H.M.S. "VICTORIA:" ARRANGEMENT OF BULKHEADS AND WATERTIGHT DOORS.

(*See opposite Page.*)

Fig. 2

PART PLAN OF UPPER DECK.

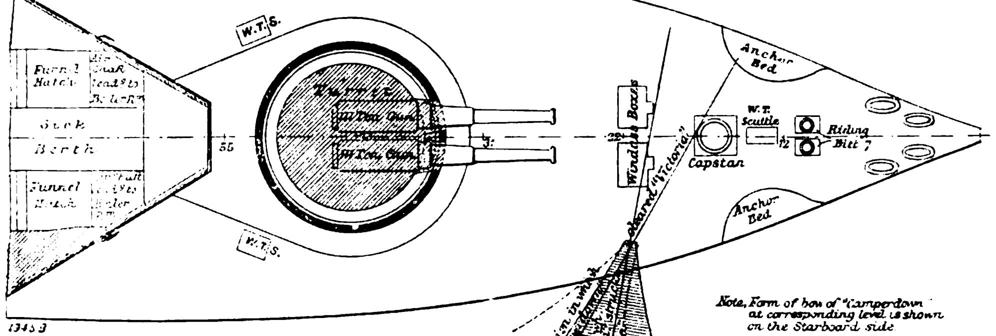


Fig. 3.

PART PLAN OF MAIN DECK.

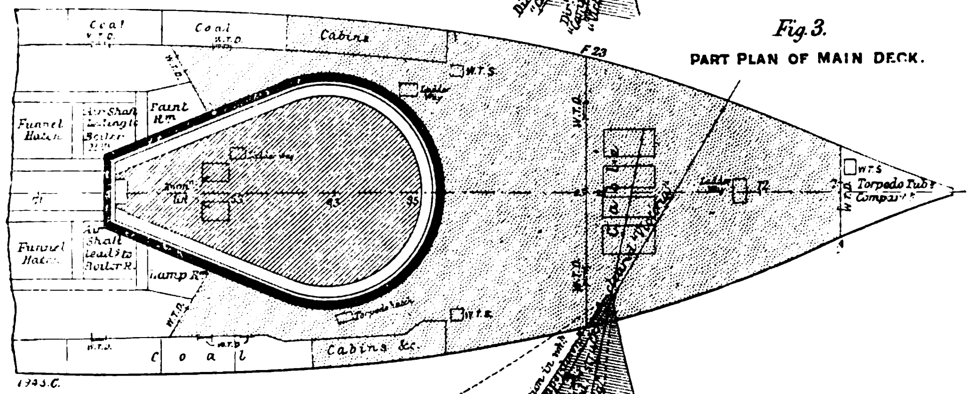


Fig. 4.

PART PLAN OF LOWER DECK

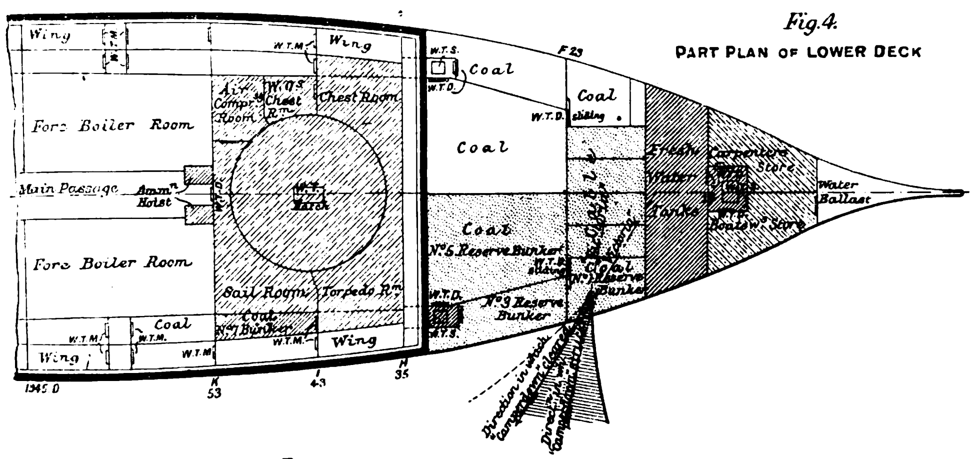


Fig. 5.

PART PLAN OF PLATFORMS.

