Scientific American.

ESTABLISHED 1845.

MUNN & CO. Editors and Proprietors

PUBLISHED WEEKLY AT

No. 361 BROADWAY, NEW YORK.

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

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year, for the U. S., Canada or Mexico.................$3 00
One copy, six months, for the U. S., Canada or Mexico................ 1 50
One copy, one year, to any foreign country belonging to Postal Union. 4 00

Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, corner of Franklin Street, New York.

The Scientific American Supplement

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, for the U. S., Canada or Mexico. $6.00 a year to foreign countries belonging to the Postal Union. Single copies, 10 cents. Sold by all newsdealers throughout the country. See prospectus, last page.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, to any address in U. S., Canada or Mexico, on receipt of *seven dollars*. To foreign countries within Postal Union, *nine dollars a year*.

Building Edition.

THE ARCHITECTS AND BUILDERS EDITION OF THE SCIENTIFIC AMERICAN is a large and splendid illustrated periodical, issued monthly, containing floor plans, perspective views, and sheets of constructive details, pertaining to modern architecture. Each number is illustrated with beautiful plates, showing desirable dwellings, public buildings and architectural work in great variety. To builders and all who contemplate building this work is invaluable. Has the largest circulation of any architectural publication in the world.

Single copies 25 cents. By mail, to any part of the United States, Canada or Mexico, $2.50 a year. To foreign Postal Union countries, $3.00 a year. Combined rate for BUILDING EDITION with SCIENTIFIC AMERICAN, $5.00 a year; combined rate for BUILDING EDITION, SCIENTIFIC AMERICAN and SUPPLEMENT, $9.00 a year. To foreign countries, $11.50 a year.

Spanish Edition of the Scientific American.

LA AMERICA CIENTIFICA E INDUSTRIAL (Spanish trade edition of the SCIENTIFIC AMERICAN) is published monthly, uniform in size and typography with the SCIENTIFIC AMERICAN. Every number of *La America* is profusely illustrated. It is the finest scientific, industrial trade paper printed in the Spanish language. It circulates throughout Cuba, the West Indies, Mexico Central and South America, Spain and Spanish possessions—wherever the Spanish language is spoken. $3.00 a year, post paid to any part of the world. Single copies 25 cents. See prospectus.

MUNN & CO., Publishers,
361 Broadway, New York

☞ The safest way to remit is by postal order, express money order, draft or bank check. Make all remittances payable to order of MUNN & CO.

☞ Readers are specially requested to notify the publishers in case of any failure delay, or irregularity in receipt of papers.

NEW YORK, SATURDAY, DECEMBER 24, 1892.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 886.

For the Week Ending December 24, 1892.

Price 10 cents. For sale by all newsdealers.

PROGRESS OF OUR NAVY.

It is gratifying to note the very substantial progress which has been made, as evidenced in the annual report of Secretary Tracy, in the building up of our new navy. It is, as the secretary says, "a progress both in ships and in ordnance, by which the United States has emerged from its condition of helplessness at sea, and, by the employment of its own resources, has distanced its more experienced competitors, marking an epoch in the naval development not only of this country, but of the world."

On March 4, 1889, there were in our navy only three modern steel vessels, with an aggregate tonnage of 7,863 tons, and mounting thirteen 6-inch and four 8-inch guns, the forgings for which last, as well as the shafting for the vessels, had been purchased from abroad, as they could not be made in this country. On the 4th of March next it is expected that there will be twenty-two modern vessels in commission, while nine additional vessels, none of which in speed, armor and armament has a superior in any foreign navy, promise to be ready for launching within the next twelve months. The nineteen vessels thus added to the navy in four years have an aggregate tonnage of 54,832 tons, mounting altogether two 12-inch, six 10-inch, sixteen 8-inch and eighty-two 6-inch guns, all of which, with the exception of five of the earliest, have been manufactured in this country. Three new steel tugs have also been constructed and put in service during this period.

Our new navy, including all vessels built or authorized, now consists of the following vessels: One seagoing battleship (first-class)—Iowa; three coast-line battleships (first-class)—Massachusetts, Indiana, Oregon; two battleships (second-class)—Maine, Texas; six double-turreted harbor defense vessels—Puritan, Monterey, Miantonomoh, Monadnock, Terror, Amphitrite; two armored cruisers—New York, Brooklyn; one ram; two protected cruisers of extreme speed—Columbia, Minneapolis; fourteen cruisers—Olympia, Baltimore, Chicago, Philadelphia, San Francisco, Newark, Charleston, Boston, Atlanta, Cincinnati, Raleigh, Detroit, Montgomery, Marblehead; one dispatch vessel—Dolphin; six gunboats—Yorktown, Concord, Bennington, Machias, Castine, Petrel; one dynamite vessel—Vesuvius; one practice vessel—Bancroft; two torpedo boats—Cushing, No. 2. Making a total of forty-two vessels.

