THE GUNS OF THE BENBOW.

Now that the Benbow is approaching completion in every respect, and about to be brought round from Chatham to Portsmouth for a trial of her great 111 ton guns, it is not an inappropriate time, remarks the *Engineer*, to say a few words in regard to the power and value of her armament, far surpassing—as it does—that of any ironclad afloat, whether in the navy of Great Britain or in that of any foreign power. The accompanying table will show in a moment that the 111 ton gun distances all competitors. In it a comparison is drawn between the salient features of our new weapon and those of the heaviest natures possessed by France and Italy—these being the only rivals worthy to be compared with it.

Country.	Caliber. In.	Weight. Tons.	Muzzle velocity. Foot secs.	Projectile. lbs.	Penetrative power.
Great Britain.	16·25	111	2,128	1,800	32·5 in. at 1,000 yds.
Italy..........	17	104	2,018	1,799	32·3 in. at muzzle.
France........	14·66	71	1,955	1,180	27·3 in. at muzzle.

Thus it will be observed that the Benbow gun has a greater penetrative power at 1,000 yards distance from the muzzle than the Italian gun—its most formidable competitor—has at the muzzle itself. This would appear to be conclusive.

Before giving a brief description of the construction and parts of the new gun—drawings of which we give—we cannot refrain from remarking upon the prodigious strides which have been made in the development of gunnery science since the period of our last great war, both as regards the dimensions of the weapons employed and the complex nature of the machinery by which they are loaded and fired. A glance at the sketches marked A herewith, which give the relative sizes of the modern 111 ton steel rifled B.L. gun and the old 10 in. cast iron S.B. gun of a past age—drawn to the same scale—will exhibit at once the extraordinary rapidity of that development as far as regards proportions. It must be borne in mind that at the close of the Crimean war, only thirty years ago, the 10 in. S.B. gun was the heaviest and most powerful piece of ordnance that Great Britain possessed, and we were then far ahead of all other nations in respect of armament. Yet in the present day the projectile and battering charge only of our most formidable weapon, taken collectively, actually bear an appreciable proportion to the entire bulk of the gun which was considered monstrous in 1857, computing to one-third of it in weight. The complicated nature of machinery required to load, fire, and control the new gun can be seen by a reference to the cut. It shows the gun mounted upon its proof sleigh at Woolwich Arsenal, and the powerful double derrick erected in rear of it, with traversing platform working beneath the davits for raising and supporting the projectile and charge—weighing respectively 1,800 lb. and 960 lb.—during the process of loading; also the duplex arrangement of Stanhope levers, carrier, and cam lever at the breech, form quite a bewildering maze of mechanical contrivances. The elevating, loading, and traversing will, of course, be performed by hydraulic power on board the Benbow, where the turrets are open and the breech of the gun is depressed beneath the steel deck for receiving its charge, but the mechanism of the breech-loading apparatus is as shown in the engraving.