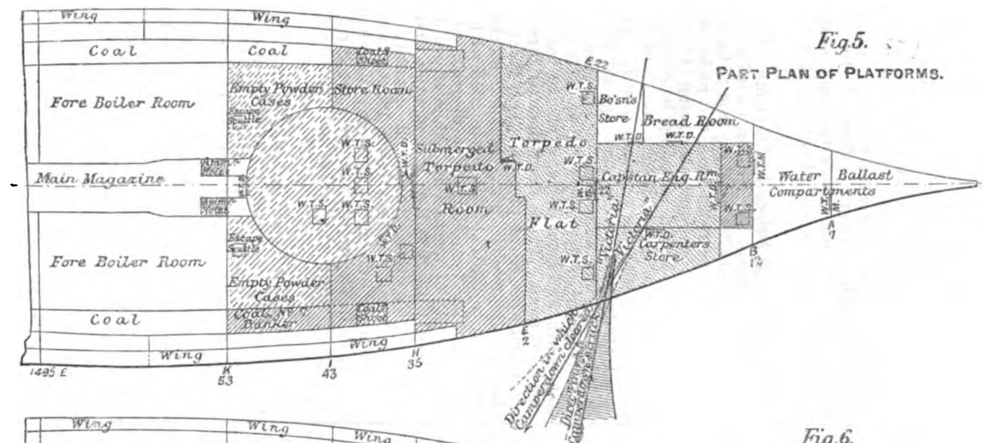


Fig. 6.

PART PLAN OF HOLD.

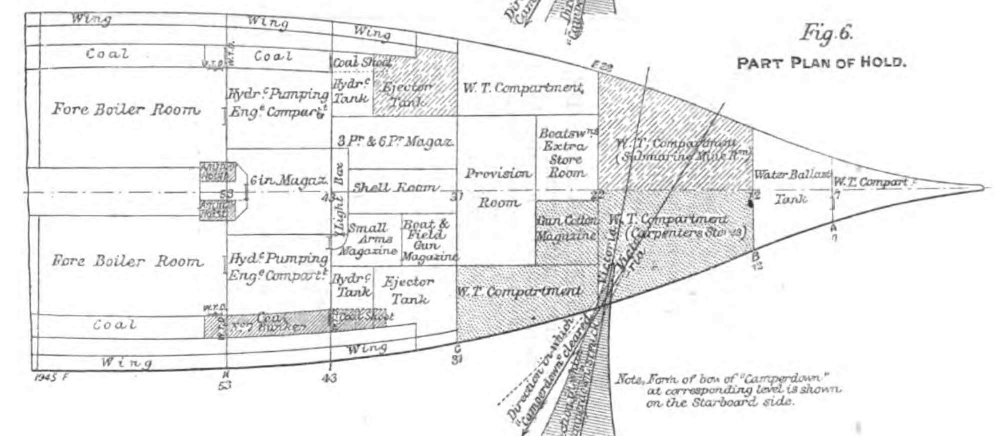
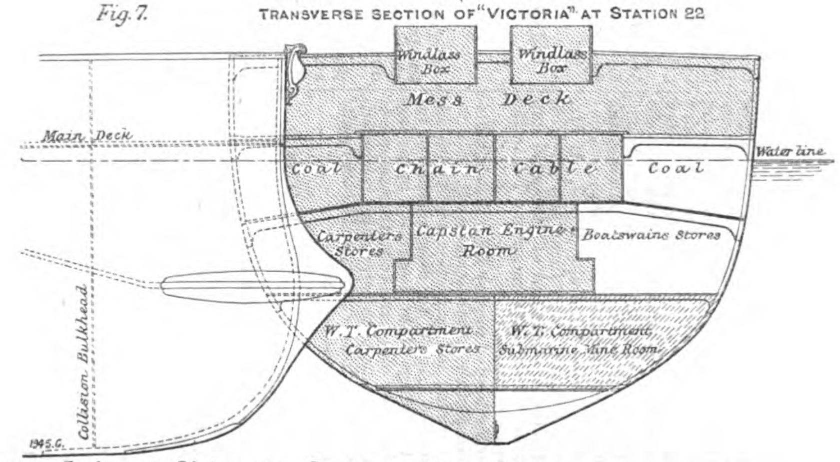


Fig. 7.

TRANSVERSE SECTION OF "VICTORIA" AT STATION 22



REFERENCES: —— The various compartments are tinted to indicate their condition as shown by the evidence.

TINT	CONDITION.
(tint)	Inevitably flooded through damaged side, decks and bulkheads
(tint)	Subsequently flooded through open doors, hatches and ports.
(tint)	Probably filled after riding bitts were submerged.
(tint)	Some of these may have been flooded, evidence is not clear.

W.T.D. Indicates a Watertight Door
W.T.S. " " " Scuttle
W.T.M. " " " Manhole

CONTENTS.

NOTICE.

The New Cunarders "CAMPANIA" and "LUCANIA;" and the WORLD'S COLUMBIAN EXPOSITION OF 1893.

