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ADMIRAL LORD ALCESTER, G.C.B., &c., &c., in the Chair.

ON MASTING OF SHIPS-OF-WAR, AND THE NECESSITY OF STILL EMPLOYING SAIL POWER IN OCEAN- GOING SHIPS.

By Captain G. H. NOEL, R.N.

INTRODUCTION.

IN these days, when steam propulsion has attained such perfection, and is even threatened to be superseded by other motive powers, the question of the masting of ships-of-war may seem to those who claim to keep pace with the advance of science, somewhat out of date and wanting in importance; indeed it is sometimes openly propounded (and that by naval Officers) that masts are useless encumbrances, and ought to be wholly done away with. While admitting that masting should be modernized and rendered more suitable to the present conditions of ships, I am most strongly of opinion that the intention of ignoring such a useful and powerful element of propulsion as the wind is neither scientific nor judicious. My endeavour in writing this paper is to win back some of the wavering to a sounder faith in sail power, by pointing out how, with the modern scientific improvements in material of all sorts, the present system of masting can be rendered very much more efficient and serviceable, and by attempting to show that in ships-of-war, while certain classes can dispense with sail power altogether, to some classes it is useful, and to others indispensable.

Most naval Officers of experience still accredit sail power with a considerable degree of value; but it must be generally admitted that, in these days, when our ships are, on emergency, required to steam at great speed, improvements in the system of masting are urgently needed. Masting should be of such a nature that, while thoroughly serviceable for setting a large area of sail, it can be quickly, easily, and effectively reduced; when the ship is required to steam head to wind, or before going into action.

In treating of the masting of ships, the fleet should be divided into several distinct classes:—

- Class 1. Coast Service Ironclads.
- „ 2. Special Cruizers or Despatch Vessels.
- „ 3. Small swift Vidette Vessels.
- „ 4. Ocean Service Ironclads.
- „ 5. Armoured Cruizers.
- „ 6. Unarmoured Cruizers.
- „ 7. Small Coasting Cruizers.

These seven classes form three groups, between which we cannot draw too strong lines of demarcation, and this not only with reference to their masting, but also to their armament, speed, and many other considerations. It would be a great help to naval architects—who often have reason for complaining that too many good qualities are wanted in one vessel—if these distinctive groups were more fully recognized.

The 1st Group comprises Coast Service Ironclads of all sizes. The 2nd Group consists of Classes 2 and 3, Special Cruizers and Vidette Vessels of the greatest possible speed under steam. The 3rd Group includes Classes 4, 5, and 6, Ocean Service Ironclads and Cruizers, and to this group Class 7 may be here added.

As regards the masting of these Classes. Class 1, Coast Service Ironclads, need no sail power. They are vessels, as their name implies, intended for duty on the coast; they will seldom, if ever, be alone on foreign service, and should never be exposed to the risk of running short of coal. Their one mast is useful for signals and the working of machine-guns from aloft, both necessary matters in action.

Class 2, Special Cruizers, of which the “*Iris*” is a specimen. These vessels, having immense engine power, and possessing the utmost speed possible (for the purpose of carrying despatches or following up and capturing the enemy’s fastest cruizers), are necessarily of fine lines, and their speed under steam is such that square sails will avail them but little. Sail power is only requisite for steadying the ship, and in case of accident to the engines; good fore-and-aft canvas is here sufficient, and flying square sails on the foremast.

Class 3, Swift Vidette or look-out vessels, small craft of about 1,000 tons, possessing the highest speed under steam that is possible, subject to their being thoroughly fit for sea service; these vessels, required as tenders to the ironclad fleet, to move rapidly under steam, discovering and warding off the attack of torpedo boats, and otherwise keeping the look-out, would (like the special cruizers) only require light masting and fore-and-aft canvas.

Class 4, Ocean Service Ironclads, of which the “*Téméraire*” is a fair type, are required to cruise in open water, keeping the sea for long periods, perhaps at some distance from coaling stations, and where colliers cannot always be cleared, even if with the fleet. To this class sail power, though desirable, is not a matter of extreme urgency; their two masts, fully equipped in time of peace, would be useful for cruising purposes, and would serve to keep the men up to those duties so essential to seamen (especially when employed in cruizers where much

will depend on the seamanlike working of sails and spars); whereas, in time of war, the masting will be reduced as much as possible, and all light spars and rigging, used for other purposes, or landed out of the way. In action the lower masts are essential for observation, signals, and machine-gun fire. It may be anticipated that the time will come when this class will be merged in Class 5.

Class 5, Armoured Cruisers, of the "Nelson" or "Warspite" type, required for service on distant stations, where they would be usually unaccompanied. Such vessels are constantly taking long cruises entirely under sail; indeed their principal duty is cruising when the world is at peace, and the time is of less value than the health and exercise of their crews. In time of war their duty will be to engage the war-vessels of minor States, or the armoured cruisers of a maritime Power, like themselves in build, and also far from their own ports. It will be more than ever necessary to economize coal on these services; the sail power should therefore be most thoroughly efficient, the masting of dimensions suitable for spreading a large area of canvas, and since it is most necessary that when occasions require they should be capable of steaming with great rapidity against the wind, it should be possible to reduce the spars and rigging (offering resistance) quickly and to the utmost extent.

Class 6, Unarmoured Cruisers of 1,500 tons and upwards. Since it is imperative for all such cruisers to have the heels of larger and more powerful vessels in open waters, this class should be even more fully rigged, in proportion to their tonnage, than the armoured heavier cruisers; their speed ought to be materially assisted by sail power, so as to secure their escape from a powerful adversary, under steam and sail (in the direction in which the wind would most help them), and to enable them to economize fuel at all times by cruising under sail; for these vessels active and experienced seamen are more than ever wanted, and the smartest possible evolution will be requisite in preparing to steam head to wind for a chase, and in replacing everything for making sail again.

Class 7, Small Coasting Cruisers, of 800 to 1,500 tons, like the larger ships of this type, should be amply rigged. Their principal protection against powerful vessels is the lightness of their draught; speed under steam is not of great moment, but their sail power should be such as to admit of their making good passages from port to port, principally under canvas.

This is a general outline of the requirements of these seven classes of ships-of-war. Masting is considered—in Group I only requisite for signal and machine-gun work; in Group II for steadying the ship, and in case of accidents; and in Group III for spreading a large amount of canvas, which (for this group) is considered essential.

PART I.

Arguments for and against Sail Power.

In dealing with these arguments we shall do well first to accurately ascertain what is being done in our fellow service, the Mercantile

Marine. Through the kindness and courtesy of some of the leading ship-building firms, and owners of the principal lines of steamers, I have been able to collect evidence and opinions on the systems of masting adopted by a considerable number of those companies whose magnificent steamers are unequalled in the mercantile world, and of the possession of which this country may well be proud. The main features of this evidence are as follows :—All the firms agree that sail power is necessary for the purpose of steadying the ships, and in case of accident to the engines, and that masting is useful for taking in and discharging cargo. Five of the principal companies, namely, the “White Star,” “Inman,” “Royal Mail Steam Packet Company,” “Dominion,” and “British India” lines are in favour of sail power as assisting the passages of their steamships; other firms are opposed to it, while some remain neutral on the question. The “Guion” Company, the speed of whose new steamers is seldom beaten, and also the “Allan” line across the Atlantic, do not value sail power, nor does the Ocean Steamship Company, though this last send their vessels to distant parts of the world. The “Cunard,” “Orient,” “National,” “Castle,” and “Union” lines, and the Pacific Steam Navigation Company admit that sail power has some value; for instance, the “Orient” steamers find the benefit of their sails in southern latitudes, between the Cape and Australia. The vessels of this line are very fully rigged, and those of the other five are serviceably rigged. It is undoubtedly the fact that with steamers of great power and very considerable speed, square sails are of little or no use. The speed these vessels keep up is such that the wind is seldom brought abaft the beam. Hence it is that fore-and-aft sails are those on which they must depend for assistance in steadying the ship, and perhaps in some cases adding to the speed, or at any rate reducing the expenditure of fuel. Some of the older companies still adhere to the three-masted rig, but a great many modern steamers in the Mercantile Marine carry either four or two masts, according to their length. Those of the most improved pattern are pole-masts, often without tops or cross-trees; the yards on the masts forward are in some cases sent down for the part of the passage where head-winds are expected, and in one or two lines they are only intended to be crossed in case of accident to the engines; gaffs are also sometimes dispensed with as holding wind unnecessarily. It will be understood from this statement that every endeavour is made to reduce top hamper and resistance to the wind to a minimum, and yet to show a fair spread of canvas when it is needed. The area of the canvas carried by some of the principal merchant steamers will be found in Table II, page 15. Except by one or two firms no reduction is anticipated in the present amount of sail power; this question might be affected by the introduction of twin-screws, but apparently there is no idea of departing from the single propeller system of propulsion.

The particulars I have received have principally reference to steamers of full power, intended for mail and passenger service; where the power is not so great, sail becomes of more value, and if it were not for the fact that economy necessitates the keeping down the number of

the crew of such steamers, the spread of canvas would in all probability be still greater. Another element which curtails the sail area in merchant vessels is the variation in the weights of different cargoes. A steamer in light draught is often too unstable to carry canvas with safety, and it is not worth her while to take in ballast to give her the necessary stability. The light draught displacement of a merchant vessel is sometimes only 30 per cent. of that at load or deep draught. The light draught displacement of a ship of war is never less than 80 per cent. of the load displacement, and is usually about 90 per cent.

Comparing the two services, in the Mercantile Marine the one great aim and object (especially with mail steamers) is to make good passages, obtaining the highest speed for the least expense. These vessels keep up the same rate throughout the voyage, sometimes making an average of 360 miles a day, while, with ships-of-war, a long passage at great speed is an exceedingly rare event. Though it is of course necessary to be careful with fuel, there is no risk of merchant steamers running short, as they take in ample to carry them to their destined port or next coaling station; whereas with a ship-of-war, economy of fuel is of the most vital importance, as there is seldom any definite route for her to take, and when least expected she may be ordered off on some special service, where there may be no certainty of obtaining coal. In merchant steamers the crews of seamen are not large enough to effectively work the sails, that is, so as to take every advantage of the wind; on the other hand, the crew of a man-of-war is, or should be, sufficient to work whatever spars and sails she may be provided with, whatever their dimensions. The variations in weights of cargo curtail the power to carry sail in merchant steamers; in a man-of-war this variation is comparatively of little moment.

