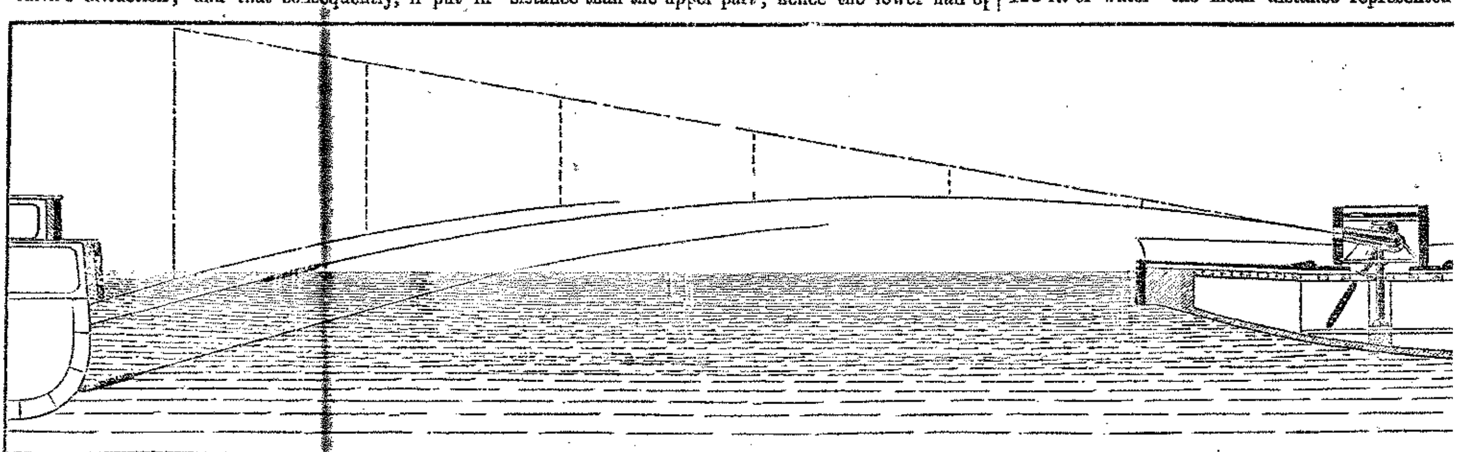
# A NEW SYSTEM OF SUBMARINE ATTACK.

To the Editor of Engineering.

Sir,—Agreeable to my letter of March 11th, I now propose to describe the general features of my new system of submarine attack.

In the communication alluded to, I stated as a general proposition: that a heavy body of regular form, of any density whatever, moving through the atmosphere, is inexorably under the influence of the earth's attraction, and therefore describes a fore-shortened parabolic curve during its flight; while a submerged body, the weight of which is equal with the weight of the water it displaces, is not affected by the earth's attraction; and that consequently, if put in



motion under the surface of a quiescent fluid of unlimited extent, such a body will continue to move in a *straight* line until the motive energy which propels it, becomes less than the resisting force of the surrounding medium.

In virtue of the first part of this general proposition, a heavy body may be projected in such a manner that the termination of its trajectory shall make any desirable angle, less than 45°, with the horizontal line, independently of the length of the chord of the trajectory. In other words, the body may be projected at *variable* distances over water, and yet strike its surface at any desirable angle. This important result is effected simply by varying the relative proportion between elevation and strength of charge. The second part of the stated general proposition is of equal importance. It points to the fact that the trajectory may be extended in a straight line under water, to any desirable distance, irrespective of the *speed* of the projectile. Accordingly, a shell may be projected from one vessel towards another within moderate ranges, in such a manner that it shall dip into the water at a considerable distance from, or close to the vessel assailed, independently of the distance between the two vessels. Also that the shell may be projected at such an angle that the prolongation of its trajectory in a straight line, after contact with the water, shall strike the hull of the vessel assailed, at any desirable depth below the surface.