The Publisher begs to announce that a Reprint is now ready of the Descriptive Matter and Illustrations contained in the issue of ENGINEERING of April 21st, comprising over 130 pages, with nine two-page and four single-page Plates, printed throughout on special Plate paper, bound in cloth, gilt lettered. Price 6s. Post free, 6s. 6d. The ordinary edition of the issue of April 21st is out of print.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—At 25, Great George-street, Westminster, S.W. Session 1893-94. Ordinary meetings. November 14, address by Mr. Alfred Giles, President, and presentation of medals, premiums, and prizes awarded at the close of last session. November 21, papers to be read with a view to discussion: "The Tansa Works for the Water supply of Bombay," by Mr. William J. B. Clerke, B.A., C.I.E., M. Inst. C.E. "The Baroda Water Works," by Mr. Jagannath Sadasewjee, Assoc. M. Inst. C.E. "The Water Supply of Jeypore, Rajputana," by Colonel S. S. Jacob, C.I.E., Assoc. Inst. C.E. "On the Design of Masonry Dams," by Mr. Franz Kreuter (Professor of Civil Engineering at the Royal Technical Academy of Munich).—Students' meeting, Friday, November 17, at 7.30 p.m. Paper to be read: "The Filtration of Potable Water," by Messrs. James and Richard Goodman, Students Inst. C.E. Mr. James Mansergh, Member of Council, in the chair.

ROYAL METEOROLOGICAL SOCIETY.—At the ordinary meeting on Wednesday, the 15th instant, at 25, Great George-street, Westminster, at 8 p.m., the following papers will be read: "The Great Drought of 1893 and its attendant Meteorological Phenomena," by Mr. Frederick J. Brodie, F.R. Met. Soc. "Thunder and Hail Storms over England and the South of Scotland, July 8, 1893," by Mr. William Marriott, F.R. Met. Soc.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday evening, November 13, in the hall of the Literary and Philosophical Society, Corporation-road, Middlesbrough, at 7.30 precisely. Paper "On Vessels Constructed for the Oversea Bulk Oil Trade," by Mr. E. H. Craggs, Middlesbrough.

CHEMICAL SOCIETY.—Thursday, November 16, at 8 p.m. "The Normal Butyl, Heptyl, and Octyl Esters of Active Glyceric Acid," by Professor Percy Frankland, F.R.S., and Mr. John MacGregor, M.A. "The Ethereal Salts of Diacetyl-Glyceric Acid in their Relation to Optical Activity," by Professor Percy Frankland, F.R.S., and Mr. John MacGregor, M.A., and other papers.

THE SURVEYORS' INSTITUTION.—Monday, November 13, ordinary general meeting, when the President, Mr. Charles J. Shoppee, will deliver an opening address. The chair will be taken at eight o'clock.

SOCIETY OF ARTS.—Wednesday, November 15, at 8 p.m. First ordinary meeting. Opening address of the 140th session by Sir Richard E. Webster, Q.C., M.P., chairman of the Council.

ENGINEERING.

FRIDAY, NOVEMBER 10, 1893.

THE SINKING OF THE "VICTORIA."

IN our last issue we made reference to the report on the loss of H.M.S. Victoria, which had then just been issued. We dealt more particularly with the Minute of the Board of Admiralty, leaving the more important part of this official publication, that consisting of the report of the Director of Naval Construction, until a closer examination of its contents could be made. This report we now propose to consider, and on pages 574 and 579 we reproduce some of the illustrations which accompany it, in order that a very fair idea may be formed of the arrangement of the ship forward, and of the effect of the blow delivered by the Camperdown's ram.

The first and most important issue hanging upon the results of this mishap is, what is the condition of other battleships of the Royal Navy with regard to liability to sink ; and here we may at once say, from general knowledge, that the Victoria is as well designed as other vessels of her class in regard to subdivision, so that what is true of the Victoria is broadly true of other ships.

In dealing with this question, it will be necessary to keep in view the distinction that must be drawn between damage to the ship that would result from gun-fire, and that from the blow of ram or torpedo. If the Victoria had only been injured above the armoured deck, she would probably have been afloat now, but the blow being what it was, no practicable amount of "armoured end" would have saved her. A glance at the section, Fig. 7, page 574, will well illustrate this. It may be that a thick armour belt would have done much to stop the penetration of the whole of the Camperdown's stem (although the horizontal armoured deck is a better disposition of material for the purpose), but we do not anticipate that any one advocates armouring ships' sides so far below water line as the depth of the submersion of a battleship's spur. Even if the penetration had been far less, the hole would have been amply large to admit all the water required for the fatal work.

In reference to the question of gun-fire, it may be well to point out—for fear of being misunderstood—that the water "line" of a ship at sea, especially when steaming at speed, is no defined straight line. Owing to the motion of the waves, the heeling of the vessel when turning, the disturbance of water level due to the progress of the ship, and to other causes, the area of the ship's side alternately immersed and exposed is of considerable size, and the chances of gun wounds resembling, to this extent, a ram blow must be considered.

