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Wednesday, July 4, 1894.

VICE-ADMIRAL PHILIP A. COLOMB, in the Chair.

A NEW METHOD OF MANOEUVRING "CONTROLLABLE"
TORPEDOES OR OTHER VESSELS WHEN ABSOLUTELY
INVISIBLE TO THE OPERATOR.

By LIEUT. C. W. SLEEMAN, R.N.

THE contrivance which I bring to your notice to-day has been the outcome of a mass of difficulties experienced during a five years' wrestle with the "Nordenfelt" electric controllable torpedo before I succeeded in overcoming its obstinate disinclination to run for any considerable distance without diving, or trying to dive, or otherwise misbehaving itself; other difficulties, of course, arose in connection with the electric motive power, but these were practically a mere nothing compared with the peck of troubles brought into being by the necessity that then existed for a controllable torpedo to be provided with some arrangement whereby its course through the water during the whole of the run remained visible to the operator directing it.

In 1887, when the "Brennan" torpedo was just emerging from its state of infancy, and after many attempts had been made to run it without hampering its movements and general handiness by fixed excrescences, such as fins, floats, masts, &c., Mr. Brennan expressed himself, according to the "Army and Navy Gazette," as not being hopeful that a contrivance would ever be found to supersede the present system of running "Controllable" torpedoes, which remark added fuel to the flame of my desire to attempt to solve this apparently knotty question.

I do not for a moment wish it to be understood that by means of this apparatus I have solved this problem, but, as a practical torpedoist, I believe most thoroughly that this contrivance is a step in the right direction, and well worth trying in connection with the "Brennan" or any of the other "Controllable" torpedoes.

Before proceeding to explain the apparatus, it will be as well to briefly consider the leading features of known controllable torpedoes in so far as they are affected by the invention I am bringing to your notice.

So far as this paper is concerned, torpedoes may be divided into two distinct classes—"Uncontrollable" and "Controllable"—the former represented by the "Whitehead," the "Schwartzkopff,"

and the "Howell;" the latter by the "Brennan," the "Sims-Edison," the "Patrick," and the "Nordenfelt."

The essential difference between the two classes is that the former, like a shot from a gun, is absolutely removed from all control the instant it is started on its errand of destruction, while the latter is always under the more or less complete control of its manipulator during the whole time of running.

We have nothing to do with the former class to-day, and so it will not be necessary to consider it further.

What is intended by "Control," in reference to the second class, is that by means of certain devices, placed within the torpedo, its propelling engine can be started and stopped, its rudder moved to port or starboard, its charge fired by contact or "at will:" all these functions being performed as it may so please or as they may be required to be exercised by the operator.

These various devices are actuated by electric currents transmitted from the operating point through a cable (composed of two or more insulated cores) coiled up in, and payed out from, the torpedo as it proceeds ahead.

This description does not quite apply to the "Brennan," as it is *mechanically* not *electrically* controlled, but the principle remains the same.

The operator possesses a more or less complete directive control of this class of torpedo by means of some thing or things forming an actual part of the *particular* torpedo in hand, which renders its position always visible to him, and by means of which he is thus enabled to maintain the torpedo in alignment with the vessel or other target it is desired to strike. Now, for any such torpedo to achieve *complete* success, it should be submerged at least 6 ft. beneath the surface of the water for the purpose of securing to its charge the maximum of destructive effect as well as to bring the explosion below the armoured belt or deck of the ship it is intended to cripple or sink. To provide for these two requirements, *a visible means for guidance and a sufficient depth of submergence*, the "Sims-Edison" is fitted with a fore-and-aft float rigidly attached to its hull, and so formed as to permit of the torpedo being driven under a boom or other similar obstruction placed in her path; this float allows of the hull being submerged some 5 ft. under the water; at each extremity of the float is hinged a small steel rod carrying each a flag or disc, the foremost one showing above the after one. This torpedo is shown at Pl. I. The "Patrick" has for the same purposes a float somewhat longer than its hull, exceptionally light and fine in structure; the visible means for its guidance are similar to those adopted in the "Sims-Edison." This torpedo is shown at Pl. II.

The "Nordenfelt" differs, or rather differed, as it is now defunct, from the foregoing in having two separate fins, one at each extremity of its hull, each fin carrying a rod and disc as seen at Pl. III.

These three torpedoes maintained regularity of submergence during a run by means of their floats, but the "Brennan" differs from them in that it uses the "Whitehead" system of submergence, and so only

requires to employ something, as, for instance, a thin telescopic steel mast, to provide it with the necessary visible means for guidance. This torpedo is shown at Pl. IV.

I feel almost bound to apologise for having to claim attention for what must be a very old story to many of you, but when a contrivance has been devised to do away with a something in common use, it is necessary first of all to set up that something for the express purpose of knocking that something down.

In this case the something is the mast, float, or fins by which, alone, at the present time, a "Controllable" torpedo is rendered possible, and it is with the object of removing this something bag and baggage that I have devised my system for guiding a controllable torpedo or any kind of vessel whose course is invisible to the operator directing it.

The four controllable torpedoes I have specially referred to have been chosen as exemplifying the two types of that class of torpedo, and all of which have been subjected to official trials in this or other countries.

Before going on to describe my system of directing Controllable torpedoes while invisible to the operator, I will point out what I consider to be the disadvantages that are common to this class of torpedo requiring visible means for its guidance, whether in the form of a mast, float, or fins, and carrying one or two flags or discs—

Loss of speed.
Exposure of attack.
Unhandiness.
Easily stopped.
Limitation of range.