The conclusions to be drawn from these comparisons are that while the experience of our fellow service is most valuable to us, and many of the improvements in the material and construction of their gear and appliances and the working of their sails may be with benefit introduced into our navy, the general system of masting in the Mercantile Marine is only applicable to our special cruisers, despatch, and vidette vessels, and that we must not be guided by the experience of rapid steamers in deciding on the masting requisite for such of our ships-of-war as are essentially required for cruising purposes, though possessing the power of steaming at considerable speed on an emergency.

Having decided that sail power is not required in Group I; that sails similar to those in the fast steamers of the Mercantile Marine are all that is requisite for Group II; we have now to deal solely with Group III, comprising all classes of armoured and unarmoured sea-going ironclads and cruisers; what are the arguments for and against providing this group with effective sail power?

Firstly, as regards the resistance to the wind offered by masting. The only argument of any weight against sail power is that the spars offer great resistance to the wind when steaming against it. No doubt this resistance is very considerable. The late Mr. W. Froude estimated

that in the "Greyhound," a somewhat fully rigged vessel with wooden masts, and nearly all her rigging of hemp, the resistance offered by the masting was equal to that offered by the hull (that is, to the mid-ship transverse section of the hull above water), about 330 square feet. The introduction of recent improvements in material, together with sending down upper masts and yards, should reduce this number to at most 250 square feet, and the further improvements proposed later on in this paper, to about 200 square feet. The estimated resistance offered by a surface of *one* square foot moving through air at the rate of 1 foot per second is .0017 lbs., and (since resistance varies as the square of the velocity) this would give a resistance of 1 lb. for every square foot moving through the air at the rate of 15 miles an hour. Hence, if the masting of H.M.S. "Greyhound" improved as proposed, and reduced for steaming head to wind, only represented 200 square feet, passing through the air at the rate of 15 knots, she would experience a resistance of only 200 lbs.; this would of course increase rapidly with the rate at which the air passed the ship, until at 80 knots we find the resistance is over $2\frac{1}{2}$ tons. Experiments are very much needed in order to obtain more definite data on the subject of the resistance offered by masting, and it is to be hoped that they will be some day carried out.

The funnels of powerful steamers offer considerable resistance; they serve to shelter the after-masting when steaming head to wind, which lessens to some extent the resistance offered by the main and mizen masts.

Another consideration is, that as at least one lower mast is essential for what are now called military purposes (that is, observations, signals, and machine-gun fire), a certain amount of resistance due to masting has to be overcome, why should not this necessary evil, when under steam alone, be made good use of, when the wind will help, especially if by ingenious appliances you can at will reduce the useful masting, until it offers little more resistance than a mast intended merely for military purposes?

Secondly, on the general duties of cruisers. From the outline already given of these duties it will be understood that cruisers should be capable of making very good passages under steam and sail: either in order to take up their post on a foreign station, to move to any threatened point, or for the purposes of a convoy. Long passages at high rates of speed will be of rare occurrence; of course occasions may arise when it will be necessary to send a ship-of-war or two, or even a squadron, to some distant station where our interests may be threatened; perhaps some unexpected event necessitating a reinforcement. In such a case, if the vessels required are not merely special cruisers, intended for like rapid movements, but something more substantial, the emergency must be met by attaching colliers to the squadron, or if they are not available, by filling the ships themselves with coal, in every hole and corner where it can possibly be stowed. Where judicious precautionary measures are taken, it will be seldom necessary to send ships-of-war to distant stations at great speed, and even if such a necessity should arise it would be no use their appearing

at the place of danger with their bunkers empty (which must result from a long steam passage), and unaccompanied by colliers. In addition to the ordinary duties of cruisers when on their station, will be that of cruising off and guarding neutral coaling ports in time of war, to prevent any of the enemy's vessels entering and obtaining coal; on which service they must be attended by vidette vessels of great speed, for searching out the enemy's ships, and putting their comrades on the scent. As regards convoy duties, ordinary cruisers should be capable of effectively conveying cargo steamers of moderate speed, such as those vessels that bring our food supply, which may require heavily armed protection. Our fast mail steamers will be able to take good care of themselves; and should the enemy send rapid vessels against them, special cruisers must hunt such vessels down: in some cases it will be sufficient if armed merchant steamers of great speed form a convoy for their consorts. For all these duties I maintain that effective sail power is necessary, and that to substitute the weight of the masting for an additional weight of fuel, would in no way render cruisers more serviceable.

Thirdly, on economy of fuel. With respect to cruisers in time of war, this question is of all others the most important. A system by which ships are so masted that coal is economized and sail used is, I am convinced, preferable to the opposite theory of expending coal on all occasions, and meeting this expenditure by making men-of-war their own colliers, to do which you must either construct enormous ships, or, if they are of moderate size, cramp all your internal arrangements and sacrifice the speed of your vessel, when in all likelihood her very existence may depend on that speed when the time of action comes. Increase of coal-carrying power means the cramping of other stowage, reducing the space for the engines and boilers to a minimum, giving the ship an amount of consumable stores which are very inconvenient (detracting from her speed when full, and from her safety when consumed), the stowage or rather the moving of which interferes with the efficiency of the watertight compartments, and after all if coal is to be the sole agent of propulsion, it is impossible for an ocean service ship-of-war to carry sufficient! Where economy of fuel is effected by the use of serviceable sail power great coal-carrying capacity is less important; the same steaming speed ought then to be attained with vessels of more moderate dimensions, and the ship's movements and safety will not depend solely on her ability to obtain coal.

One of the strategical principles in the naval warfare of the future will be starving the enemy out of his coal. Coaling stations will be seized and held, or the coal destroyed. Where then will that vessel be whose only means of propulsion and life comes out of her coal bunkers, when such a mishap occurs to her as to arrive with coal expended at a port coalless, or in the enemy's hands? She will be helpless either to fight or to fly; a well-masted vessel would have good chance of being able to do either one or the other, for with economy her coal would not be short, and even if it were so, her sail would be helpful in supplying the deficiency. Does not the best policy appear

to be so to rig our cruizers that they can take good care of themselves under sail, keeping steam as a reserve, to be used when the enemy is in sight, or for a quick passage where there is a fair certainty of obtaining coal at its end? Captain Colomb, R.N., who I am afraid is one of my opponents on this question, in one paper read at this Institution, April 15th, 1878,¹ proposed the almost entire abolition of sail power; but then in his Prize Essay of the same year he joins our system of communication in war time with no less than 75 coaling stations, 25 of which are not in our possession, and most of the remaining 50 are not fortified or protected in any way. When these important positions are *all* under our flag, and are *all* rendered practically secure from capture or destruction, we may reasonably trust our ships abroad without sail power, though even then it may be often attended with great risk or inconvenience. For instance, a mastless vessel, with just sufficient coal on board to reach her destined port, would not dare attempt the passage, and perhaps might have to retrace her route, or go considerably out of her way to replenish her bunkers; whereas a masted vessel, under similar circumstances, would proceed confidently on her voyage. We sometimes hear it suggested that there would be great economy effected by doing away with masts and sails, and substituting for the weight so saved an extra amount of coal. From Table I it will be seen how little there really is in this suggestion. Of the weight given for the spars and rigging of the "Alexandra," only 186 tons in all, what with the necessary one mast and its top-mast and rigging, tackles, &c., there might be a saving of 120 tons: this, if devoted to coals, would enable the "Alexandra" to steam at full speed for about sixteen hours, or 240 miles.

¹ "Steam-power *versus* Sail-power for Men-of-War." "Journal R.U.S.I.," vol. xxii, No. XCVI.

TABLE I.—*Showing Weights of Coal and Masting on board various ships.*

Ship's Name.	Tons Displacement.	Coal capacity.		Masting.		Approximate weight of a single mast and necessary gear.	Savings which might be applied as fuel.	Distance for which additional fuel would enable ship to steam at full speed.	Remarks.
		Weight.	Fraction of displacement.	Weight.	Fraction of displacement.				
		tons.		tons.		tons.	tons.		
Alexandra ..	9,490	680	·072	186	·02	66	120	16 hours at 15 knots or 240 miles	complement } 500 tons. of coal }
Nelson ..	7,630	1,150	·15	175 approx.	·023	60	115	18 hours at 14 knots or 252 miles	" } 540 "
Shannon ..	5,390	560	·104	159	·029	49	110	34 hours at 12 knots or 408 miles	" } 280 "
Inconstant ..	5,780	680	·115	171	·03	61	110	15 hours at 16½ knots or 248 miles	" } 680 "
Dacchante ..	4,130	500 estimated	·12	141	·034	41	100	18 hours at 14 knots or 252 miles	" } 400 "
Canada ..	2,380	470 estimated	·2	82	·034	22	60	25 hours at 13 knots or 325 miles	" } 270 "

In this table expenditure of coal has been taken at 2·24 lbs. per I.H.P., it being a reasonable all round measure with coal obtained abroad.

I contend that if, say, .15 of the displacement is to be devoted to elements of propulsion, it were better to devote .12 to fuel, and .03 to masting, than to have no sail power and .15 of displacement in coals.

Fourthly, on the value of sail power. It will not, perhaps, be out of place here to say a few words on this subject, as the rising generation of naval Officers, who have had little or no practical experience in the sailing of ships, are inclined to doubt the value of sail power. From want of experience a feeling of contempt is growing up for this mode of propulsion, especially in the more scientific school, which includes some of the most promising of our young Officers.

As an instance of the value of sails we have a passage, made in the spring of 1842 by H.M.S. "Vindictive," from off the "Start" to sighting "Java Head," in the Straits of Sunda, a distance by sailing passage of 12,600 miles, in 67 days 15 hours, or an average of 187 miles a day; on 34 days she accomplished over 200 miles' run per day, on 14 days of which, the run was over 250 miles per day, the two best runs being 295 and 296. Sail in this passage may be fairly estimated as having done the work of 500 I.H.P. with the latest improvements in engines, and a probable expenditure of about 800 tons of coal. There are numberless other instances of splendid passages under sail, notably those of the Australian clippers and of the tea-clippers from China, a very good article on which is to be found in "Naval Science," 1873. The management of a ship under sail when making a passage is most truly a science, and by its proper application sail power can be rendered of very great value. Is it because the science of profitably using the wind is being lost in our service that the present age is anxious to prove its ability to do without so powerful a motive agent? Before the days of steam, passages under sail were minutely studied, and with results such as those referred to above. The introduction of steam disturbed the old calculations, at the same time bringing about a laxity in the exceeding watchfulness and care necessary for success in sailing passages, and, either because the merchant service have never made much use of sailing ships with auxiliary engines, or because men-of-war passages are often indefinite in their aim and precision, we do not seem ever to have had the necessary calculations made, or the question of "steam-and-sail" passages thoroughly worked out and studied; though meteorological and hydrographical information is more perfect and concise than it ever was. The result is that our present ships-of-war, though they have steam to help them, often make worse passages than the old sailing ships. I have great faith in the possibility of making most excellent *steam-and-sail* passages; but they will demand, on the part of the Officers, the same constant care and attention that a good sailing passage required (which means that every breath of wind should be taken advantage of), combined with the closest study of wind charts, and the most judicious use of steam.

