a second after ceasing fire this would continue, so that a charged wing could be brought up to the lever, the shells ejected, and the fire reopened by the time the last missile of the previous charge had struck. The inventor concludes that, virtually, a continuous and unceasing stream of bullets may be kept up by the crank fire, for any desired length of time.

To Mr. J. P. Taylor of Tennessee is due the credit of this very ingenious weapon, of the successful operation of which we have assured ourselves by personal observation. In the experimental battery, an excellent piece of mechanical work from the shops of the Holske Machine Works in this city, from which our engravings were made, we remarked but few points that were susceptible of simplification, and we could suggest nothing which had not been anticipated by the inventor and fully provided for in a second gun which we learn he is about to construct. The piece has already attracted no small degree of attention in military circles, and we do not doubt but that it will excite even a greater interest when it appears, as we understand it will, according to the intention of the inventor, at the Vienna Exposition. Further and more detailed particulars may be obtained by addressing J. P. Taylor, patentee, or D. Hockett, attorney, Knoxville, Tenn.

Scientific American.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW, NEW YORK

O. D. MUNN. A. E. BEACH.

TERMS.

One copy, one year - - - - - - - - $3 00
One copy, six months - - - - - - - - 1 50
CLUB RATES { Ten copies, one year, each $2 50 — 25 00
Over ten copies, same rate, each — 2 50

VOL. XXVIII., No. 17. [NEW SERIES.] *Twenty-eighth Year.*

NEW YORK, SATURDAY, APRIL 26, 1873.

Contents:

(Illustrated articles are marked with an asterisk.)

THE SOURCES OF OUR MODERN KNOWLEDGE.

In the uncertain prehistoric ages during which the ancient human civilization was evolved, Science, which regulated the social relations, did not rise above the purely material purposes which occupied the minds of men. The small number of truths, of which Science then consisted, were only empirical deductions from facts; but she advances with the progress of humanity, and from Thales to Archimedes immense scientific labors extend her limits and tend to generalize human knowledge.

Thales, who lived twenty-six centuries ago, is one of the first philosophers, known to us, who brought his knowledge to a systematic whole. He was the founder of the Ionic school in Greece, and was equally successful as a mathematician and an astronomer. The school founded by him was afterward split up into different sects, which embraced in their researches all branches of human knowledge.

Pythagoras then appeared; this philosopher, who by grateful mankind of his age was called "divine," extended the domain of the mathematical sciences, and the tradition that he sacrificed one hundred oxen to the gods, from gratitude for the discovery of the famous problem which bears his name, is a proof of his trust in the guidance of a superior power. He had clearer notions than his successors; he taught the globular form of the earth, of which Anaximander had not the least idea, and he described the earth's motion around the sun; but mankind was not yet able to grasp this truth, and it had to be elaborated for two thousand years before general recognition of it was obtained.

After Plato, who, 2,200 years ago, had above the door of his lecture room the words "Nobody can enter here who is no geometrician," came the great Euclid, and then the illustrious Archimedes, the greatest philosopher of his time, who solved the most advanced problems with all the might of genius. The works of Apollonius, Hipparchus, Ptolemy, Diocletian, etc., fill up this earlier period of scientific history; but the authors are more specialist than universal philosophers; however, they contributed powerfully to the progress of knowledge.

At the beginning of a second period, Science seems to have been suddenly arrested, and ceases to appear as an element in the regeneration of humanity. She sheds, however, some of her light in the school of Alexandria; but after Diophantes her lamp appears to be everywhere extinct. Several centuries later, Science revives and is given back to the world by the same people that once slew her in her last asylum, and surrendered the celebrated library of Alexandria to the flames, a library which contained all the philosophical works of preceding ages.

If the Arabs gave back to Europe, during the middle ages, some of the sciences, the records of which they destroyed in Alexandria, Europe in her turn became not only a rival, but a far superior master in the advancement of philosophy. It was then that Science took possession of certain grand theories, of which the preceding ages had scarcely any presentiment; the war which thus far had only existed in the moral world was carried into the scientific field; and human intelligence had begun to crave the discoveries developed by examination and discussion in the realm of positive sciences. It was then that Luther defended freedom in the examination and discussion of moral principles, and Copernicus defended freedom in scientific research, and established the true astronomical system. Then a galaxy of great men appeared: Italy produced Galileus Galileo; Germany, Gottfried Leibnitz; Holland, Christian Huyghens; England, Isaac Newton; and France, Rénate Descartes. Since that time discoveries have succeeded discoveries with the most unexampled rapidity; and thanks to their practical tendency, the appearance of the surface of our earth has changed during the two centuries since the time of these great men more than in the two thousand years previously. The number of discoverers and promoters of progress of the present day is indeed too great to enumerate, and what is a most striking fact, it has been steadily increasing during this century. In regard to the discoveries themselves, it appears to be reserved for the end of this century to place the crown on the now magnificent edifice of human knowledge, the labor of so many centuries, by a mighty doctrine which reunites all the isolated and various phenomena, by deducing them from a single absolute principle, the main object of modern research: The conservation of force or motion, which is founded on the principle of universal gravitation.