Loss of Speed.—That a very serious loss of speed must result from the employment of means such as I have described for providing a "Controllable" torpedo with the necessary means of *visible* guidance is self-evident. In the case of the "Brennan," for instance, which, with its slender steel mast, offers the minimum of sacrifice of effectiveness in this respect, there is a loss of speed of some 4 knots per hour.

Exposure of Attack.—Here again it is perfectly obvious that either of these torpedoes must play to some extent into the hands of the enemy by reason of the disturbance created on the surface by the passage of the mast, float, or fins through the water, the degree of exposure depending on the speed of the torpedo, size and form of the particular excrescence, and the state of the surface of the sea at the time; while, unless a very strong wind be blowing *from* the enemy at the time of the attack, there is a great probability of the approach of the torpedo being discovered by the noise that must attend the tearing through the water at high speed of whatever form of excrescence is resorted to. I am aware that a torpedo attack of this sort will rarely be attempted in broad daylight, but even on a dark night the foam and spray thrown up by either of these torpedoes as it cleaves its way through the water would, by means of her electric

lights, afford to the enemy all that was necessary to indicate its approach, and most probably in time for her to avoid the attack.

Unhandiness.—It cannot well be denied that any form of mast, float, or fin rigidly attached to a torpedo renders her unwieldy and difficult to handle as compared with the same sized weapon unprovided with and not requiring an excrescence of this nature.

Easily stopped.—The "Brennan," "Patrick," and "Nordenfelt" torpedoes could certainly be very readily brought up and probably sunk by means of an anchored boom, while, though the "Sims-Edison" has been proved capable of charging an obstacle of this nature without suffering any material harm, yet a slack chain cable hung under the boom, or a strong wire net suspended vertically from and rigidly attached to it, would most effectually bring her to a standstill if no worse thing happened.

Limitation of Range.—All "Controllable" torpedoes, whose directive visibility begins and ends with one or two small flags or discs, must have their range of action very circumscribed, putting the other causes of limitation on one side, compared with the distance from the operating point that the object of the attack (a ship of war) is to be seen; and it will be readily understood that these guiding stars must of necessity be as small as it is feasible to have them, so as to reduce to a minimum the chances of an enemy discovering the approach of the torpedo by their means.

This detailed statement as to the numerous and very serious disadvantages attendant on the use of masts, floats, or fins for enabling a "Controllable" torpedo to be manœuvred, cannot, I venture to say, be controverted; in fact I might have added to the list of indictments, but sufficient has been said to support my contention that any contrivance having a reasonable show of possessing a practicable application, devised for the express purpose of improving off the face of the sea the external excrescences now carried by the unfortunate hulls of the "Controllable" torpedoes of the present day, is worthy of serious consideration, and, if there be aught in it, of the expenditure of brains, time, and money in making it successful.

I will now proceed to explain my electrical steering invention, prefacing the explanation by a reference to other attempts that have been made to adapt compass steering to torpedoes, more especially in connection with the "Whitehead." Commander Barber, of the United States Navy, in a lecture on the "Whitehead" torpedo, in 1874, refers to Gunner Burdett's proposed plan of steering a "Whitehead" by means of a compass placed within her, and so arranged that the torpedo going off the point of the compass for which she was previously set to run on would, by a simple electrical device, automatically put the rudder over to bring the torpedo back to the original point.

It hardly needs to be pointed out to any one at all conversant with the art of steering a boat that this method cannot insure a torpedo fitted with it being kept on a *steady* course or on a *constant* alignment. By my system the movement of the rudder of the vessel or torpedo is *absolutely* independent of any alteration of the vessel's course. I

merely provide the vessel to be directively controlled by this system with a compass capable of indicating to the operator by an electrical device the actual point of the compass that she may be heading at any given moment, or of any alteration therefrom; in fact, the operator of such a vessel (invisible to him) is in practically the same position as though he were on board of her, with the compass in front of him and the helm in his hand.

If it is required to keep the invisible vessel on a given course, and she, for any reason, should go off that course, the operator can then, by using the rudder, bring her back to her original course, and not only that but on the same line or alignment again. For instance, supposing it is desired to run the vessel on the E. point of the compass and she should run off to E. by S., then the operator merely has to give her starboard helm swinging her to E. by N., and then with a touch of port helm bring her back to the E. point again, thus correcting the bodily drift to starboard that would result had he merely straightened her up on the E. point in the first instance.

Fig. 5 is a plain sectional view of a compass, D is the compass card, S the spindle carrying the card, A is a metal arm with platinum contact point; B is an ebonite ring with 32 insulated metal contacts, which engage respectively with A as the compass card and A swing from point to point; E are the supports carrying the ebonite ring.

Fig. 5a shows in plan the compass C, the step-by-step instrument S, relay R, and battery M contained in the torpedo, and of the key K, galvanometer G, and batteries N and N' placed in the station. In the drawing only eight points are shown, and only five connections—N., N. by E., E., N.W., and W.—to avoid confusion. The 32 contacts on B are connected by insulated wire to 32 contacts on the step-by-step instrument. The arm T of the "step-by-step" is moved to the right or left by the battery M, which is brought into action by the relay R. The movement of the relay R is controlled from the station by the movement of the arm T' of the key K, through the line wire marked "LINE." The galvanometer G circuit is completed (with T' of K on *any* point of the compass) when the contact arm A of the compass is on a similar contact to that of the arm T of S (as shown in Fig. 5a), the galvanometer needle is then deflected, and remains deflected as long as the combination remains. The galvanometer circuit is broken, and the needle resumes its normal position on the compass card, swinging off so as to bring another of the contacts of the ebonite ring B in contact with A; or if A and T be in continuity by the movement of T' of K off whatever point it may be on. The movement of T', as it leaves its points, breaks the galvanometer circuit, and completes the relay R circuit on approaching the next point on its dial, the relay circuit is broken, and the galvanometer completed, but the needle of G is not deflected unless at the same time the arms T and A in the torpedo are on the same contact.