There is a growing impression that it is impossible for a good sailing vessel to be at the same time a good steamer. Like the question of *steam-and-sail* passages so it is with the construction of man-of-war cruisers—we have not given it a fair trial. No real attempt has been made to combine good sailing with good steaming qualities since

the building of the "Inconstant," which vessel, except for her being somewhat crank, answered both purposes most admirably. The late Mr. William Froude pointed out very forcibly that the form of vessel which offered least resistance, and consequently was best for attaining speed under steam, need not be of great length in proportion to beam, so long as it possessed fine entrance and run. Mr. J. H. Byles brought this subject up only the other day in a paper read at the Institute of Naval Architects, and clearly showed that in the construction of merchant steamers this theory was borne out by practice. I think it has yet to be proved whether on this principle a vessel could not be constructed which would combine steaming and sailing qualities to a higher degree than anything that has yet been produced. There is no doubt that such qualities as good beam and fine ends carry with them every advantage a man-of-war most needs—namely: engine space, coal space, stiffness under canvas, handiness under steam, security of vital parts, and deck-room for working guns and spars. The only difference which appears to me to be requisite in the forms of two ships, one intended only as a steamer, and the other for sailing as well as steaming, is that in the first case it is necessary that her lines should be such as will offer small resistance when on an even keel, and in the second case her lines should have a similar effect, both when on an even keel and when heeling. In the sailing steamer the fineness of the entrance and run would probably have to be worked in more horizontally than vertically, obtaining the same co-efficient of fineness as in the steamship, but giving the vessel greater stiffness under canvas. In armoured vessels the tendency has of late been to increase the beam, and also to dispense with much of the upper weight of armour, such as box-batteries, and armour round the gun-deck: both these tendencies are in favour of a ship's sailing qualities.

In all cruising vessels it will be necessary either to lift or feather the screws; this latter method has lately received the attention of several ingenious engineers, and we may shortly look for its being perfected. Where twin-screw propulsion is adopted lifting the propellers is out of the question.

Fifthly, on the numbers, efficiency, and discipline of the crews.

Since employment can be found for the men there is no reason why the crew of a war-ship should not be sufficiently large to work with ease *any* masts and sails that can possibly be put into her, and that with such effect as to obtain their full value in making a passage. In the present age, when ships are more costly, and consequently fewer than before, there is every reason for keeping the crews up to a high numerical standard. The seamen of the regular service are such a mere handful compared with the numbers of regulars employed in the principal military services of the Continent, that England may well afford to keep that handful up to its full number and efficiency. If we allow seamen and seamanship to fall into disrepute we may construct the most perfect fighting machine the world ever saw, but we shall have no one to fight it. In the days of sailing line-of-battle ships the crews were numerically very strong, in order to work the guns and the sails at the same time. The introduction of steam had the effect of

reducing the crews to the numbers required for working the guns and the engines. Improvements in the method of working the guns caused a still further reduction, and these improvements still developing with the assistance of steam and hydraulic power (which are also employed in nearly all the work of the ship) have advanced until we now find the "Dreadnought," of 10,800 tons displacement, with a complement of only 369 Officers and men. There is no great harm in carrying the reduction in numbers to this minimum in mastless vessels, intended for coast service, to be commissioned when there is a threat of war, and which probably will be only manned periodically (from barracks when we get them) for a few weeks together in peace time for purposes of exercise. But in our ocean service vessels which we *must* keep in employment, prepared for duty or action at the shortest possible notice—sometimes to send a large landing party or a flotilla of boats away, sometimes to organize a torpedo attack or (as in the case of the Sea of Marmora) to put out defences under cover of darkness, against torpedo boats, and to keep the most vigilant look-out, large and well-trained crews are a positive necessity. Complaints are sometimes made that these vessels have not sufficient accommodation for their crews; considering the comparative increase in size, and reduction in the complement of recent ships, there can be no real reason for this, though perhaps in some cases it may be necessary to use forced ventilation, and to berth part of the crew in the compartments below. Under any circumstances it can never truly be said that our ocean-going ships-of-war are not able to carry a sufficient number of men to efficiently work the masting, especially in these days, when improved appliances so greatly facilitate the handling of spars and sails.

At one time the navy of England predominated over the navies of all other nations, because (though our squadrons were often inferior in speed and power to those of the enemy) the crews of our ships were composed of such excellent seamen, and the ships themselves were so admirably handled. Steam has been a marvellous equalizer: any nation, with money to spend on her navy, can now construct or purchase ships-of-war, and claim to hold an important position among the naval armaments of the world. But there is still a strife among maritime nations, in which there will probably be found as much difference between the competitors, when put to the test, as there was in bygone days: that strife is for the mastery in seamanship, pre-eminence in which can only be attained by the most careful and attentive study, combined with experience, and nature's endowment of those seamanlike qualities through which our forefathers so greatly excelled. Seamanship—in the sense of *experienced and masterly knowledge of how to manage a vessel under all conceivable circumstances*—for the Officers, to enable them, with coolness and confidence, to take their ships into action; to manœuvre with precision, to intuitively foresee and frustrate any scheme the enemy may adopt, with judgment and celerity to take the right steps in accident and disaster, to be in fact fully cognizant of all and every duty they may be called upon to perform in the most extreme emergency. Seamanship—in the sense of *intelligent activity and adroitness in the management and manipulation of all matters*

appertaining to a seafaring life—for the seamen, who are more than ever required to be active, cool, and daring, accustomed to danger, steady, and under discipline. All the recent improvements in weapons call for these qualities in the highest attainable degree, and especially since ships under steam at great speed will do small work with their guns and torpedoes, unless those weapons are handled with the utmost smartness, while for service in cruisers, the smartest possible working of sails and spars will be requisite in preparing for an action or a chase. The training of Officers and seamen, so that they may attain true efficiency in the science of seamanship as above described, can only be thoroughly conducted by constant service at sea in masted ships, combined with plenty of boat work, and occasionally a period of practice in the management of a coast service ironclad in cruises from the port at which she is stationed. The discipline of a ship's company can only be firmly maintained where there is sufficient work to employ the men, and this is best accomplished when a considerable part of the employment is of an evolutionary nature, emulated by competition, requiring a great display of energy, and the strictest and most intelligent attention to orders. Masting, in addition to its value in other respects, is the best means of keeping the men in healthy employment of mind and body, and all the qualities conducive to good discipline.

In the arguments for and against the masting of ocean-going cruisers, which have been treated in this part as fully as the length of the paper will admit, it has been shown that of the two objections to supplying those vessels with sail power, viz., the weight of the masting, and the resistance it offers when steaming head to wind, the first has been proved to be very small when compared with the displacement, and the last is considered capable of being very much reduced by improved appliances. While in favour of masting we have the considerations (provided it is efficient) that sail power economizes fuel, helps the vessel in making a passage, enables small vessels, by augmenting the steaming speed, to escape more powerful adversaries, and it employs Officers and men in such work as will especially develop in them those qualities above all others necessary for managing and fighting their ship—intelligence, vigilance, activity, and discipline.

PART II.

Proposed System of Masting.

In dealing with this part of our subject there are three principal matters for consideration :—

1. The area of canvas it is desirable each class of vessel should carry.
2. How that canvas is best spread.
3. What improvements can be introduced in the means of spreading canvas, so as to render the masting not only efficient for this purpose, but also serviceable for steamships where it is advantageous that the resistance offered to wind by spars and rigging should be reduced to a minimum when occasions require.

First, as regards the area of canvas to be carried. The comparisons between the sail areas in different vessels have been calculated by various methods. We will here adopt the most recent, which is also the method particularly applicable to ships-of-war,¹ that of comparing certain results, the result for any given ship being obtained by dividing the area of plain sail in square feet by the displacement to the power of two-thirds, or $\frac{A}{(D)^{\frac{2}{3}}}$, a method intended to put the sail area of all vessels nearly on an equal footing, whatever their displacement. With reference to merchant vessels this formula is not so suitable, as their sail power cannot be fairly calculated in its relation to deep draught displacement, and yet there is no other means of effecting a comparison with ships-of-war, if this enormous and uncertain measure be not taken. Hence, the number representing the sail power of a merchant steamer is very small as compared with that of a man-of-war. See the following Tables, II and III.

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¹ Mr. W. H. White, in his *Manual of "Naval Architecture,"* chap. xii, on Sail Propulsion, gives a great deal of valuable information on this subject.

TABLE II.—*Area of Sail, &c., of some of the principal Steamships of the Mercantile Marine.*

Company.	Name of Ship.	Tonnage.		Area of Plain Sail. A	Area of Sail. (Displacement.) $\frac{1}{3}$ or $\frac{1}{4}$	No. of Masts.		Remarks.
		Gross.	Load Displacement. D			Total.	No. square rigged.	
		tons.	tons.	sq. ft.				
White Star Line ..	Britannia ..	5,004	9,600	19,527	43.3	4	3	
Inman Line ..	City of Berlin ..	5,494	9,850	20,224	44.0	3	3	
Dominion Line ..	Vancouver ..	4,841	9,712	17,795	39.0	4	2	
British India Line ..	Dacca ..	3,908	4,500	15,282	56.0*	2	2	* Load displacement should probably be greater, and consequently this No. less.
Guion Line..	Alaska ..	6,932	11,465	22,295	43.7	4	2	
Allan Line ..	Parisian ..	5,359	9,600	15,244	34.0.	4	2	
Orient Line ..	Austral ..	5,588	about 10,000	28,002†	60.4	4	2	† This probably includes stay sail.
Cunard Line ..	Servia ..	7,332	12,600	about 17,700	32.5	3	2	
National Line ..	Egypt ..	4,669	9,500	about 18,000	{ about 40.0	4	2	
Union Line..	Athenian ..	3,877	6,425	18,958	55.0	3	1	Area of sail probably includes stay sails.
Pacific S. Nav. Co.	Iberia ..	4,666	about 9,000	13,185	30.04	3	2	

TABLE III.—Area of Sail, &c., of the undermentioned Ships-of-War.

