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On: 05 November 2014, At: 03:34

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered

Number: 1072954 Registered office: Mortimer House, 37-41

Mortimer Street, London W1T 3JH, UK

Royal United Services Institution. Journal

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rusi19>

A New Adaptation of Screw-Propulsion

Rear-Admiral J. Aylmer Paynter

Published online: 11 Sep 2009.

To cite this article: Rear-Admiral J. Aylmer Paynter (1874) A New Adaptation of Screw-Propulsion, Royal United Services Institution. Journal, 18:79, 527-535, DOI: [10.1080/03071847409427096](https://doi.org/10.1080/03071847409427096)

To link to this article: <http://dx.doi.org/10.1080/03071847409427096>

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cals of France. A little way off, was the English table covered with English professional periodicals and newspapers, and so on throughout the principal maritime countries of Europe. The Russian Officers, who are capital linguists, follow out the practice of reading and studying all that is of interest professionally connected with the different countries of Europe. It is a capital system, and I cannot see why we should not imitate it. It would be a great benefit to have the French system of periodical discussion, for in that way the history of the Navy would be better known among Officers than it is at present, and also to adopt the Russian system which would give us a large professional library and reading-room at each of the dockyards—Portsmouth, Devonport, Chatham. The number of naval Officers on the active list is being reduced to what is called a peace establishment, incapable of sudden expansion in time of war, except by the absorption of the few Officers in the Royal Naval Reserve—all the more reason then why every pains should be taken to afford this reduced number opportunities for improving themselves in every branch of their profession. If the quantity is to be small, very small, let the quality, at all events, be not merely good, but be the very best.

The CHAIRMAN: I must remind you that although there is not exactly a paper to follow the one just read, Rear-Admiral Paynter is to bring before us a new description of screw-propulsion. Before, however, proceeding to that, I have only the usual duty to perform of expressing our thanks to Mr. Laughton for the paper which he has brought before us. It is one displaying great research, and I am sure is one that will be valued in our Journal, which is distributed, as you all know, among so large a number of Officers. I should like to make one remark, and I do so because my friend at the head of the Naval College is here to-night. He and Mr. Laughton evidently attach much importance to the study of naval history. Now I will not say one word in disparagement of the study of naval history, but I think we should be glad if Sir Astley Cooper Key could tell us, how gentlemen who are studying at the Royal Naval College,—considering the extensive programme of their studies, and the great mass of subjects they are expected to master,—are also to find time, however able they may be, to produce a paper such as that which we have heard read to-night. It is evidently a paper requiring great study and research; and although I trust our young Officers may study naval history, I hope also that those who have to direct their studies, will so arrange matters that they may be able to find time to give due attention to that most important study. I have now only to express, in your name, our cordial thanks to Mr. Laughton.

A NEW ADAPTATION OF SCREW-PROPULSION.

By Rear-Admiral J. AYLMER PAYNTER.

BEFORE I proceed to explain the new adaptation of screw-propulsion by means of the working model and diagrams before you, I beg to tender my thanks to the Lecture Committee of this Institution for their readiness at so short a notice in granting me this evening for the purpose of doing so, and at the same time to express my sincere acknowledgments to this distinguished company for the honour and courtesy of their attendance after listening to the able and eloquent lecture from Mr. Laughton on "The Scientific Study of Naval History." Under these circumstances I shall endeavour to be as brief as possible in my explanatory remarks, and after I have finished, I hope the Chairman will invite some of the able and scientific Naval Officers and Engineers present, to be good enough to afford the patentee the advantage of

their critical judgment as to the merits or demerits of its claim to the notice of the maritime world. In asking your unprejudiced opinion as to its usefulness I do not for a moment depreciate, but hold in the highest estimation, the present magnificent instruments of England's naval supremacy, the paddle-wheel and stern-screw, which have raised our steam Navy from 400 ships in 1849 to 3,000 in 1874; from 100,000 tons in 1849 to 2,000,000 tons in 1874; have increased the number of our seafaring population employed in steam navigation from 8,000 to 68,000, and by the aid of their mechanical power, our eminent astronomers and electricians are now being conveyed to the most distant points of the earth's surface in order to watch the transit of Venus across the sun's disc next December. On the contrary, the principle of propulsion is the same in both cases, and it is only in the application, that the difference will be discoverable, and may possibly be deemed by you an improvement after my explanation.