Every movement of T' of K causes T of S to be moved one step to the right or left in correspondence with T' of K, so that the key

arm T' and the step-by-step arm T' work in unison, and the galvanometer be deflected whatever point T' be on is the point of the compass on which the torpedo is then heading.

Having thus described the construction of the contrivance I will proceed to show how it is applied in actual practice.

Suppose a torpedo fitted with this arrangement to be lying at rest in the water ready for running, with all the necessary connections made and the contact arm of the *station* "key" instrument and of the "step-by-step" instrument in the torpedo on the same point of their respective dials, say the N. point, and suppose that she be heading S. (a fact that would probably be known to the operator), then the operator would move the *station* key arm, and consequently the "step-by-step" pointer step-by-step until they have respectively reached the S. point, when, as the torpedo is also on the S. point, the galvanometer, as before explained, will be deflected, and will remain so deflected as long as she continues to head S. Having thus established the direction the torpedo is pointing, and it being desired to run her on, say, the E. point, the operator will move the necessary key to start the engines of the torpedo ahead and at the same time the key to give starboard helm, he would then move his "key" arm one step to the left, watch the galvanometer, and, on seeing the needle deflected, move it another step to the left, and so on, thus following the course of the torpedo as she swings from S. to E., so manipulating the helm as to steady her on the course E. it is desired to run her on.

All the operator has now to do is to watch the galvanometer if the needle ceases to be deflected, then he knows that the torpedo has run off her course E., but whether to the right or left of it he does not, of course, know. It would be necessary to have a fixed rule in this case: for instance, to always give "port" helm, so as to cause the vessel's head to be moved to starboard, or to the right of her original course, and at the same time to move the *station* key arm two steps to the right of the point the vessel is being run on, in this case E.S.E.; the operator would then watch for the deflection of the galvanometer needle, which would occur on the "port" helm previously given to the torpedo, bringing her head to E.S.E., two points to the right of E.; the length of time this would occupy would depend on whether the torpedo, on going off her course, had gone to the right or left of it; on seeing the needle deflected, the operator would then so manipulate the helm as to bring the torpedo back to her original point and on the same alignment.

This is the whole of the operation, which is, as you will notice, merely a matter of steering, and I think you will agree with me that it is very simple.

I have only been able to make one practical experiment with my apparatus, on which occasion it was fitted up in an ordinary steam launch, and I found, to my great satisfaction, that I could follow the launch point by point as she steamed round in a complete circle, keep her on a given course, and find out the direction she was heading in when she had been purposely steered off her course. Naturally I

experienced some difficulty in manipulating the apparatus at the first time of asking, and I quite admit that this trial did not present the difficulties that will most certainly occur when the opportunity comes for such a contrivance to be tried in connection with a real live "Controllable" torpedo, but, at the worst, it will be only a question of steady practice, and trouble in such a case is but the common experience of the initiatory stage of the development of new-born ideas, whether it be a little bit of humanity in the shape of a babe, or a little bit of an invention in the shape of an improvement of some existing inanimate apparatus.

This system of steering has been subjected to close, not to say severe, examination by many experts, so that I am enabled to place before you a list of objections that have been raised by these experts from time to time.

First and foremost I was assured that the amount of power possessed by a compass card to do any mechanical work was so infinitesimally small that a hair would stop its action; well this, to some extent, is true, if the hair has to be moved at the extreme outside edge of the card, but the nearer to the centre the work has to be done the coarser and heavier the hair may be, and that is the reason why the ring of "compass" contacts should be of as small a diameter as it is feasible to construct it, while the arm of the contact maker on the spindle of the compass card should be as light as possible, with the object of reducing to a minimum the increased friction of the card pivots; similarly, the actual *contact* must be delicate, with due regard to a certain and definite contact being always maintained. There is no insurmountable difficulty in securing these desiderata. I quite admit that setting a compass card a job of work to do over and above its normal business will, to a certain extent, though hardly appreciable, impair the efficiency, but, in connection with this, it must be remembered that it is not a question of steering a ship across the Atlantic, for instance, when, of course, a compass, however slightly impeded in its action, might cause a serious disaster, but only running a "Controllable" torpedo or other such vessel an insignificant distance as compared with the former. Further, the small extent by which a compass may be thrown out by utilizing it for the purpose of this contrivance would be a fixed quantity, provable by practice, and correctable by adjustment.

Secondly, it was assumed that the small current passing through one of the wires connecting the compass and step-by-step contact would affect the action of the compass card; but this is not the case, and, were it so, would assert itself at once by visible demonstration, as, with the galvanometer current passing along one of the wires, the compass card would move one way or the other.

Thirdly, objections have been raised as to the action of a compass in a steel torpedo; unquestionably a compass in such a situation would require careful adjustment, but by insulating the compass the amount of adjustment would be reduced to a minimum.