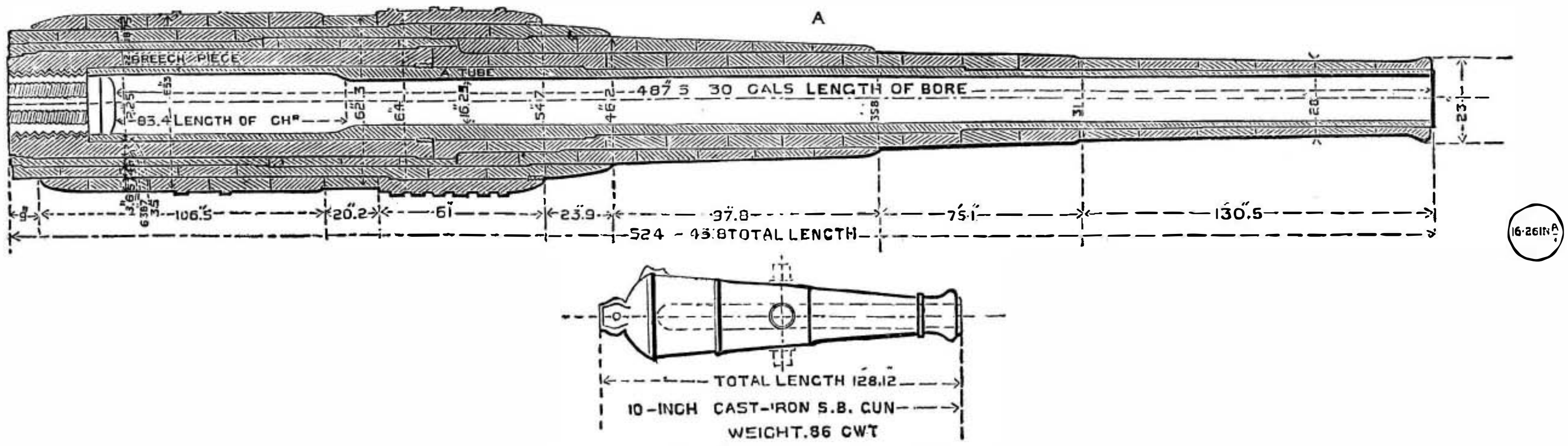
The principal dimensions of the 111 ton gun are as follows: Total length, including breech gear, etc., about 45 ft.; extreme diameter, 65·5 in.; caliber, 16 25 in.; length of bore, 487·5 in., or about 30 calibers; diameter of powder chamber, 21·25 in.; capacity of same, 28·610 cubic inches; the charge is 960 lb. of what is called experimental slow powder, of hexagonal shape, with a hole through the center, and almost analogous in its character to the well known prismatic No. 1 brown, of which most of the charges for many breech-loading guns are now made up. The building up of these charges is most curious. It is like a child's puzzle map. A plan is drawn of the exact number of hexagons that will most nearly cover a space equal to the base of the charge. Rows and rows are then placed upon the first layer, always leaving the central holes clear above one another for the flash to communicate with the whole mass, as the sides fit exactly. The mass when made up fits into a stout silk bag, and after being "choked" is put into a long metal cylinder for conveyance on board ship. Five hundred and sixty of such cartridges form the "unit" for the Benbow in peace time.

An initial velocity of 2,143 foot seconds was actually obtained on the 28th of March last at the proof butts, Woolwich Arsenal, with the second of the 111 ton guns. This was with 850 lb. of German powder only. It is not unreasonable, therefore, to assume that a higher velocity than that mentioned in our comparative statement might be regarded as normal. Of course this greatly increases the penetrative power of the projectile, and the *vis viva* or energy stored up in it. Making use of the generally accepted formula—

