INSTITUTE OF MARINE ENGINEERS
INCORPORATED.

SESSION, 1894-5.

President—SIR THOS. SUTHERLAND, K.C.M.G., M.P.

FIFTY-THIRD PAPER

(OF TRANSACTIONS),

The Commercial Speed of Steamships.

BY

Mr. J. DENHOLM YOUNG

(MEMBER),

READ AT 58, ROMFORD ROAD, STRATFORD, E.,

ON

MONDAY NOVEMBER 12th, 1894,

AT

THE UNIVERSITY COLLEGE, CARDIFF

(Bristol Channel Centre),

ON

WEDNESDAY, JANUARY 16th, 1895.

AT

THE ARTS' SOCIETY GALLERY, ABOVE BAR, SOUTHAMPTON

(Southampton Centre),

ON

FRIDAY, DECEMBER 14th, 1894.

DISCUSSION - CONTINUED AT

58, ROMFORD ROAD, STRATFORD, E.,

ON

MONDAY, NOVEMBER 26th, 1894.

INSTITUTE OF MARINE ENGINEERS

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President—Sir THOS. SUTHERLAND K.C.M.G., M.P.

"SOME CONSIDERATIONS AFFECTING THE COMMERCIAL SPEED OF STEAMSHIPS."

By Mr. J. DENHOLM YOUNG

(Member).

READ AT

58, ROMFORD ROAD, STRATFORD, E.,

ON

MONDAY, NOVEMBER 12th, 1894.

CHAIRMAN:—

Mr. S. C. SAGE, *(Member of Council)*.

A good deal has already been written about the most economical speed, the question having been approached sometimes from one point of view and sometimes from another. The writer is therefore indebted to existing literature for several of the points mentioned in this short paper; but he thinks that there is still room for information and discussion on some essential bearings of the subject, especially at a time when competition appears to be reducing profits to a point below zero.

In approaching the question, no assumption has been made regarding the existing state of practice in

the shipping world. The writer merely wishes to show how each case can be tested on its own merits, and how it can be predicted whether it would pay to take the extra half knot out of a particular ship, or if not, why not?

Undoubtedly in many cases an expensive process of trial and error has pointed out the best rate of driving, and the value of trial and error must not be underrated, especially in pioneer enterprise; but a proper analysis of past experience can generally be of some use.

The questions of form and size will not be considered in this paper, which will deal only with:—

(*a*) Possible cases of existing ships, in which the relative amounts of space allotted to cargo, and to machinery and bunker, may not always be interchangeable.

(*b*) The cases of proposed vessels, in which the weight of machinery and bunkers may reduce the cargo capacity.

It may be as well to point out that a great many actual examples must occur, which differ widely from average practice; and, of course, the general problem for one class of ship may be very different from the general problem for another class; but all these cases may be dealt with on the same method of analysis.

The common plan of graphic reasoning will be made use of in the present instances, values of speed and money being laid down to scale, so that variation of profit and loss may be self-evident.

For purposes of comparison, the profit and loss *per voyage* is chosen as being handier for shipowners' purposes than the profit and loss *per annum* or other unit of time. With proper treatment the results will, of course, be identical whatever unit be chosen.

The following items will be dealt with as forming the principal factors under consideration:—

1. Consumption of Coals and Stores.
2. Wages and Provisions.
3. Depreciation and Repairs.
4. Weather.
5. Insurance, or Equivalent Risks and Liabilities.
6. Port Charges and Expenses.
7. Tidal Effects.
8. Freight, or Value of Cargo to Shipowner.
9. Competition.
10. Limit of Supply and Demand.

1. (*a*) CONSUMPTION OF COALS.

The consumption of coals for main engines may, in the case of a proposed vessel, be generally taken as proportional to the I.H.P., so that the consumption per voyage will vary directly as the I.H.P., and inversely as the speed.

In the case of existing engines and boilers, however, it may not be possible to regulate the consumption of coals in proportion to the I.H.P., except within narrow limits, since for much lower powers than that for which the boilers are designed they will be too large for the grate; and, on the other hand, the efficiency must decrease when it is sought to take more than a certain amount of power out of them. The effect of this is to reduce the range of speeds at which it is possible to work existing steamers economically. The curve is best determined from actual trial, care being taken that the quality of coals and other conditions are similar in each case.

(*b*) CONSUMPTION OF STORES.