Anyhow, supposing this system to be otherwise a valuable one, it would surely be worth while to construct torpedoes, in which it is to

be used, of aluminium or other non-magnetic substance, or a form of gyroscope could possibly be used, as has been successfully applied to the French submarine boat the "Gustave Zédé."

Fourthly, the need of a "step-by-step" instrument in connection with this system of steering has proved a bugbear to some of my critics, because of their disbelief in the possibility of securing certainty of unison between it and the station "key" instrument. I know that "step-by-step" instruments, like most things, are liable to error, either by jumping *two* steps for one movement of the "key," or by not moving at all when the "key" is moved; this is, however, purely a matter of mechanical construction, by no means presenting any insuperable difficulty. Then, if it be necessary, by utilizing the telephone the fact of the two instruments being in unison or not can be easily ascertained. In connection with this objection I would point out that in actual practice, that is to say, when making an attack with a torpedo to which this contrivance is applied, I do not see any strong reason why the "step-by-step" instrument should be moved even one step when once the torpedo is set on her course; I refer to a torpedo truly constructed and provided, as in the case of the "Whitehead," and also, I believe, the "Brennan," with two propellers, revolving in opposite directions; for, under such conditions, there is no reason why a torpedo should of her own sweet will go out of the course she is set to run on, excepting that the unexpected always happens. In the experimental and showing-off stage a torpedo fitted with this system would doubtless be expected to perform all sorts of antics.

This completes the list of what I have so far been told are the weak points of this steering apparatus, and I trust I have shown that at least they are not ineradicable.

I now come to the second part of my scheme for doing away with masts, floats, fins, and all such abominations connected with the manœuvring of "Controllable" torpedoes. It was my good fortune to get Admiral Colomb to devote a considerable portion of his very valuable time in examining into my scheme, and after expressing his qualified approval of the contrivance from an electrical and mechanical point of view, he propounded the following, I need hardly say, practical question: "What means have you for knowing the position of the torpedo as regards the enemy and the operator at any point of its run?" In other words, the Admiral said you may be able to keep a torpedo by means of this invention on a given course, but, as it is invisible to the operator, that is possibly very interesting; but you must have in addition some means of verifying her actual position at any given moment.

I was pleased to be able to show Admiral Colomb that I had foreseen this requirement at the very outset of designing my system of steering.

So far as controllable torpedoes are in question, provided with a submergence system such as the "Whitehead" possesses, it would be a very simple matter to arrange for the immersion and emersion of the torpedo at the "will" of the operator; the torpedo could then be

run on the surface as near to the point of attack as is considered advisable, and at that point immersed, completing the remainder of its course in the submerged or invisible position; this would very materially lessen the chances of a miss, owing to the torpedo having bodily drifted out of her course by the influence of the tide or otherwise. At first blush it would seem that, under this condition of controlled submersion, a steering contrivance such as mine would not be needed; this, however, is not the case, because it would be extremely unlikely that the torpedo on being dived after, after having been brought to the surface, would maintain the direction she had previously been running on; while, suppose the torpedo to be proceeding in the submerged condition, and it be desired to bring her to the surface for a "look see," it would be found very difficult to pick her up at once, even by the aid of binoculars, unless, by means of a steering contrivance, she had been kept all the time on a known course, and so her whereabouts well within the operator's ken.

If, however, it be required to run a torpedo having this contrivance on board in the submerged position for the complete course, that is to say, invisible alike to the operator and the enemy, I have provided an arrangement which I will now describe, part being by no means new, or of my own discovering.

The arrangement consists of a board shown at Pl. IX, and torpedo path instrument, Pl. VIII. At Pl. IX, A and B are two stations at a fixed distance apart, C and D are parts of circles with A and B as centres respectively.

The torpedo path-finder, Pl. VIII, consists of a framework, F, F', carrying an endless screw, E, and sleeve, E'; on the sleeve is fixed a model of a torpedo, surmounted by a compass; the endless screw E is caused to revolve, carrying the sleeve, torpedo, and compass with it by clockwork or other suitable mechanism at H; the rate of progression of E' is proportionately the same as the rate of the actual torpedo in the water, so that a scale of distance placed on F affords an indication of the distance travelled by the unseen torpedo at any moment of its run, both the mechanism at H and the torpedo being started at the same moment. By means of the arrangement previously explained, the actual direction in which the torpedo is heading is indicated to the operator, and with the "path" instrument placed on the board, Pl. IX, the path of the torpedo in the water is thus shown on the board. Should the torpedo's course be altered the "path" instrument is similarly altered, it always turning on a pivot under the moving sleeve; thus at Pl. IX the shortening up of the length of run possible on a straight course to a controllable torpedo by large alterations of course is also indicated. Pl. X represents part of a coast line, with an enemy's ship passing down; A and B are the observing stations, with cross-bearing instruments. Pl. VII is an arrangement for obtaining correct point of intersection of the two cross-bearing lines, for use with board, Pl. IX. B, Pl. VII, is arranged to work on the inner circle C, and carries a number of prickers, kept just clear of the board by springs; A is similar to B, without the prickers, and arranged to move on the outer circle D, and just clear