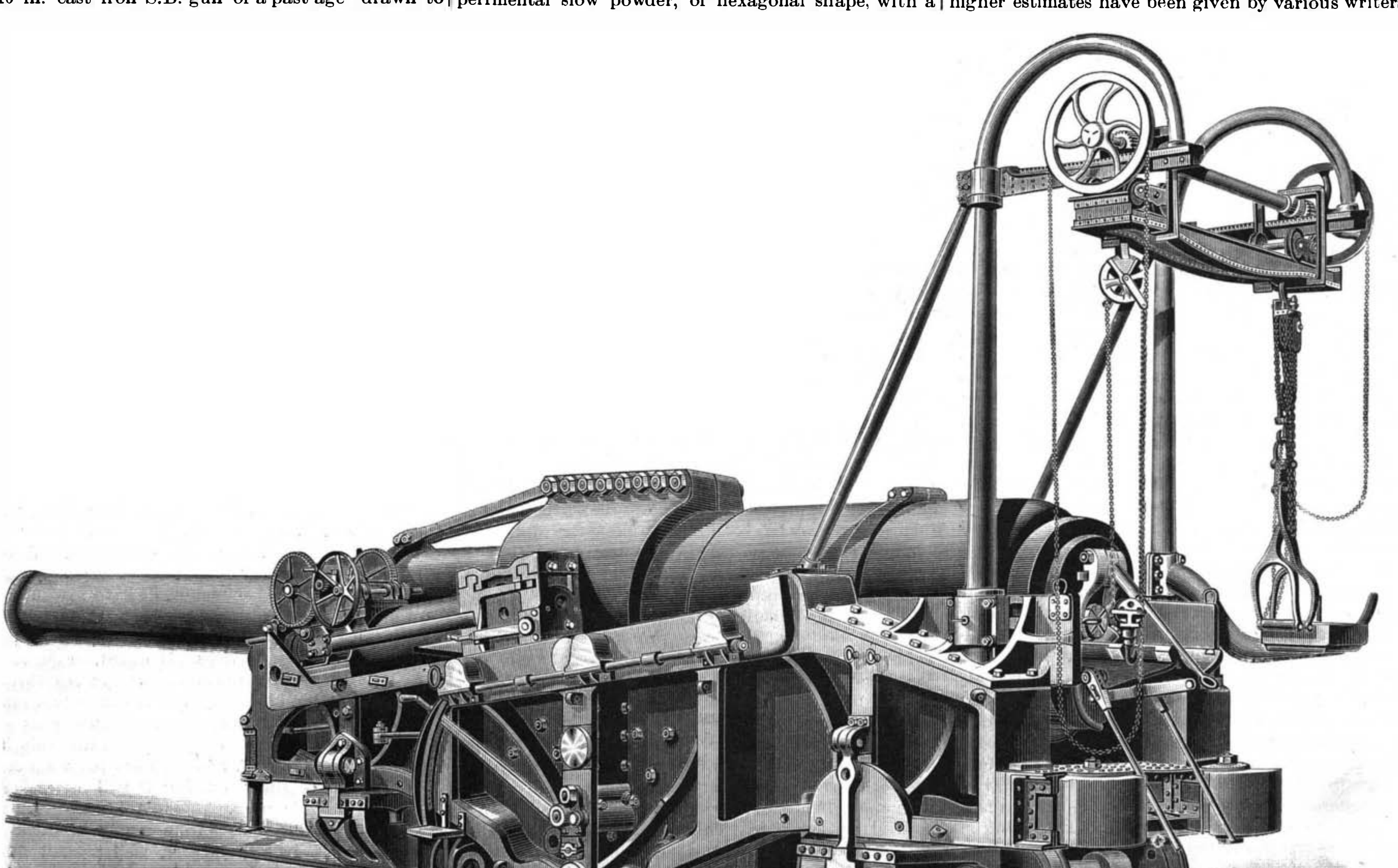
$$vis\ viva = \frac{w\,v^2}{2g}$$

where w = weight of the projectile in lb.
v = velocity in feet
g = force of gravity (32·2)[1],

we arrive at a muzzle energy with our newly constructed gun of no less that 57,304 foot tons, or nearly 5,000 foot tons in excess of anything before arrived at, the greatest amount of energy before recorded being that of the 100 ton Elswick gun of 17 in. It is true that higher estimates have been given by various writers of



COMPARATIVE SIZES OF 111-TON AND 10-INCH GUNS.



111 TON GUN, H. M. S. BENBOW, ON ITS EXPERIMENTAL CARRIAGE.

the energy developed by this weapon, but it must be remembered that they were conjectural. Lord Brassey gives it in a table as 61,200 foot tons. As, however, in order to produce this abnormal energy he quotes a muzzle velocity of 2,214 foot seconds, which has *not* been obtained during the government trials at the Woolwich butts, the figures resulting from these velocities are misleading and untrustworthy. Be it as it may, however, the 111 ton gun stands unrivaled among its compeers, and the Benbow, Sans Pareil, and Victoria will have by far the most powerful armament afloat in all the navies of the world. We only regret one circumstance connected with the mounting of these guns. It is that they should be so entirely exposed above the open turrets. This, however, is a defect of the Admiral construction which cannot, we fear, be remedied.

LEWIS MUHLENBERG HAUPT.

BY C. H. H.

Could the spirit of progress have taken its place a hundred years ago in the neighborhood of the morning star, and watched the American continent as it slowly turned toward the dawn, it would have seen a country wearing still the undisturbed livery of nature, and unsubdued by the thought of man. In that grand kaleidoscope, prairie and forest, mountain and valley, succeeded each other in endless variety, and when the gilded crests of the Coast Range and Sierra Nevada finally sank out of sight beneath the horizon of the Pacific, the vast ocean that stretched into the distance bore no fleet upon its bosom. The darkness of succeeding night was lessened only by the radiance of occasional village lamps or savage camp fires.