The three great first-class battle ships have a displacement of over 10,000 tons each, are protected by 18 inches of armor, carry 13-inch guns, and throw an aggregate of over three tons of projectiles at a single discharge, while the armored cruiser New York, formerly declared by the Secretary to be "the best all round vessel of any type," is now to be outdone by the new Brooklyn, of 9,150 tons, greater coal endurance and greater battery power. The two triple screw protected cruisers, Columbia and Minneapolis, with their maximum speed of 22 knots and sustained sea speed of 21 knots, with a very large radius of action, represent the highest type thus far attempted in this class of vessels.

A *resume* is given of the experiments and tests undertaken to obtain the best possible protective armor, resulting in the development of Harveyized nickel-steel for this purpose, from which our armor plates are now made, "far superior to any hitherto known, and destined to furnish the standard, both of quality and manufacture, for the great naval powers of Europe."

Although all our new vessels, as well as the torpedo boats especially, have been designed to use torpedoes, the kind of torpedo to be employed has for a long time been a most perplexing question, nothwithstanding that there have been many valuable American inventions and improvements made in this line. It was finally decided by the department to domesticate in this country the manufacture of the Whitehead torpedo, whose use in actual war had proved an assured success, and a factory was accordingly built for the purpose in Brooklyn, N. Y., under an arrangement with the foreign manufacturers. A number of these torpedoes, of the best modern design and of American manufacture, are now nearly ready for use.

In the manufacture of high power guns, eighty-two have been completed during the last year. The greatest progress has been made with the rapid-fire gun, of which twenty-eight 4-inch and eleven 5-inch have been completed since the last report. These guns, upon which little had been done up to last year, owing to the time required to perfect a suitable breech mechanism, are now rapidly approaching completion. The difficulties experienced in the manufacture of suitable metallic cartridge cases have now also been overcome. Of the 6-inch guns, the manufacture of which was most advanced, 135 have now been completed. Contracts have been made for forgings for six new 6 inch guns of forty calibers in length, to be used with brass cartridge cases as rapid-fire guns, and to be supplied to the fastest cruisers. Of the 8-inch guns, twenty-three are now completed and twelve partly completed. All the 10-inch guns, twenty-five in number, have been completed and are ready for installation on the ships for which they are intended. Five 12-inch guns have been completed, of which two have been proved and are being installed on the Monterey. The first 13-inch gun is approaching completion, and the forgings of the second have been received.

The development of a new smokeless powder, and of a safe high explosive for the shells in high-power guns, and the manufacture of armor-piercing projectiles equal or superior to those of any other nation, are each the subject of a discriminating and most satisfactory notice by the secretary. As to smokeless powder, it is said that the department, "by independent investigation and experiments, conducted by its own agencies at its own establishments, has succeeded in developing a smokeless powder which in efficiency and endurance gives better results than any known powder abroad." In conclusion, the secretary expresses the opinion that there can be but little doubt, in view of the progress of naval science, that the advance toward higher and higher types will continue steadily in the future, a progress in which American inventors will, doubless, be full participators.

THE USE OF PHOTOGRAPHY IN PHYSICAL RESEARCH.

This is the title of a very interesting and instructive lecture delivered before the Physical Department of the Brooklyn Institute of Arts and Sciences, Dec. 13, by Prof. Edward L. Nichols, of Cornell University.

The lecturer began by stating that photography is now used in almost every branch of physical research; that it is often used advantageously as a substitute for drawing when making observations. Prof. Nichols projected upon the screen a number of views, illustrating the exploration of the magnetic field, showing the lines of force, and of various phenomena which have heretofore been illustrated by drawings made by the hand of the observer. In some cases the hand-made drawings compared favorably with the photographs, while in others they appeared to be incorrect. The lecturer spoke of the value of photography in making long-continued observations; also in making observations of phenomena developed instantaneously, as in the case of lightning flashes, electrical discharges, sound vibrations, etc. He also showed upon the screen a plate illustrating diffraction fringes formed by a small triangular aperture in a piece of tinfoil, the figure being very intricate, and altogether different from what might have been expected.

