THE FORTH BRIDGE.

FROM time to time we have published accounts of the progress of the Forth Bridge, and in the present issue we give illustrations of the caissons for the Queensferry Pier. It will be remembered that there are three main piers known respectively as the Fife Pier, the Inch Garvie Pier, and the Queensferry Pier, and upon each of these there is built a huge cantilever stretching both ways. The Fife Pier stands between high and low-water mark, and is separated by a span of 1700 ft. from the Inch Garvie Pier, which is partly founded upon a rocky island in mid stream. Another span of 1700 ft. carries the bridge to the Queensferry Pier, which is at the edge of the deep channel. The total length of the viaduct is about 1½ miles, and includes two spans of 1700 ft., two of 675 ft., the shoreward halves of the outer cantilevers, fifteen of 168 ft. and five of 25 ft. Including piers, there is thus almost exactly one mile covered by four main spans, and half a mile of viaduct approach. The clear headway under the centre of the bridge is 150 ft. above high water, and the highest point of the bridge is 360 ft. above the same datum. The contract was let to Messrs. Tancred, Arrol, and Co., on December 21, 1882, for 1,600,000*l.*, and work was commenced in the following month.

Each of the main piers comprises four columns carried down to the rock on the boulder clay. Three of the Fife columns are completed; and the remaining one is in progress; at Inch Garvie one pier is complete, one is in progress; while at Queensferry the work on the caissons is advanced. All the pneumatic caissons will be filled with concrete up to low water mark, of a mixture having a crushing strength of 50 tons per square foot. Above low water the cylindrical piers, which are 49 ft. in diameter at the top, 55 ft. at the bottom, and 36 ft. high, consist of the strongest masonry, the hearting being flat-bedded Arbroath stone, and the facing, Aberdeen granite. In each cylindrical pier there are 48 steel bolts, 1½ in. in diameter and 24 ft. long, to hold down the bedplate and superstructure of the main spans. One of the Fife piers was built by aid of a timber and clay cofferdam, and one by means of a half tide dam. At Inch Garvie much of the work of the shallow piers had to be done at low tide under great difficulties.

The Queensferry Pier consists of a group of four cylindrical caissons 70 ft. in diameter at the bottom edge. Figs. 1, 2, 3, and 4 (pages 136, 137, and 140), show the details of construction of the south-west or shallowest caisson. Owing to the special conditions of the site the work differs in some respects from ordinary pneumatic caissons. The bed of the Forth at the Queensferry Pier is of very soft mud for a depth of from 20 ft. to 35 ft., when the boulder clay is reached, the surface of both the mud and the clay falling sharply towards the 200 ft. deep channel between Queensferry and Inch Garvie. The caissons had to be floated out and sunk about one-third of a mile from shore in an exposed seaway. To facilitate operations the caissons have double skins (Figs. 1, 2, and 3), 7 ft. 6 in. apart and vertical bulkheads between the skins. By filling the space between the skins with concrete to varying heights, the irregularity in the level of the bottom, and the hardness of the mud could be to some extent compensated for, as the weight brought upon the cutting edge (Fig. 4) of the caisson could be regulated as desired. Iron being very cheap a liberal use was made of it in conjunction with concrete where masonry or brickwork might have been employed. Strong lattice girders (Fig. 3), and cross girders, stiffen to the required extent the roof of the working chamber. These girders are subject to a heavy bending stress upwards and downwards owing to the tide, the range of which is about 20 ft. Thus if sufficient concrete were filled over the roof to balance the air pressure at mean tide level, then at high water the excess of air pressure, unbalanced by the weight of concrete, would obviously be that due to the half-tide difference of height, and at low water, similarly, the excess weight of concrete would be of the same amount. There would thus be a force of more than 1100 tons tending to bend the girders downwards at low water and upwards at high water.

Two shafts 3 ft. 6 in. in diameter, with air-locks for passing out the excavation, and one shaft with double air-lock for the men, are provided, together with ejector pipes for the mud, water pipes, supply pipes for the concrete, and other conveniences. Figs. 5, 6, and 7, page 137, show the former locks, which are of somewhat special construction and have worked extremely well in practice. The lock proper forms a simple continuation of the shafts, and there are two sliding doors placed horizontally with sufficient space between them for the skip of excavated clay or boulders. An internal drum fixed on one side of the lock is driven by an external pair of engines fixed to another side of the lock, the shaft passing through a stuffing-box. A pair of small hydraulic rams work the sliding doors, hand gear being also provided though never worked, and interlocking arrangements analogous to those used with railway signals, make it impossible for both doors to be operated together. When a skip has been filled below, a signal by air whistle is given and the engineman on top of the caisson starts the winding engine. In little more than a minute the skip will be at the top of the 70 ft. shaft, an index needle informing the engineman of the fact. The latter then stops the engine, closes the lower hydraulic sliding door, reverses the engine a stroke, and the skip rests on the closed door. He next lets the compressed air escape from the lock and then opens the upper hydraulic slide. An attendant immediately jumps down on to the skip, unlocks the hoisting chain, and hooks on the chain of a steam crane, which lifts the skip and swings the contents into the sea. About three-quarters of a minute is occupied in passing the skip through the lock, and two or three minutes in emptying and returning it, during which time a duplicate skip is being filled below. The two air-locks were designed by the engineers to pass out easily an amount of excavation equivalent to a descent of 1 ft. per day of the 70 ft. diameter caisson, but owing to the extreme hardness of the clay the rate has not hitherto exceeded 8 in. per day, which under the circumstances is very good work. Picks and shovels made no impression on this material, which had to be attacked by hydraulic spades having a ram fitted to the cutting blade and abutting against the roof of the working chamber. At the present time the sinking of two of the caissons has been completed, another is in progress, and the last of the group is being floated into position, as some weeks ago it filled with water from some cause and slid forward on the mud about 15 ft.

In going through the mud and silt, the material is blown out through pipes by the compressed air in the caisson assisted by a due supply of water from a closed tank elevated some feet above high-water level. To guard against too sudden a descent of the caisson in the soft mud the engineers designed heavy cross frames of timber to divide up the 70 ft. space and distribute the load, but the sub-contractor who undertook the sinking removed these frames. Occasional lurches and sudden descents have occurred, but the men employed have great experience in caisson sinking, and appear little disturbed by such incidents.

When sunk to the full depth, which, in the case of the north-west pier is 96 ft. below high water, the caisson is filled with concrete up to low water level, and the remainder of the pier is built of solid masonry under the protection of a wrought-iron temporary caisson.

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.*—No. I.

INTRODUCTORY.

IT is a fact that few people in England, or indeed, for that matter, in any part of the world, really know what a Whitehead torpedo is. Of course everybody has heard of torpedoes, but as a rule, popular ideas do not travel beyond the vague conception of awful weapons of warfare which can, unseen, suddenly and mysteriously, destroy the most powerful iron-clad afloat, and the use of which is as unjustifiable as that of explosive bullets. To afford information therefore on a subject, all-important but little understood, I propose, before describing my career, to give a brief account of the different kinds of torpedoes that are actually used. You see that, though all are classed together as torpedoes (the name originally given to certain mysterious boats invented by Fulton and other Americans during the American war of 1812-14 and now used to denote explosives placed under water for destructive purposes), yet the methods of using these explosives are various and differ materially.

The torpedo family is divided into two main branches—stationary torpedoes and locomotive torpedoes.

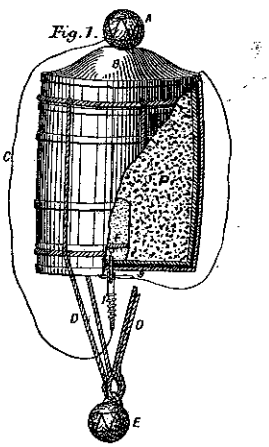
The former of these, as their name implies, are fixed in certain positions; and in order that they may be effective, the ships to be destroyed must be, either by their own will, or otherwise, brought over them. Locomotive torpedoes, on the contrary, are either conveyed, or have the power of conveying themselves, to the enemy. Stationary torpedoes are called "mines," and have three subdivisions—mechanical mines, ground mines, and electro-contact mines.

Mechanical mines are those which cannot be made harmless at will. They are (especially the ordinary mechanical mine) generally extemporised from ships' stores, and have the advantage of being easily prepared and placed in position. Their usual method of construction is as follows:

Two casks, one inside the other, are generally used. These casks are strengthened to resist the water pressure, and great care is taken to make them water-tight. The explosive (generally gunpowder, though gun-cotton may be used) is placed in the inner cask; the other one being merely a casing for giving additional strength. A chock B, Fig. 1,

Extempore Mech! Mine

Fig. 1.



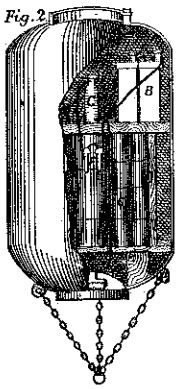
is secured to the top of the cask, and is hollowed out slightly to admit of a round shot A being placed on it. This shot is connected by a cord C with a friction tube, inside the cask, and kept in connection with the charge, by means of a water-tight joint. Slings D D are fitted to the cask to which is secured another shot E to keep the cask upright, and moorings are also attached to keep it in position. Safety pins are employed by which the torpedo can be laid out without endangering the lives of those employed in so doing. These torpedoes being placed in the required position at such a depth that they are just under water at low tide, the safety pins are removed, and they become dangerous alike to any friend or foe who may happen to strike them. The act of contact knocks the shot off the top, and this in falling pulls the friction tube by means of the line attached, and the torpedo is exploded. It will be seen that this class of torpedo can only be used in cases where it is required to entirely block up the passage. Also their removal after the use for them ceases, is a very serious matter, as they are very likely to be exploded in the act of picking them up.

Another kind of torpedo is the electro-mechanical mine. These are similar in construction to the ordinary mechanical mine, except that they are more complete, and instead of the extemporised fittings used in the latter, they have regular iron

* [The interest attaching itself to the subject of Whitehead torpedoes—their manufacture, mode of operation, and efficiency—is as great, as the available detailed information concerning them, is deficient. In preparing the series of articles commenced in the present issue, the author has found it more convenient to endow the particular torpedo, the career of which is followed, with a power of narrative, and to surround it with more or less detailed sketches of the officers and men entrusted with its management. The incidents narrated are either the record of actual facts, or are constructed with an intimate knowledge of the strong and weak points of these particular weapons, and of what may be expected of them in naval warfare.—ED. E.]

cases capable of containing from 70 lb. to 80 lb. of gun-cotton. The accompanying diagrams, Figs. 2 and 3, show the arrangements. The gun-cotton charge, it will be seen, does not occupy the whole of the case. On the top of this gun-cotton is a

Fig. 2



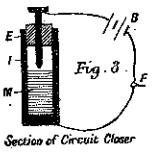


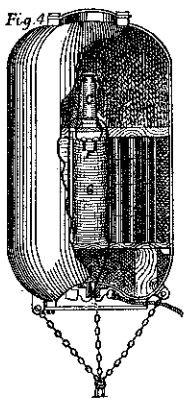
Fig. 3

Section of Circuit Closer

platform, on which two or three Leclanché cells are fixed, and a circuit-closing arrangement is also inserted. This device is for mechanically completing the circuit on the mine being struck. There are many kind of circuit-closers. The simplest, and perhaps, on the whole, the most effective, consists of a metallic cylinder or cup, in which a certain amount of mercury is placed, as shown in Fig. 3, and an iron point projects through the ebonite mouthpiece which closes the top. Wires then join the metallic point with the cylinder, the battery and fuzes being in the circuit, as shown. On the torpedo containing the circuit-closer being struck, the mercury splashes up, completes the circuit, and so explodes the torpedo. Safety arrangements permit of the torpedo being laid out, and also of being picked up, without danger to those engaged. Some time and great care, however, are required to render these torpedoes harmless, and for practical purposes they must be considered as dangerous to their owners when once placed.

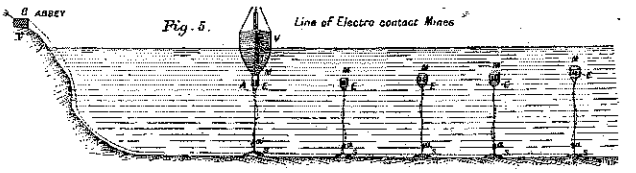
So much for the mechanical mines. Then come the electro-contact mines. These are fitted in exactly the same way as the electro-mechanical mines (see Fig. 4), except that the battery, instead

Fig. 4



of being inside the mine, is on shore, and the torpedo is connected to it by insulated wire. Fig. 5 shows a line of electro-contact mines. It will be observed that one battery will work any number of mines. At the junction of the wire from each mine with the main lead, are placed disconnectors, which are simply ordinary platinum wire fuzes placed inside the water-tight case, and their function is, as their name implies, to disconnect the mine from the main wire after it has exploded. For example, supposing the mine at A to be struck by a passing ship. The circuit is completed for a moment from the battery right through the main wire, the disconnector at a^1, and this particular mine. The current from the battery then fires the disconnector fuze and the mine fuze at the same moment. The result of the disconnector fuze being fired, is that the wire is practically cut there, and the end is insulated, since it is inside a water-tight case. Supposing that there were no disconnector, on the firing of the mine it is of course blown away, and thus the bare end of the wire would be left in the water, forming a continuous circuit running down the battery, and probably preventing other mines which may happen to be struck from firing. The advantage of

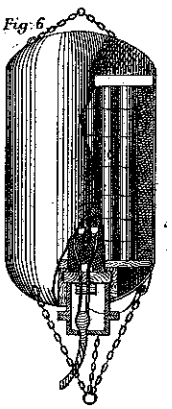
Fig. 5.



these mines over those already described is that they can be made quite harmless by disconnecting the firing battery on shore; on the other hand a considerable quantity of insulated cable is required to be used, which adds to the expense and labour in laying down; while at the same time the cable is always liable to be broken by the enemy when sweeping, and a break or flaw would render the whole system of torpedoes thus laid out, useless. Also it is necessary, in order to use this system of mines, to have a battery station near.

The ground mines used in the service (by *the* service, I mean of course the English naval service) hold 500lb. of gun-cotton. They are ordinary iron cases having a certain reserve of buoyancy, which enables them to be floated at any desired distance from the surface, and they are kept in place by heavy sinkers,

Fig. 6

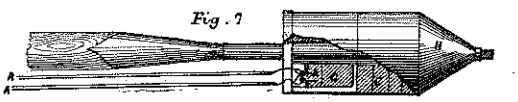


for though called ground mines they do not actually lie on the ground. Every charge of gun-cotton has a depth under water at which it will give the greatest effect, and the heavier the charge, the deeper it must be. The best depth for the 500 lb. gun-cotton mines is from 35 ft. to 40 ft.; so that if they were to be used in 10 fathoms of water they would require a length of from 3 to 4 fathoms of mooring line, to bring them about the right depth below the surface.

These mines are simply fitted inside with two fuzes, and are, like the electro-contact mines, connected with a firing station by insulated wires, and fired by an observer there. Of course the position of each torpedo is accurately known from the firing station, or rather stations, as there are two in this case, so that the observers there can readily see when a ship gets over them. Sometimes two or three torpedoes are connected to the same wire, in which case, on the man pressing the firing key, *all* so connected are fired.

These preliminary particulars would be quite incomplete, if I failed to do justice to a most important branch of our family, and one which has done, and I doubt not will again do, good service. I allude to our first cousins, "the spar torpedoes." It was the mischief done by them during the American War, that gave the impetus to torpedo warfare generally, and induced our great master, Mr. Whitehead, to devote himself to the perfection of a weapon of this kind, the upshot of which was the Whitehead torpedo. The outrigger or spar torpedo used in our service is charged with 35 lb. of gun-cotton contained in two cases. These cases are hollow (Fig. 7) down the centre to admit of the iron point of a long pole being passed through them. An iron conical end fits over the end of the pole to take the strain. Arrangements are made by which these torpedoes can be fired by electricity from the boat or ship carrying the spar to which they are attached. I will only describe the method of working them in boats, leaving it to be understood that they can in a similar way be worked from the lower booms of ships, or from gunboats. The boat is so fitted that when not in use, the spars with the torpedo attached to the end lies on either gunwale, and arrangements are made by which they can be rigged out to a distance of about 25 ft. from the bow and to a depth of 10 ft. The attack, which should generally take place at night, is made as follows: The boat steams up towards the enemy, and on approaching her the spar is rigged out until the torpedo is just touching the water. On getting pretty close the spars are still further rigged out, and the torpedo immersed to its proper depth, which, as we have said before, is 10 ft. Immediately contact is made with the ship's side, the officer in charge presses the firing key, and explodes the torpedo. The boat then gets away—if she can.

Fig. 7



THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual general meeting of the Institution of Mechanical Engineers was held yesterday week, the 29th ult., at the Institution of Civil Engineers, Westminster. The report of the Council, which was read on this occasion, showed that the members on the roll had increased from 1440 to 1553, 163 names of all classes having been added and 25 withdrawn during the past year. The receipts for the year amounted to 5094*l.* 14s. 11d., while the expenditure was 3968*l.* 6s. 5d., leaving a balance to the good of 1126*l.* 8s. 6d. The assets of the Institution, mostly in the form of 4 per cent. railway debenture stock, amount to 16,180*l.* 3s. 9d., and the liabilities are *nil*. The report also announced that the summer meeting of 1885 is to be held at Lincoln, and the principals of the important engineering industries there, and also at Gainsborough, Grantham, Newark, and Frodingham, have offered their services to render the visit agreeable and interesting to the members. The meeting will commence on Tuesday, August 4. The attendances at the last summer meeting, at Cardiff, were 241 members and 115 visitors. At the annual general meeting of January, 1884, there were 239 members and 39 visitors; at the spring meeting 106 members and 45 visitors; and at the autumn meeting at Nottingham, 86 members and 49 visitors. At the special meeting of members only, held to elect the secretary, the attendance was 215. For the last twenty-four years the President has held office for two successive annual terms, but this time Mr. I. Lowthian Bell's health compelled him to break through the custom and to resign the chair at the end of twelve months' occupancy. In addition, two

LITERATURE.

London and Provincial Water Supplies, with the Latest Statistics of Metropolitan and Provincial Water Works. By ARTHUR SILVERTHORNE. London: Crosby Lockwood and Co.

THIS work commences with a short account of the principal water works in the kingdom, and particular attention is directed to those which have been acquired by the local authorities. In many cases town councils have found that in supplanting the companies they have obtained possession of a white elephant, and the maximum charges allowed by law have had to be supplemented by a general rate, or by a contribution from the borough funds. Mr. Silverthorne is very emphatic in his condemnation of those bodies who do not provide for the early extinction of the debts which have been contracted for water works, and he points out that while a percentage of 5*l.* 8s. 9d. will pay off a loan, including both principal and 3½ per cent. interest, in 30 years, the annual amount is only reduced to 4*l.* 8s. 10¾d. if it be spread over 45 years.

The London water supply is treated very fully, as in all recent publications bearing on this subject, the prospect of a compulsory purchase lending special interest to all the metropolitan undertakings. Then follow the statistics of eighty provincial undertakings in Great Britain and Ireland. Each set of tables contains (1) the dates of the special Acts under which the works were constructed; (2) the capital cost of the works; (3) the townships included in the water limits; (4) the number of houses supplied; (5) the description of works and source of supply; (6) the water supplied daily for (*a*) domestic purposes, (*b*) trade purposes, and (*c*) flushing; (7) population in 1871 and 1881; (8) present rateable value; (9) expenditure and revenue, including (*a*) working expenses per annum, (*b*) annual instalment of capital paid off, and (*c*) interest and annuities, or dividends and interest; (10) public rate, scale of water rate, and meter supply rate; (11) governing body, including secretary, manager, and engineer. These tables represent a very considerable amount of labour, and should be of use to all who wish to form comparisons between the services of different districts and the amounts charged in various localities.

L'Année Maritime Revue des Evenéments qui se sont accomplis dans les Marines Française et Etrangères. VII^e Année, 1882. Par HENRI DURASSIER, Ancien Secretaire du Ministre de la Marine. Paris: Challamel Aîné. 1884.

The value of this annual volume is much lessened by reason of the facts and incidents of which it treats being neither historic nor contemporary. The events of 1882 are still fresh in every one's memory, but the record of the year's work has already been displaced by that of 1883, and now the public interest centres in the balance-sheet of 1884. The Eastern question, with which the work before us commences, has passed through several phases since the Anglo-French naval demonstration before Alexandria, and now the naval officer is more engrossed in the transport of Gatling guns on camel-back across the desert than in the details of the ruined forts at Alexandria, and the negotiations for the protection of the Suez Canal against Arabi Pasha. Even French doings in Tonquin, and the account of its climatic and mineral resources, are overshadowed by the grave difficulties which have arisen with the central Chinese Government, while the disputes between Mr. Stanley and M. de Brazza as to their respective powers on the Congo have been effaced by the late European understanding. But although the general contents of the volume are stale, the very lengthy preface is quite up to date, and is very highly seasoned with invective against every nation that presumes to trench on any territory that the Gallic republic has cast longing eyes upon. If M. Durassier fairly represents the opinions of the naval classes in France, it is certain that they must be actuated with a very hearty dislike of this country, founded apparently upon no better reason than that we protected our interests in Egypt, while the French declined to join in the venture, and therefore cannot share in the gain. The events which are now happening in Egypt confirm, we are told, the well-known weakness of England consequent upon the disproportion between her appetite for colonial extension and the paucity of her military resources. She is constantly put to heavy sacrifices to maintain her position, and even now is paying the penalty for translating the specious motto "Egypt for the Egyptians" to mean "Egypt for the English." M. Durassier then catalogues every discomfiture England has suffered during the last two years in endeavouring to satisfy the European powers, and prophecies that some day we may find our Indian Empire, menaced as it is by Afghanistan, Tonquin, and Cochin-China, in a critical position.

Passing over the strictures upon other nations, particularly Austria, we come to the measures recommended for the furtherance of the new-born French colonisation scheme, and it is amusing to note that our example is contiually held up for imitation, and that the Gallic inaptitude for emigration is denied in one breath and admitted in the next. The administration, we are told, must make efforts to spread a knowledge of the advantages of Tonquin among the public, "which is too often heedless and devoid of enterprise." It must also encourage people indirectly, by means of subventions or rewards, to visit the new country and establish businesses there, and when they are settled it must extend a most benevolent protection to them. Military incursions must be checked, and in their place a friendly commercial introduction must lead gradually to annexation "as with the English." At home the rage for copying British fashions and fancies must be extended to our disposition for roving, our liking for long voyages, and our keen scent for profit, and then "France will soon regain her rank in the world, fill up the gaps in her population, and repair the breaches made by fortune."

We heartily trust it may be so, and have no doubt that we shall find the French good neighbours in all parts of the world, if the better sense of the nation be not led astray by the ignorance and conceit of journalists and officials who have never been beyond the bounds of their own country. But a colonial empire cannot be created by legislation or the publication of blue-books. It must arise from the difficulty of living experienced by a population which increases more rapidly than its means of subsistence, and so long as the French limit the rate of increase of population so that each man finds a berth ready prepared for him, there will be little emigration.

Street's Indian and Colonial Mercantile Directory, 1884-5. London: Street and Co.; New York: S. M. Pettengill and Co.

This is the tenth issue of this work. It commences with tables of moneys, weights and measures in vogue in India, China, Japan, the Pacific Settlements, South America, and the West Indies. It likewise contains, in addition to the usual matter of a directory, full particulars, with rates and terms of transit, of the steam and other communication with the places treated of, wherever anything like a regular mode of correspondence exists. The leading merchants and traders of every class likely to be of use, together with the leading professional men, are enumerated. All the London agents to each of the banks are named, and whenever possible the principal officials and consuls. The number of towns and cities has been increased by the insertion of rising places, and maps of all the principal countries are given.

BOOKS RECEIVED.

Traité d'Exploitation des Chemins de Fer. Par A. FLAMACHE et A. HUBERTI. Tome Premier. *Route—Voie—Appareils de la Voie.* Brussels: Gustave Mayolez.

Practical Physics. By R. T. GLAZEBROOK, M.A., F.R.S., and W. N. SHAW, M.A. London: Longmans, Green, and Co.

Stationary Engines; especially as Adapted to Electric Lighting Purposes. By ROBERT H. THURSTON, A.M.C.E. New York: John Wiley and Sons; London: Trübner and Co.

The Engineer's, Millwright's, and Machinist's Practical Assistant. By WILLIAM TEMPLETON. Seventh Edition, carefully revised, with Additions. London: Crosby Lockwood and Co.

Weekly Problem Papers, with Notes intended for the Use of Students preparing for Mathematical Scholarships, and for the Junior Members of the Universities who are Reading for Mathematical Honours. By the Rev. JOHN J. MILNE, M.A. London: Macmillan and Co.

A Catechism of the Steam Engine in its Various Applications to the Arts, to which is added a Chapter on Air and Gas Engines, and another devoted to Useful Rules, Tables, and Memoranda. By JOHN BOURNE, C.E. New Edition, much enlarged, and mostly re-written; 212 Woodcuts. London: Longmans, Green, and Co.

Nolley's Commercial and School Book-Keeping, with a copious Glossary and Index. By A. F. NOTLEY. London: Bemrose and Son.

Elementary Principles of Carpentry. By THOMAS TREDGOLD, C.E. Sixth Edition. Thoroughly revised and considerably enlarged by E. WYNDHAM TARN, M.A. London: Crosby Lockwood and Co.

United States Commission of Fish and Fisheries. Part X. *Report of the Commissioner for* 1882. (*A*) *Inquiry into the Decrease of Food Fishes.* (*B*) *The Propagation of Food Fishes in the Water of the United States.* Washington: Government Printing Office.

Proposed Plan for a Sewerage System, and for the Disposal of the Sewage of the City of Providence. By SAMUEL M. GRAY, City Engineer. Providence: Providence Press Company.

Report to the New York Legislature of the Commission to Select and Locate Lands for Public Parks, in the 22rd and 24th Wards of the City of New York, and in the Vicinity thereof. New York: Martin B. Brown.

Das Gesetz der Proportionalen Widerstände und Seine Anwendungen. Von FRIEDRICH KICK. Mit 3 Lithographirten Tafeln und 44 Holzschnitten. Leipsic: Arthur Felix.

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. II.

Now I can proceed to our own immediate family. As you know, we were brought into being by Mr. Whitehead, of Fiume, and the accompanying sketch shows our form, which is fishlike, and we go through the water by the movement of a double screw in our tails.

Our first father had a greatest diameter of 16 in. with a length of 16 ft., and weighed, so I believe, somewhere about 300 lb. He was a slow-coach compared to the present generation, having only a single screw, and travelling at the rate of about 12.5 knots for 200 yards. If he was wanted to go further he was obliged to go slower, as he was rather short-winded. However, as you don't yet understand our nature and anatomy these remarks are rather premature.

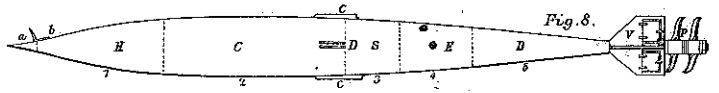


Fig. 8.

I am a 14 in. Woolwich torpedo and am 17 ft. long. Originally we were all made at Fiume, but the English Government purchased the secret of construction and set up an establishment at Woolwich for themselves. As the manufacture proceeded, Woolwich saw means of making improvements in one direction and Fiume in another, so, as so often happens, locality and circumstance dictated a divergence, which I will indicate as we go on. My technical name is "14 in. Royal Laboratory Whitehead Torpedo," mark II. Mark I. was the first pattern of a 14 in. torpedo made, and mark II. is an improvement on it. I have had it suggested to me that in order to make my readers thoroughly acquainted with my structure I should insert a section of my different parts and explain all about them. But from such an exposure my delicacy shrinks! A man when commencing to write his history does not imagine himself cut open and publish detailed drawings of his various organs; he merely gives such a description of himself as will elucidate the mainspring of his conduct and render his actions intelligible. I shall do the same, but I feel that I must enter rather more fully into details, as it must be confessed that I am not so well known or appreciated as the genus "man."

I am divided into sections which are numbered 1 to 5. No. 1 constitutes my "head," and contains the gun-cotton, when I am prepared for action. My head is connected to my body by a bayonet joint and screws, so that when I am not wanted to be dangerous, but only to run about for exercise, it can be taken off, the gun-cotton charge (which is cased in tin) taken out, a wooden dummy charge of the same weight inserted, and my head replaced.

My nose and whiskers are the only means by which I can be exploded, as I will show you. My nose has connected to it a longish rod, at the end of which is a sharp point. This is called the "striker. A spring arrangement exists in connection with my nose, something like the spring of a gun lock, so that by pulling the nose, "cocking" men call it, the spring is compressed. In this position the point of the striker is a few inches from a detonating cap, which is surrounded by dry gun-cotton. The point of my nose and my whiskers are so arranged that they act as triggers, so

MATHER AND PLATT'S SYSTEMS FOR DRIVING DYNAMO MACHINES.

(*For Description, see Page* 159.)

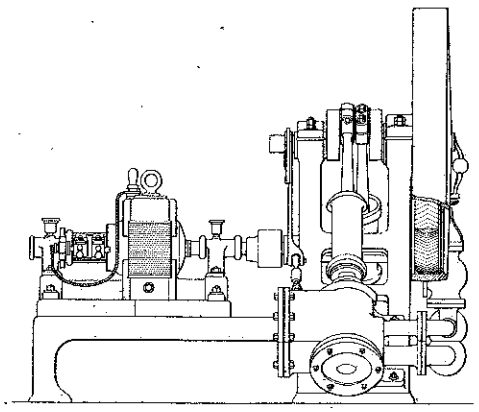


FIG. 1.

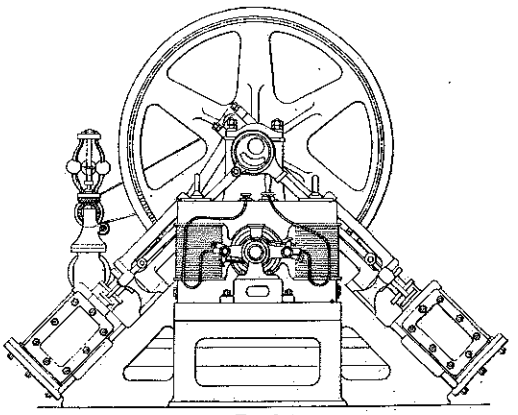


FIG. 2.

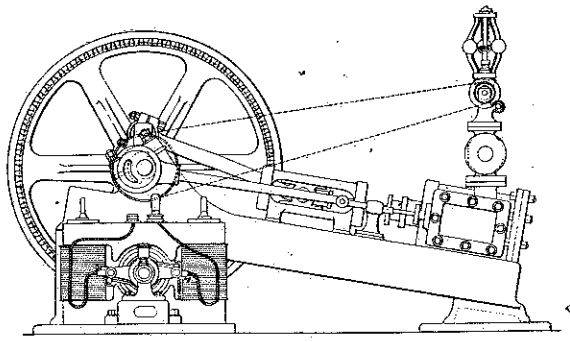


FIG. 3.