Class.	Name.	Tons Displacement. D	Area of Plain Sail. A	$\frac{A}{D^{\frac{2}{3}}}$	Rig.	Remarks on sailing qualities.
Sea-going ironclads ..	Alexandra ..	9,492 tons.	22,960	51.21	barque	sails fairly.
	Hiércules ..	8,592	28,800	68.65	ship	sails well.
	Téméraire ..	8,464	24,920	59.65	brig	sails fairly.
	Triumph ..	6,640	22,752	64.26	barque	sails well.
Armoured cruisers ..	Nelson ..	7,566	24,766	64.26	"	sails fairly.
	Warspite ..	7,390	20,575	54.23	brig	not complete.
	Shannon ..	5,405	21,580	70.07	barque	sails fairly.
	Inconstant ..	5,782	26,034	80.81	ship	sails very well.
Unarmoured cruisers, recent and new ..	Bacchante ..	4,130	18,805	73.05	"	sails well.
	Active ..	3,080	16,593	78.38	"	"
	Calypso ..	2,765	16,580	84.16	barque	not complete.
	Canada ..	2,383	14,152	81.34	"	G class. Sails fairly.
	Opal ..	2,144	13,106	78.8	ship	sails well, but too crank.
	Caroline ..	1,420	10,610	84.0	barque	not complete.
	Cormorant ..	1,124	9,942	91.97	"	sails well.
	Iris ..	3,735	12,957	53.82	barquentine	"
	Arethusa ..	3,748	14,307	59.3	"	not complete.
	Immortalité (1861) ..	3,690	25,640	107.37	ship	sails very well indeed.
Special cruisers	Rinaldo (1861) ..	1,200	12,630	111.85	"	sails very well.
Steam frigate ..	Ganges (1852), 84 guns	3,594	27,734	117.93	"	"
" sloop ..	Faeton (1849), 50 guns	2,630	24,267	127.36	"	sailed very well indeed.
Sailing liner ..	Vindictive (1842), 50 guns	2,585	24,595	130.58	"	"
" frigate ..	Vestal (1849), 28 guns	1,030	14,372	140.91	"	"
" corvette, or 6th class frigate ..	Espiègle (1844), 12 guns	465	9,989	166.43	brig	"
" sloop ..	Thermopyæ (1868) ..	1,970	17,520	110	ship	very well indeed.

TABLE IV.—*Proposed Area of Sails for different classes of Ships-of-War.*

Group and Class, (<i>Vide</i> page 544.)	Description of Ship.	Tons Displacement, D.	Area of Plain Sail, A.	$\frac{A}{D^{\frac{2}{3}}}$.	Rig.	Remarks.
Group I. Class 1 ..	Coast Service Ironclads	(tons. 10,000 to 5,000	sq. ft. —	—	1. (Military).	
Class 2 ..	Special Cruisers ..	3,500	10,000	43.5	Barquentine.	
Class 2 ..	" ..	2,500	8,000	44	3-masted top-sail Schooner.	
Class 3 ..	Videtto Vessels ..	1,000	5,000	50	Top-sail Schooner.	
Class 4 ..	Sailing Ironclads ..	8,000	22,000	55	Brig.	
Class 5 ..	Armoured Cruisers ..	7,000	25,000	68	Barque.	
Class 5 ..	" ..	5,000	20,500	75	"	
Class 6 ..	Unarmoured Cruisers ..	3,500	12,500	85	Ship.	
Class 6 ..	" ..	2,500	16,400	90	"	
Class 6 ..	" ..	1,500	12,700	95	Barque.	
Class 7 ..	Small Coasting Cruisers	1,000	10,000	100	"	

Table II gives the comparisons of the area of plain sail for mail and passenger steamers by the method described $\left(\frac{A}{D^{\frac{2}{3}}}\right)$; it will be seen from this table that the sail power of the largest steamers of the Mercantile Marine averages about 40, and those of more moderate size about 50. Table III gives the relative sail power of present and past ships-of-war, showing how much the power has of late years been decreased; this is a necessity in very large vessels, and may be partly on account of the superior fineness of the lines in the smaller vessels. Table IV shows the proposed area of canvas and the rig for the different descriptions of vessels, as classed in the introduction to this paper; it is principally compiled from the two preceding tables, and it will be seen that while coast service ironclads carry no sail, special cruizers only carry fore-and-aft canvas, and a light square rig forward, whereas sea-going ironclads carry much the same sail as the "Téméraire" and "Warspite," and armoured and other cruizers have a slight increase on the present vessels of their displacements.

Secondly, as to what is the best method of spreading the canvas. In the actual manner of setting a ship's sails, little improvement has been made since the taunt, tapering masts, and square yards of the end of the last century (for his great attention to the efficiency of which the then Sir John Jervis obtained much deserved credit). Of late years some minor alterations have been attempted in the setting of sails (such as patent reefed top-sails), but have obtained no permanent hold in the Royal Navy, where there are plenty of hands to work ordinary sails. Double top-sail-yards (and even top-gallant-yards) have been introduced largely into the sailing merchant shipping, an admirable invention, where the weight and resistance of spars are of comparatively little consequence, especially for short-handed vessels.

In the navy, though improvement in material is much wanted, there is small need for alteration in the general arrangements for setting sail; we may therefore decide that for our ocean-going cruizers masts and yards giving a similar means of spreading canvas to those in the last of the wooden frigates and smaller vessels, is still required; a lesson may, however, be learnt from the clipper ships, and greater squareness given to the upper yards, especially to the top-gallant-yard, which (I suppose for purposes of evolution) have always been short, spreading a very small top-gallant-sail, as compared to the sailing ships of the merchant service. Top-gallant studding sails can be dispensed with in large vessels, but would still be useful in the smaller classes; top-mast studding sails are indispensable for good passage where single top-sails are used (which must necessarily be somewhat narrow), and, having the booms, of course lower studding sails can be set. For special cruizers, barquentine rig, and for the smaller vessels of this class two or three masted top-sail schooner rig, or something corresponding to the masting of the mail and passenger steamers of the Mercantile Marine, is very suitable.

Thirdly, with respect to the actual construction of masts and yards, the plan on which they should be rigged and worked, and the gear for handling sails.

Improvements in the equipment of our ships have of late years been gradually effected; for instance, steel is now used in the construction of the lower masts; steel wire rigging and lower and top-sail lifts are fitted; gaffs work on traveller guides on the masts, instead of on try-sail masts, and blocks with iron straps inside the wood are substituted for larger and more clumsy wooden blocks. These improvements are all in the right direction, though they were late in coming, and many of them emanated from the Constructor's department more with a view to reducing the weight to be carried, than to the efficiency of the rig for sailing and steaming purposes, attention to which is essentially the business of naval Officers. Further improvements are still necessary in order to render masting thoroughly efficient for spreading a large area of canvas, at the same time being lighter in construction so as to hold less wind, and also to enable the surface of masting (offering resistance) to be reduced at will, as quickly and as effectively as possible. This must be done by a further use of steel, in masts, and their tops and crosstrees, the use of steel wire in all standing rigging, and even in running rigging in such parts as are of the nature of pendants, or are not man-handled or belayed; by reducing the number of the shrouds, and by facilitating the methods of sending down or housing upper masts and yards, and pointing lower and top-sail-yards more nearly into the fore-and-aft line. With this general idea in view, I have endeavoured to work out in detail the manner in which improvements may best be accomplished in these matters with the following results. The main features of the alterations proposed are—(1) that the masts be telescopic, the top-mast, top-gallant-mast, and perhaps the royal-pole, being all in one, constructed of steel, and housing into the lower mast until only the truck shows above the mast-head; (2) that the standing rigging throughout be of flexible steel wire, fitted as is afterwards explained, admitting of a reduction in the number of the shrouds and backstays; (3) that a cap-backstay amidships be fitted to the fore and main lower masts supporting them from abaft, and enabling the two after-shrouds on each side to be dispensed with, and the remainder of the lower rigging (taken to bolts in the lower masts) to be placed somewhat lower down on the mast-head than it is at present; (4) that the lower yard be fitted with a special truss arrangement, so that it may be braced nearer into the fore-and-aft line, when the top-mast is housed, and consequently the top-mast backstays are out of the way of bracing the yards, and that the top-sail-yard be fitted to hang to a span from the lower mast-head when the upper masts are housed.

Diagrams 1 to 4 (Plate XV) are intended to illustrate the proposed plan. The masts and spars here depicted represent the main-mast of a ship such as the "Calypso," of about 2,765 tons. Diagram 5 is an enlarged drawing of the actual plans of that ship's main-mast. Fig. 1 shows the proposed mast with upper mast fidded, and rigging complete. In this drawing the royal-pole is shown as part of the top-mast and top-gallant-mast, all being in one; this might be desirable in a ship depending to a great extent on her sail power, but would probably be dispensed with in larger types of vessels, where flying royals set on poles triced up

abaft all, and secured aloft, might be used instead when required. The lower mast here represented is of about equal strength and weight to that now in course of construction—by Messrs. Edward Finch & Co., of Chepstow, to whom I am indebted for a great deal of useful information—for the main-mast of H.M.S. “Calypso”; both masts are identical in diameter and thickness of material, namely, $\frac{3}{8}$ inch Siemens’ steel plates, and $24\frac{1}{2}$ inches outside diameter; there is an addition of 3 feet in the length of the proposed lower mast, but the whole height of the truck is about the same. The “Calypso’s” mast is stiffened by three tee-bars, $5\frac{1}{2}$ inches $\times$ $3\frac{1}{2}$ inches $\times$ $\frac{3}{8}$ inch, running up the whole length inside, and the mast is further strengthened by cross-bars (as shown in section, Diagram 5, Fig. 2), at short intervals apart. The proposed mast obtains an equal strength by substituting for these stiffeners and crossbars, four (instead of three) bulb tee-bar stiffeners, which admit of a sufficient space into which a top-mast of the same diameter as that of the “Calypso,” namely, 17 inches, may be housed, the top-mast being steadied by the bulbs of the steel bars, and being guided by two angle-bars on the lower part of the top-mast resting against the side-stiffener, as shown in diagram, Diagram 1, Fig. 3, the top-mast pendant, or heel-rope, working inside the lower mast over a sheave, as also shown here. The top-mast, top-gallant-mast, and perhaps royal-pole, might be constructed in one if made of steel, which material—according to Messrs. Finch & Co.’s estimate—would give the same strength for even less weight than wood. Perhaps this would not be the case if the mast was of small diameter, as with hollow tubes of the same weight per foot (or area of section) the greater the diameter the greater the strength to resist bending strains, limited only by the plates being too thin to support local strains. But we may fairly consider that with a reduced weight of crosstree, and the absence of a top-mast cap, the masts above the lower mast would not exceed the weight they are at present. The diameter proposed is quite sufficient to admit of the top-mast being made of wood, and there is no particular reason why it should not be so constructed with the top-gallant-mast in one spar. The objection to a steel top-mast is the possibility of its being crippled unless carefully handled, and the awkwardness of dealing with it if it is damaged. Against this we have greater strength, and the fact that the part where most of the strain will come when the ship is rolling, namely, that part which emerges from the lower mast-head, is greatly supported by good fitting, no tube being able to bend where it cannot bulge at the sides; so that, after all, the liability to crippling is not very great. A spare mast should be carried, and, if necessary to shift the mast, it must be hoisted out above all, using for the purpose a good spar secured to the lower mast-head and standing well above it. In housing the mast and sending it up again, it is proposed to take the breast backstay on each side to *one drum* (probably amidships on the main-deck), fitted with a break and winch, so that it can be hove in or veered at pleasure; and so by keeping equal strain on the backstays—greater or less according to the rolling of the ship—the mast can be moved up or down, well supported throughout the evolution.

