THE EVOLUTION OF THE INTERNATIONAL RACING YACHT.—II.

On February 26, 1885, a challenge for the America cup was received by the New York Yacht Club from the Royal Yacht Squadron, on behalf of the cutter Genesta.

In looking over the list of boats available for the defense of the cup it was at once decided that there was no sloop afloat that could hope successfully to meet the crack English cutter. Accordingly two sloops were built, the Priscilla and the Puritan; of which the Puritan was selected to meet the challenger.

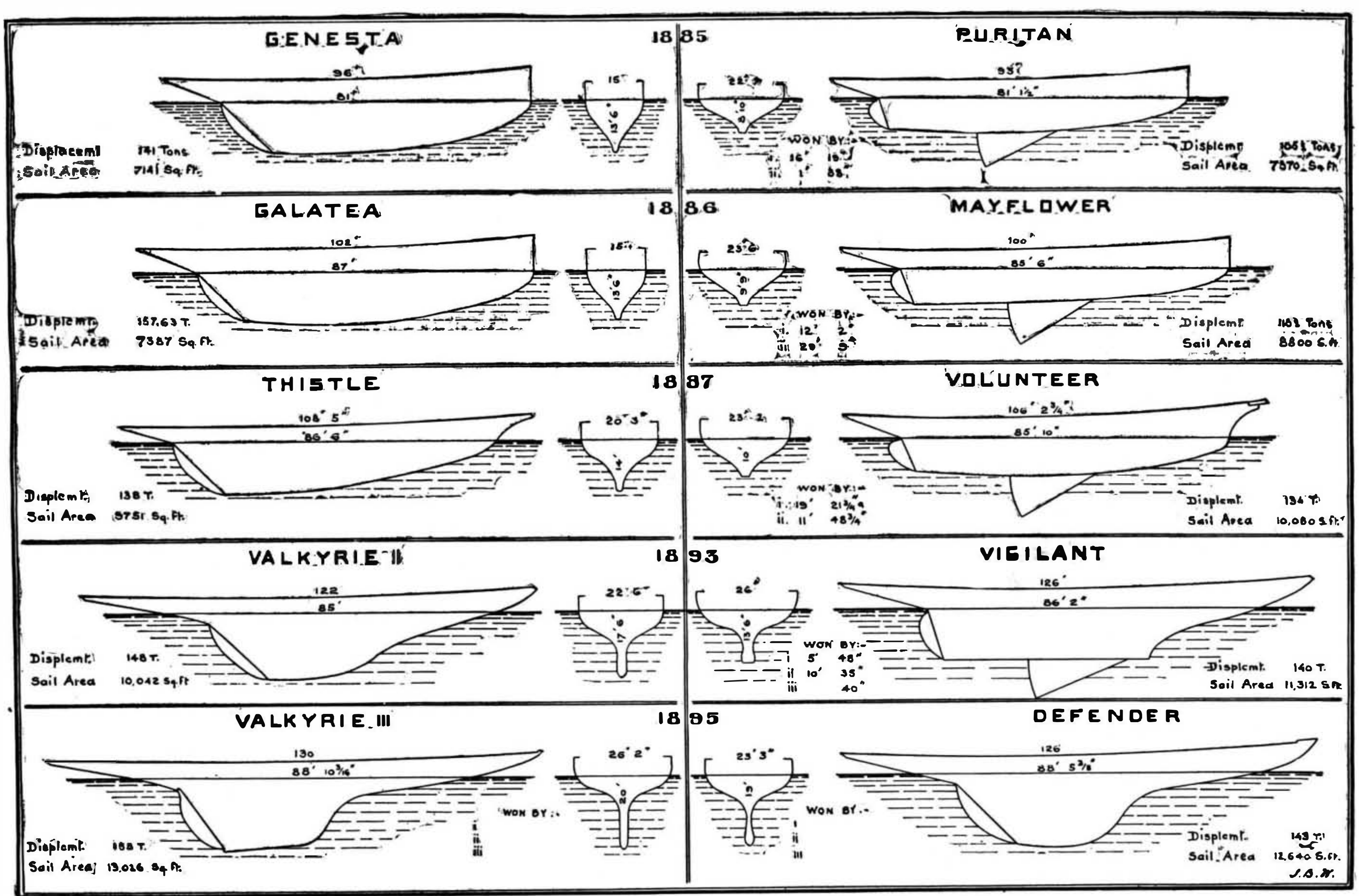
Strictly speaking, Puritan should be called a cutter sloop. She retained two good features of the national type (see preceding paper), namely, the broad and shallow hull and the centerboard; but she carried the cutter rig in its entirety, and also the cutter outside lead, having some thirty-two tons of this bolted to the bottom of her keel. She had a smaller displacement than the Genesta and showed a larger sail spread.

On the day of the first race Puritan fouled Genesta, carrying away her bowsprit. The cup committee on the Luckenbach there and then ruled Puritan out and told Sir Richard Sutton to sail over the course. Sir Richard's reply from the deck of his yacht was winner of a magnificent race by the narrow margin of 1m. 38s. To her credit be it said that before sailing for home Genesta contested and won three races, in the two last capturing the Brenton's Reef and Cape May cups.

The next competitors, Galatea and Mayflower, were similar to their predecessors, though larger. The Mayflower carried 42 tons in her keel, or 10 tons more than the Puritan. She had an easy victory over the Galatea, beating her in light winds by 12m. 2s. and again by 29m. 9s.

The measurement rule of the British Yacht Racing Association, which put a heavy penalty on beam, but none on draught, was responsible for the absurdly narrow type of English cutter. The hopelessness of winning the America cup under this rule of measurement was largely responsible for the adoption of a new rating rule, based on load water length and sail area. This left the English designer free to use all the beam he wished. The effect of this rule was seen in the next challenger, the Thistle. With 5 feet more beam than Galatea, and a much smaller displacement, she carried 2,400 square feet more sail. She had beaten all the English cutters with ease, and her owners came across the pond with the firm conviction that Thistle would carry back the America cup in her locker. But the her forefoot; but a glance at the two Valkyries, in the accompanying drawings, shows that their forefoot is cut away far more than Thistle's, and yet they are exceptionally fine boats in windward work.

