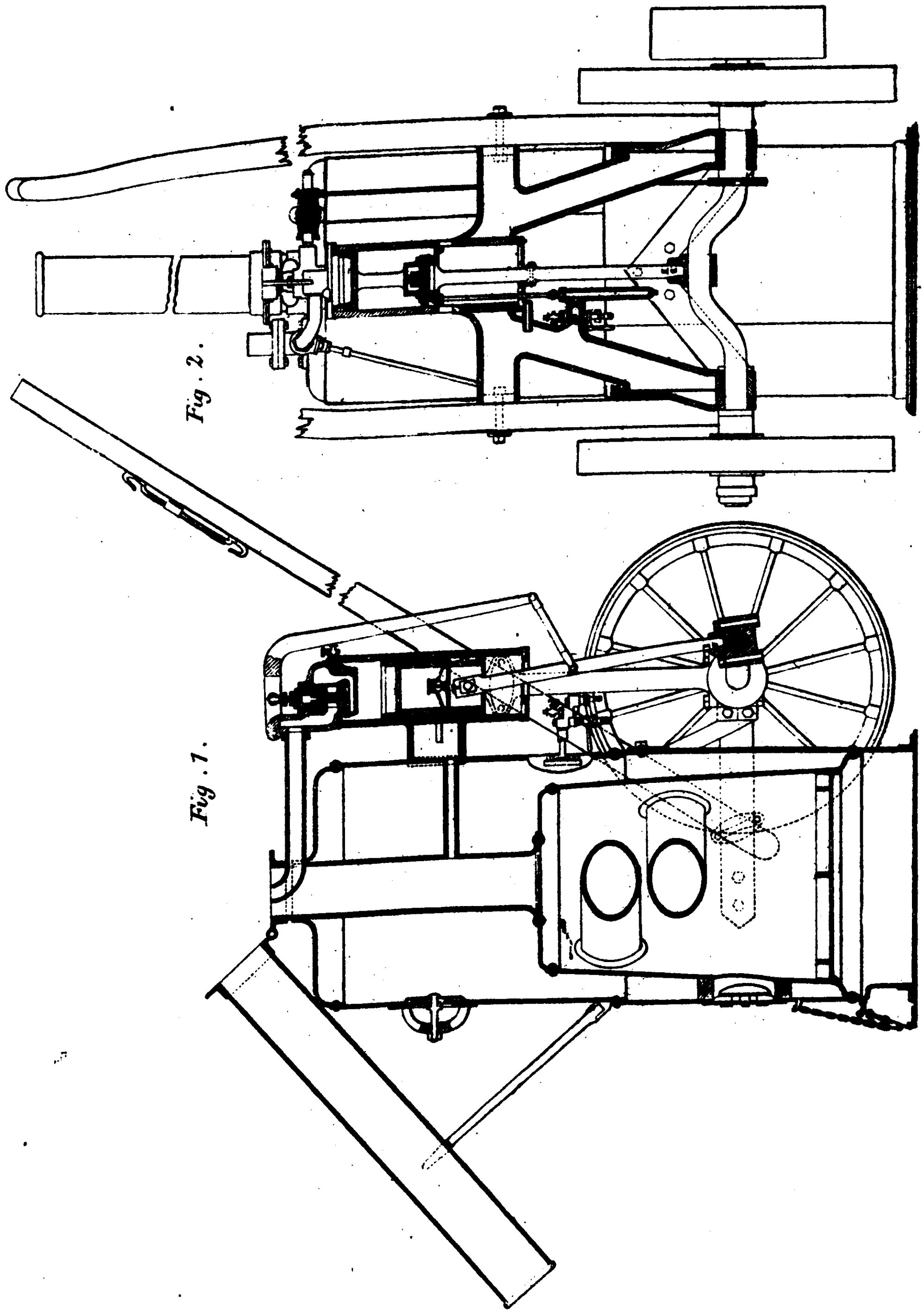
The single-ported circular slide valve, which was invented many years ago, was at first expected to give good results on account of its form, which permitted of its turning upon its port face when reciprocating, and so freeing itself should any excess of friction come upon it likely to cause it to score or seize. But this turning action could not be depended on, owing to the large dimensions and weight of the valve and the excessive load of steam upon the back of it. Its large diameter also, which was usually that of the cylinder itself, and its long travel, made it difficult to apply it to many kinds of cylinders.

These disadvantages were somewhat reduced by adapting it to rings and other complicated means for balancing ; but these, while adding to its weight and delicacy, did not reduce its dimensions or shorten its travel, and it still remained uncer-

ENGINES OF THE S.S. "COTENTIN."



PORTABLE ENGINE.



tain in action and difficult of application, especially to marine engine cylinders.

It is now claimed by the patentees that by the combination we have illustrated they have not only removed all the disadvantages the old valve possessed, but that they have produced one of the most perfect balanced and double-ported slide valves yet known. They state:

(1) That by the double-ports the travel can be reduced one-half, with a corresponding reduction in the friction and in the dimensions of the driving gear. That the diameter is also so materially reduced that the valve can be applied to any kind of cylinders, including those of marine engines, and its weight so lessoned that in all cases it is much below that of a corresponding ordinary balanced double-ported valve.

(2) That by the method of balancing adopted it is the simplest in construction, the least complicated, and the most reliable in use of all valves of its class.

(3) That by exhausting into the valve chest instead of into the centre of the valve, the valve chest cover is relieved from a large amount of steam pressure, and the piston is freed from back pressure. The peculiar shape of the ports also add considerably to the freedom of the exhaust, owing to the fact that the valve in passing over them always opens a larger area on its outside than on its inside.

(4) That by the smallness of its weight, and the ease with which it can be moved, the valve is left entirely at liberty to turn upon its centre when reciprocating, so as to free itself from any undue friction which might cut or score it, or cause it to injure its port faces.

In support of this, Messrs. Alexander Wilson and Co. inform us that during the last three years they have put to work about 130 of these valves, applied to cylinders varying from 4 in. in diameter up to 36 in. in diameter, and that in every instance they have given entire satisfaction. That, speaking generally, there has been a marked decrease in the wear of eccentric straps, pins, and other parts of the gear driving them, and that the valves themselves when examined, show conclusively that they do all that is expected of them. The valve chests of a pair of cylinders 20 in. in diameter and 36 in. in diameter were opened out a few days since, after about six months hard wear, for examination, and it was found that the tool marks had almost disappeared, and that in place of them the valves and port faces had acquired a fine cross polish without a single straight line being detected upon them.

As Joy's valve gear is now well known, and the drawings show it very clearly, we do not think it necessary to describe it, except to point out that in these engines the reversing lever is made duplex, as shown in Fig. 2, and that by drawing the coupling pin the motion of one valve may be varied independently of the other.—*Eng.*

MATHER'S PORTABLE ENGINE.

We illustrate a four-horse portable engine of a very simple type, to which we called attention at the time of the Reading and Shrewsbury Agricultural Shows. As will be seen at a glance the crankshaft and flywheels form the travelling axle and road wheels when the engine is being transported from place to place. The cylinder is single-acting, the connecting-rod being pivotted directly to a crosshead cast with the piston. The boiler has two cross tubes and is mounted on a wrought-iron foundation plate. The chimney is fitted to a pair of malleable iron joint rings and has a movable iron fork provided to receive it when doubled back for travelling.

The cylinder, guides, and framing are all in one casting; the framing joins the cylinder at its lower end, and may be compared to arms and legs, all of which are cast hollow. On the back of the cylinder is cast a bracket of the same radius as the boiler, to which it is secured by bolts. On the left leg is formed a hollow bracket, to which the feed pump barrel is bolted by two bolts; the joints, which are faced, are made with paper, for easy removal. The cylinder cover, or head, contains the steam and exhaust openings and piston valve, and also carries the governors. The piston is dished, and is fitted with two rings at the upper end and with one at the lower end under the slide plates of the crosshead, which are adjustable. The pump plunger is screwed into the crosshead flange. The crankshaft, which is 3 in. in diameter, and of Bessemer steel bent to obtuse angles, carries the two travelling wheels, one on each end. One of these wheels is keyed firmly on the crankshaft, while the other has a set screw and glut, which is tight before running under steam and slackened before travelling, to allow easy turning of corners without skidding. The connecting rod is withdrawn from the crank bearing before travelling by simply driving out a cotter, so that none of the working parts are in motion. The crankshaft also carries a driving pulley. There are no eccentrics; the valve is operated by a bent forked lever, which is at its lower extremity joined to the connecting rod by a link. This rod forces the valve downwards against the steam pressure. The height to which the valve can rise when the lever is lifted depends upon a wedge which is moved in and out by the governor Thus the steam port is more or less uncovered, according to the amount of work to be done by the engine. There is only one gland in the engine, that being for the pump rod, only ½ inch in diameter. The valve is not connected to the lever, but from the latter a short rod is suspended which works into a semscircular groove, allowing it to lift during the time the governors hold down the valve.

These engines have now been two and a half years under test, and give great satisfaction. They are at present made in two sizes, 2½ and 4 horse-power. As the working parts are all in compression they seldom need adjustment, as no knocking would be heard even under considerable wear.—*Eng.*

STEAM FIRE ENGINES FOR LIVERPOOL.