An interesting illustration was that of photographs of the manometric flame, the flame for this purpose being produced by a concentric burner, the illuminating gas being supplied to the central orifice while the oxygen flowed through the annular orifice. The photographic flames produced in this way were very bright, clear, and sharply defined, and although drawings heretofore made compared favorably with the photographic record, they were not, of course, as accurate as the photographs.

Interesting views of the electric arc were shown, with which the hand-made drawings heretofore used compared very favorably. The photographs, however, revealed some phenomena which had not been observed by the eye. Among these were the brilliant particles thrown off from the arc, also the superior actinic quality of the light given by the incandescent copper covering of the carbons. A photograph of an arc on an alternating circuit showed a succession of light flashes, proving the intermittent character of the arc when produced by an alternating current. Other peculiar features were shown, among them an illustration of the arc oscillating from one side of the carbon to the other. This the lecturer supposes to be due to the attraction and repulsion of the earth's magnetism. He stated that the singing of the arc was clearly due to rapid intermissions, and that the pitch of the sound proceeding from the arc was what would be expected from the rate of the reversals of the current.

An attempt has been made to produce a photographic record of the alternating current by means of a telephone having attached to its diaphragm a mirror, the incident beam being projected on the mirror, the reflected beam being received on a moving sensitive plate. The result showed that the fundamental vibration of the telephone diaphragm interfered with the production of a correct record. For this method was substituted one in which a stream of mercury carried the alternating current, the apparatus being so arranged as to allow the stream to pass between the poles of a magnet. The mercury was oscillated by the attraction and repulsion of the magnet, the movement correspondingly exactly with the reversals of the current. The mercury stream was photographed through a slit located at the point of greatest amplitude of vibration, and the curve produced was the sinuous curve expected from an alternating current produced by a machine working normally.

One of the most interesting illustrations of the evening was that of sun spots taken by means of the spectroscope. This method of investigation appears to have shown conclusively that the fecula around the dark portion of the sun spot correspond with the flames projected from the sun.

American Society of Mechanical Engineers.

Papers of more than usual interest and containing much original and important matter were read at the recent meeting in this city. In a paper, an Analysis of the Shaft Governor, the remarkable fact was brought out that, notwithstanding the great importance of the governor as a means of protection from accident, not to mention its other uses, not a single complete work, treating of this, either descriptive or scientific, has ever been brought out.

[Readers of the SCIENTIFIC AMERICAN will recall the series of fly-wheel breaks during the past year, a notable one in the Amoskeag mills at Manchester, N. H., in all of which the governors failed to prevent the racing which led to disaster.]

The author of the paper described a governor of his own construction, which, if it will work with certainty under all conditions, is a remarkable design. After a mathematical description of the forces involved, and his mode of dealing with them, he says of the mechanical result, that is to say of the new governor:

"At a recent test of the device in an electric light station, on an engine of 500 horse power, running at a speed of 220 revolutions per minute, where the balance found it necessary to resist reciprocating pressures of 2½ tons at each extreme of the stroke, there was not even one revolution difference between the corresponding speeds of no load and full load."

John T. Hawkins, of Taunton, Mass., described a new graduating steam radiator which he had been led to design because of the well-known defects of those now in the market. He said:

"The impossibility of adjusting the heating effect of the ordinary steam radiator to changes in the temperature of the outer air is probably the greatest objection to that system; the facility with which this adjustment is effected in the hot water systems constituting the principal advantage which the latter possess over the former; while the simplicity and perfection with which the combustion in the furnace is automatically regulated in the steam system gives it an equally decided advantage over the hot water system; to say nothing of the greater first cost of the latter."

His own design was operated in his own apartments last winter, working admirably (that's what he says of it), giving all needed relief from an overheated room in mild weather, while giving ample warmth when the thermometer ranged low. It also conclusively established its immunity from leakage when, upon a second occasion, the attendant upon the boiler forgot to shut off the boiler feed and filled every radiator in the house with water, this being the only one out of nineteen that was not discharging water pretty freely about the floors from the automatic air valves, until the surplus water was drawn from the system through the boiler blow-off cock.

An elaborate and lengthy paper was read by George Richmond, of New York, on the Refrigeration Process and Its Proper Place in Thermo-dynamics. We may sum it up by saying that the fundamental principle insisted upon is that heat can leave a body only by transformation into work or by transfer to some other body. The graphical method, though it can give no information as to the actual transfers between the steam and the cylinder, is peculiarly adapted to the representation of such transfers. This subject is merely touched upon in an application of the principles to the study of the practical refrigeration process, the object of the paper being principally to present a method which it is believed will be found peculiarly useful to those who are not familiar with the analytic methods and in sufficient completeness to enable a judgment to be formed as to its merits.