The top, crosstrees, and tressletrces, as shown in Diagram 2, Figs. 1 and 2, are constructed as lightly as possible, of box or tee-bar steel boarded over, or fitted with gratings. The top is similar in plan to ordinary tops; it is supported by light steel wire spans above and below, so as to be independent of the support usually supplied by stout wood crosstrees and the futtock shrouds. The top-mast crosstrees, also of steel, form a small stand with two arms stretching out, one on each quarter, as outriggers for the rigging; a bar joining the two giving additional support, and more room for the men to work. On the underneath side there is a box taking the place of the tressletree, and serving as a rest for the crosstrees when lowered on to the lower mast-head, the top-mast being housed; in this box the top-sail tye sheaves would be fitted to take the place of hanging blocks; the rigging and backstays would be secured to a strong band round the upper part immediately under the crosstrees; the outriggers could be fitted to work on swivels, so as to hang down abaft all when the mast is housed, being hung by light steel pendants from the top-gallant funnel.

The yards proposed would in all cases be similar to those at present in use, made of wood (there being no particular advantage in constructing them of steel); the lower yard, as shown in Diagram 3, is fitted with a plan of truss which I believe will prove very suitable for all lower yards in place of the clumsy chain trusses so universally condemned in the navy, and the patent trusses of the merchant service. It consists of two standing steel wire "rolling pendants," secured to bolts on the side of the mast, taken round the fore part (of the mast) and set up to bolts on the opposite quarters of the yard; these pendants prevent any athwartship movement without in the least impeding the bracing up of the yard, in doing which one pendant winds round the fore part of the saddle, and the other unwinds: they are made to work in a groove so as not to slip off: the "saddle" is a broad steel eccentric ring (standing out from the fore part of the mast and well supported from it by stays), against which the lower yard rests under ordinary circumstances. The yard is kept in position against the saddle by a centre "truss pendant," secured to a bolt on the upper part of the after side of the yard in its centre; the pendant passes through a nine-pin block (which has horizontal turning action), and down the fore part of the mast, being worked by a small purchase: this pendant will have to be eased slightly when the yard is braced forward, and set taut when the brace is belayed.

As regards the rigging, Diagram 1 shows the mast as rigged complete, Fig. 1 a view from a beam (the port rigging being omitted to prevent confusion), and Fig. 2 from abaft. It is proposed that all standing rigging should be of flexible steel wire rope, the strength of which is shown in Table V. A 4-inch cap backstay is the only real innovation; it is intended to support the mast directly from aft, and to take the fore-and-aft strain, which would otherwise be carried by the two after shrouds on each side, which are here dispensed with, the remaining side supports consisting of five $3\frac{1}{2}$ -inch shrouds instead of seven 3-inch as in the "Canada"; the rigging is closer together (being thus less in the way of masking guns) and lower down on the mast-head, so as to allow

the lower yard to brace well forward. The cap backstay being in the way of an ordinary gaff, a monkey-gaff would have to be substituted, setting a good storm sail, and being down on deck, instead of holding wind when the sail is not set. The top-mast rigging differs from that at present fitted, as it is intended to be set up on deck (or between decks); it passes over the top-rim (where it would be clamped), using the top as an outrigger, and is brought through the eccentric ring forming the saddle of the lower yard, over rollers down as much abaft the mast as possible, to drums or some appliance for setting it up; there are three $2\frac{1}{2}$ -inch shrouds a side, instead of four $2\frac{1}{4}$ -inch (as in the "Canada"); the backstays are, as usual, one after and one breast backstay each side of $2\frac{1}{2}$ inches (these would be out of the way of gunfire when the top-mast was housed); the breast backstays would be fitted to work on a drum (as already explained), in order to steady the top-mast while in the act of being lowered or hoisted. The upper rigging is somewhat similar to that usually fitted, only very much smaller than hemp rope, and the number slightly reduced; top-gallant, $1\frac{1}{2}$ -inch steel, two backstays and one shroud; royal, two 1-inch backstays; stays for all masts in number and strength as at present. The top-mast pendant, or heel rope, two parts of 4-inch steel rope, rove in the usual manner through the heel of the top-mast, but working inside the lower mast, would be taken down to the main-deck, and there brought to a capstan or winch (probably worked by steam); the top-mast would be fidded above the top. All parts of the running rigging—such as lifts, braces, sheets, clew-lines, reef-tackles, ties, yard-ropes, &c.—which do not reach the deck, would be of flexible steel wire, of the same strength as hemp, tailed with hemp rope for working, all the wire being rove through small iron-bound blocks, thus saving a great deal of the space, or surface, which at present offers resistance to the wind.

There are two natures of flexible steel wire rope now used in the navy, that known as "Bullivant's," where the wires in the strands are laid up the opposite way to the strands themselves (like ordinary hemp rope), and "Lang's," where the lay of the wires is in the same direction as the lay of the strands; both are of about equal strength, and will work over a sheave as easily as hemp rope of similar strength. Lang's rope is less liable to kink, and for this reason it is preferred for ropes that have to be worked. Table V gives the strength of flexible steel wire rope, and compares the smaller kinds with hemp rope of same breaking test.

TABLE V.—*Breaking Test of Flexible Steel Wire Rope.*

Size of steel rope.	Breaking test.	Remarks.	Corro-sponding size of hemp rope.	Size of steel rope.	Breaking test.	Remarks.	Corro-sponding size of hemp rope.	Size of steel rope.	Breaking test.	Remarks.	Corro-sponding size of hemp rope.	Size of steel rope.	Breaking test.	Remarks.
inches.	tons.	broke at	inches.	inches.	tons.	broke at	inches.	inches.	tons.	broke at	inches.	inches.	tons.	tons.
$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{2}$ ton.	1	3	17	20 tons.	8	$6\frac{1}{2}$	98					
1	$1\frac{1}{2}$	$2\frac{1}{4}$ tons.	$2\frac{1}{2}$	$3\frac{1}{2}$	20	—	9	7	113					
$1\frac{1}{2}$	$2\frac{1}{2}$	4 "	3	$3\frac{1}{2}$	$2\frac{1}{2}$	$27\frac{1}{2}$	10	$7\frac{1}{2}$	130					
$1\frac{1}{2}$	4	—	4	4	31	—	11	8	148					
$1\frac{3}{4}$	$5\frac{1}{2}$	—	$4\frac{1}{2}$	$4\frac{1}{2}$	39	—	12	9	189					
2	7	—	5	5	59	$75\frac{1}{2}$	—	10	220					
$2\frac{1}{2}$	9	19 tons.	6	$5\frac{1}{2}$	71	—	—	11	270					
$2\frac{1}{2}$	$11\frac{1}{2}$	21 "	7	6	81	—	—	12	320					

Preparing a ship—fitted with telescopic masts as proposed—for action, or a steam chase to windward, the upper yards would be sent down, the parrel of the top-sail-yards cast off, and the yards lowered before all, and hung to the steel wire span from the mast-head; the top-mast would then be unfiddled and lowered into the lower mast, until almost out of sight, the crosstrees resting on the mast-head, and the top-gallant funnel above it again; the crosstree outriggers would be doubled down abaft out of the way, all top-mast and upper rigging and backstays being unsnatched from the top and crosstrees taken down abaft the lower mast, and stopped in, so as to offer no additional resistance; the lower and top-sail yards would then be braced nearly fore-and-aft. Sending the masts up again the operation would be reversed. Under favourable circumstances a well-trained crew should complete either evolution in less than fifteen minutes, care being taken to stay the masts before sending the yards across, a comparatively easy matter, if the top-mast rigging is taken to drums worked by a winch.

A great many of the suggested alterations might be carried out in ships as at present masted; for instance, the further introduction of steel wire in standing rigging, the use of steel wire in running rigging, the proposed truss arrangement (so long as it was not intended to house a top-mast at sea), the cap backstay, &c.—all such improvements would tend in the right direction towards making spars suitable for vessels requiring steam as well as sail power.

I do not unreservedly advocate telescopic masting; the idea is an old one, though it has not yet been tried, principally because the materials for its construction and working were unsuitable, but now that steel, and steel wire, can be used for these purposes, that difficulty is overcome. The advantages claimed for telescopic masts are, that it is the only feasible plan of housing a top-mast at sea; that the top-mast and top-gallant-mast once housed are out of the way, instead of lumbering the decks—so housed they might possibly prevent the lower mast from falling if severely wounded in action; and, lastly, the top-mast being housed, and consequently its backstays out of the way, the lower yard can be braced nearly fore-and-aft, and the courses can be set with advantage whenever they will stand. I am sorry that I have not been able to obtain a model from which to explain the working more clearly, but at the last I found myself too pushed for time. There is a model in the Greenwich Museum of a plan for a telescopic mast submitted by the Officers of the Portsmouth Dockyard in 1864; but the lower mast is very large, and the top-mast and top-gallant-mast (in one) is very small, both matters which can be improved by the use of better material.