That a certain relation between charge and elevation enables us to project a *spherical* shot, with considerable accuracy, in such a manner as to strike the water at any desirable distance from an opponent's vessel, at angles within 45°, will be admitted. Hence, if the trajectory be such that its extension in a straight line from the point of contact with the water leads to the hull of the vessel assailed, the latter will be hit—on condition, however, that the shot is not diverted on entering the water; and provided its vis viva be sufficient to overcome the resistance encountered during its passage through the water. These indispensable conditions, which apparently cannot be complied with, point to the difficulty of hitting a vessel below the water line. And if we suppose that the projectile is not spherical, another serious difficulty presents itself. An *elongated* body will not bend to the curvature of the trajectory, but retain during its flight the same inclination as the gun from which it has been projected; hence it will fall nearly flat on the surface of the water at the end of its course.

Agreeable to our general proposition, a regular body, weighing as much as the water it displaces, is independent of the earth's attraction; but there is another force which, notwithstanding the absence of any gravitating tendency, will cause a body of regular form moving under water to deviate from a straight line tion of its apex and in the line of its axis horizontally, or on an incline, will, owing to the inertia and the nearly incompressible nature of water, more readily displace the column which rests upon and depresses its upper half, than the column from below with its lifting tendency. Consequently, the course of the conical body will be diverted from the straight line upwards, describing a curve nearly elliptical, and quite sudden, if the speed be great. A cylinder with semi-spherical ends will, from the same cause, ascend to the surface if moved in the line of its axis; while a cylinder with flat ends will take a downward course, gradually increasing its inclination until at last the axis assumes a vertical position. Obviously, the lower part of the forward flat end encounters a greater resistance than the upper part; hence the lower half of the transverse section of the cylinder suffers an excess of retardation, which occasions the downward course described.

The question whether the apparently insuperable difficulties thus pointed out may be overcome by mechanical expedients, has, as already stated, occupied my attention for a long time; and numerous experiments have been made to test the efficacy of devices resorted to on theoretical considerations. But it is not my purpose to enter on a description of these devices at present, on grounds that will appear hereafter. Accordingly, I will assume that the axis of the elongated projectile during its flight through the air is parallel with the trajectory, and that on entering the water the projectile will not be diverted, but continue to move under the surface, with the same inclination it had on coming in contact with the dense medium.

The accompanying sketch presents the main features of my new system of submarine attack so distinctly, that it will be superfluous to enter on a general explanation of the nature of the scheme. It may be well to state, however, that the elongated shell is charged with dynamite and provided with a percussion lock and trigger, to be actuated as described in my former communication relative to the self-acting torpedo.

It is well known that numerous plans have been suggested, during the last few years, for firing under water, for the purpose of piercing the hull of ironclad vessels below the point protected by the armour. In several instances these plans have been carried into practice, with the invariable result that the resistance of the water has been found so great, even at very short distances, that an ordinary wooden hull has proved to be impenetrable. The plan now under consideration bears no resemblance to these projects. In the first place, the attack is made at a distance; and, secondly, the force of the missile on reaching its destination, need only be sufficient to actuate the trigger which causes the ignition of the explosive charge.

Apart from the theoretical considerations relating to the course of the elongated shell under water, the practical question of *motive power* to propel the shell presents itself at the first step in the investigation. It is hardly necessary to state that the force relied upon is the vis viva possessed by the shell on coming in contact with the water. Before estimating this force it will be proper to call attention to the fact, that my new system to be effective and a practical success, does not call for attack at a great distance, provided the vessel from which the missile is projected has greater speed than the opponent, and at the same time adequate protection against his artillery. No reason whatever can be assigned why the attack should not be successful, and the destruction of the vessel assailed as certain if the distance of 500 ft. were the limit, as if a range of 5000 ft. better suited the new system. It will be no special limit within ordinary ranges, the plan i attack at distances not much exceeding 500 ft., un the sea be very smooth.