The mathematical formulæ introduced are in a large measure due to the translation of the results into the usual notation, and there are few questions arising in practice, so the author says, which a draughtsman could not solve in an intelligible and accurate manner by the methods with which he is most familiar. One noticeable result is the graphical determination of the amount of superheating required to produce any degree of dryness finally in the steam cylinder (apart from the action of the walls) or the superheating of a vapor by compression—results for which Zeuner's formula for superheating gases is generally used. The value of this formula is not in question, so says the author, but as a general principle it is unsatisfactory to use formulæ on trust when we can reach the same results directly by easily understood methods.

In the paper, Tests on the Triple Engine at the Massachusetts Institute of Technology, these tests having been a part of the regular work in the laboratory of steam engineering for the last school year, the conclusion reached is that "it makes but little difference where steam jackets are used on an engine, provided the jacketing is carried far enough and not too far."

This is certainly a remarkable conclusion and seems scarcely to compensate for a season's work.

A Variable Speed Steam Power Transmission, the invention of E. F. Gordon, M.E., was described with much detail. Simply stated, the device consists of a deeply grooved pulley, split by a plane perpendicular to its axis and dividing it symmetrically, with means for varying the distance of the two parts, one from the other.

Given a belt adapted for the purpose, it will, in running on such a pulley, lie nearer the center as the two parts are more widely separated, and recede as they are brought nearer together. Such a pulley may be used on either the driving or driven shaft, or both, and it is evident that the shafts may be at any practical distance apart, also that the greater the pull on the belt the greater its hug and consequent freedom from slip. In some cases it is desirable to place a loose pulley between the two parts referred to, making a compact arrangement for starting, stopping, and varying speed in the space ordinarily occupied by a single pulley of the usual style.

W. F. Durand, of Ithaca, N. Y., read a paper on the Limit of Propeller Efficiency as Dependent on the Surface Form of the Propeller, setting forth the result of a long series of studies and some striking formulas by which he endeavored to show:

(1) That the limiting efficiency of the element of the surface of a propeller, working under any given conditions, is an absolute geometrical quantity, depending solely on its direction and motion, and on the motion of the ship.

(2) That the limiting efficiency of an entire propeller, composed of helicoidal surfaces of the same uniform pitch, is equally simple and definite.

(3) That the limiting efficiency of propellers in general, whether considered as surfaces not truly helicoidal or as solids such as are actually used, depends on the additional consideration of the distribution of work over their surfaces. The latter being a subject of great complexity, and depending on the ship as well as on the propeller, does not admit of general analytical treatment. It is shown, however, that certain limits may usually be laid down between which the efficiency in any given case must lie; and in the case of solids, as actually used, it is shown that such suppositions as can be made lead to the natural conclusion that thickness in general is detrimental to efficiency.

Samuel Webber, of Charlestown, N. H., gave the tabulated result of some interesting Tests of Driving Belts, the result of the tests. The strain on the belts was 83⅓ pounds per inch, though at times it exceeded this somewhat. Summing up, the author said:

"The 'leather-lined canvas' belt gave excellent results, as before, but its opponents object to it from the difficulty of making perfect joints by lacing; and the 'slotted' leather belt called the 'Eureka,' when dressed so as to be perfectly supple, gave very nearly as high results, and showed about the same coefficient of friction, which diminished a little in the last test, when the strain was increased from 83⅓ to 91⅔ pounds per inch."

An interesting boiler explosion was the subject of a paper by F. Daniels, of Worcester, Mass., describing the precautions taken by the owners of the mill by whom he is employed to secure sound material for a new set of horizontal tubular boilers, subjecting all the plates to a careful test before they were made up; and how that even then some of them proved to be weak, and a rupture (mistakenly called "explosion") occurred. The author said: "These boilers have been in successful operation for nearly six years and are still in use. They are inspected every week. The water is run out, the manholes removed, and the interior as well as the exterior of the boilers carefully examined. As the water in the streams in the vicinity of Worcester is very pure, coming as it does from the granite hills, we never find scale in the boilers, but in the spring and fall during high water it is not uncommon to find a small deposit of debris, which is carefully washed out.

"With all this care, the accident was to us a real surprise. When it happened, the plant was running as usual, but the boilers were somewhat forced, although not to any extreme limit. Without any warning whatever, and with very little noise, the firing doors of the furnace were burst open, coal, ashes and water thrown out, and the boiler house, in an instant, filled with steam.

