INSTITUTE OF MARINE ENGINEERS
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President—W. H. WHITE, Esq., C.B., LL.D.

Volume V.

FORTY-NINTH PAPER
(OF TRANSACTIONS)

Screw Propellers, Reversing Screw Propellers, AND Non-reversible Engines.

BY

Mr. ROBERT McGLASSON.
(HONORARY MEMBER).

READ AT
THE UNIVERSITY COLLEGE, CARDIFF,
ON
Thursday, December, 7th, 1893.
AND
IN THE PREMISES OF THE INSTITUTE,
58, ROMFORD ROAD, STRATFORD, E.,
ON
Monday, December, 11th,
Discussion continued December 18th, 1893.

PREFACE

58, Romford Road,

Stratford,

18th Dec., 1893.

A Meeting of the Institute of Marine Engineers was held here on Monday Evening, December 11th, presided over by Mr. F. W. Shorey (Member of Council), when a Paper by Mr. R. McGlasson (Hon. Member), entitled "Screw Propellers, Reversible Screw Propellers, and Non-Reversible Engines" was read, in the absence of the Author, by the Honorary Secretary.

The discussion was opened by Mr. F. W. Beaumont, C.E., who, on behalf of the Author, explained the details of the enlarged diagrams which had been forwarded by the Author to illustrate the Paper. The discussion was adjourned till this evening when Mr. F. W. Shorey again presided.

The Paper was read at a Meeting of the Bristol Channel Centre held in the University College, Cardiff, on Thursday, December 7th, presided over by Professor A. C. Elliott, Vice-President.

JAMES ADAMSON,
Honorary Secretary.

SESSION 1893-4.

President—W. H. WHITE, Esq., C.B., LL.D.

SCREW PROPELLERS,

REVERSING SCREW PROPELLERS

AND

NON-REVERSIBLE ENGINES,

BY

Mr. R. McGlasson.

Read at Cardiff, December 7th; Stratford, December 11th, 1893.

I have the honour to offer a few remarks upon that time-worn subject, the screw propeller, and on the benefits which would follow the adoption of reversing screw propellers operated by non-reversible engines.

It has been my pleasure—more or less to my profit—to have waded through the literature of, and correspondence upon, this subject, and I have made a few experiments and deductions, the results of which I will shortly summarise.

Many men of eminence have advocated theories and formulated calculations on propellers. I respectfully submit that many have been misled by their mode of experiment, others by starting on a wrong basis, and others by making comparisons which do not apply to the real conditions which it is absolutely necessary to study and allow for, Some have experimetned with fixed propellers revolving in one position in a tank, and treated the appearances and results as if such would apply to propellers running normally with the vessel. Some set themselves the impossible task of designing a fixed propeller of maximum efficiency under all circumstances and conditions. Some wisely give their opinions in plain language and plain figures throughout; others do the same untill the (so-called) "mathematical" bogie crops up, in which case the opponents sooner or later get involved in a tangle of mathematical gymnastics, and seek for "constants" where all is inconstant.

The fact is that the propeller is the *chameleon* of marine engineering. The expressed opinions of the most honest and competent experimenters upon the theory of action of a fixed screw propeller vary with the point of view from which they take up their subject. With a screw of fixed pitch everything depends upon the *one* point of view from which they look at it. We might as well search for a fixed spanner to suit all sized nuts, or a sail area that will suit all winds, as for a *fixed* propeller which will suit all conditions.

I respectfully submit that the screws are of necessity continually operating under altered conditions of running, and that the developed propulsive area, and the power to suit it, must be capable of change to meet them before we can expect to secure economical propulsion, or can consider that we have obtained a screw propeller with which a marine engineer can be satisfied.

The screw is the only part of the machinery of a ship which really acts in and upon the water, and it therefore merits primary attention. It—or rather they, for I prefer the position, action and safety of twin screws—should be placed in as "solid" water, and as far away from the influence of eddies as possible. Any point on the circumference or periphery of the boss should revolve at least as fast as the vessel is designed to normally travel through the water. That is, the travel of the bottom acting surfaces of the blades should be capable of propulsion, and not be permitted to exercise a retarding action on the other part, as is frequently the case. This will eliminate the "harmful space," and avoid whorls, air suction, &c., caused by reversed action. The inoperative space should in all cases be covered or masked by a smooth coned boss. The extent or radius of the inoperative space will depend upon the revolutions. Few revolutions compel a larger boss in most cases; quickening the revolutions reduces the necessary diameter of the boss.

It will be seen that the rate of revolution of the engines is one of the first and most important things to be decided, not only for the reason mentioned above, but for others An additional thrust is produced by quickness of revolution. Quick revolutions will hold up better against a current. The resistance due to the inertia of the water becomes rapidly greater with the increase of speed at which it is operated upon. Just as the hand finds little resistance to slow motion in water, but an almost absolute resistance when it strikes the water rapidly, so does the high speed screw approach the condition of rotation in a solid nut. So we must—within reason and the limit of practicability—not give the water too much time to embrace the screw blades. There are still many old ships merely "stirring it up," comparatively speaking.

If developed propulsive area cannot be got in one way (say by deep draught and the desired circumferential revolution) it can be got in another, viz., by quick revolutions. And wherever we are able to apply both, we ought (in many cases) to get better speeds than have yet been accomplished.

Speaking generally, in regard to screw propulsion, I prefer comparatively short-stroke, quick-acting, non-reversible engines. In relation to the operation of screw propellers, piston speed (employed in the form most desirable to the type) is one of these desirable things of which we cannot have too much so long as it agrees with the constitution of the engines. We cannot without risk attempt to reverse the motion of the revolving masses of matter very quickly in a really quick-speed engine of any size. So I suggest that we let it run always at practically the same rate in one direction, and we shall not only gain mechanically, but commercially also, as I shall explain farther on.

Increased revolutions also comprehend reduction of weight and space occupied, reduction in the weight of overhanging screws and fittings, and in the number and width of blades, &c., and it will permit a greater head of water under which the screws may operate. These suggestions have begun to be to some extent adopted in the more modern types, but I submit that much more can be safely done in this direction by the adoption of the system I advocate.

With regard to the area and revolutions, I found it necessary to make an experiment. For the purpose of accurate comparison I constructed and tried a running boat, carrying its own fixed screw and motive power, and operating by clockwork (which may be looked upon as a really " constant " power for purposes of comparison) in still water. I found that letting the clockwork " run free," and commencing with a full sized screw, I could cut and trim it down to a comparatively trifling area, and yet the boat went as well as ever. The increased revolutions here made up for the reduction of area. Mr. Volk, the electrician, was good enough to advise me that experiments with an electric launch quite corroborated my conclusions on this point. He said: "In endeavouring to remedy a defect, the blades were reduced from time to time till they merely consisted of two thick triangular pieces of about six inches square, each; yet, throughout, the speed of the boat varied very little." Here we have an (accidental) corroboration by means of another practically constant power. It is difficult to get a really constant power applied in steam trials, as the human and other elements cause some degree of variability.

Here we see that area may, (within reasonable limits, and allowing sufficient for quickly starting, stopping and reversing according to the particular requirements,) be in proportion to revolutions, and also how beneficial it would be in some cases—as has been frequently proved—to "let the engines out" by making the propellers smaller. In Mr. Volk's experiment there could not have been much variation in the friction or the slip, or the speeds of the boat would have differed. These experiments also prove that—when the draught will permit—we do not require too many blades, which have sometimes "locked up" the water and corrected themselves, being found afterwards to do better work with the remaining (smaller) area. How often has a comparatively small portion of an old blade been found to be brightened by activity, and the remainder to be covered by marine growth. The experiment also proves that "cutting the curl" of the fixed (curved) pitch did no harm in the case referred to. My system abolishes all useless and detrimental weight, and has less to operate and turn in consequence.

The blades should not be too broad. The larger circumferential revolution of the outer radius indicates the fact that it is better, when designing blades and determining area, to add rather to the length of the blades than to the widths. When draught will not permit this—in single screw designs—it is of course better to have twin screws—which I prefer in any case.

There is not so much slip with them in shallow draught, and the two screws could if desired be driven from one shaft and my gears applied, by which the manipulating benefits of twin screws would be obtained in a simple manner, and in a service in which it is often wanted.

I have found that with models fitted with blades beginning where they can act, and properly revolved and pitched, no rope of water or disturbance thereof is noticeable. I have weighted pieces of cork and floated them at the level of the screw shaft, and such blades have simply "walked through" them without disturbing their position unless hit. I respectfully submit that the working of some of the theorems applying to old-time screw propellers—in a hollow between two posts—of fixed pitch, should now be somewhat altered. We want to propel the ship, and to pass through the water with as little disturbance as possible. In a well-designed ship, if the water be properly supplied to the screws and properly treated by them the disturbance caused by the screws themselves would be very trifling, as the water possesses inertia enough to "stand up" against really energetic screws with great advantage to economical propulsion. The reduced time-element makes the liquid wall which the screws push against more solid, and the ship moves more and the water less, relatively speaking. The ship creates, or should do, most of the "wake."

For many boats—as the late Robert Griffiths wrote, and said to friends who have kindly written me on the subject—approximately flat blades are practically as good as any other. Why should they not be? Make the blades of the best section to avoid friction and not too broad, begin them where they can act, and revolve them quickly enough, and we shall secure a constant pitch angle capable of being set by my system to develop the best propulsive area at all times, both ahead and astern. Such can be made capable of passing through the water with practically equal resistance and effect at all radii by making the bottom of the blade relatively wider than the top so as to equalize the circumferential action of all parts of the blades. But any reasonable shape of blade can be accommodated by my system; in fact, a popular "modified Griffith" has been running equally as well astern as ahead—operated by one development of my gears—for the last twelve months.