The next challenger, Valkyrie II, designed by Mr. G. L. Watson, the designer of Thistle, was a further development toward the greater beam and shallower body of the American type. She showed in her profile or sheer plan the growing tendency among English designers to cut away all useless "deadwood" fore and aft. This was done to reduce the wetted surface of the boat. The researches of Mr. Froude, the English naval expert, had emphasized the fact that the larger part of the resistance of a ship is due to the friction of the water against her hull, or what is technically known as "skin friction." In the effort to reduce this area of wetted surface, the helm was tucked well in under the boat, and the keel forward was cut away until nothing was left but the body, or hull proper. This reduction of the "lateral plane" also produced an underwater form that would offer the minimum of resistance to turning when the boat was coming about. This latter result was very marked in Valkyrie II, and stood her in good stead when she was maneuvering for the start, or when she had Vigilant placed under her lee. The Vigilant introduced Mr. Herreshoff as a builder of cup



THE EVOLUTION OF THE INTERNATIONAL RACING YACHT.

prompt and characteristic: "We are very much obliged to you, but we don't want it in that way." He set a precedent in such contingencies, which, no doubt, all true-blooded sportsmen of each nationality will be quick to follow. The New York Herald of the following day voiced the public sentiment when it said, "The magnanimous decision of the owner of the Genesta is only what might be expected of Sir Richard Sutton and the club which he so admirably represents." The race finally came off on September 14. The wind was very light and "fluky." It suited the shallow, broad hulled boat and she won easily by 16m. 19s. The next race was sailed twenty miles to leeward and return. This, with one exception, was the most exciting race in the annals of the cup. There was a good breeze down to the mark, which the Genesta rounded one-eighth of a mile ahead. Then as they lay for the home mark, close hauled, the wind freshened and afforded a splendid opportunity for judging of the behavior of the two types in that grandest of all tests, a thrash to windward in a strong breeze and rough sea. The cutter kept up her topsail, and heeling until her seventy tons of lead in the keel could get in its steadying effect, she carried this great topsail home through half a gale of wind. The Puritan took in her topsail, housed her topmast, and under snug canvas began steadily to overhaul her rival. Her centerboard brought her closer to the wind, and she crept up well into the weather berth, coming home genius of the late Mr. Burgess, designer of Puritan and Mayflower, was equal to the occasion. He turned out a remarkably powerful boat, the Volunteer, showing in her a further development along the lines of compromise that he had followed in the two former boats. Compared with them, she had about the same beam, more draught and more outside lead, having 50 tons in her keel, besides a large amount of inside ballast in addition. Her sail plan was the largest ever seen on a "single sticker," and her career in the trial races was marked by easy victories over her predecessors, Puritan and Mayflower.

No cup race has aroused greater interest than the Thistle-Volunteer contest. The reputed prowess of the challenger, her wider beam and larger sail spread, had excited grave fears for the safety of the cup. The event, however, proved these fears to be groundless. In the first race, sailed in the usual light breeze, the Volunteer won by 19m. 21¾s. The Thistle people then offered copious libations to God Neptune and besought his deity to grant them a strong wind from heaven. He granted the request; and, behold, it availed nothing! for the centerboard cutter lay up so much closer to the wind than her keel opponent that she reached the weather mark 14m. ahead. The Thistle pulled up somewhat on the run home, reducing the Volunteer's lead to 11m. 48¾s. It was claimed that the Thistle's sagging away to leeward, when on a wind or close hauled, was due to the cutting away of defenders. She was a further development along the sloop cutter lines. She had the unprecedented beam of 26 feet, the great draught for a sloop of 13 feet 6 inches (as great as that of any previous challenger), and the large sail spread of 11,312 square feet or 1,300 feet more than the Valkyrie. She had 55 tons in her keel, besides 29 tons of inside ballest. She carried the characteristic centerboard of the sloop.

The first race was started to windward. The wind, light and fluky, veered around so that the race was a reach both ways. Mr. Watson's later boats have all shown a weakness in reaching, but excellent windward qualities. Mr. Herreshoff's boats are all excellent on a reach; and this change of wind meant sure defeat for Valkyrie. She came in 5m. 48s. astern. The second race, over a thirty-mile triangular course, was sailed in a strong whole-sail breeze. It consisted chiefly of reaching, and the Vigilant scored a brilliant victory, winning by 10m. 35s.

The third race, 15 miles to windward and return, was sailed in a strong reefing wind and a lumpy sea. It was Valkyrie's weather, and the comparatively narrow, fine lined cutter liked it better than the broad hulled centerboard, for Valkyrie turned the weather mark 1m. 55s. ahead of Vigilant. She pointed higher into the wind, and made better weather. It was a truly sensational scene, for here was the traditional centerboard, for the first time in the history of international cup racing, being fairly beaten by its time honored opponent, the keel boat. In the words of that most charming of all nautical writers, Mr. A. J. Kenealey, " Now came the surprise of the yachting season. The English keel boat seemed to eat her way out to windward in a manner almost magical, while the centerboard craft slowly sagged off to leeward. Conditions were reversed for the nonce, and the experts of the New York Yacht Club could scarcely believe their eyes." On the run home the 1,300 square feet excess of sail on the Vigilant stood her in good stead. She gained rapidly, but not rapidly enough barring accident to save her time allowance of 1m. 33s. It looked as though the English cutter were about to place at least one well earned victory to her credit. But here Dame Fortune, that fickle goddess, stepped in and said it should not be. Valkyrie's spinnaker was slightly torn in setting. A gust of wind tore it from top to bottom. Another was set, and that too was split to shreds. Meanwhile Vigilant swept by and landed across the line, a winner by the close margin of 40s.

While Mr. Herreshoff and Mr. Watson were fighting it out off Sandy Hook, there was a battle royal going on in the English Channel between two other creations of these two designers, namely, the Navahoe and the Britannia. They were practically sister boats to the Vigilant and the Valkyrie. The outcome was strongly in favor of the cutter. When it came to reaching, the Navahoe could hold her own; but in windward work she was completely outclassed. The next season the American champion crossed the ocean to avenge her twin sister, and met with a crushing defeat at the hands of the Britannia, a boat that stands to-day with a record of victories that has never been approached. It is true that, when there was any reaching to be done, and particularly when the wind was fresh, Vigilant scored some splendid victories; but the balance of the wins was vastly in favor of the keel boat. It was the same quickness in stays, consequent on her reduced lateral plane, and the same fine windward qualities which her twin sister Valkyrie showed in America, that won for Britannia so many victories over Vigilant. Mr. Herreshoff was aboard Vigilant during the third race of 1893; he was aboard her again in 1894 when Britannia so frequently tucked her snugly under her lee; and the lesson of this experience was not lost upon him. Lord Dunraven is quoted as saying on leaving for England at the close of the 1893 contests: "If I come again, I shall find a keel boat built to meet me."