THE BROADWAY UNDERGROUND RAILWAY.

The bill for an underground railway beneath the great thoroughfare of New York city, known as Broadway, has finally passed both branches of the State legislature, received the Governor's signature, and become a law. The wonder is, in a community like this, so noted for the number of its intelligent, active, and vigorous men, that such an important enterprise should have been so long postponed. No city in the world has more pressingly needed the facilities for rapid transit than New York.

It has always been conceded that the best route for a fast railway was under the surface of Broadway. The peculiar formation of the metropolis, very narrow, surrounded on two sides by deep rivers, permits the movement of its population along one general line only—towards the north. The splendid thoroughfare of Broadway, seventy-five feet in width, lies in the very center of this movement, forming in fact the backbone of the city. Business of all kinds has Broadway for its focus, and probably no other street in the world is so constantly thronged with passengers and vehicles. The value of property on Broadway has become very great, and it is lined with many noble and costly edifices. Its peculiarly central position, the ease of its grades, the firmness of its soil, to say nothing of its enormous traffic, have always marked it as the natural route for an underground railway; and many different companies of railroad builders have vainly attempted to secure it as a prize. The property owners on the street, comprising many of our most wealthy and influential citizens, have always, until recently, opposed the railway, and nobody appears to have had wit or power enough to overcome their opposition.

The grounds for their hostility were plain and simple. They alleged that the operation of digging for the railway would endanger the water mains, break up the sewerage, set the gas pipes leaking, and tumble down every building on the street; causing a thousand times more damage and mischief than all the underground railways in the world were worth. This idea, in whole or in part, has pervaded the minds of owners and so united them in purpose that whenever any persons made a movement for the railway, they met with formidable opposition and signal defeat. Many and memorable have been the contests in the State legislature on the subject, and immense the sums of money expended; but the property owners invariably triumphed. In vain were they told that London had built such a railway and property, instead of being injured by it, was improved. To this it was replied that New York was not London, and that a road built here would certainly destroy the houses. For fifteen years has this sort of nonsense been allowed to bear sway, while the people suffered for want of the railway; and by reason of its lack thousands of families and business establishments were driven out of the State into New Jersey.

Our readers are familiar with the details of the construction of the short experimental section of railway under Broadway, by the Beach Pneumatic Transit Company. They will remember how this tunnel was bored by mechanism, under the surface of the pavement, below the water pipes, sewers, gas pipes, and foundations of adjoining buildings, the enormous traffic of the streets going on as usual, directly over the heads of the diggers. The public had no knowledge of the work until it was finished, and were greatly pleased with the quiet but effective manner in which it was done. That tunnel has been in existence and the experimental railway has been in operation for three years, presenting at all times an unanswerable argument in favor of an enlarged railway, and a practical refutation of the frivolous reasoning of the property owners. Meantime the company asked from the legislature the privilege of enlarging and extending the work, so as to provide a first class underground railway, and the public gladly seconded their request. For three years the company have pressed their enterprise upon the attention of legislature, and have at last succeded. Their charter is secured. Their aim now is to make the work the model of its kind. The railway is to extend under Broadway, Madison avenue, and Harlem river to Westchester county, nine miles, with an additional lateral branch. The work of construction is to be done under the supervision of State engineers. Stringent provisions are made by law to guard all public and private interests.

We shall, from time to time, present such information concerning the progress of the work as may be of interest to our readers. The office of the company is at No. 260 Broadway, corner of Warren street, and all communications should be addressed to the Secretary, Joseph Dixon, Esq.

THE FIRE ON BOARD THE STEAMER ALASKA.