These will require to be treated in separate groups in this investigation, according to the nature of the wear, usage, or consumption to which they are subjected.

The consumption of such material as lubricants, gland packing, bushes, &c., will naturally depend principally on the size of the machinery (other conditions being alike), and the total revolutions or distance run.

In the case of materials subject to atmospheric or other chemical corrosion, the expense will probably vary nearly as the size and the time on voyage.

The wear and tear of firebars and stokehole furnishings should be approximately proportional to the coals consumed.

Bearing these considerations in mind, the expenses due to the various items under this heading may be classified as in the following tables: —

CURRENT EXPENSES DUE TO STORES AND FURNISHINGS FOR AN EXISTING STEAMER OF GIVEN NORMAL I.H.P.

CONSTANT PER VOYAGE OF GIVEN LENGTH.	VARYING INVERSELY AS SPEED.	VARYING AS $\frac{\text{I.H.P.}}{\text{SPEED.}}$
Pump Valves Bushes Lubricants Gland Packing Engine Waste, etc. Cargo Gear Coals for Donkey Boiler	Ropes, Sails, and Rigging, Hardware and other Stores, and Furnishings for Ship use, Flange Joints, Paint, Lamp Oil, Candles, Electric Light Expenses, Boiler Chemicals, &c., Galley Coals.	Firebars and Stokehold Furnishings

PROPOSED STEAMER, NORMAL I.H.P. UNDECIDED.

CONSTANT PER VOYAGE OF GIVEN LENGTH.	VARYING INVERSELY AS SPEED.	VARYING AS $\frac{\text{I.H.P.}}{\text{SPEED}}$	VARYING AS I.H.P.
Cargo Gear, Coals for Donkey Boiler	Ropes, Sails and Rigging, Hardware and other Stores, and furnishings for Ship use, Flange Joints, Paint, LampOil,Candles Electric Light Expenses, Galley Coals.	Boiler Chemicals, &c., Firebars and Stokehold Furnishings.	Pump Valves. Bushes. Lubricants Gland Packing. Engine Waste, &c.

2. WAGES AND PROVISIONS.

The number and wages of crew and officers remaining constant, the value of wages and provisions per voyage would be inversely as the speed. The curve will therefore appear in the diagram as a common hyperbola, with its origin at O knots, the scales of speed and money forming the asymptotes. In the case of existing machinery where the numbers of engineers, &c., are fixed, the above may be all that need be taken into account regarding these items.

In proposed vessels, however, if the range of speed be wide and uncertain, it may be considered advisable to take the engine-room expenses by themselves, allowing for an increased number of hands with an increased horsepower, or for deck exigencies. It may be observed that the line should be a stepped or broken one, the step occurring where the extra man is brought in. Of course, by a judicious paring down of wages this little peculiarity can be avoided, and a fraction of profit saved for the disappointed shareholder.

3. DEPRECIATION.

Whatever view may be taken as to the actual amount of allowance that should be made for depreciation, it will probably be admitted that machinery, from its constant wear and tear, should depreciate at a quicker rate than the hull itself, this being especially

the case with boilers. An allowance of twice as much for boilers as for hull does not seem over the mark, this only involving the assumption that the hull should outlive two sets of boilers.

The question of the engines probably becoming obsolete and requiring alteration may also be taken under this heading, and if the necessary capital for carrying out these operations is to be provided or reserved out of freight earnings, then the allowance made for depreciation of these parts will require to be doubled.

The ordinates of these curves will, of course, be directly proportional to the value of the machinery, and inversely proportional to the speed.

In the case of existing vessels, where the value of the machinery may be taken as fixed, this will tend towards showing an advantage in favour of working the engines at full power.

As against this allowance for what may be called natural decay in the engine department, the usual depreciation in the value of deck and other fittings and gear will necessarily form an influential factor, varying with the nature of the traffic engaged in and other circumstances, such as original soundness, and care taken in preservation of material.

The necessary percentage having been decided upon, its effect will be inversely as the speed, giving another advantage to the faster vessel.

4. WEATHER.

Under this head, only extension of actual voyage due to influence of weather is meant to be included. Damages, &c , due to this cause should be taken under the heading of Insurance.