"As soon as an examination could be made, it was found that one of the plates in the third row, just over the most intense heat, had bagged and ruptured, leaving an orifice about one inch in diameter, thinning the metal around the orifice to a knife edge. The remainder of the shell was not damaged, because the boiler quickly emptied itself of water and steam, which extinguished the fire and cooled the brickwork. The analysis of the ruptured plate is as follows:

Phosphorus	0·063	per cent.
Sulphur	0·022	"
Silicon	0·024	"
Manganese	0·261	"
Carbon	0·10	"

"It was suggested that this thin scale covered the entire surface over the fracture before the rupture, and was caused by oil which had become burned onto the plate; but as the feed water for this plant was supplied from a closed heater, it is difficult to see how oil could have found its way into the boiler. We have been informed by Mr. Robinson (who made the boiler) that he was called a short time ago to examine a boiler of the same construction as the one referred to in this paper. It had been overheated directly over the fire box, making the shell plates wavy. After carefully drawing the water from the boiler, nothing could be discovered on the plate excepting a whitish powder. There was neither scale nor mud.

"The conclusions the writer arrives at are that the importance of mechanical, physical and chemical tests cannot be overrated. While the plate makers invariably subject their plates to tests and stamp them accordingly, at the same time a confirmation of quality by the consumer is desirable, for we have seen that in the tests at Watertown one plate was condemned. If the ruptured plate had been of improper material or had contained sufficient carbon to harden when the water came in contact with the overheated plate, a crack might have developed, resulting in a serious explosion, possibly destroying the entire plant and causing a loss of life."

In the discussion that followed the reading of this paper, J. McBride, an experienced boilermaker, gave it as his opinion that dirt caused the trouble. J. F. Holloway, another expert, attributed it to a blister or air bubble in the plate. Geo. H. Babcock, the boilermaker, said: "The dirt will gather at a definite point; it will not spread over the bottom of the boiler, the circulation tending to bring it toward one point, where it will gather in a mass and cause a burning out."

Professor Denton said: "It has been shown that a scale of very small thickness, which would ordinarily escape the attention of a boilerman, would cause this result."

The Process of Cutting Cams, was read by W. A. Gabriel, of Elgin, Ill. Mr. Gabriel is a designer of small and intricate machinery for the manufacture of parts of watches and, in the course of his experience, found it necessary to produce cams of greater accuracy than could be obtained by the old and well known ways.

A paper on Tests of a Pump Receiving Suction Water under Pressure, described a series of experiments made with a view of determining the advantages of the plan of feeding water under pressure to a direct-acting pump over that of drawing the water from a receiving well. No measurement of the water pumped under the two conditions was attempted, as it went directly into the supply pipes; but the pumps appeared to work more smoothly and to keep the stand pipe level more constant under pressure than when sucking.

Experimental Determination of the Heat Generated per Candle Power by Oil and Gas Lamps, was the title of a paper read by D. S. Jacobus, of Hoboken, N. J. J. B. Stanwood, of Cincinnati, O., treated Strains in the Rims of Fly-band Wheels, the conclusion being that this strain varies nearly as the rim velocity squared, and, if the velocity is doubled, the strain is quadrupled and the factor of safety is reduced to a minimum.

A highly instructive series of experiments was described by R. C. Carpenter, of Ithaca, N. Y., on Comparative Variation in Economy with Change of Load in Simple and Compound Engines, Effect of Steam Jackets on High Speed Engines. By the use of diagrams, the author was enabled to show the actual results obtained very clearly. From these it appeared that for most conditions the engine with the cylinders steam-jacketed consumed less than when not jacketed; that this difference was greatest for the least loads, was probably about 2 per cent at rated capacity, and the conditions were reversed for heavy loads, the unjacketed cylinder becoming the more economical.

Considering these results only for loads between 60 and 120 horse power, the author found as the average:

With steam in jackets....	19·10 pounds of dry steam per I. horse power per hour.
With no steam in jackets.	20·1 pounds of dry steam per I. horse power per hour.

These tests, the lecturer said, show in all cases a slight gain due to the use of the steam jackets, the amounts varying in the different tests to from 2·75 per cent to 5 per cent of the steam consumed. The use of the high pressure jacket alone seems to have produced no especial effect, the results being better without it.

It should also be noticed, as pointed out by Dr. R. H. Thurston in Paper CCCCXXV., Vol. XII., of the Transactions, that in actual use the jackets would produce somewhat better results than shown in the test, due to the fact that the water of condensation from the jackets would ordinarily be returned directly to the boiler, thus saving the heat required to raise a given weight of feed water through the required range of temperature.