The vis viva of a shell 15 in. in diameter, of suc length that it displaces 500 lb. of water, may be rea estimated if we suppose the charge of powder in gun to be so regulated that the shell will enter water at the required rate of 400 ft. per second; tl

$$\frac{400^2}{64} = 2344 \times 500 = 1,172,000 \text{ foot-pounds.}$$

A cy drical body 15 in. in diameter, with semi-spherical e moving at a rate of 50 ft. per second under wa requires a constant motive force of somewhat less t 400 lb. Assuming, then, that the shell passes thro 120 ft. of water—the mean distance represented the accompanying diagram—we have a resistance $120 \times 400 = 48,000$ foot-pounds to overcome. motive force, it will thus be seen, is more than t times greater than the resistance; hence no doubt be raised as to the adequacy of the motive power nished by the vis viva of the shell. It should be served, that the resistance is very great at first, that the speed of the shell diminishes in a very ra ratio; but it would be futile to present a formula pressing the ratio of speed and resistance since *form* of the body is the chief element in the calc tion. Suffice it to say, that while the resistance aga a blunt body is so great that it can hardly be o come, one provided with a sharp point enters the w with much facility, even at the rate of 400 ft. second. The passage of the shell through the w will, therefore, be sufficiently rapid to reach the des object in proper time.

With reference to the gun, it should be born mind, that the very low speed of the shell, and consequent small charge of powder needed, re heavy metal unnecessary. Besides, slow burning c powder contained in cellular cartridges, will be ployed for the purpose of checking rapid ignition, in order to sustain a uniform pressure during the charge. By reference to our sketch it will be s that the guns are loaded from below, and for purpose so arranged as to admit of being depre 60°. Gun carriages are dispensed with, the trunn being suspended by adjustable pendulum links sec under the turret roof. The recoil is checked by bu attached to the turret wall in rear of the breach.

I feel called upon to state, that loading guns be deck, as here shown, was planned by me, and draw representing this method exhibited in New York sev years before it was claimed by certain American e neers as their invention.

Respecting the safety of the charge in the shell t ignition during the discharge, it will be well to serve that efficient means have been devised to pre such an accident. With reference to the *calibre*, evident that this system of attack calls for dimen that will admit a shell of sufficient capacity to co a charge which by its explosion will destroy a class ship of war built on the cellular plan. Not short of 300 lb. of dynamite will suffice for this purp hence nothing less than 15 in. calibre will ans The American and Swedish 15 in. guns are admi calculated for the purpose, although they are unn sarily heavy.

European savans, especially certain Swedish r artillerists who have criticised my advocacy of the l smooth-bore gun, will understand on looking into matter, why I have persisted in advising the Scan vians to carry this large calibre in their mo turrets as the most effective weapon against no cause to fear the Prussian König Wilhelm or Friederich der Grosse, when their ports are defended by vessels armed with guns by means of which 300 lb. of dynamite may be exploded under the hulls of the intruders.

The important question of hitting the intended object will be best answered by a careful examination of the accompanying diagram, which cannot fail to convince naval men that, in moderate weather, the elongated shell may be made to dip at the proper distance from an opponent's vessel. The diagram clearly shows that no great accuracy is called for, and that the shell may dip at various distances from the vessel assailed and yet strike the hull. It should be observed that the vertical scale of the diagram is different from that of the horizontal, in order not to place the vessels too far apart for the limited size of this page; consequently the trajectory shown is distorted.

The turret, it may be briefly noticed, in which the light 15 in. shell guns are mounted, is composed of flat wrought-iron plates forming a square box, wide enough to accommodate the two pieces, suspended as already stated, by pendulum links secured under the turret roof. A massive central shaft of wrought iron supports the square box, on the plan adopted in the monitor turrets. The vessel designed to carry the rotating square box with its light shell guns is a mere iron hull crammed with motive power, in order to insure a higher speed than that of existing ironclad ships of war. The midship section is triangular, and the bow raking, as indicated by our sketch. The overhanging sides and deck are heavily armoured.