It was stated by Mr. Griffiths, when lecturing here on his bow-screw in June last, that "If any further advance is to be made in screw-propulsion it must be sought in the manner and position in which the screw is to be applied to the ship; in fact, we know very little about screw propelling, and there are a great many things to be found out as to the effect of the resistance to bodies moving through water;" and Captain Hoseason, R.N., remarked, "We certainly are arriving at a rather a dangerous point of length in our ships, unless we have some new kind of screw propeller." The central wheel may supply these wants.

This system of screw-propulsion has been patented by Mr. J. Buchanan, of Catrine, Ayrshire, now resident in Bath. Old age renders him unable to push the claims of his patent before the public, and he has requested his brother, Mr. James Buchanan, to dispose of it. He is no engineer, like his brother, nor does he profess to be a mechanic; he therefore begged me, as a friend, to work the model and give him my opinion as a steam Officer on its merits. After examining the model and working it in a small tank, I told him there were two points on which I could not feel sufficiently satisfied to give an opinion, viz., firstly, that the speed would be as great as that obtained by the stern-screw of proportionate area; and secondly, that he must not take my opinion as to strengthening the ship; though in the present advanced state of iron-ship building with its transverse, longitudinal and bracket systems of framing, I saw no naval engineering difficulties, but that he must rely on the judgment and professional skill of ship-builders and naval engineers as to their ability to construct ships to work the screw-wheel. With regard to its speed, that could only be practically proved after repeated experimental trials with a model large enough to be worked on a river, for, unless the patent secured a high rate of speed at a moderate expenditure of power and fuel, so as to equal the speed of our present screw-propeller on the same consumption of coal, it would be hopeless to expect the system to be generally adopted in ships of war, passenger, transport, or swift commercial vessels, though it might be usefully and economically employed on canals. With the usual sanguine feeling

Fig. 2.

Section.

Shewing Wheel
with Blades

Fig. 1.

Elevation

of an inventor, he asserted that the speed would be greater with a less consumption of fuel, and he showed me letters, regarding the invention, from some eminent ship-builders. One from the firm of Messrs. John Hall and Co. says that they "saw no difficulty in strengthening the ship by girders on this principle to become stronger than the present ones, and took a most favourable view of the system as a probable considerable saving of fuel and cost in navigation." Also one from Mr. Hutchinson, engineer at the Elswick works, Newcastle, who writes: "I have had sufficient ship-building experience to enable me to do away with all the engineering objections which may be raised, and I can see many important advantages." The large steamship owners, Messrs. Nixon, Howard, and Co., and Messrs. John Holman and Sons, write as follows: "Have seen the model at work, and think we shall see the day when it will be generally adopted by steam-owners." Having thus far cleared my conscience from advancing statements which I might not be able to prove, I experimented with the model, applying the working power (a clock-spring) by turns to the wheel in the centre, and the screw in the stern, and I am bound in honour to say, that the speed developed was in neither case "as swift as a hare or as slow as a tortoise." But in all the trials, the screw had no superiority over the wheel; though in both cases the speed was decidedly slow. I tried her at her lightest draught, at her load water line, and heavily weighted, her deck just above the water line. I found no difference in speed in the two former cases, but naturally less speed in the latter, 120 revolutions giving a mean rate of one knot; but that I account for by the amount of friction generated by so small a model, moving in a trough only 20 inches in breadth and 11 in depth, worked by clockwork of very limited power, which made it impossible to obtain any satisfactory result, such as might be expected with a larger model with proportionate steam and propelling power working on a river.