It will not nowadays be considered necessary to prove that an average amount of detention due to weather—or prolongation of voyage—comes within the range of calculable probability for most voyages. Professor Elgar has called attention to the fact that this is a decreasing amount with ships of increasing size. In the present instance the problem assumes the form of the question: "How will this factor vary with the speed?" The old-fashioned phrase, "Stress of weather," points the way to a solution; it is, in fact, stress of weather* *versus* stress of machinery, or, force of wind and waves *versus* utilised force of steam. According to Newton's second law of motion, "Change of momentum is proportional to the impressed force, and takes place in the direction in which that force acts."

If therefore the average stress of adverse weather be known as a certain amount over a given voyage, then at varied speeds its effect upon a steamship's rate will be inversely proportional to the actual thrust of the engines, or approximately to $\frac{\text{I.H.P.}}{\text{speed}}$.

The curve thus laid down tends to show a further advantage in favour of higher speeds. It should be taken, of course, on the total value of other expenses.

5. INSURANCE.

Insurance, or equivalent safeguard against loss through what—it is customary to describe, in English of varied ages, as "perils of the seas, risks incidental to steam navigation, men of war, acts of God, fire, pirates, enemies, rovers, thieves, &c."

If the vessel under consideration be insured annually, then the loss due to insurance will vary inversely as the speed, provided that the amount insured and the

* It may be objected that a concrete meaning has been given to an abstract idea. The writer apologises, but begs leave to retain the phrase.

sum paid for insurance remain unchanged. This, of course, tends to give the commercial advantage to the faster vessel.

It may be gathered, however, from previous considerations, that a vessel's comparative safeness lies largely in her capability of resistance to force of weather, and, therefore, that the probability of the more common of the above mishaps causing loss will vary inversely as $\frac{\text{I.H.P.}}{\text{speed}}$ on a given voyage.

The logical deduction from this is that since the possible number of voyages increases directly as the speed, the value of insurance premiums or equivalent safeguard for a given time ought to tend towards varying inversely as $\frac{\text{I.H.P.}}{\text{speed}^2}$ for a given tonnage.

Various risks, however, which do not diminish with increase of power—such as the danger of fire—partially modify this tendency, and should be considered for each individual case.

6. PORT CHARGES.

These being taken as per voyage, will only vary in so far as quantity of cargo carried is affected by necessary weight of machinery and bunkers. The actual expenses under this head can therefore be laid off at each speed.

7. TIDAL EFFECTS.

(*a*) Under this head it is intended to note the effect of catching or losing a tide, whether a daily or a fortnightly one.

It is evident that upon, say, a fixed run of short voyages, when a steamer's trade is such that she leaves

at high water and should arrive at high water, a considerable amount of expense may be incurred or profit lost by running at an ill-calculated speed. Or with long voyages, if a harbour is such that a particular vessel can only enter at spring tides a similar effect may be produced.

In the diagram this appears in the form of a series of steps upon the curve of expenses cutting into the space allotted to profit. The longer the voyage is with reference to the tidal period, the smaller and therefore the less important do these steps become.

(*b*) TIDAL CURRENT.

This may necessitate an addition to or a deduction from the apparent speed, which should be allowed for in assigning the horse-power, &c.

8. FREIGHT.

If the loss due to extra weight of machinery and bunkers be dealt with under the headings of other expenses—and it will be as easy to do so—then upon the diagram the line of Freight will be parallel with the base, and the distance between this line and the curve of total expenses will show the probable profit or loss at the various speeds,—the best commercial speed for the vessel and voyage under consideration being seen at a glance.

The form of the freight line may, however, be influenced by various circumstances, such as those mentioned under the two following headings.

9. COMPETITION.

The effects of competition may be illustrated in several ways on the diagram. If freight or passenger fares were to rise or fall at a certain speed, the line would have a step in it like that shown on the diagram. In extreme cases, say of vessels built for a particular

traffic, profit might be barred altogether below a certain speed, and it would depend upon the position of this bar upon the curve of total expenses, whether the lowest speed admissible, or a higher one, would be the more profitable. These conditions will be best seen on the diagram.

10. LIMIT OF SUPPLY OR DEMAND.

Limit of Supply or Demand may put a similar bar to profits above a certain speed,—for example, in a steam ferry, where only a certain number of boat loads could be expected to cross per day. In ordinary marine cases, however, this item should rather be taken into consideration when fixing the size and dimensions of the vessel—an operation which does not come within the scope of the present paper.

11. MANAGEMENT EXPENSES.

Fixed annual charges can be dealt with under the head of wages; brokerage, &c., being treated with "Port Expenses."