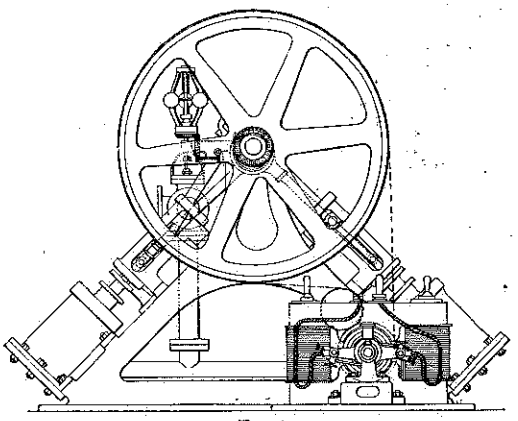


FIG. 4.

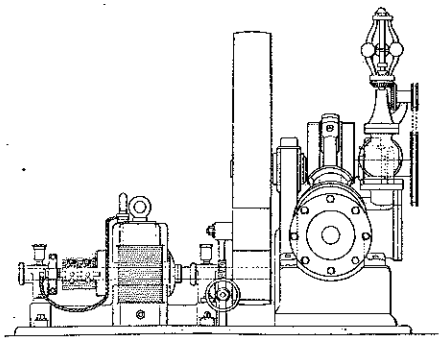


FIG. 5.

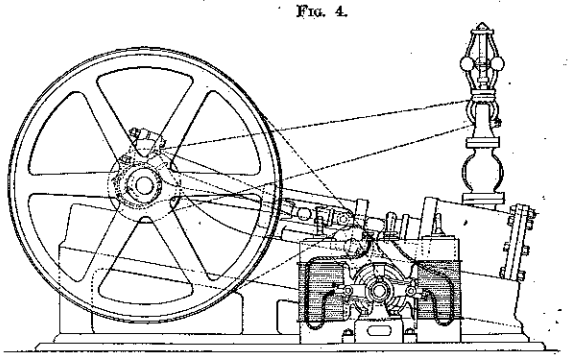


FIG. 6.

that if I am struck on the nose or my whiskers are pulled, the spring is released, the striker meets the cap, and off goes the charge, and there is a blow-up. Of course, if the gun-cotton charge and detonation are not inserted we are quite helpless, and, as a matter of fact, we do not feel explosive on these occasions. There is one more point which I must dwell on while dealing with my organs, and that is my safety wedge. You see once we get the explosive into our heads we become so touchy that we explode on the slightest provocation, hence we have to be provided with what is called a safety wedge. This is a wedge so arranged that it fits under the nose and whiskers and prevents any action even when they are struck—a sort of muzzle in fact. This wedge is connected by a wire to our tails, and, as I will explain later on, is arranged so that it is pulled out after we have travelled a certain distance away from the spot where we were fired. I am sorry to have to confess to being such a touchy character, but, as I have said, it is only when the explosive is in me, and then I don't know what I do.

Section No. 2 is the air chamber, and in this chamber is stowed motive power in the shape of air compressed to a pressure of a thousand pounds on the square inch. There is nothing much to explain about this portion of my body, except that the air is forced in from a high-pressure reservoir through a non-return valve.

Section 3 contains the arrangements for preserving the exact depth required under water. I regret being unable to enter into details on this point, as each of us, as soon as he is put together, has to promise never to reveal this part of his construction. This arrangement was made when the English Government bought the secret from Mr. Whitehead. They (the Government) refused to buy it outright, and so had to promise that this secret should only be imparted to those who were actually required for the construction and working of the torpedo. At first, on board each ship only five per-

MATHER AND PLATT'S DYNAMO-ELECTRIC MACHINE.

(*For Description, see Page* 159.)

Fig 7.

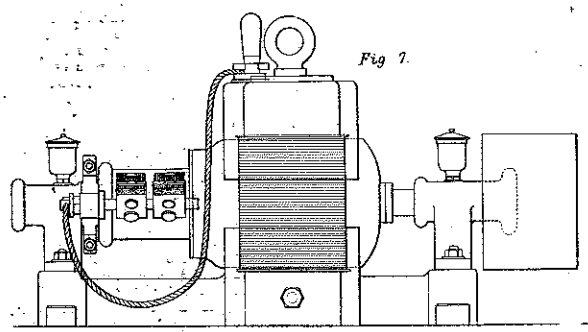


Fig. 8.

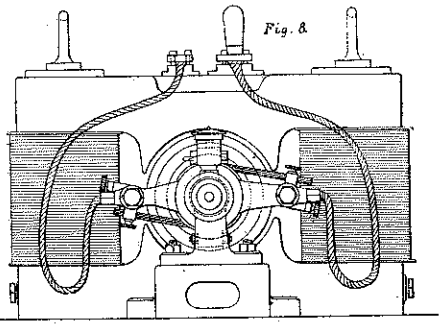
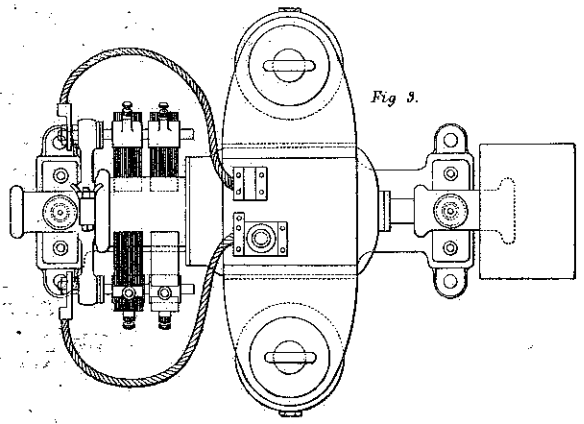


Fig 9.



sons knew the secret. The captain, gunnery or torpedo lieutenant, chief engineer, engineer in charge of torpedoes, and torpedo artificer. Lately the knowledge has been more extended, and quite rightly too, for we Whiteheads require a good deal of attention; and familiarity with all our needs and requirements is essential if we are to do well. The section abaft the screw chamber contains the engines. These are Brotherhood's three-cylinder engines working up to 60 horse-power, and driven by the compressed air stowed away in section 2. The air from the air chamber passes by a pipe through the secret chamber, then through a reducing valve, the object of which is to reduce the pressure in the air chamber, to a suitable point to work the engines. If the air were admitted direct we should have a heavy pressure on first starting, which would gradually be reduced on the air being expended, but by means of the reducing valve the air is admitted at a lower pressure than that at which it is forced into the air chamber, and so we have a uniform pressure throughout the run. Between the air chamber and reducing valve is a stop valve connected with a trigger which emerges from my back, and by means of which the air can be admitted to or cut off from the engines.

Section 5 is the buoyancy chamber; there is nothing in this but the screw shaft, and it is necessary in order to give flotative power.

In my tail, which of course is abaft this section, are two rudders, one vertical and one horizontal, and the screws are abaft this again. The vertical rudder is set to a certain fixed small angle sufficient to counteract the deviation from the course caused by the screws. This deviation is effected by the speed at which we may be going, being greater at low speeds; hence you see the necessity for having constant pressure in the cylinders as given by the reducing valve. The screws are made of steel, the foremost is on the screw shaft, while the second, which is close abaft it, is geared up so as to make it revolve in a direction opposite to the former. By this means there is very little slip, and when I put out all my strength I can go 20 knots an hour. Some of my younger brethren can nominally go 22, but I do not think they could manage more than 20 knots on service. Arrangements can be made by which, at the end of the run, water is admitted to the buoyancy chamber, and I sink. This is a fate which we torpedoes always pray to escape, though we do not mind being exploded in a proper way—it is what we are made for, and we look upon it as the most glorious ending a torpedo can have. As you will find out, the former was my bad luck once, for a short time only, but luckily I was rescued before I had been down long enough to get my constitution seriously damaged.

There are three points which I must explain before I commence my autobiography, namely, the means taken to start the engines, to pull out the safety wedge, and to stop the engines, replace the safety wedge, and sink the torpedo if required.

In order to do this, I must describe what is called the counter. This is placed on my tail just before the screws, and consists of two small wheels with their axes perpendicular to the horizontal axis of the torpedo. One wheel gears into an endless screw on the screw-shaft, and the teeth are so arranged that for every 40 yards (say) I travel, the wheel goes round once, the other wheel is worked by a stud on the first wheel, so arranged that every revolution of this first wheel rotates the second through one tooth. There are two studs on the second wheel, one of which works the wedge arrangement, and the other the valve trigger, as follows: A stiff rod passes from the wedge to the trigger in communication with the stop valve, and a wire passes on from thence to one of the studs before described. The stop valve itself is connected with a spring (also placed in the tail) by a wire, and this spring, before the torpedo is used, is compressed. On its being released it pulls on the wire, closes the stop valves (which of course stops the engine), and pushes in the safety wedge. Now you will ask, "But how is this done when the torpedo is far away and running along under water?" Well, I will tell you. A trigger is attached to the spring in the tail, and is so placed that when the second stud on the second wheel comes round, it presses against it, releases the spring, and so stops the torpedo, &c. I dare say this is rather confusing, so I will just summarise it and try and make it clearer. Suppose the engines are started off by pulling the trigger. The screws of course go round and the counter wheels revolve. The first stud so works that it commences a steady pull on the wedge wire which lasts during two revolutions of the first wheel, that is while the torpedo would be going 80 yards; the wedge is then free of the nose, the torpedo becomes dangerous, and the wire disengages itself from the studs. Meanwhile the second stud is placed the number of teeth from the tail trigger corresponding to the distance which the torpedo is required to run. For example, say we want to go 400 yards, then you would move the second wheel until the stud is ten teeth above the trigger, so that by the time the wheel has revolved these ten teeth, the stud presses the trigger and stops the torpedo.

You remember I mentioned before that the torpedo could be sunk if required; this is done by having an optional connection between the stop valve wire and a little valve in the buoyancy chamber. If this is connected, then when the tail spring is released, the valve is also opened, water rushes in, the buoyancy is destroyed and the torpedo sinks. I think, now that I have told all that is necessary for you to know and understand about me, I can go on right away and tell you some of my adventures, which I am sure will interest you.

CABLE TRAWMAYS.

By J. BUCKNALL-SMITH.

(*Continued from page* 28.)

HAVING in previous issues somewhat exhaustively described the construction and operation of the Clay-street Hill cable tramway, we will now pass on to more briefly consider the more recent lines in the city of San Francisco.

Although all endless cable tramways are founded upon the same general principle, yet no two lines appear to be constructed actually alike, and the modifications adopted in many cases do not seem to be the result of experience. This lack of similarity may be attributed to the patent epidemic or mania which has beset the development of the system, and to the different interests fostered by the various constructing engineers who were patentees.

The development or extension of cable tramways in the far west of America was at first, by no means rapid. The system was established step by step, and under long and careful tests as to efficiency, economy, safety, effect upon other street traffic, and upon the adjoining property, and it was not until the authorities and inhabitants became satisfied upon the above points, that the system made much headway. Thus we find that nearly 3½ years elapsed between the successful inauguration of the first cable tramway up Clay-street Hill in August, 1873, and the opening of the next cable line, viz., the

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. III.

As I have already mentioned, my native place was Woolwich, and there my early days were spent. Like all my race I arrived very rapidly at maturity, and no time was lost in putting me through the usual ordeals to prove my agility and the soundness of my constitution. I was then drafted with many of my relations to the store in Portsmouth Dockyard to await my turn for sea. While residing there I had plenty of time to look around and observe how things were done. At the time I speak of, a great many of the officers under instruction in Whitehead torpedo work were in the habit of coming to the store and pulling us to pieces—when I say us, I mean some of us—and I used to be edified and very often much amused by the remarks they made, and the tremendous awe in which the new-comers used to hold us. I am more conscious of this now on looking back, than I was at the time, as then I was a young and untried torpedo, brand new, and full of spring and energy. Above all I had been handled always by men who thoroughly understood all the little weaknesses and foibles of our race, and I little knew how great a difference it makes when we are committed to the care of those who, though their will and energy may be of the best, yet have not the intimate knowledge required to treat us as we should be treated.

The officer in charge of the store at that time was a chief engineer named Mellor, and he thoroughly understood his business. He was quite willing that his ability should become known, and I have often been amused at the skilful way he would lead the conversation round to some of the delicate questions of torpedo construction, in order to be able to impress upon the listener the amount of his knowledge. You may be sure there was always a considerable amount of excitement among the torpedoes in store as to when we would be sent to sea and in what ships we should go. At the time I speak of, few of our ships had Whitehead torpedoes, and their armament in this respect was being rapidly extended, so that we did not have to wait very long in store. One day I overheard a consultation between Mr. Mellor and his assistants. It seemed that eight 16-in. torpedoes, and four 14-in. torpedoes, were required for H.M.S. Fearnought, then flagship of the Channel Squadron. I may as well say that, in writing my adventures, I have thought it wiser to adopt assumed names for the different ships of which I have to speak and of the officers with whom I have come in contact. Some perhaps will recognise facts that actually occurred, and I am unwilling that it should be thought that there should be any personality in any remarks I may have to make.

I had heard of the Fearnought before, and knew that she had the reputation of being a smart ship, though it was said that her commander had no great idea of the torpedo and gunnery business, but considered that the efficiency of a ship was measured by her smart and cleanly appearance and the way her crew drilled aloft. In fact her gunnery lieutenant (she had no torpedo lieutenant) and chief engineer, had just completed a course of Whitehead torpedo instruction, and I had been struck with the energy with which the gunnery lieutenant mastered the details of his work, and consequently I indulged in the hope of serving with him. Nor was I disappointed, for Mr. Mellor and his assistants stopped opposite me and marked me as one to go on duty.

H.M.S. Fearnought was a magnificent vessel, looked at as a vessel alone. As a fighting machine she was not so efficient. She had arrived at a certain age, and was of course somewhat behind the times in consequence. Our accommodation was not by any means good, as the ship was not originally intended to carry Whiteheads, and therefore when it was decided to add us to her armament, the best arrangements that could be made under the circumstances had to be extemporised.

Behold us, then, in our wooden cases carried down to the jetty alongside which H.M.S. Fearnought was lying. The ship it seems had been ordered to sea suddenly, so we poor torpedoes had to be bundled on board as quickly as possible, and sent off with carriages and fittings which had never been tried, to do our duty under the care of young inexperienced officers. Indeed I afterwards learned that no one on board the ship had ever seen a Whitehead torpedo fired from above water, this item having by some means been neglected in the hurried course of instruction which the officers had just gone through. However, to resume. I was lying on the jetty comfortably wrapped up in my box and listening with all my might to what might go on, when I heard two voices speaking on the jetty.

"Well, Hand," said a voice, which I found out afterwards belonged to the commander of the Fearnought (John Cursem); "well, Hand, here are some more of these infernal things to be taken on board to lumber up the ship and give us something more to keep clean."

"Yes, sir," responded the other voice, which was the gunnery lieutenant before mentioned, and whose name was Hand, commonly called Shorthand on account of his size; "here they are, and I'm very glad we've got them at last. Hadn't they better be hoisted on board?"

"Well, I suppose they must come, so hurry up, and get them hoisted in!"

"Aye, aye, sir! What hands shall I take to do it?"

"What hands? Why, your gunnery instructors, of course—and engine-room artificer," he added, as a supreme afterthought.

I heard a laugh from the gunnery lieutenant at this. He evidently was used to the commander's way.

"Well, sir," said he, "considering that each torpedo weighs about 600 lb." (this was rather an exaggeration, but the commander did not know any better), "and that we have to sail in about half an hour, and the torpedoes have to be unpacked and struck down below, I'm afraid three men won't be sufficient; I think I could do it with forty, though."

"Where do you think I can get forty men from for your torpedoes, sir?" snarled the commander. "Here are only 900 men on board the ship; the mooring chains have to be got ready for slipping" (this takes about forty men, I found out), "and besides, as we are going to coal at Spithead this evening, I must have the upper deck scrubbed ready for it. Always the way! You think everybody on board the ship has nothing to do but attend to your guns and torpedoes. What we want them all for I don't know, in times of peace. We aren't going to fight any more, and we might just as well leave them on shore."

"Yes, sir," said Hand, "but as we have to take them, may I have the gunners to hoist them in?"

"No, you can't!" said the commander; and he turned round and stamped off.

I heard Hand grinning out loud, if I may use the expression, as he turned away; and presently he sang out to some one on board:

"Just tell the gunner to have the strops for these cases passed out. We'll have the hands here in a minute."

A voice replied, "Aye, aye, sir," from the ship, and almost immediately afterwards I heard a pipe, followed by a gruff voice singing out, "Gunners of both watches fall in!" and a few minutes after a short, sharp pipe, and the same voice, "In torpedoes!"

Then we were picked up, and the strops (which, as everybody knows, are simply ropes for putting round cases and things, so that they can readily be hooked to the tackles for hoisting in) placed round us, and soon I felt the sensation of swinging in the air, and then alighting on the upper deck. Then our cases were opened, and we were encompassed by iron vices called tongs, and lowered down into the torpedo flat, where our heads were taken off, filled with their gun-cotton charges, and stowed away in the magazine, while we, the bodies, were ranged up in berths in the torpedo room.

The torpedo flat, that is the compartment appropriated for torpedo work, and more especially Whitehead torpedo work, contains the air pumps for charging us with air; these communicate by pipes with a strong reservoir capable of holding air at a pressure of 2000 lb. to the square inch. From this reservoir, pipes are led to convenient positions for charging the torpedoes, suitable valves and pressure gauges of course being attached. A working bench for the purpose of making the necessary repairs to torpedoes, is also placed in the flat, and trollies for conveying us from the torpedo-room out under the hatchway are also provided. We were under the charge of an engineer and engine-room artificers as long as we remained in this flat, and they were responsible that we were properly looked after and in working order. As soon, however, as we were taken on deck for exercise or action, we passed into the charge of the torpedo lieutenant and his staff, or if there was no torpedo lieutenant (as in our case) to the gunnery lieutenant.

I must pass over the next few days, during which the ship went to Spithead, got in her coal and powder, and with the Portsmouth division of the Channel Squadron, joined the rest of the fleet at Portland. Here we remained some time, the crews being exercised in all sorts of drills, gun, rifle, and cutlass drills, exercise aloft, landing parties, musketry instruction, &c.

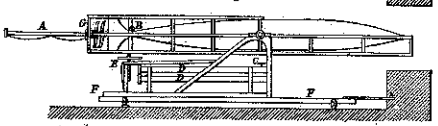
The first general quarter-day on board, it was determined to make a trial of the Whitehead torpedoes. For the information of those who may not be up in nautical affairs, I must state that on general quarter-days, the ship is supposed to be put in the same state as she would be if actually going into action, and all the circumstances of a real action are supposed to be as nearly as possible, imitated. I say supposed, because in very few ships is this arrangement carried out in its entirety. A sort of a drill is gone through, the guns are worked, &c., but as for officers putting themselves in the same position as they would have to do in the real business, passing the orders down, and assuming a real enemy, I am sorry to say it is very seldom done.

However, the performance is gone through more or less correctly. In this instance I will confine myself particularly to our own work. We were apprised of what was going on by the engineer and his assistants coming in about eight o'clock in the morning, and taking out another torpedo and myself. It seems that we two had been selected for exercise, and were to make our début that day. So we were wheeled out into the flat, and the engineer proceeded to look us over, and see that we were all right. Our tails were gauged to see if they were perfectly horizontal and vertical, and our heads which had been previously filled with a wooden charge instead of with gun-cotton, were put on. Then the air pipes were connected, and we were filled with air compressed to about 800 lb. to the square inch.

After this the counter was adjusted for a short run. The air was admitted to the engines, and we were allowed to run our screws to see that the stopping gear, safety wedge, &c., all worked correctly. I must say I was very nervous about this preliminary canter as it were, for, though I knew I was in good condition, yet I was afraid that inexperienced men like these might make some mistake, and so spoil my running. However, everything was managed satisfactorily, though they were somewhat slower than I had been accustomed to, and I was rather afraid they were going to forget one or two things.

We were ready at last, and soon afterwards I heard the bugle sounding "For exercise, action," which means that everything is to be got ready for action, but the guns are not to be loaded. Then there was a rush of many feet, and apparently endless confusion, though I must say I did not hear a word spoken, and in three minutes there was perfect silence. The guns were all cleared away,

Fig. 9



the men stood silently round them and awaited further orders. I said perfect silence, but this was not quite the case, because we could not get quite so quickly into our carriages, as that is a performance not to be raced over with delicate weapons such as we are. I have not described our carriages yet, and I must pause in my story to explain them. The carriages used with us in this ship were called underlip carriages, and are shown in the accompanying sketch, Fig. 9.

The upper part was of the shape shown; that is, open at the top from about half-way out. This part was of rather greater diameter than the torpedoes, and had guides to take our upper and lower body and tail fins, and also the side fins. A door at G opened to admit the torpedo from the rear, and to this door was attached an impulse tube. Inside of this tube there was a telescopic piston, to the rear of which air could be admitted. This air was supplied from a reservoir of air tubes under the upper part of the carriage D D, and on its way passed through a stop valve C and a valve connected

with the handle B, which also worked a stop half-way along the tube to prevent the torpedo from slipping out. Now observe the action. The torpedo being pushed in from the rear till its side fin came in contact with the stop, the door is closed and secured. The carriage is then run out to its proper position, in which the fore part of the tube with the torpedo in it projects 3 ft. or 4 ft. over the ship's side. It is then trained for the object. At the order "stand by" the stop valve C is opened, and the air is then only kept from the impulse tube by the valve attached to the handle. On this handle being turned, the stop holding the torpedo is withdrawn, and at the same time air being admitted to the impulse tube, the telescopic rod flies out, pushing the torpedo in front of it. As the tail of the torpedo reaches the open part of the tube it goes up, and the nose goes down, the impetus given putting it into the water at an angle of about 15 deg. This method of firing has since been improved upon, as I will tell you when we come to it.

Now I can continue my story.

The admiral in command of the squadron was a great swell, thinking a deal of eating and drinking and fashionable acquaintances. At the same time he was a good sailor, and possessed a great amount of tact. He, in common with most of the other officers, knew very little about Whitehead torpedoes, and what he did know was obtained from the torpedo staff of the Vernon. Now the captain of the Vernon at that time was a very enthusiastic man. A man thoroughly up in his work, and knowing as well or better than any one, the good and bad points of torpedoes generally, though he never admitted to outsiders that torpedoes had bad points. By his account they could do almost anything but talk. I have heard say that he carried his enthusiasm too far, inasmuch that he concealed things that went wrong, from the officers undergoing instruction, and thus they lost the benefit of some valuable experience. There is no doubt of the fact, that seeing mistakes made, is the best way to avoid them in the future, and if those officers under instruction had seen that such mistakes could be made by people skilled in the use of torpedoes, they would be naturally very careful themselves. The admiral, Sir Shoreham Peerless, had then been thoroughly impregnated with ideas about our good qualities, and was convinced that we could do almost anything. This was fortunate for us, of course, because it increased our importance. If we went all right, it was a case of "I told you so," and if we did not, it was the fault of those who had charge of us. Very nice for us, but very hard luck for those who had to manage us. We are all but perfect, though I say so myself, but we require very careful management indeed, and should have people thoroughly trained to look after us, for it cannot be expected that they should become thoroughly *au fait* in such a delicate machine during the period in which they are going through a course. Sir Shoreham was naturally anxious to see the performances of these wonderful weapons, so after the crew had been a little time at general quarters, he said to the flag captain (Captain Tarr), "I'll go away in the cutter, Tarr, and will you let them fire a Whitehead torpedo so that it will pass about 10 ft. under her."

"Very good, sir," responded the captain, who forthwith ordered the first cutter to be manned and sent for the gunnery lieutenant.

"Hand," he said when the latter came up from the main deck where he had been drilling, "the admiral is going away in the cutter and wants you to fire a Whitehead torpedo so as to pass 10 ft. under him."

"Aye, aye, sir," said the gunnery lieutenant, who then came down to the main deck and gave the necessary orders. He had before seen that we were charged with air to 800 lb. pressure, that the impulse acted properly, and that as far as possible everything was all right. The depth was now regulated to 10 ft., and on looking out of the port to see the direction the admiral had taken, we found him a little abaft the beam and about 800 yards off.

"Bless my soul," murmured Hand, "he doesn't expect us to hit him there, surely!"

I must say I shared his apprehensions, and was very much afraid I should disgrace myself in my first sea run. If I had known then what I know now, I should have been still more apprehensive, as experience has shown me that about 300 yards is the greatest distance we can traverse with certainty in a straight line. But I was young then, and strong in my pride, and on this occasion, though I knew from the little experience I had had on trial trips, &c., that it was a hard task, yet I hoped I might be able to do it. So the counter was set to twenty teeth, the safety pin taken out and the order "Stand by" given. I felt a nervous shudder pass down my back as I heard the words spoken, and the whizz of the air escaping through a small leak in the valve, did not tend to reassure me and made the situation seem more awful still. I knew that in a very few seconds I should be ploughing my way under the still surface of the ocean. Another moment and it came—"Fire" is the order.

I feel the stop withdrawn, and almost immediately experience a push from behind. I start in my carriage, and in an instant later spring into full energy, for the trigger is caught by the tripper as I am pushed past it. The communication valve is opened, and I am whirling round my screws at a terrific pace in air. Then I jump from my carriage headlong into the sea, a dive of 15 ft. But alas for my high-flown hope! My chances of going straight were ruined at once, and by no fault of mine. You remember I mentioned that in the top and bottom of the carriage, were guides for my fins. As I had to be pushed in along these guides it was necessary that there should be a certain amount of play between these guides and my fins. Consequently when I was pushed along the tube by the piston, instead of going out quite fair, I found myself deflected a little to the left. Not much, but still, instead of entering the water pointing in the direction in which I was to go, I was inclined a trifle to the left. Then as I dived in head first the water gave my head a blow, sending me off still more to the left, so that when I got fairly away under water I was really deflected about 15 deg. from my proper line. I had felt this one-sided blow, and knew I was going wrong, though of course I could not tell exactly my direction under water, but there was no help for it, and I could only hope that nothing would get in the way till I had run my 800 yards. Alas! no such luck awaited me.

I had gone about 600 yards, and was still rushing along at the rate of 17 knots an hour, when I saw a dark mass suddenly appear in front of me. A second more and there was a crash; the pistol was broken after acting, my head was violently torn from my body, and a leak was made in the air chamber. I knew no more until I found myself lying at the bottom of Portland Harbour, being critically examined by all the fish in the neighbourhood. As long as I preserve my shape entire and am moving along, the fish don't notice me much, as they think I am one of themselves, but now they could not make me out. They were, I must say, most prying and impertinent, coming and smelling about me, and the larger fish even going so far as to send the little ones in through the crack that was made in the air chamber, and into the engine-room, to see what I was made of. Luckily the secret chamber was intact, and they couldn't get in there.

Meanwhile everybody on board the ship was anxiously looking out to see the torpedo run. The air, you know, after doing its work in the engines, escapes through the screw shaft, which is hollow, and of course rises to the surface. Consequently the course of a torpedo can be traced by the air bubbles it leaves behind it. It was soon seen where I must come to grief, and boats were instantly manned and sent to try and pick me up. The admiral had been standing in the cutter with his arms folded, and a proud expression on his face which seemed to say plainly, "Look at me; I'm in command of this splendid squadron, and if you wait a second, you'll see a magnificent torpedo come right under the boat's bottom, fired from my flagship." He saw me fired, and, it being a calm day, traced the air bubbles. As soon as he saw what was going to happen, he ordered the men to give way, and made for the White King, the ship which I had rammed, arriving there to find my head floating about, though my body, as you know, was down in the depths.

The next sight was the gallant admiral and the midshipman of the boat trying to catch hold of my unfortunate head. This was no easy task, as the buoyancy was so little that my nose was only just above water, and on the slightest touch it disappeared. However, it was at last secured and the gallant admiral, panting and perspiring at every pore, returned on board with his prize, which was hoisted in in triumph. Divers were immediately sent down after me, and as the place where I sank had been at once buoyed, I was soon picked up. I'm thankful to say that some of the little fishes that had been examining my interior, paid the penalty for their curiosity, for when I was picked up they got so confused they could not find the way out, and so were brought up with me.

Of course there was a great "to do" about the failure of the new weapon, and the gunnery lieutenant was cross-examined as to it all. However, neither he nor any one else could give an explanation of the matter, and the private opinion of every one, by no means privately expressed, was that the gunnery lieutenant was an idiot, and knew nothing about it. When the matter was reported to the Admiralty, and forwarded by them to the Vernon, the latter fully indorsed this idea, and accordingly the next time the ship went to Portsmouth all the torpedo authorities, came on board to show how it was to be done.

(Meanwhile I had to be sent to Woolwich for repair, and after being away about two months, duly returned on board, ready for duty again.)

The torpedo authorities having made their preparations, looking at poor Hand the while as much as to say, "You're a pretty fellow not to be able to do this yourself!" proceeded to fire a torpedo.

Alas, sad to relate! the first torpedo deflected 20 deg. from the direction it should have followed. They were dumbfoundered, and had nothing to say. A second and a third trial followed with very much the same result. There was nothing for it but to confess themselves quite in the dark as to the cause, and to bestir themselves and try and find it out. Hand, as you may imagine, was triumphant, though he took care not to show his feelings on the subject, and appeared to be simply studying the matter closely. In the course of his scrutiny he noticed that, as the torpedoes were pushed home, there was the play which I have already mentioned, and he suggested this as the true reason of the deflection. However, even then the authorities would not accept the explanation, saying that in H.M.S. Khedive, which had been armed with Whitehead torpedoes just before, the carriages and torpedoes were similar in every respect to ours. The drop of the torpedo from the carriage into the water was much the same, and the present difficulty had never occurred there. No, it must be the fault of the officer in charge of the torpedoes somehow; they didn't quite know how, but the others had gone straight and these had gone wrong, so the fault must lie with those who had charge of the business. Further inquiry into the matter, however, showed that torpedoes had only been fired from the Khedive while she was under way, and as soon as he found out this, Hand immediately went to the captain and told him of it. Captain Tarr was quite willing to back his gunnery lieutenant up in every way. He was not a scientific man himself, and much preferred seeing his men drilling aloft, to exercising with guns and torpedoes, but at the same time he liked to understand the theory of everything in the ship, and if anything did go wrong he used to follow it up until finally he got the wrong-doer into a corner. When he did get hold of the culprit he seldom punished him; it was quite sufficient that the matter had been traced home. It was wonderful how this answered. Every one knew that if they did wrong they were safe to be bowled out, and as most of the wrong-doing in the service occurs from carelessness, they became careful. Of course mischief deliberately done was heavily punished, but it is very rarely that a case of this occurs. In the present instance the torpedoes had gone wrong, and as far as Captain Tarr could make out, it was indirectly the fault of the gunnery lieutenant. Consequently he had shown him that he was not pleased, and as up to this time Hand and he had got on very well together, the latter was very much distressed at having our erratic wanderings laid at his door. When he had told the captain of the new discovery that he had made about the Khedive and torpedoes, the latter did not seem to see the matter in the same light as himself. "I can't see what difference it makes, the ship being under way or not," he said; "you have exactly the same conditions as if you were at anchor, except that when the ship is under way, the torpedo is deflected aft in consequence of the head getting into the water before the tail, the whole torpedo having of course a lateral velocity equal to that at which the ship is passing through the water."