The influence of the racing of 1893-4 on Mr. Herreshoff is seen in a comparison of the midship section and sheer plan of Defender with that of Vigilant and Valkyrie. As compared with Vigilant, he has thrown over the great beam, the moderate draught, the long straight keel, the almost plumb stern post and rudder; and, as compared with Valkyrie II, he has adopted the moderate beam, the deep draught (in Defender's case 5½ feet more than Vigilant), the cut away and rounded keel, the raking stern post placed well in under the boat; and finally, and most startling of all, he has thrown out the national and time honored centerboard! The midship section of Valkyrie III shows the influence of Vigilant on Mr. Watson. Following along the lines on which he worked in Thistle and Valkyrie II, he has greatly increased her beam, and consequently her sail spread; he cut further into the lateral plane both fore and aft, and he increased the draught.

In their performances the two boats show the same strong and weak points of sailing that have ever characterized the work of their designers; though it is scarcely just to speak of weak points in the work of Defender, for she is a most consistent performer all round. Her weakest point is running with spinnaker set and the wind dead aft; and her strongest point is reaching. Strange to say, the conditions are exactly reversed in Valkyrie. She is superb in windward and leeward work and a miserable failure on a reach, the three year old Britannia easily holding her on this point of sailing.

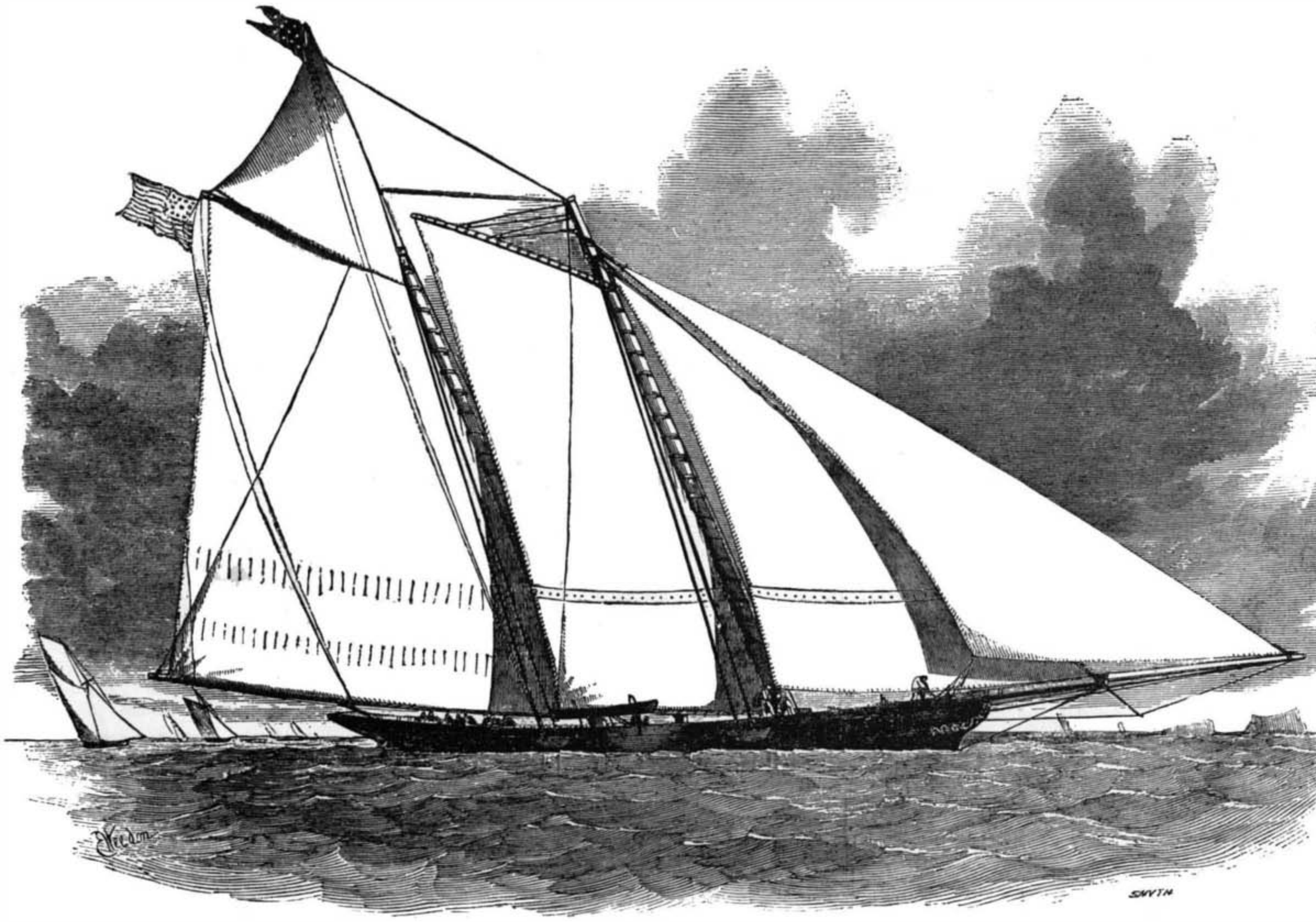
Judged by their previous performances, Valkyrie's best chance of winning would be on a windward and leeward course, and Defender should always win on a triangular course.

By a strange fatality the same shift of wind occurred in the first of the 1895 races to windward as did in the first windward race of 1893. When both boats were on the starboard tack and Defender to starboard of Valkyrie, the wind shifted several points to the south, bringing it further round on the starboard bow and placing Defender well to windward. This also changed the home course from a dead run with spinnakers, Valkyrie's best point of sailing, to a reach, Defender's best point of sailing; and the home boat literally ran away from Valkyrie, and won a splendid victory by between 8 and 9m.

The next race, over a thirty mile triangular course, was marred by a foul between the two boats, which the committee subsequently decided against the visitor. Defender, though crippled with a sprung topmast, sailed over the course under reduced sail, and actually gained ¼m. on one leg and 1m. 17s. on the last leg of the triangle, losing the race by only 48s. This was a moral victory for Defender, and seems conclusively to establish her superiority over such a course. Before the final race, Lord Dunraven, the principal owner of the Valkyrie, wrote the America Cup Committee, stating that unless they could guarantee a course free from obstruction by excursion boats, he would decline to sail his yacht. The Valkyrie was at the starting point under reduced canvas, and crossed the line in order to make the race count. Then she wheeled around and started for New York, leaving Defender to sail alone and secure the third and decisive race of the series.

