smaller except when in practice it is desirable to press the slice over very firmly on to the last slice, cut B. From Fig. 50 the five principal positions of the centre of gravity of the section, illustrative of the work done, are shown. A uniform twist, it will have been seen, is thus undesirable; a convex surface becomes necessary to obtain the proper twist, and a concave surface is undesirable, because too large an area is in contact, at any section, with the slice, and by it the upper and lower angles of the slice are broken and rubbed off. Mr. J. E. Ransome has found that any part of a turnfurrow which presents an angle greater than that shown at X, Fig. 48, should not bear upon the slice over more than about one-fifth of its whole width. The turnfurrow which conforms to these conditions is much like that shown at Fig. 47, but the most recent forms for general purpose ploughs will be shown hereafter. Returning to the trials at Warwick in 1859 referred to in connection with Fig. 47, we may give some of the figures obtained as showing the decrease in draught as compared with the ploughs tested by Mr. Pusey. In heavy land the furrow slice was 12in. by 9in., those for light land are not recorded, but were probably about 9½in. by 6½in., and 9in. by 5in. for general purpose ploughs.

Draught of Ploughs in 1859.

Heavy Land. Maker.	Draught. lbs.	Light Land. Maker.	Draught. lbs.	General Purpose. Maker.	Draught. lbs.
Hornsby	132·33	Hornsby	139·76	Howard	123·35
Ransome	138·475	Ransome	136·00	Ransome	117·35
Howard	132·25	Howard	138·46	Hornsby	120·20
Ball	127·33	Hensman	142·30	Hensman	112·63
Busby	137·00	Busby	135·00	Busby	117·10
				Ball	115·90
Mean	133·437	Mean	138·30	Mean	117·83

There are so many conditions affecting the working of even the same plough that it is at all times difficult to make comparison between different ploughs tried on different lands. In Mr. Pusey's experiments the draught was greater in heavy land than in light land, while the above figures show that on the light land at Warwick the draught was the greater. The condition of the land in respect of stones, roots and weeds, and slight differences in the proportions of alumina and sand, hardly distinguishable by feel or examination, make much difference in the toughness of the soil and the difficulty of working. For purposes of a rough comparison, however, between the effective work to be done by horses on a plough in 1839 and in 1859, we may take Mr. Pusey's figures for the 9in. by 5in. furrow to compare with those of the general purpose ploughs of 1859. Mr. Pusey gave his draught as 16⅛ stones. This is 226 lb. as the mean, or, taking the plough of lightest draught—12 stones—168 lb. The mean draught of the 1859 ploughs was but 117·83 lb., and the minimum draught 112·63 lb. The mean draught in 1859 of a general purpose plough was thus only about 50 per cent. of what it was in 1839; while the heavy land modern plough turning a furrow 12in. by 9in. worked with about 44 per cent. of the power required in 1839 to make a 9in. by 7in. furrow in light land.

AGGRESSIVE TORPEDOES.

The U.S. *Army and Navy Journal* of October 4th contains an interesting article on aggressive torpedoes, from which we make the following extract:—

Compressed air has been deemed an indispensable agent in propelling and manipulating aggressive torpedoes. Our readers are aware that the Whitehead "fish torpedo" is propelled by a small motive engine actuated by compressed air supplied by a cylindrical reservoir contained within the body of the torpedo, into which atmospheric air is pumped when the aggressive instrument is to be used, until it reaches a tension of nearly 1000 lb. to the square inch. Compressed air of less tension is also employed to start the "fish torpedo" in the direction of the object intended to be struck.

Captain Ericsson has devised an aggressive torpedo of great speed, composed principally of light wood and actuated by compressed air without employing internal motive machinery. The expedient adopted is that of converting the potential energy of compressed air contained in a capacious reservoir, into kinetic energy imparted to the torpedo. The preliminary trials on the Hudson, reported to the Bureau of Ordnance, recorded a mean rate of fifty-three nautical miles for the first 250ft. by employing air of the moderate tension of 150 lb. to the square inch. It should be observed that the areas of the bore of the torpedo tube and its propelling piston were greater than the sectional area of the torpedo, hence the extraordinary velocity attained by such moderate pressure.