The Watch Committee of the Liverpool Corporation has lately purchased from Messrs. Merryweather and Sons, of Long Acre, London, two powerful steam fire engines. The larger of the two we illustrate, and in an early issue we shall publish a similar engraving of the second, and shall then give a complete account of them both, and of the trials to which they were submitted at the Liverpool Docks. In the mean time we shall content ourselves with a short account of the leading features of the former engine. It is called the "John Hughes," and is the most powerful portable steam pumping engine in the world. It is capable of throwing 1350 gals. per minute, and of forcing the water through a jet as large as a man's wrist to a distance of 200 ft. horizontally. Attachments are provided for working twelve streams simultaneously, each of which would overtop the highest warehouse in the city. The boiler is of the "Field" type, with smoke tubes running through the steam space.

The engine is 100 indicated horse power. It is direct-acting, working a pair of double-acting pumps 7 in. in diameter, the diameters of the steam cylinders being 9 in., and the stroke 24 in. The slide motion is actuated by a pair of twisted bars. The capacity of the pumps is 13 gals. per revolution, so that if the engine makes 110 strikes per minute, the delivery of water is 1430 gals. per minute.—*Eng.*

THE "CHAMPION" BASE BURNER AND SELF-FEEDING BOILER.

The testimony of those who have experience in warming dwellings by steam is that a self-feeding boiler for the purpose is the best. It is necessary to shake out the ashes and supply the magazine with coal but twice in 24 hours, and a steady even heat is given constantly without any further attention. A surface burner requires fuel to be put in every few hours, and during the night the fire will often go out, leaving the house cold.

In our engraving the "Champion" is shown, giving a sectional view. The following explanations of cut will give a good idea of its construction, working, etc.:

AA—The "fire pot" or furnace.
BB—Water leg around magazine.
C—Fuel magazine.
DD—Return draft tubes.
F—Connection for grates.
G—Ash or regulating door.
L—Pipe to conduct gases from top of magazine to furnace.
M—Automatic draft regulator.
N—Safety valve.
RR—Cast iron flange for upper section of boiler to rest on, having cleaning holes and lids over the ends of the down draft-tubes.
S—Covering-plate for top of brick work.

Some of the points of superiority claimed for the "Champion" over any other boiler are:

1st. It is made entirely of wrought iron, and all its parts which come in contact with the fire are made of the best boiler iron thereby durability is assured.

2nd. It is free from gas. There is a water-leg extending around the fuel magazine its entire length, which protects the magazine from the heat of the furnace. At no time can the fuel in the magazine reach a higher temperature than of the boiling water by which it is surrounded, which precludes the possibility of the formation of gas in the magazine. A pipe, extending from the upper part of the magazine into the fire-space, carries off any gas that may accumulate when the fuel is allowed to get below the mouth of the magazine.

3rd. The fuel is deposited into the fire-pot in its natural state. The water-leg surrounding the magazine so limits the temperature at all times that there can be no partial combustion of the fuel while passing from the magazine into the fire.

4th. All the down draft tubes are accessible for cleaning. By referring to the sectional engraving it will be seen that in the cast-iron plate upon which the upper part of the boiler rests, there is an opening opposite each down-draft tube. These openings are large enough to admit of a scraper with which the inside surfaces of the tubes may be easily and speedily cleaned. These openings are covered by close-fitting cast-iron lids,

5th. The draft is controlled by an automatic steam diaphragm, by which means the combustion in the fire-pot is regulated, and the steam kept at any pressure desired, to heat any sized house.

6th. Being made in two parts, is easily handled. The fire-pot, outside shell of boiler, and return-draft tubes form the main or lower part of the boiler. The fuel magazine and water-leg, with the steam-space, form the upper part. The two parts are united by large connection-pipe, so arranged at to form a perfect circulation of water. The pipe joints are not subjected to any strain, as the weight of the upper part of the boiler rests on a cast-iron flanged plate which prevents it. All these connections are made by means of bolted flanges. The boiler can be put together quickly by screwing up a few bolts.

These boilers are made throughout of the best charcoal hammered boiler-iron, and are made as strong and perfect as are boilers for high-pressure work. They are all thoroughly tested before leaving the works. Many of the principle dwellings, churches and other public buildings in Chicago are now heated by the "Champion."

Over one hundred of these "Champions" have been put in during the past season, in private residences, all of which are giving entire satisfaction. The demand for them is steadily increasing and orders coming in from all parts of the country.

RECENT PROGRESS IN ENGINEERING.

Sir Frederick Bramwell, in his inaugural address as the recently inducted president of the British Institution of Civil Engineers, called attention to the progress made during late years in various departments of engineering. Taking up first the materials of constructions, he noted the enormous gain in the economy of brick-making by the introduction of brick-making machines and the continuous kiln; the improvements in the making of artificial stones, enabling them to be produced with uniformity of quality, and of such durability as to constitute them successful rivals of natural stones. The use of wood is steadily decreasing, partly because of its scarcity, and its unfitness for use where longitudinal stresses are to be encountered, and partly through the introduction of other materials which are now made at less cost than formerly. Progress is to be expected in the direction of improved processes for the preservation of timber.

The modern processes of steel manufacturers he referred to as furnishing masses of enormous magnitude and of great uniformity of quality. The processes of Siemens and of Bessemer are now supplying such steels, while the Thomas and Gilchrist method permits the use of ores formerly quite inapplicable to such purposes. The cost of cast iron is decreasing with the construction of larger furnaces and the use of more highly heated blast, and with a better understanding of the chemistry of the process of reduction.

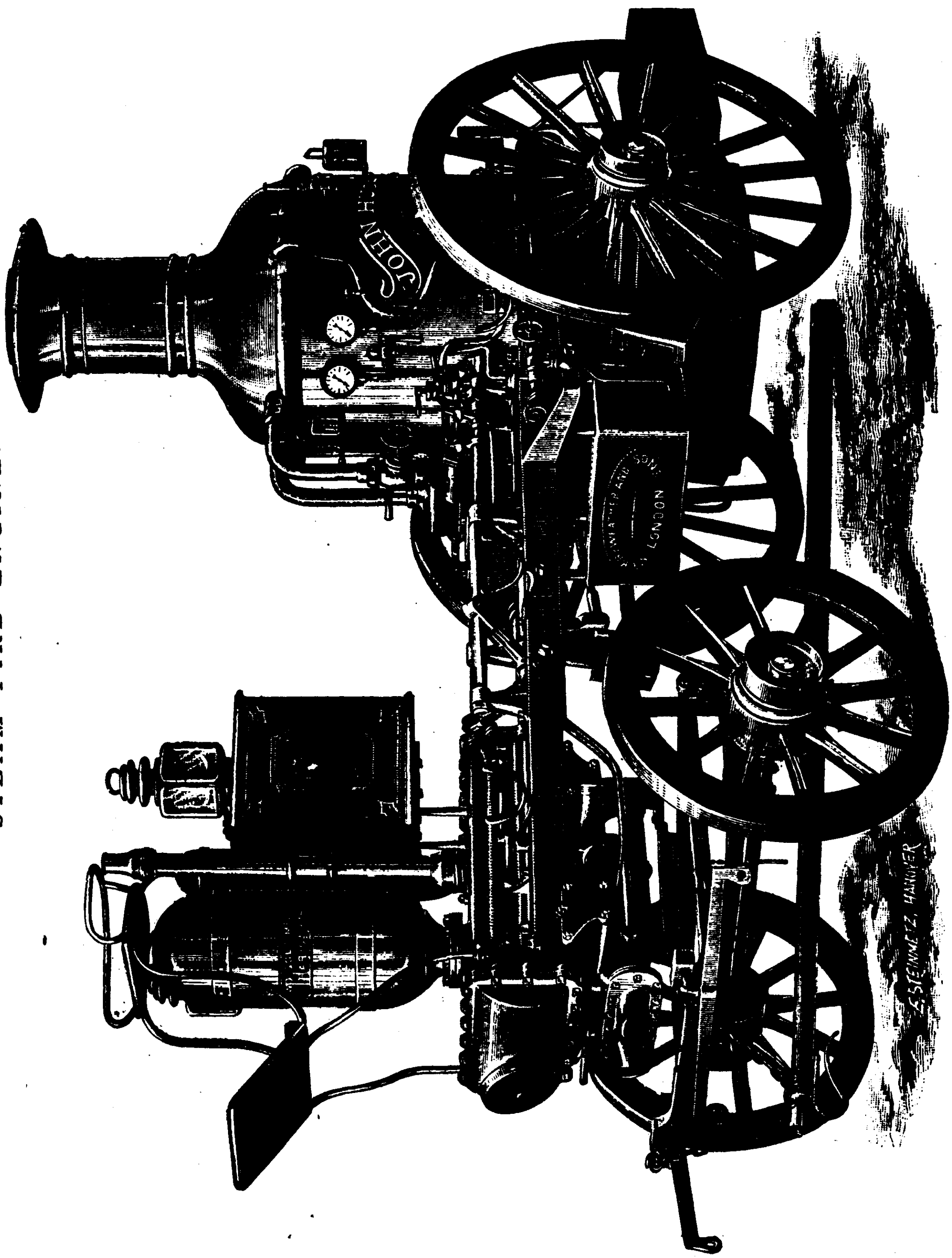
Copper is finding new and important applications in the new alloys, phosphor-bronze, manganese-bronze, and other compositions. The working of heavy masses is demanding the construction of larger hammers, and it is becoming seen that light steam hammers are actually injurious to the parts forged by them. Testing machines are now in daily use in the hands of the engineer to determine the exact value of the metals proposed for use in his designs, and to exhibit the strength of completed members. In bridge construction the St. Louis bridge was a novel departure in the use of steel in compression and the New York and Brooklyn Bridge is an equally successful example of application of wires for suspension over long spans. The new bridge over the Forth, Scotland, exhibits still another modern novelty in its great cantilevers, the only known expedients for successfully spanning 1700 feet with a rigid structure. In railroad and canal construction, the rivalry between the two systems of transportation is best illustrated by the enormous canals now in progress and proposed to connect ocean with ocean and sea with sea, and, as in the case of the Manchester ship canal, to take ocean-going ships into the interior of the country. This led to the study of harbor construction and reference to the methods of making and handling blocks of masonry weighing 350 tons each in the building of their sea-walls. A new and great improvement in the methods of supply of air for respiration to the workmen sent into the depths during the operations just referred to is that of absorptions of exhaled carbonic acid by a basic salt, and the introduction of oxygen from under compression in small tanks carried by the diver, who is thus enabled to remain under water for considerable periods of time. In tunneling red sandstone a speed of from 10 to 14 yards per day is attained, and of 24 yards in chalk. Dynamite and tunneling machines are making this great progress possible.