In the design of battleships of the class now under consideration, the ends above the protective deck are frankly given up to destruction, if the enemy elect to turn his gun-fire on to them. It is claimed that their flooding would not destroy the flotation or stability of the ship. She would naturally sink deeper in the water, but the armoured central part, and the ends below the armoured deck, would afford the required displacement. This, of course, is a matter of ordinary calculation to any naval architect having access to the drawings of the ship, and the constructive department claims that these calculations have been made, and that they result in the vindication of the design. Constructors' calculations are, however, one thing, and the conditions of wind and waves, or shot and shell, are another. Certainly a battleship, of the type ruling in the British Navy, with her ends above the armoured deck flooded, would be a very uncomfortable vessel to be on board in even a moderately rough sea. Comfort, however, is not a feature much to be considered during a naval engagement, and the question for the designer is whether the end upper works are most likely to draw the gun-fire, or whether the enemy will not be more likely to attack the midship citadel, where the men are situated, and where are the guns by which destruction is dealt.

The illustrations we give show very clearly the locality and extent of the damage sustained by the Victoria, as far as the details are known or can be fairly surmised from the evidence of witnesses, or can be deduced from the condition of the Camperdown's bows after the collision. The penetration was probably 5½ ft. to 6 ft. for the vertical portion of the stem. The extreme point or spur of the Camperdown's ram bow projects about 7 ft. before the upright part, and this spur pierced the thin plating below the protective deck, which "it was designed to do," as the report pertinently adds. Notwithstanding the form of the athwartship section of the Victoria at the part rammed, as shown in Fig. 7, the spur of the Camperdown was driven about 9 ft. within the side plating at a depth of 12 ft. below water. It is further pointed out in the report that the Victoria was moving directly across the bows of the Camperdown at a speed of 5 or 6 knots, and that the bottom must have been torn open for some distance abaft the first breach, if the forward motion of the former ship, compared to the latter, had continued. What actually happened was that the Camperdown's bow was virtually locked in the protective deck of the Victoria, so that the relative forward movement of the latter ship was practically destroyed—at the expense, it may be added, of the Camperdown, which thus had her bow wrenched across.

In regard to the important question of watertight doors—upon which the value of subdivision depends, for unpierced bulkheads are practically impossible—we last week quoted a sentence from the Board's Minute, which is so important that it should be repeated. Speaking of the Victoria, their Lordships say : "According to established practice of the Admiralty in all classes of ships, the number of watertight doors is made as small as possible consistently with the essential conditions for working and fighting the ship." It will be noticed that the blow was struck almost on an important bulkhead, and Mr. White points out that a number of the watertight doors in the neighbourhood of the point of collision were open, and could not subsequently be closed ; and, further, "the shock of the collision no doubt destroyed the absolute water-tightness of some of the partitions adjacent to the place where the blow was struck, so allowing water to pass through the interstices." This is a very candid expression of opinion on the part of the Director of Naval Construction, and it may here be said generally that Mr. White's report, as will be seen by our extracts, is characterised by an impartiality and absence of bias not always displayed by official documents destined for public perusal. In the case of the Victoria collision, a large weight of water found its way in a very short time into the interior, and passed for a considerable distance fore and aft. A very great depression of the bow was observed within three or four minutes of the collision.

Mr. White considers the cause of failure to close the doors, hatches, &c., is to be found in the very short time before the collision that orders were given to make the attempt. Mr. White does not attribute this failure to any shortcomings on the part of the officers or crew of the ship, he would be travelling outside his sphere were he to do so, but he quotes the statement of Captain Bourke that, under ordinary conditions of drill, three minutes were required to close the doors, &c. From the evidence, it appeared that the order to close the doors was given about one minute before the collision; so the doors evidently were not closed to any large extent. The result of this is clearly shown in the illustrations we publish, where the large spaces undoubtedly flooded are evidently more than sufficient to account for the loss of the vessel.