We recently published a communication from Mr. Norman Wiard, giving us the particulars of the ignition, by "over heated steam" as he alleged, of the felting of one of the boilers of the United States steamer Alaska. The report of this fire was sent to us by Mr. Wiard for the purpose of vindicating his theory of "ignition by superheated steam" from the charge of being "absurd," as criticised in the SCIENTIFIC AMERICAN, and also for the purpose of placing before our readers a positive example of such ignition, the facts concerning which might be examined and verified by any one who so desired: the previous examples referred to by Mr. Wiard not being open to such examination.

It appeared to us when we published Mr. Wiard's last letter that the fire on board the Alaska could not have been caused by overheated steam, and we then gave our reasons for so thinking. We will now present further information concerning the fire in question, derived from an authentic source, which completely upsets Mr. Wiard's superheated steam theory.

We give a diagram showing the general form of the boilers of the Alaska, and the arrangement of the superheating tubes. The steam passes from the boiler into the superheater and thence to the engine in the usual manner. We also give a diagram on an enlarged scale of the upper portion of the boiler and superheater at the junction with the uptake. It was at the corner *A*, where the uptake begins, that the felting took fire, and the ignition was occasioned by the contact of the felting with the uptake. The felting had very improperly, been packed against the uptake, the heat of which finally produced ignition. Neither the boiler proper, the superheater, nor "overheated steam," had any thing to do with the fire, and so Mr. Wiard's superheated steam theory is again shown, by the facts in the very example he adduces, to be absurd.

Fig. 1.

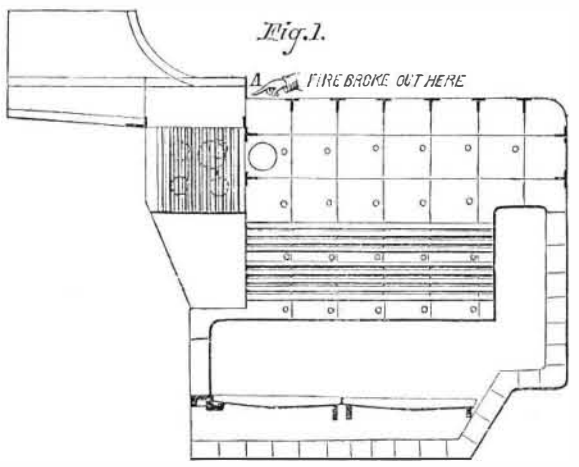
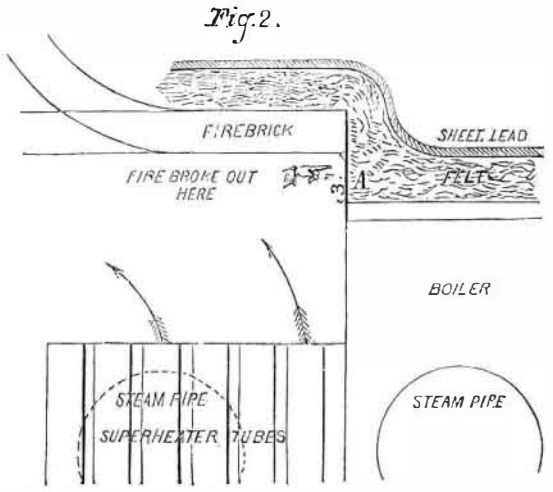


Fig. 2.



We trust that the fire on the Alaska will serve as a warning to engineers, and others who are charged with the duty of clothing boilers, to use proper care in such matters. The felting should never be packed against the uptake or chimney, as in this case. We are glad to know that since the fire the proper precautions have been taken on board the Alaska to prevent a recurrence of a similar disaster. The felting

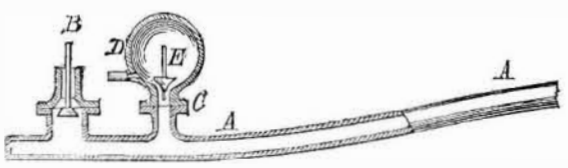
around the uptakes of the boilers has been removed a distance of twelve or fifteen inches, and cement substituted.

In relation to the superheating of steam, we have frequently shown that it was always difficult to bring up the vapor to a temperature sufficient to cause ignition, and, practically, impossible to do so in any of the boilers ordinarily used. In the case of the Alaska, if we are correctly informed, the ordinary boiler pressure is 30 pounds, and at this pressure the ordinary heat of the steam, on issuing from the superheater, as shown by the thermometer, is from 276° to 278° F. Every intelligent person knows that this heat is not sufficient to ignite combustibles such as felting or wood. On the occasion of the fire referred to, the engineer reports that the fires in the furnaces were low, indicating that the pressure and temperature of the steam were not as high as usual.