The favourable result of the preliminary trials on the Hudson induced Captain Ericsson to construct a vessel, the Destroyer, for the purpose of handling the new aggressive weapon. In our description of the Destroyer and the several notices relating to her speed trials towards the close of last year, we made no allusion to the torpedo gear, then not quite finished, our intention being to furnish a detailed description when presenting a record of the torpedo trials intended to have been conducted last summer. Before the commencement of these trials, however, the constructor had elaborated a new method of expelling the torpedo which dispensed altogether with compressed air, thus rendering the intended minute description of the torpedo gear of the Destroyer superfluous. It will be instructive, however, to mention that a large reservoir capable of sustaining any desirable pressure is suspended under the intermediate deck of the Destroyer, nearly filling the vessel forward of the chimney; a torpedo tube 20in. in diameter, 33ft. long, being applied near the bottom and passing through the stem. The mouth of this tube is closed by a sea-valve of peculiar construction, which when open offers scarcely any resistance to the progress of the vessel. An engine of 150-horse power is applied abaft the main engines, actuating the compressor machinery, appropriate tubes conveying the compressed air to the reservoir at the bow.

The new method of manipulating torpedoes devised by Captain Ericsson, which we are now considering, is based on the fact that gunpowder is virtually potential energy stored within a very small space and procured without the expenditure of mechanical power; while the compressed air stored in the reservoir is potential energy demanding a very large space, and called forth by a great expenditure of steam and engine power. The striking contrast between these two potential energies, in favour of the new method, does not end here: the powder is always at hand, the compressed air calls for an expenditure of the important element of time, which, during torpedo operations, will, in most cases, defeat the object in view; for while a Whitehead torpedo intended to take the place of one that has just missed its mark is being charged, the enemy may change his position or retreat.

The important problem then presents itself—Can the violent energy of gunpowder be made available in propelling the heavy, bulky, and comparatively weak body of the torpedo, without crushing or splitting the same. This problem the designer of the Destroyer determined to solve last spring, and for that purpose applied to the Secretary of the Navy for permission to use a 15in. gun and carriage to conduct experiments with. The application met with a favourable reception from the hon. secretary, and the Chief of the Bureau, Commodore Jeffers, caused a navy 15in. gun and carriage to be forthwith mounted on the gun scow belonging to the Ordnance Department, at the New York Navy-yard. He also instructed the Inspector of Ordnance, Captain Matthews, and his assistants, Lieutenants Hanford and West, and gunners, to assist during the experiments. The gun being thus placed at his disposal, Captain Ericsson applied to it a hinged cylindrical extension secured to a muzzle ring bolted to the termination of the chase, as shown by the annexed illustration, representing a sectional plan and side elevation of the piece. The principal object of this cylindrical extension—partially open at the top during the preliminary trial—is that of sustaining and directing a torpedo 19ft. long, pointed at both ends, and proportioned to carry an explosive charge of 250 lb. at the head, the tail being provided with a cast iron armature to balance the weight of the charge and receive the thrust produced by firing the gun. The object of the hinge is that of enabling the gunner to swing the extension to one side for the purpose of facilitating the sponging of the piece. The sectional plan, on which the outline of the torpedo is marked, shows the propelling piston, composed of cast iron, employed to transmit the initial energy of the charge and the gradually diminishing energy of the expanding powder gases. The tail end of the torpedo is made blunt in order to withstand the crushing effect of the great pressure brought to bear upon it. An elastic cushion composed of discs of pasteboard is inserted between the bottom of the piston and a loosely fitting disc applied between the cushion and the blunt end of the torpedo. It will be observed that the propelling piston is placed at a considerable distance from the charge, the latter being located near the termination of the chamber and contained in a flannel bag supported by a conical piece of wood held by a slender iron rod inserted in the bottom of the piston. A charge of 8 lb. of powder, composed of hexagons weighing 96 grains each, was employed during the entire series of experiments, its volume being 216 cubic inches, while the actual volume of the explosive body (weighing 8 lb.) was only 135 cubic inches, and the unoccupied contents of the chamber 2997 cubic inches. It will thus be seen that the air space was 2997-216ths=13·83 times greater than the volume of the charge, and 2997-135ths=22·20 times greater than the actual volume of solid powder. Notwithstanding this extraordinary disproportion of charge and air space, it was found during the trial that a bright flame issued from the muzzle of the gun at each discharge following the expelled propelling piston for a distance of nearly 8ft. This circumstance becomes the more remarkable when the fact is taken into consideration that the total internal contents of the gun in rear of the propelling piston, at the instant of leaving the bore, is 24,377 cubic inches or nearly 112 times greater than the volume of the charge. The internal pressure, indicated by the flame issuing from the gun after such an extraordinary expansion of volume, can only be accounted for by assuming the combustion of the powder gases to be perfect owing to the presence of a large volume of atmospheric air. Obviously the great compression of the air in the chamber at the instant of explosion brings the particles of the oxygen of the confined air into closer contact than even in pure oxygen gas under atmospheric pressure. This consideration accounts satisfactorily for the perfect combustion indicated by the bright flame issuing from the gun, notwithstanding an expansion in the ratio of 112 to 1 as compared with the volume of the charge, and 178 to 1 compared with the actual volume of the explosive body. Experts cannot fail to regard the foregoing facts as very important, proving as they do that the explosive energy of gunpowder is not, as generally supposed, a mere momentary development of energy. The result of the trial is conclusive in this respect, and shows that the developed power may be controlled, and to some extent regulated as we regulate the expansive force of permanent gases.