Permit me to add, for the information of your readers, that I intend to make a formal offer, under certain stipulations, to furnish, at my own cost and risk, a swift screw vessel provided with a pair of 15 in. smooth-bore guns, and the necessary apparatus for sinking by submarine explosion, a vessel of the average draught of the ironclad fleet of England, while such a vessel is being towed at the greatest speed possible, or performing whatever evolutions her owner may choose, with the distinct understanding that the attack shall not be made at a less distance than 500 ft. Accordingly, it has not been my purpose on this occasion, to enter into a full description of my new system of submarine attack. It may be well, however, to define clearly what the scheme is intended to accomplish. If a first-class swift ironclad ship, say the Devastation, unassisted by other craft, will meet in open water a vessel constructed agreeably to the new system, it is contended that the latter will sink the breast-work monitor in spite of her guns, and notwithstanding evolutions designed to avoid the submarine missile.

Yours truly,
J. Ericsson.

New York, March 27, 1870.

The Des Moines Valley Railroad, Iowa, U.S.A.—Subscriptions are invited by Messrs. Chadwicks, Adamson, Collier, and Co. for an issue of 8 per cent. mortgage bonds to the amount of 2,000,000 dols., of the Des Moines Valley Railroad, Iowa. The bonds, which are of 1000 dols. each, and issued at the price of 95 per cent., are a first charge on the line and on 365,000 acres of land, and are redeemable at par in 1898.

Death of William W. Cornell.—This well-known and highly esteemed citizen of New York died at his residence, on Washington Heights, on the 17th ult., of typhoid fever. Mr. Cornell began life depending entirely upon his own energies. He served a regular apprenticeship of seven years at the buiness in which he subsequently became distinguished. In 1847, in partnership with his brother, J. B. Cornell, he established his iron foundry, employing at first, by reason of the small capital possessed, but one man. The original manufactory was located in Center-street. Here the business of the deceased gradually increased until at the end of ten years it had attained to such large proportions that it was necessary to move to another locality. During this year the firm constructed their great foundry in Twenty-sixth-street, between Tenth and Eleventh avenues, and which has since remained the principal one owned by the brothers. Mr. Cornell's name is conspicuously associated with the progress of the use of iron as a building material, many of the best known edifices in the country having been constructed by him. Among them we can name the United States Custom House at Savannah, Ga., the Sun Atlantic Mutual Insurance Company, A. T. Stewart's, H. B. Claflin and Co.'s, Blank of New York, Bank of Commerce, Union Bank, Ball and Black's, and the *New York Herald* buildings. These are but a few of the many fine structures which will long remain monuments to the skill of the firm of J. B. and W. W. Cornell. Indeed, owning as the deceased did, the most extensive and completely equipped works in the United States for the construction of fireproof building, it is not surprising that he, with his brother, held the foremost position among our iron founders. In his private life Mr. Cornell was distinguished for many sterling and amiable traits of character, and was very liberal in his gifts, especially to the Methodist Church, of which he was a member.—*Scientific American.*