ADDENDUM.—For other views on this subject see Mr. Hamilton's Paper in the Trans. Inst. N.A., 1893, also Mr. W. J. Millar's Paper, Edin. Math. Society, and sundry correspondence in *Engineering*.

INSTITUTE OF MARINE ENGINEERS

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SESSION 1894-5.

President—Sir THOS. SUTHERLAND K.C.M.G., M.P.

DISCUSSION

ON

"THE COMMERCIAL SPEED OF STEAMSHIPS,"

HELD AT

58, ROMFORD ROAD, STRATFORD,

MONDAY, NOVEMBER 12th, 1894.

CHAIRMAN:—

MR. S. C. SAGE *(Member of Council).*

THE CHAIRMAN: We have now heard this paper read and have been able, but only to a certain extent, to follow the description of the diagram which is represented here before us; and as the author of the paper is present I think it would be well to have the diagram pointed out more clearly in respect to some of the intersecting lines, or, possibly the questions which may arise in the course of the discussion will make the doubtful places plain.

MR. YOUNG: The diagram as shown is not drawn to a scale and possibly this has led to a slight confusion. The curves are set off to show graphically what a particular class of steamer would probably do under the

different conditions noted for speed and coal. As the chairman has suggested, in place of going through a minute description of the diagram, it would be better to invite discussion and questions regarding any obscure references to the lines or figures.

Mr. JAS. ADAMSON (Honorary Secretary): The subject introduced to the Institute in this paper by Mr. Young, is of very great interest and importance, inasmuch as the necessity for working on the most economical lines in every trade is greater now than ever it has been, and any basis which can be laid down for estimating approximately the expenses of steamships will prove of great value to managing owners. The method adopted in the paper will no doubt commend itself to engineers especially, as being in the direction in which we have been accustomed to work out other data; at the same time, it appeared to me that the diagram which accompanies the paper required considerable explanation from the author's point of view; we are indebted to him for the explanations given. The curves for cargo steamers and those for passenger steamers would, I should say, require to be constructed on somewhat different groundwork. I can conceive diagrams drawn out for different classes of vessels based upon actual results, and the best lines of each class brought into a curve to represent approximately the best conditions under which each particular class of vessel may run, and this I apprehend is the intention of the author. Every managing owner and superintending engineer has drawn before him a chart of the performances of the various steamers which come under his control, and if the diagram submitted by Mr. Young had been drawn to scale, a comparison might very easily be made between the type referred to in the diagram, and others.

I have placed down a few figures here, which, in respect to several of the details tabulated in the paper, can be placed to represent the curves due to weather, coal, quality of coal, cost of coal, speed, oils,

&c., but in extending the curves for several voyages, they are found to vary considerably with even the same steamer, owing to circumstances beyond control, and not only so, but they vary more considerably when taken for sister ships I am aware of several cases where one steamer built and engined by the same firm as another steamer, owned by the same company, running on the same voyage, has given better results in speed and consumption than that other steamer, and where every effort had been made to bring about the same results in both cases, but the equalisation has not been attained.

Most of the members present have seen the apparatus designated a "Ship's Course Recorder" for the purpose of showing a diagram of the ship's course traced by a pencil. It seems a very good instrument, and from the samples of its work much of the steering had need to be improved to bring the percentage of slip down to a fair average in some cases shown. Besides the human element which is associated with the steering of the ship, it comes into play in connection with the steaming of the ship from port to port, when it becomes possible, by one day's hard driving, to more than lose the economy which may have been gained by a week's previous easy steaming; still, this is better known now, or shall I say, better understood, than it was, and what an increase of speed from 12 knots to 13 knots per hour means. I understand from Mr. Young he assumes a clean bottom in each case, which involves dry docking the ship each voyage, or in the alternative a certain drop would require to be allowed, varying according to the nature of the voyage. The question of whether an inferior class of coal with an enhanced consumption is more economical than a better class with a lower consumption, taking the aggregate cost into consideration, can be very clearly shown by this method of diagram in comparing one voyage with another or with a series of voyages, and for the purposes of such comparison the graphic method is

extremely useful, and, of course, to a certain extent it is approximately useful in determining from results what are the best conditions under which certain types of steamers can be worked. We are indebted to Mr. Young for the paper he has presented and for bringing this subject before us.