We are told that in fixed screws a true screw or helix—in which pitch multiplied by revolutions is the same at all radii—is supposed to be best under ordinary conditions. If I design the above fixed screw to suit the maximum speed (which is certainly what I ought to do) of a war ship, at which the revolutions are, say, 104 as in the "Edgar," how will this fixed pitch or helix economically accommodate the speeds at which she will run for probably three-fourths of her time, at which speed the revolutions will, say, range between 45 and 55? I contend that the revolutions must be kept at the maximum available or desired, while the pitch and power is made alterable—without stopping—over the whole economical radius.

Having thus barely indicated—more can scarcely be attempted in one paper—a few general ideas upon screw propellers, you will perceive that I can do all I require—in all reasonable cases—by applying the maximum power obtainable at the highest desirable rate of revolution, and by keeping up that normal (highest) rate of revolution, making provision to change the pitch and the power to suit it when alterations in the conditions of running render it desirable. By this I can bring the action of the developed propulsive area more in the plane of motion of the vessel either when desired, when running at reduced speeds, or under equivalent conditions. Keeping up the revolutions will therefore provide an additional element of improved propulsion and ensure further economy.

I can also alter speed, stop, and reverse by the same means, the engines continuing to turn in but one direction with only the necessary expenditure of power at whatever angle the blades may be placed. In short, I can hereby vary the developed propulsive area from the maximum to nil in either direction, thus ensuring the utmost economy.

The best modern practice has already corroborated the necessity of doing what I suggest, "trial and error" and "cutting and changing" of screws in "crack" boats still goes on, and provision is made in all the best new vessels of most nations for altering the pitch in dock. Why not do it in the water? If it is good to a very limited extent—done in one way, it will be still more beneficial—and to the fullest possible extent—done in another; and will provide the means of suiting the screws to the engines and vessel. For we must do more than meet one set of "average" conditions, which may vary at any time; and we cannot go into dock to change the pitch, and we cannot—now-a-days—afford to stop. And if we did we should not be certain that the pitch we had put on could not be improved upon; and the running conditions might vary again at any moment. We must alter developed propulsive area to suit the then conditions of the ship and surroundings while running.

With regard to the engines, to be able to discard a large quantity of gear and run always in one direction, offers very material advantages, economically affecting the working, the wear and tear. &c,, and it also permits of simplification in the arrangement of various parts. Nothing is imported equal to what is discarded from the engine, for my gears are only active when the pitch of the blades is changed or reversed, instead of constantly—whether wanted or not—as the links, with their many vibrating points, are now. The change of direction of movement of the ship will be effected more rapidly and more directly; and as the direction of rotation of nothing—not even that of the screw itself—is changed, the alteration is made smoothly and without extra stress on either engine or propeller. The pressure is always in one direction on the guides, and the brasses will greatly benefit, and "knocking" be prevented. In all the larger engines the whole of the links, the levers, and reversing-gear way-shafts, several eccentrics and rods, and much other gear would be dispensed with, and many complications become un-necessary, and the merely manual labour be thereby much lightened. During the act of changing the position or angle of the blades from full pitch in one direction to full pitch in the other, the tension strain upon the shaft cannot be increased, the speed of the rotation may remain unaltered, and inertia—either of motion or of rest—does not come into play, and cannot affect the magnitude of the stress upon the moving parts. The complete reversal can—without risk of strain of any parts—be made in considerably less time than with reversible engines and fixed propellers, and no change in the direction of rotation of any parts is required.

The reversal or manipulation of the blades may be effected from the bridge or any other part of the vessel as well as from the engine room, on emergency or when desired, just as easily as the helm is now operated therefrom. The time occupied and risk in transmission of orders would be saved in the event of imminence of collision, fogs, &c. All sudden stopping and starting is detrimental to the machinery and boilers, and is avoided.

Long experience has proved that the modification of the pitch of a screw may be made to effect considerable improvement in the speed of a ship or in the power taken to propel it at a given speed. It is also known that when a ship is lightly loaded, economic advantages attend the power of changing the pitch of the screw as compared with that which is used, and it is best when the ship is fully loaded. Draught, state of bottom, wind, current, coal burnt, &c , all affect the economical question; and to secure the ideal propeller we must change it every day.

By my system the adjustment of the pitch may be made whenever required, either for obtaining the most efficient angle, for manœuvring, or for stopping and reversing, with no trouble or risk whatever. For manœuvring purposes, entering and leaving port, navigating crowded rivers or estuaries, &c., this system will relieve the engine-room staff of a lot of orders closely following each other, often of vexatious contrariety, and always involving a lot of harmful reversal of stress (sometimes amounting to strains) of engines, shafts, propellers, and boilers. Those amongst you who have had the happiness of "standing by" during a fog, in a crowded river or channel will appreciate this.

For modern fleet and war manœuvring it will be found to be an absolute necessity.

The engines, during temporary stoppages, are "run light," so engine-driven air pumps are still operated, and no dead points are possible.

In all cases the power is regulated to suit the developed propulsive area—in the case of steam by throttling all intermediate pas ages if necessary, or by varying the expansion – even while the blades are being turned for reversal, and this facility of feathering the screw blades and reducing the power employed while "hovering," will be of very great advantage to war ships, and. on occasion, temporarily reduce the horse-power employed from thousands to hundreds. This power regulation is automatically effected while the blades are being turned, and is capable of further manual or motor adjustment when desired.

Single-acting engines may be used; we can remove the strain of working and holding heavy valves from and by the main shafting; we are able to connect the lengths of shafting by screwing the ends or by screw collars (avoiding all the trouble connected with bolts and nuts), and we can also, by special means which are practically possible to my system alone, prevent racing from any cause whatever.

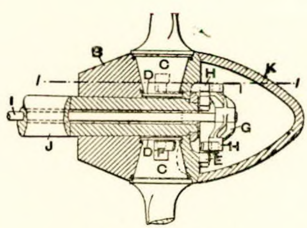
The reversal can be affected by hand, or motor, by gear on main shaft, by fluid pressure, or by electric gear, and in the largest vessels can be carried out by simply operating a wheel, lever, or switch, and moving a valve or sliding a clutch along a shaft.

Modifications of the outboard operating gear which I use in some of my combinations, have been well tested. The "Calliope" faced and conquered the hurricane at Samoa in which the German and American war vessels were lost. She was then fitted with the feathering screw of my esteemed friend Mr. Bevis. The well-known sea-going yacht, Lord Brassey's "Sunbeam" which travelled round the world, was fitted with another. I could multiply instances, but there is no need to do so.

My outboard gears are operated while the engines are running; they are in frequent use, so it is impossible for them to stick through inattention or corrosion, especially as they are effectively lubricated, and experiments I have made prove the fact that they have to perform but light work. Developments of the propellers and gears I advocate have been running for over twelve months, and have given great satisfaction. They are very easily operated, and one opened out the other day, after several month's service, was found in as good condition as when floated.

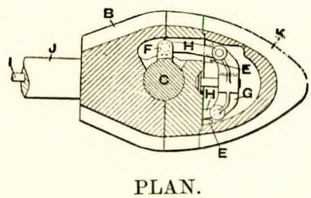
I will now explain one or two merely typical diagrams, which must be locked upon as explanatory only:—

PROPELLER BOSS.



ELEVATION.

FIG. 1.



PLAN.

FIG. 2.

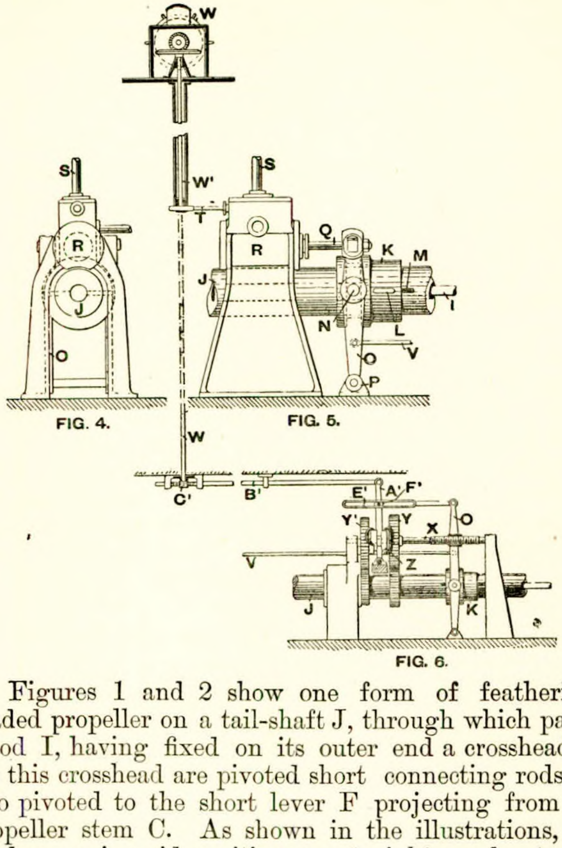


FIG. 4. FIG. 5. FIG. 6.