As already stated, the torpedo employed during the experiments is made of wood, 19ft. long, exactly fitting the bore of the 15in. gun, its weight including that of the propelling piston being 1281 lb. It should be mentioned that the flight of the torpedo during the trial presented several remarkable features, especially in regard to the position of its axis, which in place of retaining parallelism with the axis of the gun, gradually changed its inclination corresponding exactly with the curvature of the trajectory near the termination of the course. On the other hand, no deviation whatever was observed in the vertical plane of the trajectory, the course being perfectly straight.

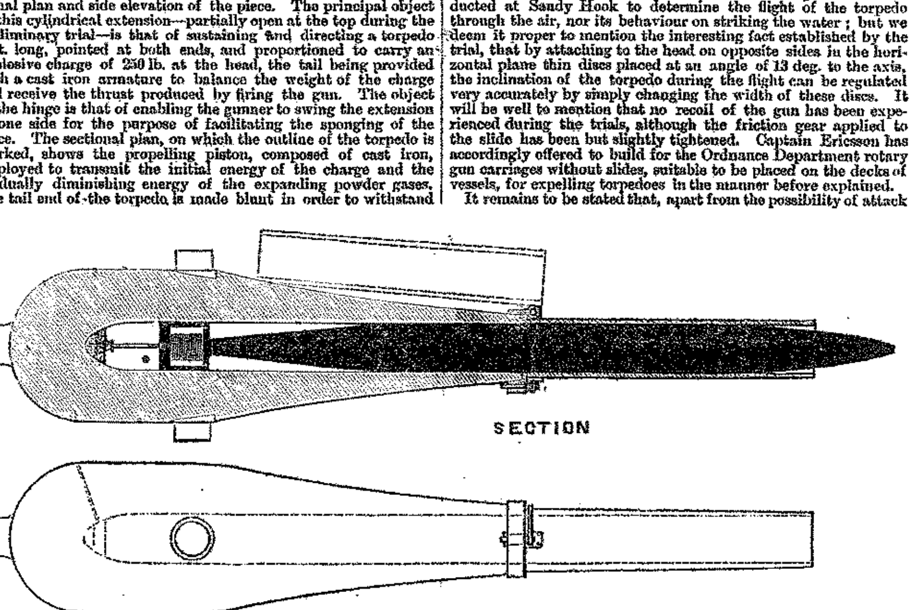
We have omitted to state that the experiments were commenced on the west side of the Hudson, but as the bottom there proved very soft, the gun scow was towed to the Horse Shoe, near Sandy Hook, where the bottom is very firm, being composed of fine sand. It should be mentioned also that during the experiments on the west side of the Hudson two torpedoes were lost by striking the water at a considerable angle and entering the soft bottom at nearly full speed. The entering force, estimated at upwards of one million foot-pounds, caused both torpedoes to disappear completely. At Sandy Hook, however, the bottom proved to be so firm that the torpedo, the weight of which is somewhat less than its displacement, invariably floated to the surface at whatever angle it struck the water. It will be asked, what became of the propelling piston which, being composed of cast iron, of course dropped into the sea after having parted company with the torpedo during its flight through the air? The answer is, that owing to the firmness of the bottom the piston was recovered at each discharge of the torpedo, excepting the one which terminated the trial. It is scarcely necessary to mention that spare pistons were provided, and at hand, in case of such accidents.

Captain Ericsson discovered a mode of discharging torpedoes from the 15in. navy guns, entering the water near an enemy's vessel, and then proceeding in an inclined straight line until the lower part of the hull is reached. This device, which has been supposed to be impracticable on the assumption that the torpedo during its flight retains the inclination of the axis of the gun, can no longer be regarded as a visionary scheme, since the recent trial has shown that the angle of the axis of the torpedo on striking the water at the end of its course coincides with the angle of fall of the trajectory. Again, the original torpedo experiments on the Hudson, before referred to, showed that when the torpedo after a short flight through air at a small elevation is laid flat on the water, it proceeds at a high rate of speed in a straight course near the surface. Our professional readers will be interested to learn that Commodore Jeffers thinks that this mode of projecting torpedoes towards an enemy's ship will prove very effective.