Strains in Lathe Beds was the title of a paper read by G. W. Bissell, Ames, Iowa. De Volson Wood read one on Hydraulic Reaction Motors and another on Negative Specific Heat.

TELESCOPIC steel masts or rods are to be used in lighting the public squares in Brussels. The object of this system is to preserve the beauties of the parks in the daytime.

Telegraphing Without Connecting Wires.

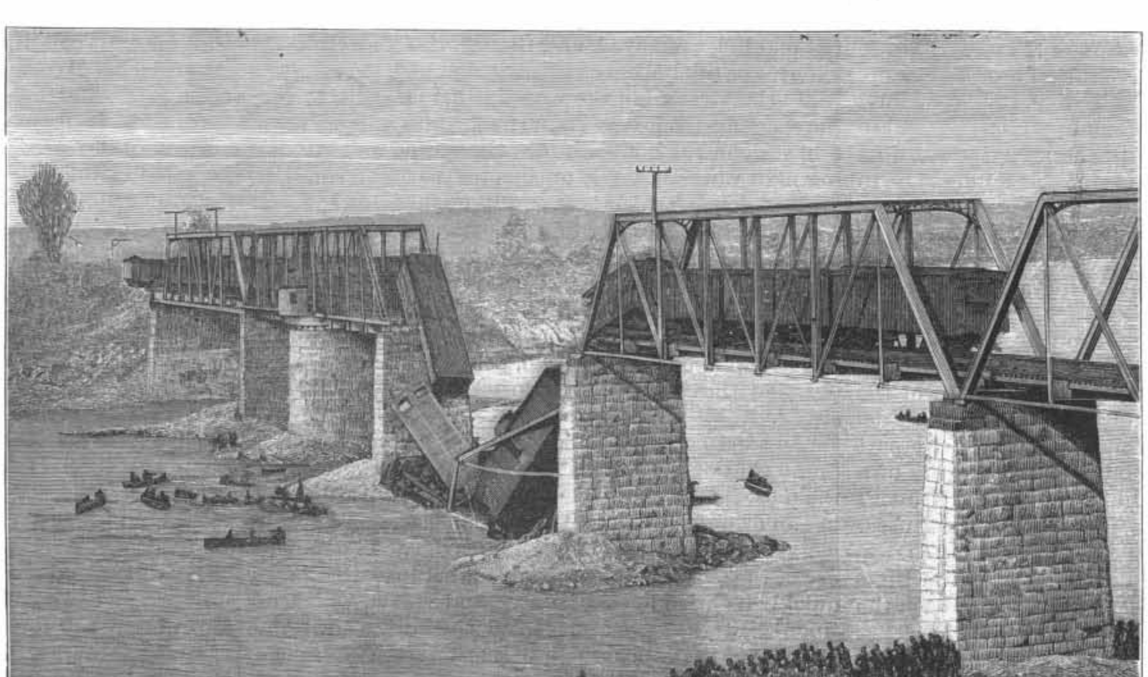
Interesting experiments have recently been made under Mr. W. H. Preece, with a view to electric communication between distant points without wire connection, namely, through air, water, or earth. Mr. Preece proposed to conduct experiments in three different methods. First, by running a wire along the shore on light poles for a distance of about a mile, and a second wire from stem to stern of the ship, the two acting upon each other inductively through the intervening space; secondly, by suspending a short line over the side of the ship, so that it might dip into the sea in the direction of the end of the shore line, to work by conduction through the sea; and, thirdly, by running out a light cable from the shore to the ship, terminating in a coil at the bottom of the sea, near the ship, but not attached to it, while another coil is placed on board. These two coils are expected to act inductively, and to give ample sound on telephones by means of rapid alternations. The experiments by the first method have been carried to a successful issue within the last few days, the shore wire having been erected along the Welsh coast, commencing at Lavernock Point, a little south of Cardiff, and proceeding for a mile in the direction of Lavernock House. The lightship was represented for the occasion by the island of Flat Holme, in the Bristol Channel; and the line there erected, parallel to the first and three miles distant from it, was about half a mile long. The shore line was furnished with a powerful generator at Lavernock Point, and the island line with a sounder to receive the messages. The result was that the words dispatched into the mainland wire were heard on the island with perfect distinctness, but we can scarcely admit that Flat Holme represents the conditions of a ship. This method is analogous to that patented by Mr. Edison for establishing telegraphic communication between two vessels when at sea.