Figures 1 and 2 show one form of feathering-bladed propeller on a tail-shaft J, through which passes a rod I, having fixed on its outer end a crosshead G. To this crosshead are pivoted short connecting rods H, also pivoted to the short lever F projecting from the propeller stem C. As shown in the illustrations, the blades are in mid position, or at right angles to the propeller shaft. By moving the rod I, the crosshead G, and thereby the propeller blade stems, the blades may be made to take any position between their extreme positions, which are determined by the lever F coming into contact on either side with the beveled surfaces shown in Fig. 2. By moving them from one position to the other, the direction of propulsion is reversed, and between these positions any desired change of pitch may be made to suit the requirements of the ship or of navigation. The boss B is oil-tight and kept filled with oil.

For the purpose of moving and controlling the position of the rod I by fluid pressure, apparatus such as that typically shown in Figs. 4 and 5 will be employed. On the shaft J (Fig. 5) is a collar K; through this and the end of rod I a key L is passed and fixed, the key being free to slide in slots M in the shaft. In a large groove in collar K is a ring held by large pins N in the levers O, pivoted at P. Between the upper ends of these levers is a crosshead, which is fixed on the end of the rod Q. In the cylinder R is a piston, to which the rod Q is attached. Water (say) under pressure is admitted by the pipe S to the valve chest above the cylinder R, the valve being moved by the rod T. This valve rod is actuated by connections W^1 to a hand-wheel W, or by telemotor, motor, switches, or such other arrangements as the requirements of the ship may dictate. The rod V (Fig. 5) indicates a connection or connections with the engine room, by means of which steam supply to the engines may be concurrently decreased and increased with the decrease and increase of the pitch of the propeller. This gear and these operations would, of course, be under the control of the engineer; but can, on emergency or when desired, be operated from the bridge or any part of the vessel.

In Fig. 6 is shown a typical gear which may be used in any vessel, from the smallest to the very largest, and in which the running inertia of the main shaft does all the work, the officer merely sliding a clutch along a shaft. The sliding collar K is moved by a nut on the screw X, and the levers O. Upon the screw-shaft J are two steel cog wheels, which gear directly with the wheel Y and indirectly with the other wheel Y^1, both of which are loose upon the screw-spindle X. Between the wheels of Y and Y^1 is a double-faced clutch Z, by means of which either wheel may be put into gear by the lever A^1. The latter is operated by the rod B^1 and pinion C^1, connected by a rod to the controlling apparatus W, such as that shown at Fig. 5. I need hardly mention that any equivalent gearing may be used. The slotted bar E^1 (Fig. 6) is provided for automatically throwing the friction clutch out of gear by means of the pin F^1 and lever A^1, when the blades of the propeller have reached full pitch in either direction.

The blade-shanks may be single or double coned, or of any desired shape, and ball or roller-bearings may be used where desired. In small vessels my screws and gears may be operated (directly) by a hand wheel or motor on bridge or deck. My system and designs will equally well accommodate more than two blades where requisite or desired. I have several other special designs for propellers, in which these gears are made to operate as nearly as possible in the centre of the shaft and blades, direct. Only a small separate section of the shafting requires to be slotted when so fitted, and this can take the shape of a screwed connection of slightly extra strength and capacity to the (hollow) shafting. The system enables one pitch to be employed to get up speed and another to economically "hold" it.

In corroboration of what I have remarked, I quote from "The Engineer" of October 13, 1893:—

"In many of the crack Atlantic and other high-speed steam ships, it has been found necessary or advisable to have repeated changes made in the propellers—either new propellors altogether, or the old ones with reduced diameter, surface, &c. In most cases these changes have been instituted with a view to increase speed, but in some, the question of minimising vibration has been also involved." It will be obvious that my system will enable the engines to be held to the (non-vibratory) speeds of revolution under all conditions, by adjustment of the developed propulsive area. I may here repeat that the "normal" (maintained) rate of revolution need not necessarily be kept at the maximum possible, say, under extreme conditions of easy running, unless desired; and that my special automatic throttling or expansion gears are capable of adjustment within desired limits. As "The Engineer" says, "The only mode is to ascertain the natural period of vibration of the hull, and choose the propellers which give the speeds most frequently required, at rates of revolution not approximating to multiples of the period of vibration." We cannot tell the exact periods of vibration until the vessel is tried, with the screws on it, and it will therefore be again seen that my system provides the only means by which the case can be met.

Also, "Some modifications have, it is true, been made on the propellers as at first fitted to the vessels—(the "Campania" and "Lucania")—but these have not lain in the way of *increased* diameter or surface."

Again, "the first Atlantic Screw Steamship" left Liverpool for New York on a voyage which was full of incidents, the result of which proved conclusively that a three or four bladed propeller was a decided improvement on one of six blades. It also appears that "the ship still made good way" with only two. Messrs. Jno. Penn & Sons afterwards fitted the "Great Britain" with a screw of three blades; and, had the revolutions been higher, two would probably have answered equally well. There is no lack of "holding up" power in two blades—witness the "Calliope."

Blades begun where they can act, revolved at the highest desirable speed with pitch capable of variation to "pick up" an adverse current and also of making use of the normal revolutions while applying their impulse as nearly as possible in the plane of motion of the vessel (as the conditions and surroundings may render desirable); screws capable of reversal, alteration of speed, or temporary stoppage of propulsion; power suited to the developed propulsive area at all times, and engines held (under all conditions) to the desired or non-vibratory speeds, are the desiderata that modern screw propulsion must aim at, and such can be attained by this system alone.

It also provides the only practical means for direct manipulation, which will be invaluable in the event of imminence of collision, and *essential* in modern warfare and manœuvring.

I seek safety for those who "go down to the sea in ships," and economy for those who "do business in great waters"; and I respectfully submit to your consideration a system that will ensure the utmost economy in screw propulsion, that will save you much onerous manual labour and mental anxiety, and will give you more satisfaction in your work as marine engineers, and that will, on occasion, save both property and lives --your own perhaps included.

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Volume V.

DISCUSSION

ON THE

FORTY-NINTH PAPER

(OF TRANSACTIONS)

Screw Propellers, Reversing Screw Propellers and Non-Reversible Engines,

BY

Mr. ROBERT McGLASSON

(HONORARY MEMBER).

READ AT 58, ROMFORD ROAD, STRATFORD. E.

On Monday, December 11th, 1893.

DISCUSSION CONTINUED

On Monday, December 18th. 1893.

READ AT THE UNIVERSITY COLLEGE, CARDIFF,

On Thursday, December 7th, 1893.

PREFACE.

58, ROMFORD ROAD,

STRATFORD, ESSEX,

December 18th, 1893.

A meeting of the Institute of Marine Engineers was held here this evening, when a Paper on "Screw Propellers, Reversing Screw Propellers, and Non-Reversible Engines, by Mr. ROBERT MCGLASSON (Hon. Member), read on December 11th, was further discussed.

The chair was taken by Mr. F. W. SHOREY on both occasions.

The Paper was also read in the University College, Cardiff, on December 7th, at a meeting of the Bristol Channel Centre, presided over by Professor ELLIOTT, D.Sc.

The discussion which took place on the subject will be found in the following pages, also Mr. MCGLASSON's reply to the criticism offered by the various speakers.

JAS. ADAMSON,

Honorary Secretary.

INSTITUTE OF MARINE ENGINEERS

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DISCUSSION

AT

58, ROMFORD ROAD, STRATFORD,

ON

MONDAY, DECEMBER 11th, 1893,

ON A PAPER BY

MR. ROBERT McGLASSON

ON

"SCREW PROPELLERS, REVERSING SCREW PROPELLERS, AND NON-REVERSIBLE ENGINES.

Chairman: Mr. F. W. SHOREY (Member of Council).

The HONORARY SECRETARY (Mr. James Adamson): The circumstances under which Mr. McGlasson has written this paper are such as to prevent the author himself being present. He is an invalid, otherwise he would have been with us to-night. The diagrams on the wall, and the model can be referred to by members, so that the description can be the better followed and understood from the paper, and any point of interest made subject of question.

The CHAIRMAN: You have now heard this paper on the reversible propeller. The number of styles of propellers is legion. They are of all descriptions. This one before us is a novel idea, but I do not believe myself that it is applicable to large engines, although it may do for yachts or river boats. It appears to me that you would require a pair of engines on deck to reverse these blades in any moderate sized ship. The subject is now open for criticism, and I hope you will thresh it out. The author lays great stress on single-acting engines and running at high speeds; but there is another point to be considered, and that is whether there should be a coarse pitch or a fine pitch. I would say, a coarse pitch is all very well running before the wind, but you do better with a fine pitch running against the wind. The author of the paper, however, claims for his system that it is better under all conditions—that you can adapt it better.

———o———

Mr. J. ROBERTSON, Mr. LATTA, Mr. JAMES ADAMSON, Mr. MELSOM, Mr. NOBLE, The CHAIRMAN and other gentlemen present, then asked a number of questions in regard to various points of detail, suggested by an examination of the drawings, and most of these questions were dealt with by Mr. W. Worby Beaumont, who furnished the information desired on behalf of the author.