The diagrams on the wall are from sketches of my own, and only profess to show the wheel and the mechanical arrangement of the levers to work the blades; they are not drawn to scale, but the wheel is supposed to represent one of 20 feet diameter, including the blades, fitted to a vessel of 2,500 tons, 40 feet beam, drawing 16 feet water, as shown in the plan, Diagram No. 2, and by the model on the table; Diagram No. 1, represents a vertical section of the face of the wheel, showing the levers, arms, and blades.

Diagram No. 2 shows the circumference of the wheel, the main shaft, the position of the blades in their three positions of rest, and the movement of the vertical lever which controls the movable collar on the main shaft, and consequently the movement of the blades. It also shows the side view of a wheel carrying six blades. The wheel is of wrought iron, and deep enough to inclose the mechanism, which is protected by a cone of light sheet iron. The whole of the machinery can be made of good wrought iron except the collars, stuffing boxes, and glands, which would be of gun metal, thus causing a great saving of weight and costliness over the present screw and its shafting. The trunk, hydraulic lift, disconnecting gear, and thrust posts are not shown, as they are of no

consequence in pointing out the principle of the propeller's action. The screw wheel, you will observe, revolves in a transverse chamber or well, built as near the centre of the ship as convenient, communicating freely with the water under the bottom by means of an aperture through which the screw-blades work. The wheel which carries the blades on its circumference, revolves entirely in the still water in the transverse chamber, and consequently offers no resistance to the water over which the ship is gliding, as it continues to cut a canal for itself equal in weight to its own displacement, and in size equal to the immersed area of its midship section. This chamber is regulated in its thwartship's length by the diameter of the screw-wheel and blades, and in its fore and aft length by the pitch of the blades. The breadth of the aperture at the bottom, is governed by the extreme pitch, and its length, by the length of the blades. In the model which I worked, and which is now exhibited at Liverpool, the transverse bulkheads have large waste water-pipes opposite each other, but in my opinion they will be found not only useless but detrimental to the speed of the ship, being simple tunnels to convey to the chamber a body of water having a velocity equal to the speed of the ship, which water, striking against the screw-wheel, must find its exit by passing under and around the wheel through the after waste pipes, offering great resistance. If any tubes are used in the chamber, they should be placed high up in the centre of the bulkheads, far above the water-line, so as to assist in ventilating the decks and engine-room when the screw-wheel is in action. The bottom of the vessel, for about 30 feet before and abaft the aperture, is built slightly concave, so as to enable the water to have free access to the screw-blades as they grip the water, and to allow freedom of passage under the bottom, to the used-up fulcrum-water—a system of framing of questionable utility. The wheel can be of any diameter, according to the requirements of the ship; a vessel of 40 feet beam could easily carry a 20 feet wheel, including the blades, which would offer no resistance in its revolutions save from friction, whilst a screw of that diameter offers great resistance, for Mr. Griffiths's experiments have amply proved that only a small portion of the area of the screw is really efficient as a propelling power. The wheel ought, therefore, to be worked at a lower speed, at a less consumption of fuel than a screw of proportionate diameter, to give the same results, and the pitch of the wheel-blades could be always angled in accordance with her trim. The short axle shaft of the wheel passing through its block in the bulkhead is connected direct to the cranks of the engines placed before or abaft the wheel, as found most convenient for trim or stowage, and only one engine need be used on ordinary occasions, the wheel acting as a flywheel to carry the engine over the dead points of the centre. If iron is used, wooden ships must be sheathed with zinc, as it does not injure iron.