Society of Naval Architects and Marine Engineers.

Prominent men in the shipbuilding and shipping interests of the United States have completed the preliminary organization of a professional society, to be called the Society of Naval Architects and Marine Engineers, whose object will be to promote the art of shipbuilding in all its branches, both commercial and naval. The committee of organization, consisting of William H. Webb, of New York; Lewis Nixon, general manager of Cramp's Shipbuilding Company, of Philadelphia; Col. E. A. Stevens, of Hoboken; Francis T. Bowles, Naval Constructor, United States navy; and (*ex-officio*) Clement A. Griscom, president of the International Navigation Company, expect to incorporate the society in New York and are now sending out invitations to membership.

FALL OF A RAILWAY BRIDGE AT TERRE HAUTE.

Our engraving is reproduced from a photograph showing the very serious consequences which resulted from a rather slight butting collision at Terre Haute, Ind., on October 28. The bridge, which carries the track of the Cleveland, Cincinnati, Chicago and St. Louis road, crosses the Wabash River at an elevation of about 50 feet above the water. The cars which appear at the right of the engraving were those of a train which had been run upon the bridge for a few minutes to get out of the way of another train, switching in the yard. While it stood there it was run into by the stock train from the opposite direction and a truss was broken sufficiently to cause it to give way, letting both engines and eight cars of cattle and coal into the river. One of the engines was entirely submerged. One engineer was killed. The other men on both trains saved themselves. The published accounts indicate, so says the *Railroad Gazette*, that there was fault on both sides; that the brakeman of the standing train did not go far enough with his flag, and that the approaching train was running too fast.



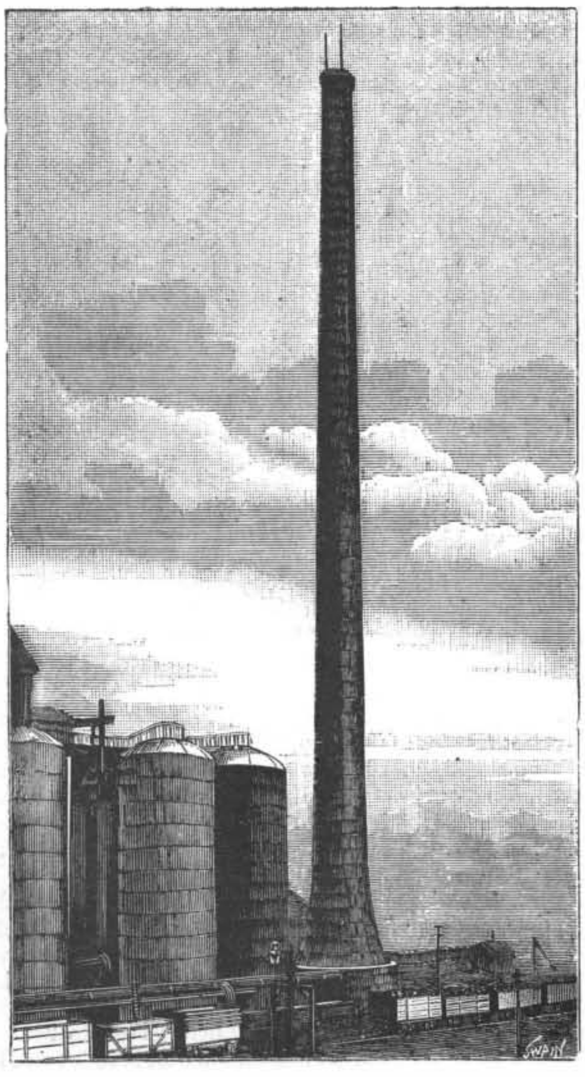
FALL OF A BRIDGE FROM COLLISION.

Morley's Polishing Paste.

Made by calcining flint and grinding the calcined material to a very fine powder, then mixing with fat, oil, or other such liquid to make a suitable paste, which "is put up or sold preferably in tins or boxes, and on the application of a little moisture is ready for use." For cleaning glass the levigated flint is sold dry to be used with water.

THE TALLEST WROUGHT IRON CHIMNEY.

The annexed illustration is from a photograph of a large wrought iron chimney, erected at Darwen, in North Lancashire, by the Pearson & Knowles Coal and Iron Company, of Warrington, for the Darwen and Mostyn Iron Company. It was designed, says the *Engineer*, by Mr. J. T. Smith, of Rhine Hill, Stratford-on-Avon, and the Pearson & Knowles Coal and Iron Company, to supersede brick stacks of the ordinary description, which were used for carrying off the gases from the blast furnaces of the Darwen and Mostyn Iron Company. This chimney is 275 feet high from foundation to top, and the tallest iron structure of its kind in Great Britain. Shortly after erection, and before more than half the lining was in, it withstood without injury and in a perfectly satisfactory manner one of the severest gales experienced for many years.