———o———

Mr. W. WORBY BEAUMONT said: I have had occasion to go into the subject of Mr. McGlasson's paper very carefully, and I have done so with the result that I think there is no doubt as to the possibility of carrying out the proposed system, even in large vessels, with practical success. I believe that what has been done with the Bevis propeller, with blades operated from inboard, by stopping the engines, can be at least equally well and satisfactorily accomplished without stopping the engines, in the way described by the author, or by some such method. There is nothing in the details of Mr. McGlasson's gear which has not been in use in many ways, and there is, therefore, no experiment required, except of the system as a whole. On the small scale of a 40-feet launch, it has already been successfully tried by Messrs. Priestman, and might be applied to vessels of the size of the

Calliope, with very little change in the conditions which have already existed in that ship, which, as is well known, was fitted with a loose bladed or Bevis "feathering" propeller when she weathered the great Samoa gale. The advantages which may be derived from the facility of change of pitch of the screw are very numerous, and every-day experience shows how valuable this facility would be on ships working uneconomically. The author of the paper devotes a good deal of space to the question of the design of propeller blades, and I do not know that it is necessary to say much more about it. The author has a small laugh at mathematics, as applied to the design of screw propellers, and perhaps that is justified, inasmuch as in spite of all that has been done, it is necessary to this day, whenever a ship is fitted with a propeller, to see if the propeller put on is the best one that can be provided for that particular ship. We all know that in many cases the propeller is altered after the first few trials, showing that it is really a case of experiment with almost every ship. One of the advantages which Mr. McGlasson claims for his system, and one which is of great importance, is the continuous rotation of the shaft in one direction only. One knows that when we have large masses of machinery, such as these large propeller shafts, to deal with, very heavy strains indeed are set up when it becomes necessary suddenly to reverse the direction of rotation. The danger becomes greater as the length of the shaft increases, and there is no doubt that a good many shafts have been broken, because, after having been run in one direction only for a long time, during which the metal has ranged itself to suit that line of stress, a sudden change has been made in the direction of rotation, setting up strains in the material which at least tend to the fracture of the shaft. If one imagines a shaft made up of a number of wires, all of which have been gradually drawn into a certain position while the shaft has been revolving in one direction, one can easily see how those wires would have to change their position if the direction of rotation was completely reversed, and possibly the alteration would take place while the engines were going at a very great speed. In the system advocated by Mr. McGlasson, engines and shaft are benefited by moving and having the stresses always in one and the same direction. The author also refers to the question of the shape of the blades, and, of course, the one point in which he is specially interested is, how far he may claim that it is possible to make a screw propeller blade which shall have all the necessary efficiency for going astern, with the greatest efficiency for going ahead. His contention is that the great bulk of the work done consists in going ahead, while the work done in going astern is very little, and that therefore a small difference in the efficiency going astern is a matter of no importance. Considering, that of the total revolutions made by these shafts, many do not make a tenth of one per cent. in the go-astern direction, the author's claim in this respect may be admitted. But, apart altogether from the advantage arising from the rotation of the shaft and the movement of the engines in only one direction, the advantage — in a crowded waterway—of the system advocated by the author must, I think, be apparent, inasmuch as it is possible to change the angle of the blades of the propeller from the deck the instant that the officer sees the necessity for stopping or reversing. Without having to reverse the engines and turn steam off and on every time the ship has to go ahead or astern, it is possible by simply moving a lever to go either backward or forward, and it can all be done under the eye of the man who is responsible for the navigation. Such a system would certainly tend to avoid accidents, as it would enable the master's or pilot's orders to be carried out more speedily than under the present system, for there can be no doubt that there is considerable time lost in telegraphing, receiving and acting upon the orders from the bridge—time which need not be lost at all when the necessary alteration can be actually carried out from the bridge or the deck by means of simple machinery. Objection is sometimes made to that on the ground that it is taking the work out of the hands of the engineers, who are responsible for the working of the engines, that it would lessen their responsibility. I think it is a very great question whether that is a point which can be regarded in this matter. But it seems to me that the engineers are just in the same way responsible for the engines, and it matters not to them whether the propeller blades are at one angle or another. It is clearly not more important for the engineer to know at what angle the blades are placed, and, therefore, in which direction those blades are pushing the ship, than it is for him to be informed in which direction the rudder is being moved by the steam steering gear. Neither the dignity of his position nor the importance of his work is in the least degree altered by the fact that the captain can himself move the handle, instead of telegraphing to the engineer to move his reversing gear. The Chairman said he did not think this system suitable for large ships. I think that one may say with regard to that, that as similar things have already been fitted to large ships, and as there would be no difficulty in making apparatus of the kind mentioned for a large ship, it is rather a question, perhaps, of what one is accustomed to than of what could or could not be. The *Calliope* is not a small ship. There are other vessels similarly fitted, and what has been done upon that scale might, I think, be done upon another. But I put it to those who claim to be engineers in this way:—If you were asked to provide this gear, or some such gear, by means of which the pitch of the screw blades could be altered in this way, would you reply that you could not do it? I have never yet found an engineer who would admit that he could not carry out a system of reversible propellers if asked to do so. I may, perhaps, also mention that the progress made by the system is such that several large firms are now quite prepared to undertake to fit ships in this way, provided they have orders to do so. That is a very great advance on the position a year or two ago. They now see not only the possibility but the practicability of the system. Several small boats have already been fitted, and they have been running for some time. There are, I think, very great advantages possible from the use of the system, and, I believe, it will only be necessary for those interested in such things to consider it for a time in order to agree that ships should be fitted, and that the advantages claimed for it can be realized.

Mr. MELSOM (Member): It would almost seem at first sight that by means of this invention we have reached the happy period when the machinery can be worked by a turn of the handle. But this idea seems to me to be far fetched in more than one particular. When the lever that is to work this gear is worked from the bridge, and the pitch of the propeller blades is lessened, the engines will race, so that in order to have everything safe below it will be necessary to have an efficient governor. As a means of altering the pitch of the propeller blades when the engines are stopped it seems a very good idea, but I do not believe that it is possible to work it successfully with the engines running.

Mr. BEAUMONT: That the system can be worked successfully with the engines running is not a matter of opinion. The thing has been done. It has been proved.

Mr. MELSOM: Yes, in small ships. There is another objection I would mention. In the Bay of Bengal and round the south coast of Africa, the propeller blades and boss, and in fact the whole of the ship below the water line become coated with barnacles, and it seems to me that this would very likely lead to the propeller blades becoming set or fixed so that it would be impossible to work them. It is perfectly well known to many members here that some ferry boats are worked on practically the same principle, and they are very handy, but they are only small boats.

Mr. J. ROBERTSON (Member): One point I should like to be informed about in regard to this invention is, What is going to keep those blades rigid? With a large propeller the strain would be very great, and I think there would be any amount of play in a very short time. It looks to me that those joints at the roots of the blades must get slack. There is bound to be a lot of wear on them.

The CHAIRMAN: We all know it is very desirable to have a means of altering the pitch of the propeller blades, as desired, especially when the engines are running, but it would mean a lot of work, and, in my opinion, it is hardly practicable at present. This arrangement may do for small engines, but I should like to know, when this gear is operated by hydraulic or steam power, and you have got the propeller blades in a certain position, how are they to be maintained in that position. The power required would be very great, indeed this gear, when fixed, would take quite as much as having the ordinary reversing gear. Mr. Beaumont spoke about the strain set up in the shaft when this plan is employed being all one way, but he must remember that when we are going to reverse our engines in a river or a crowded waterway, we are generally running slow. On coming into a river or into a port, when there is a likelihood of having to reverse the engines, you are only running at a half, or perhaps a third speed. This gear, as shown, would be down below, but it can be operated from the bridge, and look what a lot of gear you would require. I noticed that great stress was laid on the case of the *Calliope*. I understand they have tried the *Calliope* with a similar system; but you cannot alter the pitch of her propeller blades unless the engines are stopped. There are very different conditions to be encountered when you attempt to reverse the propeller blades with the engines running, and great power would be required. If it has answered so well in the *Calliope*, how is it that it has not been adopted in other ships since? Our great merchant vessels have not all this gear, and the owners always endeavour to provide for them the very best means of propulsion, irrespective of expense. The author advocates single acting engines; but, in that case, should this gear get slack, you have no means at all of reversing the propeller. The ship would run all one way. I am afraid myself that the system will never be practicable, although it is very desirable to be in a position to shift the blades when necessary. There are now so many propeller blades in the market that shipbuilders, knowing the class of ship and the rate of speed they want, know pretty well the pitch to give the blades of the propeller, and the best shaped blade for preventing vibration, and being most effective. The author also says in the paper that he cut and trimmed down the propeller blades, until they represented a comparatively trifling area as compared with that of the original blades, and that with these reduced blades the boat went as well and as fast as ever. It may be my obtuseness, but I cannot see that at all.

Mr. JAMES ADAMSON: It only goes to prove that the original design of the propeller blades was bad, and wanted cutting down in the proportion of area.

The CHAIRMAN: Perhaps these things have been sprung upon us too suddenly, and we cannot yet appreciate them. Possibly, if we adjourn the discussion until another occasion, we may come better prepared. It would be a pity to allow the matter to pass without adequate discussion. The author has given a great deal of attention to the subject, and I think we should be prepared to put a number of questions before him, as there are many points that must occur to our minds concerning this subject which might be dealt with by the author in his reply.

Mr. JAMES ADAMSON: I do not think that anything will be lost by postponing the discussion upon this paper until another evening. I recently took a run on a steam launch—fitted on the system advocated—a photograph of which is given here, and she certainly did very well indeed. The engines ran away, in spite of the governor, while the blades were being reversed, and there was naturally the quick and a slow point in the working of the engine, while in the act of reversing. With larger engines and machinery the gear probably could not be manipulated so quickly. The boat was about forty feet long. She was fitted with one of Messrs. Priestman's petroleum engines, and the gear was arranged beside the rudder. The reversing was done simply by a turn of the wheel. It was manipulated very easily and very readily by hand, but I cannot see my way at present to support the author of the paper in recommending the system for large engines. I should say there would still remain a great strain on the shaft in reversing added to the strain on the gear itself, aggravated by play, so that instead of doing away with the anxiety in connection with a possible breaking of the shaft, the anxiety would be increased on account of the possibilities in connection with the propeller gear. But very often ideas are propounded by men, after a good deal of thought, which bring about results little expected in the first instance; and although we may not approve the particular gear and its application, advocated in this paper, it is possible that the discussion may lead to some modifications which may be a great improvement on present methods, and one which may be adopted with advantage.