THE CHAIRMAN: Mr. Adamson has mentioned the fact of two ships supposed to be exactly alike, which gave very different results. I also know two similar ships built at the same time, of the same tonnage and horse-power, built by the same builders, and engined by the same engineers. Yet one of these steamers would give 9½ knots on 17 tons of coal, while the other boat took twenty tons to go 9 knots. Both ships were four years old, and the hands on the expensive ship had been changed several times. The makers of the engines had tried all they knew to lessen the consumption and improve the speed of the slower boat, but in spite of everything the results remained practically the same. There was a difference of at least three tons per day between the two ships, whatever the kind of coal used, and some of the coal put into the bunkers of steamers at both North of England and South Wales ports was quite as bad as that obtained in the East Indies and other places abroad. There was very little difference between the indicated horse-power. These two steamers each indicated about 1,000, and the boat which burnt the least coal did the best.

In inviting further discussion on the subject I think we will all be agreed that the paper is far too short, and I hope it is only to be accepted as preliminary to something further in the same direction. The thanks of the Institute are due to Mr. Young for the paper he has brought before us, and if I may judge from the discussion, so far as it has gone, something is wanting from the author in the way of practical examples to further illustrate the system, these possibly may be brought forward at the next meeting, when the discussion will be resumed.

INSTITUTE OF MARINE ENGINEERS

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SESSION 1894-5.

President—Sir THOS. SUTHERLAND, K.C.M.G., M.P.

ADJOURNED DISCUSSION

ON

"THE COMMERCIAL SPEED OF STEAMSHIPS,"

HELD AT

58, ROMFORD ROAD, STRATFORD,

MONDAY, NOVEMBER 26th, 1894.

CHAIRMAN:—

MR. S. C. SAGE *(Member of Council)*.

THE CHAIRMAN: Mr. Young has kindly come forward to our meeting to-night to further the discussion commenced at last meeting on the subject of "The Speed of Steamships," introduced in the paper which he read here on November 12th. I will now ask Mr. Young to initiate the discussion.

Mr. J. D. YOUNG: I will briefly explain the graphic method of reasoning. The diagram accompanying the paper indicates at a glance the speed at which it would be most economical to drive the ship referred to, I have here a second diagram prepared since the last meeting

from the following figures, which have been obtained from actual accounts, and which show that in one case there will be a loss and the other a gain, through increasing the speed by one knot: *A, 10 knots, coals and stores per voyage, £204; other expenses, £530; total, £734. A, 11 knots, coals and stores per voyage, £271; other expenses, £442; total, £713. Gain through increase of speed, £21. B, 13 knots, coals and stores per voyage, £700; other expenses, £2,192; total, 2,892. B, 14 knots, coals and stores per voyage, £893; other expenses, £2,035; total, £2,928. Loss through increase of speed, £36.

Mr. C. L. E. Melsom (Member of Council): As previously remarked, it seems to me that a considerable loss may be due to bad steering, causing a larger mileage on the voyage than there is any need for, and which the engineer does not get credit for at the end of the voyage, when his coal account appears to be large in comparison with the mileage of the ship, as given to him by the captain, often resulting in trouble to the chief engineer.

Mr. F. W. Shorey (Member of Council): I believe that this will prove a valuable paper to engineers, but I would like to know if in arranging his diagram the author took into consideration the design of the ship, because a vessel with fine lines would require less power to travel at the same speed than an old tub.

Mr. Young: The design of the the ship was taken into account in the curve representing coal consumption. The greater power required to drive a ship that is not of fine lines would show itself in the increased cost of coal.

Mr. Shorey: Supposing a shipowner is about to have a ship built for a particular trade, and he gives you full particulars of the vessel and engines—her

* The above figures were based upon data published in the *Times*. Inst. Nav. Arch., 1883.

dimensions, lines, sizes of engines, sizes of boilers, pitch of propeller, and all other data—could you give him the most economical speed at which to drive that ship before it is launched; because, if so, such a thing would be very valuable to shipowners?

MR. YOUNG: It is certainly possible.

MR. SHOREY: The all-important question in ascertaining the most economical speed of steamers is the coal consumption, and I doubt if it is necessary to know the out-go for wages, insurances, &c.

MR. YOUNG: I would, however, point out that the amount of money expended in wages depends on the length of time occupied by the voyage.