Like Mr. White, we are not concerned to inquire whether there was any laxity on the part of the officers of the Victoria. Such an accident as this during peace time, sad and serious as it is, is altogether dwarfed in importance by the seriousness that would follow such a disaster during battle. The vital question, therefore, is, What is the vulnerability of our warships during actual fighting? It is evident that if all, or nearly all, the watertight doors shown are necessary for fighting the ship, subdivision as practised is little good as an answer to ram or torpedo, to say nothing of damage from shot or shell below the line on the ship's side to which water reaches, which, of course, is a different thing to the draughtsman's "water line." To answer this question in a manner to satisfy public doubt requires a public and independent inquiry, which should certainly be something more than a departmental committee. There is no doubt that, logically or otherwise, public confidence in the present manner of settling designs of ships has been rudely shaken by recent misadventures. This mixture of naval architects' and naval officers' designs appears to be a compromise which does not lead to good results; at any rate, neither division appears satisfied with the influence of the other—speaking, of course, of the two bodies at large. Nominally, and as a matter of procedure, the constructors have no voice in the matter; they are the subordinates of the naval officers on the Board, and have simply to do as they are told. Practically, however, they are able to get a great deal of their own way, the extent varying with the ratio of strength of character between the representatives of the two parties. This "Pull, devil; pull, baker," method of settling affairs does not always lead to harmony of design, and it makes the onus of responsibility so uncertain in its incidence that there is always an excuse for either party. According to some persons, constructors are all pedants, and according to others, naval officers are all blockheads. Although these are foolish views, they represent the extremes of two parties, and the public would like to form its own opinion to which side the balance inclines.

To return, however, to Mr. White's report, we find that when the Camperdown had cleared, the Victoria continued to settle by the bow and increase her heel to starboard. For nine or ten minutes these movements continued to proceed gradually and steadily. Then came a lurch to starboard, which commenced suddenly, the ship fell over on her side, and turning bottom up, finally sank by the head at an angle 20 deg. or 30 deg. to the vertical. At the instant the lurch began the Victoria was steaming slowly ahead with both screws, her helm being hard-a-starboard.

By reference to our illustrations it will be seen how large a part of the ship was flooded of necessity by the blow. This space extends over all the mess deck up to the thwartship armour forward, only the extreme forward part of the vessel being free. The space is divided by a bulkhead with two watertight doors, but this bulkhead appears to have been injured by the blow, or at any rate suffered when the Camperdown swung sideways, wrenching open the rent still further. The water flowed also around the armoured breastwork of the turret, and flooded the cabins forward on this deck. On the lower deck there is more subdivision, with longitudinal bulkheads, the central one apparently preventing the water going to the port side, and thus giving the ship the observed list to starboard. Reserve coal bunkers are at the side here, and are divided off by longitudinal bulkheads. As the stem of the Camperdown did not get as far as these bulkheads, it was to be expected that they would have stopped the flow of water to other parts of the deck, had their doors been closed. Presumably they were not, and the question arises whether they would be closed in action, a fact which naturally would depend upon whether coal were required from these bunkers. Probably it would not be.

So far we have dealt with that part of the ship which would be freely open to damage by gun-fire, and it is to be presumed that, so far as regards this part, the ship had received no vital injury, but we now proceed to the portion beneath the armoured deck. Here we do not find the same conditions of longitudinal subdivision; a fact due, no doubt, to the exigencies of design of the ship as a fighting engine. There is, however, a thwartship bulkhead, close upon which the spur of the Camperdown entered, penetrating deeply into the carpenter's store, but not far enough to destroy the fore-and-aft bulkhead which separates that compartment from the other part on this level, namely, the capstan engine room. The destruction of the thwartship bulkhead here admitted water to the torpedo flat, which extends right across the ship. The capstan engine room was also flooded, owing to openings being unclosed. The large space aft of this was also flooded subsequently, also on account of doors being left open. Other spaces at this level may also have had water admitted to them, but of this there is no sure evidence. On the lower level we find a large compartment devoted to carpenters' stores undoubtedly flooded, whilst an adjoining wing compartment was probably opened up. The submarine mine compartment was possibly filled with water.

Four minutes after the collision the bow had sunk 10 ft. This change of trim continued, and two minutes later the men were called away from the forecastle. The ship was listed to starboard until there came a lurch, the ship fell over on her side, and finally sank by the head at an angle of 20 deg. or 30 deg. from the vertical. The vessel was still steaming ahead slowly with both screws. Immediately before the lurch the water was washing into the open turret ports nearly 100 ft. from the bow and 14 ft. above the original water-line. This would bring the upper deck right forward 13 ft. under water, or 23 ft. below its normal position. Nearly half the length of the ship would then be submerged, the after part being lifted considerably. The rising of the water at the turret and its flowing through the ports allowed it to pass into the redoubt, but, apart from this, the armoured door in the oblique bulkhead was open, and water was thus passing into the battery, and accumulating on the starboard side, whilst the two 6-in. gun ports on the starboard broadside were noted to be just awash.

Without going further into details, it will be evident that in such condition of change of trim, by reason of the vast quantities of water that had entered forward, the conditions of stability, due to the design of the vessel at anything like her normal load water-line, must be entirely changed; in fact, one hardly expects a ship to be stable with her fore part under water and her stern in the air. How much longer the Victoria would have floated had she not turned over is an open question, but it would be absurd to let conditions of stability, when a ship is in the condition the Victoria was when she turned over, govern a design. Whether the ship can be arranged so that she will not take in water in the manner which occurred in the case of the Victoria, is quite another matter, and one which mainly depends on the amount of communication necessary on service.