Progress in motors has not been rapid during late years. The best of recent double-cylinder non-condensing steam engines demand but $2\frac{7}{10}$ pounds of coal per horse-power and per hour, while the condensing engine has worked down to about $1\frac{1}{2}$ pounds. The gas engine is gradually coming forward as a rival of the steam engine in small powers, its greater safety and the reduction of current expenses in various directions giving it a superiority in some respects. Water-wheels have attained an efficiency of 85 per cent., and the turbine, with its high efficiency, offers great advantages in application where the fall is low or the variation of height of tail water considerable. In the transmission of power the introduction of water, steam and compressed air sent out from a central station is a promising direction of progress.—*Ex.*

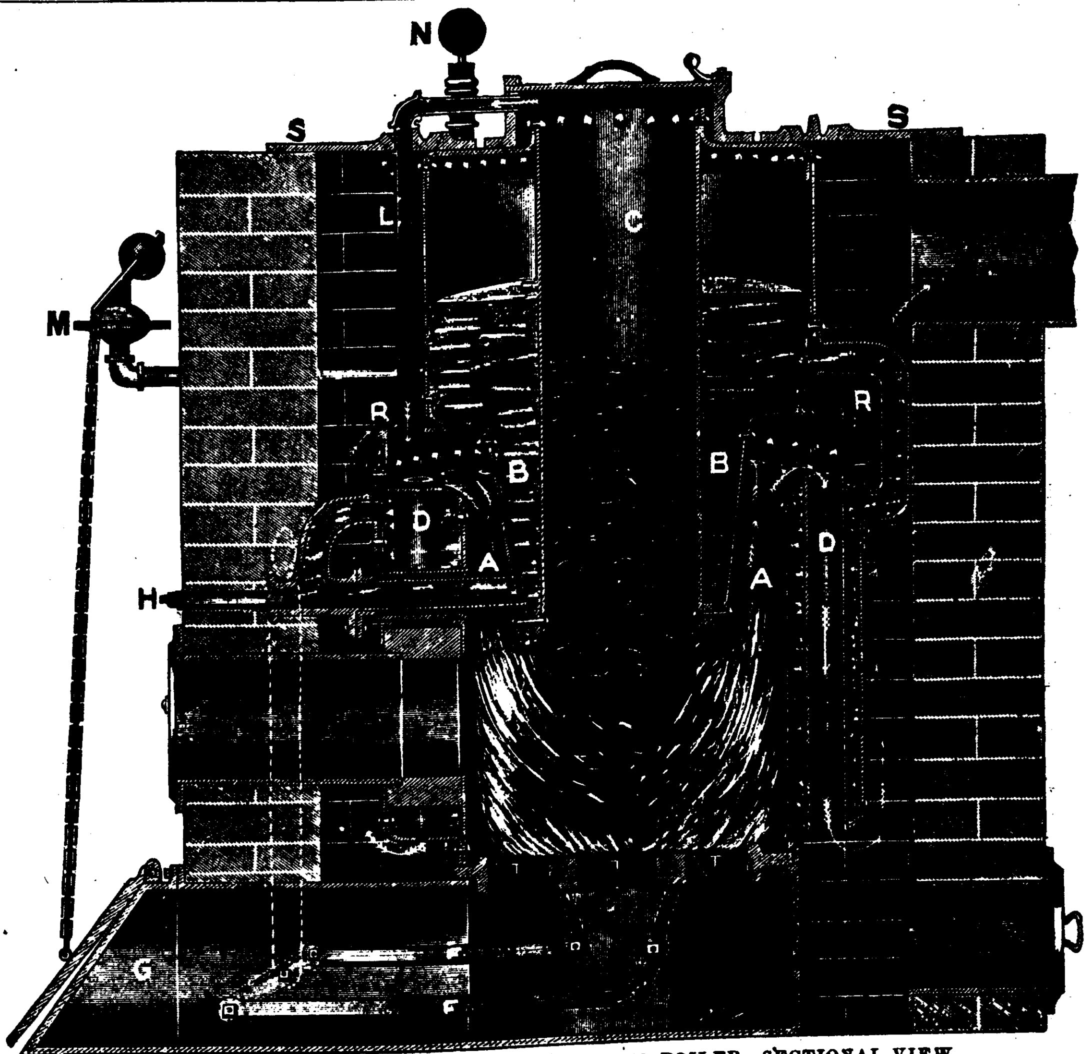
SEA TELEGRAMS.

The desirability of securing telegraphic communication with floating vessels moored at sea on dangerous parts of the coast has long been under the consideration of the British lighthouse authorities, but the difficulties opposing a successful solution of the problem proved so great that little, if anything, was done until within a short time ago.

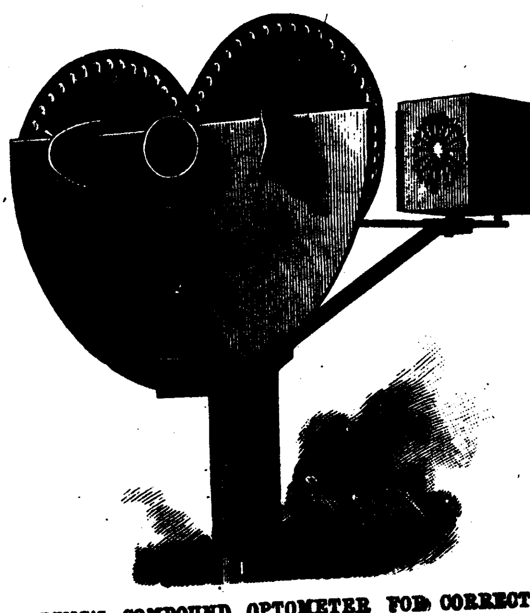
The great difficulty has been to secure the telegraphic connection on board the ship, as the light vessels are moored at the bow by a chain cable $1\frac{1}{2}$ inches in diameter; this chain in bad weather is payed out sufficiently to allow them to ride and swing freely. Sometimes the motion is so great that the vessels describe repeated circles. Any wire connection of an ordinary character would become so inextricable totally useless. The connection would also require to be payed out whenever the mooring chains were payed out. Fouling with the ship' anchors was also another difficulty to be overcome. The problem, according to an English paper, was ultimately placed in the hands of the British Telegraph Construction and Maintenance Company, Limited, and a contract was entered into whereby they were to electrically connect a light vessel with the shore and maintain such communication for one year, no payment being made in the event of any failure to comply with such condition, unless the failure should arise during the working of the cable from exceptional causes for which the contractors could not fairly be held responsible. The company, after a variety of experiments, have adopted a hollow steel-wire rope, $8\frac{1}{2}$ inches in circumference, formed by 14 twisted strands, to be used as a substitute for the chain mooring. The wire rope has been proved to 70 tons stress. The telegraphic cable runs through the centre of this wire rope. On board the lightship a Morse transmitter, a Wheatstone A B C and a telephone have been fixed. The light-vessel is moored in 10 fathoms at low water, and is about 9 miles off the shore. The importance of establishing direct communication with the light-ships cannot be too highly valued, as they frequently see ships in danger several hours before the fact has been known on land. No doubt if this first experimental departure in a new direction be successful, all other light-ships round the coast will be electrically connected with the shore, and there seems no reason why all lighthouses should not also be in telegraphic communication with the main wires of the country.



STEAM FIRE ENGINE.



"CHAMPION" BASE BURNER AND SELF-FEEDING BOILER. SECTIONAL VIEW.



BETELING'S COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.

COMPOUND OPTOMETER FOR CORRECTIVE ERRORS OF REFRACTION.

In making examination of the eye for the purpose of determining its refraction and the adaptation of spectacles to correct defects which may exist, the first part of the process is to determine visual acuteness. Letters are placed before the individual whose eye is being examined, of varying sizes; some to be seen by the normal eye under a visual angle of 5' at 200 feet, and from that down to the distance at which the letters are from the observer. In order that the refraction of the eye be correctly measured, it must be in a state of rest—adjusted for parallel rays; and this ophthalmologists claim can only be secured by placing objects to be observed at a distance, and 20 feet has been accepted as the distance which practically accomplishes this object. But it is claimed that the optometer herewith illustrated renders rays emanating from objects placed at 13 inches from the eye parallel, and consequently measures the refraction perfectly. Lack of visual acuteness may be due to a defect in the perceptive part of the eye, the retina, or to a refractive anomaly. To determine this a concave and a convex lens, about one-thirtieth, are alternately placed before the eye, and if either improves the vision there is either myopia or hypermetropia. The number of the glass that produces the greatest visual acuteness measures the refractive error. If neither the concave nor convex lens increases the visual acuteness, the test for astigmatism is made, and when none of these tests improves vision the defect is in the retina.