Mr. J. H. THOMSOM (Chairman of Council): For many years I have had a great fancy for the graphic method of showing results. A diagram showing the consumption or price of coal during a stated period, for instance, is a very good means of enabling one to grasp the situation at a glance, but when employed to prophesy or foretell results I have never looked upon the system as likely to be of much service. It is an easy method of representing results and obtaining approximate figures for a voyage or series of voyages, but when brought within the range of prophesy I cannot see how any dependance is to be placed on it. I understand from the paper this form of diagram is intended to be laid before the shipowner, so that he may at a glance see the most economical speed a vessel of given dimensions can be driven. I think there would be some difficulty in laying down a curve to represent competition.

MR. C. L. E. MELSOM (Member of Council): Mr. Young's paper is certainly a step in the right direction, for, as he remarks (or in words to that effect) competition has reduced profits to such an extent that, in many instances, an actual loss per ship per voyage

has to be faced, and it is only in relying on hopes of better times coming that some lines of ships are being run at the present time; but the better time, now long expected, has not as yet put in an appearance, nor is it likely to be visible in the near future. The direct cause, however, I think, is pretty generally agreed upon as over-production, there is a glut in the ocean carrying power of the world, this is what lies at the roots, gnawing the vitals of the tree, and I am afraid the only way to escape this demon is to cause him to eat of our neighbour's tree, by making one's own less palatable, in other words, we must be smarter than our neighbours in the planning and carrying out of our methods in reducing expenses, and then, not to blow our horn from the mountain top of the why and the how of it, we must be up and doing at all times, *quietly* studying the best means to make use of, in trying to win the race. Mr. Young touches upon a most important point, namely, what is the best paying speed of our ships? Seeing that if we ignore this point we lose money, either by going too slow or too fast; in the former case we could do more work with a very slight increase in our expenses, in the latter, we lose more or less heavily in the direction of the greatest expense of a steamer, namely, the coal account; a very slight increase in speed over the boiler power means an altogether disproportionate increase in consumption of coals. I do not think, however, that Mr. Young's idea of working ships in accordance with diagrams or geometrical figures will do much to help the harassed shipowner or manager, but I will say this, that careful analysis of voyages should be carefully noted and studied as to kind of cargo, trim of ship, speed, and weather, if possible. In the Eastern trade far too little study is given to the matter of stowage of cargoes and the consequent trim of ship; this matter is, I am afraid, often left to the judgment of stevedores; these men, however capable they may be at their business, cannot possibly know the peculiarities of the different ships passing through their hands; rather is it the place of the ship's officers to carefully study this question as it applies to their

several ships. I do not for a moment mean to imply that this state of affairs is general, but I know from personal observation that it is not non-existent. Another means of economising to a considerable extent (more so than is generally known to be the case) lies in the care by which a ship is navigated, especially in regard to steering, and here again crops up the question of trim of ship; if the ship is not properly trimmed she cannot steer well, hence a longer course at the expense of coals. As to the other points in Mr. Young's paper respecting stores, wages, gear, provisions and insurance, the management of all of these have been reduced to a fine art; we therefore cannot hope to save or economise much in any of these, the proof of this can be found in the general discontent existing amongst the workers, *vide* the press of late, on the under-manning question. I think that I have now been able to show that the pith of the question of economy lies in the careful management by the crew of the ship, in the direction which suits such ship best, and that no hard and fast rules can be laid down for general guidance.

———o———

MR. YOUNG'S REPLY.

The design of the ship is taken into account in the curve representing coal consumption. The greater power required to drive a ship that is not of fine lines will show itself in the increased cost of coal.