of top of A. The bearing of the ship having been given from cross-bearing station A, Pl. X—B, Pl. VII, is moved to that bearing; similarly, A, Pl. VII, is moved to the bearing given from the station B, Pl. X, then a slight pressure on the top of A, Pl. VII, will cause the pricker or prickers under it in B to move the board; if only one mark, that is the point of intersection; if two marks, the centre of them; if three marks, the centre one, and so on. In combination with the board, Pl. IX, the torpedo path-finder, and the cross-bearing markers, there is also provided a set of circles inscribed on a transparent card, the distance between the circles (drawn from same centre) representing on the same scale the distance travelled by a ship at different speeds for a given time, say, 3 mins. Suppose cross-bearings of the ship S, Pl. X, be taken, and her position marked on the board, Pl. IX, and then 3 mins. afterwards cross-bearings again taken of the ship S', and her position marked off on the board, Pl. IX, then, the centre of the speed card being placed on the first position, whatever line is cut by the second position represents the speed of the ship. Thus the board, Pl. IX, shows the position of the ship, and her course, while her speed is also known. The position of the torpedo at the starting point is also marked on Pl. IX. In Pl. X the ship S is moving at 10 knots per hour, and the torpedo is supposed to travel at 20 knots per hour. The torpedo path-finder is placed with the sleeve pivot on the starting point of the torpedo on the board, Pl. IX, and in same direction as the torpedo is heading, which is known to the operator by the compass steering system previously described. Further cross-bearings of the ship may be taken from time to time, so that her path is shown on the board, Pl. IX, while by the path-finder, Pl. VIII, placed on the board and kept in unison with the torpedo course, the operator, without seeing the torpedo, sees before him the position of the ship and torpedo at any part of the attack. This scheme has been devised as showing *one* way of utilizing my compass-steering invention.

In brief, this arrangement is an indicator board, on which I am enabled to show, by means of cross-bearings and certain other devices, as explained, the distance of the enemy from the "station," together with her speed and course; while on the same board the actual track of the torpedo is exhibited, so that at any point of the run the relative position of the torpedo and the enemy can be readily noted by the operator. Such a scheme opens up an infinite number of arrangements, only to be definitely settled in actual practice.

The bodily set, due to tidal influence, of a torpedo fitted with this or any other system of steering which renders her course invisible to the operator cannot be observed, but as such would invariably be used in places perfectly familiar to the conductors of the attack, due allowance in the course set for the torpedo to run on could be made to counteract this tidal influence.

Personally, I should prefer, in manœuvring a torpedo on this system, to be in a position to bring her to the surface from time to time so as to insure her being in proper alignment; even so, the indicator board arrangement would be invaluable.

Having now initiated you in the mysteries, if there be any, of my system of steering controllable vessels which are guided by sense, not sight, I will point out some of the directions where the system may be advantageously employed.

The adoption of this system in the case of the "Brennan," "Patrick," "Sims-Edison," and "Nordenfelt" controllable torpedoes would very materially enhance their value as weapons of war for coast defence purposes.

The "Brennan," by being able to do away with her mast, obtains a higher speed, complete invisibility, handiness, and cannot be stopped by a boom.

The "Patrick," "Sims-Edison," and "Nordenfelt," being freed of the encumbrance of their floats, secure higher speed, greater submergence, complete invisibility, unlimited range, handiness, and cannot be stopped by a boom.

It will be noticed that I score an additional point, *unlimited range*, for the latter weapons. I mean that the striking range of either of these torpedoes need not necessarily depend on the length of cable carried by them, as, not requiring to be seen to be guided, they can be towed to any distance from the station, and then started from that point. The towing boat would carry a reel of cable, similar to that in the torpedo being towed, paying it out as she proceeds, and, on arriving at her destination, the two cables would be connected up together, thus establishing direct communication between the station and the torpedo. A separate single-core cable would provide for telegraphic or telephonic communication between the operator at the station and the occupants of the towing boat.

It is very possible that a similar arrangement could be devised for the "Brennan," when her present somewhat limited striking range could, with this system of steering, be very considerably increased.

Uncontrollable Torpedoes.—It has always seemed to me a great pity that no serious attempt has been made to utilize the potentially valuable features of the "Whitehead" and the "Schwartzkopff" by transforming them into "Controllable" torpedoes, and so eradicating, once for all, their one grave defect, viz., "Uncontrollability."

By aid of this system of "directive" control it is possible to construct a controllable Whitehead or Schwartzkopff; that is to say, a torpedo differing only from an uncontrollable Whitehead or Schwartzkopff in the addition of the apparatus necessary to provide it with "directive" control. The extra weight, inclusive of 1,088 yds. of cable, would come under 100 lbs.—so there is no reason why a controllable Whitehead or Schwartzkopff should not be constructed very little, if at all, larger than the present ones, provided that some of their very high speed be sacrificed.

I show at Pl. XII a full-sized drawing of a coil of 1,088 yds. of cable, and the weight of water occupying the chamber containing it is not more than 50 lbs., also a 20-ft. Whitehead discharging tube with this cable chamber above it on same scale.

Sea Service Controlled Torpedoes.—In considering the application of my system of directive control to controllable torpedoes intended for

use in ships or torpedo-boats, it will be necessary to treat of them in two distinct classes, viz., short range and long range controllable torpedoes. In the former class I place a Whitehead or Schwartzkopff torpedo provided with my system of directive control, having a range of 1,000 yds. and a speed of 20 knots. In the latter class I include all controllable torpedoes provided with this system of control, having a range of 3,000 yds. and a speed of 20 knots.

Short Range.—The mode of conducting an attack with a short-range controllable torpedo such as I have described is similar to that employed when using its uncontrollable Whitehead, only the torpedo-boat would, by reason of its controllable Whitehead having now more than double the range of the former, be in a vastly superior position. The 1,000 yds. would be traversed in 90 secs., and the moment the torpedo is started on its errand of destruction the torpedo-boat could be steaming away from the enemy, it being only necessary for the operator in her to keep the torpedo on her course, and this without seeing her.