This is the procedure followed by oculists, and while being correct theoretically and in its practical results, it is stated to be awkward and tedious when compared with the optometer.

The optometer shown in the accompanying engravings has an upright of about 12 inches, upon which are mounted two circular disks, one for spherical and the other for cylindrical lenses. Each disk can be so revolved that the lenses can be brought in front of a common opening or eye tube, through which the observer sees letters. The disks containing the cylindrical lenses is attached to an arm, by which it has a movement besides the one upon its central axis, and whereby the axes of its cylindrical lenses can be placed in any degree of a circle before the eye tube. The disks are so situated that the lenses of one can be interposed with that of the other, thus combining their effect if necessary. Upon the extremity of a horizontal bar attached to the upright, about 12 inches in length, rests a card rack in which the test letters are placed 13 inches from the observers's eye.

The spherical lenses are 38 in number, 19 concave and 19 convex, embracing a series from 1-74 to 1-4·5·. Intervening between either extremity of the positive and negative lenses is a plain glass. The disk containing the cylindrical lenses has the same arrangement as the one containing the spherical, as mentioned above. There is an eye piece for the eye being examined, while the other will be deeply shaded, thus practically disposing of the inclination to convergence. The reason for this is that convergence and accommodation are co-ordinate acts, and in this case by controlling the convergence the tendency to accommodate is also greatly controlled.

At the extremity of the eye tube, and with the center of its system, about 2 inches from the cornea, as it rests in the eye piece, is placed an objective which is a compound achromatic lens, the principal focus of which falls on the test letters on the card. This practically produces a myopia of 1-11. The rays proceeding from the objective to the eye are of necessity parallel, since the test letters are at the principal focus of the objective. It is claimed that this disposes of the objection to the instrument by those who state that it will not relax accommodation. Placing the objective outside of the anterior focal distance of the dioptric media of the eye magnifies the letters to be observed, but this in no way changes the results of the test for refraction, but the letters used should be proportionately small if a test for visual acuteness be made, else the visual angle of 5' will be changed; if the letters are magnified one-half, they should be one-half smaller.

In the construction of the system for measuring visual acuteness with this optometer, a letter is used for a basis the measurement of whose diameters forms the base of an angle of 5', the distance from the center of the system of the objective to the letters forming the sides of the angle. If the eye were placed at 11 inches from the letters, they would be the same size as the objective renders them at 13 inches, so that the visual angle is measured from the center of the system rather than from the position of the cornea. The letter, then, at 11 inches should have a diameter of 21·60 of a line, or for practical purposes 1·5 of a line. For the purpose of keeping a record of visual acuteness, as by the method of snellen, when the smallest letters can be read, which are 1-5 of a line in diameter, it may be stated that V=20·20. When the next letters which are one-half larger are the smallest that can be read, V may be marked 20·40, and so on up to 200 feet.

This optometer, which is result of several years of careful study and experiment, has been patented, and is now manufactured, by Mr. L. A. Berteling, of 427 Kearny Street, San Francisco, Cal.—*Ex.*

ADJUSTABLE ECCENTRIC.

The accompanying cut gives two views of an adjustable eccentric, suitable for a link motion model. The cut shows the devise so clearly that no detailed description is necessary. It was invented by Mr. L. Wichert, who is with Mr. Harington, chief draftsman in the drawing office of the Pittsburgh, Cincinnati & St. Louis Railway at Columbus, O. It is the intention to apply this eccentric on a new link motion model they are getting—*Am. Mach.*

THE DIAMOND DRILL.

Although the diamond drill can no longer be regarded as a novelty, having for a number of years assumed an acknowledged and leading position as an indispensable adjunct to the work of the engineering profession, there is still so much to be learned respecting its adaptability for many uses, and such an absence of familiarity with its capabilities among those who would be benefitted by a knowledge of them, that we need make no apology for devoting some space to a general-descriptive article upon the apparatus with special reference to its utility in quarrying operations.

The diamond drill, when first introduced to the engineering profession about twenty years ago, attracted an unusual share of attention by reason of the novelty and originality of the means by which it accomplished its work, no less than by the remarkable character and value of the work itself. It was so radical a departure from everything that had preceded it, that engineers at first were disposed to regard the innovation with distrust; but the demonstration of its wide range of serviceability awakened, first surprise, then admiration. In the engineering world, to-day, the diamond drill ranks among the foremost of the numerous powerful engines that have contributed in recent years to so materially strengthen the forces at the engineer's service in his contest with nature. Perhaps the best estimate of its value is to be found in the judgment passed upon it by the eminent judges of the Centennial Exhibition, who, in granting to it the highest award within their gift, explained that this award was made for "originality of method; simplicity in its construction; convenience in its application; value of results obtained; cheapness and remarkable speed."

The diamond drill has come to be used extensively for the following purposes, for all of which it is claimed to possess preeminent merits—namely, prospecting, well-boring, shaft-sinking, submarine drilling, open-cut work, channeling and gadding in quarries, etc. The manufacturers have taken advantage of the experience gained in its various applications to simplify and improve the machine in every way that seemed desirable, and with the result that for one or the other of the applications named above, the diamond drill is in use to-day in almost every quarter of the globe, in all situations, and under the most diverse conditions.

The following general description of the principle of boring with the diamond drill will serve for all modifications of the machine, the different forms of the machine representing simply modifications of construction in details, the general principle of operation remaining the same in all.

For deep boring, for wells, or prospecting mineral lands, the machine is driven by a reciprocating or double oscillating cylinder engine, steam being furnished by an upright or horizontal tubular boiler. The capacity of the engine varies according to the depth and size of hole requiring to be bored. These machines have a screw-shaft made of heavy hydraulic tubing from 5 to 7 feet in length, with a deep screw cut on the outside. The shaft also carries a spline, by which it is feathered to the lowers leeve gear. This gear is double, and connects by its upper teeth with a beveled driving gear, and by its lower teeth with a release gear, which is a frictional gear, and is fitted to the lower end of the feed-shaft, to the top of which a gear is feathered, fitting to the upper gear on the screw-shaft, which has one or more teeth less than the upper gear on the feed-shaft, whereby a differential feed is produced. This frictional gear is attached to the bottom of the feed-shaft by a friction-nut, thus producing a combined differential and frictional feed, which renders the drill very sensitive to the character of the rock through which it is passing, and maintaining a uniform pressure upon the same. The severe and sudden strain upon the cutting points incidental to drilling through soft into hard rock with a positive feed is thus avoided. The drill-rod, made of heavy lap-weld tubing, passes through the screw-shaft and is held firm by a chuck at the bottom of the screw-shaft. To the lower end of this tubular boring-rod the bit is screwed, and to the upper end a water-swivel, to which connection is made with the steam pump. By means of this pump a constant stream of water is forced down through the hollow drill-rod, thereby keeping the bit cool and the hole bored clear of sediment, which is forced by the water pressure up the outside of the rods to the surface. The hollow bit is a steel thimble, having three rows of diamonds (bort, or carbon) embedded therein, so that the edges of those in one row project from its face, while the edges of those in the other two rows project from the outer and inner periphery respectively. The diamonds of the first mentioned row cut the path of the drill in its forward progress, while these upon the outer and inner periphery of the tool enlarge the cavity around the same, and admit the free ingress and egress of the water, as above described.

The screw-shaft, being rotated and fed forward, rotates the drill-rod and bit, and as the bit passes into the rock, cutting an annular channel, that portion of the stone encircled by this channel is, of course, undisturbed; the core-barrel, passing down over it, preserves it intact until the rods are withdrawn, when the solid cylinder thus formed is brought up with them, the core-lifter breaking it at the bottom of the hole and securely wedging and holding it in the core-barrel. Where a core is not required, the perforated boring-head can be used, the detritus being washed out by the water inserted through the drill-rod, the same as when boring with the hollow bit.

In order to run the screw-shaft back after it has been fed forward its full length, it is only necessary to release the chuck and to loosen the nut on the frictional gear, which allows the gear to run loose; then the screw-shaft will run up with the same motion which carried it down, but with a velocity sixty times greater—that is, the speed with which the screw-shaft feeds up is to the speed with which it fed the drill down as sixty to one, the revolving velocity in both cases being the same. By tightening up the chuck and the nut on the frictional gear, the drill is ready for another run.

The drill rods may be extended to any desired length by simply adding fresh pieces of tubing, the successive lengths being quickly coupled together by an inside shoulder nipple coupling, made of the best forged iron, and having a hole bored through the centre to admit passage of the water. In order to withdraw the drill rods, they are uncoupled below the chuck, the swivel head, which is hinged, unbolted and swung back, thereby moving the screw-shaft to one side, and affording a clearance for the rods to be raised by the hoisting gear on the machine without moving the drill. By the erection of a derrick of sufficient height, it will be necessary to break joints only once in every 40 or 50 feet.