Thus ended the most disappointing and unsatisfactory contest in the history of the cup races.

That the Defender is a better boat on the average than the Valkyrie, would seem to be proved; but that these two magnificent yachts should never once have spread their spinnakers, and never once have found a wind that lay their lee rails awash, is a source of genuine disappointment to all close students of yacht design and performance. J. B. W.



THE YACHT AMERICA, 1851.

The Trip Valve Gear on Marine Engines.

It is odd that a form of rapid cut-off valve gear has not been successfully applied to marine engines, as in the case of engines for stationary duty. It is well known that steam machinery has received the greatest amount of attention by engineers with the object of economical fuel consumption, and every source of waste of heat and steam has been most carefully studied. Especially have the efforts been marked for economical operation in the marine plant, where saving in coal is of vital importance. The marine triple and quadruple expansion engines, which are furnished with steam at a tremendous boiler pressure, are far ahead, in point of economy, of the stationary engines, which have very often better methods of "cut-off." The writer sees no reason why stationary engines should monopolize the best steam valves. It is clear that a valve of this kind would not be satisfactory on very small high speed screw engines, because of the inertia of the tripping parts, or perhaps on the engines of large ocean steamers, where the gear would have to be very massive, but there seems to be room on engines of medium speed and size for profitable experiments. The compounding of locomotives is comparatively a recent thing, and the improvement was brought about in the face of much opposition.

N. MONROE HOPKINS.

[There are some difficulties met in adapting the Corliss movement to large marine compound engines that more than compensate for any possible gain; as, beyond the operation of the high pressure piston, there is no gain in power.

The complication of parts in a valve movement of the Corliss type is not desirable, as it increases the liability to derangement or breakage on shipboard. Simplicity in construction is the first principle in marine machinery.—EDITOR.]

New British Torpedo Boat Destroyer.

The trial trip of the torpedo boat destroyer Salmon was lately run. This vessel has been built and engined by Earle's Shipbuilding and Engineering Company, of Hull, and is one of the larger class of the destroyers, her displacement being 280 tons. Her draught, on trial, was 5 ft. forward and 7 ft. 3 in. aft. The mean speed on the six runs on the mile was 27·88 knots, and for the whole three hours 27·608 knots, or at the rate of 31¾ miles per hour. The Snapper is a sister vessel, built by the Earle Shipbuilding Company for the Admiralty. The contract price for each vessel is $176,960, exclusive of armament.

El Capitan Meteorite.

BY E. E. HOWELL.

This handsome meteorite was found by a Mexican sheep herder, Julian Jesu, in July, 1893, on the northern slope of El Capitan range of mountains in New Mexico. Three small pieces were broken from the thin edge, which show beautifully the octahedral structure of the iron. The smallest of these, weighing a few ounces, was sent to the National Museum, and the two larger, weighing respectively 1 pound 12½ ounces and 3 pounds 14 ounces, together with the main mass, 55 pounds, came into my possession at different dates in 1894.

The weight of the iron when whole was about 61 pounds. It measured 10 × 9 × 5 inches, thinning at one edge, and had the usual irregular pitted surface.

My information in regard to the history of the meteorite, as well as the meteorite itself, was obtained from Mr. C. R. Biederman, of Bonito, N. M. Mr. Biederman says that he, in company with many miners, was standing in front of a store in Bonito some time in July, 1882, when "they saw a meteorite which looked like a fiery ball moving rapidly toward the north at an angle of 45° and vanish behind the Capitan range." Mr. Biederman thinks the meteorite found by the Mexican is the one they saw fall, and there is nothing in its appearance to disprove his claim. It is entirely free from oxidation and evidently fell at a comparatively recent date.

The Widmanstatten figures are developed very easily and clearly, as is usual with irons containing the percentage of nickel which this has, showing it to belong to the usual type of octahedral irons, with rather broad bands of kamacite somewhat like those in the Cooperstown meteorite.

I am indebted also to the courtesy of Professor Clarke for the following analysis of this iron by Mr. H. N. Stokes, of the United States Geological Survey:

Fe	90·51
Ni	8·40
Co	0·60
Cu	0·05
Si	tr.
P	0·24
S	tr.
	99·80

—Amer. Jour. Science.

Argon and Helium in Meteoric Iron.

Professor W. Ramsay, extending his researches upon the new element argon, has proved that it exists with helium in meteoric iron. The meteorite investigated was that of Augusta County, Virginia, two ounces of which, heated to redness in a hard glass tube, yielded 45 cc. of gas. This appeared to consist chiefly of hydrogen, but after it had been exploded with oxygen, and the carbon dioxide and excess of oxygen absorbed, a residue of half a cubic centimeter was obtained. Several vacuum tubes having been filled with this after being dried, spectroscopic examination proved it to be for the most part argon, the trace of nitrogen which first appeared rapidly disappearing. All the argon lines were observed and also, faintly, the yellow D_3 of helium. A comparison of the spectrum with that of the helium from cleveite showed the presence of the red, blue green, blue and violet lines characteristic of it. From quantitative observations with a mixture of argon and helium it is concluded that the latter element makes up less than 10 per cent of the gases obtained from the meteoric iron.—Nature.

The Story of the Paris-Bordeaux Race.

One of those who rode in the winning carriage has written for Figaro a spirited account of how the race was run and won. The contestants in the coming race will not be compelled to press on in the night, but there will doubtless be incidents fully as exciting as those described by Edouard de Perrodil, who writes as follows:

I took part in the race of the automobiles from Paris to Bordeaux and back in carriage No. 16, the winner of the first prize. The story is worth telling under the circumstances.

Nothing noteworthy occurred on the way to Bordeaux. The pace was 25, 30, 40, and even 50 kilometers [a kilometer is equal to about 0·62 of a mile] an hour on the down grades. After passing Blois night fell, dark as ink. The whole population was on the lookout, and from time to time one passed groups of people waiting along our route. The cyclists were legion. They, too, were massed along the road, and with their bobbing lamps they resembled a gathering of shadows, about which flickered here and there the will-o'-the-wisp. How cold it was! A wind which blew steadily full in our faces turned us to ice.