## THE GENERATION OF STEAM BY GAS.

The difficulty, and in some cases the impossibility, of employing steam power in warehouses and similar buildings, has long been felt. The difficulties have arisen from the circumstance that where the use of the engine is only occasional during the day, the expense of maintaining steam is very considerable. Further, the extra premiums charged by the insurance companies are very heavy where an ordinary steam engine and boiler are even permitted to be used in warehouses. Space also is sometimes such an object in this class of buildings, that the use of steam is for this reason alone prohibited. All these difficulties, however, are overcome in a compact and well-arranged system of engine and boiler, which has been designed by Mr. Arthur Jackson, of No. 1, Loman-street, Southwark. In this apparatus the steam is generated and maintained by gas, and is so safe that the insurance companies do not require any additional premium. The apparatus consists of a cylindrical tubular boiler heated by jets of gas mixed with air, and from which steam is supplied to a small vertical cylinder engine, which works the hoist, lift, or crane, as the case may be. The engine and boiler are in some cases carried on a small bed-plate, and at once embody compactness, safety, cleanliness, economy, and simplicity. After the steam has once been raised to the working pressure, usually 60 lb., it is maintained at a pressure of 40 lb. while the engine is out of use, by a few jets of gas. This renders the apparatus especially suitable for intermittent work, such as is common to warehouses and similar establishments. About thirty of these engines have been laid down in and about the City during the past three years, and are all working satisfactorily. The most recent example of these engines is one which has just been erected in the Crutched Friars tea warehouses of the East and West India Dock Company in Hart-street, Mark Lane, and which we recently inspected. This apparatus is used for the purpose of lifting the teas, the work having been hitherto effected by manual labour, as steam has been strictly prohibited in the building. In the present instance, the apparatus is fixed on the fourth floor of the building, which is five stories high, exclusive of a ground floor and basement. The boiler is placed in a corrugated iron house, carried on cantilevers, outside the building, the engine and apparatus being just inside the warehouse. The boiler, which is of the vertical tubular type, is of 2 horse power, and occupies an area of 3 ft. square, it is 2 ft. in diameter, has 164 tubes, and is heated by gas mixed with air, steam being generated very rapidly. The crane or hoist is worked by a vertical cylinder 6 in. diameter and 10 in. stroke. It operates a cage 7 ft. by 5 ft. 6 in., and which is raised by the engine and lowered by gravity, a friction brake being attached to the chain barrel of the engine for that purpose. Up to the present time the dock authorities have been pleased to go on warehousing their teas in the style of their forefathers, the first importers. In this special portion of the warehouses thirty-six men have been employed from time immemorial in lifting tea from floor to floor by the staging process. Now at one fell swoop Mr. Jackson has knocked off thirty-four, retaining only one to tend the hoist below and one to drive the engine above. The cost of working is very moderate, and varies with the work done and the cost of gas per thousand feet. With an engine such as that we have just described the cost is found to be about 5s. per day for gas. Or, to bring it into lower terms still, in constant working the boiler consumes 100 ft. of gas per horse power per hour; how much less is required depends upon the time the engine is in actual work. During our visit, steam was maintained at 75 lb., and the hoist was in active operation and worked very satisfactorily. There are unquestionably many advantages attending this method of generating steam, to which its increasing adoption bears testimony. Another important point should not be lost sight of, and that is that the adoption of this method of working hoists and cranes, if more general, would tend, by the rapidity of delivery it ensures, to facilitate the circulation of heavy vehicles in some of our over-crowded thoroughfares.

Brunel's Timber Roof at Birmingham.—The Snow Hill Station of the Great Western Railway at Birmingham, with which most of our readers are doubtless familiar, is about to be removed, together with Brunel's fine timber roof. This structure will be superseded by an iron roof and new offices of more commodious character. The old roof is an excellent example of carpentry, and, as such, deserves further notice at our hands which we purpose shortly to give it.