"Well, sir," responded Hand, "I look at it in this way. If the ship is at anchor, the torpedo on leaving its tube may be inclined at a small angle on either side of the true direction, that is, it enters the water partly sideways. As soon as ever the nose touches the water a further deflection and a

considerably greater one takes place, and the torpedo consequently goes off a good deal one way or the other. Now with the ship under way, the torpedo strikes the water, and in turn receives from the water a heavy blow on the side of the head. This blow is sufficient to deflect the weapon about 1½ deg. for every knot of speed. Suppose the ship to be going ten knots, the torpedo would be deflected from its course about 15 deg., more or less. Now imagine the torpedo to have gone out of the tube inclined at a small angle, the moment it touches the water it receives this blow, and is deflected at once its 15 deg. So in this case the error would never be more than that due to slight deflection on leaving the tube."

"H'm, there seems something in that; but when I see it I'll believe it. I must say I'm not quite clear as to why the difference should be so great in the two cases," said Captain Tarr.

"Well, sir, the proof of the pudding is in the eating," said Hand; "we are going out to target practice to-morrow, and we can easily try them while the ship is under way."

"Very well," replied the captain, "you get a couple ready and we'll fire them after we've done the other firing. I must say I'd like to confound these Vernon fellows, though at the same time I'm only half a believer in it."

"All right, sir," answered Hand, "I don't want you to believe anything till you see it, but I hope to-morrow will show that I'm right." And away he went to get things ready.

PRIVATE BILL LEGISLATION.

CONTINUING our description of the projects for the ensuing session, the Glyn Valley Tramway Company propose sundry deviations and extensions of their undertaking which traverses the valley of the River Ceiriog, in Denbighshire, and is more of the character of a railway than a tramway in the general acception of the term, inasmuch as it is for the most part constructed, or to be constructed, through property acquired for the purpose, and it is proposed to work both the existing and proposed tramways by locomotives or carriages moved by steam or other mechanical or motive power, subject to the regulations of the Board of Trade. The proposed works are four in number, and consist of, first, a deviation 12¾ chains in length of the existing line near Pontdolywern, by which two sharp curves are avoided; second, a similar deviation, seven chains long, near New Inn, Llansaintffraid; third, a branch, about 3¼ miles in length from the existing line at the last-named point, to be carried up the valley of the Ceiriog to the village of Tregeiriog, the ruling gradient being 1 in 42; fourth, a line, about 1¾ miles long, which commences by a junction with a line authorised in 1870, at a point about three-quarters of a mile west of the viaduct carrying the Shrewsbury and Chester Railway over the River Ceiriog at Chirk; it then proceeds in an easterly direction along that side of the river for a quarter of a mile, and then turns to the north, and is carried for about a mile parallel to the before-mentioned railway to Blackpark Wharf, at which point the Blackpark Colliery branch meets the Shropshire Union Canal. There are curves upon this line of four chains radius, and these to a great extent will define the nature of the traffic over these tramways, which will probably consist for the most part of coal brought from the collieries with which it will communicate.

It is proposed to dissolve and reincorporate the Birmingham Tramways and Omnibus Company and to apply for powers to construct a number of new lines, among which the principal are, No 1, a line, about 2½ miles in length, commencing by a junction with the lines of the old company at the junction of Snow Hill with Summer-lane. It is then carried in a northerly direction along the latter thoroughfare and Alma-street, thence along Victoria-road in an easterly direction, then, again turning to the north, it traverses Bevington-road, Aston Park, to Trinity-road, along which it is carried in a westerly direction to a junction with the authorised line of the Birmingham and District Tramway Company at Bedefield-road. No. 2 is a line, about three-quarters of a mile long, commencing at a point in Hockley Hill near its junction with Guest-street; thence it is carried along the latter street, Alma-street, Villa and George-streets, terminating by a junction with the old company's line in Lozells-road. No. 3, about a mile in length, commences by a junction with the same company's existing line in Soho Hill; it then traverses Soho, Holyhead, and Crockett's-roads, and terminates at the company's depôt at New Inns. No. 4 is a connecting line traversing Villa-road between the last-described line at a point on Soho Hill and the company's depôt at Lozells-road. No. 5, about a mile in length, commences in the Bristol High-road near the old company's depôt at Bournebrook, and is then carried along that road in a south-westerly direction through Selly Oak, and terminates with a loop near the Weoley Park-road. There are also several junction lines in the neighbourhood of Soho Hill and Hamstead-road. All of the lines are to be partly single and partly double, are to be of the 3 ft. 6 in. gauge, and are proposed to be worked by steam, animal, or other power, but vehicles suited for railways are not to be run upon them.

With the exception of those relating to subways already described, the plans relating to the metropolis deposited under the head of miscellaneous, are few in number, and since the date fixed for the Parliamentary money deposit, some have been withdrawn. The Tower Bridge, promoted by the City Corporation, will probably demand the most attention in Parliament, being, as it is, the outcome of a special recommendation of an influential committee, who rejected both the schemes for a bridge and subway brought before them last session. The site of the bridge is situate between a point in the Middlesex river wall 50 ft. west of Irongate Stairs, and a similar point on the Surrey side 150 ft. west of Horsleydown Stairs. The bridge will be 880 ft. in length, divided into three spans by piers 40 ft. wide; it is proposed that the centre span shall be 200 ft. wide and be formed in two leaves, turning at the piers upon horizontal pivots. When required these leaves could be raised into an almost vertical position, to allow shipping to pass, by means of machinery actuated from an upper girder, fixed between the piers at such a level, as to give a headway of 125 ft. above Trinity high water. The side spans will be each 300 ft. wide, and the headway beneath them will be 29 ft. The width of the bridge between the parapets will be 50 ft., allowing 36 ft. for roadway and 7 ft. on each side for footpaths. The northern approach, about a quarter of a mile long, commences in the Minories at a point about 58 ft. east of the house numbered 91 at the corner of the Circus. The southern approach, about 200 yards long, commences in Tooley-street at a point 75 yards west of Short-street.

The Metropolitan Board of Works, one of the defeated parties, have not made any effort to proceed with the work, which the before-mentioned committee recommended to their especial consideration, and which consisted of a subway near Limehouse, with long approaches on both sides of the river, the cost being estimated at about two millions; but they propose to revive the ferry scheme, introduced and abandoned by them last session, for the improvement of the communication across the river at Greenwich and Woolwich. At the latter place the pontoons forming the points of departure and arrival of the ferry boats, which will be on a system embodying all the latest improvements in such structures, will be situate 80 yards from the bank on either side; the landing place on the north side will commence at a point 110 yards west of the junction of Stanley-road and High-street, North Woolwich, and will terminate 170 yards west of the same point; that on the south side will be near Nile-street, Woolwich, at its junction with High-street. At Greenwich the pontoon on the south side will occupy the site of that now belonging to the Greenwich Pier Company; on the opposite side the pontoon will be 50 yards from the bank, and the landing place will be at a point 110 yards east of Johnson's drawdock. The Board propose to take power to lay down chains across the river for controlling and guiding the ferry boats. This is a most important provision, as it is during fog that the chief difficulty and danger arise with the present means of communication across the river at these two spots. The other proposed work of the Board is the formation of a new street about three-quarters of a mile in length from the junction of Clerkenwell-road with Gray's Inn-road to John-street-road, at a point 30 yards north-west of the junction of Myddleton-place therewith; this will much improve the communication between Islington and the south-west, which at present is rather circuitous.

The Corporation of Southampton are seeking to supplement their present water supply, which is not able to keep pace with the increase of population, by sinking a well into the chalk and erecting a pumping station at a point close to the London and South-Western Railway about four miles south of Winchester Station; in connection there will be: (1) Tanks, filtering, and softening works; (2) a line of pipes about 1¼ miles long, leading to the (3) works, which is a service reservoir situate at Otterbourne Hill Common; (4) a line of pipes, a little more than four miles long, connecting the said reservoir with the existing mains of the corporation at the junction of the Mansbridge-road with the Winchester and Southampton-road; (5) a siding 100 yards long, connecting the London and South-Western line with the works at the pumping station; and (6) a road, 30 chains long, from a point on the Winchester and Southampton-road before mentioned 280 yards north of Pole-lane, giving an access by road to the station.

The promoters of the Manchester Ship Canal have abundantly proved their possession of a large amount of pluck, and undeterred by repeated reverses are now making further efforts, which, if the peculiar advantage proverbially attaching to a third attempt holds good in their case, ought to be rewarded by complete success. This session, with undiminished confidence, they again present their important undertaking for the consideration of Parliament, but having learned some useful lessons during their oft-repeated contests, they have to some extent adopted the suggestions put forward by their opponents as being the proper mode of dealing with some portions of the scheme, and have so modified the details of the works that they hope to defy criticism on the more important points.

It is an open secret that the great divergence of opinion as to the injurious effects which might arise from the then proposed training walls and dredging works in the estuary of the Mersey, which formed an essential part of the scheme in the last two sessions, deterred the committees from taking upon themselves the responsibility which could be thrown upon them, should they have sanctioned the measure. This session these parts of the scheme have been altogether dispensed with, and it is hoped that thereby all serious opposition will be avoided.

The principal works now consist of a ship canal, and undertakings connected with it, such as dock accommodation at Manchester, Salford, Warrington, and Runcorn, and the diversion of the five existing railways, which interfere with the course of the canal. The canal will be about 35 miles long, having as a rule a bottom width of 120 ft., and a minimum depth of 26 ft., and where the sides are formed with slopes their inclination will be 1½ to 1; they will be carried up to a length of 7 ft. above the highest water level, and will be faced with stone. The canal commences on the south foreshore of the Mersey at a point nearly opposite to Garston Docks, about 10 chains east of Eastham Ferry Stage; thence it is carried along the foreshore to Pool Hall Crook, where it enters the land and continues therein to Ellesmere Port. In front of this it is again constructed on the foreshore for a length of about a mile; thence it is carried inland to the River Gowy, which it crosses at a point about half a mile south of Stanlow Point. With the exception of a length of about a mile, the foreshore is again occupied, and the canal is carried through Frodsham Marshes to the River Weaver; here its general easterly course is changed on a curve of about a mile radius to the north, and the estuary of that river is crossed at a point about 10 chains west of the junction of its low-water channel with that of the Mersey. At Weston Point the foreshore is again approached and closely followed, with curves of a minimum radius of half a mile, through the southern opening of the London and North-Western Railway bridge, past Runcorn to Old Quay, from which last point to the western end of the racecourse at Old Trafford, the course of the canal is practically identical with that of last year. It passes through Latchford and Thelwall, thus avoiding any great interference with that portion of the Upper Mersey lying between Warburton and Runcorn, which, it has been contended, is of so much importance as giving a ready outlet for the flood water. Eastward of the racecourse the canal is carried forward about three-quarters of a mile to its termination at a point where the River Irwell is crossed by the Old Trafford-road. For a distance of about five furlongs, from the commencement to the first series of locks, a channel will be formed with a depth at low water of 20 ft., communicating with the deep water in the Eastham Channel. The first locks have a lift of

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. IV.

WHILE all this was going on on board the ship, I was away at Woolwich being repaired, but on my return, one of my fellow torpedoes told me all about it, and I include his story in my adventures as it is really the sequel to my mishap.

The day after that on which the conversation related in the last number took place the proposed trial was made, and sure enough it turned out very much as Lieutenant Hand had predicted. The following Table gives the results of three runs:

Speed of Ship.	Nature of Target.	Distance and Bearing of Target.	Torpedo Laid.	Result.
8 knots	Boat	250 yards on the beam	12 deg. before beam	Passed 5 yards to right of boat.
10 ,,	,,	200 yds. 10 deg. abaft beam	5 deg. before beam	Passed under boat.
12 ,,	,,	220 yds. 5 deg. abaft beam	13 deg. before beam	Passed 10 yards to left of boat.

Now this is very accurate firing, for the cutter used as a target was only 30 ft. long, and when you think that the length of a ship may be taken at 200 ft. as a minimum, the chances of her escaping being hit under circumstances like these, are very small indeed. True, if fired at, end-on, you would only have from 40 ft. to 60 ft. as the width of the target, but this latter would, I think, never be attempted unless at very close quarters. Apart from the smallness of the target, end-on attack is not recommended, for, if directed against the bow, we would be attacking the most invulnerable part of the structure, and if at the stern, unless the torpedo actually strikes the stern-post or screw, there is a considerable chance of its being deflected without exploding, owing to the shape of the ship.

Captain Tarr was greatly delighted at the success of the torpedo firing, and very naturally at once adopted Hand's theory as his own. The interview between him and the captain of the Vernon on the occasion of their meeting after the firing had taken place, was very amusing.

Captain Gorman Whistler was this officer's name, and Captain Tarr met him in the dockyard as they were both on their way to the admiral's office.

"Oh, Whistler," quoth Captain Tarr, "about those torpedoes!"

"Eh," said Captain Whistler, "what about them? Has that gunnery lieutenant of yours broken any more of them?"

"Oh, no!" responded Captain Tarr; "after the capital way you showed us how to fire them the other day, of course no mischief could happen. I'm afraid it's something nearly as bad though. We've found out why they wouldn't go straight."

"H'm! I could have told you that before," said Captain Whistler. "You don't manage them properly."

"Indeed, I'm sorry to hear that," retorted Captain Tarr. "By the way, though, that could not have been the reason they did not go straight when you came on board the other day. How was it that happened?"

"Oh, well, we needn't discuss all that; let us hear this wonderful secret of yours," responded Captain Whistler, testily.

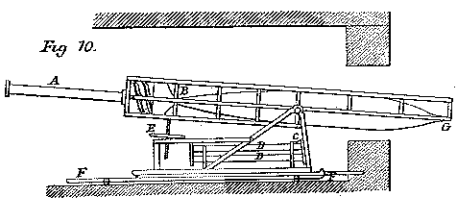
"Well, we fired some torpedoes yesterday when we were under way, and they all went as straight as——"

"Ah! *that* certainly is wonderful," drily interrupted Captain Whistler.

"Now, be quiet you old cynic," laughed the captain, "and I'll tell you all about it."

And he proceeded to relate the whole story, quoting the result of the yesterday's firing as a confirmation of his theory.

Fig 10.



Naturally Captain Whistler was not going at once to admit that this was the right view of the case, but as a matter of fact the carriages have since been altered so as to allow the torpedo to fall more flatly in the water. They are called the overlip carriages, and the arrangement is shown in Fig. 10.

The guides for supporting the side fins extend right along to G, consequently, as these side fins are in the centre of the torpedo, if the carriage is laid horizontal the torpedo will fall horizontally. A slight depression is generally given though, to enable it to get its depth, for were it to fall flat altogether it might skim along the surface before, or instead of, going under water.

In launching torpedoes, as well as in many other matters of vital importance to both branches of the service, authorities at home would do well to copy from other nations, just as foreign countries do copy from us whenever we have anything good, and I feel justified in making a little digression here to mention what is undoubtedly the very best arrangement for firing torpedoes that has been yet devised. It is a French invention, and is largely used in the French Navy, though it has not yet found its way on board any English ships or torpedo boats. The gun, for that is what it must be called, is a long tube of a diameter large enough to admit the torpedo from the rear, which is closed by a hinged breech-block. The forward part of the gun rests on trunnions, the trunnion bearing saddle encircling the lower half of the tube, and terminating in a pin that swivels in a socket bolted to the deck. Attached to the socket is a radius bar that is joined to a two-wheeled carriage placed under the tube near its rear end, which can be raised and lowered by an elevating screw. In this way the gun with the torpedo inside it can be trained with the utmost nicety and speed. A small charge of powder is placed in a chamber inside the breech-block, and when ignited the gases escape through a number of radial openings in the chamber, in such a way that the gases impinge upon the inside of the tube, and in no way injure the delicate mechanism of the torpedo. I have attempted to give only a general idea of this neat device, which, as I have said before, is in much favour with the French Navy, so much in favour indeed that I have heard our neighbours desire to keep the system to themselves.*

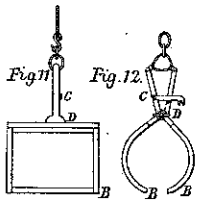
I told you just now that I rejoined the ship after being put right at Woolwich, and I was very glad to get back again, and was longing to have another chance of redeeming my reputation. My longings, however, were not yet to be realised, for in a very short time I came to grief again, and once more the gunnery lieutenant got into hot water about me.

We had been exercising at general quarters, and after everything had been secured after the exercise, we (that is, the other exercising torpedo and myself) were being struck down below.

Now, in order to explain what happened, I must premise that the instrument used to put round our bodies for lifting purposes are called tongs, and that there are three kinds of these tongs used.

1. The water tongs are of the shape shown in Figs. 11 and 12. A catch at C keeps the jaws open, and when in its place the jaws at B are wide

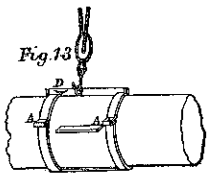
Fig.11 *Fig.12.*



enough to allow of the tongs being lowered over the torpedo. This done, the catch is knocked out, the hoisting tackle hauled taut, and the jaws falling together, grip the torpedo, which is prevented from falling out by the side fin being between the two sides of the tongs, and a line made fast from the nose to the cleat at D. These tongs are used for lifting the torpedo out of the water.

2. The lifting tongs are of the shape shown in Fig. 13, and have ways (A A) for the side fins to pass through. These are used for working the torpedo between decks, and the ways are required to enable the torpedo to be slid along as in entering it into the carriage, &c. The proper way of putting these tongs on is to slide them into their place past the side fins, and then turn them round a little, so that should there be a slip, the fins would

Fig.13



be brought up against the solid part of the tongs as shown in the drawing. Further, as the torpedo always goes down tail first, a line is secured from the tail to the cleat at D as a further security.

3. The third pair of tongs is similar to those just described, except that there are no ways for the fins. Consequently in order to put them on, they must be opened well out, and screwed up again when in place. On the occasion of which I am now speaking, the lifting tongs were those used, and unfortunately the principle of turning round the ways clear of the fins was not properly understood, consequently on being struck down I found to my horror that the ways were right in a line with the fins, and that the tail line was rotten.

A differential purchase is used for working us torpedoes. The two sheaves in the upper block are of different sizes and connected together rigidly, the chain fitting into indentations in them, and therefore travelling with the sheaves. The lower block contains a single roller over which the chain is free to move. The advantage of this purchase is that heavy weights can be lifted with small power, and that the weight will hang suspended wherever it may happen to be without the fall being secured. For this reason it is eminently suited for torpedo work, as there is no fear of the torpedo taking charge, and it can be worked by one or two men.

Well! the tongs were put on as I have said, the purchase hooked, and the men began to pull up. Of course it was all right as long as I was nearly horizontal, but the hatchway was much too narrow to admit of my going down horizontally, so my nose was lifted up and my tail pointed down the hatchway. And then, horror of horrors, I felt myself gradually slipping through my tongs. The men saw it too, and frantic efforts were made to right me again. Too late! Another moment and the tail line snapped like a thread, there was a sharp cry of "Stand from under," as a warning to those below, and then down I went with a crash!

Have any of my readers ever seen a man fall from aloft? It's an awful sight. You become suddenly conscious that something is wrong, then probably the "Stand from under" is heard, making every heart stand still from its terrible significance, and then—it makes me shudder even now to think of it—a mass of whirling arms and legs are seen descending, while every soul seems paralysed with horror, then a hard sharp thud on deck, and all is over! Ah, many's the poor fellow I've seen lose his life this way, and I've wondered what they thought of during their fall. It's a curious fact and shows the innate religion that is in the hearts of most men, that in almost every instance in which a man comes face to face with sudden danger, "God help me" is the cry that comes first to his lips. I have seen ruffians hardened in sin as you'd think, yet in the near presence of death their first impulse is almost invariably to call on their Maker. The reader will probably say, "Well, if he had a fall like this he ought to have some experience of what one's thoughts would be like." True enough, but I'm talking of mortals' thoughts, and as the thoughts of a torpedo would not help in the matter I don't introduce them. You see being broken is only a matter of inconvenience to us, while I fancy men consider it a much more important matter. If I must confess it, I did not think of anything much. I hadn't time to. I just knew I was slipping and thought what duffers they were, when I found myself lying up and down the hatchway with my tail broken.

There was dire consternation among the torpedo men as you may well imagine; 350*l.* worth smashed up again, and so soon, and really through sheer ignorance and carelessness this time. They might well be ashamed of themselves. Poor Hand got into disgrace again. He was not there himself at

* For illustrations and description of Canet's torpedo gun referred to, see ENGINEERING, vol. xxxvii., page 230.

the time the thing happened, but still he was in charge of us, and he had not instructed his men properly, so the fault lay at his door.

Captain Tarr came down on hearing what had occurred, gazed at me thoughtfully for a few seconds, then turned to Hand and said:

"Well, Mr. Hand, I shall be glad to hear what theories you can bring forward in support of this," pointing to me.

"My theory is that the gunner's mate there," pointing to the man in charge of my torpedo carriage, is a d——d fool, and that I'm another for trusting him," said Hand, who was terribly mortified and in a towering rage.

"Ah! Well upon my word I think I must agree with you. I'll report accordingly," and away he went.

I will not dwell here on the commotion that ensued on this accident being reported; suffice it to say that the screw shaft was bent, a portion of the buoyancy chamber damaged, and a few minor details knocked about, but that it was found possible to repair me at the torpedo store at Portsmouth. Accordingly I was landed, and in a week's time was duly returned to the Fearnought as good as new. Soon after this a torpedo lieutenant was appointed to us; and as somebody may ask, what is a torpedo lieutenant? and what is a gunnery lieutenant? I had better explain.

Gunnery and torpedo lieutenants are selected from officers on the lieutenants' list, who volunteer for the work. Those who are selected go to the Royal Naval College, at Greenwich, for a session (nine months), undergoing there a course of mathematics (up to and including integral and differential calculus), physics, fortification, and chemistry, the gunnery lieutenants only doing the calculi, while the torpedo lieutenants go deeper into practical chemistry.

This course being completed at the end of June, two months is expended in torpedo work on board the Vernon. They then separate, the gunnery lieutenants spending eight months more in drilling on board the Excellent, and the torpedo lieutenants having six months on board the Vernon, during which time they go thoroughly into torpedo details.

On the completion of their respective courses they become gunnery or torpedo lieutenants, and are appointed to different ships. The gunnery lieutenant has charge of all the fighting details and gunnery drills (under the captain) with the exception of the torpedoes, which are under the charge of the torpedo lieutenant. It is only within the last few years that torpedo lieutenants have been in existence. Before that, the gunnery lieutenant had entire charge of all the fighting arrangements However, as torpedo use extended, it was found that in large ships (especially flagships where there was fleet work besides) there was too much work for one man to do, so specially trained torpedo officers were introduced. At the time of which I am speaking, torpedo lieutenants were being appointed to the different flagships as they (the torpedo lieutenants) qualified, and so in the ordinary course of events Lieutenant James Eves was appointed to H.M.S. Fearnought.

Jimmy Eves he was called, and was about as curious a character as you'd meet in a day's march. He was rather tall, decidedly stout, and had a smooth face beaming with good-nature, and a tongue which the blue-jackets used to say was "slung amidships," because it never stopped talking.

Dear me! the amount of nonsense that Jimmy Eves *did* talk. Good-natured nonsense, you know, and interspersed with a good deal that was of sterling value. But that was just the point. You had to do such a lot of sifting to get at the good part, that it lost the greater part of its value. I'd like to give you a specimen of his mode of talking, but it would take up such a lot of space that I am afraid it can't be done. So having introduced our new master I'll proceed with my tale.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the American Society of Civil Engineers was held in the Society building in New York on the 21st and 22nd of January. The vote for officers resulted in the election of President, Frederick Graff; vice-presidents, George S. Greene, Jun., and Thomas J. Whitman; secretary and librarian, John Bogart; treasurer, J. James R. Croes; directors, Theodore Cooper, William R. Hutton, Walter Katte, O. Chanute, and F. W. Vaughan. The report of the directors showed that the present membership had reached 878, being 100 greater than a year ago. During the year there have been 1410 additions to the library, which numbers 15,000 volumes. The report of the treasurer showed a prosperous financial condition of the Society. The censors appointed for the purpose, awarded the Norman medal to James Christie, Member Am. S.C.E., for a paper entitled "Experiments upon the Strength of Wrought-Iron Struts," and the Rowland prize was awarded to Hamilton Smith, Jun., for a contribution upon "Water Power with High Pressure and Wrought-Iron Pipe." The notifications and appointments were all given in twenty-four hour time, and the lunch lost none of its attraction from the hour being styled 13.30 o'clock. Dr. Thomas Egleston, of Columbia College, read the report of the committee upon the continuous time system, and stated that the action of the International Conference, recently held at Washington, was in accord with the opinions of the committee in favouring such changes in the ordinary division of time. In reply to circulars of inquiry, 92 per cent. of the answers from persons of general prominence favoured the change, while 98 per cent. of the 171 letters from railway officials expressed a desire for the proposed change in railway time. Those officials who will support the twenty-four hour system represent 59,100 miles of railway. The president of the Western Union Telegraph Company has stated that besides reducing the number of errors, the transmission of 150,000,000 letters would be saved to that company annually by the proposed change. The second day was devoted to an acceptance of the various courtesies tendered to the Society, the first visit being at the New York station of the Consolidated Gas Company, where illuminatting gas is produced by the decomposition of water exposed to incandescent anthracite coal, making what is termed "water gas." The process, although simple, possesses novelty to those unfamiliar with this method of gas making. The first gaseous product is formed in the gasogens, which consist of iron shells lined with firebrick and containing a deep bed of anthracite coal, heated to incandescence by an air blast; when the mass is thoroughly heated the air is shut off, and a blast of steam blown through the coal is dissociated by the intense heat, the hydrogen of the water being set free and the oxygen combining with the carbon forming carbonic oxide (CO), and a small amount of carbonic binoxide (CO_2) is present as an impurity. This product at this stage is what is known as fuel gas, being made and sold in some places solely for heat and power. It burns with a pale blue flame, characteristic of carbonic oxide and of hydrogen. It is necessary to enrich such gas with hydro-carbons to fit it for illuminating purposes. This is done by passing it over shallow trays containing naphtha, whose vapour becoming commingled with the fuel gas, passes along with it through firebrick retorts, where the whole is heated until the vapour becomes dissociated into the lighter petroleum products which are gaseous at all ordinary temperatures. The addition of four gallons of naphtha, and its subsequent gasification, augments the volume of the fuel gas 50 per cent. The gas in the benches is tested by the heat stain of a gas jet upon a sheet of paper, and the colour indicates the excess or deficiency in the carburetting process. When the jet of steam has blown through the coal a short time, the fire is dimmed, and it is necessary to shut off the steam and regenerate the fire by means of an air blast. The process at the first stage is an intermittent one, the several gasogens or converters being used in turn. After leaving the benches the gas passes through the vertical tubes of the condensers, where the greater part of the heavy hydro-carbons caused by the decomposition of the naphtha in the benches, is deposited. Then the scrubbers subject the gas to a spray of water, after which it passes through air-slaked lime to remove carbonic binoxide, before passing through the meter and into the gasholder.

On leaving the gas works the party were taken by a special steamer to the grain storehouses in Brooklyn known as Dow's Stores, described in Engineering, vol. xxxvi., pages 232, 362, and 402, where, under the guidance of Mr. George B. Mallory, the engineer of the building, the party inspected this large work, which has a capacity of 2,500,000 bushels. Thence by boat the visitors returned to New York, where the Society were entertained at lunch by Mr. Cyrus W. Field, of Atlantic telegraph fame, in the elegant Washington building recently erected by Mr. Field for offices. Bidding adieu to Mr. Field and his hospitality, the Society called upon the Telemeter Company (described in Engineering November 14, 1884), and thence went to the Produce Exchange, where they were received, and inspected the building. By one of the nine passenger elevators in the building they reached the summit of the tower, which carries its dimensions of about 50 ft. square to an elevation of 300 ft. The machinery of the traction plant of the Suspension Bridge connecting Brooklyn with New York, formed the next point of interest. The steel wire cable, $1\frac{1}{2}$ in. in diameter and 11,450 ft. long, is kept in motion at the rate of ten miles per hour, by a pair of stationary engines on the Brooklyn side of the bridge, and by means of grips the passenger cars are pulled across the bridge by the rope.

New York and Brooklyn Bridge.

	feet
Size of New York caisson	172 by 102
,, Brooklyn ,, ...	168 ,, 102
Depth of tower foundations below high water, New York	78
Depth of tower foundations below high water, Brooklyn	45
Size of towers at high-water line ...	140 by 59
,, ,, roof course	136 ,, 53
Total height of towers above high water	272
New York tower contains 46,945 cubic yards masonry.	
Brooklyn tower, 38,214 cubic yards masonry.	
Size of anchorages at base	129 by 119
,, ,, top	117 ,, 104
Height at top	89
Length of main span	1595½
,, each land span	930
,, Brooklyn approach	971
,, New York ,, ...	1562½
Total length of bridge	5989
Clear height of bridge at centre of main span above high water	135
Clear height of bridge at centre of main span above Chatham-street (on roadway)	100
Width of bridge	85
Grade of roadway	3¼ ft. in 100
Number of cables...	4
Length of each cable	3572
Diameter of each cable	15⅝ in.
Weight of main span	6740 tons
Total weight of superstructure ...	14,680 ,,
Extreme movement of slip joint of main span	12⅝ in.
Extreme variation in elevation of the centre of the main span	30 ,,

The bridge is lighted by 82 electric lights, of 2000 candle-power each, in two circuits.

The electricity is generated by four 20-light dynamos, driven by two 50 horse-power Corliss engines.

This plant was furnished, erected, and put in running order by the United States Illuminating Company.

Cable Railway Plant.

One steel wire cable, $1\frac{1}{2}$ in. in diameter, 11,450 ft. long, weighing $3\frac{1}{2}$ lb. per foot = 40,075 lb.
Two main driving drums, each 12 ft. in diameter.
One intermediate friction drum, 5 ft. in diameter.
One spur wheel 12 ft. in diameter.
,, ,, 5 ft. in diameter.
Two guide sheaves, 10 ft. in diameter, one on each balance car.
Seven guide sheaves, 10 ft. in diameter, for changing the direction of the cable at various points.
Two packed sheaves, 10 ft. in diameter, for driving auxiliary machinery.

Motive Power.—Two horizontal steam engines, with cylinders 26 in. by 48 in. Each engine has a flywheel, and is capable of acting singly or in conjunction with the other. These engines and the machinery were made by the Dickson Manufacturing Company, of Scranton, Pa.

Four Babcock and Wilcox water tube boilers, 104 horse-power each. These also furnish steam for two 50 horse-power engines, which drive the dynamos for lighting the bridge; also for one 20 horse-power engine in the machine shop, besides the steam required for heating the shops and offices.

One Baragnanath heater, 40 in. by 136 in.
One Knowles pump, cylinders 10 in. and 6 in., stroke 12 in.
One Hancock inspirator.
Engine, speed 57 revolutions per minute.
Speed of cable, 880 ft. per minute, or 10 miles per hour.
Engine duty required to run the machinery and cable, without cars, 35 horse-power.
Average coal consumption for car service, twenty hours, 6 tons.