Mr. LATTA (Member of Council): The author, as I understand him, says that the engines shall always be run at the same speed, and that the revolutions shall continue the same all through, the speed of the ship being increased or diminished by altering the pitch of the propeller blades. The question is whether that will tend to economical working!

Mr. JAMES ADAMSON: I apprehend he refers to one ship, the engines of which, under normal conditions, make, say, 104 revolutions. But under certain conditions the number of revolutions requires to be reduced to 65 or 66. Now, the author says that in order to reduce your speed to the rate represented by 65 or 66 revolutions you do not require to reduce the speed of the engines, but you should alter the pitch of the propeller blades.

Mr. LATTA: Yes, but is that economical working?

The author also claims to do away with a good deal of gear in the engine room, but he gives you a lot more gear elsewhere, and you would want more engineers to look after this additional gear, it seems to me.

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After a closer examination of the models and diagrams, and some further discussion on points of detail, it was agreed that the discussion be adjourned until Monday, December 18th, and the HONORARY SECRETARY proposed a hearty vote of thanks to Mr. McGlasson for his paper, and the motion having been seconded by Mr. LATTA was carried unanimously.

INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION 1893-4.

President—W. H. WHITE, Esq., C.B., LL.D.

ADJOURNED DISCUSSION

AT

58, ROMFORD ROAD, STRATFORD,

ON

MONDAY, DECEMBER 18th, 1893,

ON A PAPER BY

MR. ROBERT McGLASSON,

ON

"SCREW PROPELLERS, REVERSING SCREW PROPELLERS AND NON-REVERSIBLE ENGINES."

Chairman—Mr. F. W. SHOREY (Member of Council).

The CHAIRMAN: We are met to-night to continue the discussion on Mr. McGlasson's paper on Reversible Screw Propellers. You are aware that the paper was read and partly discussed last Monday, and it was then decided to further discuss it this evening.

Mr. C. L. E. MELSOM (Member): After careful study of Mr. McGlasson's paper since it was read here on Monday last, I have come to the conclusion that although he has undoubtedly made a step in the right direction, still he is, with his present method, far too sanguine; but possibly much may be learnt by bringing the idea into the full light of criticism and discussion, and the ultimate result will, I hope, do justice to Mr. McGlasson and to all concerned.

A propeller whose pitch can be controlled at all times, and without going into dock, will be a great acquisition, and will enable ships to run more economically, as I certainly hold with Mr. McGlasson's idea, namely, that the pitch should be altered to suit the different conditions, such as a light or deep loaded ship, and running with or against a current. It is, of course, quite another matter whether in Mr. McGlasson's method this most desirable end has been attained; I understand that this method has been tried with success in small vessels, I do not think, however, that the same would hold good for any size of ship, especially very large ones, when taking into consideration that there are limits to the size of boss of propellers, inside of which the most important part of Mr. McGlasson's gear is placed, and when we consider the enormous strains that will be brought to bear upon this gear in heavy ships, and the limited space at disposal for gear of suitable strength, then we can form some idea of the suitability or unsuitability of the whole; besides, it goes without question that the factor of safety must stand very high, as, if anything goes wrong, it is out of reach for repairs until the ship is in dry dock, if she is lucky enough to get there; she certainly would not reach there under her own steam power.

The weakest portion of this gear, I should say, lies in the pins of the connecting rods, H, not that these could not be made strong, but that, as I said before, there are limits as to space, also that of the severe stress, which would be set up by vibration coupled with the heavy strain due to the blades of the propeller tending the whole time to feather; the wear and tear due to vibration would be excessive, as seen in the rudder pintles of all ships, and from which the gear cannot possibly be free; the fact that the blade sockets must be free working journals, and therefore loose, will tend to aggravate this; by the same reasoning the blades will also quickly become loose in their sockets and so make it impossible to stop the entry of sea water into the oil well and gear, so making the whole liable to becoming choked by marine growths. Should the pins or any of the gear break whilst the ship is on a voyage, then, undoubtedly, she would become entirely unmanageable, and to tow her even, would be a risky and delicate job. As I remarked before, that to repair this gear outside of dry dock would be impossible, and the great likelihood of breakdowns happening will go very much against Mr. McGlasson's present method.

I should say that to keep this gear efficient would give birth to many heavy bills, both for labour and material, as well as for extra dockings.

Ships going long voyages with few stoppages would likely tend to the blades getting set fast in their sockets by marine growths, and so become unworkable; this would be a very serious thing indeed, if, as the inventor suggests, the propeller blades were to be manipulated instead of the engines, the engines being constructed to work one way only.

I should very much like to know what Mr. McGlasson proposes to prevent racing of engines from any cause whatever; I think he should have made this point clear, instead of only referring to his claim in this matter, it is a vital point in his invention, as unless the engines are properly governed whilst manœuvring the ship, damage and breakdown will certainly happen; I know of no governor which would answer the purpose.

I do not think for a moment that any saving will be effected by applying this gear, and doing away with portions of the main engines, either in cost or weight, it is rather more likely that the cost and weight would be greater when we come to consider the fitting of necessary heavy hydraulic reversing gear and connections to the bridge of the vessel, and the increased size of propeller boss and connecting gear.

Mr. S. C. SAGE (Member of Council): With regard to the reversible-bladed propeller to work in vessels fitted with machinery working in one direction only, I am not aware if the inventor of this system and author of the paper claims that there is any economy in the construction, maintenance or working of same, but it seems to me that there is neither.

Propellers with feathering and altering blades have been before the world of Marine Engineering for many years, and I have yet to learn that they have been permanently adopted either in the Royal or Mercantile Navies, and especially the latter.

Considerations of first cost are always important factors in the construction of merchant steamers, and, in my opinion, always will be.

Many inventors have spent very large amounts of time and money in perfecting and placing before the world different specimens of their inventive ingenuity and mechanical skill with more or less success.

It will be within the memories of many present to-night that a host of so-called economisers have been produced of which only a modicum now survive.

Respecting the particular invention now under discussion, I beg with all possible deference to the inventor thereof to give expression to my opinion. In my experience I have always had the idea that all the connections of a ship's propeller, and the shaft that carries it, should be made as *fast* and secure as possible, as the coming slack of any part thereof is a very serious matter, and likely to cause damage more or less.

I have not had time to so carefully as I could wish peruse the paper and examine the drawings, models, &c., which are furnished by the author of the paper, and it is not clear to me how it is proposed that—in the case of a large ship—the propeller would be secured to the shaft.

If by a nut and key, as is the usual manner now prevailing, it would entail a prolongation of the boss so as to obtain sufficient bearing, as a good part of the boss, as shown upon the model, is appropriated by the cap cover at after end containing the crosshead and gear, which actuates the blades; and in the case of a four-bladed propeller, it would require to be even longer to contain the two crossheads, &c.

Looking at the model in a cursory way, it appears that some alteration in the width of the screw aperture of some vessels would be necessary.

I am very much afraid that the semi-revolving of the blades would not be so easily accomplished after a long and tempestuous voyage, upon which a good deal of racing had been experienced, as when the gear left the maker's hands.

It is, in my opinion, a very good rule that now obtains in the practice of marine engineering, viz.:—avoid complications, and make all working parts of your machinery as accessible as possible, which certainly cannot be said of the reversing gear now before us.

Much may no doubt be said in favour of the invention, but until it can be practically demonstrated that it effects a saving both in the first cost and working it will not in my opinion be a success.

For my part, I cannot see that there is any potent objection to the present starting and reversing gear of marine engines.

First of all there was the loose eccentric and gab gear, which was sufficiently quick for the old style of slow-moving paddle engines, and those of a similar type, working with multiplying gear on to the screw shafting, but with the advent of direct acting, quick-moving engines, something else was required, and the link motions come almost universally into use.

Many patent valve motions have been devised, but I venture to say that at the present day more than 90 per cent. of the steamers afloat are fitted with the link motion, not because it is by any means perfect, but because it has been found to be the best yet devised.

It will, I think, be quite clear to all who are present to-night that the reversible-bladed propeller and apparatus for reversing those blades could not be fitted to such vessels as our present Atlantic greyhounds at the same cost as the link motion with all its paraphernalia, and in the event of any accident occurring to either, it is plain which could be remedied in the easiest manner.

It is not an uncommon thing for eccentric straps to break, and every engineer knows how to repair the damage, at least in such a manner that the engines will work to propel the ship forward; but on the other hand, if anything goes wrong with the reversing rod through the shaft the whole machinery is disabled, and being situated in the most inaccessible part of the ship it is impossible to repair it except in a graving dock.

It is stated that the reversing gear of this system can be manipulated either from the bridge or the engine-room, but I need not point out to a body of engineers like this the complicated nature the gear would assume and the liability of it to derangement. Even with the engines moving before the eyes of the engineers it has been known that they were put ahead instead of astern, and *vice versa*, and when there is a double operation to perform—*i.e.*, start the engines and reverse the screw blades, therefrom confusion may arise.

Some people may say that there is a possibility of injury to large bodies of machinery when their motion is suddenly stopped and reversed, but this I maintain is a fallacy, for the action of the ordinary link motion in reversing is to gradually stop the machinery as it approaches the middle, and as gradually move it in an opposite direction upon reaching the other end of the link, and the reversal of these large engines is never attempted with all the steam on.