But to-day could that same spirit, with Mercury for company, follow the advancing light from ocean to ocean, the same broad plains and lofty mountains, the same swift rivers and fertile valleys, would meet the eye as before, yet everywhere would be seen the dominance of man, the master. The plains are yielding harvests, the mountains, stores of gold and iron; the torrents have been bridged and the valleys converted into homes. Swift steamers cross its waters, and loaded trains its lands. On all sides would be seen the wonderful results of human activity. No magician has been at work, though even the conjurer's art could scarcely have been more potent. Back of each of these changes there has been an idea, and back of the idea a man. The modern magician, at whose touch distance is annihilated and busy cities spring into being, is the engineer. It is his collective work that has changed the face of nature.

It is said that the best history is biography. In science and engineering as well, the best record of ideas is to be found in the lives of the men who held them. In presenting, then, a brief sketch of one of the busiest of these workers, there is given a fragment of the history of progress.

Professor Lewis M. Haupt, whose activity as an engineer perhaps entitles him to be called the successor of Captain Eads, is a native of Pennsylvania. He was born at Gettysburg, on March 21, 1844. His father, General H. Haupt, was at that time professor of mathematics at Pennsylvania College, but shortly afterward becoming connected with the Pennsylvania Railroad, he removed his family to Harrisburg, and subsequently to Philadelphia. Professor Haupt's boyhood was spent in an engineering atmosphere. He attended the public schools for a short time, but his health being delicate, out-of-door exercise was recommended in place of the school room.

As General Haupt now assumed the contract for building the Troy and Greenfield Railroad, and the Hoosac Tunnel, the son had an excellent opportunity to put this recommendation into practice. He was but fourteen years of age when his engineering work began. School, however, was not entirely given up. The winters were spent at the Greenfield and Cambridge High Schools, and later at the Lawrence Scientific School. From the latter institution he was appointed by President Lincoln, in the fall of 1863, to a cadetship at West Point. Four years later Professor Haupt was graduated and immediately assigned to duty in the United States corps of engineers. His first work in the service was with a party then conducting the triangulation of Lake Superior.

It is generally considered somewhat of a disadvantage that Americans move around so much, but it has the compensation of affording a wide experience. Though the severe climate of the lake region made it very soon necessary for Professor Haupt to apply for a change of duty, the experience gained there was of great value to the engineer and future teacher. In the spring of 1869, the young lieutenant was ordered to report to General Canby, then in charge of the Fifth Military District (Texas). The change from one frontier to another brought a corresponding change of duties. As aid and engineer officer, his work consisted chiefly in the examination of government buildings and military roads. He had also occasion to devise a scheme for the protection of the Fort Brown Reservation from the encroachments of the Rio Grande.

Again Professor Haupt's work was of short duration. In the fall he resigned from the public service in order to accept the position of assistant engineer and topographer in charge of the surveys of Fairmount Park, in Philadelphia. He was engaged on this work for several years, collating the data for an elaborate contour map, and locating and constructing the drives, drains, and other engineering features of this extended pleasure ground.

In 1872 came another change of occupation. He was appointed an assistant examiner in the Patent Office in the class of engineering and architecture. Though enjoying rapid promotion, he resigned his position in a few months in order to accept the professorship of civil engineering at the University of Pennsylvania. Up to this time Professor Haupt's life had been spent in gaining experience. He was now in a position where he could make good use of it, both as a student himself and as an instructor. It is at the university that his best work has been done. A professorship offers unusual opportunities to a man of ideas. The work of the position is itself constantly stimulating, while the leisure it affords permits him to undertake researches that would be quite impossible to a busy man of affairs.

The danger of it is possibly that one may be tempted to let this outside work encroach too far upon the time that should be devoted to his students. On the other hand, if kept within proper bounds it adds greatly to the efficiency of the teacher, for it gives him a constantly increasing store of experience to draw upon. In this respect, Professor Haupt has been fortunate in the utilization of his spare time. He has spent the long vacations of summer in practical engineering work. He has held appointments as an engineer in charge of the light house service in making hydrographic surveys for the range lights in the Delaware, as an assistant in the United States Coast and Geodetic Survey, in charge of the geodesy of Pennsylvania, for five years, and of various works on the Northern Pacific Railroad.