Rolling Stock.—Two switching locomotives of 9 tons each, built by H. K. Porter and Co.
One switching locomotive of 13 tons, and one of 14 tons, built by the Baldwin Locomotive Company.
Twelve passenger cars, 48 ft. long, and twelve 36 ft. long, built by Messrs. Bowers, Dure, and Co.
Six passenger cars, 49 ft. long, built by Pullman Palace Car Company.
Weight of cars, each 10 tons.
Weight of cars with maximum load, 20 tons.
Present number of cars in each train, two.
Maximum number of cars running at one time, twenty.

damage; secondly; the great majority of projectiles which strike a ship in action would not be at right angles or at point blank range; thirdly, the fire from the light and machine guns would have a terribly destructive effect on the ship unprotected by armour, as every shell would burst inside the ship with deadly effect;" and to still further strengthen the last point he urged that the rate of firing of these small guns would be very much quicker than that of the larger guns, and there being more of them also, the damage done by them would be immense. He then proceeded to submit the following suggestions:

That in view of the recent development of light and machine gun fire, no iron ship is fit to go into action at all, or to be called a man-of-war, which has not got a complete water-line belt of some kind of armour, and that an armoured deck is no substitute for such a belt. Secondly, that a water-line belt of only 3 in. of steel will keep out about two-thirds of the projectiles that are likely to be fired against a ship, for it will keep out all the machine gun fire, and most of the light gun fire which strikes obliquely and at long ranges. Finally, that from a naval point of view, it is a grave, nay a fatal, error, to leave two-thirds of the water-lines of our line-of-battle ships absolutely unplated, and therefore certain to be penetrated in a hundred places by the terrible hail of light and machine gun fire which would be poured upon them in action; seeing that in this condition their seaworthiness would be at least doubtful.

Having made these suggestions, Captain Fitzgerald urged that even now the whole of the so-called citadel ships should be altered immediately, the whole of the armoured deck being taken away except patches to cover the crowns of the magazines, and if necessary other weights should be taken out—coal or even guns and ammunition—so as to enable them to be given a complete water-line belt of armour, at least thick enough to keep out light and machine gun fire.

In order to illustrate his ideas on the subject the lecturer then considered the case of an action between a belted ship as represented by H.M.S. Hercules, and the citadel ship as represented by the Italia, and he considered that the chances of success are very much in favour of the former ship. The respective characteristics of the two ships he described as follows:

The Hercules has a complete belt of 9-in. armour tapering off to less at the ends, and she has eight 18-ton guns protected by 8 in. to 6 in., her smaller guns being unprotected.

The Italia carries four 100-ton guns, which, with their communications below, are protected by armour of great thickness; all her other guns and the whole extent of her water-line are absolutely unprotected even from the fire of heavy machine guns. The Italia having the speed of the Hercules, has three courses open to her: (1) She can run away (which the lecturer considered would be her wisest course); (2) she could play at long bowls (which the lecturer considers would do the Hercules no harm as the Italia would not hit her); or—and this is the course Captain Fitzgerald takes it that she must adopt—she can close and fight it out.

Under these circumstances Captain Fitzgerald was of opinion that if the Italia did not sink the Hercules by the very first discharge of her heavy guns, the latter would certainly put the Italia in a sinking condition before she could fire another shot from the heavy guns, for during the fifteen minutes (about) thus employed, the 18-ton guns of the Hercules would be firing a round a minute, and there would be a perfect hail of shot from the machine and light guns on both sides, the effect being to make a considerable number of shot marks on the water line of the Hercules, and shot holes on the water line of the Italia. Besides this the large capacity shell from the 18-ton guns exploded inside the ship above the armoured deck, would make short work of compartments, cork stuffing, and other devices for keeping the Italia afloat.

Captain Fitzgerald proceeded to express his disapproval of the citadel ships, considering that the appliances for keeping the water out of the unarmoured ends are unpractical, and not sufficient to check the destruction likely to be caused by the fire of light and machine guns. He thought that the citadel ships were designed under the impression that only heavy guns would be used against them, and with the idea that as it was impossible to keep out their projectiles along the whole length of the ship, it was better to keep them out of a part, and trust to cork filling, numerous compartments, &c., as substitutes for armour along the remaining length.

The lecturer then considered how far an armour deck is a substitute for side armour, and maintained that it must be intended not merely as a protection for the vital parts, but as a means of keeping the lower part of the ship free from water, when the upper part, or rather the water-line section, is damaged; and he maintained that in the case of the Italia and some of our own cruisers with under-water decks, the effect of this would be simply to capsize her, likening the arrangements, for dealing with water which gets inside the ship, to dealing with a very troublesome burglar who has been allowed to get inside the house, when with proper cautions to exclude him you might argue the point with him outside.

The lecturer concluded his interesting paper by saying that he considered the new designs in which the armour decks are above the water-line, and slope down to 4 ft. under water at the sides, to be a step in the right direction, but that even here he considered that the weight thus used might be better employed in making a belt round the water-line.

In the foregoing lecture Captain Fitzgerald has taken up a very strong position, and one from which it would be difficult to dislodge him, but there are many points in the lecture which are open to criticism. First, he has confined himself entirely to the question of armour as opposed to gun fire, but seeing that it is generally admitted that the ram and torpedo are each more deadly weapons than the gun, we can hardly allow that they can be left out of consideration when dealing with the question of armoured and unarmoured ships. However, since the paper professes to deal only with the question of "side *versus* horizontal armour," we may confine our criticisms to this point. The lecturer considers that the water-line belt would be effective to a great extent in keeping out large capacity shell, but it must be remembered that the lately introduced steel shell, with gun-cotton charges and base fuzes, will penetrate equally with shot, and do as much damage as shell when they burst inside, so that this argument in favour of the belt falls through.

The point upon which great stress was laid in the lecture, is the necessity of having armour to guard against the effects of light or machine gun fire striking at the water-line, and Captain Fitzgerald considers that a 3-in. steel belt would be sufficient to keep out these projectiles. We will assume, though we cannot admit, that the number of projectiles striking at the water-line would be as great as the lecturer thinks, and suppose his suggestion as to the 3-in. belt carried out, even to the extent of altering all our citadel ships, some of which, by the way, have been *only* seven years building already. Now the Hotchkiss 47 mm. revolving cannon of the latest type, and which is much in vogue with foreigners, can penetrate 3 in. of steel at 500 yards, and this is only a machine gun; while the 6-pounder rapid-firing gun will pierce 3½ in. easily at the same distance; therefore, supposing everything to stand as at present, the 3 in. of steel proposed would perhaps just be efficient to keep out the greater part of the light shot. But can we for one instant expect to remain in *statu quo*; indeed, have we not already made an advance by the introduction of supplementary 6-in. guns (in the Colossus) capable of firing two to three rounds a minute, and penetrating (with steel shell) 8 in. of steel at 1000 yards; and 25-pounders, firing five to six rounds per minute, capable of penetrating 4 in. of steel at 1000 yards? Do we not hear of one of the great machine gun manufacturers constructing a 32-pounder rapid-firing gun for a foreign government, and are they not all prepared to increase the size and power of the rapid-firing guns if required? In the face of all this can we for one moment agree with a hard drawn line fixing the thickness of the belt at 3 in.? It would only be the same old story over again. As the power of the guns increases, the armour becomes worse than useless, and so we arrive again at the point from which we started. A very slight thickness of horizontal plating, on the contrary, would be sufficient protection against the heaviest guns, and in conjunction with it the devices for dealing with the water which may get in (which devices Captain Fitzgerald now stigmatises as unpractical) should be made practical, for there seems little doubt that it is on them that we shall have to depend. The last point upon which we have to remark, is the suggestion by the lecturer as to the instability of those vessels with under-water armoured decks. This has long been a question, and though we understand that at a lecture given by one of the Admiralty officials the other day at the Royal Naval College at Greenwich (since the lecture with which we are dealing), a model of one of this class was tried, and stood the test satisfactorily, yet it would be very much more to the purpose if the experiments were carried out on one of the ships themselves. Naval officers would then know what they had to expect, for either the method of construction would be proved to be wrong, or confidence in these vessels (which is certainly not felt now) would be restored. By the avoidance of a practical test of this kind, the constructors lay themselves open to the imputation that they are afraid the result may be against them, and if this is so, so much the more reason for the truth to be ascertained in time. Naval officers have few means of making themselves heard, but anybody who has moved in naval circles during the last five years, can vouch for the want of faith in these vessels displayed by naval officers generally, and how great is the wish that steps should be taken to test one of them practically.

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. V.

ABOUT this time there was a scare in the Mediterranean, and as usual the Channel Squadron was ordered out there to reinforce the Mediterranean fleet. The latter were, at the time of our arrival at Malta, lying in Besika Bay, waiting to force the passage of the Dardanelles, so that we had the grand harbour at Malta all to ourselves. While there I had two or three pleasant under-water trips, but they were very short, as the size of the harbour or rather the manner in which the shipping fill it up, make it very difficult to get a decent range.

We exercised here a good deal at starting torpedoes from alongside boats, the idea being that you have no boat specially fitted or large enough to carry torpedoes. The latter are therefore charged with air on board the ship, then towed by the boat to within range of the enemy, pointed at her, and then, the engines being started by pulling the trigger by hand, away goes the torpedo.

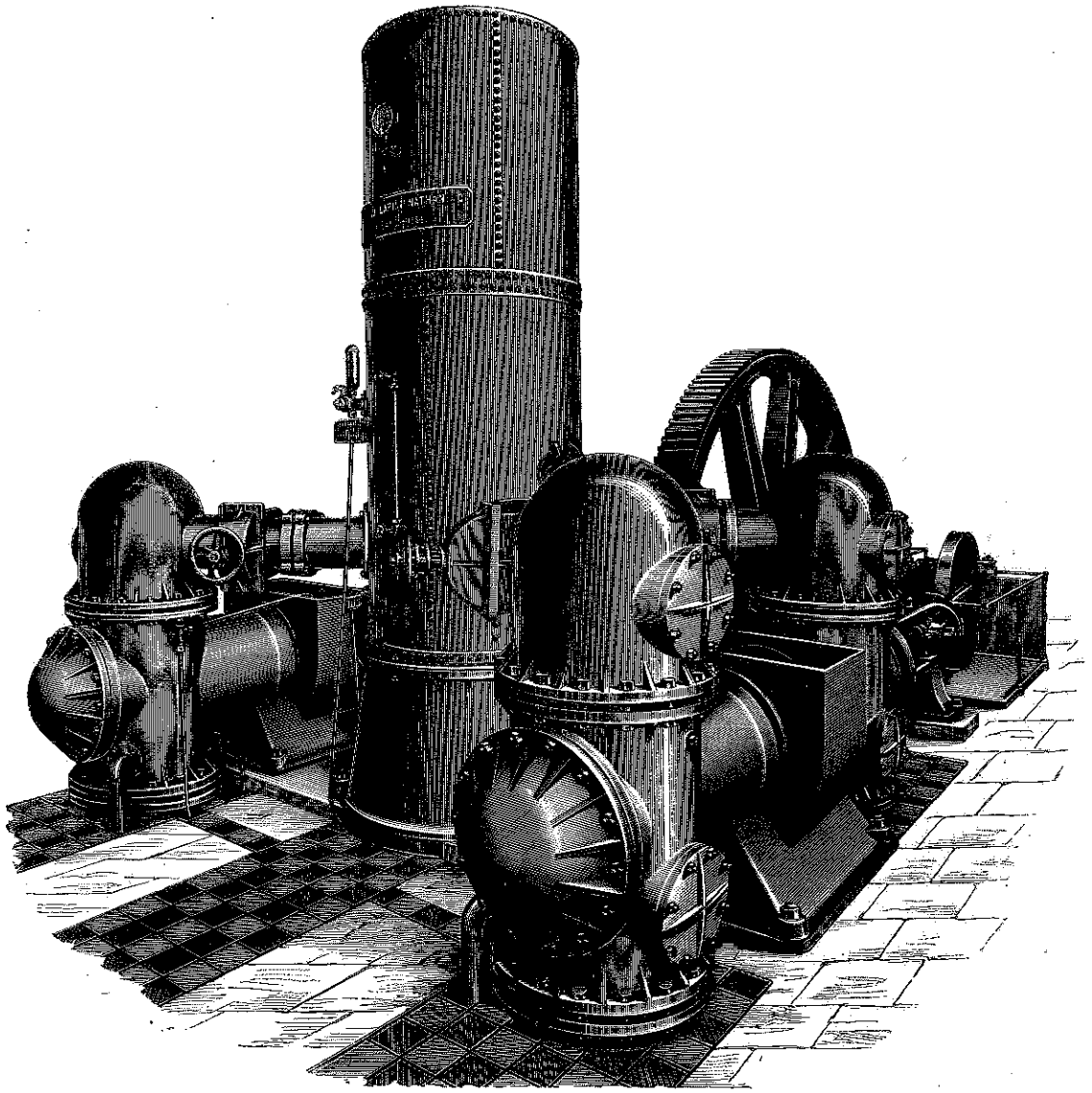
You will remember I have explained that the compressed air, after doing its work in the engines, passes away through the screw shaft which is hollow. In the first torpedoes that were made this was not the case, and the used air escaped through a valve in the top of the torpedo near the trigger. This air you know, on being admitted to the engines, passes through an oil valve, the oil in which answers the double purpose of keeping the valve air-tight, and (since a certain amount passes through with the air) of lubricating the engines. As you may imagine, this air when it escapes is strongly impregnated with dirty oil, and thoroughly marks anything with which it may come in contact.

The first day that we were performing this exercise, it happened that the other exercising torpedo, which was fitted with a top escape like that I have described, was used. It was duly charged on board, towed out to within range of a boat which was doing duty as target, hauled up alongside the towing boat and pointed for the target. Jimmy Eves was superintending the work, and he leaned over the side of the boat in order that, as soon as the direction was on, he might pull the trigger and open the valve. This soon happened, he pulled the trigger, and the result was the torpedo gave a kick and started off, the exhaust air (mixed with its dirty oil), at a pressure of fifteen atmospheres, flying up through the escape valve, striking Jimmy in the face, sending his cap flying up to a height of 40 ft., and causing him to go over backwards into the boat, not so much from the effect of the blow as from the unexpected nature of the assault. He quickly recovered himself, and such a sight you never saw. His face and the front of his shirt were thickly covered with filthy black oil, his hair dishevelled, and the most comical expression on what you could see of his face, as if he did not know whether to laugh or to cry. The former had it though, and after fishing in his cap, which fell down close alongside the boat, he thought of looking after the torpedo. In the excitement caused by the air episode every one had forgotten to look out for it, and now, behold it was nowhere to be found. The

PUMPING MACHINERY.

CONSTRUCTED BY MESSRS. BOSISIO, LARINI, NATHAN, AND CO., ENGINEERS, MILAN.

(*For Notice, see Page 237.*)



counter, Eves said, was adjusted for only 200 yards, and the thing could not have got very far at any rate, so immediate search was made for it. Jimmy Eves, forgetting all about his dishevelled appearance, rowed round and round the spot where it ought to have come up, trying in vain to discover it, and giving vent occasionally to angry grunts. All in vain, though; there it certainly was not; so after an hour's search he was compelled reluctantly to proceed on board and report the loss to the captain.

Captain Tarr was walking up and down the quarter-deck with Hand, the gunnery lieutenant, discussing the arrangements for a grand field-day, which was going to be held on Florian parade ground, when Eves came over the side. He, seeing the captain, immediately made for him, and touching his hat, commenced:

"I'm very sorry sir but I'm sorry to say that it can't be found anywhere it's very odd because I'm quite certain it couldn't go more than 200 yards and yet it doesn't seem to be there I'm afraid that something must have gone wrong with it but I think the best thing we can do is to send divers down at once near the spot because——"

How long he would have gone on in this way, utterly regardless of stops, it is impossible to say, for Captain Tarr interrupted him with:

"What *are* you talking about, Mr. Eves. What is *it*? And who have you been fighting with? Really I must say you have not at all a quarter-deck appearance!"

Hand meanwhile was in roars of suppressed laughter. He at once guessed what had gone wrong, and though he and Eves were very good friends, I dare say he wasn't sorry to see that we could go wrong under skilled torpedo officers quite as readily as with him. Besides, the appearance of Eves, all besmeared as he was and in a violent state of excitement, was too much for any one's gravity. Captain Tarr was so surprised at seeing one of his officers on the quarter-deck (the Holy of Holies of a man-of-war) in such a guise, that he did not take in the ridiculous part of the situation so readily.

Poor Eves had forgotten all about the dirty oil in his excitement and looked unutterably foolish for a minute. He soon recovered himself though, and was just commencing a voluble explanation of the

whole matter, when the officer of the watch came up to the captain, saying, "The captain of the German frigate is close alongside, sir!"

Captain Tarr, telling Eves to wait a minute, went to the gangway to receive the foreign captain, and a moment afterwards the latter appeared. The boatswain's mate piped the side, the marine guard presented arms, and the officers on the quarter-deck all took off their hats politely to the new arrival. After the customary greetings had been exchanged, the German captain said, "I believe I have some of your property alongside my vessel!"

"Indeed!" said Captain Tarr, wondering what that might be.

Hand, who was standing by, immediately guessed what it was; he was a good hand at jumping to conclusions having had a high mathematical education; and turning to Eves he whispered, "Here you are, Jimmy, your lost darling's found."

Eaves pricked up his ears, and the German captain proceeded to relate what had happened as follows:

It seems that every one was on deck listening to fire stations being read, when suddenly a heavy blow was felt as if some boat had rammed the ship very hard, and on some of the officers running to the side, a lot of air bubbles were seen coming up from under the quarter for a few seconds, and then all was quiet. This particular ship was a wooden frigate, and had no Whitehead torpedoes, therefore this solution of the difficulty did not present itself. Everybody got into a great state of excitement as to what could have happened, and an immediate search was made inside and outside the ship. Nothing was found, and then a diver was sent down, with the result that my companion was found sticking in the side, and no efforts that they made could dislodge him.

When torpedoes are exercising they generally have an arrow head screwed on instead of the

Fig. 1.

pistol, so as not to risk damaging the latter. This torpedo came along with an energy of 450 foot-tons (300 lb. at 17 knots about), and you can imagine that the arrow head pretty well imbedded itself into the wooden side.

Captain Tarr apologised for the torpedo's behaviour, and then said:

"You must let me introduce you to the officer who fired the torpedo." And turning round to poor Eves, who had been endeavouring to keep himself out of sight, he introduced him, oil and all, to the German captain, much to the latter's amusement. He was still more amused when he heard the account of it starting.

The reason of its going in that direction at all, or so far, was however still a mystery, but on the torpedo being extricated later on, it was discovered that the counter instead of being adjusted to 200 yards was at 800 yards; so it appears that Eves must have set it wrong. As for its divergence from its proper course (about 10 deg.), the conclusion arrived at was that in opening the valve Eves must have canted the torpedo over, and thus the horizontal rudder, which would at that time be acting to send the torpedo down, must have acted partly as a vertical rudder, and so given it an initial divergence from its true course. Poor Eves got tremendously chaffed about this and didn't hear the last of it for many a long day.

Whilst speaking of under-water movements I can't help telling you of an episode that occurred whilst we were at Malta, though it does not bear on the subject of my work.

I must explain, in ships of the Royal Navy, the men are given what is called "general leave" once a month, when the opportunity occurs. This means that the whole of one watch, that is half the ship's company, are allowed to go on shore for twenty-four or forty-eight hours, as the case may be. A certain time being fixed for the men to return on board, "leave breakers," that is, those that do not return at this time, are punished according to the time that they have broken their leave. If they are absent over twelve hours, a reward is offered to the police on shore for their apprehension, which is increased again in proportion to the time that they are absent, the amount so given being deducted from the leave-breaker's pay. Now, Malta is celebrated for the bad liquor sold by the tavern keepers, and the Maltese police are pretty well known to have, on many occasions, enticed men to drink just before the expiration of their leave, made them insensible, and then kept them locked up somewhere for a day or two, after which they would take them off to their ships and claim the reward. In many cases this was done by accomplices, who hocussed the men, and then shared the reward.

It happened that a case of this occurred when one of the old screw three-deckers had been given general leave. Two policemen brought down a blue-jacket to the landing-place at the Ropewalk, who had been treated in this way, intending to bring him off to his ship. The blue-jacket, however, watched his opportunity, and just as they were going to embark, tripped up the heels of one, knocked down the other, and then jumping into another boat he and the boatman commenced pulling as hard as they could towards the ship. Of course if he got on board before the police, he would be punished for breaking his leave, but would not have to pay the amount for his apprehension. The police, quickly recovering themselves, jumped into their boat and a most exciting chase followed.

News of anything unusual soon spreads, and before the boats had got over half the distance (about 800 yards) men were crowding up the rigging of the different ships to watch the result. The sympathies of all were of course with the blue-jacket, the police being cordially detested by the men generally.

On they came, the police gaining slowly but surely on their victim, and at last, when about twenty-five yards from the ship, they caught him up and jumping on board his boat tried to seize the offender.

Not yet though! They had got hold of a slippery customer, for the next moment he had dived overboard and disappeared under water.

As may be imagined, the excitement was intense. The police eagerly watched for his coming to the surface, ready to seize him in the water the moment he appeared.

Two seconds! three! four! five passed, each seeming an age to the excited spectators. Six! eight! ten! a whole minute, and still no signs of the unfortunate man.

Angry murmurs began to be heard from the different ships, and boats began to crowd round the spot, and an eager look-out was kept in every possible direction. At last it became apparent that the poor man must have been drowned, and the unhappy policemen endeavoured to slink away on shore among the groans of the spectators.

Not so, though. A cutter from the ship is seen approaching, and soon they in their turn were made prisoners and taken on board. When there, however, nothing could be done to them. They simply said that a description of the man had been sent to the police office, and they, in accordance with their duty, having found him, had arrested him and were bringing him on board, when he escaped, and they had given chase as in duty bound. Under these circumstances, nothing could be done with them, so they were unceremoniously bundled over the side and went their way.

Shortly after this, as a group of officers were still gathered together on the quarter-deck talking excitedly over what had just occurred, a dripping figure appeared from under the poop, and coming up to the officer of the watch, touched his forelock and reported "Come on board, sir!"

Every one started as if they had seen a ghost, for there sure enough was our hero safe and sound, and very much pleased with himself too, judging from the broad grin which spread over his face as he reported himself.

The explanation was simple enough. In those old line-of-battle ships, sailing used to be much more resorted to than steaming, and consequently (as indeed is the case with many ships of the present day), the screw was made to lift. This necessitated a shaft or well from the upper deck down to the screw. Malta is a great place for bathing, and when the men were skylarking about in the water, many of them used to amuse themselves by diving down and coming up inside the screw well. The man in question was one of these, and when hard pressed by his pursuers on the above occasion, the idea of utilising his experience had flashed across him, consequently he had made his dive and disappeared as I have related, a feat I must say worthy of a Whitehead torpedo, and so given a place among my adventures.

After remaining a few weeks at Malta our squadron was ordered to Port Said to guard the passage of the Indian troops who had been ordered to the Mediterranean through the Canal. The water at the mouth of the Canal is very shallow, the squadron, when lying at a distance of over two miles from Port Said, being in six fathoms of water. This small depth was the cause of another mishap occurring to me.

We were exercising one day, and I was just going to be fired. The tube was laid at 7 deg. depression, the order "Stand by" given, and then "Fire." Unfortunately something went wrong with the "stand-by" valve, so that very little air got through it. The consequence was that I just went slowly out of the tube, toppling over as soon as my tail fins was freed from the upper guide and going nearly vertically into the water.

Down I went with no chance of recovering my horizontal direction until soon I found my nose buried several feet in the soft muddy bottom, being kept down there by the action of the screws, and so gyrating round and round on my nose. This turning process gradually freed me, and up I came, but unfortunately just pointing direct for the ship. If the screws had kept going I must have come to smash again, but luckily they had performed the number of revolutions for which they were adjusted, and the counter coming into action stopped them when I was about ten yards off. I luckily had not had much time in which to get up my velocity, so I got off with only my arrow head smashed. If I had been fitted with my proper pistol, and had been ready for action, it would either have exploded while I was at the bottom, as soon as the safety wedge had been withdrawn, in which case the ship would have been shaken, or the explosion would have taken place on my striking the ship, when she would have had a hole blown in her.

There was neglect here again, for had the expulsion gear been properly tried, as it always should be before firing, this would never have occurred, or had the French system been used that I mentioned last week, of expelling with a small powder charge instead of the compressed air, such an accident could not possibly have happened.

It was about this time that it was determined to keep the exercising torpedoes on the main deck in their carriages, instead of striking them down below every time. I was heartily glad when I heard of this arrangement, because, in the first place, since my fall, I was always very nervous about going up and down the hatchway. And in the second, I would now be in a better position for seeing and hearing all that was going on about me. With regard to the former I need not have been afraid, for a lesson like that is not easily forgotten, and as I have had occasion to remark before, the best way to make people do right is to let them see the results of doing wrong. Of course I don't want to make out that everything should be broken, when teaching people, in order to show them the results of their evil-doing, but I do wish to protest against the practice of hiding things that go wrong, because they are not to the credit of those in charge. They should be made as public as possible, and a clear explanation given of where and how the mistake was made. A terrible accident occurred about this time which will illustrate this. As I have already told you, we two exercising torpedoes were now kept in our carriages on the main deck, and I was thus a witness to the events I am about to relate.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, February 20, 1885.

THE total sales in iron and steel in New York, Philadelphia, Pittsburg, and in the leading western markets, for the week ending to-day, according to mail advices, show very little increase over the previous week, but indicate better prospects, through inquiries and offers made for material to be furnished during the next sixty days. Among these inquiries are requirements for between 50,000 and 60,000 tons of rails, of from 56-lb. to 40-lb. sections; between 1000 and 2000 tons of bridge iron; about as much building iron; between 20,000 and 30,000 tons of forge and foundry iron; with firm inquiries for sheet and bar iron, &c. The consumers throughout the country are very backward in placing large orders, even when assured that lower prices will lead to restriction of production. The total quantity of ingots converted last year in the United States was 1,538,355 tons, seven per cent. less than for 1883, and nine per cent. less than the highest production, which was in 1882. Pennsylvania's production was 1,029,244 tons, against 1,044,396 tons in 1883. There are Bessemer steel

auxiliary guard plates may be attached to the jaws of the grippers, so as to prevent the cable leaving them upon opening the apparatus to allow a car to stop.

(To be continued.)

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. VI.

OUR guns, like those of all modern ships above the sloop class, were fitted to fire by electricity, and in order that you may clearly understand how the accident just referred to occurred I must explain the lead of the electric wires used in the gun circuit. Figs. 16 and 17 show this lead.

The battery (a large Leclanché of six cells) is placed on the orlop deck below the water line, so as to reduce the chances of its being damaged by shot. From one pole of this battery two wires A A are led. (Note, all wires are insulated.) These wires go up to the main deck together, and then separate, each going its own side as shown, Fig. 17. They then pass along the main deck until immediately under the conning tower, when they go up, each to its own firing key, being joined to one another by a wire crossing the bridge (*a a*). Thus so far we have a complete wire lead from one pole,

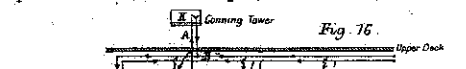


Fig. 16.

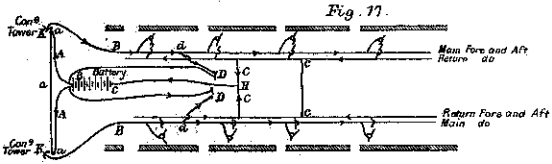
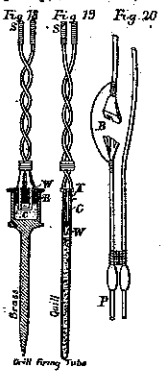


Fig. 17.

through the firing keys and back to the same pole. From the other terminal of the firing keys the wires go down, each on their own side, to the gun deck, where they join the main fore-and-after at B. This main fore-and-after is one of two wires running the whole length of the guns and having branches for each gun let in as shown. These branches are fitted with what are called slots and bolts (which serve to break the connection should the particular gun to which it belongs be not required), and have points at the ends over which the spirals on the tubes fit (see Figs. 18 to 20). Wires C C connect the return fore-and-after with the other pole of the battery, and another wire *c c* joins the return fore-and-afters each side with one another. By following the circuit it will be seen that as long as the firing keys in the conning tower are not pressed down there is a break in the circuit, and therefore no current can flow. When, however, either key is pressed down, if the tube is in



any gun or guns, and the slot and bolts from that gun or those guns, are connected up, then there is a complete circuit on the side that the firing key is pressed down, and the guns so connected up will be fired. The object of having wires connecting the opposite wires at *a a* and *c c* is that if the wires on one side (between L *a* or H *c* for example) are shot away, the current will still act along the other branch. Such is the gun circuit in the main points, but after this was fitted it was found desirable to have means of firing the guns by electricity from the main deck as well as from the conning tower. Hence firing keys were inserted each side at *d d*.

Now we observe that if any of the firing keys at D D or K K are pressed down, the broadside or the guns which may be connected on the side to which that particular firing key belongs, will be fired. It was this double arrangement of firing keys that caused the accident about which I am going to speak.

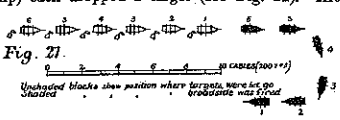
It is customary to test the gun circuit once a month, and as a rule it is always done before firing takes place. I need not stop to enter into all the details of testing; suffice it to say that the real practical test is to put drill tubes in the gun point, connect up the slots and bolts, and see if on pressing down the firing key, the tubes explode.

On this occasion the drill tubes were put in, the slots and bolts were connected up, and Hand, who was superintending the testing, went up into the conning tower to press down the firing key. He had just pushed back the half-cock arrangement ready for firing, when, to his astonishment, off went all the drill tubes on that side. He immediately rushed down again, his impression being that somebody had pressed down the main deck key, but on getting down on the main deck there was nobody near the key, and the men who were about all swore they had not touched it. The only conclusion he could arrive at, was that he had by some means when moving back the half-cock arrangement, completed the circuit. Accordingly the conning tower keys were taken to pieces, and a certain amount of dirt was found inside them, hardly enough, Hand thought, to afford any chance of completing the circuit through it, but as after the keys had been cleaned the circuit tested correctly, he could only conclude that this must have been the cause.

I could have told them better, for I saw everything that happened, which was as follows:

When Hand went up to the conning tower the first time, one of the gunnery instructors who was assisting, seeing the main deck firing key near him (it had been put out for testing purposes) commenced to fiddle with it, and without thinking, pressed the knob. Of course the tubes immediately went off. He directly realised what he had done, and being afraid of a rowing for his carelessness, and there being nobody near (he didn't think of me) he quietly sloped away, so that when Hand came down nobody was near the key. If the man had only spoken up he might have prevented a serious accident.