THE HYDRAULIC RAM.

We have received a number of communications, recently, from readers who desired information relative to the construction and efficiency of the hydraulic ram, and take pleasure in giving them a brief account of it.

This ingenious piece of apparatus is generally said to have been invented by the French aeronaut, Montgolfier, and improved by his son, but the earliest recorded accounts of the apparatus indicate that it was built in a ruder form, and still earlier, by an English watchmaker, Whitehurst, of Derby, in 1772. It consists simply of a pipe, A, large enough to convey the whole required volume of water from the upper to the lower level, and fitted at its lower extremity with a check valve, B, so weighted that it will remain open until the water, rushing out around it at nearly the maximum velocity due to the hight of fall, lifts it and suddenly closes the orifice. The long column of water contained in the pipe A, is thus, while in rapid motion, refused egress at B, and its great inertia and its almost perfect inelasticity compel it to seek some other outlet; and if that were not found the heavy shock of such a mass of water, instantaneously checked, would burst a very strong pipe unless it were "cushioned" by an air chamber. In the hydraulic ram the new outlet is at C, and the water forces its way up through the air cham-



ber, D, lifting the check valve, E, without difficulty, and is finally delivered by a properly arranged pipe, leading to a reservoir which may be at a considerably higher level than the original source.

This action is one of those whose effects are estimated by reference to the principles stated in an article which we recently published on the laws of impact. Were there no friction, the energy due to the weight of water and the hight of fall would all be expended in raising a part of the water to the reservoir. One hundred gallons falling ten feet would be capable of raising ten gallons to a hight of one hundred feet, or twenty gallons fifty feet. As soon as the work done in throwing water into the reservoir has equaled the energy of the whole moving mass, the stream ceases flowing and the valve, C, closes, B opens and the stream starts again, its velocity accelerating until B is again thrown up to its seat, and the operation just described is repeated.

The friction of the pipe and the tortuous course of the water prevents the full realization of the effect as above estimated. This machine where well designed and properly made gives, on the average, about sixty per centum of the perfect result. We have, in our replies to correspondents, assumed forty per centum as the more common measure of its efficiency. It evidently is not as efficient a means of raising water as a good turbine or overshot wheel and pumps, as the latter should be capable of throwing nearly twenty per centum more water into the reservoir than the ram, with the same available quantity of water. The ram is, however valuable where the quantity of water is too small to justify the use of the wheel. The fact that small wheels are not as effective as large ones is also a fact telling strongly in favor of the ram.

ESTIMATING POWER BY SIZE AND SPEED OF BELTS.

We have already complied with the request of some of our readers who desired us to state how the proper width of belting to transmit a given power was estimated.

We have now before us a request from others that we should give the rules adopted in determining the power actually transmitted by belts of given widths and speeds.

The rule already given was expressed by a formula which can be readily transformed into another, which shall meet the wants of the present case. It would be $HP = \frac{W\,S\,V}{7{,}000}$, that is: Multiply the width of the belt by its speed and by the length of that portion of the circumference of the smaller pulley which is in contact with the belt, and divide the product by 7,000. The result is the power which the belt is proportioned properly to drive.

Or, accepting the common millwrights' rule of 1,100 feet per minute on a belt one inch wide, for a horse power, we should state it thus: Multiply the speed of belt in feet per minute by its width in inches, and divide by 1,100. The result is, as before, the proper amount of power to be driven by the belt. The first rule is the most exact, the latter the most convenient for rough estimation. It must be remarked, however, that it by no means follows that the belt, in any particular case, transmits this estimated power. It may drive much less or, if running very tight, it can be made to carry more than the proper amount.

It is evident that, where power is rented, its amount cannot be accurately computed from the size and speed of belts. The policy of those who have power to rent to others is always to charge for the maximum capacity of the belts, and those who use the power and pay for it will use the smallest belts and drive them at the highest power possible. The only satisfactory method of settling disputes between landlord and tenant is by the application of the dynamometer, thus measuring precisely the power used. Every one dealing in power should keep a dynamometer of good construction on hand, and should use it more frequently than a good engineer uses his steam engine indicator. There are several good dynamometers in the market; and if those directly interested cannot use them, or do not find time, they can always find reliable consulting engineers to do the work for them. We know manufacturers who understand this, and who send hundreds of miles for an engineer and his apparatus, to give them trustworthy information regarding the amount of power which their machinery is using.