In my opinion, feathering propellers or those with blades which are not firmly fixed to the boss have not made their way yet, but the propeller that is firmly secured in the best possible manner is with us to stay, and the best proof I can bring forward as to this statement is to call your attention to the latest productions of naval architecture and marine engineering with which you are all familiar, and in none of these do we find feathering-bladed propellers.

Mr. G. W. NEWALL (Member): One of the chief objections to loose-bladed or feathering screw propellers raised by marine engineers is the pressure put upon the blades and transmitted to the journals or shafts when the engines are suddenly stopped. This sudden stoppage causes a nipping action to take place; and when it is desired to alter the pitch or reverse the blades of such propellers from the absolute angle of ahead to astern while the ship is still making almost full headway, an enormous resistance to turning the blades must be overcome by the mechanism within the boss and the gear connected therewith. At the same time the necessary smallness of the boss offers certain restrictions, and controls the sizes of the levers and pins, or the equivalent gear employed for this purpose. Take a vessel making 15 knots per hour:—On every square foot of blade surface there would be a pressure of about 350 lbs., as the blades would be drawn through the water at the rate of 25 feet per second, and, owing to leverage, this pressure would be considerably increased on the shaft or journal. The levers for reversing purposes must, therefore, overcome this strain produced by the way of the ship, when perhaps going at full speed, to avoid collision, for instance, and this fact, in my opinion, somewhat restricts the employment of such propellers to small ships, or at least to vessels where the horse-powers transmitted are small. At the same time, I am aware the author states that any ship, from the smallest to the largest, may be fitted with this system of propulsion. The proposal to drive twin screws by one shaft may carry certain objections, as the operating of either propeller separately for turning the ship and manœuvring purposes has its especial advantages. I think some of the details of the author's invention may probably be open to objection, as confidence in such propelling machiney is one of the most important factors with the engineer in charge, but the principles involved are worthy of our careful consideration. The subject of the paper is one of very great importance, and I am inclined to think the screw propeller, as we know it, is more or less neglected, and has not yet received an equal share of consideration as compared to the motor which is designed to drive it.

This is the age of economy, and we have left scarcely any holes or corners untouched to further improve the main and auxiliary engines, as well as to bring the boilers up to the highest possible efficiency, with the knowledge and materials at our disposal at the present day. The desideratum of marine engineers is to wring from his pound of coal the utmost energy possible; and while the machinery within the ship is perfect in a certain degree, from careful nursing and investigation, the propelling machinery, being the great power absorber, is still subjected to much speculation and rule of thumb, and it is only fair to both ends of a system to deal with them equally. If we are just in taking care of our pound of coal in the engine-room, we should endeavour to obtain the best result possible from the propeller side of the question, after due allowance is made for friction of shafting or other equivalent means of the transmission of power between the producer and absorber. The system advocated, to my mind, is an attempt to reduce a theoretical requirement to a practical possibility, and I think the object of the author in introducing to our notice a new form of screw propeller and system for operating same is a very laudable one, for the simple reason that it is an attempt to further economise our pound of coal, and lessen weight and space occupied by the motor, as well as reduce the number of working parts to a minimum. The arrangement appeals to me as constituting a variable mechanical spring, disposed between the work done by the propelling mechanism and the power applied, endeavouring to fill a gap in one of our most important systems of steamship propulsion. How far the author will succeed remains to be seen, as in nearly all new applications of mechanics prejudice and orthodoxy are the fiercest opponents, and one of the greatest difficulties of an inventor is to get engineers to leave the rut. All reasonable encouragement should therefore be given to any application of mechanics that tends to raise the economy of propulsive energy to its best commercial value, whether the energy is to be employed to drive a 10,000 ton vessel, a railway train, or a sewing machine.

Mr. GREER (Member): I have not read the paper, but I have looked at the model, and although I am very much averse to condemning anybody's invention, it is certainly my opinion that this is an impracticable system. The model looks very well; but I think the mechanism is altogether out of proportion, to say the least of it. I think the system impracticable.

The CHAIRMAN: From what has fallen from some of the members, they seem to think that Mr. McGlasson has not made any provision for checking the racing of the engiues while the blades of the propeller are being reversed; but, as a matter of fact, he has provided a throttle valve here, which is operated by a connection with the reversing gear, as shown on the diagram.

Mr. SAGE: That can be very well understood; but I should say that the most mechanical way to overcome that difficulty is to stop the engines before you reverse the blades. and so avoid that complicated arrangement leading from the reversing gear to the throttle valve It would be madness to depend upon an arrangement of gear connected in that way acting simultaneously. Shut off your steam before you reverse. It would require twice as much power to turn the blades with the engines going as with them stopped. Try the model. It is well known that in manœuvring a vessel into dock, or up a river, you sometimes have to "stand by" for ten minutes between the orders. Surely you would not have the engines going all that time and consuming steam, but with the propeller blades inoperative.

Mr. MELSOM: I do not think that Mr. McGlasson has mentioned in his paper the method of throttling.

The CHAIRMAN: He shows it in the drawing.

Mr. J. H. THOMSON (Chairman of Council): There were several cards sent here inviting members to see some experiments with this system, and I regret very much that so few of our members attended. I was unable to get there, and, if I mistake not, Mr. Adamson was the only one who went. At our last meeting he gave his experience of that trip, which was very satisfactory indeed. I may have got old-fashioned notions, but I must say I have a certain amount of prejudice against this arrangement, because of the complicated nature of the gear that would have to be employed. It is my opinion, and it is, I believe, the general opinion of those who have made long sea voyages, that for such voyages you cannot have the blades of the propeller too solid. My experience has been that if there is not an equal strain on each of the blades when you leave dry dock, you generally find it out when you return. However nicely and sweetly this model may work I do not think I should care to trust myself with such an arrangement on a long sea voyage I have no doubt that Mr. McGlasson has studied the proportions well, but my experience goes against it. It might be well enough in smooth water, but with the weather you are likely to have in the Bay of Biscay or crossing the Atlantic, it would be all to pieces in the course of a few days. The Chairman referred to the provision of a throttle valve for preventing racing of the engines when the reversing gear is being operated, but I cannot see in the drawings any provision whatever for preventing the ordinary racing of the engines in rough weather.

Mr. JAMES ADAMSON: You still require a governor in the engine room in the ordinary way, in addition to this connected to the throttle valve, I apprehend.

Mr. THOMSON: One of the previous speakers mentioned a case when you may have to stand by for ten minutes without an order. If the propeller blades are kept revolving during all that time do you not think that they must have some effect upon the stern of the ship. You would find that the stern of the vessel was surging round. The disturbance of the water would do it, and you would never get these blades to perform in a dead straight line. I am certainly under the impression that this system is not suitable for sea-going or ocean-going ships. With regard to the novelty of the idea, I have got one of our young members to turn up Bourne's Treatise on the Screw Propeller, and if you will allow me to refer to the book, I will give you some of the dates. In 1844, Woodcroft invented an arrangement, somewhat similar to that under discussion, except that instead of having a large boss, we had the gear working outside in the water. Here we have the clutch and the levers for twisting the blades, only they were not inside the boss. The lever is attached to the outside of the blade, and of course that is very objectionable. That was Woodcroft's idea in 1844, so that there was something coming pretty near to Mr. McGlasson's system then, and there have been half-a-dozen different arrangements brought out since. In 1845, there was Oxley's propeller--an expanding propeller he calls it—and if we object to Mr. McGlasson's method, there is ten times more objection to this. In 1845, Hays also brought forward a propeller which seems to come very near Mr. McGlasson's idea. The gear in this case appears to be inside the boss. In 1847 we had Macintosh's propeller; but an unfortunate feature of that invention was that, although he reversed the engines, he never reversed the motion of the ship, which always went ahead. Griffiths, in 1849, introduced an arrangement very similar to Mr. McGlasson's; he had a large boss, with the levers inside. In 1851, Woodcroft brought forward another propeller in which the mechanism was also inside the boss, so that there is not so much novelty about the idea as one would suppose on first reading the paper. Now that we have been speaking against the system, I should like someone to point out its good poiuts. It is very unfortunate that the author of the paper is not able to be with us, and the discussion, I think, has become a little bit one-sided.

Mr. SAGE: With regard to the good points of this system, the only instances in which I think it might answer would be in the case of small vessels, driven by spirit or petroleum engines. Those engines are non-reversible and the reversing of the propeller is done by means of gear. They must not stop those engines, and when they want to stop the propeller they just throw the clutch out of gear and let the engines run round as slowly as possible. This plan of Mr. McGlasson's would be very suitable, possibly for boats with engines of that class, and for such vessels as do not go into moving water, that would throw unequal strains on the blades.

Mr. MELSOM: I should not like to have to take a large ship into moorings like those of Calcutta with a propeller and gear of that sort.

The CHAIRMAN: I notice that we have some strangers with us this evening. I may say that this meeting is quite open, and we are always glad to have some fresh ideas. I notice two gentlemen here from the Danish Mercantile Marine, and we shall be very pleased to hear any remarks from them. Will Mr. Levering favour us with his views?

Mr. LEVERING: I cannot speak English sufficiently well.

Mr. MELSOM : I have asked Mr. Levering and the other gentleman their opinion of this system referred to in the paper, and their opinion is distinctly unfavourable.

Mr. LEVERING : I do not think that it will be any good for a ship of any large size, or for a ship in the Atlantic trade. The propeller is fitted with only two blades, and if one of them should carry away at sea the consequences might be very serious. No marine engineer requires to be told that a propeller with only one blade is next to no good. I also think that the blades would very soon work slack on the boss.