Fig. 1 represents the large artesian-well boring drill, the operation of which will have been made clear by the fore-going description. This machine has a hydraulic feed in lieu of the screw-feed described. The advantages claimed by the manufacturers of the diamond drill, over the percussion system, may be concisely stated as follows:

1. *Speed in Boring*, which, with the diamond drill is affirmed to be greater than by any other method, whether measured by the day or for a considerable period of consecutive work.

2. *Economy.*—It is affirmed, on the authority of railroad contractors, engineers and geologists, that the diamond drill will perform a given amount of work more cheaply than it can otherwise be done.

3. *Durability and Simplicity.*—The diamond drilling machines are affirmed to be so simple in construction and operation that they can be operated by any workman of average intelligence, and so substantially constructed that they seldom require repairs. As compared with the percussive types of drills, the diamond drill is not subject to the constant and destructive shocks of concussion to which the former are subject; nor have they any delicate parts requiring to be kept in nice adjustment. The only part of the machine which comes in contact with the rock is that which is faced with the diamond teeth, and the resisting qualities of these are so great, that, we are assured, *two thousand* feet have been drilled by the same points with but little apparent wear. The cost of resetting the diamonds, so as to present new cutting points, is trifling, and no special skill is required to perform the operation.

4. *True Holes.*—The holes bored by the diamond drill are perfectly cylindrical and unform in size from the top to bottom—a feature, the importance of which in blasting, need only be named to the practical driller or quarryman to be appreciated. Furthermore, they are not deflected from a straight line by seams or crevasses, nor hindered in their progress by the hardest rock.

5. *Depth of Holes.*—With the diamond drill holes can be bored as rapidly and cheaply at the depth of 50 or 100 feet as at the surface; while at a depth of 500 or 600 feet there is but little appreciable difference. With the exploring and well boring machines innumerable experimental borings have been made from 300 to 1,500 feet in depth through solid rock. The machine is, furthermore, adapted for boring holes in any direction, from the horizontal to the vertical, and as close to a side wall as a hand drill can be turned; and the hole bored, no matter what its depth, is invariably straight.

The diamond drill has been found to be especially well adapted to shafting, tunneling, well-boring, submarine blasting, and, what is of particular interest to us in this place, for rock excavation in mines, quarries, etc.

For prospecting purposes, where it is desired to determine in advance of location, purchase, or shaft-sinking, the character, depth, value, etc., of a mineral or rock property, the diamond drill accomplishes results which can be attained by no other means, and for this species of work is absolutely indispensable, since by its use, mines, quarries, etc., can be penetrated experimentally to the depth of a thousand feet if desired, in any direction, and perfect specimens of mineral, ore, or rock taken out for the entire distance, thus absolutely disclosing, without fear of possible error, the character and value of the material. It should be borne in mind, also, that these specimens are not disintegrated fragments of rock, but continuous solid cylinders, showing all the characteristics of the rocks that are penetrated.

Fig. 2 exhibits a portable form of the prospecting drill, which may be run either by steam or compressed air. The entire machine weighs only 300 pounds, and its lightness, combined with the rapidity with which work may be executed with its aid, make it a very serviceable machine for underground prospecting.

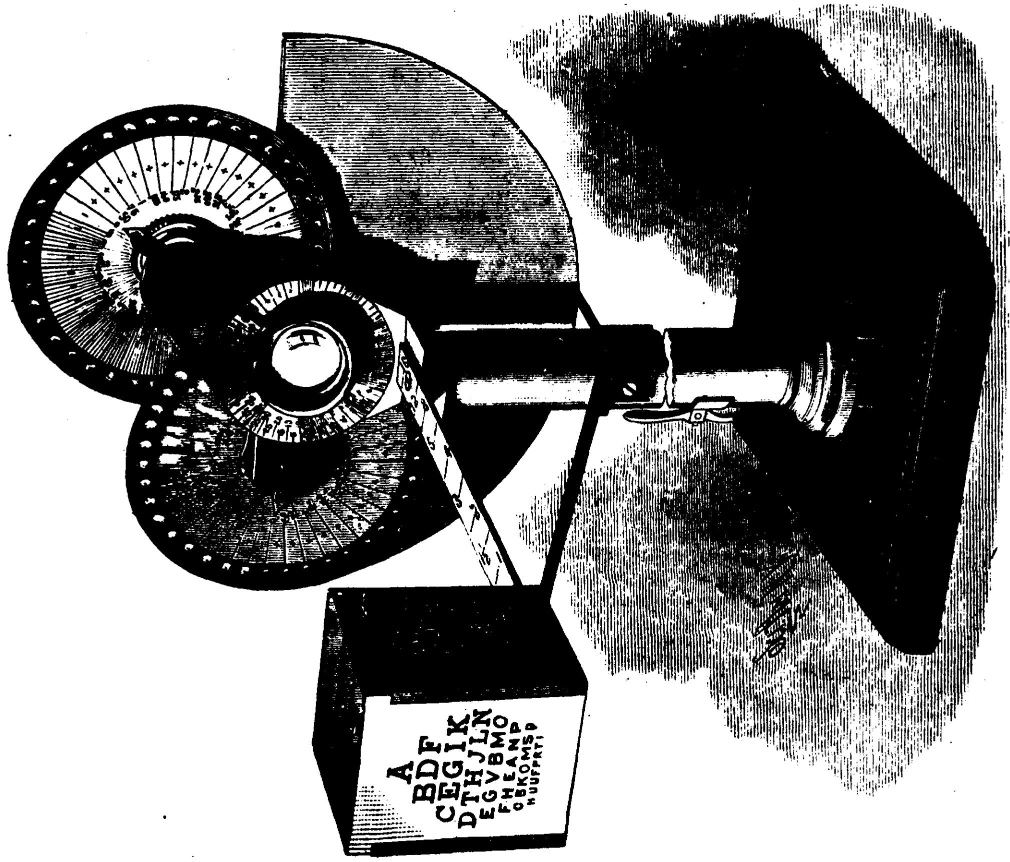
Fig. 3 exhibits a prospecting drill of larger size and capacity a detailed description of which will not be necessary after all that has preceded.

The manufacturers, appreciating the requirements of quarrymen, have produced several modifications of their drill for open cut work, for drilling, blasting in quarries, and for rock excavation generally. The quarry drill is light, portable, easily adjusted, and, it is claimed, will bore more rapidly than is possible with any other drill, true cylindrical holes of uniform size from top to bottom, at any depth to 50 feet.

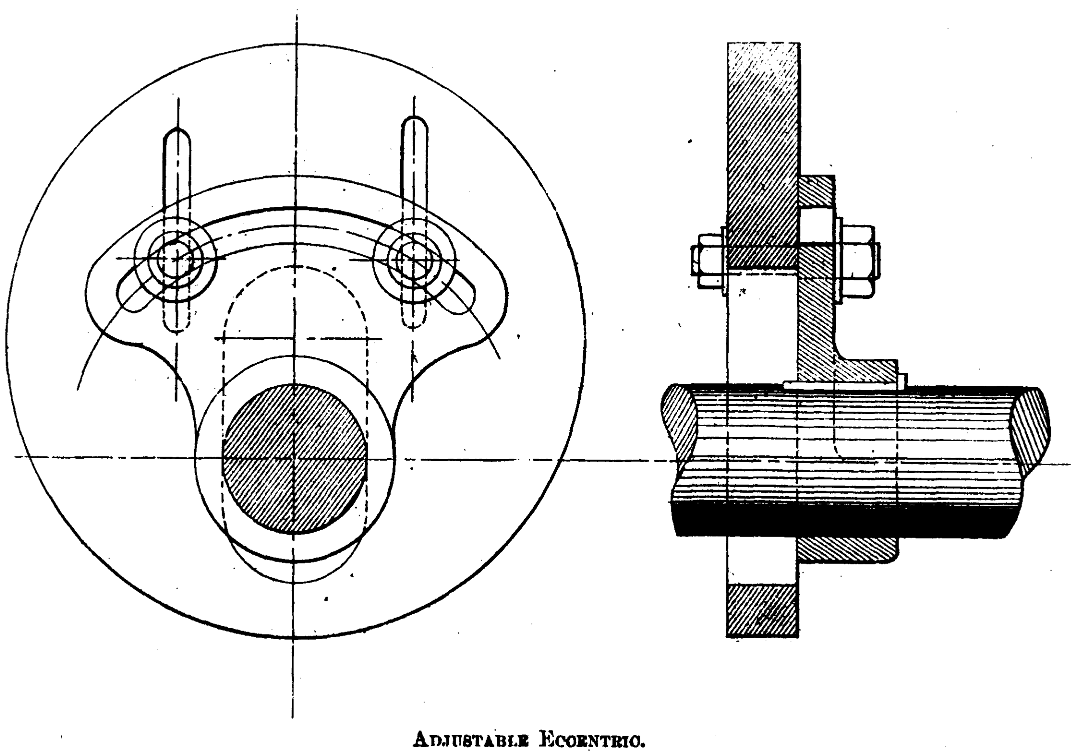
For boring blasting holes, special machines are provided, as also for channeling and gadding in quarries. The simplicity of these machines, the rapidity and elegance of their work, to say nothing of their economy and durability in service, render them specially valuable for quarry work, and we commend them warmly to the favorable attention of such of our readers as are interested in quarrying operations.—*Ex.*

STAIN REMOVING SOAP.