If, armed with the 400-yd. uncontrollable Whitehead, it is considered feasible and permissible for a torpedo-boat, costing from 50 to 100 times more than this the only weapon she is armed with, to approach so close to the enemy's ship, in these days of machine and quick-firing guns, with a reasonable chance of delivering a successful attack and herself escaping without material damage—then the advantage accruing to a similar attack, which, however, can be delivered at more than 1,000 yds. from the enemy's ship, must be immense, and appears to me to demand an immediate and searching inquiry into the possibility of practically realizing my notions, by which alone this advantage is to be obtained.

Long Range.—In considering the application of this system of directive control to the long range controllable torpedoes which are intended for use in ships, special or ordinary, a difficulty at once presents itself, in that it is most probable that both the operating station (the vessel using it) and the object of attack (the enemy's ship) will be on the move at one and the same time; this brings in a fresh development of the indicator-board arrangement, and one only to be satisfactorily settled by actual practice. The essence of a successful application of the long-range ship controllable torpedo lies in the necessity that the ship and its torpedo should be capable of being operated absolutely independently of one another; by this I mean that the captain of the ship must be able to manœuvre his charge as though no such weapon existed or an attack with it in progress, while the torpedo operator must not care one jot what manœuvres the ship may be performing during the run of his "charge."

Cable.—I know it is a popular idea that the navy will have nothing to do with a torpedo which needs a cable connecting it and the ship from which it is directed, but so far no serious or practical effort has been made to design an arrangement for enabling a ship controllable torpedo to be used which shall disarm the present naval opposition to its adoption, an opposition based on the supposition of the fouling of the torpedo cable and the ship's propeller. I have often run the

Nordenfelt electric controllable torpedo from an ordinary steam launch, carrying a coil of cable in addition to the cable in the torpedo and moved about ahead and astern in all directions independent and oblivious of the torpedo's movements, without experiencing any trouble on this score. It must be remembered that there is no strain on the cable, either when paying out from the torpedo or the launch or other vessel operating it; as an instance, on one occasion the Nordenfelt ran her nose in the mud, and her engine could not be stopped for some time, and when I came to pick her up the whole of her cable, 3,000 and more yards, had been payed out merely by the pumping action of the water as it was drawn through the cable chamber and tube by the revolving of her propeller.

There is nothing impossible, nor any great difficulty to be overcome in attaining this object—a practical ship controllable torpedo; at least, this is my humble opinion, after conducting immense runs with cabled torpedoes. Where there's a will there's a way—and with a controllable Whitehead a fact, the will is achieved; and the way, the adapting it to ship use, will, in fact must, rapidly follow.

Submarine War Vessels.—A submarine vessel armed with the uncontrollable Whitehead or Schwartzkopff has to approach only partially submarine to within 500 yds. of the enemy before delivering her attack and becoming completely submerged; but if supplied with the short range controllable Whitehead or Schwartzkopff, this distance is more than doubled, and therefore its value as a fighting unit vastly improved.

Fire Ships and Countermining Boats.—A countermining boat provided with this system of directive control, a coil of cable, and means for moving its rudder from the operating point, would be far more capable of successfully fulfilling its object, the destruction of an enemy's mine field, than is at present possible, because it could then be directed on a given course, or set of courses, so as to ensure its passing round, through, and across the mine field, dropping its counter-mines on its way, and as by this system it needs not be seen to be guided, this operation could be conducted at night-time, or from a point out of sight of the mine field. The advantage of being able, by this method of directive control, to run a fire, or other such ship, on a set course or courses, are obvious, I think, and need not be enlarged upon.

Life-saving Vessels.—For the same reason this invention might be applied with great advantage, under certain circumstances, to life-saving vessels, for the purpose of conducting a line to a ship driven on the rocks by stress of weather.

Ships.—As by this means a ship may be kept on her course and manœuvred from a position anywhere beneath her upper deck, it might be found useful in guiding a torpedo-boat, when driving through a heavy sea and battened down, or when making a daylight attack, or again in the case of a "ram," which has to approach very close to the enemy in delivering her attack.

In conclusion, I am going to take you into my confidence by telling you that I have altogether failed to induce financialists to join me

in proving the justness of my contentions, not because the intrinsic value of this invention is considered worthless, but solely because it is connected with that commercial terror, torpedoes.

The reasons for this state of terror are not far to seek, but are difficult to overcome. In the first case, the commercial world have been bitten rather severely from time to time with bogus torpedo and other such-like inventions, represented as veritable gold mines to the speculative financialist, but which ultimately prove mere quicksands for the absorption of all the gold that may be squeezed out of the unfortunate company, syndicate, or single party running the invention. As an instance, I know of a so-called torpedo invention, in connection with which I was on three different occasions implored to throw in my lot as an expert, by the supposed inventor, notwithstanding that from the first I expressed my opinion of the scheme to him in the straightest possible language. Well, this invention, to my great surprise, was accorded a detailed and lengthy description in the "Times," and some of the leading scientific papers, and after over three thousand goodly sovereigns had been absorbed by this worthless and impossible scheme, I will not say expended on it, the inventor precipitately retired, and the bubble exploded, leaving no atoms in the shape of a torpedo behind.

I have, when bringing my invention to the notice of likely supporters, held up as a bait the huge financial successes of the Whitehead and Brennan torpedoes; but, alas! without effecting the loosening of their purse-strings. They admit these facts, they admit the possible value of my invention, but they advance insurmountable obstacles in the shape of the protracted delay common to all such matters controlled by Governments as purchasers, and also the very restricted field for the sale of every kind of war material, especially torpedoes.