As day broke one had plenty of time to catch the efforts which the sun made to break through great banks of gray clouds. Toward 10 o'clock the weather again became superb. After leaving Couhe-Verac the automobiles simply flew. In this way were passed without a stop Ruffec, Angouleme, and Libourne, and we entered Bordeaux in triumph.

I only joined it again at Blois, to which place I traveled by rail. While I waited at Blois a telegram from Tours brought us the news that the struggle for the first prize had narrowed down to two carriages—No. 8, which had passed at noon, and mine, No. 16, which had passed at 12:30 P. M.

At Blois No. 8 arrived at 2:45. She took in petroleum and started once more at 3:05. Everyone was anxiously looking out for No. 16. "Has she gained ground?" Yes; she has gained five minutes. I have resumed my place beside the engineer, with a keen sense of satisfaction, mingled with excitement, for the fight is going to be a hot one. We are twenty-five minutes behind No. 8.

Our carriage travels splendidly. The road, too, is magnificent. I hold in my hand the ordnance map and I point out to the engineer the various places. We pass rapidly by Mer, Beaugency, Meung-sur-Loire, La Chapelle. Every other minute the engineer, Mr. Koechlin, or the other traveler, inquires: "Are they far ahead?" "Hurry up; they are half an hour ahead of you!"

At the umpire's station at Orleans an immense crowd. A halt of two seconds. One of the committee tells us: "You are twenty-five minutes behind No. 8." Why, we are still as far behind as ever.

We bound forward on the Paris road. We pass Saint Lye, Autruy. It is already late, and the day is visibly drawing to a close. "Sapristi! What is going to happen," I say to myself, "at such a pace at night, when we descend the hills of Saint-Remy and Buc?"

All at once an emergency arises. One of those that I had most dreaded. The drivers we met always kept a bright lookout, generally on foot at their horses' heads. But this time a dray horse at the sight of our automobile backs so violently that the driver cannot hold him. Our engineer does not stop. He describes an enormous elbow on the grassy slope, upon which the automobile leaps and doubles round the back of the dray. We have passed by safely!

Every minute now one inquires: "Where are they?" Every time the same answer: "Go on! Go on! Make haste! A quarter of an hour ahead!"

Mr. Koechlin, the engineer, loses his nerve badly. He is rattled. He no longer stops at anything. Night has now fallen, densely dark, as before. "Where are they?" yells the engineer to each passer-by. "Quarter of an hour ahead; push on!" "Thunder!" says the engineer; "shall we never overtake them?"

At the steep hills we get down to lighten the carriage and we run breathlessly behind. Here we are at Etampes. At the entrance of the town some one who was on the lookout for us throws us a bag of ice to cool the cylinders.

Suddenly, in the middle of Etampes, a young fellow calls to us: "They stopped here to take in water. Go ahead; they have three minutes' start!"

The engineer is quite beside himself. We dash forward into the night, and suddenly, on a hill which is before us, we make out a red fire and we recognize the sound of a motor—tuff, tuff, tuff! It is No. 8.

We attack the hill in turn. We leap from the automobile and courage! We are within 200 yards of No. 8. Hurrah! But our competitor has reached the top of the hill and is leaving us at full speed. We shall have to make two deep descents in zigzags—here comes the first. No hesitation. We attack it at 25 miles an hour. It is alarming.

Suddenly we come to a fork in the road. "Which way?" cries the engineer. It is terrible. I do not know.

"Left!" I cry. "No, right!"

The pace is such that the engineer's hesitation comes very near causing a catastrophe. For he has no time to make the sharp turn from left to right, and we shoot on toward a wall which stands at the angle of the roads. Our automobile was supplied with two air brakes. One can be worked by the feet, while still steering; the other, and much the more powerful brake, must be worked by hand. To apply the latter one has to release the guiding bar.

In our critical position the engineer showed great presence of mind. He dropped the guiding bar completely and applied both brakes at once. This saved us. The front wheels nearly ran up against the slope which was at the foot of the wall. All this took but a second. Here we are rolling along at a mad pace once more.

We pass through Versailles. A halt of two seconds at the umpire's station. No. 8 is still three minutes ahead.

This time the engineer no longer knows the road at all, but, on the other hand, I know it thoroughly, having traveled it an incalculable number of times on a bicycle.

Then, standing beside Mr. Koechlin, I find myself in the same position as the young son of King John the Good when, at the battle of Poitiers, standing beside his gigantic father, who was holding at bay the entire English army, he kept calling out: "Father, strike to the right! Father, strike to the left." I call out to the engineer: "Steady; turn to the right! Steady; turn to the left!"

And so, rolling and bounding along, we pass the Suresnes bridge, the riverside drive, Avenue de Madrid, Boulevard Maillot, and we reach our goal at two minutes and thirty seconds past midnight—two minutes later than No. 8, but we were winners! For No. 8 had left Paris fifteen minutes ahead of us. It was, therefore, thirteen minutes late.—Chicago Times-Herald.

A New Theory of Sleep.

Since the discoveries made by Golgi, Cajal, Retzius, and others of the peculiar anatomical characteristics of the nerve cells, a number of new theories regarding brain function and brain action have been in the field. The nerve cell, as it is now understood, consists of a very large number of long branched processes, which are called the protoplasmic processes, and a single axis cylinder which extends out, becoming eventually the nerve fiber and giving off fine lateral branches. It has also been shown that each nerve cell in the brain is in contiguity with some other nerve cell, or rather with the terminals of the axis cylinder process of that cell, but that no actual union takes place between the processes from the one cell and fiber process of the other. When one set of nerve cells, for example, are thrown into activity, impulses are sent out along the axis cylinders and their terminal end brushes, and these affect by contact the protoplasmic processes of other cells.

Cajal and others look upon the axis cylinder and nerve fiber as conveying impulses out from the nerve cell or body, while the protoplasmic processes receive impulses brought to them and carry them to the cell body. These latter, therefore, are sometimes called cellulipetal, while the axis cylinder process is called cellulifugal. We are speaking, of course, now of the relations of the different groups of cells in different parts of the brain, rather than of the relations of these cells to the spinal cord and parts below. Some time ago Professor Duval proposed the theory of sleep based upon the peculiar relations of the brain cells and fibers. According to this theory, the nerve cells in repose retracted their processes, (which, as he thought, were really pseudopods. The cell processes being thus retracted, the contiguity of the cell with other cells was less perfect; hence their functions became lowered, consciousness was lost, and sleep ensued.