WROUGHT IRON CHIMNEY AT DARWEN.

The following are a few general particulars of this chimney. As stated above, the total height, including foundation, is 275 feet; height from bottom of base plate to top of chimney, 260 feet 6 inches; distance from bottom to top of cone, 28 feet; distance from top of cone to top of chimney, 232 feet 6 inches; taper from bottom to top of cone, 10 feet 6 inches; taper from top of cone to top of chimney, 6 feet; number of tiers of plates, 66; total number of plates in chimney, 308; diameter of base plate, 27 feet 6 inches; base plate made in six segments; number of rivets used in construction, 17,000; twelve foundation bolts, 16 feet 3 inches long, by 2½ inches diameter, with swelled and screwed ends; total weight of iron work, 114 tons 7 cwt.; thickness of brick lining at bottom, 1 foot 6 inches; thickness of brick lining at top, 3 inches; time occupied in erection of iron work, 11 weeks; total weight of chimney, including foundations and lining, about 1,100 tons; total weight of a brick chimney same height, over 3,000 tons.

This system of construction, for chimneys about the same height, has many advantages. These should receive the careful consideration undoubtedly due to them by all interested in the subject. In the first place, there is a saving in the cost as compared with a chimney of similar height built in any other manner. The time occupied in erection is also much shorter, and, under certain circumstances, this must be a considerable advantage, especially as the work is not affected or stopped by frost. It is well known that the uncertain and imperfect nature of ground upon which a chimney may have to be constructed is often a source of grave anxiety to owners of chimneys, architects and builders. If, therefore, a reduction from the ordinary weight can be effected by building with iron, without, at the same time, in any way impairing the margin of safety, this should be a recommendation to the system. It is proved that iron chimneys are of much less weight. There is also the satisfaction of knowing that chimneys built in this way are necessarily free from the liability to sudden collapse, and to cause accident by material falling from them, due in brick chimneys to the cracking and displacement of the external surface, caused by the high temperature of the gases or defective workmanship. An additional advantage of this form of construction, to the Darwen and Mostyn Iron Company, is the freedom from damage to their chimney by excessive heat, produced in the manufacture of ferro-manganese.

In America there are many wrought iron chimneys erected in connection with different works. The Pennsylvania Steel Company have no less than eight such chimneys, varying in height from 110 feet to 170 feet. The Cleveland Rolling Mill Company, Ohio, has one 213 feet high. In France and Russia iron chimneys are also used. MM. Schneider & Company have one at Creusot, France, 280 feet high, and Mr. Bhekoldin, of Kineshnia, Russia, has one at his paper mills 170 feet high. There are also several smaller chimneys of the same kind in this country, in addition to that at Darwen already described. The Pearson & Knowles Coal and Iron Company, Limited, has seven, varying in height from 50 feet to 87 feet. The Acklam Iron Company, Limited, has two, 165 feet high, at the Acklam iron works, near Middlesbrough. There is one at Messrs. B. Heath & Sons works, Stoke-on-Trent, and also at the Nine Elms cement works, and several at different iron works in the Middlesbrough district.

The tallest brick chimney in the United Kingdom is at Glasgow. It is 468 feet from bottom of foundation to top of coping; diameter outside at ground line, 32 feet; at top, 13 feet 4 inches; thickness of brick work at bottom, 5 feet 7 inches; at top, 1 foot 2 inches. No piles were used in the foundation, the blue clay upon which the chimney was built proving satisfactory. One million and a half bricks were used in its construction, and the time occupied about three years. Total weight, about 8,000 tons; total cost, about £8,000. The next tallest chimney, also at Glasgow, is 455 feet 6 inches from bottom of foundation to top of coping; outside diameter at foundation, 50 feet; at ground line, 40 feet; at top, 13 feet 6 inches.

A short account of the successful demolition of a tall brick chimney may be interesting. Some years ago the tall circular brick chimney at Messrs. Muspratt's chemical works, Warrington, 406 feet high, 46 feet diameter at base, 17 feet diameter at top, was destroyed by gunpowder. The works having been moved to another locality, the chimney was not required. Mr. Stephen Court, engineer and architect to the St. Helens Canal and Railway Company, superintended these operations. A number of holes were dug