Mr. GREER : Of course, if a propeller is fitted with only two blades and you lose one it would be very awkward. But I have heard it remarked that this plan can be applied to propellers with four blades. I should like to know, however, whether the four blades are put on one boss, or whether there is one boss behind the other?

Mr. NEWALL : I think that Mr. McGlasson's idea in this matter is to decrease the diameter of the propeller considerably. It is a kind of orthodoxy that for a very big ship you must have a very big propeller, but I believe that what Mr. McGlasson is aiming at is, to have a simple single-acting engine to go only one way, and to bring up the revolutions by hundreds. His idea is to run at 400 or 500 revolutions, and to reduce the whole of the machinery and gear from the coal bunkers right away to the propeller. We know, as a matter of fact, that to-day we are using the best and biggest part of the ship for bunkers and machinery, and the idea seems to be to bring the engines down to smaller dimensions. That being so he puts another phase on the subject. Of course there are objections to some of the mechanism which he employs, but I think we ought to deal fairly with the arrangement, and see what can be made of it.

A MEMBER : Are any of the Bevis propellers in use now?

Mr. NEWALL: I do not know.

Mr. GREER: With reference to what Mr. Newall said about a small propeller, it is a most objectionable thing to have a small propeller in a large ship, you want a large propeller—as large as possible. I know some ships that are running now with the propellers that are too small. The great objection is that they are not large enough in diameter, and owing to the construction of the ship they cannot be made larger. It is right enough to run the engines quickly, but you want a propeller big enough.

Mr. J. H. THOMSON: I do not think that Mr. McGlasson should be too eager about getting a non-reversible engine, because in the event of these blades getting jammed, or the gear getting fixed so that you could not move them, the best thing to do would be to reverse the engines in the ordinary fashion. It would be far better to have a reversible engine, because it might help you out of a difficulty.

Mr. SAGE: Then why all this special gear?

Mr. MELSOM: Mr. McGlasson distinctly remarks in his paper that he tested the question whether the diameter of the propeller had anything to do with its efficiency, and he says it had not.

The HON. SECRETARY: The model of Mr. Newall's propeller arrangement is here, and it would be well to have the result of his experience with reference to it.

Mr. NEWALL: This is a model of "Newall's Patent Feathering Screw Propeller." It was patented in 1879 by my father and myself, and fitted to one of Messrs. Forrestt & Company's torpedo boats. The model which I have here disconnected represents on an inch scale a 15-feet propeller, and includes a large hollow boss about two-sevenths the diameter of the propeller, which is bored at right angles to the line of tail shafting for bearings to accommodate a large solid cross head, and carrying the flanges on the outer ends for fixing the propeller blades to, which is done in the usual manner by studs and nuts. The holes in the flanges of the propeller blades are made slightly oval to accommodate altering pitch. The cross head carries two short arms, which fit into corresponding openings through the forward end of the boss, and each arm is fitted with a roller for running on to an oblique-faced cam fixed to the stern post of the ship. The action of the blades when the propeller is revolving is to feather the blade to little or no pitch coming up over the shaft into what is termed slack water, while the blade descending below the shaft is at the same time feathering to a greater pitch. The work done by the propeller is thus in the more solid water below the shaft. At every revolution an action similar to that made by a fish's tail when swimming takes place, due to the cam on which the rollers run to operate the blades. The boss is in halves and secured by four large bolts. The pitch in this model can be altered from five feet on the top to 27 feet underneath, and the pitch of the blades may be altered by adjusting the oblique face of the cam more or less at right angles to the line of screw shafting. This propeller, as I have said, was fitted to one of Messrs. Forrest's torpedo boats which I believe had been rejected for want of speed. The propeller in question was the fifth one that had been fitted, and on the trial trips which were run for three days on the measured mile, gave a speed of nearly two miles per hour over that given by either of those fitted previously. But it was found that after about 40 hours' run the gear for operating the blades was considerably cut up and fearfully scored by grit and sand having found access to the working parts of the propeller. Another propeller on this principle was fitted to Messrs. Lester and Perkins's steam launch for general use in the Royal Albert and Victoria Docks, and was running for quite 18 months, although the gear in the propeller boss was very shaky, judging by the noise and rattle sent along the shaft to the engines. The failure was due in all cases to grit, &c., floating in the water, and quickly destroying the fit of the parts of the mechanism contained within the boss. If you can only maintain the mechanism the theory of the propeller is good, but in the case of the torpedo boat, it had worn itself out in some 40 hours.

Mr. J. H. THOMSON: That is the one great objection I have to Mr. McGlasson's propeller. It will not stand the wear and tear.

Mr. NEWALL: The action of Mr. McGlasson's propeller is brought about by different means, and it has not the same objects as the one I have just shown you. The object of Mr. McGlasson is to reduce the machinery and propeller, and run them at a higher speed. If you are transmitting, say 10,000 horse power, through 60 revolutions, Mr. McGlasson's proposal is to transmit that same 10,000 horse power through, say 600 revolutions, by means of lighter machinery.

Mr. MITCHELL (Member): With reference to one point that was referred to by Mr. Thomson, I do not think that the effect of the propeller upon the steering of a ship is generally known or understood; but it is a very important point. If you turn the engines astern the ship will go to starboard with a right handed propeller, and *vice versa* with a left-handed propeller. This is a matter which is not sufficiently recognised.

The CHAIRMAN: This paper has given rise to a very interesting discussion. From Mr. Thomson's remarks I gather that Woodcroft, in 1844, brought out something similar, and that Griffiths, in 1849, also brought forward a similar idea, so that there is not very much novelty about Mr. McGlasson's system. At the same time he has taken great pains to make the subject clear. Mr. Newall said, he thought Mr. McGlasson's idea was to reduce the engines in size and run them faster. But we know that if we have a ship of a certain tonnage we require a certain power to force it through the water. The shaft must be in proportion to the tonnage, and the engines must be in proportion to drive that shaft and the propeller, so I fail to see how Mr. McGlasson's system would be the means of reducing the dimensions of the engines in any way. You must have the power to do a certain amount of work. You may run the engines fast or slow, but if you run them much faster you would require heavier engines. I cannot follow Mr. Newall's argument on that point at all. Great credit is due to Mr. McGlasson for the manner in which he has brought his idea before us. I think with Mr. Sage that the system might do for small boats with oil engines, but I do not think it is suitable for sea-going ships.

Mr. Greer: I do not follow the Chairman with regard to what Mr. Newall said. I cannot agree with him there.

Mr. Sage: Torpedo boats are fitted with a greatly reduced weight of engines and boilers, but they develop a great amount of power, as is proved by the fact that they propel the boats at a speed of 24 or 25 miles an hour. There is nothing that has been more experimented upon than the screw propeller, and there is nothing, in my opinion, that will better repay further experiments and research. It certainly does not seem that we have got to the end of the matter yet.

The Chairman: The meaning I intended to convey in my remarks was that it would be necessary to have the screw shaft and the propeller of certain dimensions, to drive a heavy ship through the water. With regard to having lighter engines and running them faster, you all know how much we have increased our piston speed of late. Do you advocate increasing it still further? Do you think we should gain anything? Do you think there would be any economy? It is Mr. Glasson's idea that we should save fuel by running at a higher rate, but I think we have already attained almost the highest rate of speed it is desirable to run at. Look at the piston speed we are getting now. Why, it would surprise some of our forefathers.

Mr. SAGE: Mr. McGlasson does not mean 600 revolutions of a six-foot stroke, but a short-stroke, quick-running engine. I do not believe in short stroke myself.

The CHAIRMAN: It seems to me that the general opinion taken by the members who have spoken of the idea which Mr. McGlasson has brought before us is that it may be suitable for very light engines, river boats and light craft, but that at present it would not do for large sea-going vessels. I think that that is pretty well the general opinion we have arrived at, judging from the discussion of the subject.

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MR. McGLASSON'S REPLY.

The great success which has attended the application of my system, since the reading of the paper thereon before the Institute of Marine Engineers, enables me to compliment the gentlemen who spoke and wrote in its favour, and to reply with a light heart to the "doubts" of the (possibly) prejudiced.

Should the reader not be in present possession of a copy of the paper, he will find it reproduced in *The Steamship*, February, 1894, pp. 289 to 292, and abstracts thereof in all the leading technical journals at about that period. The first publication of the discussion in a technical journal appeared in *The Steamship*, of February, 1894, pp. 294 to 296. A preliminary reply was kindly permitted to appear on pp. 310 to 312 of the same number; and I should be glad if anyone interested would reperuse the paper itself, and also that portion of the reply, as it will avoid the necessity of my referring at too great length to some of the points therein mentioned. I am happy to say that the views enunciated in the paper have been, so far, corroborated in every particular, after three years practical experience of the working of my screws and gears. They have been applied, as auxiliary power, to a large sailing ship, are on order for trawlers for the North-east Coast Fisheries, and have been running on Continental waters for some considerable time and on a very fair sized scale. The right of manufacture for practically the whole of Europe and the Far East has been secured by eminent firms, after careful enquiry and actual trial with every satisfaction. I take this opportunity of sincerely thanking the very many gentlemen of many nations who have honoured me with their encouragement and my system by their approval. I have also to express my obligations to the engineers who have so ably assisted me in the development of my ideas.

I will now shortly touch upon the few remarks in the now published discussion which merit further reference, taking up the points as they occur.

(*The Chairman*): Either a coarse or a fine pitch can be applied at any time under my system, to suit conditions.