The screw-blades are secured to powerful wrought-iron arms, passing through glands on the periphery of the wheel to their seat on the main shaft, where they are securely fixed, with power to move only in a rotatory direction in their seat, by means of short lever arms, attached to levers, working in a movable collar, on the main shaft; a

long, vertical lever, acting in a notch on the movable collar, and reaching to the bridge on the upper deck, works to a limited extent the collar on the shaft, in the same manner as we open and shut an umbrella. This lever, worked from the deck, enables the Officer in command to alter the blades from a coarse pitch ahead, to a coarse pitch astern, or to neutralise them in an instant without stopping the engine, and he can start ahead, astern, or stop, without any order to the engine-room, or without bringing the slightest strain or jar upon the machinery, whilst the engine is still running. Consequently with the lever of the screw-blades, and the lever of the throttle-valve, which I propose should also be brought on deck, and be put in connection with the lever of the screw-blades, as well as the action of the helm under his immediate control, he commands the situation, and with such efficient instruments in his power, ought to give increased security and confidence to the passengers and crew under his command—far above any they now possess—to avoid collision or shipwreck, leaving the engineers to attend to the practical duties of their profession. I think this adaptation alone ought to be sufficient to secure for this patent most favourable notice from ship-owners and navigators; but it has other advantages. The entire removal of the heavy screw from the sternpost, and of its ponderous wrought-iron main shaft, of great length from the screw alley, with its blocks, thrust posts, and its liability to fracture, is a clear gain, both in weight and stowage-room. All seamen know what a serious thing it is for vessels of great length to have their screw blades broken; the ships become unmanageable in the trough of a heavy sea, unless they can be put under canvas sufficient to give them good steerage way, and they cannot undertake repairs until they are docked. It is also well known that as length increases, so the lever vibration increases; but commerce requires long ships to secure great speed, and to economise fuel, is of vital importance in long voyages; but great speed requires large screws, and large screws require great draught of water, and even then, when pitching heavily, a portion of the screw is often thrown out of water, and racing takes place to the great danger of the heavy engines; and the lighter the draught, the greater the danger. On all these points of economic value, the central screw claims an incontestable superiority over the stern screw; for the longer the ship, and the finer the lines, the better for the wheel; the ship may roll and pitch in the roughest weather, without the blades for an instant losing their grip upon the water, or ceasing to exert their full power; it matters little whether the ship is flying light or loaded deep, in either case, lever-vibration and loss of momentum are avoided. Instead of requiring the vessel to be docked to look at her stern-frame, or to replace a broken shaft or screw, the wheel can be hove up in its trunk at sea to be repaired, or by closing the bottom-aperture by sliding ports, the water can be pumped out of the chamber by a small auxiliary engine, and the works carefully examined whilst the ship is under canvas, for she will possess all the properties of a sailing vessel, as the sliding ports should be kept closed when not using steam. One of the blades could be made removeable, and so render unnecessary the lifting of the wheel.

All navigators are aware that there are seas, as Captain Hoseason remarked on a former occasion, where sails set to the trade-winds or monsoons, will send a vessel as fast as her steam-power over great distances; but the present large screws, unless hoisted up, must always act as a heavy drag upon speed, whereas by the adaptation of the wheel, the Officers taking advantage of these long sailing voyages, can take it to pieces, and if necessary examine its simple mechanism thoroughly.

The liability of the stern screw to foul is well known to every seaman, and I presume, that there is no Officer in this theatre, who has not at one period or another had their towing hawsers destroyed, when taking ships in tow, and their screw power endangered by obstructions of one kind or another; whereas a ship fitted with a central wheel can take a ship in tow with the same ease and celerity as a paddle-tug, without any fear of fouling or injuring the towing-cables, and without any order being necessarily given to the engine-room.

If by an accident a fore compartment fills, the alteration in the vessel's trim by the head makes no difference to the blades of the wheel, though it may seriously affect the efficient working of the stern-screw. If she takes the ground, the keel and bilge pieces protect the blades, and by raising the wheel five feet, or removing the blade, the sliding ports can be shut down and the well water utilized, as removable ballast to assist, with other means, to lighten her and float her off. If fitted with bow- and stern-rudders, working in connection with each other, the steerage of a long ship in narrow channels, rivers, or canals would be greatly facilitated; she need not wind, could be moved ahead or astern at the same speed, and if her bow or stern grazed along a canal bank or river-wall, her screw blades are safe from fracture.