A universal stain-removing soap for use in bleach, print, and dye works is thus described in the *Moniteur de la Teinture.* "Take 22 pounds of the best soap and reduce it to thin shavings. Place the soap in a boiler with 8.8 pounds of water and 18.25 pounds of ox gall. Cover up and allow to remain at rest all night. In the morning heat up gently, and regulate it so that the soap may dissolve without stirring. When the mass is homogenious and flows smoothly, and part of the water has been evaporated, add 0.55 pound of turpentine and 0.44 pound of benzine and mix well. While still in a state of fusion, color with green ultramarine and ammonia, and pour into moulds, where it should stand several days before used.



BERTELING'S COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.



ADJUSTABLE ECCENTRIC.

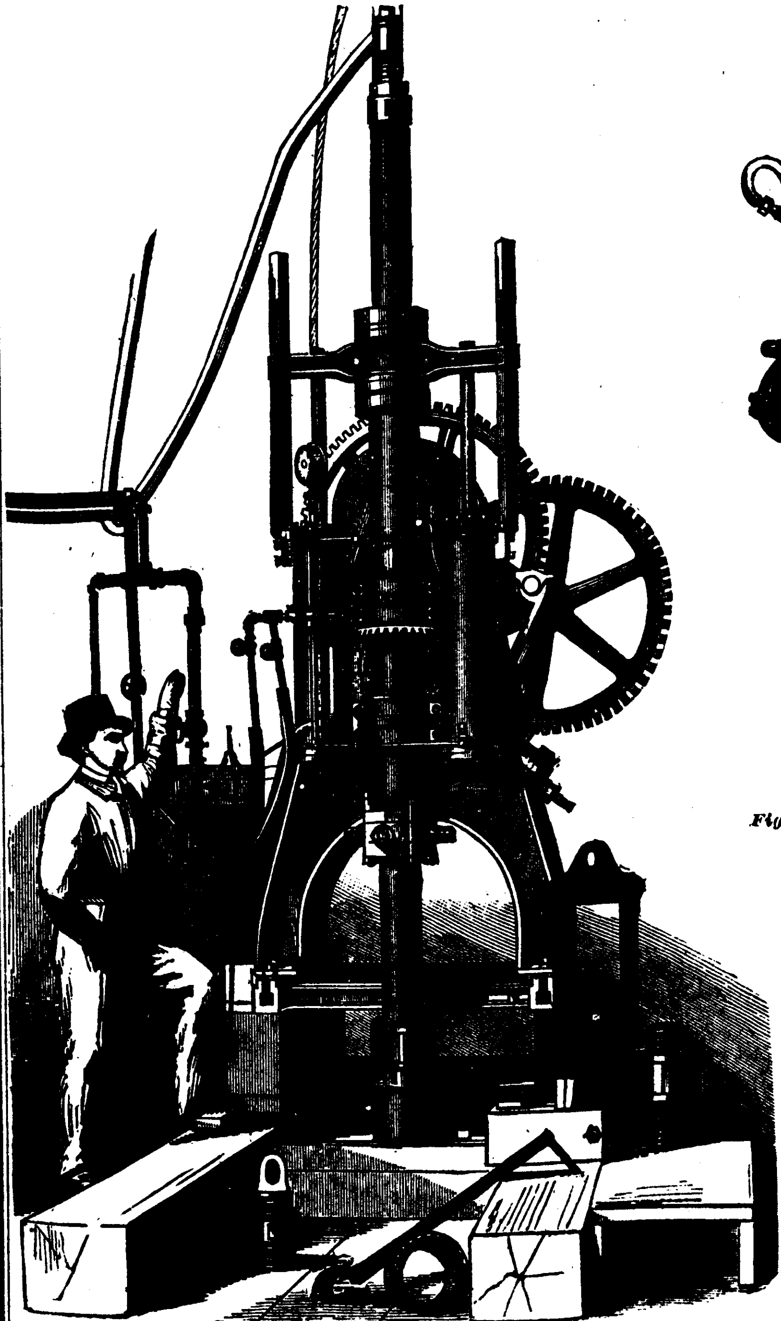


Fig. I.—LARGE ARTESIAN-WELL BORING DRILL.

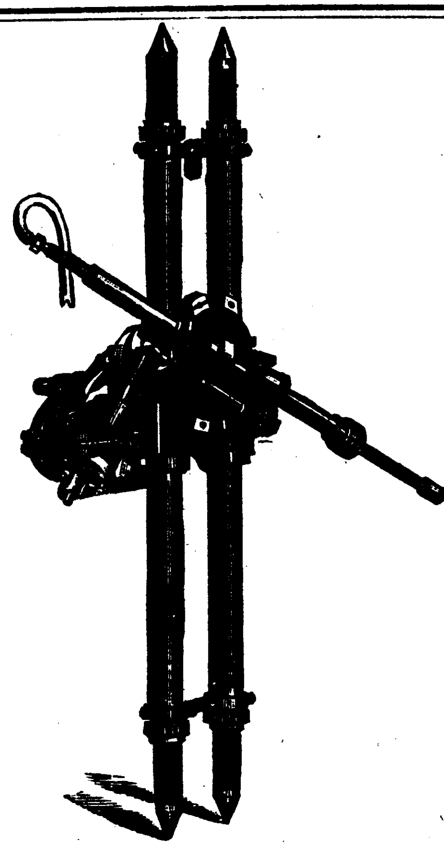


Fig. 2.—Underground Prospecting Drill.

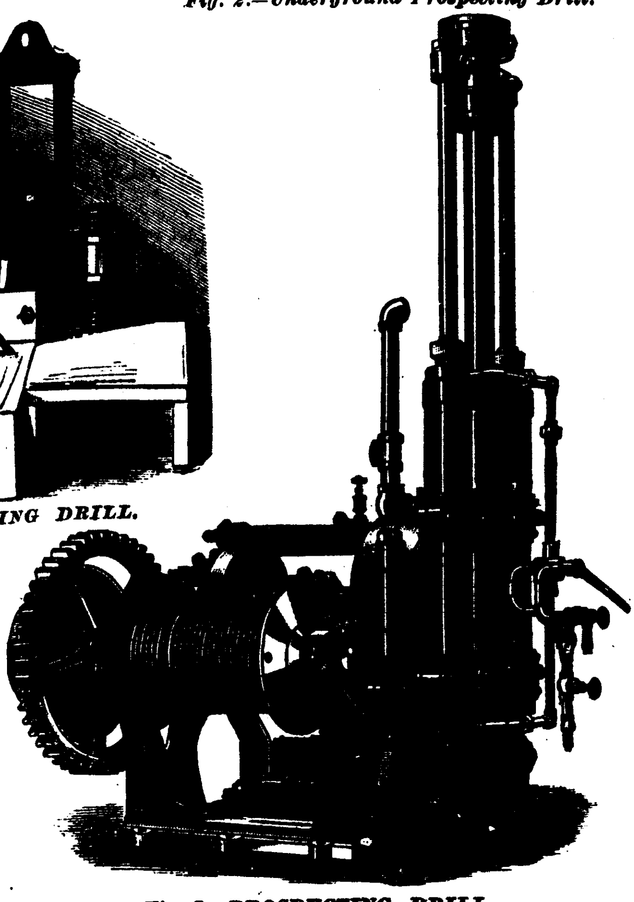


Fig. 3.—PROSPECTING DRILL.

BOWER AND THORP'S REGENERATIVE GAS LAMPS.

At the time of the Gas Exhibition at the Crystal Palace we gave an account of the various regenerative gas burners that were shown there, and among others of the Grimstone lamp exhibited by Mr. George Bower, of St. Neots. Since then this lamp has been considerably modified, and now is made in the form shown in the accompanying illustrations. As in all lamps of this class the temperature of the air which feeds the flame is raised by heat abstracted from the escaping products of combustion. The hot air is delivered in three streams; the first is directed on to the upper side of the jet; the second impinges on its lower side just at the point where the gas leaves the burner; while the third sweeps round the inside of the globe before it reaches the jet. This latter is an important improvement, as at the crystal palace we noticed that the glasses of all lamps of this type exhibited a tendency to become coated with a white film which greatly interfered with the transmission of the light. It is the object of the third part of the air supply to prevent the deposition of this film by means of a constant ventilation of the globe. The burner consists of a vertical pipe pierced with a ring of holes, and thus differs both from the argand and batswing burners. The gas is ignited in a number of horizontal independent jets, but these unite and turning upwards form a cup-shaped crown of light. The temperature of the flame is, of course, very much greater than ordinarily, and hence the illumination is of a very high quality and far whiter than that usually obtained from gas. It takes about fifteen minutes for the light to reach its greatest intensity and to increase from the usual three-candle power per cubic foot per hour to the eight-candle power which it attains at its best. The lamps are made in all sizes, including those applicable for domestic purposes. Hitherto all the economy effected in burning gas has been attained with large consumptions, and nothing has been done to aid the householder in reducing his quarterly bills, but it is claimed for the Bower lamp that it is applicable to houses, and that it is easy to discharge the products of combustion out of doors and thus to produce an illumination which will vie with electric light for colour and healthfulness. Even if the products of combustion enter the room in the accustomed manner they are free from the usual element of soot, for the whole of the carbon is transformed into carbonic acid and none of it escapes either uncombined or as carbonic oxide. Referring to the illustrations, the course of the incoming air and the outgoing products of combustion can be clearly traced on Fig. 1. The air enters just above the globe all round into a heating chamber *i* called the secondary regenerator; part of it turns downwards into the globe, and part upwards into the primary regenerator. This portion again divides, some going down the central tube *k* and emerging through perforations to be directed by the deflector *b* on to the issuing jets. The remainder descends by the outer annular tube d_1 and diffuses itself over the upper flame surface. The products of combustion ascend by the twelve metal tubes *d*, which are bathed on the outer sides by cold incoming air. In addition to the heating surface thus provided there are in each regenerator a large number of plates *h* and *i* which conduct the heat for the metal framework and deliver it to the air. The gas enters by the central pipe *a* and then descends by the annular space between the lower gas-pipe a_1 and the central air pipe *k*, to the burner from which it issues in jets, as shown. The globe *o* is supported by a ring *x* which bears against the plate *g*, and against a ring of elastic material, such as abestos.