In conclusion, I trust that I have not altogether failed in attaining the object I had in view in preparing this paper, namely, of winning naval Officers back to a sounder faith in sail power. Perhaps I have not satisfied some of those gentlemen who so kindly supplied me with information on the subject of masting the steamships of the Mercantile Marine, but as a matter of fact I fully concur in the general principles on which those steamers are masted; no merchant vessel is required for cruising purposes, so it is unreasonable to suppose that their owners

will put cruising masts into steam vessels. With ships-of-war it is different; our principal ironclads, which for the safety of our country should never be sent out of European waters, and those armoured vessels intended only for the protection of the Colonial ports at which they are stationed, may well be mastless; but all other ships required for ocean cruising should be well and effectively provided with sail power as an auxiliary to their steam. I am most firmly convinced that any departure from this policy would, in case of a long and severe war, prove most disastrous. I have therefore endeavoured to show that, by judicious modification, masting may be still rendered of very great value, and that sail power should not be considered a dead letter.

Captain P. H. COLOMB, R.N.: My Lord, Ladies, and Gentlemen,—As I have been in some sort challenged by the lecturer in his paper, and as I had the honour to read a paper here on the same subject some time back, I thought it might be convenient to the meeting if I were, so to speak, to open the ball by giving what will be possibly considered somewhat of an opposite view. It is very difficult indeed to discuss a paper of this nature, which, besides dealing with such very important subjects, is such a strong paper. There is no question that the lecturer has taken up a very strong position, and that he is not very eligible to attack. It would be impossible to do it at all were it not for the admirable system which the Institution has adopted of printing the paper beforehand and circulating it, so that we may have the opportunity of thinking over the matter which the lecturer is about to bring forward. I shall be glad to define my position with regard to this question, so that there may be no mistake. I believe that wind-force every day pales before the advance of steam; I believe that in considering the fitting of our ships-of-war we must look to fighting power first of all; I believe that full rig for any steamer burns more and not less coal, besides greatly encumbering her locomotive powers; but I favour any rig which turns out to be a true auxiliary, which does not interfere in any way with the ship's fighting power, which only assists locomotion and economizes coal. I do not believe in a navy arranged to develop a particular class of men. I believe that the British seaman has altered in my time very greatly; I believe he will alter in the time of our successors much more; but I believe he will be still the British seaman, although of a totally different kind—that is to say, that he will be superior, when it comes to fighting, to the seaman of any other nation. Captain Noel says that the wind is “a useful and a powerful element of propulsion.” I say, “useful,” certainly; “powerful,” no; for the simple reason that in ordinary service you always have as much wind against you as you have in your favour. He goes on to admit that “improvements in the system of masting are urgently needed.” When I came to that passage I bethought me of Balak, the son of Zippor, and I considered that whereas the lecturer had been sent to curse me, he had altogether blessed me; for after all, the whole of my contention heretofore has been for this improvement in the rig which the lecturer tells us is “so urgently needed.” He goes on to say that “a long passage at great speed is an exceedingly rare event.” Quite so—in peace time—although my experience does not go quite so far. I am not going to take upon myself, and I suspect very few naval Officers would, and the lecturer, when he comes to take a cool view of it, will not be able to lay it down, that in war time long distances at great speed must not be undertaken by our ships. But our gallant Chairman himself possibly has in his recollection an incident which happened in the Mediterranean, where certainly the passages are not long, but where an urgent necessity required that a ship should proceed at her full speed 600 miles, and it so happened that the only ship which was available, although the whole Mediterranean fleet were with her at Malta, and under similar conditions to herself, was a mastless ironclad. I think that the resistance of rigging in proceeding under steam is very much under-estimated. In my paper I took it at

5 per cent.; I suppose that the coal cost 5 per cent. by the resistance of the rigging and the spars. I believe it to be considerably more. Of course experiments are necessary. We have not got them; I wish we had; but I believe the friction of ropes, and the vacuum formed behind each of them increasing the pressure on the fore side, are elements which make their retarding power very much greater than is generally understood. We should all be struck with this fact, that in the Mediterranean, during the Dulcigno business, where the masted ships were lying in smooth water, land-locked in a very heavy gale with terrific squalls, most of the ships present had their lower yards and topmasts struck: some of them had three anchors down, and some dragged their anchors. The single mastless ironclad—the “Thunderer”—was lying the whole time at single anchor with her buoy well out on the starboard beam, and she never even approached the tautening of her cable. I am quite sure Lord Alcester will recollect that; and although it was not entirely due to the absence of masts and rigging, I cannot help putting some of it down to that absence, and I am borne out in that by what happened to the “Inflexible” not very long ago, where, being masted and having the same anchors—the Martin anchors—as the “Thunderer,” she, not in anything like the same weather, dragged those anchors. That is one of the things which make me think that the resistance is under-estimated. The lecturer gives us to understand that the single mast for machine-gun firing is an absolute necessity. I am a little doubtful about that. Of course we are so using it; I presume we are bound to use it now. We are furnishing the mast-heads of our ironclads with considerable structures for the purpose of carrying machine-guns. What I am afraid of is that, as in the “Huascar,” those structures may become, more or less, slaughter-houses, inasmuch as they will certainly draw the fire of the machine-guns upon them, offering such an extraordinary mark, and the men being so crowded together that what misses one will hit another. The lecturer goes on to speak of “cruizers” and “cruizing,” and I am afraid he and I, and all of us, more or less, are misled by the old meaning of the word “cruizer.” A cruiser in old times was always in motion, but the orders she got were seldom such as to dictate motion. She was generally to maintain a position on a given spot, and it has always struck me that this “cruizing” in war time would now simply be going and lying on a particular spot, and remaining on that spot a given time, as closely as possible; and I venture to think that taking a fully-masted ship and an unmasted ship of the same coal capacity, the unmasted ship would probably have more coal in her bunkers after a given time of such “cruizing” than the fully-masted ship, because the one would be blown off her station while the other would not. The lecturer also speaks of “convoys,” and he certainly uses the term “steam-convoy.” But he does not seem to carry in his mind what steam-convoys mean. I cannot avoid thinking that steam-convoys will proceed at some considerable speed, and I feel that most of our ships, being fully rigged, would not be able to keep up that speed which was necessary for the ordinary steam-convoy. We come then to the question of coal endurance. I have taken two ships. I do not mean to say that they offer any argument, but they are simply illustrations to give us matter round which our minds may circulate. I take the “Comus,” which with 440 tons of coal could keep up a speed of 13½ knots for six days, or 1,950 knots; or a speed of 10 knots for thirteen days, or 3,120 knots. Now I pass to the “Hecla.” She can take a great deal more than this, but suppose she can take in 2,000 tons of coal. She will go 10 knots sixty-nine days, or 16,000 miles; and if you come to cruising at low speeds, or using low speeds only, she will go 6½ knots 166 days, that is to say, 26,000 miles, and it looks very much as if the “Hecla” might coal at the beginning of a war and not positively have used the whole of the coal when the war was over! There is a strong feeling at present as to the collier tender, and the lecturer is very firm as to putting your coal outside the ship rather than inside. I think his argument is identical with what used to be urged before the days of steam line-of-battle ships. We all recollect how strong the feeling was in those days, that we ought to build more paddle-wheel steamers, the object being that they should attend the sailing line-of-battle ships, and should tow them in and out of action; and it was a considerable time before the service frankly gave itself over to putting the paddle steamers inside the line-of-battle ships instead of outside. I cannot help thinking that condition of things will be also brought about with

reference to the steam collier. The lecturer has laid great stress upon the difficulties of stowage of coal. Now I do not see that there is any such difficulty. You have to make the ships longer. The practical question is to get speed, and to do that you must have length, and small beam in comparison. Doing that, you can always get sufficient coal supply. The lecturer draws a comparison between the case of a sail-masted ship out of coal, and the case of a steamer without masts, possibly without coal also. But supposing the other steamer has coal; what possible hopes can a sailing vessel without coal have of winning any action against a steamer with coal? In Table No. 1, he leaves out the retardation, and also the question of stores and accessories, which must follow masting, and I think, therefore, that table must be somewhat modified in order to be applied in practice. But then I think all the real power of sail can be got with very much less weight. Coming to sailing passages, I do not think it is quite fair to take a special case. As a fact we know that the speed of sailing passages is exceedingly small, except in those cases where ships are built specially for particular runs, and can make use of a fair wind, first one way and then the other. The present steam war-ships, we are told, sometimes make worse passages than the old sailing ships. I am afraid that is the case, but it is because we are allowing the steam and sail to fight a battle in the ship without either of them being permitted to gain the victory. The lecturer has laid it down that the crews ought to be sufficient to work masts and sails. I am not quite prepared to say that they ought not to be sufficient to work the masts and sails; I only say that, by some occult process, that is not now the case—the tendency is the other way. We have in a ship of 9,500 tons, for instance, a complement of 691, and we only have 336 seamen; in another ship of 7,600 tons, with a complement of 576, we have 283 seamen; in another smaller ship of 5,400 tons, with a complement of 452, we have 243 seamen only; in another, essentially a sailing ship, of 4,100 tons, with a complement of 407, we have only 174 seamen; and it gets worse as you go on, because in more modern ships still, of 7,400 tons, with a complement of 436, you only have 188 seamen; so that, in spite of us, the numbers are being reduced, and I cannot see how we are to increase them. One of the difficulties, no doubt, is the difficulty of finding space for them, of which the lecturer speaks so lightly. I wish he were Captain of the Steam Reserve for a little time to correct that view. But, as a matter of fact, the condition of our war-ships is such that whatever else we might want to do, we cannot find the time with an ordinary crew to properly work the masts and sails. I am sure there is no one in the service, at any rate of those who have had the honour, and I may say the pleasure, of serving under the gallant Chairman, who will doubt that he is a man more likely than any other to make full use of every appliance which is under his control in that way, and he must know that in the Mediterranean squadron it was, as a rule, a difficulty to get that amount of training and drill aloft which was generally considered desirable. Either the wind was ahead, or the passage had to be made at a certain speed and we could not wait. There was one occasion certainly when we got a bit of fair wind, and the masted ships turned the unhappy mastless ship away about her business, but in the end she came in with a great deal more fuel than those who had started so gaily with a fair wind. The lecturer, speaking of seamanship, tells us that in cruisers the smallest possible working of sails and spars will be requisite for preparing for action or chase. What I am afraid of is, with the existing rig this “preparing for action or chase” would mean a general pitching overboard of the spars, because I am assured that any “chase” will go straight in the wind’s eye. They will certainly never take the other line. Then we have a subject adverted to by the lecturer which we cannot yet get rid of, namely, that sail work is a necessity in the training of Officers and men as to discipline. I continually think to myself, “Is this true?” I cannot make up my mind about it; but whenever I see, as I saw the other day, a parade of eighteen or twenty blue-jackets, hard at work with batteries and electric cables and Whitehead torpedoes and galvanometers, and a variety of appliances which were utterly beyond me, requiring the most delicate handling and careful watching, any mistake meaning the destruction of the ship, supposing the torpedoes had been filled, I could not help thinking, Are these men the better for having been royal yardsmen?—supposing they ever had been. I do not dogmatize,