Mr. White has had made calculations showing the effect upon trim and transverse inclination due to the water taken on board by the Victoria. It was found that the flooded compartments, nineteen in number, had a capacity which involved a total loss of buoyancy of 1110 tons. Of this amount less than 110 tons were in compartments above the protective deck, and about 1000 in the spaces below that deck. It will be seen from these figures, which are presented on the authority of the department, the extent to which the "unarmoured end" problem governs the position. The following figures bring out the case more clearly. The loss of buoyancy in compartments so far forward produced a moment of change of trim of about 140,000 foot-tons. Of this total moment the 110 tons above the protective deck account for only 15,000 foot-tons—the balance (nine-tenths of the whole) being due to the water below that deck. With water above the protective deck only, the change of trim would be 3 ft. only. Although this would be no inconsiderable amount with vessels of the Victoria type in a fairly rough sea, it would be insignificant compared to the effect of water admitted below the armoured deck in parts which are fairly safe from gun-fire. The additional moment due to the 1000 tons below the protective deck brings the change of trim to 29 ft. The depression of the bow would be 21 ft., and the rise of stern 8 ft., as compared to the normal. It is, in the face of these figures, absurd to take the sinking of the Victoria as an object-lesson upon the folly of unarmoured ends, and a proof of the virtues of continuous belts. Whatever may be the merits of the two systems, the Victoria disaster certainly does not prove the triumph of the latter; perhaps it is a vindication of those who uphold the former.

The total volume of water which the ship had taken in when the Victoria made the final lurch is put down at 2200 tons, but this neglects water which may have entered through the turret ports. Mr. White explains that the sudden entry of water into the 6-in. gun battery, above the upper deck, through the open ports and door, caused the final lurch which led to the capsizing and foundering of the vessel. He says: "Had the ports in battery and turret, and the armour door, been closed, and water excluded from both battery and turret, the Victoria would not have capsized, and would have remained afloat for a much longer time, even if eventually she had foundered."

Calculations were also made to find the probable effect had all doors, hatches, &c., been closed at the time of the collision. The flooded compartments would then have been twelve in number, and would have involved a loss of buoyancy of 680 tons, and of this loss 600 tons would have been below the protective deck. The change of trim resulting would have been $13\frac{1}{2}$ ft., or less than half that observed before the lurch began. The upper deck and the stem head would have remained just above water. The heel to starboard would have been about 9 deg., and the metacentric height would have been $2\frac{1}{4}$ ft. Under these circumstances, as Mr. White says, the Victoria would have been under control and navigable.

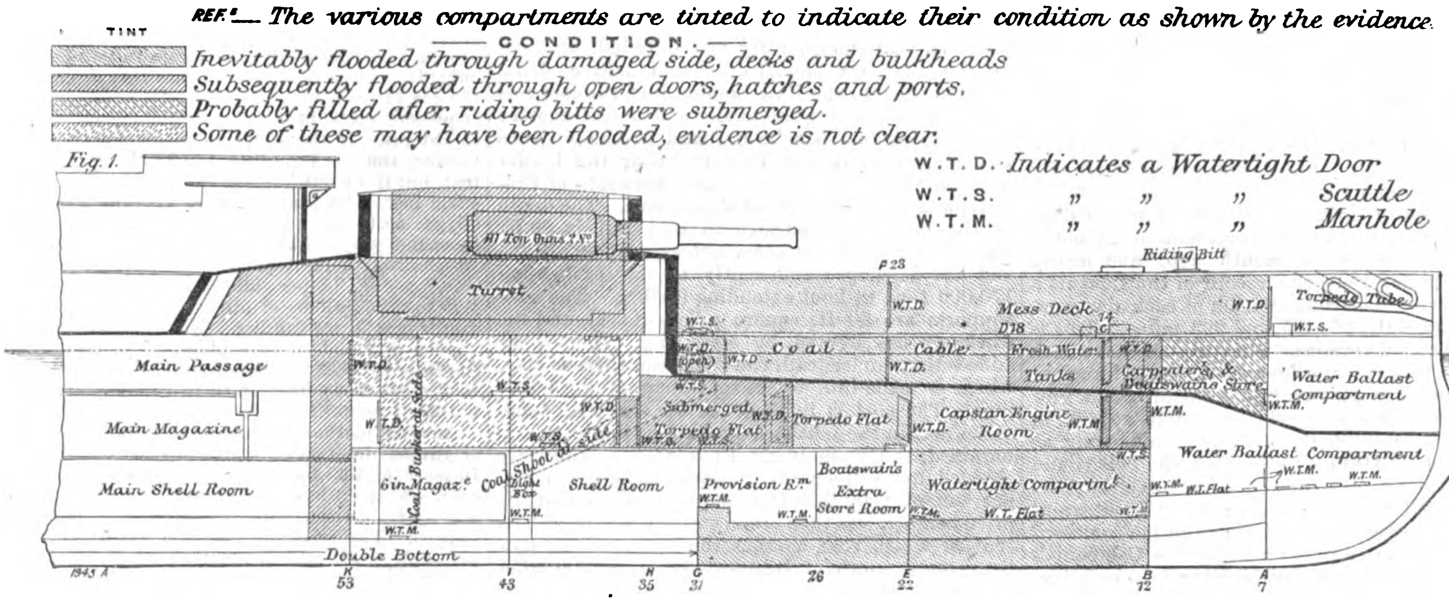
Mr. White has done his part as a naval architect, and it now remains for the Admiralty to consider whether it is possible for a battleship, subdivided as the Victoria, to be fought to fullest advantage with watertight doors closed. We may depend that in action captains will put their ships into the best fighting trim, irrespective of other considerations. If a watertight door obstruct duty in action, that door will be opened, risk or no risk, and in spite of all regulations. It is necessary to guard men against themselves sometimes, and the ship should be arranged with this view. We quite agree with the report that an automatic closing door which would meet the occasion is not likely to be introduced, but it would be well to arrange many of the communications so that there would be no inducement to leave them open during the progress of a fight. In the meantime, the sinking of the Victoria has shown how vulnerable our battleships are under certain conditions. The blow of the Camperdown was one out of many hundreds that are possible. It has taken the naval world by surprise; hardly a naval officer in the fleet thought the ship was going to sink; and however satisfying Mr. White's calculations may be, could we forget what did happen, and had only to speculate on what might happen, the great moral of the event is that an independent inquiry should be held whilst this object-lesson from real life is still fresh in memory. Such a concession is due to the public from those who make such heavy demands on their purse-strings.