As we are only dealing with the question of substituting powder for compressed air in manipulating aggressive torpedoes, it has not been our intention to present a record of the experiments conducted at Sandy Hook to determine the flight of the torpedo through the air, nor its behaviour on striking the water; but we deem it proper to mention the interesting fact established by the trial, that by attaching to the head on opposite sides in the horizontal plane thin discs placed at an angle of 13 deg. to the axis, the inclination of the torpedo during the flight can be regulated very accurately by simply changing the width of these discs. It will be well to mention that no recoil of the gun has been experienced during the trials, although the friction gear applied to the slide has been but slightly tightened. Captain Ericsson has accordingly offered to build for the Ordnance Department rotary gun carriages without slides, suitable to be placed on the decks of vessels, for expelling torpedoes in the manner before explained.

It remains to be stated that, apart from the possibility of attack by throwing aggressive torpedoes from the decks of vessels, the dispensing with the internal propelling machinery employed by Whitehead opens a wide field for the application of the submerged torpedo tube. Obviously such a tube may—as pointed out by the patentee in his American and English patents—be suspended from the sides of vessels of all classes, and submerged at any desirable depth. Nautical experts can best determine the utility of aggressive torpedoes expelled from such tubes in a naval action.

The success which has attended the substitution of gunpowder for compressed air as a means of expelling torpedoes now enables the constructor to remove from the Destroyer the entire air compressing machinery as well as the large air reservoir which is at present suspended under the intermediate deck of the vessel. Much space will thus be saved for the accommodation of coal, at present too limited; while considerable reduction of the cost of construction will be effected in future vessels, the enhanced cost of a torpedo tube of increased thickness being inconsiderable. The most important advantage, however, attending the substitution of powder for compressed air will be that of saving the time lost during the operation of charging, inseparable from the Whitehead system. In action this loss of time may prove fatal, since a vessel capable of expelling her torpedoes in rapid succession will certainly defeat an opponent compelled to remain inactive while the charging process is going on.



ERICSSON'S AGGRESSIVE TORPEDO.

A Simple Message Transmitter.—In a recent impression of *La Natura*, Signor Guisseppe Serra Carpi, says:—"I have lately constructed an apparatus by means of which anyone can transmit or decipher telegrams, using the Morse system, without previous study. I must premise, however, that my plan is designed only for use in exceptional cases, and not in ordinary telegraphy, where the skill of a professional operator is indispensable. The illustrious Morse himself invented, if I mistake not, an apparatus to enable non-experts to send messages, but it was too complicated and difficult of transport to be of much practical value. My apparatus consists of a square piece of cardboard that can be folded into four for convenience of carriage. In this are made a number of openings parallel to each other and to the sides of the cardboard, so that, passing underneath a thin sheet of metal, the surface shows so many metallic rectangles separated from each other by equal intervals, one for every sign required in telegraphy. Thus the letter A would be represented by a short metallic rectangle followed by a longer one, the letter itself being clearly written to the left of the signs. Of the four compartments of the board, two are occupied by the alphabet, one by the stops, and one by the ciphers. In order to send messages by means of this board a little fork must be used composed of two conducting wires, insulated from each other, enclosed in a glass tube to the ends of which they are fastened. At one end the tube terminates in two tongues of elastic metal, and parallel to each other at a distance of about two millimetres, and communicating respectively with the two wires within the tube. These latter are also attached to two other wires, flexible in the highest degree, and insulated from each other, which communicate with Nos. 1 and 3 of the key-board, so that the two tongues form the ends of an open circuit which will be closed every time that an arc of conductivity is formed from the one to the other. It is easy to see, then, that drawing the fork with a certain degree of uniformity over the various series of metallic plates there will result such and so many completions and interruptions of the circuit as to form the dots and dashes of the Morse alphabet. In practice I have found the system answer admirably, giving the signs with the utmost regularity and clearness. I may observe that the metal fork should not be too stiff, in order that it may press lightly on the plates, and further, that these latter should be prepared so as to resist the ordinary influence of the air. I need scarcely point out how useful this apparatus would prove in various cases, for instance, as summoning the fire brigade from distant stations. It is admirably adapted for field telegraphy. I have only to add that, to enable non-experts to read messages received, I have devised a card, having the letters of the Morse alphabet disposed in groups according to the number of signs in their composition. In this way the receiver, having counted the number of dots and dashes in the letter, has to search only in a limited group, instead of looking through the whole alphabet."—*Electrician.*