VOTING APPARATUS.

Mr. Joseph J. Butcher, of St. Nichola's Buildings, Newcastle-upon-Tyne, has devised a simultaneous voting apparatus by which the vote of every person in a building provided with such apparatus, can be collected and counted within a very short space of time without any one leaving his seat. For the purposes of parliamentary and municipal elections it is proposed that halls should be provided, having within them a seat for every elector on the register. At the proper time the constituency would be called together, and it would be seen at a glance who was present and who was absent. At a given signal each person would turn a handle attached to his seat, and forthwith a ball would be released and would roll down one of two passages, one collecting all the "ayes," and one all the "noes." The balls would run by gravity to two elevators, which would raise them to the chairman's table, when they would be automatically counted or weighed. In large constituencies there would be a hall in each ward, and this would also be used for public meetings, when subjects of the day could be voted upon in turn, and the results transmitted to the papers, members of Parliament, and others.

Mr. Butcher prophesies that the use of his apparatus would work many political changes, and would bring the electors into closer contact with their members and the Government providing means for the demonstration of the popular will at all times. This is a subject which we must leave to that part of the press which deals with party politics, and shall content ourselves with explaning the construction and action of the apparatus. Fig. 1 illustrates a hall or amphitheatre in which each seat is fitted with the voting appliance. Double conduits or shoots lead from each chair to other conduits beneath the rows of seats, and these converge on the centre of the hall, where passing behind the chairman's seat, they reach the elevators. The appliance at the command of each voter is shown in Figs. 2 to 9, and comprises a store of balls, all of the same size and colour, and means for directing them, one at a time, into the appropriate passage or shoot. The reserve of balls is contained in a closed case, and is quite beyond the voter's control. At the proper time one sphere is withdrawn from the case by a device which is operated by an air piston, worked by a pump indicated in dotted lines in Fig. 1. By means of this pump one reservoir is stored with compressed air, while a second is partially exhausted. Pipes run from the chairman's table to every voting apparatus, and by putting them in communication with the plenum or the vacuum he can effect a simultaneous movement of all the air pistons, the plenum pushing them outward and locking all the apparatus and the vacuum moving them in the opposite direction, and placing a ball in such a position that a simple turn of the voter's hand will discharge it either down the "aye" or the "no" channel. The store of balls is contained in a spiral inclined passage (Figs. 2 and 6) formed of a central cast iron screw, and an outer case. The end of this passage debouches into a box (Fig. 8) of rectangular section, partly filled with a rectangular plunger. Within this plunger is a recess or cell designed to accommodate one ball, and when this cell is placed opposite to the mouth of the spiral passage the last ball rolls into it and rests there. The plunger is connected to a long and narrow air piston (Figs. 2 and 3), packed with a leather or rubber diaphragm. The right-hand side of this piston is connected to the air reservoirs mentioned above by a pipe (Fig. 2) passing up the inside of the casing, and when the air is exhausted through the pipe the piston moves back, carrying with it the plunger and the ball it contains. The blank portion of the plunger seals the opening of the inclined passage, and the cell takes up its position at a part of the box where the lower side is cut away to form an opening into the two conduits. This opening is at the time closed by a segmental piece cast upon the voting disc (Figs. 2, 6, and 7), which is pivoted on a central pin. The face of the disc is covered by a sheet of plate-glass, shown in section in Fig. 6, and in elevation in Fig. 7, and through this the ball can be seen. By means of a handle [Figs. 5 and 6] the disc can be rotated either way, until the segment is moved from under the ball and the latter falls either to the right or left [Fig. 2]. A small curtain [Fig. 5] hung upon a rail [Fig. 8] screens the voter's hand from observation, and enables him to give his suffrage secretly. As soon as he releases the handle a spiral spring [Fig. 2] moves the disc back to its middle position. The chairman then admits air behind the piston, and the plunger is returned to receive another ball. Simultaneously with this a bolt upon the piston [Fig. 3] enters a slot in the voting disc, and locks it until the next ball is ready to be released.

The balls are about ⅝ in. in diameter and are made exactly to gauge. From seventy to eighty can be accommodated in the inclined passage, so that one filling will provide an outlet for a very considerable time for the political enthusiasm of the most ardent admirer of the caucus. The passages are of such a width that two balls cannot jam in them, and are laid with a constant incline. They are made exceedingly smooth inside except when the gradient is so steep, as in the inclined passage as to render this unnecessary. In case the voter be absent from his chair the ball in the cell does not fall; the voting disc is locked until the last moment, and when the piston is returned it carries the ball back with it to the initial position.

A set of apparatus, of an earlier type to that we illustrate, has been manufactured, and has been shown at several places in the North, where it has excited much interest. The details have evidently been worked out with much care, and in places where many votes have to be taken the apparatus would undoubtedly effect a great saving of time.

HER MAJESTY'S THEATRE AND GRAND OPERA HOUSE, SYDNEY.

THE ceremony of laying the foundation stone of Her Majesty's Theatre and Grand Opera House, at Sydney, was preformed by his Worship the Mayor (Mr. Thomas Playfair), at noon on January 27th. The building is to occupy a site immediately opposite the establishment of Messrs. Farmer & Co., and at the north-eastern corner of Pitt and Market Streets. The land has a frontage of 102 ft. to Pitt Street, by a depth of 167 ft., the width increasing at the rear to 125 ft. There is a frontage to Market Street, of 29 ft. The main entrance to the theatre will be in Pitt Street. The most has been made of this valuable site by devoting the frontage in Pitt and Market Streets to hotel accommodation, separated entirely from the theatre by thick walls and fireproof floors and ceilings in the vestibule and passages which give access to the theatre from the streets. The hotel (the plans of which have been approved of by the Licensing Board) will contain 100 rooms, distributed over seven storeys, accessible by wide staircases and an hydraulic elevator.