THE EARNINGS OF BRITISH LOCOMOTIVES.

There are on the railways of the United Kingdom 17,439 locomotives of all types, of which 85 per cent. belong to England and Wales. This total does not give one locomotive per mile of railway,

H.M.S. "VICTORIA:" ARRANGEMENT OF BULKHEADS AND WATERTIGHT DOORS.

(See Page 575.)



it, without ascribing so enormous a comparative action to aqueous vapour. For example, the cylinder which contained the air in which these experiments were made, was stopped at its ends by plates of rock salt on account of their transparency to radiant heat. Rock salt is hygroscopic; it attracts the moisture of the atmosphere. Thus a layer of brine readily forms on the surface of a plate of rock salt, and it is well known that brine is very impervious to the rays of heat. Illuminating a polished plate of salt by the electric light, and casting, by means of a lens, a magnified image of the plate upon a screen, Dr. Tyndall breathed for a moment through a tube on the salt; brilliant colours of thin plates (soap bubble colours) flashed forth immediately upon the screen, these being caused by the film of moisture which overspread the salt. Such a film, it was contended, is formed when undried air is sent into the cylinder; it was, therefore, the absorption of a layer of brine that was measured, instead of the absorption of aqueous vapour.

Dr. Tyndall met this objection in two ways—firstly, by showing that the plates of salt, when subjected to the strictest examination, show no trace of a film of moisture; secondly, by abolishing the plates of salt altogether, and obtaining the same results in a cylinder open at both ends.

It was next surmised that the effect was due to the impurity of the London air, and the suspended carbon particles were pointed to as the cause of the opacity to radiant heat. This objection was met by bringing air from Hyde Park, Hampstead Heath, Primrose Hill, Epsom Downs, a field near Newport, Isle of Wight, St. Catherine's Down, and the sea beach near Black Gang Chine. The aqueous vapour of the air from these localities intercepted at least seventy times the amount of radiant heat absorbed by the air in which the vapour was diffused.

Experiments made with smoky air proved that the suspended smoke of the atmosphere of West London, even when an east wind pours over it the smoke of the city, exerts only a fraction of the destructive powers exercised by the transparent and impalpable aqueous vapour diffused in the air,

The cylinder which contained the air, through which the calorific rays passed, was polished within, and the rays which struck the interior surface were reflected from it to the thermo-electric pile which measured the radiation. The following objection was raised: You permit moist air to enter your cylinder; a portion of this moisture is condensed as a liquid film upon the interior service of your tube; its reflective power is thereby diminished; less heat, therefore, reaches the pile, and you incorrectly ascribe to the absorption of aqueous vapour, an effect which is really due to the diminished reflection of the interior surface of the cylinder.