Kolliker objected to this view, on the ground that amœboid movements are never observed in nerve cells at least of the higher animals; Duval having contended that he had seen such movements in the lower orders of animals. Cajal, siding with Kolliker, states that no matter what way you kill an animal—by shock, strangulation, or anæsthesia—the nerve cells never differ in aspect, and one never can discover any amœboid movements among them, even when they are placed freshly in the field of the microscope. Cajal has, however, suggested another theory of sleep which he believes more rational and more in accordance with facts. While nerve cells do not have amœboid movements, there are, scattered richly throughout the brain tissues, other cells known as neuroglia cells. These are cells with very numerous fine processes, and they form in a large measure the supporting framework of the brain tissue, sending their fine processes in among the nerve cells and blood vessels.

Now Cajal's theory is that these neuroglia cells during repose extend or relax their fine hair-like processes. As the result of this the perfect contact between the processes of the nerve cells and the end brushes from the axis cylinders that surround them is interfered with, hence the brain function is slowed up and sleep ensues. During activity these neuroglia cells retract their numberless fine processes, the contact between the nerve cells becomes perfect again, and mental functions are resumed. The practical facts upon which Cajal bases this ingenious theory are that the neuroglia cells are found to be in different states. In some their processes are retracted and shriveled and in others they are extended. There is unquestionably an amœboid movement, therefore, in this class of cells.

Furthermore, it is in accordance, he says, with physiological facts that a cell would retract its processes during activity and relax them during repose. The physical basis of sleep, therefore, according to this view, would be the bristling up of the hair-like processes of the neuroglia cells, a squeezing of them in between the machinery by which the nerve impulses pass, and a sort of a clogging of the psychical mechanism. Such theories are of course as yet only theories, and may be regarded by practical minds with great contempt. Still, there is sometimes an advantage in scientific hypotheses, even if they furnish only an intellectual exercise to the student.—Medical Record.

Aluminum Boats.

A practical test was made of aluminum in the construction of small boats by Mr. Walter Wellman, who had three constructed to carry his polar expedition last year. These boats, it was said at the Navy Department, had been brought back to Washington, and an examination some time ago showed that the material had so deteriorated that it could be easily crumbled in one's hand.

Science Notes.

Pictet's Gas.—Mr. Pictet, having observed that an addition of carbonic acid to sulphurous acid seemed to materially increase its powers of disinfection, requested Professor D'Arsonval to investigate the value of this admixture and report thereon. Mr. D'Arsonval has communicated the results of his experiments to the Société de Biologie. He finds that carbonic acid and sulphurous acid, in the proportion of four of the former to six of the latter, combine chemically to form a gas (which he calls "Pictet's gas") possessing marked antiseptic properties and extraordinary powers of diffusion. Thus, cultures of typhoid and cholera were placed on rags between the leaves of a book which was enveloped in cloth and exposed to the influence of the gas. In the space of an hour the germs were found to be entirely destroyed. Pictet's gas has also proved fatal to microbes that were still living after treatment with sulphurous acid.

Direct Spectrum Analysis of Minerals.—Among the theses recently presented to the Faculty of Sciences of Paris, may be mentioned an important one by Mr. Arnaude de Gramont upon spectrum analysis. The process employed differs from those used up to the present time. A spark from a condenser is made to pass between two fragments of the mineral to be examined, and the methodical spectrum analysis of the rays that are produced furnishes accurate and quickly obtained data as to the chemical composition of the mineral. By this method Mr. De Gramont has also been able to find in fused salts the rays of the metalloids contained therein. He has given the rays of sulphur and silenium with a closer approximation than has ever before been obtained.

Formation of Drops.—In a paper presented to the Royal Society of Edinburgh, Mr. Hannay gives the following interesting data in regard to the formation of drops.

The drops were studied by allowing water to drop through oils of different density and viscosity and causing drops of oil to ascend through water. The volume of a normal drop of distilled water in olive oil was found to be equal to 0·4096 cubic centimeter. When the drops succeed one another at intervals of ten seconds, the volume is increased to 0·5611 cubic centimeter, while the drops formed from a cylinder of water so arranged as to eliminate the effects of gravity have a volume of but 0·5470 cubic centimeter, which shows that the determining factor in the formation of drops is contractibility. Gravity has a tendency to make the drop lose its spherical form, but the contractile force of the liquid prevents such distortion, and the result of those two contrary forces is the constriction of the drop and its separation.

Mr. Hannay confirms the observation made by Tate as long ago as 1864: "The weight of a drop is sensibly proportional to the diameter of the tube from which it falls. The force that retains the drop is wholly superficial. It is an extremely thin envelope that determines the size and form of drops."

This fact was proved by causing water at 20° C. to drop in the vapor of benzine at 37°, so that the latter was suddenly condensed and formed a thin stratum around the drops of water. The volume of the drop of 0·1081 cubic centimeter in the normal state was found under such circumstances to be reduced to 0·0449 cubic centimeter.

Properties of Carbonic Snow.—At a recent session of the Société d'Encouragement, Mr. P. Villard made known the results of some experiments made by him in conjunction with Mr. R. Jarry upon solid carbonic acid. Crystallized carbonic acid melts at —57° under a pressure of 5·1 atmospheres. This melting point was determined by means of a toluene thermometer plunged in the melting carbonic acid, which was contained in a glass tube protected against radiation by a metallic jacket. The crystals of carbonic acid have no action upon polarized light. The point of ebullition of carbonic snow at the ordinary pressure, that is to say, the temperature that it takes of itself when it is exposed in an open vessel, was likewise determined with a toluene thermometer carefully protected against radiation. Such point of ebullition is situated at —79°, and at this temperature the vapor emitted possesses an elastic force precisely equal to the pressure of the atmosphere, conformably to the laws of ebullition. It is, therefore, impossible to admit the temperature of —60° hitherto proposed, to which corresponds an elastic force of about four atmospheres.

Contrary to the opinion that has been held, ether added to carbonic snow does not lower the temperature of it. In whatever way the mixture is made, the minimum temperature is —79°, and this is not attained unless there is an excess of snow; and the feeble thermic effect due to the dissolving of the snow cannot manifest itself under ordinary conditions.