In action, ships of war may have their screws disabled by falling masts, spars, sails, or rigging, or their propellers reached by an enemy's shot, whereas the wheel would pass unscathed and unharmed by shot, or shell, or falling spars; and save from vertical fire, torpedoes, or rams—to which all war-ships are exposed—would continue to keep the ship in her appointed station during the continuance of the action. If used as a ram, her striking power would be at the command of the Captain at a moment.

I believe that I have now stated all the advantages I have thought of in favour of this system as a propelling power, and I trust that I may hear your opinion on its merits or demerits. The disinterested verdict of a body of scientific gentlemen, upon a subject so interesting and of so much importance to the maritime world, will be received with the greatest consideration and the most profound respect by the patentee; no favour is expected at your hands. I told Mr. Buchanan the ordeal his patent would have to pass through if it came under the notice of the members of this Institution, and that the decision of men so qualified would unquestionably influence companies in purchasing his patent, and he readily accepted the conditions.

The questions I should like to have answered are—

1st. Is the patent suited for ocean steamers, auxiliary screw ships, ships of war or rams?

2nd. Is it suited to canal navigation, for barges, steam launches, small gunboats, and circular monitors?

3rd. Can speed, strength, and economy be secured by its use?

If these can be secured, the patent will fight its way to the front, in defiance of all obstacles; though, like all other meritorious inventions, it will have to bide its time. We know, for instance, how the paddle and the screw fared at the hands of officialism on their first introduction.

An anecdote was related to me the other day by an old and excellent Naval Officer that, in 1817, a member of the House of Commons urged that two small paddle-steamers should be bought or built, and attached to Plymouth and Portsmouth yards, as tugs; and that John Wilson Croker, the then Secretary of the Admiralty, laughed the proposal down and treated it as the idea of a lunatic; and as late as 1837, when Lord Melbourne was Premier and Lord de Grey was the First Lord of the Admiralty, Captain Ericsson, in his small screw vessel 45 ft. in length, 8 ft. beam, and with a draught of only 2 ft. 3 in., towed the American ship "Toronto," of 630 tons burthen, on the Thames at the rate of four and a half knots an hour against tide, and also towed their Lordships in their barge from Somerset House to Blackwall and back again at the rate of 10 miles an hour; but after repeatedly urging and explaining to their Lordships the manifest and self-evident advantages of a submerged propeller for ships of war for nearly two years, they declined to entertain the project; and thus unable to move the Board, one of the greatest inventors of the day gave his talents to America, where canals, towns, and ships are named after him, and where statues are erected in his honour. Their motto was not "Work and learn," but "Rest and be thankful." They had the paddle and the screw at their command, and they could have maintained our ancient naval glory with them; but in spite of their determination, Lord Dundonald's words proved true, "that in 15 years our line-of-battle would be screw ships," and Croker, much to his disgust no doubt, lived to see them go forth to battle in the Baltic.

Vice-Admiral Sir ASTLEY COOPER KEY: I should like to ask Admiral Paynter whereabouts is the water line in that wheel?

Admiral PAYNTER: It depends upon the draught of water. The water is through the aperture at the bottom. The chamber must be filled with water.

Sir A. C. KEY: Then the wheel is entirely immersed?

Admiral PAYNTER: Partially immersed in the water of the chamber; of course there is no resistance from that, no matter what her speed is.

Sir A. C. KEY: Is not that wheel practically a screw of great circumference with the interior part of the blade removed? Those blades appear to be the extremities of the blade of a large screw.

Admiral PAYNTER: Just so. You may have six blades, and when they are connected, they form a circle.