But why should the aqueous vapour so condense? The tube within is warmer than the air without, and against its inner surface the rays of heat are impinging. There can be no tendency to condensation under such circumstances. Further, Dr. Tyndall sent in 5 in. of undried air into the tube—that is, one-sixth of the amount which it can contain. These 5 in. produced their proportionate amount of absorption. The driest day, on the driest portion of the earth's surface, would make no approach to the dryness of the cylinder when it contains only 5 in. of air. Make it 10 in., 15 in., 20 in., 25 in., 30 in., the absorption is exactly proportional to the quantity of vapour present. But lest a doubt should linger in the mind, not only were the plates of rock salt abolished, but the cylinder itself was dispensed with. Humid air was displaced by dry, and dry air by humid in the free atmosphere; the absorption of the aqueous vapour was here manifest, as in all other cases.

Dr. Tyndall has, therefore, established the extraordinary opacity of this substance to the rays of obscure heat; and particularly such rays as are emitted by the earth after it has been warmed by the sun. It is perfectly certain that more than 10 per cent. of the terrestrial radiation from the soil of England is stopped within 10 ft. of the surface of the soil. This one fact is sufficient to show the immense influence which this property of aqueous vapour, discovered by Dr. Tyndall, must exert on the phenomena of meteorology.

This aqueous vapour is a blanket more necessary to the vegetable life of England than clothing is to man. Remove for a single summer night the aqueous vapour from the air which overspreads this country, and every plant capable of being destroyed by a freezing atmosphere, would be destroyed. The warmth of the fields and gardens would pour itself unrequited into space, and the sun would rise upon an island held fast in the iron grip of frost. The aqueous vapour constitutes a local dam, by which the temperature at the earth's surface is deepened; the dam, however, finally overflows, and we give back to space all that we receive from the sun.

The sun raises the vapours of the equatorial ocean, they rise, but for a time a vapour screen spreads above and around them. But the higher they rise the more they come into the presence of pure space; and when, by their levity, they have penetrated the vapour screen, which lies close to the earth's surface, what must occur?

Dr. Tyndall has shown that, compared atom to atom, the absorption of an atom of aqueous vapour is 16,000 times that of air, and that the power to absorb and that the power to radiate are perfectly reciprocal and proportional. The atom of aqueous vapour will therefore radiate with 16,000 times the energy of an atom of air. This powerful radiant in the presence of space, with no screen above it to check its radiation, pours its heat into space, chills itself, condenses, and the tropical torrents are the consequence. The expansion of the air, no doubt, also refrigerates it; but in accounting for these deluges the chilling of the vapour by its own radiation plays a most important part. The rain quits the ocean as vapour; it returns to it as water. The vast stores of heat set free by the change from the vaporous to the liquid condition are for the most part disposed of by radiation into space.

Similar remarks are made by Dr. Tyndall as regards the cumuli of our latitudes. The warmed air, charged with vapour, rises in columns, so as to penetrate the vapour screen which hugs the earth; in the presence of space the head of each column wastes its heat by radiation, condenses to a cumulus, which constitutes the visible capital of an invisible column of saturated air.

It is the absence of this screen, and the consequent copious waste of heat, that causes mountains to be so much chilled when the sun is withdrawn. Its absence in Central Asia renders the winter there almost unendurable. In Sahara the dryness of the air is sometimes such that, though during the day "the soil is fire and the wind is flame," the chill at night is painful to bear. In Australia also the thermometric range is enormous, on account of the absence of this qualifying agent.

A clear day and a dry day, moreover, are very different things. The atmosphere may possess great visual clearness, while it is charged with aqueous vapour, and on such occasions great chilling cannot occur by terrestrial radiation. Sir John Leslie and others have been perplexed by the varying indications of their instruments on days equally bright; but all these anomalies are completely accounted for by reference to this discovery of the radiating and absorbing powers of aqueous vapour. By its presence it checks the earth's loss; its absence, without sensibly altering the transparency of the air, would open wide a door for the escape of the earth's heat into infinitude.

NOTES.

H.M.S. "Speedy."

On Tuesday last the trial of H.M.S. Speedy was brought to a successful conclusion, and the last of the torpedo gunboats was thus added to the Navy. This vessel is especially interesting from the fact that she is fitted with the Thornycroft water-tube boiler, and that her builders, Messrs. J. I. Thornycroft and Co., had promised 1000 indicated horse-power over other vessels of the class. The guarantee for the rest of this class has been 2500 indicated horse-power with natural draught, and 3500 with forced draught. The Speedy was guaranteed for 4500 forced draught. The contract was exceeded on both trials, no less than 4674 indicated horse-power being the mean on Tuesday. The revolutions were 247 starboard and 243 port engine, the steam 193 lb. The day was a bad one for the purpose, a strong north-east wind, which blew through the night and during the trial, making a nasty sea; the course being from the Nore to the North Foreland. The speed, however, was 20 knots, which could be considerably exceeded under favourable conditions. We shall return to the subject of these vessels in a future