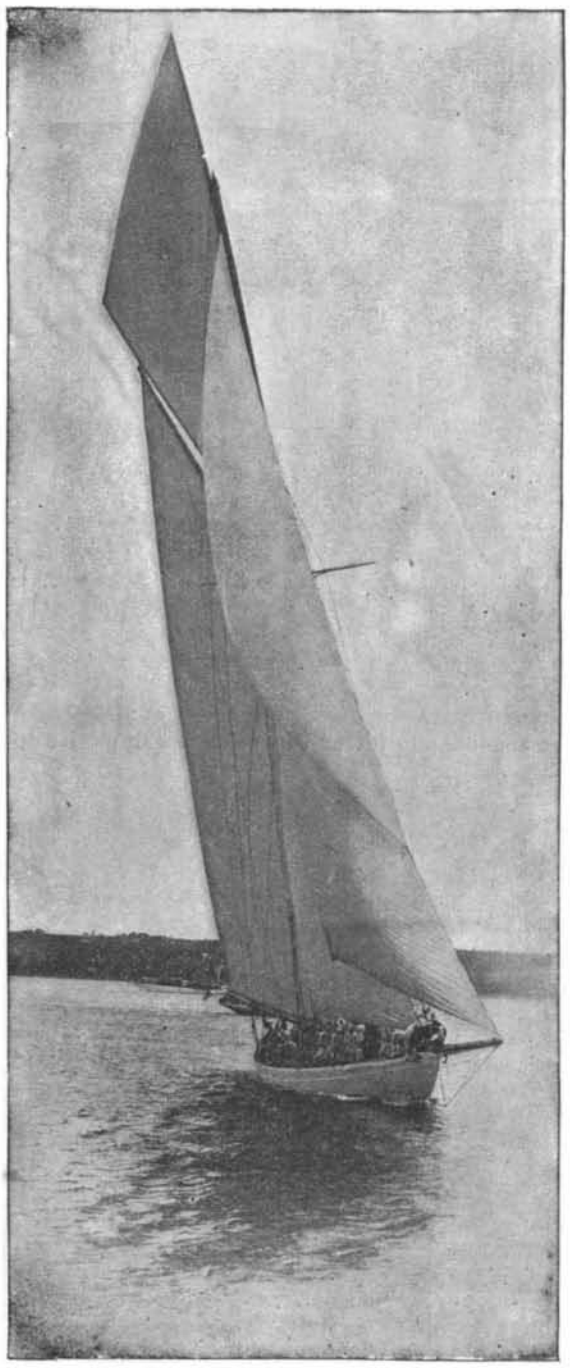
The cold obtained is due to the fact that the snow is cold and tends to maintain itself at its point of ebullition. Consequently, it brings to this point the liquid that surrounds it.

Chloride of methyl acts quite differently. The snow dissolves in this without any gaseous disengagement, starting from —65°, and, at the moment of saturation, the thermometer marks —85°, a temperature lower than that of the coldest of the bodies employed. We have thus a true freezing mixture comparable to a mixture of nitrate of ammonia and water.

Liquid protoxide of nitrogen was tried without success as a solvent of carbonic snow.

In a vacuum, the temperature of carbonic snow readily falls to —125°, and this degree of cold can be maintained for a very long time with little material. The author concludes from this that it is easy to succeed in liquefying oxygen without any other refrigerant than carbonic snow and with the ordinary resources of a laboratory.

Arsenic in Steel.—Mr. J. E. Stead has recently published a paper upon a subject to which metallurgists have hitherto paid but little attention—the presence of arsenic in steel. Mr. Stead finds that a proportion of from 0·1 to 0·15 per cent of arsenic can exert no influence upon the resistant properties of the metal employed in constructions. The resistance to breakage is slightly increased by the presence of a feeble proportion of arsenic. The elongation is in nowise affected, and the contraction of the section of the broken trial bars is practically the same as that of steel that contains no arsenic. But with a proportion of 0·2 per cent of arsenic, the difference becomes marked in the steel obtained in the open hearth furnace. But even then the resistance to flexion alone is a little reduced. With one per cent of arsenic the resistance to breakage increases, the elongation diminishes a little, and the contraction is reduced. When steel contains four per cent of arsenic, the resistance to breakage ever increasing, the elongation and contraction disappear.


THE AMERICAN YACHT DEFENDER.

Electrification by Rain Drops.—In a paper recently presented to the Philosophical Society of Glasgow, Lord Kelvin showed, by the aid of special apparatus, that the passage of a drop of water through the air has the effect of slightly electrifying the latter. The electric action is much more intense if the drop of water meets with a solid body or a liquid surface. He has also found that if a drop of fresh water strikes a surface of salt water or a solid body, the air is negatively electrified, while if salt water is used, the air is positively electrified.

The clash of waves against each other likewise gives rise to a positive electrification of the air, and in a much larger measure than the negative electrification due to the fall of rain.

Theory of the Sensation of Colors.—Mr. George Arzens, struck by the insufficiency of the theory of vision from the view point of the perception of colors, has conceived the idea of applying the theory of stationary waves to the explanation of this phenomenon. He remarks, in the first place, that the nerve fibers, after traversing the retina, are so inflected as to present a direction inverse to that of the luminous rays, and that some of them are terminated by cylindrical rods and others by small cones. These nerve fibers receive an excitation from half-wave to half-wave. Mr. Arzens believes that they are differently impressed, according as it is a question of rods or cones. The first gave the sensation of light and the second that of colors. In the case of the conical fibers, there intervene phenomena of interferences that unequally displace the planes of the stationary waves. The planes that correspond to red light are thrust forward with respect to those of the red rays, so that the cone is impressed at different points by the rays of the various colors. In support of this theory, he makes the following remarks: (1) Nocturnal animals have no cones; (2) in the alterations of the retinal pigmentation due to senility or disease (achromatopsy), there is a suppression of the perception of colors; (3) when we consider points of retina remote from the central part, the notion of color diminishes in the same ratio as that of the number of cones to the number of rods.

Non-Shrinkable Fabrics.— Messrs. Mathelin, Floquet and Bonnet have just devised a process which they claim has the property of rendering thread and fabrics absolutely non shrinkable. They combine the old alumina or sulphate of alumina process with a treatment with a solution of carbonate of soda and the use of steam. The latter, in addition to its fixing property, permits of sensibly increasing the degree of solution of the alumina salts, while removing the unctuous, gelatinous or glutinous feeling resulting from the treatment.

Artificial Indigo.—What is known as "indigo salt" is now being introduced as the latest substitute for the genuine article. It is said to possess the property of being converted into indigo by means of caustic soda, and, in dyeing, all that is necessary is to treat the cotton in a bath of the salt and then pass the treated cotton into a solution of the soda. The value of this method may be estimated from the statement made that, in printing, it suffices to thicken a solution of the salt with dextrine, print this on, and pass the printed fabric through caustic soda.