Sir A. C. KEY: Has only the lower blade propelling power?

Admiral PAYNTER: Only the lower blade; but as this blade (pointing) comes down, I think that it will have a slight effect, because it is pressing the water down and making it pass under the bottom of the ship. But unquestionably this lower

blade is the only one that has a grip on the water, but before that is out, another is in.

Sir A. C. KEY : Another little difficulty I think you will have to overcome, is the movement of the lever for putting the blades in and out of gear or altering their position. I should not think it possible for any lever to be arranged so that one man's power could reverse the action of those blades, especially when going at full speed. It must be a very slow motion of great power, and then I think you would lose the advantage of it. There would be great resistance against those blades in one direction.

Admiral PAYNTER : It is only the blade, not the wheel.

Sir A. C. KEY : The three blades?

Admiral PAYNTER : This blade is out of water, and the other has a rotary motion, and will carry the water round with it, and therefore will offer very little resistance. The only real resistance would be the one or two that are gripping.

Sir A. C. KEY : The resistance is equal to the whole propelling power ; the whole propelling power is opposed to the action of that lever ; but you might get over that by a complicated mechanical motion, which must be very slow. I should think there might be danger as far as the ship was concerned of its running aground.

Mr. R. GRIFFITHS, C.E. : As far as I can see, this is nothing but a screw put athwart, and just propelled ; and the lower blade comes in contact with the water. I should like to know what becomes of all the friction when that blade goes round. It certainly will propel when it is just crossing underneath the ship, but if I am not very much mistaken, that friction will have considerably more power than will be used in propelling the vessel. It revolves in that case of water, and only comes in contact with the outside water when it is underneath the ship.

Admiral PAYNTER : The water is still, and it has a rotary motion.

Mr. GRIFFITHS : If you revolve the screw in still water, it takes an enormous deal of friction.

Admiral PAYNTER : It is only the blade, it is not the large boss, and the wheel will offer no friction to speak of.

Mr. GRIFFITHS : It appears to me very complex ; I do not know how they will keep all that loose work in order on board ship.

Admiral PAYNTER : It is very simple and very strong. It is screwed on to the collar, and the movable collar is on the main shaft. The lever is very large and powerful. The speed certainly in that vessel was just the same with the screw as with the wheel as far as I could judge ; in fact the screw has a greater proportionate area than the blade, but there was no difference at all in the speed.

Admiral NOLLOTH : Would not this combination of wheel and paddle afford greater facility for stopping suddenly or turning suddenly than the ordinary screw?

Admiral PAYNTER : As I said, you have the advantage of having the whole control of the wheel under the Officer on deck ; by moving this lever he can send her ahead, astern, or stop her.

Admiral NOLLOTH : You would stop the vessel more readily than by the ordinary screw?

Admiral PAYNTER : Yes, because you can go astern at once without moving the engine.

Admiral NOLLOTH : If you stop the engine, you will have a greater surface than the paddle.

Admiral PAYNTER : The wheel will have nothing to do with stopping the vessel, it is only the blade, because the wheel is in its transverse chamber. The water in the transverse chamber does not get out except by the blade moving through it.

Admiral NOLLOTH : In stopping the engine you would not have a greater resistance to stop the way than in the ordinary screw.

Admiral PAYNTER : But you need not call down the engine-room at all, you have the power by altering the blades by means of the lever, of at once sending the vessel ahead, stopping her, or sending her astern.

Admiral NOLLOTH : You would be able to resist the ship's way more suddenly than you would with the screw as ordinarily applied? Provided you can get the speed, I think it has a great superiority over the screw.

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Steam Launch N° 3. Commander of the Steamer Vladimir, Capt. 1st rank Kudavyi—Gave 2 blows. } during a space of 37 minutes
Steam Launch N° 1. Chief Officer of the Steamer Volga, Capt. 2nd rank Ousoff—Gave 0 blows. } July 16th 1873.