(*Mr. Beaumont*): My Licensees report, that with our blades there is no practical difference in the efficiency of the go-astern angle.

(*Mr. Melsom*): Complete and simultaneous government is a point in the invention, and is fully provided for.

My screws are too active for barnacle fishing, and are internally lubricated. The ferry boats referred to are not handled on the same principle. If that system is admitted to be very handy, mine is much handier and safer.

(*Mr. Robertson*): We find nothing of the sort occur, even under stiff conditions.

(*The Chairman*): With hydraulic gear, the locking of the water in the cylinder will hold the blades at any angle. With some other gears a screwed counter-shaft is employed to maintain the lever in position. The holding, &c., gear is always suited to the particular case. It will not take as much power as the ordinary reversing gear. But even suppose it did? you would gain anyway. "On coming into a river," &c., the whole power of the engines often has to be employed, and sometimes suddenly. You do not require a lot of gear, and the *Calliope* is appealed to as an absolute proof that loose-bladed propellers can be put to the hardest work on a large scale. As to my suggestion for single-acting engines, if the reversing gear of the present engines gets broken or adrift you could not reverse. The latter is more likely than the other. The experiments as to a constant power (which is hardly ever seen on steamships) operating "surface" at varied revolutions are obvious as regards intention, and proved valuable. Will the Chairman kindly re-peruse the paper?

Mr. Adamson will note remarks elsewhere as to the object of the particular experiment.

The boat on which Mr. Adamson took a run was not fitted with my special governing gear at all, but the running away while reversing was slight in this case, and the builders were willing to depend upon the ordinary oil-engine governor. The strain is, in my gear, only varied in amount from ordinary to minimum, and is not changed in direction.

(*Mr. Latta*): If desired, speed of rotation could be automatically varied by my gears while reversing. By my gears you also alter the power employed as you alter the pitch—even while reversing; and, as regards keeping up the revolutions under certain conditions while running, you can at times gain by bringing the developed propulsive action more in the plane of motion of the vessel, &c. The gear I add is nothing like what

I remove, and mine is only in operation when it is required to do actual work, and will give far greater satisfaction to the intelligent engineer, with less manual labour.

ADJOURNED DISCUSSION.

(*Mr. Melsom*) : I am happy to say that the practical results so far attained in no sense indicate that I have been too sanguine. I am obliged to Mr. Melsom for expressing the opinion that I have made a step in the right direction. In no case do we increase the size of the boss to the detriment of area of blade effective for propulsion—as I have proved in the paper. This has also been borne out in practice. The gear is relatively stronger than the tail-shaft itself, considering the real work it has to do, which is much over-rated. Doubtless Smith and Ericsson were told the same thing as to the shaft itself! The propeller, if properly balanced, &c., and pitched to suit the conditions, does not tend to feather as might be anticipated. My experiments have proved this, as will be seen by the Paper. Experience, also, proves Mr. Melsom's fears to be imaginary as regards my properly-fitted and lubricated propellers. I am not permitted, as yet, to freely illustrate working details, or I would soon convince all doubters thereby ; but they can at least rely upon, and believe in, ascertained facts. Many of this gentleman's doubts equally pertain to all other present machinery of the ship. Let him apply my system to a twin-screw ship and convince himself. He won't give the blades time to set fast by marine growths, for he will turn his attention to making the developed propulsive action suitable to the ever-varying conditions at all times. I have already stated that the whole is efficiently governed. Should oil fuel ever be used, you can even automatically and simultaneously govern the supply of that, or regulate the fans controlling the draught, by attachment to my gears or connections, such as rod V in the diagrammatic sketches—as mentioned in one of my patents.

The extra attachments would be less, and the frictional gear removed far more than anticipated.

(*Mr. Sage*): There will be less of constantly working machinery in the engines;—but half the eccentrics; and no reversing gear with a large number of continuously vibrating points requiring lubrication, &c. I could go on with very many further arguments in favour of the system, but it would pay to fit it for the simplification and extra efficiency of the engines and screws alone, combined with the safety of always turning everything—screws included—in one direction. You can never improve screw propulsion unless you render the only thing that acts in and upon the water capable of alteration as to its developed propulsive action; and the "loose-bladed" type (for altering the pitch in dock only) is already in use in the mercantile marine. "Built" propellers are quite as strong—and can be made stronger—than the so-called "solid" ones. What better proof is required than that of the *Calliope's* "built" and "feathering" propeller? We have proved the new system to be safe, practicable, and very desirable in every way; and my manufacturing friends have well and practically assured themselves of the fact. Reversal of everything, as at present effected, means strain and change of direction of stress; and Mr. Sage will admit that shafts are sometimes broken thereby. Navy practice with the link-motion will sometimes, in modern warfare, be very gradual indeed, and there is less chance of my system failing under such circumstances and high revolutions than the present one. I take leave to inform Mr. Sage that when we have overcome our little prejudices, the propeller that is "secured in the best possible manner"—viz., that which will at last render it capable of *suiting* any condition while running. &c.—"is with us to stay." The "latest productions" are "loose" and "alterable"—to a certain extent—*in dock*, which is very much under "half doing a thing." Mr. Sage must try my system.

(*Mr. Newall*): You need not stop the engines under my system, if you do not absolutely desire to do so; that is, you can nullify the way of the ship without stopping the engines. None of the difficulties mentioned by Mr. Newall occur in real practice with our properly designed and proportioned reversing propellers. We could safely and without loss of effective space (see paper) convey very considerably more than the thrust-block pressure through the shaft were it needed, but nothing approaching it is required. If Mr. Newall knew all, he would dismiss his doubts, and "look only on the credit side," which he can so well appreciate. The strength is child's play to modern engineering and material. Twin screws may be driven by my system by one engine-shaft and two tail shafts, and the gears be made to operate the blades of either screw independently. Mr. Newall has evidently studied my paper carefully, and I am greatly obliged to him for it, and for his kind appreciation and encouragement.

Mr. Greer admits that he has not read the paper, but he has looked at the model. He says it "looks very well," but thinks it impracticable. The exact counterpart of that model has been in practical work for over three years now.

(*The Chairman*): Valve, valves, expansion, or suitable gear.

(***Mr.*** *Sage*): Instead of "most" read "least." The complete gear cannot help acting simultaneously. The inference as to power required—with blades properly designed and revolved—is altogether wrong. There is nothing to prevent you turning off the steam or temporarily slowing the revolutions, if you wish to do so at any time. Have the power always available to the hand—or instant direction—of the man who knows what wants doing, and can then and there do it—or *see* it done—instantly and without risk.

Mr. Thomson admits it is "prejudice." Ours is the only correct way of equalizing the strain and letting the blades assist in balancing each other—with most beneficial results. The proportions, &c., are made suitable to each case. Only diagramatic sketches accompanied the paper, though some of them gave practical notions as to proportion. Did the *Calliope's* screw "go to pieces" in one of the fiercest gales ever known, and in which all the other war ships were lost? Commander Kane was not one of the "doubters," and saved his ship where he had over 4,000 horse-power on a "loose-bladed"—two-bladed screw.

As I said before, you can always stop the engines if you want to do so.

All self-respecting ships worthy the name, will, for very obvious reasons—especially if likely to be chartered by Government at any time—shortly be twin screws, and if you fear canting you may have them fitted to run right and left handed. But we have found no difficulty in manœuvring single screws up to piers, &c.

I am afraid Mr. Thomson does not quite grasp the theory and action of my *complete* system. I am quite aware of the feathering screws mentioned; but my system combines propellers, with loose, moveable blades of practical make, so constructed as to change pitch and properly propel over all desired arcs, with special gears, governing gears, non-reversible engines, and every necessity for safely reversing and operating while engines are running, &c., &c. Will Mr. Thomson kindly read the paper again?

Mr. Sage seems to indicate that the direction of motion of all machinery *ought* to be reversible – it is not so, say, in watches, in the main engines of manufacturing mills, or the universe. Such seems to me false engineering. Reverse the direction of motion of nothing but the ship, and gain in every way. He need not fear our unlumbering, quick-running, comparatively light, though relatively stronger, well-balanced propellers. The only wonder to me is, that any wise man should continue to persist in using the present fixtures of inefficiency.

(*Mr. Melsom*) : Try it with twin screws on my 'system, worked from the bridge.

Mr. Levering is erring on the point he refers to, as it is already on a ship of large size; also, the *Calliope* had but two blades, but if three or four be desired, my system and gears will accommodate them (see wording on large diagrams). Our double-cone and centre-bearing arrangement prevents slack working of any kind. We can accommodate Mr. Greer with four blades in one boss, if desired, or three either; but he might do worse than employ two. They don't "lock up" the water, under stress of weather, so much. (Some of the four are sometimes broken off—" under stress"—by " natural causes.")

(*Mr. Newall*) : You might well run fairly powerful mercantile machinery at (say) 200 or 250 with advantage, and a short and quick stroke will save much surface condensation in cylinders, &c. Begin at that, and (as Mr. Newall says) reduce the whole weight right away to the propeller.

(*A Member*) : Yes, but they are only intended for feathering for sailing purposes, and are only moved, with engines stopped, for placing the blades in position for sailing. But they have conclusively proved the safety of out-board holding gear for loose bladed propellers on large ships, and that for very many years.

Mine also alters the pitch and developed propulsive action to suit conditions at any moment, while running, and without stopping the engines—let alone reversing, altering speed, stopping and steering (with twin screws) direct from the bridge, the engine room, or any part of the vessel—with safety and the highest economy.

I would advise Mr. Greer to change his idea with