The next day we had target practice. The fleet was formed in "single column line ahead," two cables distant, and at a signal from us (the flagship) each dropped a target (see Fig. 21). After



running on six cables the signal was made "Alter course in succession eight points to starboard," and then when we (the flag-ship) had gone three cables (600 yards) on this course, again "Alter course eight points to starboard." "Engage as targets come abeam." By this means we would, when all got in line ahead again, be steaming along parallel to the line of targets which would be about 800 yards on our starboard beams. It will be seen by referring to the diagram that when we had got on our new course parallel to the targets, we had about 900 yards to run before the first target got on the beam, so as we were going 12 knots, we had only two minutes and a quarter to spare. The word "Ready" was therefore passed down to the gun deck, the tubes were put in the guns, slots and bolts connected, and the word "Ready" passed up again to the conning tower, to show that the guns were ready. Just then, one of the midshipmen near me getting fidgetty, saw the main deck firing key near him, and like the gunner's mate the day before, he commenced to fiddle with it. He did not know what he was doing, poor little chap, he had only come out fresh from the Britannia a few days before, and hardly knew what electricity meant, Here was something to play with, while they were waiting to fire the broadside, so the next moment down went the key, and off went the broadside. Decidedly well-aimed too, for in an instant down came the whole mainmast and gear of the Aurora, the last ship in the line.

I have taken a long time to tell all this, but really it only occupied about a minute, just time enough, as you will see by reference to the diagram, to bring the Aurora on our beam. Luckily we happened to have a slight roll away from her at the time, so the broadside went high, one of the projectiles bringing down the mainmast, as I have told you.

The author of all this mischief, as soon as the broadside was fired, dropped his plaything, and went to attend to his guns. He had no idea that anything was wrong, and as for *his* having fired the broadside by just pushing that button, he never dreamt of it. However, he soon was enlightened on the subject, and I don't think he'll do *that* again. You see the admiral felt rather guilty for having run the thing so close, so he vented his displeasure on the captain for not having the broadside under proper control. Captain Tarr, you may be sure, passed it on to Hand for carelessness in not seeing the key safe. Hand passed it on to the small middy, and talked to him like a father, and he, poor boy, he had no one to pass it on to, so all he could do was to creep away into a quiet corner, and cry as if his little heart would break, feeling himself a murderer, and thinking sadly how all his bright visions of one day being a second Nelson had been brought to an abrupt end by this awful event. He knew he had done wrong, and behaved in an unofficer-like way in playing with this thing when he should have been attending to his duty—indeed, he had this dinned into him enough, poor boy—and he felt that everybody would be pointing at him, and saying look at that fellow in the midshipman's uniform, he's only a little boy, because he plays instead of attending to his work. He was touched in that most tender of all points in a young man's mind, his manliness. However, he got over it in time, and I saw in the paper the other day that he had taken a first-class certificate as gunnery lieutenant.

I pass over the inquest held by Captain Tarr on the matter; how he went into every little detail, and at last actually ferreted out how the instructor had behaved the day before, when testing. Hand got a "talking to" that he remembered for many a long day, while the instructor was disrated to able seaman on the spot. Serve him right, too, I think. If he had only spoken out when he first made the mistake, none of this would have occurred, as the necessity of being very careful with the main-deck firing keys would have been thoroughly appreciated and steps taken to keep them out of harm's way. You may be sure that after this accident people were careful enough about them. Indeed, on board our ship, they were for some time kept under lock and key, the key being in the gunnery lieutenant's charge. Great inconvenience, however, was found to arise from this, as the gunnery lieutenant had to be chased every time "Electric firing by directing gun" was used, so that eventually the order was given that these keys were to be kept stowed away in their boxes until the order "Electric firing by directing gun" was given, when it was taken by No. 1 of the directing gun, who was responsible that it was stowed away when the firing was finished. I have gone out of my way again to tell you about this accident, but I consider the time by no means wasted, as the incident is instructive in the extreme.

When the accident I have described occurred, the squadron was on its way to Crete, where the inhabitants had rebelled against Turkish rule, and where an insurrection was consequently proceeding. We had no exercise here, but I must

MACGEORGE'S CLINOMETER.

(*For Description, see Page* 260.)

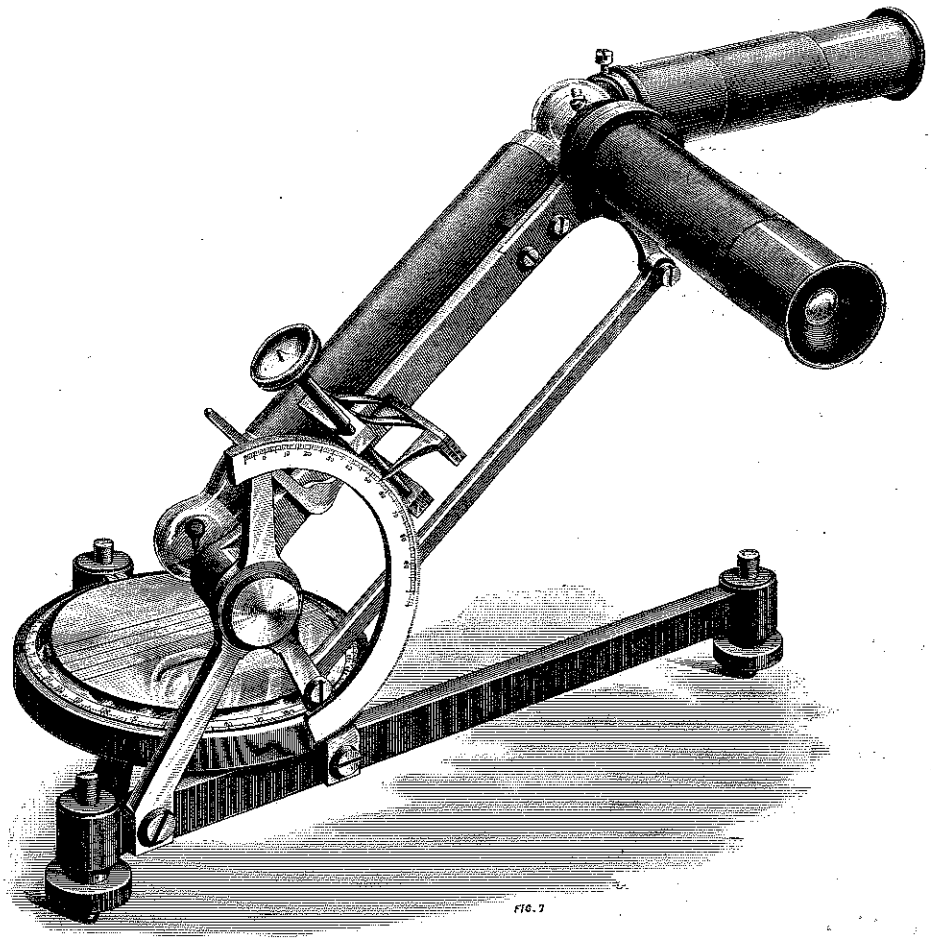


FIG. 7

tell you of an incident that occurred. The reader will perhaps be saying, "This old Torpedo is always wandering off and telling us something quite different to what we are supposed to hear, that is, his own adventures." Well, perhaps I am. But you must excuse me, because when I remember a thing that struck me at the time I can't help thinking that it will amuse you too, so I just tell it. You'd better let me tell the tale my own way. Well—

Fighting was continually going on round Suda Bay, in which we were lying, and great complaints were made on both sides about the atrocities committed by their opponents. I dare say every one will remember the excitement there was about the Bulgarian atrocities. The papers nearly made their fortunes by them.

The Turks being at that time very anxious to stand well in the eyes of the English, seized upon every opportunity of exhibiting the atrociousness (if I may use the expression) of their enemies; consequently one morning they brought off, for the admiral's inspection, the corpse of one of their soldiers who had been frightfully mutilated by the enemy. The insurgents, anxious to defend themselves, a few mornings later brought off the body of a woman who had been treated in much the same way by the Turks. Altogether there didn't seem much to choose between them, though one could not help admiring the splendid physique and endurance of the Turkish soldiers. The pay of these men is a penny a day, and at the time of which I am speaking, they had not been paid for over a year, so that they hadn't much to spend. We left the opposing forces still fighting, we having received orders to proceed to Cyprus, and it was here that an adventure occurred which nearly changed the whole tenor of my existence.

It was a beautifully calm day and everything promised well for a run; the water at Cyprus is particularly clear, and it is a real luxury to have a swim in it, so that I was very pleased when Eves came along the main deck about eight o'clock, and patting me on the back, said:

"Well old fellow you are going to have a swim this morning and I hope you'll manage to swim straight."

I should have liked to have said:

"Thank you, old fellow; you may be quite certain that if you and your people manage me properly I'll go straight enough!"

Unfortunately, not being able to express myself in words, I was unable to hurl this sarcasm at his head, so he turned round and walked away, quite unconscious that I had any feelings in the matter.

Just then I heard Commander Cursem sing out:

"I say, Eves, that torpedo is just beginning to get a proper polish on it. I hope we are not going to have any rubbish in the way of exercise with it."

Eves turned round with his usual grin, and said:

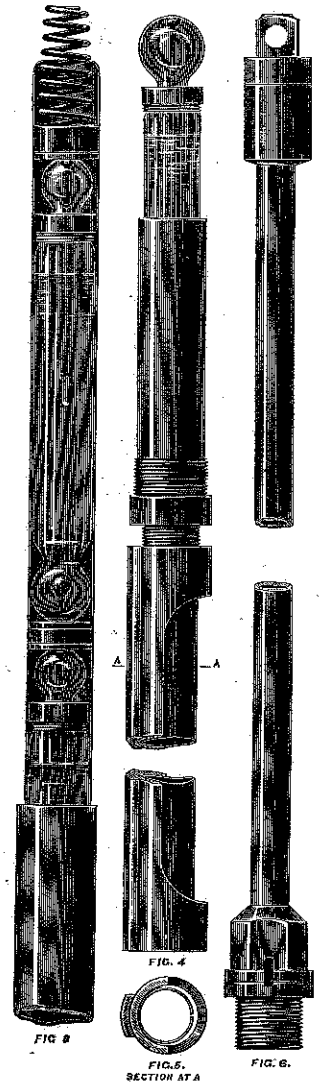
"Oh yes sir I was just going to tell you—the captain wants it exercised to-day."

"Eh! What! Nonsense! The thing is just beginning to look respectable, and now you want to spoil it again. I've had three men burnishing that torpedo for a week, and that's all the thanks one gets for trying to make the ship look decent. It's always the way with you torpedo and gunnery lieutenants, pulling things about and making them in a mess as soon as they get decently clean. You can't have any men this morning. I can't spare them. Besides, it's your forenoon watch. I'll bet you put the captain up to this."

The reader must know that torpedo lieutenants on boardship have to keep watch, but it is expressly laid down that when torpedo work is going on they are to be relieved. Of course the commander knew this, but he always thought it his business to be as obstructive as possible to anything in the way of torpedo or gunnery drills, especially if there was a chance of the cleanliness of the weapons suffering. Hand, the gunnery lieutenant, understood him very well, and used to let him run on, merely saying, "Very good, sir, then I'll enter in the gunnery log that the men could not be spared for the drill;" and as this log was examined by the captain every week, the commander knew that inquiry would be made closely into the matter, and so unless there was a very good excuse, the drill was generally allowed. But Eves was of too excitable a disposition to take things in this way, so whenever his drills were interfered with, an excited expostulation generally followed, which did no good,

MACGEORGE'S BOREHOLE SURVEYING APPARATUS.

(*For Description, see Page* 260.)



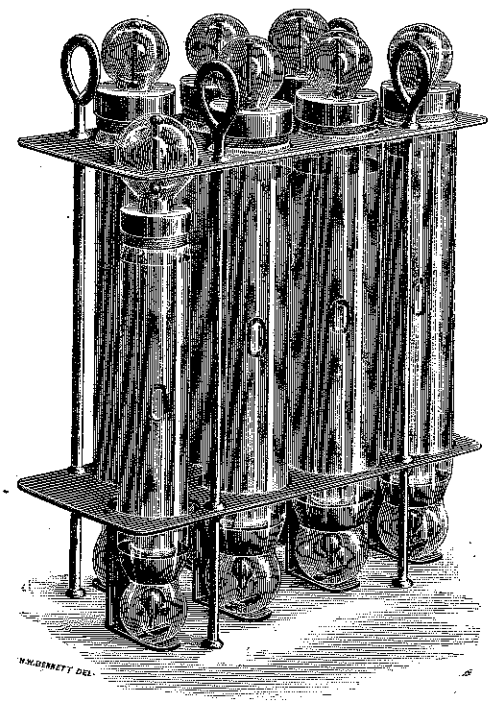


FIG. 1.

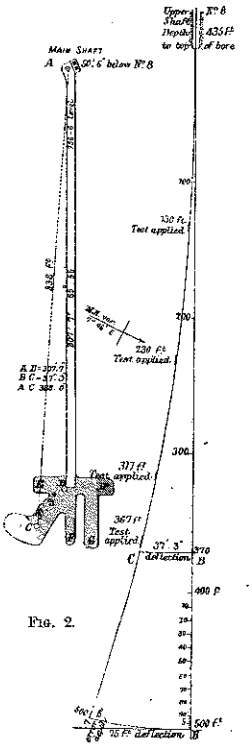


Fig. 2.

and created ill-feeling on both sides. This occurred now, and he ended by doing what he ought to have done at first, touching his cap, and saying "Very well sir I'll tell the captain you can't spare the men," and walking off in high dudgeon. He went down into the ward-room, and relieved his feelings by abusing his superior officer for half an hour to any one who would listen to him, at end of which time the commander's messenger came to him saying:

"The commander says, sir, that you are to have the Whitehead ready for exercise immediately, and please will you be as quick as possible."

As you may imagine, this didn't tend to calm him down much, and in a vile temper he proceeded to make the necessary arrangements for firing me. The result of all this was that everything was done in a hurry and I was not properly looked after. However, I was filled with air, the carriage trained into port, and the necessary adjustments being made, I was fired as usual. I had been conscious that the hot weather we had lately experienced was affecting the india-rubber seating of one of my valves, and I was in hopes that it would have been looked to before I was used again. Now, however, things were done in such a hurry that there was no time for a close inspection, and it was with horror that, almost immediately after making the plunge, I felt this seating go, and the water slowly trickling into me. I made frantic efforts to show that something was wrong. Of course in the natural course of events, as soon as I had made the first dive, down I went to a certain depth, and then the regulating gear coming into play brought me up again, and so I travelled horizontally at the required depth, but now owing to the water getting in, as I turned up, this water rushed aft, and up come my nose at a considerable angle, so much so that I came to the surface with a jump. Then I fell and dived again, the water now rushing the other way, and down I went again. Luckily the counter was only adjusted for 100 yards, and when the screws stopped, having plenty of buoyancy still left in me, I floated and was picked up by the boat which was looking out for me.

I was delighted when they got hold of me I can tell you. As long as I was near the surface the damaged valve did not act, and the water did not come in, so I was safe. I floated a little lower and that was all. I thought I was all right now and fully expected to be towed alongside and hoisted in. Not so, however, for when I got alongside, Eves, who had not yet recovered from his rage at the occurrences of the morning, came down the side, growling at the "infernal torpedo," and expecting to see what was wrong with me at a cursory glance. Of course he couldn't do this, for to all appearance I was the same as ever, only floating a little lower, and what was my horror when I heard him say to the engine-room artificer, who had immediate charge of me:

"We'll give him another run and see if he goes all square I don't see anything the matter he must have struck something and got deflected up."

Has any one of my readers ever had that most terrible of nightmares, in which you imagine yourself about to be killed, and feel that you have neither power to move nor to save yourself? If so you can imagine my feelings on being thus doomed to what I knew was almost certain destruction. A cold perspiration broke out in my every pore, and I believe I actually shivered whilst lying on the clear bosom of the blue Mediterranean. It's no use bothering you about my feelings, though; they couldn't make any difference. So the counter was adjusted, this time for 300 yards, the steam pinnace sent out as a target, and I was started away in her direction from alongside the cutter.

How can I describe what followed?

The same thing happened as in my first run, only my course this time consisted of short runs down, and then ascents ending in violent jumps out of the water, the amount of which inside me increased every time I went down. Still, I had yet some buoyancy left, and I hoped against hope that I might still survive, when what was my horror to find that the spring of the counter had hung and that I was now bound to go until the air ran out. I made an effort and came up for the last time about 400 yards off, then down I went and struck the bottom at the depth of about 25 fathoms. As I struck, my nose caught in the sand and I turned clean over, and as I did so the trigger was caught by a rock and the air valve closed. Too late though. The buoyancy was all gone, for the chamber in which the leak was, was nearly full of water.

The sub-lieutenant of the steam pinnace had meanwhile seen there was something wrong with me, and as I passed the boat he followed in the hope of picking me up. He did get close to me just as I came up the last time, and the bowman made a grab at me with the boathook. He just touched me and no more, so all they could do was to watch me disappearing in the blue depths, buoy the place, and then return on board to report my loss.

The reader may imagine the way the news was received by the different authorities on board.

Eves said, "D——n the torpedo and confound

me for being such a fool as to let it go when I had it safe once."

Commander Cursem said, "Well, Mr. Eves, I hope you are satisfied now at the results of your torpedo exercise. I hope for the future you'll employ your time in keeping the torpedoes in a decent state on board instead of losing all our weapons, which may be wanted at any moment."

You see, he admitted we might be useful when it suited his purpose.

Hand said, "Poor old Torpedo, so you really are gone at last," and then proceeded to try and devise some means of recovering me, and of fitting a theory to account for my loss. The latter he could not do, but he suggested the advisability of trying to pick me up by dragging for me with the ship's seine doubled and well weighted at the bottom. The water was too deep for divers, the greatest depth at which a seaman diver is supposed to work being 12 fathoms.

Captain Tarr of course immediately held an inquest on the matter, but, contrary to usual, no conclusion was arrived at except that I was gone, and nobody disputed that for an instant.

The question now was how to get me back? The water was, as I have said, very deep, 25 fathoms—too deep for divers; there was nothing for it but to try dragging. This dragging is, as most of my readers probably know, carried out by two boats. A long hawser has a weight attached in the centre as shown in Fig. 22. The ends are then taken

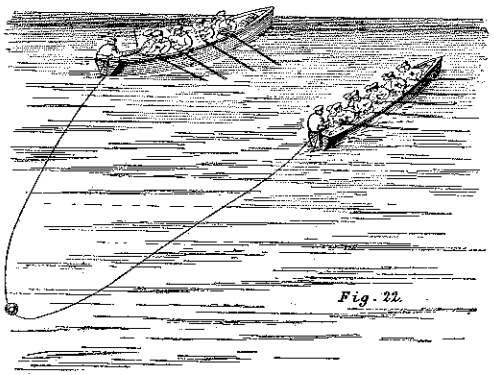


Fig. 22.

in each boat, and they pull slowly along where the object is supposed to be. Should the bight, which drags along the bottom, come across the object, the boats are brought up by it, and, coming together, a ring is put on over both ends and allowed to slip down to the object, which is thus inclosed in a noose, and can be pulled up. It will readily be seen that this is not by any means a good way of picking up a torpedo in deep water, the odds being so much in favour of the bight passing over the torpedo without catching it, or, if it did catch, the chances of getting it up are small, as it would probably slip out. However, it was tried, and for two or three days boats from the squadron dragged steadily over the spot where I was supposed to be. They met with no success, and finally it was decided to try Hand's method with the ship's seine.

The ends of the seine were therefore doubled in towards the centre, leaving the cod A (see diagram)

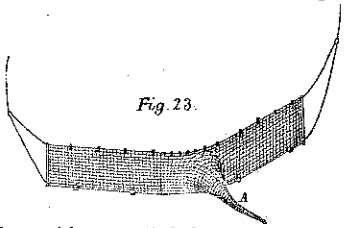


Fig. 23.

clear, weights were attached to the lower edge to counterbalance the flotative power of the corks and keep the net down at the bottom, poles were arranged as usual at either end to keep it spread out, and ropes were attached to the poles for towing. Two steam pinnaces were used to tow, and the dragging recommenced, and was continued for three more days, but with no result save the catching of a few unwary fish and submarine monsters. The conclusion then arrived at was that either I was not there or that if I was, I was uncatchable, so the pursuit was given up, and once again the report that I was lost was sent home to the Admiralty.

I must now return to myself, and relate what happened to me meanwhile.

THE CLINOGRAPH, OR BOREHOLE TEST.

IN our issue of January 9 last we published an interesting communication respecting a lost borehole at the Holyrood Brewery, Edinburgh, where a very ingenious method was adopted of finding the approximate position of the bore. It had become desirable—doubtless because of that natural want of faith in the absolute straightness of the path of the diamond or other drill which every practical man must feel—to ascertain, by means of a drive from the bottom of a well 200 ft. deep, and only 18 ft. distant from the mouth of the presumably perpendicular bore, whether the drill had pursued an approximately vertical course. The drive having failed to intersect this, although an excavation had been made extending 3 ft. all round the spot where it should have been, bar magnets were let down the borehole and a compass taken into the adjoining drive or gallery, and, from the behaviour of this compass under the influence of the bar magnets, the position of the borehole was indicated. It was eventually intersected, no less than 8 ft. away from its theoretical path, which is gratuitously assumed by diamond drill manufacturers to be absolutely straight and true. Such a deflection at only 200 ft. depth would indicate a probable error of at least 40 ft. in 500 ft., and increasing in geometrical ratio, as can be easily proved by holding a straight steel wire, such as a very fine knitting needle, stiffly against the edge of a foot rule or graduated scale at one end, and lifting the other end of the needle until, at 200 parts on the scale, the needle deflects eight of these parts. The deflection at the end lifted, which is at 500 parts (representing 500 ft.), will be found to err, roughly, by the amount stated, namely 40 parts, or feet. In fact, the reader will perceive at once the serious aspect of these deflections—they are increasing errors. If at 50 ft. the error is 2 deg., at 100 ft. it is 4 deg. or more, at 150 ft. it is 6 deg. or 8 deg., and it will pursue a curve of more or less regularity until it returns upon itself, unless the deflecting influences sooner terminate.

It is not very wonderful, therefore, that the common belief in the capacity of diamond drills to bore a straight hole through hundreds of feet of strata of varying densities, and standing or lying at every possible angle to the line of bore, has during the past two or three years been severely shaken. At various places, and notably at Sandhurst and Stawell, in the province of Victoria, Australia, where costly operations were in several instances rendered necessary by a mistaken confidence in the rectitude of drills, the bores made by these implements were found to have deviated so seriously from their initial direction as to imply errors amounting to from 30 ft. to 75 ft. in boreholes of 500 ft. Inquiries recently made in California and other mining States have elicited the fact of grave deflections involving large outlay, and great perplexity having occurred there also. In fact, wherever a drill has touched payable stone, and wherever the results, therefore, had to be mined for, the search for them has been protracted, bewildering, and expensive; and in every case the borehole and the mineral deposits touched by the drill, have been found at a considerable distance from where they should have been. Hence the unpopularity of diamond drills among those who stand most in need of their assistance in prospecting; and hence the necessity of devising some method of detecting their deviations, and of turning their vagaries to useful account by reducing them to rule and measure.

The account of the successful search for the lost bore at Holyrood elicited a letter from Mr. E. F. Macgeorge, of Victoria, who is at present residing at Bailey's Hotel, South Kensington. This letter, which we published on January 23, related that in the case of a lost bore at Stawell, after various methods had been suggested, such as infiltration of chemicals, hydraulic pressure, magnetic action, electrical measurements between borehole and drives, and had been rejected in succession, and after the mining management had entertained serious thoughts of abandoning the search, the writer, struck by the gravity of the situation, devised a simple and delicate, yet effective, means of making a survey of the borehole from its origin. Since the date of the letter we have prepared engravings of the latest form of Mr. Macgeorge's exceedingly ingenious apparatus, and we now publish a detailed account of its construction and operation. The part that is inserted in the borehole (Figs. 1 and 3 to 6) will be found illustrated on page 259, and the instrument by which the indications are read off (Fig. 7) on page 258.

Clear glass phials (Fig. 1) nearly filled with a hot solution of gelatine, and each containing a magnetic needle in suspension, free to assume the meridian direction, were encased in a brass protecting tube (Fig. 3), and let down to the depth required, being allowed to remain for several hours until the gelatine had set. On withdrawal the phials could each be replaced at the same angle at which they had cooled by means of the congealed surface seen through the sides of the phial, and which was brought horizontal. Revolving the phial upon the part where the magnetic needle was seen imbedded in the gelatine, until the needle again was in the meridian, the phial then was manifestly in the same position, both as regards inclination and azimuth, as it was when its contents congealed; and thus the gradient and bearings of the borehole at that part were known, and soon were measured by means of a rough-and-ready angular instrument constructed by the inventor. The mean of the several phials gave a still more accurate result. By repeating this operation at measured intervals throughout the borehole, its course was mapped. Such was the device which was first brought into use in the Scotchman's United Mine at Stawell, and which was so effectual as to enable the borehole to be found shortly afterwards, 37 ft. away from its supposed position at the depth of 370 ft., a deflection which increased to the large amount of 75 ft. at the depth of 500 ft.

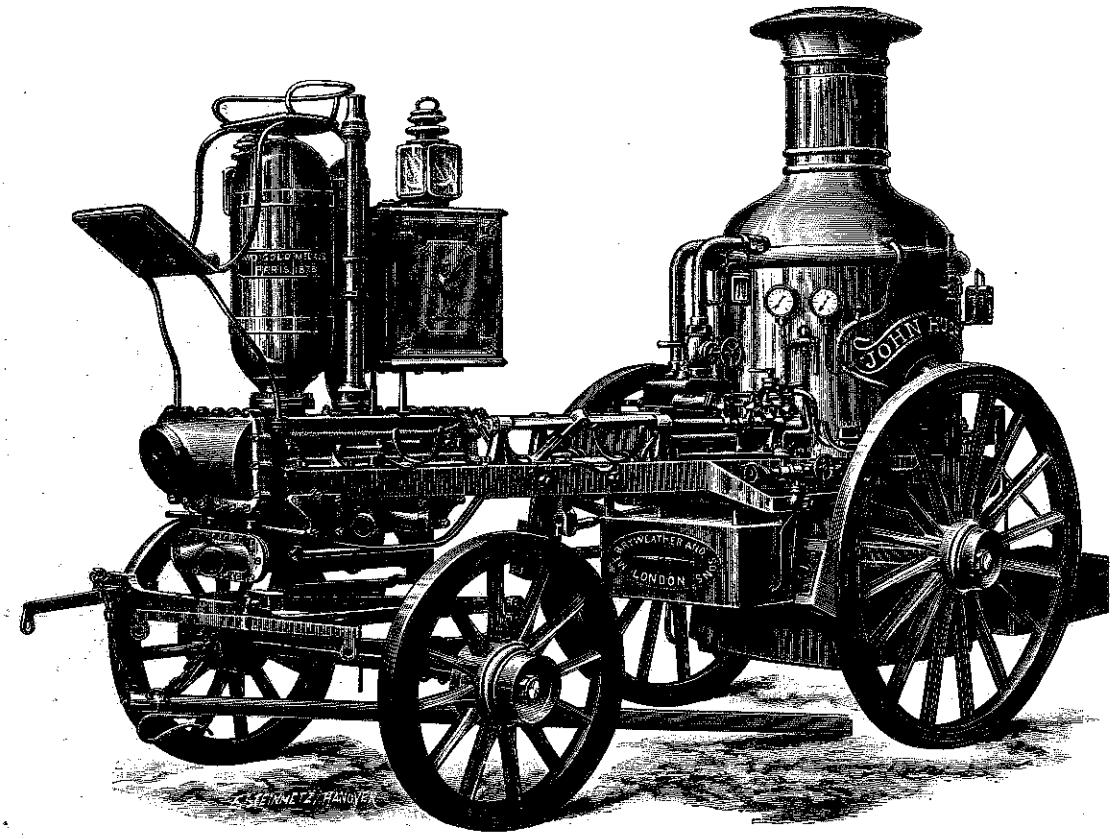
Scotchman's United Mine.—The most obvious waste of work is where the drill has passed through a lode or reef, and where a drive or a shaft, having been carried on for some scores or some hundreds of feet in the supposed direction of the borehole, fails to come within sight or sound of it, and where, after passing far beyond where it should be found, and putting forth crosscuts to intercept it, the prospectors are finally compelled to cut huge chambers in various directions without success. This was done in the above mine at Stawell, before the borehole was found, as indicated by the test, nearly two score feet away from its proper position, in little more than two-thirds of its full depth. This is a serious waste of time and money; yet similar mishaps have more than once taken place, and will continue to do so until mineowners substitute survey for random and costly search. The exact data are given in Fig. 2.

In the plan of the workings will be seen the exploring level A B, which failed to find the borehole at B, its theoretical position if the drill had gone straight down. The subsequent exploratory workings B F, B D, B E, D G were huge

STEAM FIRE ENGINE FOR LIVERPOOL.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, ENGINEERS, LONDON.

(*For Description, see Page* 284.)



THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. VII.

You will remember that I had just struck the bottom, and in consequence of my capsizing on striking, the air valves had been closed, so that I lay an inert mass at the bottom. The chamber that had been filled was one of the smaller ones, so that though I had not sufficient buoyancy left to rise, yet I was comparatively light. There is a strong current runs away to the northward here along the shore, consequently I found that on touching the bottom I was immediately carried away by it, from the fact above mentioned that I was comparatively light. The reader will now understand why all the dragging was of no avail, and that even Hand's patent drag failed to pick me up.

Thus I drifted for about twelve hours, occasionally being stopped by a rock, and anon borne clear of it by the current. The amount of bruises I sustained in this voyage was wonderful, and not only bruises, for in parts I was polished like a mirror by friction with the sand. If Captain Cursem could only have seen me I'm sure he'd have been pleased with my appearance. With reference to this cleaning effect of the sand I am tempted once more to turn aside to give you another instance of it.

It was about a week before the events which I have just related took place, that a stoker belonging to the admiral's barge fell overboard. The barge was lying alongside the ship with steam up, and was moored to the lower boom. For the information of those of my readers who may not know what a lower boom is, I may say that it is a long spar which is used for setting the lower studding sail. In harbour this boom is rigged out perpendicular to the ship's side, and the boats when not in use are moored to it to prevent their rubbing against the ship's side. It was 4 P.M., and this stoker, who had been in the boat during the afternoon watch, had just been relieved to get his supper. Accordingly he climbed up the Jacob's ladder on to the boom, walked in along the boom, and was climbing up over the fore chain to get inboard, when somehow he slipped and fell, striking his head as he did so against the corner of one of the main deck ports, and then bounding off into the sea. The boat keeper of the cutter, which was also laying at the boom, immediately gave the alarm "Man overboard," and dived after him, as did also another man, who was standing in the gangway at the time. Neither of them succeeded in reaching him, however, and though a good look-out was kept by a hundred anxious eyes, he never was seen again.

Three days after this one of the officers who was out shooting near the beach to the northward found his body on the shore, and having reported the matter on his return, Hand was sent with a boat's crew to bury him, and I heard him talking about it when he came back. I avoid entering into the revolting details of how the poor fellow was disfigured, but the one point which bears upon what I have said before about the effect of the sand, was that every bit of clothing and every particle of his hair had been washed off by its action.

Poor fellow! they could do nothing but dig a hole near the beach, lay him in, read the funeral service over him, and then cover him and leave him to his long rest.