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- Steam Launch N°1 Commander of the Gunboat Opit, Captain Lieut. Voisehoff..... } during a space of 2 minutes
Steam Launch N°3 Commander of the Monitor Strolets, Captain Lieut. Ibraleshin }
Steam Launch N°1 Commander of the Gunboat Opit, Captain Lieut. Voisehoff..... } during a space of 1 minutes
Steam Launch N°2 Commander of the Steamer Grand Duke Alexis, Capt. Lieut. Titz }
Steam Launch N°3 Commander of the Frigate Menin, Capt. 1st rank Korneloff..... } during a space of 2 minutes
Steam Launch N°1 Commander of the Gunboat Opit, Captain Lieut. Voisehoff..... }

ЧЧ

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- Steam Launch N°3 Commander of the Frigate Menin, Capt. 1st rank Korneloff..... } during a space of 12 minutes
Steam Launch N°2 Commander of the Corvette Bayan, Capt. 2nd rank Guld..... }
Steam Launch N°3 Commander of the Frigate Menin, Capt. 1st rank Korneloff..... } during a space of 2 minutes
Steam Launch N°1..... } Capt. Lieut. Bersin..... } August 3rd 1873.

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Commodore Sir EDWARD COMMERELL, U.C., K.O.B.: I think the enormous quantity of water that you will have to drag along with the vessel held in that large aperture would diminish the speed very much.

Admiral PAYNTER: Not in the least.

Mr. BUCHANAN: With regard to the friction of three of the blades, there would only be the water in the chamber that the blades are working in, and water is the best friction roller we have. There is no friction when under water; it does not retard the thing a bit. We proved this by the fact that with very moderate propelling power the model traversed the 18 feet trough in 20 seconds.

Admiral RYDER: By moving the handle and bringing the blades at right angles to the ship, the engines (unless great care is taken) would go off at an enormous speed, that would be one of the risks. If a man moving the handle does not succeed in reversing the angles of the blades, but leaves them actually at right angles to the ship, the engine will go off, there will be no resistance at all. Sir Astley Key mentioned the difficulty he anticipated of moving the lever. Of course with hydraulic power that difficulty will be very easily got over.

Admiral PAYNTER: The throttle-valve closes to shut off steam as the lever handle alters the angles of the blades to prevent the engines from racing,—hydraulic power would give action to the handle.

The CHAIRMAN: We are always desirous that any invention should be brought here to be exhibited and discussed. I should very much doubt whether any one in this room, even Admiral Paynter himself, is prepared to give a definite opinion upon models on a very small scale. We all know from experience that models—and models tried especially in a trough of water—give results really of very little value. The only true way of trying an invention (especially with which it is proposed to propel ships) of this novel character, is on a large scale, experiments carefully made and carefully noted. All we can hope is, if this invention does prove of value at some future time, Mr. Buchanan will give us in this theatre, the benefit of the results of his experiments. We at any rate thank him and Admiral Paynter for bringing the subject before us this evening.

A STATEMENT TO ACCOMPANY THE RUSSIAN "RAMMING" DIAGRAMS PRESENTED TO THE ROYAL UNITED SERVICE INSTITUTION.*

By Vice-Admiral A. P. RYDER, late Naval Attaché to the Courts in European Countries.

My friend and host Admiral Boutakof of the Russian Imperial Navy, who has had charge of the Fleet of Instruction in the Baltic for ten years, has sent me numerous diagrams of the ramming experiments with gun-boats in 1873.

These diagrams are very instructive, and the experience gained by the Russian Officers by these practical experiments is very valuable. As we have no such opportunities, it may be well to study the Russian diagrams carefully.

The whole fleet of ships is anchored in a square surrounding the combatants as in an ancient tournament, the flag-ship sometimes in the centre. There are three observers at the flag-ship's cross-trees noting the

* Diagrams III (Plate XXII) and VIII (Plate XXIII), are given as illustrative of the series.