but I cannot help asking myself the question. Of course it is impossible for us to look at this change which is going on in the service with easy minds. We cannot help thinking, "Dear me! the days of our powers, and our display before the world as a navy, are disappearing!" As the lecturer says, "steam is equalizing things." I do not think myself that it is; I believe that we are going to take the lead in steam just as before in sail; but the point of the matter is this, that these changes will take place unless we are duly prepared to hang those inventors who bring forward new weapons which are not asked for! If we had hung Dr. Gatling, and Mr. Whitehead, and Mr. Nordenfelt, we should not be in these troubles now, and until we are prepared to take that sort of action, I am afraid the thing will change in spite of ourselves. I ought to be much more side by side with the lecturer when I come to the second part of his paper, because he is proposing a modification of the rig, and that is my point. I want to see the rig so altered as to give a real efficient help to the ship without in the slightest degree encumbering her, and although I must say I like a great many parts of his proposals, I do not like them as a whole. The lecturer does not seem to have been quite clear upon the point, that were you to rig a ship in this way the only sail which is really of use to the ship will be the double reef topsails and the reef top-fore-sail—that is to say, giving the proportion of area which he gives to the plain sail. I want to give a greater area of strong sail and to reduce the area of light sail as much as possible. Then all these appliances for easing the working of the sails tell against that process which you want to keep for the training of your men. If you make the process very easy the men get none of the training which they are now getting, for essentially that training is the overcoming of the difficulties which at present exist. The lecturer says we do not need these alterations and appliances in our own navy. Certainly not, because if we did we should lose the drill and training which we are told we want. When I read my paper, I was pretty strong upon the question of the mastless ships, but I had not then commanded a mastless ship. My impression is, that if any person had gone through my experience, first commanded a masted ironclad, and then a mastless ironclad, his instincts in favour of the mastless ship would have been so immensely aroused, that it would be almost impossible for him to argue fairly on the question, and I grant that very possibly my experience prevents me from arguing quite fairly on the question; but still I cannot help thinking that what we want to do in our war-ships is to become utterly independent of the elements. They are not to be coaxed: they are to be mastered. You must draw their teeth and pare their claws, and when you are thoroughly masters of them, then you may play with them—if you like!

Admiral BORS: My Lord and Gentlemen,—If it had been a custom of this Institution to second any resolution, or to second a paper, in spite of what my friend Captain Colomb has said, I should have been very happy to have seconded Captain Noel's paper. My opinion has always been that sail power in certain descriptions of war-vessels is indispensable. He has very clearly divided his ships into classes and groups. I will touch shortly upon each class as numbered. No. 1, "Coast service ironclads," I agree with Captain Noel. No. 2, "Special cruisers, or despatch vessels," I do not altogether agree with, for the same reason that Captain Colomb has given. I draw a conclusion directly contrary to him with regard to having no masts at all. These are cruisers of the "Iris" type, and their special duty is chasing; Captain Colomb implies that chasing is always to be in the wind's eye. I differ from that because it must depend upon where you discover your chase. If you discover her to leeward, or in the vicinity of land, you will of course not let her cross you to get to windward of you, and the addition of sail power may in that case enable you to catch her, when without it you would lose her. I will instance what happened in the case of the old "Warrior." When first commissioned her full steaming power was from 13 to 14 knots, but she actually, for some consecutive hours, running free with a strong breeze with all plain sail set, made 17½ knots, and if that had been in chase, those additional 3 or 4 knots would have been the means of attaining the very object required. Class 3, "Swift vidette vessels."—Yes. With regard to ironclads of the "Téméraire" class, Class 4, I quite agree with what Captain Noel says. It happened to be my duty

to be sent out in the "Devastation" on her first cruise to the Mediterranean. The "Hercules" was to accompany us. We started one evening from Portsmouth to go to Plymouth, with a nice easterly breeze steaming easily 8 or 9 knots. The next morning the "Hercules" made a signal that her cylinder was cracked and she could not steam any longer. She made sail, and kept her station alongside of us all the way to Plymouth. Now if she had not had those masts she would have been a helpless log, and could not have moved without assistance: that is one instance in which the sails of the ocean service ironclads actually did come into play. On the subject of machine gun fire from one mast it is generally accepted that machine-gun fire must be kept under by machine-gun fire, as Captain Colomb says, and I think the machine-gun in the top has a great advantage over the machine-gun on the deck. There is another purpose, which has not been mentioned, for which the one mast becomes a necessity, viz., to hoist in and out heavy weights, especially torpedo boats, which amount to 12 or 13 tons. Class 5.—I quite concur. Class 6.—Yes. Captain Noel says, in regard to Class 7, that small coasting cruisers of 800 to 1,500 tons should be amply rigged. In that opinion I do not agree. I think these vessels, being only coasting cruisers, and never far from a port, will always be able to renew their coals. They are not intended to make long passages. The lecturer goes on to "arguments for and against sail power," and he adduces the system and practice of various lines of ocean steamers. I do not think any satisfactory conclusion can be drawn from the action of these mercantile steamers with regard to sail power, for the reason that they start from their port, and go on for hours and days, and perhaps weeks, without any alteration in speed. Their engines are constructed for this purpose, whereas most men know that in a man-of-war, especially in fleet manœuvres, with the exception of the flag-ship, the alteration in the amount of revolutions and speed is something interminable, and for that reason I do not think we can make a comparison between what is done in men-of-war and merchant vessels. With regard to the resistance of the wind to masted ships, Captain Noel's figures come to this, that in the "Greyhound," in a calm, going 15 knots, one man power exerted more by the engines would compensate for the resistance of the air. I do not think that is very material, and with regard to the remark about the resistance offered by masts going head to the wind, and the assistance of sail when we are making a fair wind of it, it comes to this, that when we are going head to the wind, we reduce our mast to almost nothing, but when we are making use of the wind we expand the power of the masts a hundredfold, or more, by setting sail wherever it will draw. With regard to steaming and sailing qualities combined, my impression of Mr. Froude's experiment is that it was only at low speed that the proportion of breadth to length did not interfere much with the speed. At high speed I believe it really does, and I do not think that Mr. Froude's experiment ever warranted the same conclusion as to very high speed. Certainly our Mercantile Marine Constructors do not think so, for they have increased the length of their ships to ten or twelve times their width, and thus obtain their great speed. With regard to the "numbers, efficiency, and discipline of crews," of late years the tendency has been to reduce crews to a minimum. I believe it has principally been done at the suggestion of the Constructor's department, the great object being to save weight, as every additional man increases the weight to be carried, not only in himself but in the bag, hammock, &c., required for him. I think crews have been reduced a great deal too much. We can never send our ships cruising all over the world to destroy an enemy's ships, like the "Alabama" did, because we should have to send prizes to a Prize Court for adjudication, and to put prize crews into them for the purpose, and where the crews are so very small we could not possibly do it. I think we *must* increase our crews. I recollect some years ago I was appointed to the command of the "Pelorus," a ship once commanded by our noble Chairman; we were starting for China, and were ordered to take out thirty supernumeraries. I did not want to be troubled with them, with their hammocks and baggage; however, they were sent. We stowed them away somewhere or other, and when they had shaken down, we were very glad to have them. I think there is too much complaint made of not having room to put the men in our ships. We must increase the crews and let them find room, d

depend upon it they will do so. With regard to Captain Noel's proposed rig and bracing up yards, we have learnt one lesson, that we must be cautious how we allow the yards to brace too readily fore and aft. One of the supposed causes of the upset of the "Captain" was the topsail yards flying fore and aft in the squall, on account of the tripod masts, and they had not power to brace the yards in again to get the sail off. That was adduced as one cause—bracing up too sharp. In my opinion, as long as we have a navy that depends upon coal as the means of propulsion, it will be a monstrous waste not to make use of that universal and costless power, the wind, and we must not forget the old ditty that "when the wind blows then the ship goes."

Captain HARRIS, R.N.: My Lord, Ladies, and Gentlemen,—Long ago, when I read Captain Colomb's very valuable paper, in 1878 I think, on Sails *v.* Steam, I fancied he had gone rather too far in condemning sails, but now I agree with every word of it; indeed I go so far as to think that his paper of 1878 is appropriate to the present time, and that Captain Noel's paper would be more appropriate to that period. I believe that masts and sails, in most cases, are only an encumbrance, and waste of time and power. Still I cannot help regretting them; and I confess to enjoying, as much as anybody, the glorious feeling of bounding over the waves, under the influence of sail power alone; still the common-sense view must be taken, and delightful as those feelings are we must put them on one side. Steam is gradually and relentlessly driving everything before it, and masts and sails will have to go too. However, I think we all ought to be exceedingly thankful to Captain Noel for putting the matter in such a very good light. In this way we are able to judge very fairly of the respective merits of steam and sail; we have had the matter most ably advocated on both sides. I am glad to find that Captain Noel seems to be quite of one mind with Captain Colomb as to the uselessness of masts and sails for actually fighting armoured vessels; in point of fact, when he treats of ironclads of the "Téméraire" class, he there also seems a little doubtful whether masts and sails are a matter of great moment; but when he comes to actual cruisers, then he makes a great point of it. Now whenever I see a cruiser heavily masted and rigged, the story at once occurs to me of the old woman who was selling apples on a common during a very windy day; it was in the time when so much crinoline was worn; a small boy came up to her stall and made off with an apple without paying; she ran after him; with a strong breeze at her back she was quickly overhauling him, until a sailor, standing by, seeing with his nautical eye at a glance how matters stood, shouted, "*Try her on a wind, my boy.*" The moment the old lady had the wind against her she was nowhere in the chase, and the boy easily escaped with his apple. So will it be with the cruiser of the present day, if encumbered with heavy masts and sails. Captain Noel says that "his object in writing this paper was to win back some of the wavering to a sounder faith in sail power." But I should rather put it thus: that he is trying to win them back to an unsound faith in sail power. Captain Noel refers to the wonderful and almost historical passage of the "Vindictive." Now I think it is somewhat unfair to make so much of such an exceptional case: without putting against it all the slow passages on record, including such facts as that a sailing line-of-battle ship has been six weeks making the passage from Gibraltar to England. There is no doubt, however, that having masts and sails, and the power of being able to exercise men aloft, does certainly seem to make the seaman more active and cheerful; but I think what we gain in this exercise we lose in others which are of more importance to the efficiency of a vessel, especially when we reflect on the heavy shorthanded work that has to be done now in our men-of-war. There is one other thing we ought to take into our consideration in dealing with the question of masts and yards, and that is the number of men who have been killed or invalided out of the service through accidents happening aloft, mostly at drill. Captain Noel has, apparently, in theory, produced a very clever plan for reducing masts and yards to a minimum in a very short time: this is, to my mind, a convincing proof that he is alive to the disadvantages inherent to heavy masting. Here I am quite of his opinion; and certainly, if we are going to retain heavy masts and sails for cruisers, it will be well to adopt his plans: but personally I think it far wiser to let masts and sails gradually die out than go to the expense of adopting any new system.