In 1877 the Engineers' Club of Philadelphia was organized, and Professor Haupt chosen as its first president. It is now one of the largest and most influential technical organizations in the country. The proceedings of the club contain many of his contributions, the papers on Intercommunication in Cities, Rapid Transit, Harbor Studies, and Proposed Removal of Smith's Island (in the Delaware River opposite Philadelphia), being perhaps among the most important. The titles to Professor Haupt's numerous articles and monographs, for his pen has been a very active one, show a wide range of subjects, but it will be observed that prominence has been given to those problems of engineering which come the nearest to everyday life.

However busy a man may be, and however varied may be his occupations, first preferences are pretty sure to come to the surface if they have half a chance to do so. In Professor Haupt's case, his first professional work was in the triangulation of Lake Superior, and throughout the rest of his career his attention is constantly reverting to the problems connected with water and waterways. At the present time his name is prominently before the public, on account of the valuable contributions of a practical character which he has made to our knowledge of the conditions essential to all harbor improvements. In his most recent paper on the subject, "The Physical Phenomena of Harbor Entrances," he has presented important discoveries and suggested new methods for a general solution of the difficult problem of improving the entrances to all alluvial harbors. In recognition of the merit of these discoveries, the American Philosophical Society has just awarded him the Magellan premium, the highest acknowledgment it is in their power to confer. The jealous care with which the honor is guarded by that conservative body may be judged from the fact that the award has been granted but twice during the past forty-five years.

Like most valuable discoveries, Professor Haupt's is so simple that the only wonder is that the engineers who have been spending such large amounts on attempted harbor improvements had not long ago found it out for themselves. He has shown that bars are the result of the increasing semi-diurnal action of the flood tide as it is affected by the general trend of the coast line and compressed toward the bight of the three large bays extending along the Atlantic coast from Cape Sable to Cape Florida. The mean tide at the salient points of these capes is between one and one and two feet. It gradually increases along their flanks to its maximum value at the greatest distance from the chord joining the points. The ebb channels and the crossings over the bar are moulded by this component. To prevent in part the compression and deflection of the ebb channels, Professor Haupt has proposed a barrier of peculiar form, which is designed to prevent the land from being carried into the channel by the flood. It is so constructed, however, as to freely admit the flood tide to the inner bay, and concentrates the ebb. The length of the proposed barrier is ultimately to be about one-half that of the present jetty system. The latter, it is contended, does not fulfill the conflicting conditions of this admittedly difficult problem. The method seems to be very simple and efficient, and if carried into effect might reasonably be expected to accomplish much for our alluvial harbors.

Professor Haupt is the author of several standard works on engineering subjects. He is also actively connected with a number of prominent societies besides the Engineers' Club. When the scheme for reorganizing the public civil works was under discussion in 1885, he was one of the delegates and was assigned important duties. The result of his investigations was published in *Lippincott's Magazine.* His system of movable dams for use in tidal waters is familiar to most of the profession.

As a teacher, Professor Haupt can best be judged by his results. He has been a very busy man outside of the university, but his work there has gained rather than suffered by this activity. It has brought the student into actual contact with the problems of the times. It has undoubtedly been a great help to them, and has given them a working efficiency unattainable by more abstract methods of instruction. The department of civil engineering ranks among the first in an institution which enjoys the distinction of numbering among its faculty some of the most eminent men in America.

The Elements not Patentable.

In arguing the Bell telephone case before the Commissioner of Patents the other day, Robert G. Ingersoll, one of the counsel, closed his argument with the following pertinent remarks, which it will be well for all inventors to remember. The conclusions are sound and as applicable in other cases as the one on which the learned counsel made the application:

"I do not believe any man can patent the idea of sending speech by electricity. He can patent devices by which that can be done, but he cannot get a patent on the lightning. A man can patent a water wheel but he cannot patent the water, or say to the water you cannot turn any other wheel but mine. A man can patent a windmill, but not the wind, and any man who can make a better mill may use the same wind, because we do not get our entire stock of wind from the Patent Office or from the attorneys on the other side. Wind is the free gift of all politicians, and, looking at the attorneys of the Bell people, without wind where would your case be?"

IT is said that a finely polished lusterless surface can be produced in steel by rubbing, after tempering on a smooth iron surface with some ground oilstone till it is perfectly smooth and even, after which it should be laid on a sheet of paper, and rubbed backward and forward till it acquires a fine dead polish.