ZIRCONIUM.

This metal takes its name from zircon, the mineral in which it was discovered by Klaproth in 1789. Although the metal is rarely met with and has no use in the arts, the mineral zircon is comparatively plentiful. It is found in many parts of the United States, among which the localities nearest to New York city are in Orange and Essex counties, N. Y., and at Trenton and Franklin, N. J. It is usually of a reddish brown color, and is very hard. The colorless and yellowish zircons of Ceylon have long been called *jargons* in jewelry, in allusion to the fact that, while resembling diamonds in luster, they are comparatively worthless. Zircons occur in crystaline rocks, especially in granular limestone and granite. They are infusible before the blowpipe. If pulverized and fused with soda on a platinum wire, the product when dissolved in dilute muriatic acid, gives a characteristic orange color to turmeric paper. Zircons are almost pure silicate of zirconium, containing less than 2 per cent of oxide of iron. The finer specimens of zircon have been used for ornaments, resembling, as we have said, the diamond. Zircons have also been employed, on account of their hardness, for axles and bearings.

Metallic zirconium was first prepared in the amorphous form in 1824, by Berzelius; Troost prepared crystallized zirconium in 1865. The former obtained it by heating a mixture of the double fluoride of zirconium and potassium with metallic potassium. It can also be prepared by conducting the vapor of chloride of zirconium through a red hot porcelain tube containing metallic sodium; or by heating the chloride of zirconium and sodium in a crucible with sodium or magnesium. The amorphous metal prepared in this way burns with a bright light at a temperature below redness. *Aqua regia* and the ordinary acids have but little effect on it; although it dissolves in hydrofluoric acid.

Crystallized zirconium was prepared by Troost by heating 2 parts of the double fluoride of potassium and zirconium with 3 parts aluminum to the melting point of iron in a plumbago crucible, and dissolving out the aluminum with hydrochloric acid. In this state it is easily attacked by *aqua regia*, but resists the ordinary acids. It is less fusible than silicon, and burns only at the temperature of the oxyhydrogen blow pipe.

A metal possessing such a remarkable power of resisting the action of acids and heat will one day become invaluable in the arts, if methods of preparing and working it with some degree of facility are ever discovered. Let those inventors who wish that they had been born a century or two earlier, before everything had been invented, take heart, for wide fields of usefulness as well as glory await those who possess real genius and talent. To-day metallic zirconium is of no use, and only exists as a curiosity in a few cabinets.

Oxide of zirconium, or zirconia, is more easily prepared and better known, for Tessie Du Motay and others have proposed to employ it instead of lime or magnesia for the oxyhydrogen lamp. It is prepared by Du Motay for this purpose by mixing the finely pulverized zircons with charcoal and exposing to the action of a current of dry chlorine gas, which decomposes it into the volatile chloride of silicon and the basic chloride of zirconium, which latter is sublimed, and may be dissolved in hydrochloric acid and the zirconia precipitated by ammonia. The precipitate is dried, ignited, and mixed with borax, clay, etc., and pressed into cylinders the size of a pea. When these cylinders are heated in a jet of oxygen and hydrogen gas, they become intensely luminous, giving a steady white light fourteen times brighter than street gas. The advantage which it possesses over lime and magnesia are its perfect infusibility and its non-attraction for moisture from the air; it crumbles as lime does by air slaking. The great difference in cost has, however, overbalanced the advantages on the side of zirconium, and it seems doubtful at present whether it will ever meet with extended use.

When perfectly pure oxide of zirconium is required, the above method cannot be employed; for although the chloride of silicon is much more volatile than the chloride of zirconium, it is practically very difficult to separate them completely in this way. A better method is that of Marignac. The mineral is broken in small pieces and ignited in a platinum dish with 2 or 3 parts of the acid fluoride of potassium. The mass, which consists of the double fluoride of potassium and zirconium, mixed with the double fluoride of potassium and silicon, is boiled with water containing a little hydrofluoric acid, filtered, and the residue washed with a small quantity of hot water. On cooling, the fluoride of potassium and zirconium crystallizes out. After purifying by recrystallization, the crystals are evaporated to dryness with concentrated sulphuric acid, and the sulphate dissolved in water. From this solution the hydrated oxide is precipitated by ammonia.