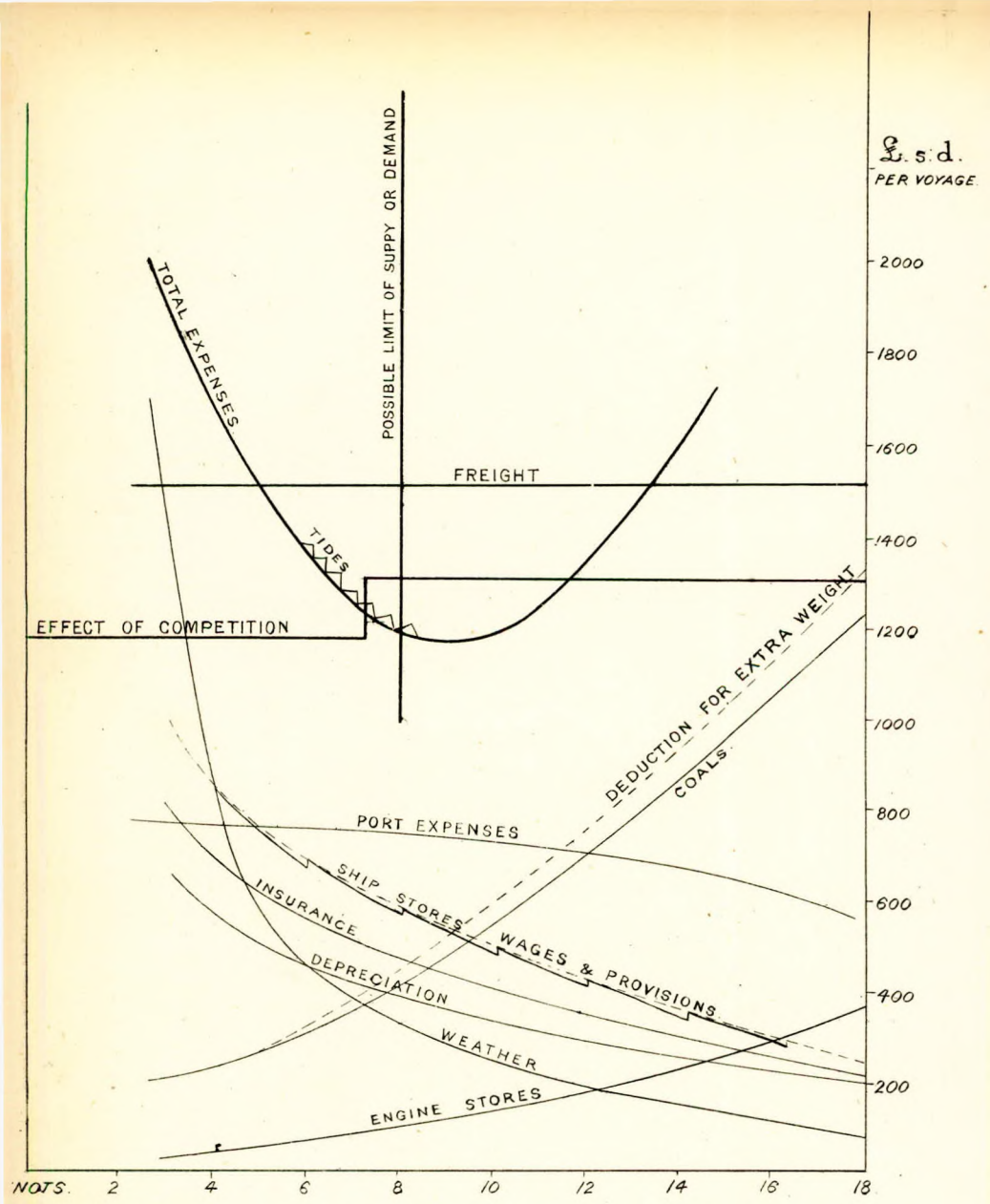
The line for competition generally fixes the lowest limit of speed, but not the highest limit.

It is evident from the diagram that if a higher freight could be obtained with a higher speed, this might be the more economical way of running.

If any gentleman present would furnish me with the actual accounts of any ship, I would be very willing to work out the curves, provided of course that there

was no objection to the publication of the accounts. References have been made to the difficulty of obtaining averages where an owner has only one or two ships, but where a man has only one vessel, let him take the highest known average and calculate on that as a basis.

I am afraid that the paper has been misunderstood in some points. The remark about cutting down wages in order to fair a curve was, of course, not meant to be interpreted seriously, and I hope that no one present gathered that in all cases an "extra half knot" meant additional expense. Each ship should be taken by itself, and I hardly need contend that whatever can be expressed in figures can also be laid down in lines. The calculations are chiefly made by simple "rule of three," and the curves shown are based on actual ships. With regard to Mr. Melsom's remarks about bad management and careless navigation, if a certain speed is found to be the most economical with good navigation, then that speed would be in a very approximate degree the most economical speed with bad navigation, because the voyage would be so much longer and the expense would be greater in the former case. We cannot predict by means of a diagram of this character what a certain ship would exactly do on a certain voyage, but can predict *with probability what a ship would do on the average of a number of voyages.*



NOTE:- THE ABOVE CURVES ARE NOT DRAWN TO SCALE.

TO ILLUSTRATE MR YOUNG'S PAPER ON

"THE COMMERCIAL SPEED OF STEAMSHIPS"