One thing about this funeral particularly struck Hand, and I repeat it, as I think it does great honour to the British sailor's heart. After the grave had been filled in, and there being nothing else in the neighbourhood, they had planted some furze over the grave as a sort of headstone, one of the men plucked some of it, and proceeded to put it carefully away. Hand asked him what he was going to do with it.

"Well, you see, sir," said he, apologetically, "poor Jim here had a mother and sister at home, and we thought it 'ud be a comfort for 'em to have something that came off his grave."

This story came into my mind as I was lying at the bottom having been washed up against a steep bank by the current, and I couldn't help thinking sorrowfully that my mourning relatives wouldn't even have the advantage of having something off my grave, unless indeed they had a bucket of salt water, and I fancied that they wouldn't appreciate that even if anybody did take the trouble to present them with it. The remembrance of this story gave me hope, however, for as the poor fellow and I had both gone down in much about the same place, the chances seemed to be in favour of my also being washed up on the beach. Instead of this, though, here I was, in very shallow water it is true, but in such a position that there seemed but little chance of getting myself clear. I wondered that the ingenious Hand had not thought of looking for me in this direction, remembering, as he would be certain to do, the manner in which the drowned man had been washed on shore, and I began to get very low in my mind as the days passed away, and no signs of any living thing appeared—always excepting of course those inquisitive fishes who were perpetually

prying about me, and trying to make out who and what I was.

I had been in this position about a week, when I heard the sound of oars, and listening attentively, I could soon hear voices. The first was that of Eves.

"Well," he said, "I give it up as a bad job here have we been pulling about in every conceivable direction after this old brute" (meaning me) "for the last week and never a sign of it have we seen. I believe it's down at the bottom close to the ship only we can't get at it." And so saying he banged himself down in the sternsheets of the boat just as they were passing me. They had been, as he said, rowing along the shore in the hopes of discovering me, and now, just as he could not have failed to have seen me, for I certainly was not two fathoms down, and the water was beautifully clear, he sat down and gave it up. I could have shaken him, I was so cross with him.

"Well," responded the voice of Hand, who was apparently looking out the other side, "if it's anywhere it should be about here, so keep your eyes open a little longer, old fellow."

Thus adjured Eves gave a grunt and got up again, but of course it was too late then, for they had got well past me, and so the last chance of my being rescued was gone.

After this I lay there for days, years they seemed to me. The monotony at first was simply awful, apparently the same unchangeable dulness day after day, without break or change of any kind. Soon, however, I began to take an interest in the fishy inhabitants round about me, to know them all by sight, and to become familiar with their habits, and this helped me to pass the time away by giving me something to think about. One night I was surprised to see a bright glare spreading over the water, and found that my neighbours the fishes were also in a great state of excitement about it, for they all crowded in as close as they could to the shore, and eagerly tried to make out the meaning of this strange phenomenon. Poor little beggars, they soon discovered to their cost, for, being frightended suddenly by the sounds of human voices, and trying to make their escape into deep water, they found themselves surrounded on all sides by a net. The voices, in fact, belonged to fishermen, who had lit the fire to attract the fishes, and now were drawing in the seine.

I was so taken up with the fate of my late companions that I quite forget how I might be affected by it, until suddenly I found that the seine had caught me and that I was being slowly dragged back to the world again. Somehow I wasn't very glad; I suppose I'm like mortals in that way, once get into a groove and it is an awful business to get out of it again. I had got into the way of lying still and watching the fishes, and now I did not feel inclined for any exertion, and though I can't say I exactly felt sorry at the chance of once more seeing dry land, yet I had the feeling, which I'm sure every one must have experienced at some period of their lives, of its being a tremendous bother, and that I would almost as soon be left alone. However, here I was, being dragged ashore, and I could hear the voices of the fishermen, some English, some Maltese, and others Turks I suppose, for I had never heard the Turkish language before. They were partly swearing at the hard work they had in dragging in the net, made heavy by my weight, and partly congratulating themselves on the splendid haul they fancied they had made. Meanwhile, the sharp edges of my tail were by no means improving the net, and soon I felt that a hole had been made in it, and that I was slipping through. I have explained that I had felt rather as if I did not much want to be released, but now that I found myself slipping through and found that there was a very good chance of my being left to vegetate there after all, a revulsion of feeling took place and I was seized with a great loathing of the life I had led, and an intense longing to be once more on board the old Fearnought, took possession of me. My tail had got right through as I have said, and I gave myself up for lost, when I found myself once more firmly gripped by the meshes and knew that I was again being dragged slowly but surely on shore. The hole made was not large enough to allow the centre part of my body, which as you know is larger than the extremities, to pass; and there being nothing sharp to cut the meshes here, they held me fast, and I was saved. I dare say the reader has had quite enough of my feelings, and perhaps some may even think that a torpedo has no business with such luxuries, so I won't trouble you with them any further. In another minute I was once more on dry land, in company with many of my quondam friends, and surrounded by the throng of half-clad fishermen whose voices I had before heard. They all kept at a respectable distance from me at first, not knowing what sort of a creature I was. Most of them said I was a shark, though some said a dolphin, while others maintained that I was a porpoise. At last, seeing that I made no movement, they plucked up courage and came closer, when they were still more astonished, and the exclamations and ideas hazarded were curious in the extreme. At last one of them touched me and declared I was made of iron (rather insulting, I thought, seeing I was made of the best Bessemer steel), and then they all crowded round to feel me and judge for themselves. One of them paid the penalty for his rashness, for he got hold of one of my screws while at the same moment another opened the air valve (you will remember that this had been closed on my striking the bottom). The consequence was, round went the screws with a sudden twirl, taking three fingers off the man who was holding them, and at the same time the water which had of course accumulated in the hollow screw shaft, was blown out with terrific force into the faces of the other onlookers who were behind me. The effect was wonderful; the wounded man (a Maltese) raised a scream such as only a Maltese could raise, the others, including the man who had opened the valve, jumped back, and the utmost consternation ensued. The valve which had been only partly opened immediately closed again (there being a partial spring in it) and I was motionless as before.

Imagine the excitement amongst the group of fishermen and the bad language that ensued. The man who opened the valve had no idea that it was he who caused all the mischief; everybody had been fingering me, and he with the others only dropped me when they saw the sudden rush of the screws and the jet of air and water. The attack, therefore, appeared to be quite spontaneous on my part, and they could only conclude that I was some wonderful marine monster possessed of intense cunning who had waited until I had tempted them within reach, and then, with a wag of my tail and a spit, as they termed it, had shown that I possessed powers of mischief little dreamt of by them.

Some little time was spent in howls and execrations, and then a consultation was held as to what should be done with me. As this consultation was carried on in English, with which most of them seemed to be more or less acquainted, I could make out pretty well what they said.

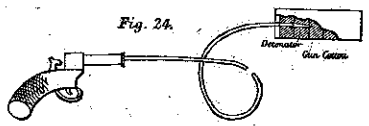
The first proposal was to put me back in the sea again, and was at once agreed to, only when the question arose as to how it was to be done, nobody was brave enough to venture again within range of such a formidable animal, and how to get me into the water without doing so they did not see. This proposal therefore fell to the ground. A second followed, which was to dig a hole just above me in the sand, then drag me into it with the seine and cover me up. This seemed feasible enough at first, but nobody seemed to be inclined to risk the danger that might be incurred in covering me up. A third was to light a fire and burn me, but this was overruled on the ground that I probably could not be burnt as I was an armour-plated monster, and besides the fire would have to be placed round me, and nobody cared to volunteer for the placing of it.

All this time a good look-out was kept on me, it being thought quite possible that I might take the offensive and attack them. Finally it was determined to report the occurrence to the governor of the island, who was then at Larnaca, and see what he said about the matter. Accordingly two of the party immediately set off for Larnaca, while the others proceeded to take steps to secure me, and to this end got a couple of strong ropes (those that were attached to the end of the seine) and making a slip knot in the end of each, threw them hurriedly over my head and tail, half of the party holding on to the end of each rope in case I should kick out. Needless to say, I made no move, so they firmly secured their ropes to stakes driven into the ground, and putting two of their party to watch me, sat down round the fire to discuss the events of the evening.

Next morning, about 10 A.M., I heard the clatter of horses' hoofs, and then the voices of several English people, amongst others those of Captain Tarr and Hand. The envoys had duly arrived at the governor's house late the night before, and insisted upon seeing the governor, refusing to say what their business was, but intimating that unless they were immediately admitted to an audience, severe disaster to the island was likely to follow as a consequence. They were so importunate that at last an aide-de-camp was called, and to him they told the story of some wonderful animal who might ravage the coast, but had fortunately been secured and was held prisoner by their powers. The aide-de-camp was impressed and immediately called the governor, who at that time was Colonel Medland, R.E. He saw the men, and being well up in torpedo work, and knowing that a Whitehead had been lost from the fleet, immediately sent them off to the Fearnought to tell their own tale. They got on board that ship about 4 A.M., and the officer of the watch failed at first to understand what they were driving at, as they still told the story of the wonderful marine monster. He, however, reported to Captain Tarr, who came on deck and soon made out what it was they meant, so telling the officer of the watch to let the men have some breakfast, he sent down for Hand to be ready to land with him in an hour's time. Thus it happened that they made their appearance as I have told you. A cutter from the ship having been sent round by sea at the same time as they left, I was soon released from my bonds, towed back to the ship, and my captors liberally rewarded. Need I dwell on the inquest that was held on me on my arrival. Of course I was in a very rusty state and had to be completely taken to pieces, but the broken valve told its own tale, and so the mystery of my disappearance was cleared up. It was decided that no fault could attach to anybody, and poor Eves was acquitted of blame. The reader will wonder why I say poor Eves, and why Hand, and not he, came to recover me. Alas, poor old fellow he was no more! The manner of his death was as follows:

Amongst other means of destroying life supplied to Her Majesty's ships and vessels, there are what are called hand charges, which consist of slabs of gun-cotton, weighing together 2½lb., confined in a

Fig. 24.



tin case (see Fig. 24). In each charge is a detonator, and to this detonator is attached about six fathoms of instantaneous fuze, having at the other end a pistol by which it can be ignited. The instantaneous fuze consists of a core of cotton impregnated with powder, and covered with gutta-percha in such a way that an air space is left. The core thus burns very rapidly, about 100 ft. in a second.

The method of using the hand charge is as follows:

The man who is to use it holds the pistol and part of the coil of fuze in his left hand, while the remainder of the coil and the charge itself is held in

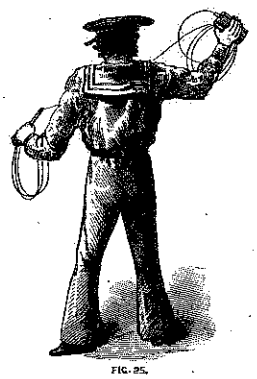


FIG. 25.

the right (see Fig. 25). When the object against which it is intended to use the charge, comes within range, he throws the charge and coil with his right hand, allowing the coil on his left to run out as

horizontal vibrations is shown and marked N H C, the only difference between them being one of mechanical detail necessitated by the change in the position of the axis of vibration from the vertical to the horizontal.

If circularly vibrating cylinders, such as we have described, be immersed in a viscous fluid and set into action, the following phenomena may be observed: 1. The effect upon the fluid itself, setting up therein a field of vibration, and corresponding by analogy with the production of a field of force around a wire conveying an electric current. 2. The effect upon other circularly vibrating bodies within that field of force corresponding to the action and reaction of electric currents upon one another. 3. The effect on pulsating and oscillating bodies similarly immersed, illustrating the mutual effects upon one another of magnets and electric currents. The first of these effects is one of induction, and, from what has been said in an earlier part of this article, it will be understood that the analogy between the hydrodynamic and the electric phenomena is direct and complete. The effects classified under the second and third heads, being phenomena of direct action (in the restricted use of the word), are uniformly analogous to the magnetic and electric phenomena which they illustrate.

(To be continued.)

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. VIII.

AFTER returning once more on board the ship, life went on very smoothly. I was, as I have said, duly taken to pieces and cleaned, my defects made good, and to all intents and purposes I was as sound as ever. Now I come to think of it, though, I am afraid this statement is not quite true, for though the rust had been duly cleaned off and I looked as bright as ever, it had eaten into me, and I did not work quite so freely as I used to. However, I had plenty of go in me yet, and made two or three successful runs.

Meanwhile there had been rumours of trouble stealing about, and at last these came to a head, and we found ourselves actually at war with France.

Now I don't want to make this a political story at all; a Whitehead torpedo should have no politics; all he has to do is to go straight and die manfully doing his duty. But at the same time I could not help hearing what was said by those about me, and from what I heard there seems little doubt that the country was, at the time I speak of, in a bad way. To be brief, the accusations made against the Government were, that for the sake of economy the number and power of the ships had been permitted to fall far below what it should be. It was not for want of warning either, for the public press had for months been filled with articles and letters pointing this out, and showing by figures that could not be disputed that France was slowly but surely creeping up to us in the strength of her navy. One admiral of the fleet was particularly persistent in this respect, and you would think that the opinion of a man like that, who had worked his way up to the top of his profession, should have had some effect; and perhaps it may have had some, but, at all events, here we were at actual war with France, and our fleet, on which everything depended, was not superior to hers. Some said it was actually inferior, but our people did not generally believe that. The next point was, that our guns were all behindhand. Nobody even attempted to deny this. The only excuse offered by the authorities was that they had been waiting to copy from other nations.

Our fellows were awfully indignant about this, the more so that it was a well-known fact that the system of wire building for guns, offering as it did very many advantages, and which had been at last very nearly adopted, had been persistently urged on the Government for the last twenty years. It showed such petty official jealousy they thought. The inventor was an engineer, and not a gunmaker. Hence the gunmakers refused to listen to him, until they were at last actually obliged to, when, as we know, it was too late.

However, here we were arrayed against France, and the thing was to make the best of it. We, the proper Channel Squadron, were ordered to remain out in the Mediterranean, our places, as usual under the circumstances, being supplied by the reserve ships, and ships especially commissioned. We did not join the Mediterranean squadron, however, but two of their ships were sent to join our flag, thus making the squadron up to eight ships. The reason for this I only imperfectly understood, but it had something to do with the arrangements of the French fleet, part of which were at Toulon preparing for sea, while the remainder were somewhere over on the North African coast, threatening Malta or Gibraltar. It was the former portion of the enemy that we were told off to look after, the other part of the Mediterranean Squadron watching the remainder.

Our duty was to keep a good look-out on the movements of the enemy, running in as close as we could by day and retiring to a respectable distance at night. We had six second-class torpedo boats attached to the fleet, and these were always kept in the water (except on the approach of bad weather) and with the steam pinnaces of the fleet, did

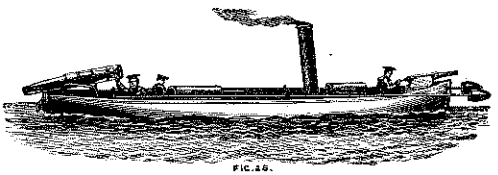


FIG. 26.

duty as guard-boats, forming a cordon of about two miles inside the squadron, so as to give timely notice of any attempted torpedo attacks on the part of the enemy. Besides this the ships always had their torpedo nets out at night, and one watch was almost always on deck specially detailed to man the guns (machine guns especially) should the enemy attempt to attack us with torpedoes. They on their part had swift cruisers always on the watch and an opposing force of torpedo boats guarding the harbour.

Matters went on like this for three weeks or more, many feints at night attack being made on both sides, but neither party making a real attack.

Having been used as an exercising torpedo, I was very much afraid that now we had come to real fighting I should be sent below, and my place taken by one of the torpedoes which had not been used. But to my delight it was determined that I should have my proper gun-cotton charge in, and be used should occasion occur. The reason for this rather unusual arrangement was that I had been running uncommonly well lately, and Hand (who still had charge of the torpedo work as well as the gunnery) considered it was better to have one which they knew than one which had not been practically tried. Two other torpedoes were placed in the second-class torpedo boat, which had, together with a new and powerful steam pinnace been sent out to us. The latter, however, though capable of steaming sixteen knots, and being fitted with most of the latest improvements, had no Whitehead fittings. To remedy this, Hand proposed that when necessary one of the carriages belonging to the ship (there were three on board) should be hoisted into the pinnace without its slide and placed pointing over the stern (see Fig. 26).

This method up to that time had never been adopted in the service (indeed I don't think even now it is recognised as a service fitting), and was one of Hand's original ideas. His plan was to run up astern or down ahead of the enemy, until getting pretty close, then swerve to the right or left, and fire his torpedo going away from the enemy. He was convinced that by this method a more effective attack could be made than by the ordinary method of firing ahead, because:

1. The boat could be more readily got into position.
2. She need not stop to deliver her fire.
3. There was more chance of the boat escaping.
4. There would be less flurry in the minds of those on board when they appreciated that each moment was taking them further from the danger instead of running them into it.

Considerable objections were raised to this last proposition of Hand's, his opponents saying that anybody worth his salt would not be flurried by running into danger, and that it was a cowardly thing to strike your enemy and then run away.

To this Hand replied, that however cool and fearless a man might be, he must appreciate the fact that the boat and the lives of several of his fellow-creatures were in his hands; that it was his duty to do as much damage to the enemy as possible with a minimum amount possible to himself; that it was acknowledged amongst all civilised nations, that the duty of a torpedo boat was to deliver her blow, and then escape if she could, and that if the officer in charge knew that his boat was running out of danger, he would have his mind free to think of the discharge of the torpedo alone. If only the officer's courage were called in question, he could show that, by going as close as he liked to the enemy before turning, and he hoped to show them if the opportunity occurred, that this courage was not wanting.

This idea of Hand's had been broached before war was declared, and I had been fired from the old steam pinnace several times very successfully. Now, as you may imagine, he was very anxious to try it in real earnest. Accordingly he had spent much of his time in observing the position of the French fleet whenever we got near enough to do so, and the outcome of it was, that he proposed to Captain Tarr to make a night attack on the French fleet. A dash of all our torpedo boats would have had no effect, as it would simply have meant a hand-to hand fight with the numerous guard-boats at the entrance of the harbour. What Hand proposed was, to take the main portion of the boats, to divert the attention of the French guard-boats by an assumed attack on one of the smaller vessels, which were used in combination with them to patrol the entrance. By this means he hoped to be able to get the mass of the guard-boats away to the western entrance, while he, with two boats, the second-class torpedo boat and the new pinnace, would creep in along the eastern shore and attack two of the vessels lying furthest out in the roads. Captain Tarr thought the matter over, and fancying there might be some chance of success, laid the proposal before the admiral. After some debate the latter agreed to it, but objected to Hand going away in charge, for should anything happen to him, there was the gunnery and torpedo lieutenant gone at once. This was a great blow to Hand, who of course was longing for an opportunity to distinguish himself, and thought it very hard lines that he should not have the chance of coming to the front in his own particular line. The admiral, however, was firm, but promised him that should the attack be successful, his claim for promotion should be fully recognised. With this Hand was fain to be content, and putting his own feelings on one side busied himself with preparations for the attack.

There would be no moon on the third night from the time when this was settled, and it was decided that the attack should take place then. A lieutenant was told off for the second-class boat, while the sub-lieutenant (Willis) belonging to the steam pinnace, and who had always been in her when the trials were carried out with the torpedo over the stern, was allowed to remain in command of her. Captain Tarr was very undecided for a long time about this latter arrangement, as he thought so young an officer very likely to be flurried. Still Willis had seen the thing done many a time when practising, and finally it was decided that he should go. I rather fancied that I might be sent as I had generally been used for exercising in this way, but another carriage was taken, and the torpedo that happened to be in it at the time was selected. Just as well, too, or else I should never have been able to write these my adventures. However, I can tell you pretty well what occurred; indeed I can throw more light on the matter than most people, because I happened to hear a conversation between two of the men afterwards, which never came to the ears of those in authority—more is the pity! The pinnace and torpedo boat left the ship at about 11 P.M., the squadron being at that time twelve miles off the harbour with a pretty fresh breeze blowing from the north-east. It had been arranged that the guard-boats, which as a rule kept in two lines inside of us, should, at half-past eleven, edge further down to the westward, and make a feint of attacking one of the corvettes in that direction. Certain gunboats were to be fired

so as to endeavour to attract the guard-boats that way. Of course it was not expected that the whole bevy of the enemy's boats would swarm down to the point attacked. But Hand fancied that there would be a general move right along to the westward, and that by these means the two boats might be able to creep up the eastern shore unobserved. True there were powerful batteries there and sentries on them, who kept a bright look-out, but there were so many of the enemy's boats perpetually passing in and out that the probabilities were they would be able to pass without much trouble, if an alarm was not given from the boats.

True to time the sham attack commenced, and indeed it became a real attack, for one of the second-class boats getting pretty close to the corvette, fired a Whitehead at her, which, however, had no effect, and our boat got terribly knocked about with machine gun fire for her pains. A sort of desultory action then took place between the boats, our object being to keep them employed, and theirs to defend the corvette.

Meanwhile the two boats crept stealthily along the shore, meeting with no obstruction of any kind, but going very slowly to avoid making any noise with the engines. They met with no adventures of any kind until they got inside the forts, and were beginning to look out for the ships which they had come to attack. The night was, as I have said, intensely dark and hitherto they had been guided by the compass, the wash of the waves on the shore, and the occasional loom of the forts. According to their calculations they had not got very far inside these latter and had yet some little time to go. Suddenly, and as it appeared almost close alongside them, rang out the sharp "Qui vive" of a French sentry. You may imagine they were rather startled, but soon recovering, they looked eagerly to see where the hail came from. Meanwhile the "Qui vive" was repeated, and the flashing of a light showed a vessel on the starboard beam. I should have told you that the pinnace had her outrigger torpedoes on board as well as the Whitehead (see Fig. 26), and a sudden bold resolve flashed upon Willis. He was a very good French linguist, and immediately answered "Jean Bart," at the same time moving ahead with his engines, and rigging his port torpedo out quietly. You see he had no idea what the proper answer to the "Qui vive" might be, but he thought by answering the name of the French flagship, Jean Bart; even if it did not mean anything, it would at all events make them hesitate as to whether it was one of their own boats or no, and by the time they had made up their minds he hoped to be alongside.

[In the English Royal Navy, when a sentry sees a boat approaching any time of night, he always hails her "Boat ahoy," the persons in the boat, if they belong to the service, answer as follows, according to their rank:

An admiral answers "Flag;" a captain, the name of his ship; a commissioned officer, "Aye, aye;" all others, "No, no."

Not content with this though, as he couldn't see how the vessel was laying, he hailed her again in French, in peremptory accents, "To show a light." The people on board had now evidently made up their minds that it was one of their own boats wishing to come alongside on some urgent business, for a light promptly appeared, and by it those in the pinnace could see the man ropes being put over the gangway ready for the supposed friends to come up the side. Willis saw not only this, but the light enabled him to see the position of the ship. Accordingly he steered right up under the quarter, as if going alongside the starboard side, only when he got there (going quite slow) he suddenly put his helm to starboard, got his port torpedo in good contact, fired it, and then went full speed astern (see Fig. 27). The result was instantaneous. A heavy concussion was felt, making the boat shiver from stern to bow. A tremendous wave was thrown over the boat, partly filling her second foremost compartment, which was not covered in, and the whole French ship seemed to spring into life. Confused shouts and noises were heard, and three or four of the guns were fired, apparently quite at random, showing that the men were there ready, and had simply primed and fired in the confusion. Meanwhile the boat went astern, and under the influence of her starboard helm the bow came round to starboard. One would have thought that enough had been done then, and that he might honourably seek his own safety, and that of his boat's crew, but the brave young fellow was not thus satisfied. Allowing the engines to run on astern till he had got well off the starboard quarter, he then deliberately went on ahead again, steering so as to bring him up on the starboard beam, and then putting his helm hard a-port, he headed away from her, and the moment his stern was pointing at her fired his Whitehead at a distance of a little over a hundred yards. A few seconds afterwards a second explosion showed that this, too, had taken effect, and then he thought it high time to be off. Even then he preserved his coolness, and instead of drawing forward his fires and going away at full speed, which would

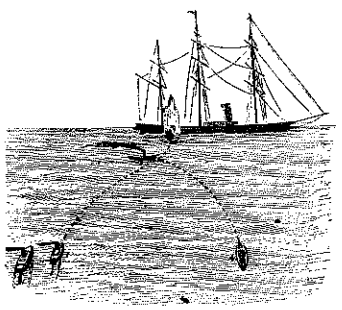


FIG. 27

have necessitated a volume of sparks from the funnel, he quietly made for the point at which he had entered the harbour, and soon disappeared into the darkness at the mouth of the harbour. He began to hope then that he would be able to crawl out as he had come in, but in this he was disappointed, for a few seconds only had elapsed since his getting clear, when electric lights began to play over the surface of the water from the ships inside the harbour and from the forts. The latter were the worst, since from either side a beam was thrown right across the entrance. There was no help for it, he must dash through this illumined part to get clear.

Meanwhile the water in the boat was washing about and seriously interfering with the stoking, so baling and pumping were at once resorted to, and the water soon began to diminish perceptibly. By the time they had approached the beam of light it was pretty well clear, and the fires began to burn brightly once more. Nothing for it now but a dash, and ordering the engineer to go ahead full speed, he steered straight for the middle of the entrance. In doing this, he knew he should probably have to run the gauntlet of two or three of the guard-boats outside, but he thought this preferable to the risk of being sunk close in shore by the batteries. For if once he got among the guard-boats, the forts could not fire for fear of hitting their own friends.

Whiz! Bang! And a shower of shrapnel bullets striking the water well astern of him as he passed the light, showed that he had been seen. The guns were evidently trained on the light, but allowance had not been made for his speed. Another shot with the same result. Try as he might, he could not get out of that beam of light which was kept on him unflinchingly. At this moment he heard the sound of a boat coming up astern and apparently flying through the water in pursuit. He gave himself up for lost then, recognising that one of the French torpedo boats was in pursuit. However, he determined to fight to the last and to this end prepared his hand charges ready for close quarters. At this moment he heard a voice from the approaching boat, saying quietly, "Starboard a little."

CABLE TRAMWAYS.

By J. BUCKNALL-SMITH.

(*Continued from page 257.*)

THE fourth cable tramway in San Francisco was constructed about two years after the California-street line, the route selected being Geary-street, a central and densely populated thoroughfare connecting some of the principal business centres and attractive resorts of this beautiful western city. The gradients upon this line are, however, comparatively unimportant, as will be seen upon reference to the longitudinal section as represented in Fig. 35, page 308.

The Geary-street cable tramway was completed in March, 1880, under the superintendence of Mr. W. Eppelsheimer, the length of the line being about 13,200 ft., or 2½ miles; the gauge is 5 ft. The Market-street terminus is 35 ft. above datum level, and the maximum elevation attained is about 350 ft. above this base.

The construction of the permanent way and cable tube used upon this line is shown in the transverse and longitudinal sections, Figs. 36 and 37 respectively. The central slotted tube A is practically of similar construction to other examples already described, and with the exception of drawing attention to its very compact or small section (viz., about 7 in. by 13 in. in the clear), a very cursory explanation will suffice to make its construction understood.

B represents one of the intermediate trough-shaped castings which form the principal elements of the tube. These carry the slot beams or rails *b* (in this case ordinary inverted rails), so arranged as to leave a parallel opening or clearance *c* between them, through which the cable grippers operate and travel. The sides, bottom, and foundations of this tube are chiefly composed of woodwork D, as represented in the drawing, the side planks, however, being so arranged as to be capable of being readily withdrawn and replaced by concrete if desired. The rails E are laid upon longitudinal wooden sleepers carried in chairs *e* connected with the tube frames by transverse and diagonal bracings *f* and *g*.

The cable supporting pulleys H, situated at suitable intermediate distances along the tube A, are of special design, as will now be explained. The type of cable-gripping apparatus used upon this line differs from those employed and described upon earlier lines, inasmuch that the jaws are arranged to engage and hold the cable in the same vertical plane as the slot in the tube, as referred to in our last article, in contradistinction to the ⌊-shaped type of apparatus.

In consideration of the action of this type of gripper, and of the accepted desirability of allowing the cable to travel out of the plane of the slot, in order to prevent some amount of wet and dirt falling upon it, a special form of supporting pulley was designed so as to meet both requirements. These pulleys are about 3 in. broad, and are formed with inclined or conical peripheral surfaces terminating with vertical flanges, as shown in Fig. 36. X indicates the centre line common to the tube slot, grip-shanks, nipping jaws, and cable when the latter is engaged in the jaws, and Y shows the position of the hauling cable when running free upon its carrying pulleys H.

It will now be understood that although the passing cars drag the cable into the same plane as the tube slot, it is caused to so return to its supporting pulleys and slide down their inclined surfaces, as to run when free under cover of one of the slot rails *b*, as shown at *h*, Fig. 36.

Figs. 38 and 39 represent a side elevation and an end view (with quadrant frame removed) respectively, of the Geary-street Company's gripping apparatus above referred to. A is the operating lever, terminating with the bent enlargement *a* working upon the fulcrum a^1 carried by the plate B to which the quadrant frame *b* is attached. To this lever there is pivotted a double link *c*, the opposite extremity of which is connected to the carrying plate or bar *f*, which is suitably attached to the central grip framing of the dummy car. C are the vertical shank or actuating plates, fixed at their top ends to the quadrant plate or bar B, whilst their lower extremities terminate with the framing D provided with horizontal rollers E. The lower framing bar *f*, connected to the car, carries the central shank plate F terminating with the jaws G, mounted upon hinged joints *g*, so as to be capable of moving radially to or from each other as the rollers E are raised or lowered in a vertical plane. These swinging jaws are fitted with suitable metallic packing pieces *h*, which may be readily replaced when worn out from pressure or friction upon the cable I. In this apparatus, it may be observed that no small friction or carrying pulleys are provided for the cable to run upon, when the jaws are released, and as in the other gripping appliances described in our previous articles.

In the accompanying illustrations the gripping apparatus in question is shown in its open position, and the cable is therefore assumed to be running inoperatively through it. When it is required to close the apparatus in order to impart the movement of the cable to the dummy, then all that is necessary is to pull over the lever A from right to

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. IX.

SUDDENLY it dawned on him that this was their own torpedo boat, which he had forgotten all about in the excitement. Uttering a loud "Hurrah" he once more turned all his attention to extricating himself from his perilous position.

To explain the presence of the other boat I must go back to the time when the Frenchman first hailed. Griffiths seeing the pinnace go off boldly to attack the corvette, thought he would try the other French ship, which they knew to be close to this one. Accordingly he steered by compass in the direction he knew she would be, but failed at first to find her. As soon, however, as Willis had exploded his first torpedo, lights appeared on all the ships, and he discovered an ironclad just inside him. Hastily preparing his torpedo, he went straight for her, and when within about 100 yards, as he thought, fired, putting his helm hard a-port, as soon as he had done so, and so turning his head out.