As to the salts of zirconium, the preparation of the chloride and fluoride has already been described. Bromide of zirconium was first prepared in 1869 by D. E. Melliss of New York, then a student of Professor Wöhler at Göttingen. The oxide of zirconium was mixed with charred sugar, and kneaded into pellets by means of starch paste and dried. These were then introduced into a tube of hard Bohemian glass. The tube was heated to redness, while a current of bromine vapor was conducted through it by means of dry carbonic acid. The bromide of zirconium is a white crystaline powder. It has a great affinity for water, with which it forms an oxybromide of zirconium, by exchanging two atoms of bromine for one of oxygen. The sulphide of zirconium is prepared by heating the metal with sulphur in a vacuum or in hydrogen gas. Zirconium forms double fluorides resembling the fluorsilicates. Its oxide also combines with bases after the manner of silica.

Zirconium, then, may be said to stand intermediate between silicon and aluminum, being willing to combine with either: with this difference, that no compound of silicon and zirconium has been prepared without oxygen, while its union with aluminum more nearly resembles an alloy. At all events, until it has been more thoroughly studied, we must class it among the metals.

PATENT MEDICINES.

The German scientific papers are accustomed to publish the results obtained by analyzing the various quack medi- and nostrums that come under their notice, thus exposing humbugs and warning their readers against wasting money and endangering their lives by the use of such compounds. Of course our American patent medicines are often subjected to the same test. Recently the Berlin *Industrie Blätter* published the composition of Mrs. Allen's "World's Hair Restorer." In a recent number of the same journal the following is given as the composition of the stuff sold as Dr. Sage's "Catarrh Remedy":

It contains 7 grains carbolic acid, 7 grains camphor, and 2·57 drams common salt. The whole is colored with a little Prussian blue, and sold at 50 cents per bottle, which affords a nice little profit above the expense of labels, advertising, etc. The same number of this journal exposes an eye balsam sold by a widow Müller in Berlin, which is warranted to cure every form of eye disease. It consists simply of 3 grains oxide of mercury (red precipitate) and 2·5 drams strong, unsalted butter. This old and well known salve is sold in boxes holding about 3 cents worth for the modest sum of 15 cents. From this statement it will be seen that the German quacks are satisfied with smaller profits than our people; for it is not long since a Philadelphian firm had the audacity to put up less than a cent's worth of carbolic soap and sell it for 25 cents as a sure protection against small pox.

The composition of the article called Dr. Pierce's alterative extract or "Golden Medical Discovery" is given as follows: 4 drams purified honey, 15 grains extract of poisonous lettuce, 30 grains tincture of opium, 3·5 ozs. dilute spirits tasting like fusel oil and wood spirits, and about 3 5 ozs. of water. Ten cents worth of this trash sells for $1.00.

The Cincinnati Industrial Exposition.

The fourth yearly Industrial Fair will open in Cincinnati on the 3rd of September and close on the 4th of October. We take this early opportunity of calling to it the notice of our readers generally, and of suggesting that they prepare their contributions in due season. The exhibition, we are informed will be one of the largest and most extensive yet held in the West, and will form an excellent medium for Eastern manfacturers to introduce their new products to the people of that great section of the country. Rules, premium lists, etc., may be obtained upon application.

New British War Steamer.

An event of interest recently took place at Chatham, Eng., in the launch of the Raleigh, a ship built, not, as the majority lately constructed, to offer great resistance to shot and shell, but with a view to combine great speed with a very heavy armament. She is therefore built of iron, sheathed with wood and coppered, and lined with brown cardboard, as being less likely to splinter, and also less inflammable than timber; and her dimensions are: Length, 298 feet; breadth, 48 feet 6 inches; draft of water, forward, 20 feet: aft, 23 feet; tunnage, 3,210 tuns; armament, upper deck, two 12½ tun guns, four 64-pounder guns: main deck, fourteen 90 cwt. guns, two 64-pounder guns; horse power, 800; crew, 530; and she is estimated to cost, when entirely finished, about $1,000,000.

A SHELL which exploded recently at the shell foundery at the Royal Arsenal, Woolwich, when placed in a cupola for being melted down, is believed to have been a 600 pounder for the 11 inch gun, a conical projectile constructed on the Palliser system which had been returned from the practice ground at Shoeburyness. The roof and skylights of the adjacent buildings were damaged more or less by fragments of coke and chalk thrown up from the furnace by the force of the explosion, but the mischief done is comparatively trifling.

A GENIUS in New York has notified the Post Office department that he has applied for a patent for printing two or more advertisements on the new postal cards. He wishes he may get the patent, but probably he won't.