MR. EVERETT W. FRAZER: I wish to express my appreciation of the valuable invention that has been placed before us by Lieutenant Sleeman. As a representative of the Sims-Edison Company I should like to explain why we have not adopted something of this kind up to now. Messrs. Edison and Sims have experimented with a number of attachments of this nature, which have not so far been certain in their action. Some fairly good results were obtained when the attachments were manipulated by the inventors themselves, but the torpedo officers and men found much difficulty and uncertainty when putting them into practical use. I may say that with regard to the Sims-Edison torpedo our aim has been simplicity. The Whitehead, up to within the past few years, has been rather uncertain in its operation, and it is generally estimated that five or six launchings are required to secure the certain destruction of the object aimed at. As I said, we have tried to make the Sims-Edison very simple and also very sure in its action. The result has been that we have cut down one attachment after another until nothing remains but the plain torpedo which goes ahead and steers from right to left. As Lieutenant Sleeman states, the float undoubtedly does lessen the speed of a torpedo, amounting in one case to perhaps as much as 7 or 8 knots, but we found the desire of the American officers was rather to sacrifice speed in order to obtain certainty of action. Within the last year or so the Whitehead torpedo has certainly achieved wonders, and there are now officers in all the navies of the world who can operate them with surprising accuracy. I think that Lieutenant Sleeman's invention can be adapted to our system as well as to others, but no doubt such adaptation will take time to introduce because it will be hard to make officers believe in it.

They feel that at critical moments they must have as few key-instruments and galvanometers as possible to watch. But the superior education and experience of the officers of to-day will gradually clear away many objections, and if Lieutenant Sleeman will persevere it may eventually be adopted. From my personal intercourse with Belgian, Dutch, Japanese, and Brazilian officers I know they, one and all, desire simplicity above all things. With regard to our range, as mentioned by Lieutenant Sleeman, it was the opinion of a French Commission that the torpedo could be followed for a distance of 2 miles. With the apparatus exhibited by Lieutenant Sleeman the range might be greatly extended, perhaps to 4 or 5 miles, or even indefinitely, but it is an open question in my mind whether in a shore-defence weapon, such as the Sims-Edison, a greater range than 2 or 3 miles were necessary especially if it be gained at the expense of simplicity. A shore-defence torpedo is not for offensive purposes. It is an adjunct or auxiliary to fixed mines, torpedo-boats, &c., and would render the greatest service in preventing the forcing of an entrance to a harbour or the landing of troops. I thank Lieutenant Sleeman for his courtesy in writing me to be present.

Captain C. V. ANSON: I should like to say a few words, and in doing so I would ask to be allowed to point to one of the diagrams. As far as the mechanical difficulties are concerned I think that Lieutenant Sleeman in his invention has grappled with them very cleverly indeed, but I personally cannot help thinking that the induced electricity in the wires will render the movements uncertain of such a very fragile thing as the compass needle. Granting that this does not occur, as to this question of directing the torpedo I cannot see how you are to tell how far the torpedo has gone when it goes off its course. Instead of being at the place supposed it may be deflected by the tide, although on the same course, somewhere else, and when the helm is put over it will not hit the ship. Unless you can see what you have to work with how can you tell the position of the torpedo? And the more times that your helm is altered the more difficulties you must contend with.

The CHAIRMAN: You get the movement to scale.

Captain ANSON: What I mean to say, sir, is (pointing to the diagram) this, there is the ship and there is the torpedo; you go straight for the ship, you get out of your course.

Lieutenant SLEEMAN: Why should we?

Captain ANSON: If you do not go out of your course you may just as well have a Whitehead at once. Of course the idea of a controllable torpedo is that it does go out of its course, and you have to put it right again. Suppose it goes out of its course and it goes in this direction (Diagram), I only ask Lieutenant Sleeman or anybody else how you will know *when* you are to put your helm over so as to make a hit? In my opinion it would be impossible to use this against a ship in motion. Against a stationary ship, of course, it is more likely to be successful, but against a ship moving I think it would be useless. It is all very well to say that the enemy is going on one course and at a certain speed, but no man would be in his senses if in command of a man-of-war, knowing that he may be attacked by Whitehead torpedoes and perhaps controllable torpedoes, who would keep one course and go one speed. I wish, in conclusion, to add my humble thanks to Lieutenant Sleeman for his clever contrivance and his very interesting lecture.

Captain MEYER: With regard to the very interesting paper we have heard to-day from Lieutenant Sleeman, I cannot say that I am prepared to make any remarks of special interest. I, however, do not see any real difficulty in the practical working of Lieutenant Sleeman's invention, providing an accurate estimate can be made of the distance of the torpedo at the various stages of its run. This, in combination with a careful manipulation of the step-by-step instrument, I think ought to give the operator every chance to direct it to the point aimed at with very great certainty. The invention is certainly a very ingenious one, and, in my opinion, likely to lead up to other uses of importance, in which the principle embodied could be successfully applied, in addition to those indicated by the lecturer.

Mr. WALTER GORDON WILSON: Might I ask a question? As regards the increased range of the torpedo, it seems to me to keep your torpedo at the surface of the water; you will not be able to see your torpedo at any greater distance than

the present torpedo with floats. After that you could only steer point by point, and I calculate that in a distance of 3,000 yds., supposing you deviated from your course by half a point, it would give an error of something like 275 yds., which I fear would make the increase of range of not much value.