To his surprise and mortification no explosion followed, and he was about to turn and renew the attack with the other, when the signs of increasing activity round him showed that if he wanted to get away at all, he must go now. Accordingly he drew forward his fires, and went out at full speed, keeping a good look-out for his colleague. Thus it was he appeared coming up astern of the pinnace. In a very short time he came up alongside, and then slowing his engines a little, so as to keep with her, they dashed on side by side. So they proceeded for about five minutes, when two or three dark objects ahead showed that they had reached the guard-boats, now thoroughly on the alert. Willis now rigged his starboard torpedo pole out until the torpedo was just skimming the top of the water, and seeing a boat ahead, went straight for her. She had very little way on, and the next moment the torpedo came in contact with her, and was promptly exploded. The heel tackle of the boom was not strong enough to stand the blow, and consequently the torpedo rigged in so that at the moment of firing it was not more than about 4 ft. from the pinnace's bow. Further, the speed she was going at carried her right on, on the top of the Frenchman, Fig. 28. The consequence of this was that the French boat went down almost instantly, while the bows of the pinnace, weakened by the explosion, were knocked in. Luckily these boats are fitted with a water-tight bulkhead, and so did not fill, but she was in a terribly crippled condition, and her speed was seriously impaired. Griffiths mean-

Fig. 28.

while dashed at the next boat and tried to ram; unfortunately he just missed her, passing a few feet astern. She had suddenly gone ahead full speed to avoid him. So as he shot past, the Frenchman also went away on his starboard beam. Hastily throwing a hand charge, which only just struck the enemy's stern, but luckily broke the tiller, Griffiths went on to the assistance of the pinnace, which was now lumbering along about 20 yards on his port bow. Ranging up alongside he took her in tow, and the two made for the ship, going about 12 knots. Meanwhile the enemy's third guard-boat, which had been sighted, came up on the port quarter, and began firing shell from a Hotchkiss gun with which she was armed. The pinnace's gun had been dismounted by the collision, and even if this had not been the case, it would have been useless, as it did not train abaft the beam, but the second-class torpedo boat responded with her 1 in. Nordenfelt gun.

The fire was not very effective on either side, as there was a lumpy sea on, which made it extremely difficult to make a hit. Our boats (especially the pinnace) had the worst of it, as their vital parts were more exposed to the fire; the defensive arrangements being more especially intended to protect the boat from fire from ahead. On the other hand, the volleys fired from the Nordenfelt were, in the choppy state of the sea, more effective than the Hotchkiss gun, for every time the sights could be brought on, a volley of four shots were delivered, while Hotchkiss only fired one shell at each discharge. Rifles were freely used from all the boats, but apparently with no results, the shields being proof against the bullets. Matters went on thus for about a quarter of an hour, the Frenchman declining to come to close quarters with his two opponents, but hanging about 50 to 60 yards on the port quarter and trying to disable the engines by his fire, when he hoped that some of his consorts would come up and enable him to effect a capture. Affairs were in this state, when suddenly two more torpedo boats appeared off the starboard bow and steaming towards them. Willis hastily called out to Griffiths, "Hadn't you better let me go, sir, and look out for yourself?"

To which Griffiths responded, "I'll hold on as long as I can, but if they try and ram, we'll do better apart."

The Nordenfelt gun on board the torpedo boat had meanwhile been trained on one of the new opponents, and the captain of the gun, now in a state of the wildest excitement, fired his first volley and shouted, "Take that ye blackguard!"

The result of the shock was to knock the funnel of the approaching boat over, but the result of the expletive by the captain of the gun was still more satisfactory, for a voice immediately hailed, "Boat ahoy!" "Hurrah" was the instantaneous response from every throat on board the two boats, and Griffiths, thinking the tables were now turned, slipped the pinnace's painter, put his helm "hard a starboard," and turned round at the French boat.

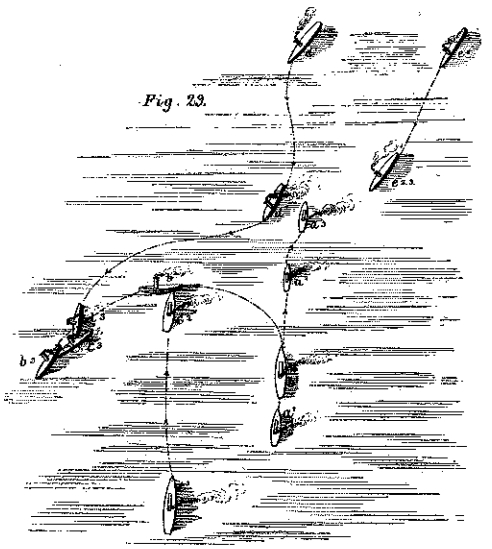
It was done without thought, his only idea being to turn on his opponent, but the Frenchman immediately seized his advantage, and, slightly starboarding his helm, ran right into him, striking on the port quarter about 8 ft. from the stern, and cutting into the boat.

The engines had not been stopped in either boat, the consequence being that both commenced turning round, the Frenchman gradually swinging round nearly parallel to the other boat, and in so doing getting wedged in the hole that she had made. All on board the English boat were for a moment stunned by this unexpected occurrence. The coxswain of the boat was the first to recover, and seeing the chain cable of the Frenchman lying on the head sheets, he immediately caught hold of it and took a turn round the towing bollard of his own boat, which was close to; then shouting to Griffiths, "Come along, sir, they've rammed our boat, let us take theirs," he jumped on board the Frenchman and rushed at the two men working the Hotchkiss gun, both of whom having been knocked over by the collision, had now hastily picked themselves up, and were endeavouring to get their gun to bear on our boat. Griffiths seized the idea instantly, and at once jumped on board, followed by the rest of the men, including the engineer, engine-room artificer, and stoker, who had rushed from the engine-room when they had felt the shock. A hand-to-hand fight followed, and it was hard to say who would have had the best of it, when a new actor appeared on the scene. This was one of our own torpedo boats which had so unexpectedly appeared. As Willis came up with them in the pinnace, he hastily pointed out what had happened as far as he knew, namely, that the Frenchman had rammed our boat; the lieutenant in charge immediately went to the rescue, and seeing a chance at the Frenchman, he went into him on the starboard beam. The blow was well aimed, for he struck just at the bulkhead, separating the engine and boiler-room compartments, thus making a breach in both. The combatants mutually ceased, and the Frenchmen, at their boat going down, surrendered. The coxswain of the original torpedo boat, see his own boat still afloat, jumped on board and shouted to Griffiths, "Come on, sir, quick, we're all right after all," meanwhile standing by to cast off the Frenchman's chain.

Griffiths had seen this at the same time, and calling his men to follow, jumped on board again, and shouted to the engineer to go down and stop the engines. Meanwhile, the Frenchman's engines were effectually stopped by his fires being put out by the water. What was left of the crew jumped on board the two English boats, and in two minutes the other boat quietly went down stern first. She settled so gradually that there was very little commotion and none of the whirlpool effect caused when a vessel sinks quickly. On examining our torpedo boat it was found that the second compartment from aft was quite full of water, but beyond being well down by the stern, she seemed but little affected by it.

The boats then proceeded onward without further

Fig. 29.



molestation, the pinnace being taken in tow again by one of the sound torpedo boats. Fig. 29 illustrates the latter part of this miniature fight.

Such was the attack on the Toulon fleet, and I need hardly say that, on the report being sent home, Willis was immediately promoted; Griffiths was also thanked, but he had made several errors in judgment, as we have seen, so though his gallantry was undoubted, it was not considered desirable to promote him just then.

You will remember that he was unlucky in that the Whitehead torpedo fired by him had failed to go off. He never could explain the reason for this, for the men at the torpedo swore to everything being correct, and so he could only conclude that by some means the torpedo had missed its mark.

It so happened that two of the torpedo men who went away in this boat were stationed to clean me, and a few mornings after the occurrence I have related, they were rubbing me down and polishing me up, talking meanwhile of their adventures.

"I say, Bill," said one, "I swore black and blue before the skipper that the safety-pin was out

t'other night, because you did, but I have my doubts d'you know."

"Well, Jack," says Bill, "I know I can trust you, and the more I comes to think over the business, the more I concludes as it wasn't. You see I just never thought about it. In this carriage" (patting the one in which I was) "we takes the safety-pin out *after* the torpedo is in, but in them new-fangled things in the boat, you should do it before it goes in, so I just clean forgot all about it."

"Well of course you'll not say nothing about it now," said Jack, whose morals and grammar were like those of his companion, none of the highest order.

"No," responded Bill, "it 'ud do no one no good, and would do Bill Styles" (himself) "a good deal of harm, so we'll just clap a stopper on our jaws about it."

And so these two worthies let the matter rest; they had had a very rough time of it the day before, when Captain Tarr as usual held an inquest over the failure of the torpedo, but both had lustily sworn that it was all right, and no one could gainsay them. In order that the reader may understand how this occurred I must explain that the tubes fitted to the new second-class torpedo boats are not like the carriages I have already described, but are tubes pure and simple. The torpedo is placed in them, and the back closed by an air-tight metal door (see Fig. 30). There is no impulse tube,

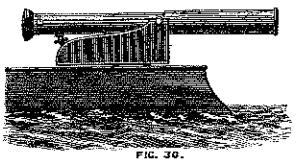


FIG. 30.

the torpedo fitting pretty tightly in the tube, and being blown out of it by air admitted into the rear part at a pressure of about 200 lb. or 300 lb. on the square inch. It will thus be understood that the torpedo once in the tube is not readily got at, and therefore the safety-pin in the nose must be taken out as the torpedo is entered instead of waiting, as is the case with the open carriages, until it is actually in place for firing. It was this new fitting that caused the failure of the torpedo in question.

Three weeks elapsed after the events described above, and still there appeared to be no sign of the French fleet coming out to meet us, or in any way moving from their position. They all, as far as we could tell, were quite ready to go to sea, but then they had been so ever since we had first come there, so that this was no criterion. We could do nothing, as they were snugly stowed away under the batteries, and the entrance was also blocked with mines. However, if we, a squadron of eight ships, could keep a dozen or so of the enemy in a state of inactivity, we could not say that we were wasting our time, though it was uncommonly tedious. We were soon to have a change though it came about as follows:

I think I have mentioned before that we always had our torpedo nets out at night. These nets, I may say, were made of grummets of ½-in. wire rope

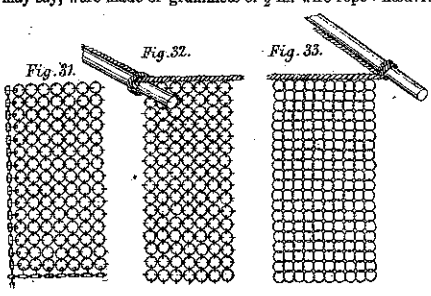


Fig. 31. *Fig. 32.* *Fig. 33.*

(in talking of wire rope the round of the rope is always meant) joined together by small steel rings as shown in Figs. 31 to 33.

The nets are of a uniform depth of 15 ft., and of lengths varying from 40 ft. to 80 ft., according to the positions they have to occupy. They are suspended at a distance of 20 ft. from the ship's side by spars or iron booms especially fitted. The arrangement of these booms varies in different ships, some have no regular spars (indeed, at the time I speak of, none of the ships in the squadron had them), and have to extemporise their outriggers from the ship's stores, others which have been regularly fitted in the dockyards, have wooden outriggers, whilst there are some made of iron.

The best in my opinion is one that has been lately tried by the Admiralty together with other patterns, and consists of a gallows-shaped angle iron, so placed on the side that when hanging freely it would take a position perpendicular to the ship's side. You see the great desideratum in these nets and outriggers is, that they should be able to be readily got into position on the shortest possible notice, and also of course to be as light as is compatible with strength. The system of which I speak satisfies these requirements better than any others I have heard of, as when not required for use the outriggers lie along the sides of the ship, at such an angle, that the nets which are kept secured to the ends, will when brailed up, be out of the water. A powerful purchase fitted to the foremost of the outriggers, keeps these in position close to the side.

When they are required for use, this is eased away, and the outriggers fall into their place perpendicular to the fore and aft line. The brails of the nets being then let go, the nets are spread, and other nets being lowered for the protection of the bow and stern, the defence is complete. As I have said before, we had not these outriggers, and had to use the top-gallant masts, jibboom, &c., for the purpose, the outriggers being pivotted just above the main deck ports, and triced right up vertically when not in use. It was very heavy work at first, getting them in position, but practice, which perfects everything, soon enabled us to work very smartly.

Well, as I was saying, these nets were always got out when we stopped for the night; up to the present time they had not been wanted, as our enemy had never attacked us. On the night of which I speak we were hove to, the guard-boats being in shore of us as usual, when about twelve o'clock one of them came alongside with the intelligence that there was a movement among the French ships inside, and it was thought that the squadron was putting to sea. The signal to get up steam full speed and close on the admiral, was immediately made, for as a rule the fleet was extended in line, and the fires were allowed to burn down a bit at night. The object of the former arrangement was to reduce the chances of a torpedo attack from the enemy's boats, which would have more chance of success were several ships huddled close together than if they were separated, and also to guard the harbour better.

Now, however, I suppose the admiral considered that he must have the ships together in case of an action, but, at all events, they duly closed in, and we formed two divisions in groups. Nothing more occurred till about three o'clock in the morning, and then the enemy's torpedo boats retired, their place being taken by some four or five corvettes protected with torpedo nets and heavily armed with machine guns. Our guard-boats didn't quite know what to make of this manœuvre, as the night being comparatively clear, it could be distinctly seen that these ships were not supported by others. Soon the corvettes opened a heavy machine gun fire on the guard-boats, before which they prudently retired. On came the corvettes straight towards the fleet, our torpedo boats retreating before them, and working off the flanks so as not to mark the fire of the ships. The corvettes steadily approached till within 1000 yards of our squadron.

The admiral could not make it out; the idea of a squadron of eight ironclads being boarded by four corvettes was too preposterous, so he waited to see what would happen. Up they came to within 800 yards, and they seemed to show signs of hesitation.

Needless to say, all the ships were at quarters, the guns being loaded with common shell fitted with percussion fuzes. Having approached to within a little under the 800 yards, the enemy seemed to think better of it, and altering course together, four points to starboard, they seemed to have made up their minds to attack the extreme ship of the port division. Sir Shoreham, who up to this time had been quite calm, now lost his temper, and turning to Captain Tarr, he said, "Now did you ever see such d——d impudence? Just let them have a broadside." Then to the flag lieutenant, "Make the signal to commence firing."

MACGEORGE'S CLINOGRAPH, OR BOREHOLE TEST.

(Concluded from page 262.)

It is perfectly natural for those who work diamond drills and have the charge of them, who never see the course of the hole which they bore, beyond the first few feet, who look at each length of drill-rod in its 10 ft. or 15 ft. of sturdy stiffness as a thing which cannot bend; it is perfectly natural for such men, intelligent, good workmen, proud of their instrument, which has always taken gratuitous credit for boring straight, and so rarely has its crooked path opened to the light of day—to disbelieve *in toto* that drills are hardly 20 ft. into the earth before they begin first by fractions, then by inches, then by feet, and at last by fathoms, to stray away from the course they should pursue. But if such men, intelligent and observant as they are, once saw 500 ft. of such drill-rods jointed end to end and lying upon uneven ground—to which this great jointed wire will readily adapt itself, and sag and bend with ease because of its great length and its mere inch-and-a-half of thickness—they would no longer accept the doctrine of its infallibility as preached by diamond drill manufacturers. And if they were shown a score of the finest steel knitting needles jointed end to end, as being an implement of the same proportions as a 500 ft. drill, length for length and diameter for diameter, and therefore a perfect miniature model of their trusted drill, they would at once see the folly of expecting to bore even approximately straight with such a tool. The wonder would be, not that drills should err, but that they should stray so little as 75 ft. in a course of 500 ft., which they have been proved to do. It is natural, also, that a drill operator should dislike to hear of the peccadilloes and greater errors of his implement, after having for so long a time believed the simple and easily comprehensible statement that "it bores a straight hole." The main virtue of a prospecting or mining drill, which is simply an earth-probe, is that the operator may know what ground he is testing. His inability to bore straight for long distances, however, matters little, if he can survey his bore and become thoroughly acquainted with its course. Boring is to a certain extent random and tentative work before it is done, but when done, it is of vital importance that we should know exactly what has been done, or left yet undone; else future work will be wasted.

The hard "caaing" of a reef or lode, for example, has been known to deflect a drill so that it was not pierced at all, thus giving rise to the impression that no reef or deposit existed in that direction, although subsequent operations have proved its presence.

The most obvious waste of work is where the drill has passed through a lode or reef, and where a drive or a shaft, having been carried on for some scores or some hundreds of feet in the direction, or rather the supposed direction of the borehole, fails to come within sight or sound of it, and after passing far beyond where it should be found, and putting forth cross cuts to intercept it, finally obliges the prospectors to cut huge chambers, or diverging galleries 30 ft. wide, as was done in one instance in Stawell (Fig. 2, page 259 *ante*). Here the borehole was scores of feet away from its proper position, and the desired portion of it was at a higher level than was expected, owing to the curvature of the borehole having misled the miners not only in direction but in height.

Ascertained Deviations.—It may be of interest to add that the legal manager of the Scotchman's United Mine kindly checked the figures given relative to Fig. 2, and ascertained that they are a little understated, so that the saving by first testing that bore would have been more than 2300*l.* The Board of the Oriental Company's mine also courteously gave access to their accounts, which showed that after the test had been refused as unnecessary, and a drive made to the supposed place of their borehole, 111 ft. more driving had to be done at a cost of 534*l.* 3s. 9d. before the bore was found; when discovered, it was no less than 60 ft. 9 in. out of its proper course in a depth of

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. X.

ANOTHER instant and the stillness of the night was broken by the roar of the guns, and the hitherto clear view we had had of everything was effectually clouded over by a thick smoke. The "Cease fire" was immediately sounded, but in the excitement it was easier to give the order than to get it carried out. Guns were loaded and ready to fire, and the No. 1's would fire them, though there was nothing to be fired at, consequently it was nearly a minute before the firing ceased. I think I have said that it was quite calm, and the smoke hung about for a long time after this. Before it cleared away we heard one, two, three, four violent explosions round us, one close alongside ourselves, accompanied by a shock which made the ship shiver. The reason of this was soon apparent. The French torpedo boats had hung about behind the corvettes, and, taking advantage of the smoke, had made a dash in amongst us. Dear me! how the admiral did swear. I could hear him plainly, though I was down on the main deck and he was upon the poop. And as for Commander Cursem, he came down on the main deck roaring like a bull, and cursing the officers for not making the men cease firing at once. Considering they had now ceased, it was a little late in the day, and did more harm than good. Up to the present the attack had been with Whitehead torpedoes, and these, thanks to our nets being out, were harmless, but a more dangerous antagonist now appeared. A first-class torpedo boat was suddenly discovered not 80 yards off, rushing directly at us armed with an outrigger torpedo.

One torpedo was rigged out, and the other was

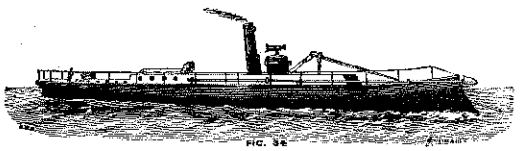


FIG. 34.

evidently ready to follow its example. (See Fig. 34.) Hand was the first to see this from the conning tower, as the boat was then steering directly towards him. With one bound he was off the bridge, with another, down on the main deck, and at the gun immediately under the conning tower. "Elevate! Raise!" he shouted.

I must pause for one instant to tell those of my readers who may be unacquainted with the fact, that when the order "Cease firing" is given, the guns are always reloaded and run out ready for firing again. Thus the gun in question was reloaded, and had to be pointed. Hand quickly laid it for the top of the torpedo net, and shouted "Well! Ready!" An instant afterwards there was a loud explosion alongside, followed by the immediate discharge of the gun, and then screams, yells, and execrations.

This is what had happened. The French torpedo boat had come up, and striking her torpedo against the net, had exploded it, intending thus to blow the netting away, and then to attack the ship itself with her second torpedo. Hand had foreseen this, and the moment the torpedo exploded, he fired. At such close quarters as this the effect of the 10-in. shell (weight 400 lb.) was instantaneous; it struck the boat fair in the bows, breaking in through the stem and then bursting, shattered the hull into atoms, and effectually prevented the other torpedo from being exploded. Another ship in the other division was attacked in the same way, and the attacking boat actually got away, seriously knocked about, it is true, but she got away clear, and was towed in by one of her comrades. The ship struck by her torpedo had a narrow escape; she was hit right under the quarter, just abaft the double bottom, and consequently a clean hole was made, there being no armour or protection of any kind. The orders about keeping the water-tight doors always closed at sea were very strict, but the door connecting the two flats next to the after one opened from the ward-room into the neighbouring flat, where were several of the officers' cabins, and this door was left open for their convenience. The torpedo exploded and made a hole just under one of the officer's cabins inside the ward-room, and very soon the water poured into the ward-room, the store-room below, and into the neighbouring flat, and the provision room which was below it. The flat in question was occupied with midshipmen's chests, the mids themselves sleeping in hammocks hung to the beams overhead. The hammocks were unoccupied at the moment, everybody being on deck at the guns. The noise of the explosion, the violent jar experienced by everybody on board, the breaking in of the side, and then the violent rush of water which entered into a jagged hole of over 3 ft. greatest diameter, at the speed of fifteen miles an hour (the hole was 10 ft. under water), all

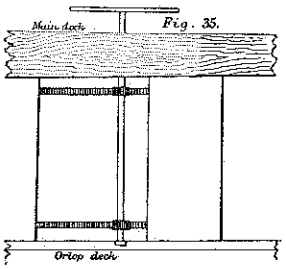


Fig. 35.

tended to promote confusion, and there was naturally an immediate rush to see what was wrong. Only for a minute, however, then the "still" bugle brought everybody up sharp, and the order was briefly given for the after quarter to man their pumps, and the remainder to get to their quarters. Order was at once restored, and on the G being sounded, the men at once moved smartly to their stations. Meanwhile the water-tight door was being closed, or rather they were trying to close it. I must again digress for a moment to explain that the water-tight doors (see Fig. 35) were fitted to slide in grooves made above and below the doorway, the grooves being slightly wedge-shaped so as to be perfectly water-tight when the door is in its place. The door itself is moved by a rack and pinion which is worked from the deck above. Consequently to close the door there is no necessity to go down to the deck below. The handle is always kept hanging close handy to the pinion, so there was no delay in this case in applying it, but after getting the door half closed it refused to go any further. It was evident that something had got jammed in the doorway. Instant search was necessary; the water was already halfway up the midshipmen's chests and rushing through the door with a great velocity. Search must be made instantly; one of the lieutenants, followed by two or three men, immediately jumped down, taking lanterns with them, for the usual lights had been extinguished by the concussion, and, making their way along by the hammocks overhead, soon discovered that the door was wedged up with ward-room chairs, which, floated by the water, had been dashed into the opening and then jammed there by the closing door. There was nothing for it but to open the door again and drag the chairs through. Accordingly the handle was once more worked and the door opened. This, however, had only the effect of wedging the chairs in tighter. Matters were becoming critical, for it was extremely doubtful if the ship could float with these two compartments full. True the pumps, both steam and hand, were at work, but they made little difference, and the most that could be expected of them would be to stave off the danger for a short time. More men now went down to the ward-room skylights with ropes attached, and after a time the chairs were dragged out and the door shut. None too soon either, for the provision room was full, and another ten minutes would have sufficed to have filled the two compartments completely.

It is small wonder that, under the circumstances, the attacking boat got away in safety.

This is one more example of the many accidents that may result from water-tight doors. In almost every case of collision in which our men-of-war have been concerned, the doors have been open, and thus the water-tight bulkheads are rendered useless. There should be no doors to our water-tight bulkheads. They are made, as a rule, simply for convenience, and this convenience entails such danger to the ship that it should not be consulted.

Now where was I before I wandered off on my long dissertation? The fleet had been attacked by torpedo boats in the smoke, with the results I have shown. And when the smoke had cleared away, the corvettes were seen steaming away to the western entrance of the harbour, followed by the now flying torpedo boats. Our boats were sent in pursuit, and they captured one that had been disabled. The total loss then to the attacking party was two torpedo boats, and probably some men wounded, while two of our torpedo boats had been damaged by the fire of the Hotchkiss guns on board the corvettes and one ship had a hole made in her, so that she would have to go into dock. Bad for us, you see, but the matter did not end there. On standing in as usual the next morning at daylight, we found the harbour occupied only by the five corvettes who had made the attack the night before. The birds had flown! the French fleet had gone! I leave you to imagine the chagrin of all on finding how we had been befooled, while at the same time no one could help admiring the consummate way in which the manœuvre had been planned and carried out. One Englishman *may* be worth three Frenchmen, and indeed the authorities seem to think so by the way they are allowing us to get behind in ships and guns; but the Englishman in question will require to keep his eyes open, and every sense on the alert, or, as on the occasion just mentioned, his three opponents will be one too many for him.

With regard to the attack just mentioned it will be observed that not one of the Whitehead torpedoes did any damage. There were, as far as we knew, seven fired, four had exploded in the netting, the others had run their noses into the grummets and stuck there until their engines stopped. When this occurred the torpedo had worked itself so far into the grummet that its own weight in the water was not sufficient to make it fall out, though the valves had been regulated for sinking. This failure of my kinsmen was of course due to the nets, and there is no doubt that the device is thoroughly effective in keeping us out, but then in a fleet action you cannot have these nets out, since everything depends on your ship's speed and handiness, and the fact of a ship lumbering along surrounded by heavy netting at once fixes her as an easy victim to the enemy's ram. At the best, this surrounding ships with nets is a clumsy contrivance, the whole arrangement is unwieldy, and, as I have said, effectually puts a stop to a ship manœuvring at speed. But it certainly was effective in this instance, as far as the Whitehead torpedoes were concerned, and doubtless as we get on we shall have things lighter and more easily managed. The first watch made was a very crude affair, but now-a-days we see excellent timepieces the size of a shilling. So it has been with everything, and so doubtless it will be with our torpedo defence. The introduction of machine guns has been a great blow to torpedo attacks, increasing the danger quite 90 per cent., but there is no certainty about them. In a night attack, and these attacks generally would be made at night, the machine gun, or any other gun, is at a great disadvantage. First, because of the difficulty of seeing the enemy. Secondly, because of the difficulty of judging the distance when seen. Thirdly, because of the impossibility of getting the sights accurately on, even if successful under the first two headings.

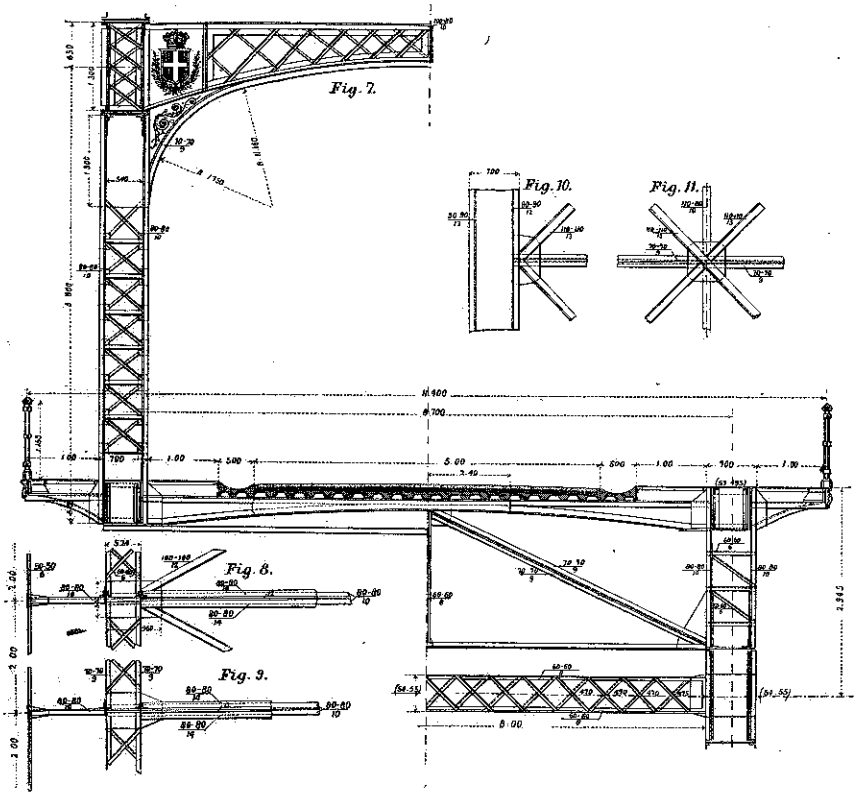
You must have some automatic and effectual barrier which will stop Whiteheads, and if an attempt is made with an outrigger, some defence will detain the boat that carries it under the immediate fire of the guns, and thus reduce the chances of success to a minimum. These requirements are, as you have seen, partly filled by the nets, but their use introduces a fresh element, namely, the partial crippling of the vessel's manœuvring powers.

The enemy having escaped, it was no use our blockading the empty port of Toulon any longer. The next thing to be done was to find out where they had gone to. We knew that Malta or Gibraltar was threatened, and it seemed quite probable that the portion of the fleet which had now escaped us would probably endeavour to effect a junction with the remaining portion of the squadron, then on the African coast, and make an attempt on one of these

BRIDGE OVER THE RIVER ADIGE, AT VERONA.

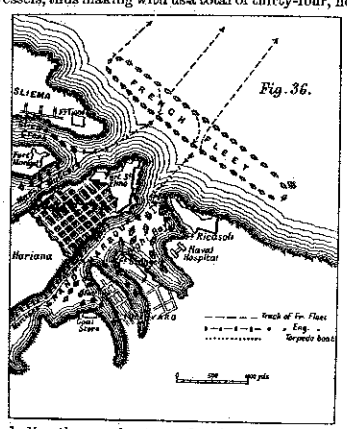
MR. G. B. BIADEGO, ENGINEER, GENOA.

(*For Description, see Page* 390.)



places. Gibraltar, the admiral thought, was out of the question. They could not hope to reduce that place, except by starving it out, and long before that was achieved, our squadron would have come to the rescue. Much the same might be said of Malta, though the reduction of that fortress might be an easier matter than that of Gibraltar. The idea of their attempting an attack at all on either place, while our fleet still remained available, seemed very ridiculous. True they were numerically superior to us, the economical tendencies of a Liberal Government had secured that, but still this superiority was by no means such as to enable them to make an attack on either of the places above mentioned, in the presence of our fleet. The portion of the squadron which had got out of Toulon was far superior to ours, and the wonder was that they did not attack us. Hand was strongly of opinion that they would endeavour to do this, and thought that the story about Malta and Gibraltar was the greatest rubbish. However, something must be done, the enemy had passed us to the eastward, and there seemed little doubt that if they did not mean to attack us, they would be trying to effect a junction with the others. Accordingly we went away to the south-eastward, keeping well extended, so as to increase our chances of finding them. We had two fast cruisers attached to the squadron, and they were perpetually scouring the neighbourhood, but no signs of the enemy were to be seen. On the fourth day, after leaving Toulon, we arrived at Malta, and there we learned that the remainder of the squadron was also on their way thither, the French fleet that they were watching having succeeded in giving them the slip out of Algiers, in much the same way as our part had escaped from us at Toulon.

We had hardly taken up our moorings in the Grand Harbour when the other ships arrived. There were ten of us, and we occupied the whole of the moorings in the Grand Harbour, consequently the other squadron had to get where they could. Some took up the three moorings that are in the "Bihi" bay, while others anchored in the bay, and some went round to Sliema Creek and Marsa Musceit. There were twenty-four of them, including the despatch vessels, thus making with us a total of thirty-four, not



including the merchant vessels, of which, at the time I speak, there happened to be more than usual in the harbour. It will be seen, by consulting the attached chart (Fig. 36), that we were pretty closely stowed.