Captain CURTIS, R.N.: I may state, with regard to our old line-of-battle ships, that I was in one, the "Queen," that went out to Malta in ten days and a half. In 1846, the "Inflexible" paddle steamer, which was started to the Cape with half a regiment of soldiers on board, and 80 tons of coal short, by courting the wind, made the passage to the Cape in fifty days without replenishing coal. The true policy is to court the wind and not to ignore it, for we can never conquer it.¹ It is by ignoring the wind that many merchant vessels are lost: that is, we are told, the sea is impelled in a cycloidal curve form, and by keeping the maintop sail, close reefed in a gale, on the ship,—when youngsters we were told never to take the main topsail off the ship, but to heel her over, "*and give her a weather side*"—by so doing we prevented the sea from overwhelming the ship. What I maintain is that by not having sail power the ships are very often overwhelmed by the sea. In doing away with the masts you do not actually gain the amount of weight which the masts and sails weigh, inasmuch as you have not the storage room in the ship. For instance, a mast does not take up any room below, and you cannot find space for the amount of coal that the masts, &c., would weigh. It is perfectly true that in the Baltic, in the Channel, and in the Mediterranean, it is a good practice to have mastless ships; but we are told that in the Pacific, the East Indies, and so forth, where we have sea-going cruisers, it is absolutely necessary that you should have coaling stations, for there is no coal port that we can go to between Vancouver and the Falkland Islands, on the Pacific Coast, that we can call our own. We put in at Valparaiso, but if we were at war with a Power friendly to Chili, do you think they would fill us up with coal, coal being a munition of war? I think it is out of the question. I perfectly agree with the lecturer and also with Admiral Boys; I do not think we have come to that enlightened period at which we can ignore the winds, but I think we must in a certain class of vessels maintain sail power, so as to enable us to keep the command of the sea; sail power is a necessity as a means of safety in a gale, and in case of mishap to the machinery.

Captain NOEL: My Lord, Ladies, and Gentlemen,—I think you have almost heard enough of my voice to-day, but I would nevertheless like to answer a few of Captain Colomb's remarks. First, as regards long passages. I think we must have certain vessels of the "Iris" class (carrying plenty of coal) to make the long passages, or passages with great speed; but I doubt very much whether the ordinary ship-of-war of our service would ever in war time be required to make long passages. With regard to the resistance of ropes, in my paper I have fully acknowledged the importance of this question, and have endeavoured as much as possible to get rid of the resistance due to the ropes. There is no doubt we have a very vague idea of what the cruising of the future will be, but "cruising" is a term which includes a great deal. It does not mean only remaining at a certain position. It means cruising from one port to another, and so on. It is in these short passages that we expend our coal, and my object in advocating masting is that in all those petty little movements from one port to another we should economize coal. Captain Colomb compares the "Hecla" with the cruiser. Now I consider, with all due deference to him, that it is an absurd comparison.

Captain COLOMB: I said as an illustration.

Captain NOEL: I meant that there is no comparison whatever between the two. There is no doubt that the "Hecla" can go round the world and not expend all her coal, but what is the "Hecla"? Simply a merchant vessel. She is not a fighting vessel; she has no great speed; she could not get away from the least of our cruisers; she would be taken by the first craft that could fire four guns at her. What I contend throughout is that if you are going to have the cruising vessels that Captain Colomb and Captain Harris are so anxious to introduce, you must have them immense. I think the other day Captain Jackson talked about cruisers of 10,000 tons, and I believe he is perfectly correct, if masts are done away with; you cannot otherwise carry the coal. Mr. Barnaby says, "I must have

¹ See Captain Washington's Report, 28th July, 1849, on the Loss of Life on the East Coast of Scotland, 19th August, 1849—"No boat ever known to be lost by shipping a weather sea; boats lost by not carrying sufficient sail, &c."

tonnage; I can do nothing without tonnage; I cannot get speed, and I cannot get coal-carrying power," and therefore it follows if you do away with your masts you must be prepared to have cruisers of 10,000 tons. Masts are a means of economizing fuel, and in that way you enable the country to have cruisers of moderate dimensions. The "Vindictive" was not a special ship. She was an old 60-gun liner, cut down and made into a 50-gun frigate, and about ten years after being cut down she made this passage—a most extraordinary passage, no doubt; but she was not built as a special ship. Still I do not know why Captain Colomb should attempt to give us to understand that it was an extraordinary feat which only happens once in a generation. Against this impression we will just consider the clipper ships. The clipper ships were, we may say, almost as regular as the mails. Taking the tea-clippers from Foochow to the Downs in 1866, three made the passage in ninety-nine days, and two of them raced up the Channel. In 1868 the "Ariel" made the passage in ninety-seven days, and in 1869 the "Sir Launcefot" made the passage in ninety from Foochow to the Downs. What I say is, that if we thoroughly understand the sailing passage, we ought to be able to make it with almost the regularity of a steamer. Now we are throwing sail power out of our calculations, and the consequence is we are forgetting how to use it. Now about reducing the crews. I must say this is a most serious consideration. I fully concur in all that Admiral Boys said; and this consideration alone, to my mind, makes it necessary that we should have masts as a means of employing the men. Captain Colomb has rather contradicted himself, for he tells us that we cannot find time for sail drill, &c., and then the moment afterwards he says, "According to the lecturer's diagrams he is going to make everything so nice and neat that we do not want the time, and should not have employment for the men." I wish to show that between the two we do get the necessary amount of employment for the seamen. When it is requisite to prepare for action, down would come the masting as easily as possible. We still have a gymnasium (as we may call it), which keeps the men employed, and which is conducive to discipline, order, health, and everything else. It is a very curious thing to me that whereas the military are making gymnasiums all over the world, we appear to want to do away with our gymnasiums. No doubt with old appliances it did take up a lot of time, and I daresay that squadrons, when they have many other things to consider, could not get time to work the old plans of masts and yards, but if you have improved appliances, you can keep up your exercise in peace time; and when there are other duties to do, very little is required in order to reduce the masts or to make sail again. With regard to the area of strong sail, I can see no objection to obtaining a good area of strong sail in the proposed plan. In fact, I am for giving a good area of strong sail. Unlike housing your topmast before all, a telescoped topmast is entirely out of the way of the lower yard, and consequently your course is always ready for setting. I have thought of that difficulty referred to by Admiral Boys as regards bracing the yards up too. No doubt it is a very great danger. But when the topmast rigging and backstays are in place there is no possibility of bracing the yards any further forward than it would be now, and the topmast rigging would prevent the topsail yard going further than it would before. There is one other point, with reference to the question of coal. If you have no working crew on board a vessel, you must do everything with your auxiliary engines; and in time of war, when our vessels are miles away from the coal stations, you will find that your coal is being used up by its daily consumption for auxiliary engines, and that will be very large, owing to the fact that you have not got a crew to do the work. Captain Colomb gave us some numbers of seamen, and said that you want the seamen to go aloft alone; but I do not see why; when making a sailing passage, the Marines and stokers can do the deck work. We do not want the stokers to go aloft so long as we have seamen who have been trained to do the work that is necessary aloft. Gentlemen, I am much obliged to you for your kind attention.

The CHAIRMAN: I am sure we are all very much obliged to Captain Noel for his very interesting lecture, and also to Captain Colomb for what he has said. Perhaps you will allow me to say one or two words bearing on the point. First of all with reference to the relative effect of winds on unmasted vessels, and on masted

vessels in bad weather when at an anchor. No doubt if Officers, commanding ships being in 20 fathoms water, let go their anchors and veer only to 40 fathoms of cable, something is likely to happen if a squall should strike them. Captain Noel, I think, has hit the nail on the head by saying that if you want cruising vessels under coals alone, you must have your ships of 10,000 tons. He has also alluded to the eternal working of your auxiliary engines in order to do the work on the ship, and I am sure no better illustration of that can be found than in the "Inflexible." There is also another point which must be considered. You have not got now, with your 110 rounds of shot and shell, half enough ammunition on board your ships. It is all very well in the Mediterranean, or the Channel, near your own ports, but what do you suppose would be the effects of the next action which takes place in the Pacific? I do not mean when you are close to Esquimalt, where you have got a depôt, but anywhere else, and that is a most serious consideration. You cannot have room for your coals, and shot and provisions, and therefore you must, in my opinion, trust very largely on distant stations to your sail power. The Italians have the largest vessel on the stocks and afloat, and they are going entirely for very large coal storage and mastless ships—just two trysails. In France, all the larger class of ironclads, like the "Redoutable," are having the yards taken out of them entirely; the lower masts are left, with a very strong battery of machine-guns on the top. In Germany they have not done away with the practice of having full-rigged ironclads; but this year, owing to the short time of their ships being kept in commission, they have decided to send steamers with lower masts alone, and with poles for the topmasts for signalling. I am afraid, by-and-bye, we shall have too much the same sort of thing, as we generally follow other people's notions, and I shall expect to see, before many years are past, all our ironclads in the same way. I shall be sorry to see it, because I think in the Mediterranean and the Channel you are so close to your own ports that at the first outbreak of war you could get rid of all your topmasts and yards instantly. Until then, I am quite convinced, it is of the utmost service to our men in every way to have the means of exercising them aloft. As I said the other day in another place, I am fast going into old fogeyism; but still I maintain the opinion that it is from the top-gallant and the royal yard men, and the men stationed aloft generally, that you get your best men, who afterwards will doubtless be found, under Captain Colomb's direction, filling shell, and employed in various avocations where the nerve that they had acquired at our mastheads will serve them in all other capacities so well. I beg, on your behalf, to return a vote of thanks to the gallant lecturer.