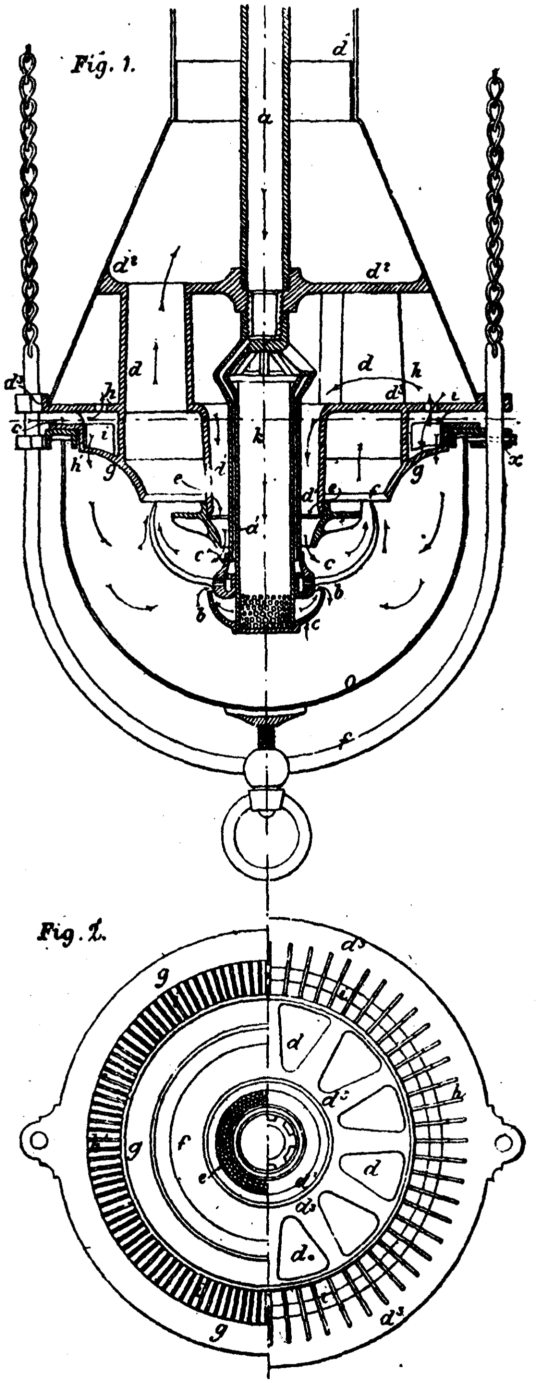
In the design of the theatre the details of construction have been particularly studied to secure the comfort and safety of the public, and the arrangements, by affording facilities of access on three sides to all parts of the building, from one of the necessary features of the structure. The dangers of fire will be considerably lessened by the use of brickwork, concrete, ironwork, and non-combustible materials where practicable, instead of timber. The stage will be separated from the auditorium by a thick wall, the proscenium opening being protected by an asbestos fireproof dropcurtain, and all others openings protected by iron doors made to close automatically. The principal entrance to the theatre will be by a vestibule 57 ft. by 38 ft., opening into Pitt Street by three doors, each 9 ft. wide. This vestibule will give access to every part of the auditorium, which may also be reached by numerous fireproof staircases and passages, opening into the side lanes and Market Street. On entering the vestibule the staircases will be so distinctly visible that, it is asserted, no confusion can exist by their being used for ingress or egress. Visitors will know at once which way to turn their steps, according to the portion of the auditorium they wish to occupy, thus obviating all unecessary hurry. Staircases for the public will lead from the lanes and from Market Street to all parts of the auditorium. These staircases will be separate, straight, and direct from each storey, and will be constructed in concrete arches between solid walls. Other staircases will give access to the orchestra, and to either side of the stage. The total area of stairs and passages to the auditorium will be over 4,500 square feet, and the width of egress 110 ft. The area of passages inside the auditorium will be over 4,000 square feet, and the area of the vestibule, degagement and ground-floor passages will be 3,239 square feet. The auditorium is intended to contain only 1,400 seats, although sufficient area will be provided for 2,000 sittings. Consequently the passages inside the auditorium will be of sufficient size to contain the whole of the audience when on their way out, with standing room equal to 2·86 square feet per person. In addition to this the area of the stairs leading from the auditorium to the ground floor will give standing room equal to the 3·25 square feet per person; and the area of vestibule and passages on the ground floor standing room equal to 2·3 square feet per person. From these actual measurements it will be seen that there is provided in the stairs, passages, and vestibule standing room equal to 8·4 square feet for each person. Comparing the widths of exit on the ground floor with the number of the audience, the building is calculated for 12·59 persons for every foot of width of exit. It is stated that of 40 of the best theatres in the world only three have better means of ingress and egress. Regarding internal arrangements, the stage is to be of large dimension, namely, 84 ft. wide and 50 ft. deep, and measuring in height 109 ft. from the basement to the roof, in which will be placed a grid to work the machinery. All the most modern appliances are provided for in that part of the building to ensure admirable order. Eighteen dressing rooms, artists' rooms, and other conveniences are to be provided, and will communicate with the stage by separate staircases, and iron-lined doors. These rooms are to be furnished with the most improved sanitary arrangements. All the machinery of the stage is to be supported by massive iron girders, and the whole of the roof trusses will also be of iron. The auditorium will consist of stalls, dress-circle, amphitheatre, and gallery, each of the storeys having separate means of access, with crush and retiring rooms for ladies and for gentlemen. Provision has been made for 18 private boxes. The whole of the framing within the walls of the auditorium is to be of iron, and the ornamentation work covering the walls, ceilings, and balustrades is to be of papier-mache, lino relief, fibrous plaster, and other non-combustible materials. The comfort of the audience will be secured by luxurious seats, richly-carpeted floors, and ample space and ventilation. The lighting is to be effected by four different services—one for the stage, another for the dressing rooms, a third for the auditorium, and the other for the passages. Provision has also been made for lighting the auditorium and stage by electric light. The system of ventilation adopted will reach every part of the house, the fresh air being washed and cooled by water-spray before being introduced into the auditorium. Outlets are to be provided in such a manner that the fresh air forced into the building will not cause any draught or unpleasant sensation to those sitting near the doors. The apparatus is calculated to introduce 30,000 cubic feet of fresh air per hour into the auditorium, which is more than 20 cubic feet per person. To prevent this enormous quantity of air from rushing through the proscenium when the curtain is raised, some of the ventilating pipes are connected with the stage to equalized the temperature; the whole of the ventilation is to be regulated by throttle valves in a large ventilating shaft passing through the roof. This shaft will also be provided with an apparatus to exhaust the vitiated air. The most important features of the design are the precautions taken against fire, or the panic which generally follows an alarm of fire. The staircases and passages being made fireproof, and each floor of the auditorium having four separate staircases (two of which are direct) the audience will be able to disperse from each part separately, without crushing to the same outlet. Water will be stored in a number of tanks in the roof, and 14 fire-cocks, with hoses and nozzles, will be placed in the auditorium and on the stage. Where the use of timber or other inflammable material is indispenable on the stage, it is to be coated with asbestos fireproof paint. It is understood that the building will cost between £50,000 and £60,000. Mr. G. A. Morell, C.E., is the architect, and Mr. W. H. Jennings the contractor.

TORPEDOES OF THE AUSTRIAN NAVY.

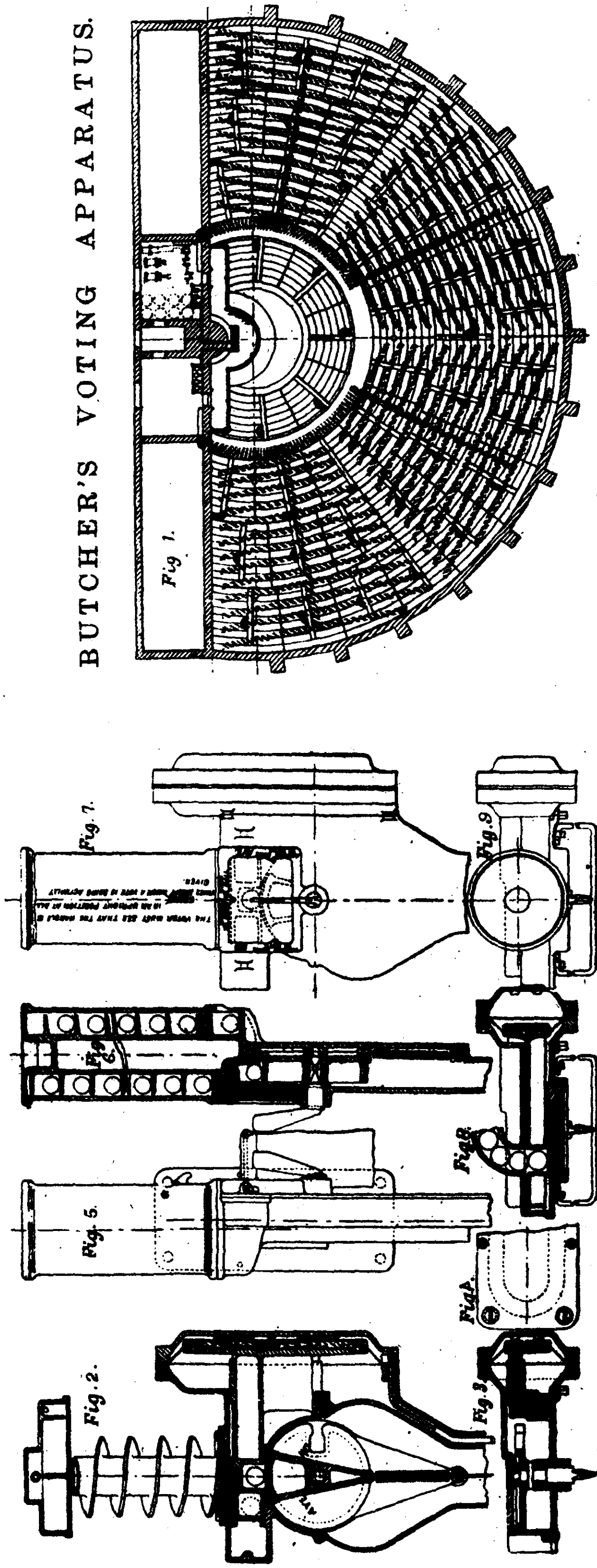
At the time of the Austro-Italian war, in 1866, the Austrian Government made great efforts to put its ports in a state of defense against attacks of the Italian fleet. Torpedoes in large numbers were sunk, and all the commandants of these places were ordered to exercise the greatest vigilance.

The torpedoes were placed in several concentric lines, and were sunk to such a depth below the level of the water that at the surface no signs of their presence could be discovered. Each of them was connected by a wire with a post of observation situated at a sufficiently high point on the coast to allow the port to be well seen. The operating-room was dark, and in the wall a lens was fixed facing the port. The luminous rays from the exterior traversing this became refracted and passed into a prism which directed them upon a plate of ground glass lying horizontally upon a table in the center of the room.

According to the well-known laws of optics, an image of the port is thus formed upon the glass. Black points marked upon this image indicate the exact site of each torpedo, and all these points bear numbers that are reproduced upon the keys of a key-board. It is only necessary to press one of the keys with the finger to put the corresponding torpedo in connection with an electric battery, through the intermedium of the wire that connects it with the port, and to cause it to explode. One employee of the telegraph never takes his eyes off the glass upon which the faithful image of the port is reproduced. No detail, no movement, escapes him. If a ship of the enemy attempts to approach, its image appears upon the glass, and, at the moment it passes over a point indicated upon the latter, a simple touch of the key corresponding thereto causes an explosion and destroys the vessel. These torpedoes are sunk to a sufficient depth to allow ships of the port to move around without having anything to fear. It is probable that it was due to a knowledge of the danger that the Italian fleet would have experienced in attacking the Austrian ports that the latter were protected against all surprise. Arrangements analogous to those just described are now adopted by most of the navies of Europe.—*Ex.*



REGENERATIVE GAS LAMP.



BUTCHER'S VOTING APPARATUS.