Mr. LOUIS BRENNAN, C.B.: Mr. Chairman and gentlemen,—I am very sorry that I cannot enter into a discussion on this very interesting subject, because, owing to my connection with the Government, it would lead me on to matters that I feel I should not speak about. My object in rising is simply to correct a statement made by the lecturer at the commencement, when he mentioned something about the "Army and Navy Gazette" having stated that I said no other method than steering by a mast could be adopted. I think that was the statement made. I never remember having the pleasure of meeting the editor or any of the staff of the "Army and Navy Gazette," but it is quite possible I have said I do not believe in any system of controlling a torpedo unless you could see the precise position of the weapon while it is running. And if I made that statement, which, no doubt, I have done, it was not because I had not thought out a system of this kind myself, but because I had thrashed it out and had abandoned it as impracticable. These are the only words I have to say. I can only join in what other speakers have said as to the ingenuity and cleverness of Lieutenant Sleeman in his work, and express again my sorrow that I cannot enter more minutely into a discussion of the details.

Lieutenant SLEEMAN: In reference to what Mr. Brennan said about the remark that he is alleged to have made in the "Army and Navy Gazette," and quoted by me, it does not specify any particular mode of running controllable torpedoes, but refers only to the present system. This remark has been published in my book, but whether Mr. Brennan ever said it or not I do not know. As regards Captain Anson's remark as to the relative position of the ship and torpedo, I am afraid I did not explain myself at all clearly. The indicator board represents a plan of the waters in which the particular torpedo attack is to take place, and is on a scale of 200 yds. to the inch; the torpedo track indicator is on the same scale, and the endless screw carrying the model torpedo is so arranged that it travels along this track indicator at the same relative rate as the actual torpedo travels under the water. Thus, if I place this track indicator on the indicator board at the point where the torpedo is lying at rest, and on that course which the torpedo is heading on, and I start them both together, I get on the indicator board the path of the torpedo in the water, provided she runs on that particular course, which I know by the galvanometer. The only thing I do not know is whether she is drifting bodily by the tide; that is one of the horrors of torpedo running. If I find the torpedo has gone off a point, I turn the track indicator accordingly. So that I really get on the indicator board the path which is made by the torpedo as near as you can get it by such an arrangement. If to-morrow I had the money given me to put this invention into a torpedo and showed the torpedo running absolutely out of my sight so as to strike a moving target at any distance within her range, without my seeing the torpedo at all but only the target, that is, I think, good enough, and I am perfectly sure I could do it. I have had a tremendous lot of trouble with torpedoes run like the Nordenfelt, the Sims-Edison, and the Patrick, and I think anything you can do to get rid of these floats is worth attempting. I think Mr. Brennan will admit that if anybody can run his torpedo as well as it is run now, but without the masts, that will be something gained. Then there was a question about tidal set. Of course if you were running a torpedo at Portsmouth, or Plymouth, or Brighton, or elsewhere, you would insure her being manœuvred by an operator familiar with the tides of the particular locality; while, when feasible, you would not rest your attack and defence on a *single* torpedo.

The CHAIRMAN (Admiral Colomb): Gentlemen, I am sure you will heartily join with me in offering Lieutenant Sleeman our thanks for his paper on the very ingenious and carefully described instrument that we have had before us. But I dare say a good many of you feel with me that in an exceedingly complex piece of business such as this is, one cannot grasp the whole of it at once. One cannot quite see in every respect how far such an instrument as this might be applicable. I think the lecturer was just in that difficulty, leaving too much to explain before we

could pronounce an opinion upon the value of the proposal. I am afraid for myself I am a bad person to sum up a discussion on a subject of this kind, as I admit myself prejudiced against dirigible torpedoes of all sorts, sizes, and shapes. My feeling about it is, that if you want to torpedo a ship you had better go to work as the "Almirante Condell" and the "Almirante Lynch" did on the coast of Chili. I do not feel that you can carry these things to a very high scientific point, and I cannot help thinking you might have this instrument quite perfect, and doing all that the lecturer hopes it would do, and yet that it would be too theoretical in its action to come into practical use. I think that, generally speaking, we want something rough. I suppose Mr. Brennan's invention, up to the point that he goes to, is of practical value, although I am afraid I should have been hostile to that if I had had anything to say of its initiation. The immense amount of time and thought that Lieutenant Sleeman must have given to this we must all appreciate: and the difficulties he must have got over in manipulating his compass so as to get it to actually work, most of us will understand. With regard to the failure or not of the electrical arrangements I am not competent to speak at all. I think the real practical difficulty—we seem to be all running on it—was that question of observing the distances of torpedo and target; you might know the direction by this instrument very well, but the real question is to get the direction *combined with the distance*. Although Lieutenant Sleeman repudiated any particular originality in the instrument he proposes to employ for this purpose, I cannot but think that there is a great deal of originality in the idea, actually putting in motion a sort of model torpedo to scale, so that he would have his bearing and his distance before him under his eye at the same moment. To some extent, if it would work, it would meet our point. Whether it would work or not I think is quite another question. But whatever may be our views upon the utility of the instrument before us, we must all sympathise very strongly with Lieutenant Sleeman in his endeavour, and I think we may all offer him our thanks, and hope that, after all said and done, when times get a little easier he may get some financier to take the thing up and let us see what it really means, because I feel quite strongly none of us can see exactly what it means, or exactly what the inventor thinks it means, till it has actually been tried on a full scale.