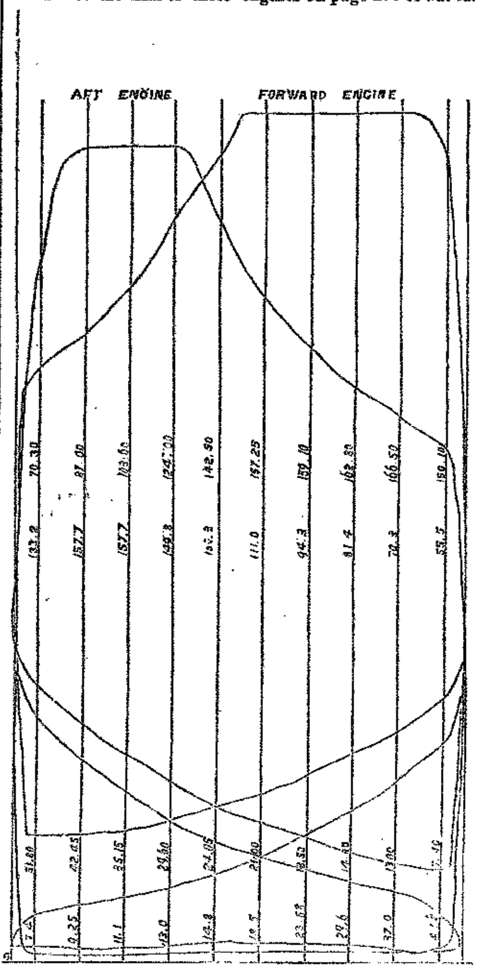
Instruments of Horse Torture.—At the Royal Institution on Friday night, on the occasion of Professor Huxley's lecture on the horse, there was exhibited a number of large razor-edged flint stones, some with frightfully jagged edges with most terrific points, and many of them of great size. These were picked up from the roads as specimens of the cruelty inflicted on horses, at the present time. The inscription upon the black board to which they were attached was as follows:—"Instruments of Horse Torture employed in the Nineteenth Century on the Roads of the South of London, within the four-mile radius of Charing-cross. April, 1870." The indignation felt was very great that such frightful barbarism should be practised at the same time, when by the adoption of the steam roller by the public bodies all these sharp stones could be pressed into the earth, and a perfectly flat and even road be made in a few hours. It is to be hoped that this session will not pass over without a short Bill making the use of the steam roller compulsory on all public bodies laying down loose stones.

## LONG SPAN BRIDGES.

We publish, this week, the general drawings and some the details of a bridge designed by the late John A. Ro bling, and which although never erected, will be found much interest on account of the care with which the eng neer had worked out all the details of a structure in whic his system of the "Parabolic Truss" was adopted. The thr openings of the bridge are spanned by two parallel co tinuous trusses 1184 ft. long, placed 14 ft. apart in t clear, and carrying the roadway upon their lower chord The superstructure is bolted down to one pier, and left fr to move upon rollers over the others. The towers which car the cables at the middle pier form a part of the movab structure, and are, therefore, free to move with the truss under variations of temperature. The roadway is supported transverse rolled girders placed 5 ft. apart, 12 in. in dept and 21 ft. 5 in. long. Between these girders, and underneat the rails trussed timber stringers are placed, and upon the are laid the longitudinal sleepers of the permanent wa Every alternate transverse girder is suspended to the cab of the trusses, and all the girders are rivetted to the low chord of the main girders. Each of the trusses is doub throughout its length, the posts being separated by an i terval of 2 ft., in the centre of which space the cables a suspended, the suspenders hang also in the same pla as well as the rope stays passing over the towers below t cables. In the trusses the arches are relied upon for givin strength and rigidity, and the cables for strength alon and the rope stays, six to each tower, to increase th strength of the structure as well as add to its stiffness. W intend to publish further details of this bridge next week.

## PERKINS'S HIGH-PRESSURE MARINE ENGINES.

We subjoin an engraving of a pair of indicator diagram taken from the engines fitted by Messrs. A. M. Perkins an Son, of Seaford-street, to the tugboat "Filga." We gave a account of the trial of these engines on page 236 of our la




number, and as we then described their construction, all w need do here is to give the particulars relating to the tw diagrams we now publish. One of these diagrams was take from the forward and the other from the aft engine, and th particulars are as follows:

| | Forward. lb. | Aft. lb. |
|---|---|---|
| Initial pressure per square inch ... | 188.7 | 181.3 |
| Mean pressure per square inch in small cylinder ... ... ... | 132.2 | 112.0 |
| Mean pressure per square in. in large cylinders ... ... ... ... | 25.7 | 20.3 |
| Pressure in boiler ... ... ... | 230 lb. per sq. in. | |
| Revolutions per minute ... ... | 82 | |
| Total indicated horse power : | [illegible] | |