As soon as the commander-in-chief had anchored, the other admirals (there were two in our squadron and four in the Mediterranean) went on board to report themselves, as is customary. A council of war was held, and the result was that orders were given for coaling with all despatch, as we were to proceed to sea again the next day.

Meanwhile four of the despatch vessels were sent out as preventions against surprise, though it seemed almost unnecessary, as the east end of Malta and the west end of Comina (a small island to the westward) are in telephonic communication, and thus embrace a vista of about forty miles. Valletta, as my readers are aware, is about five miles from the end of the island.

Meanwhile the coaling proceeded vigorously. Malta is celebrated as being one of the best coaling stations in the world, and as a rule 80 tons of coal can be got on board in the hour. But a large squadron like ours severely taxed the resources of the place, and the rate of coaling was, to say the least of it, slow. The ship's launches were hoisted out and used as coal barges, and the men worked right willingly, but at sunset that night the coaling was not nearly half through, and it seemed certain it could not be done by the morning. We in the Channel Squadron had secured the barges, &c., before the others came in, and were complete about 10 o'clock that night. But we were right inside the other ships, which effectually blocked up the entrance to the harbour.

LITERATURE.

Practical Physics. By R. T. GLAZEBROOK, M.A., F.R.S., and W. N. SHAW, M.A., Demonstrators at the Cavendish Laboratory, Cambridge. London: Longmans, Green, and Co. 1885.

THIS work treats physics from a different standpoint from that usually assumed in text-books. It supposes the student to be placed in a well-equipped

highest possible importance to the research—for, just as a galvanometer needle, heavy in itself, and involving considerable friction in its method of suspension, is unable to respond to certain currents of electricity transmitted through its coils, indicating an absence of current, when in reality comparatively strong currents are flowing around it, so it is equally clear that in the use of the apparatus which we have been describing, all the phenomena exhibited are reduced in their significance by disturbing and retarding influences, and many phenomena, slightly more delicate but equally important, must be lost altogether to demonstration. Thus Electric Science, as well in her instrumental defects as in her phenomena, finds her hydrodynamic analogue in the researches of Professor Bjerknes and his son.

(To be continued.)

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. XI.

At sunset that night the signal was made from the palace signal station; "Only four corvettes in sight" (being those that had been sent out as pickets).

The coaling proceeded merrily, the officers of those ships which had completed their coaling were allowed to go ashore for an hour or two, and everything seemed very satisfactory. At twelve o'clock rockets were seen from the eastward, followed by two or three guns. Signalmen had been sent up to the palace signal station, so as to communicate with the corvettes in case of need, and now soon the signal was made to them from the eastermost corvette and repeated at once to the admiral, "Enemy in sight close to." Almost immediately after the signal was reported, the corvette ran in and reported that the French were close behind them, coming up from the eastward.

The forts of course were prepared for attack, and now immediately the guns were manned, and preparations were made to resist the attack should the fleet get near enough. The fires of the ships had been banked, but now the signal was made to get up steam full speed again and prepare for action.

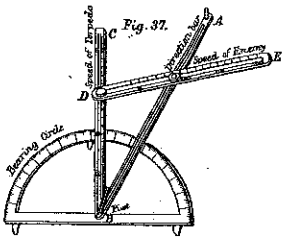
Steam was not yet ready in all the ships, and we were awaiting the next signal, when we heard the eastermost forts open fire, and a very short time afterwards a heavy broadside replied. Another and another followed; and then the projectiles began to fall among the shipping. It was certainly the most ridiculous sight any one can imagine; thirty-four English ships like sheep in a fold packed together in Malta harbour, while the whole French squadron steamed past in single column, line ahead at a distance of certainly not more than 800 yards, outside the forts, and firing electric broadsides as they passed. The forts defending the entrance, at the time I speak of, and which can be seen on the chart, were neither so numerous nor so heavily armed as they are now, when we have 100-ton guns in St. Elmo and 38-ton guns in Riscasoli and Tione. The majority of the guns mounted there were the old 10 in. smooth bore coverted guns, with a sprinkling of 8 in. M.L.R. guns, and two 10 in. M.L.R. guns which, if I remember rightly, were at Riscasoli.

The forts inside were armed with 64-pounders and 7 in. M.L.R. guns, and are intended more especially to command the harbour. Hence they were of little use on the present occasion. You can imagine our feelings in the Fearnought, stuck right away inside the Grand Harbour, with half a dozen ships between us and the enemy, so that we could neither get out nor reply to their fire. I had heard some bad language when the fleet got away from Toulon, but the language now was ten times as strong. The abuse that the old admiral got heaped upon his devoted head was something wonderful. "The idea of allowing us to be caught here like rats in a trap, with (like them) nothing to do but squeak; he was an old idiot and only fit to be pole-axed." It never struck any of those who gave vent to these hard sayings, that a suspicion of a thing like this occurring had never for a moment flashed across their own minds until it had actually occured. Ah me! how easy it is to see danger when once you are in it, but how very difficult to foresee what trials or difficulties the next turn of the wheel of fortune may bring upon us.

The French leader having passed along the forts and got well beyond them, made the signal to alter course in succession sixteen points, so arranging his time, that having steamed back well outside his attacking ships, he was ready to follow on again in the wake of the rear ships. Thus a continuous fire was poured into the devoted forts and the shipping beyond them, while fresh assailants were continually coming on. Some two or three of our outermost ships managed to get their broadside to bear, and responded to the fire, but all the other ships were bundled together, and were getting struck right and left, by the enemy's projectiles. It is true that these did not do vital damage, we were too far off for that, but several guns were dismounted, and our upper works knocked about, men killed, and so on; the most galling part of it was that only a few ships could respond to the fire. Meanwhile the reader asks, what was the admiral doing? Surely he did not mean to stop there all night, and let this go on until the French had reduced the forts to a lump of stones and smashed up the fleet.

Oh, no; he had made up his mind at once that he must take the fleet out to meet them, though he fully recognised the great disadvantages under which he must labour, for as our ships were placed, it was impossible to set the fleet out at once in its proper formation, and of course this necessitated making the action simply a disorganised melée, each ship coming into action as best she could and fighting hand to hand regardless of any formation. The enemy were numerically stronger than we were, and of course a hand-to-hand fight like this would give them a great advantage; besides, the first ships that went out would have to contend with fearful odds. All this was fully appreciated, and, while reproaching himself for having thus been caught, he resolved that the attack must be thus made, and that he himself would lead it. He could not move, however, till steam was up, and another twenty minutes, at least, was requisite for this. It was very unfortunate that the ships which were the most backward in this way were the outside ones, but patience is a virtue, and it was necessary to practise that virtue now. Besides, even if some of the ships could have got out, it would have done no good, simply enabling the enemy to mass their whole squadron on the few, and so destroy us piecemeal. Meanwhile the admiral was not idle, but collecting a dozen Maltese boats, he sent off orders to the different ships telling what was to be done. Briefly, these orders were, that when the signal was made to weigh, the ships were to slip, follow the admiral out in the order in which they happened to be anchored, and then engage as the opportunity occurred.

To return to my own ship. The moment that Hand heard that the French fleet were signalled he had caused the torpedoes to be charged and hoisted into our second-class torpedo boat, which had been hoisted out so as to be out of the way of the coaling, and as soon as the firing commenced he asked permission to try his luck with the enemy's fleet. The admiral would have again refused, but the gallant fellow was so eager and enthusiastic that he gave in, and away went Hand in the torpedo boat. He had no preconceived plan, for a wonder, but worked his way out under the high rocks on the left of the Grand Harbour. Having got as far as Point St. Elmo, and seeing the fleet steaming past, he thought this too good an opportunity to be missed, for here was a whole fleet, unprotected by nets, so that they might not be hampered in manœuvring, and steaming steadily past in line. Surely something could be done now with his pet weapon. There was very little chance of concealment, as, though the night was dark enough, the continual flashes from the guns made it quite light, though at the same time the smoke from these same guns helped to increase the obscurity. The breeze was from the north-east and so blew the smoke down from the French fleet on top of the forts, and over the harbour, giving them a decided advantage. Hand might have fired his torpedoes from where he was with comparative safety, and a very fair chance of success, for the enemy were only 800 yards off, and there was a constant stream of them running up and down, so that the odds were much in favour of his hitting something, even if he fired at random. He was not at all fond of leaving things to chance though, and though he well knew that he would be running a risk from the stray fire of both fleets as well as the forts, he determined to run out towards the enemy and trust to the projectiles going over him. I'm not certain whether I told you that I was away in the boat with Hand all this time; you see I was all ready and handy on the main deck; they had charged me with air and whipped me into the boat, so here I was, bound to go at last, and I nerved myself to meet my fate, like a true Whitehead should do; of course it is of no use firing a Whitehead torpedo direct at an object moving through the water, for by the time the torpedo gets to where the object was when it (the torpedo), started, the latter has moved away. Hence the speed of the torpedo and of the object must be taken into consideration when aiming, and for this purpose an instrument called a "torpedo director" is used. The instrument now in use is somewhat as follows:—(see Fig. 37), A B is a director carrying



sights at A and B. B C is graduated in knots and pivots at B, while B E, which is also graduated in knots, is clamped at D to the speed bar (B C), and at E to the direction bar. The graduated circle serves as a guide for the position of either the speed of torpedo or the direction bar.

An explanation of the method of using it will be best understood from the manner in which it was adjusted on the occasion of which I am going to speak, when Hand judging that the enemy were going 8 knots, while the speed of the torpedo he put down at 20. The torpedo fired right ahead and our head was pointing directly at the enemy perpendicular to the direction in which they were steering. The speed of the torpedo bar then, which is always parallel to the direction in which the torpedo goes, was clamped right ahead, while the speed of ship bar D E was clamped at D at the mark 20 placed at right angles to it, and then the direction bar A B clamped to the 8 mark. Then on looking along the sights B A, when the ship to be fired at came on in a line with them, the torpedo must be fired, for the torpedo leaving in the direction B C, and the enemy coming along parallel to D E, it follows by similar triangles that the two would meet.

So it turned out. On arriving within 300 yards we stopped, and the sights coming on the port torpedo was fired at a French ironclad. We had no sooner fired this torpedo than a storm of Hotchkiss shell falling round us apprised us of the fact that we were discovered. Too late to save the ship though, for thirty seconds afterwards, a loud explosion told that the shot had taken effect. We had no time to watch the result, for Hand was again preparing to discharge the other torpedo, which you know was your humble servant. The ships were one cable apart, therefore in about one quarter of a minute more the sights must come on. Oh, how long that quarter of a minute seemed! Every second appeared a minute to my excited imagination, and I thought the time for action would never come. It became evident too that the next ship, that is the one at which we were going to fire, had also discovered us and had seen the torpedo fired at her next ahead, and preparations being made to give her the same compliment, for a hail of shell now came from her machine guns, threatening us with instantaneous death. Ten, eleven, twelve, thirteen, fourteen, fifteen, then the order "Fire," and I experienced the feeling as of being lifted up by the wind (it was an air gun you know) and thrown into the water, and then I was wending my way under water to destruction.

I was beginning to think that I could not be very far off the enemy, and expecting in a short time to come into collision, when I saw a dark mass on my starboard bow, looming like a huge precipice and rising perpendicularly in the water. "Missed by jingo," I exclaimed to myself, whilst a sort of reprieved feeling crept over me.

I was rather premature, though, in my expression, for the next moment as I glanced past the ram, I found that I had not quite cleared, for I received a violent blow on the screws. This had the effect of bringing the engines to a standstill at once, for as you know the two screws work in opposite directions, and the foremost one being bent by the blow, they immediately locked one another, and so brought up the engines. The result was that in a

few minutes I rose to the surface and was thus enabled to have a clear view of what was going on. My counter had been adjusted to its extreme limit, and the sinking valve also set so as to sink me on arriving at the limit of my run, but now as the screw shafts could not revolve, the counter could not work, and consequently neither the wedge was put back nor could the sinking valve come into play. Therefore I rose as I have said to the surface.

Before going on to describe the action I may as well explain how it was that I missed my ship. She seeing the torpedo fired at her "next ahead" (that is the ship close in front of her), and that another was ready, immediately put her helm hard a starboard (thus turning to port towards the torpedo boat), and went astern full speed. The helm of course was soon put over, but the sudden reversal of the engines was no such easy matter. Thus it happened that at the time I was fired she was actually turning towards us and the engines just beginning to go astern. The accompanying diagram drawn to scale will show this.

A B C represents the director in the boat. S the position of the ship at the moment of firing, the sights being then on with her mainmast. The main-

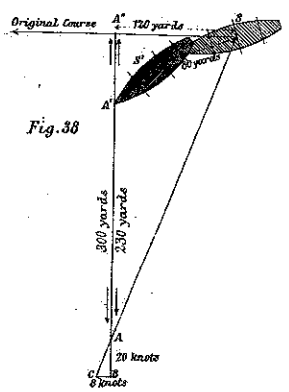


Fig. 38

mast then passed from S to S' while I was travelling to A', so that I just shaved the ram and came to grief. If she had gone on at her normal speed, the mainmast and I would have arrived at A'' at the same time.

Now for the others. Hand as soon as he had fired me, went off, and in spite of the boat being struck in several places, got back safe on board the ship just as she was steaming out. I have no intention of describing the battle that followed in detail. From my position in the water I obtained a limited view of the preliminary proceedings, but the after events have been described by various historians, and as I know of nothing particular having occurred that would be instructive with reference to the special subject with which I am dealing, namely, torpedoes, I will not attempt to enter into it. I may say that I afterwards heard many accounts of the fight, and they all differed materially. I can quite understand this, as though people can tell pretty well what is going on in their immediate neighbourhood, it is almost impossible to get the different stories accurately pieced together.

What happened at first was this.

The admiral of our squadron led the way out, and was followed in succession by the ships as they happened to be anchored, and at the same time as he started out of Bighi Bay the leading ship of those who were in Marsa Musceit Harbour also came out, followed by the other ships in there.

The splendid organisation of the French fleet was however equal to the occasion, and as our leading ship came out making direct for the centre of the enemy's line, the ship for whom she made put her helm to port and stood out to sea to the north-east. The ships to the eastward of her followed religiously in her wake, while those to the westward followed their "next aheader" as before. These in their turn moved off in the north-east on the advance of the ships from Marsa Musceit Harbour, and those to the westward did the same. Thus they had three lines between which the two of ours would have been had the leading ships stood straight out. Our admiral, however, didn't do as it was supposed he would, and lead out his fleet in two lines, but seeing a good chance of ramming a ship belonging to the eastermost line (see diagram) he took it, and rammed her. Her next astern endeavoured to do the same by him, and partially succeeded, but the second of our ships coming up, the Frenchman fell a victim to her. The ship who had been struck by Hand's first torpedo was lying close about there in a helpless and water-logged condition, for the torpedo had struck under the boilers, effectually putting out her fires, and flooding that and the engine-room compartment. There was thus a knot of five ships, more or less, in a lump, and these formed a nucleus, for the ships on both sides as they came along tried to ram some of those who appeared likely to fall victims, and the pile thus increased. The two outer divisions of the French squadron, seeing what an unexpected turn things had taken, were nonplussed. Evidently arrangements had been made for most eventualities, but here was one which appeared not to have been foreseen, or at all events, not expected. Where were all the arguments of tacticians now in favour of this and that system of attack or method of formation? Literally nowhere. The French Admiral was somewhere in the middle of his squadron, but even if his ready brain could have devised a manœuvre, the difficulty of transmitting signals (owing to smoke, &c.) was so great that nothing could have been done in time. Under these circumstances some of the ships stood on, whilst others turned to go to the assistance of those of their friends who were in the melée, and who, it was evident, must soon be overpowered by numbers. It is needless to say that in a very short time confusion became paramount, and soon the action became like those of olden days, a series of hand-to-hand fights.

Tacticians, delivering their views at the Royal United Service Institute and elsewhere, had told us that boarding was a thing of the past. "Bless you, we'd never come to close quarters now. Couldn't do it, sir! Look you! Torpedoes, machine guns, and all that—the idea was absurd. It was all very well in olden times, when you could carry the shot for your broadside in your pocket, but now, sir, manœuvring is the thing—ram, gun, and torpedo; nothing so obsolete as pistols, cutlasses, and boarding pikes!"

Alas for theory! Here were the first two squadrons that had met since the introduction of steam and armour had changed the face of everything. The ships, the finest of the two countries who justly boasted of being the greatest naval powers in the world. The officers, men who had studied tactics and argued the pros and cons of every system of attack; and what did we see?

Hammer and tongs, pure and simple! That was all. True, torpedoes were fired, and machine guns did their deadly work, and several very clever manœuvres were executed by single ships; but, as for any great design being carried out by the opposing squadrons, there was none of it. The design, if any, melted into thin air with the smoke of the guns.

Well, I cannot give any better description of the fight than the above; suffice it to say, that after this had gone on up to twelve o'clock noon the next day, there appeared to be very little of either ammunition or energy left on board either fleet, and they gradually drew asunder, each taking the prizes they had captured. Those taken by our squadron were immediately sent into harbour, and supplies of ammunition were sent out to the fleet.

CABLE TRAMWAYS.

By J. BUCKNALL-SMITH.

(*Continued from page* 310.)

THE Union, Presidio, and Ferries Cable Tramway is the next cable traction scheme in San Francisco to claim our brief attention.

This line consists of about 10,500 ft. of double track (about two miles long), constructed to a gauge of 5 ft., and the section of the route along which this line is laid is represented in longitudinal section at Fig. 42. Upon reference to this figure, it will be at once seen that the grades upon this tramway are extremely severe, and, as previously mentioned, the line affords a capital illustration of the capabilities of the system in question, this being the steepest tramway (proper) ever successfully constructed and operated.

The steepest gradients upon this line, which occur about Polk and Larkin-streets, vary from about 1 in 4½ to 1 in 5. The engine-house, car depôt, and offices are situated at the summit of a hill between Leavenworth and Hyde-streets, or about midway between the termini, as shown in the section above referred to.

The permanent way and tube are substantially constructed, the latter being formed with cast-iron frames, connected with rolled channel irons, whilst the continuity is obtained by the employment of a sheet-iron tubular casing. The construction and equipment of this line bears generally a very close resemblance to those already described in previous articles, and therefore we shall only devote a very brief notice to it.

About 2600 ft. from the eastern terminus there exists a curved portion of way (at the intersection of two streets), where the cable is suitably deflected by two horizontal pulleys 8 ft. in diameter. Here the operators upon the approaching cars have to release the cable, and travel round the curved portion of line by momentum and gravitation; the site of the deflection being situated in a depression, it is conveniently located for such auxiliary method of locomotion. After passing this curve the operators upon the cars retake the cable on the opposite sides. There is nothing particularly advantageous or instructive in this method of working or running over curved portions of line, and such practice would unquestionably not be allowed in this country.

The gripping apparatus used is exactly similar to that already described upon the Clay-street line, although somewhat more heavily constructed to suit the rolling stock. The dummies and cars weigh alike 4000 lb. They run at about five minute intervals, thus making about 220 trips per day of nineteen working hours, the service being performed by twelve cars of each kind.

Two crucible steel wire cables are used to work this system, the one 10,500 ft. and the other 11,000 ft. long, both being alike 3 in. in circumference; the speed at which they are driven averages about 600 ft. per minute. The hauling engines are of the ordinary horizontal type, with suitable valve gear, such as previously described in connection with other lines, their cylinders being about 18 in. in diameter by 36 in. stroke, and working to a piston speed of about 350 ft. per minute. Steam is supplied to these engines by three multitubular boilers, 16 ft. long by 4 ft. 6 in. in diameter. The average working pressure is about 80 lb. to the square inch, and it has been found that upwards of fifty per cent. of such pressure is necessary to set the machinery and cables in motion, without any cars. This is much in excess of the previous examples mentioned, and is mainly due to the extremely heavy gradients upon the line. The driving motion is transmitted from the crankshaft of either engine to the drums or pulleys through the intervention of leather belting, in practically a similar manner to the rope-belting used in the Geary-street engine-room, but with less advantage as regards silence in working. The driving drums used for hauling the cables are provided with gripping peripheries, as employed upon the Clay-street line. These drums are fixed upon a countershaft, which also has keyed upon it a large driving pulley, 25 ft. in diameter, and around which a colossal leather belt (2 ft. 6 in. broad), passes from the driving pulley (8 ft. in diameter), fixed upon the prime motion shaft as before mentioned. This being a comparatively recent line, little reliable information can be given regarding the average lives of the cables employed, but it may be mentioned that one lasted about eighteen months, which should be regarded as a most satisfactory performance, considering the heavy loads upon the rope. From the nature of the heavy gradients upon the various cable lines in San Francisco, some questions naturally arise as to the safety of stopping cars upon such steep declivities, when the cables are released? It should, therefore, be made clear that the cars are never released from the cable, nor stopped upon such gradients as those alluded to above. The stoppages always take place at level crossings, which occur at about every 412 ft. (or "block") along the line, as represented in the diagram at Fig. 43.

In this figure, A indicates the manner in which the transverse streets intersect the cable lines with level crossings, upon which the cars are stopped to pick up and set down passengers, and B represents the angular relation that the route of these lines bears to such intersecting thoroughfares. It is at these angular changes upon the cable lines that the

THE AUTOBIOGRAPHY OF A WHITEHEAD TORPEDO.—No. XII.

THE guns on the forts up to this time had not been able to do much, friends and foes being so mixed up, though they occasionally managed to get in a round at a stray ship, but as soon as the fleets separated they commenced to make themselves heard again. Only for a very short time though, for the enemy soon got out of range. I must refer you to histories of the battle for the amount of loss sustained, for I have heard so many different versions that I don't quite know which to rely upon. One English paper said we had lost ten ships, and the enemy thirty; another put it down as fifteen and twenty respectively, while somehow the French papers changed the numbers, and made out that they were the victors.

Curious! I have always been taught to believe that whatever the papers say must be true, English papers at all events, yet none of our papers gave the same numbers, and the French differed entirely. However, that has nothing to do with the question; what I do know is that the remainder of our fleet having had a certain amount of ammunition put on board, went out that night and tried to renew the action, and found the enemy gone. They chased them some way, picking up five disabled ships which had to be left by the enemy, and finally lost them in Toulon again. It certainly seemed as if we had the best of it, though I don't know how matters would have turned out if Malta had not been close at hand with supplies. The poor old Fearnought was not one of those that went in search of the enemy. She had been terribly knocked about in the struggle, one of my foreign brethren having exploded in her foremost compartment early in the action, and she having shortly afterwards rammed a French ironclad, had very little bow left to speak of, but rather presented the appearance about the bows of a Thames mud barge.

Captain Tarr had been badly wounded early in the fight, and was sent to hospital immediately the ships came in. Commander Cursem and the first lieutenant had been killed, and Hand was now in command, having fought the ship through the latter part of the action, of course under the admiral, who was safe and sound.

I think now that it is quite time that I told you something about myself. If you remember, I was left *hors de combat* by my screws striking an enemy's ram, and that I floated to the surface, whence I was a spectator of the action. The breeze was blowing gently from the north-east, and as I was only about 800 yards from the shore when I was stopped, about eight o'clock in the morning I found myself grounding on the rocks off Fort Ricasoli. I may mention again that the screws having got suddenly locked, here was I all prepared for action, air turned into the engines, which were, however, prevented from moving by the locked screws, pistol cocked and safety wedge out. Every moment I was afraid that some rock would strike my nose or whisker and set me off. The anxiety I suffered during that time was awful, and if it was in the nature of torpedoes to have hair, I'm sure mine would have been white as snow. My usual good luck followed me through, and I got wedged in between two rocks with my tail towards the shore, and the wind falling, there I remained snugly enough till the following morning. About six A.M., two of the soldiers stationed in Ricasoli came to bathe, and one of them soon discovered me. He came and handled me to see what I was, and I was in a great fright that he would by mistake press my nose or whisker, but luckily he kept at the tail end, and after examining me for some time shouted to his companion: "Look 'ere, Roberts, blessed if iver I see a turnout like this afore. It's a sort of a iron fish. Somethink belongin' to them Frenchers I think."

His companion immediately came running up, and at a glance recognised what I was. It appears that he was a sergeant in the Royal Engineers, and belonged to a detachment told off for torpedo work, and who under suitable officers had charge of the torpedo defence of the island. There are no Whiteheads in the train, but he had seen one or two, and recognised me at once. He had evidently been imbued with a deep sense of our dangerous proclivities, for he at once drew his companion away, saying in broad Scotch, "Coom away, mon, ye'll no ken when it may be breakin' op. We'll gang aboord yon ship, and let un know she's here." So saying he and his companion cleared out, and I was left alone for an hour or more. Then I heard footsteps approaching, and the familiar voice of Hand once more fell joyously on my ear. I knew then that I was saved. The Fearnought was anchored in Bighi Bay, and being the flagship, the sergeant had gone on board, and reported finding me. Hand, combining as he did on himself the functions of captain, commander, gunnery lieutenant, and torpedo lieutenant, came on shore as soon as he could get away. He recognised me at once, for my number was stamped all over me, and saw at a glance what had occurred.

"Well, old fellow," he soliloquised, "you are a wonder of the deep; I guess we'll keep you for exercise for the future, for you never get lost."

So saying he pushed in the safety wedge, unscrewed the striker, closed the air valve, and I was safe.

"Just keep a look-out on it for half an hour," said he to the sergeant, "and I'll send a boat round for it. And here's something for you for your pains," and I heard the chink of money.

Away he went, and an hour afterwards I was safe on board the old ship again with my head off, and my body stowed away in the torpedo room.

Poor Captain Tarr was no longer available to hold an inquest on me, and Hand on seeing the state of my screws, and having observed the evolution of the Frenchman had little difficulty in guessing how the accident had happened. On examination it was found that the only damage done to me was that the screw shaft was bent and the screws more or less damaged. These defects were easily repaired at the dockyard, and I soon returned to my old position on the main deck.

All this time we remained at Malta, being patched up as well as the resources of the dockyard would permit. Hand was promoted at once to commander's rank, his commission being antedated to the date of the Toulon attack, and he was further promised promotion to post rank as soon as he had served the necessary time (two years) to qualify him for that position. Never did a man better deserve his promotion in my opinion and in that of his brother officers, with whom he was a great favourite. He remained as commander of the Fearnought, and Captain Tarr coming out of hospital soon afterwards, things resumed much of the old swing. I missed poor Commander Cursem's loud voice for many a long day and grieved sincerely for his loss, for though in times of peace he ran down the gunnery and torpedo work, yet when it came to real work he was always ready to give them their proper place.

Shortly after this peace was proclaimed, and we were ordered home and paid off, so once more I returned to my old place in the dockyard store.

One day I was surprised and delighted at seeing Hand enter the store. He had a great affection for me, and as soon as he came in asked to be shown where I was.

"Ah, old fellow," said he, patting me on the back in his old friendly way, "and how are you getting on after all your adventures?" Then turning to Mellor, who was in the store, he said, "If that fellow could speak," pointing to me, "he could tell you some fine tales. Next time I go to sea you must let me have him, for I think he brings me luck."

This speech set me thinking, and after deliberating on the matter for some time, I determined that it was my duty in the interest of my kind to lay before the public all that I could tell them on the subject. To this end I devoted myself while in store to preparing the history of the adventures which I now lay before the reader. My tale is done. It may be that fresh adventures are yet in store for me, but even if this is the case it hardly seems probable that I should be once more spared to tell the tale, so, feeling as I do, that there is much here that may interest and instruct, I venture to beg of my readers a kind criticism of "The Adventures of a Whitehead Torpedo."

CONCLUDING REMARKS.

After finishing the story of my adventures it occurred to me that the work might be rendered still more useful if I appended to it a few remarks on the points that appear to me to deserve special attention.

The one point to which have endeavoured to give special prominence is the absolute necessity in all torpedo work of giving due attention to the minutest details. If all officers in charge of torpedoes would follow the example of Captain Tarr, and when a mistake was made spare no pains to get at the why and the wherefore of it, there would be very few of the failures of which we are constantly reading. I know—none better—the difficulties that envelop the proper management of my species, and that, to a certain extent, nobody can be blamed for some of our wrong doings, but then there are others which might be easily avoided were the men thoroughly instructed and trained. It is not enough that they should be taught how to handle us when everything goes smoothly. Advantage should be taken of every mishap that occurs (and goodness knows there are plenty of them) to teach a lesson and show how serious the consequences may be of the slightest inattention.

Instead of this, it now often occurs that where anything goes wrong in instructing or exercising, the mistake is put right by the officers or artificers in charge of the torpedo, and very little is said on the matter to the crew who were employed working it. Take, for instance, the occasion of my being lost at Cyprus. If Eves, instead of trying to run me again when he saw that something was wrong, had only hoisted me on board and examined me thoroughly, that accident might have been avoided, and a valuable addition made to his and others' experience of torpedoes.

Again, in the Toulon failure, if the men who failed to take out the safety pin had only had the courage to confess their mistake, their experience would have helped others to avoid a similar mistake.

It is partly with this view that I have published my adventures, and I can only hope that they will prove useful in this way. If they only help some few to avoid the mistakes of which I speak, I shall be amply rewarded. Indeed, I feel sure that they will have this effect. There is no instructor like experience. Officers and men are alike anxious to do their duty to the very utmost of their power, and the reason why so many failures occur is want of experience. You will think perhaps I am needlessly repeating these views, but I want to thoroughly impress them, and to do so I would reiterate them again and again. The motto to be borne in mind by those who teach should be *experientia docet*, and unless they want to pay for the experience necessary for thorough instruction by the failure or loss of their weapons, they must provide this experience themselves. I have endeavoured to help them in this respect, and can only hope that my poor attempt may be successful.

Another object that I have had in my mind when writing the above, is that of giving the general public moreof an insight into torpedo work than they have previously had, and I hope the interest accruing to a tale of adventures may induce some to read the work who would not be bothered with the dry description of torpedoes alone.

Some of my readers will say, Now I wonder why this old fellow is so anxious for us to know all about torpedoes? Wants to show what a fine fellow he is, I suppose!

To such I reply:

Not at all? What I want you to do is to take an interest in our Navy and all that pertains to it, and I hope that a knowledge, even if only partial, of one branch of the subject, may induce you to look further, and satisfy yourself that our Navy is as efficient as it should be. Look at the reports of the debates on the naval estimates in the House of Commons. What do we see? As soon as the debate comes on most of the members leave their seats!

And why?

That's just it; they know nothing about our Navy, and therefore they care nothing. Nobody does care about things they don't understand. We all know that. Well, then, what I want to do is to try and make people take an interest in our Navy and its doings, by first getting them to understand about it. After reading the foregoing history they will understand to a certain extent about torpedoes, and will at all events know what is meant when they are spoken about, therefore they won't run away, or turn the subject as one possessing no interest for them whenever it may be introduced. Then perhaps somebody will follow my example and tell something about guns, others masts and sails, engines, and so on, and then, if people will only read them, the information given by these works will enable them to judge for themselves whether our first line of defence is what it should be to enable England to keep her place as mistress of the seas.

In conclusion let me quote the old motto, "Si vis pacem para bellum."