Paper Pulp for Leaks.

Paper pulp is one of the most useful articles in the reach of mankind.

Mixed with glue and plaster of Paris or Portland cement, it is the best thing to stop cracks and breaks in wood.

Pulp paper and plaster alone should be kept within the reach of every housekeeper.

The pulp must be kept in a close-stoppered bottle, in order that the moisture may not evaporate.

When required for use, make it of the consistency of thin gruel with hot water, add plaster of Paris to make it slightly pasty, and use it at once.

For leakage around pipes, to stop the overflow of water in stationary washstands, where the bowl and the upper slab join, it is invaluable.

Used with care, it will stop leaks in iron pipes, provided the water can be shut off long enough to allow it to set. Around the empty pipe wrap a single thickness or two of cheese cloth just wide enough to cover the break, then apply the compound, pressing it in place and making an oval of it somewhat after the fashion of lead pipe joining, only larger.

The strength of this paste, when once it is thoroughly hardened, is almost beyond belief. The bit of cheese cloth prevents any clogging of the pipe by the paste working through the cracks.

An iron pipe that supplies the household with water had a piece broken out by freezing. The piece was put in place, bound by a strap of muslin, then thoroughly packed with paper pulp and Portland cement, and was to all appearances as good as new.

Paper pulp and fine sawdust boiled together for hours, and mixed with glue dissolved in linseed oil, makes a perfect filling for cracks in floors. It may be put on and left until partly dry, then covered with paraffine and smoothed with a hot iron.—Rural Mechanic.

An Earthquake on the Atlantic Coast.

A shock of earthquake was felt a few minutes after 6 o'clock on the morning of Sunday, September 1, along the Atlantic coast from Delaware to Long Island. The shock in New York City was very slight, but was sharp in New Jersey and to the east of New York. The vibration was attended by a slight rumbling noise. This makes the fourth shock which has been felt in New York City in the last eleven years. On August 10, 1884, at 2:14 P. M., there were three distinct vibrations, the second being the severest ever recorded in this vicinity. Other slight shocks were felt on August 31, 1886, and on March 8, 1893.

A Test of a War Vessel Frame and Armor.

The Naval Ordnance Board conducted an important test at the Indian Head Proving Ground, near Washington, September 4. Though primarily it was a test of a steel armor plate, it was in reality a trial of the strength of the frame of a modern warship. It has been claimed that the frames of modern warships would not withstand the shock caused by heavy projectiles striking against the armor which covers them.

It has even been asserted by some authorities that the armor, if not penetrated or shattered by the shock, would be driven through the vessel by the crushing of the frame. Some time ago the English government fired at an old armored vessel for the purpose of observing the effects of the shock, but this test at Indian Head is the first frame test ever made of a distinctly modern warship's frame with armor attached.

The plate tested represented twenty-four others weighing 620 tons. It was made by the Carnegie Company and was what is known as double-forged, being forged both before and after Harveyizing.

The plate was 14 inches in thickness and formed the outer surface of a target which was a representation of a side section of the battleship Iowa. It was 18 feet long by 7½ feet high, and represented that portion covering the vitals, and extending 5 feet below and 2½ feet above the water line. Behind the armor was a backing of 5 inches of oak, and then came the "skin" of the vessel—the inner and outer bottoms, each five-eighths of an inch of steel plate.

Some four feet further back was a ⅝ inch steel plate, representing the inner shell of the vessel. Between this plate and the "skin" were the frames or braces, also of ⅝ inch plate, alternately two and four feet apart. The whole structure was covered by a 2½ inch steel plate, representing a protective deck. Against the inner plate were heavy timbers resting on the side of a hill.

The conditions were not exactly the same as on board a ship in the water, because the water would yield, while the solid earth would not, but the difference would be very slight, as the vessel in the water could not yield quickly enough to be of any real benefit. The first shot fired was a 10 inch Carpenter projectile, weighing 500 pounds, which was propelled by 140 pounds of prismatic powder. The velocity was 1,472 feet per second. The shell was completely shattered by the impact, part being lodged in the plate. The backing and frames were found intact. The charge of powder was increased to 216 pounds. The projectile then had a velocity of 1,862 feet per second. Again the shell was shattered, a larger portion being embedded in the plate, which still remained without a crack or bulge. The frame was uninjured, except that one of the armor bolts was driven out. This completed the acceptance test for the lot of twenty-four plates. Then a shot was fired from a 12 inch gun, using a Wheeler-Sterling projectile weighing 850 pounds, which was propelled by 400 pounds of powder at a velocity of 1,800 feet per second. This test was one which was ordinarily used for the 17 inch armor plate. It was, therefore, thought that the projectile would pass entirely through the plate, but it did not. The plate was penetrated almost its entire depth and cracked from top to bottom, but the oak backing was scarcely disturbed and the frame was uninjured. A further test with a 13 inch gun will be made as soon as the gun can be set up.

The test of the new armor bolt designed by the Ordnance Board to replace the bolt now used in fastening armor to the ships was also entirely successful. The bolt is less than half the length of the bolt now in use, and the saving of weight in each ship will be considerable.

The test demonstrates the fact that the frames of our warships are able to meet ordinary demands and that the 14 inch armor for the new battleships will, under ordinary conditions, receive the fire of any vessel without serious damage.

Why the Bicycle is so Popular.

The evolution of the bicycle from the original idea of manumotion down to the present diamond-framed rear driver has been by certain positive steps, each step marking a distinct advance in the grand march of improvement.

In schools are taught something of the revolutions wrought by the steam engine, the telegraph and the loom, but the schools of the future will surely take notice of the wonders wrought by the bicycle, and will teach something about the Draisine or "go-devil," the velocipede, the bicycle and all such inventions of whatever name, by which man is enabled to travel quickly, merely through the application of his own muscular powers.

What makes the bicycle so popular with all classes of people? Cheapness? No; the trolley or cable is cheaper. Speed? No. If one merely wants to travel fast there is the railroad. Luxury? No. The brougham is far ahead of the bicycle on that score. And yet people with all these things at their command have taken to bicycling with great fervor. It must be because of the outdoor exercise, you say. No, again. The term outdoor comprehends infinite space, and as for forms of exercise—well, they are without limit. There never was a complaint of the lack of either outdoors or methods of exercise in it.

The secret seems to lie in the fact the wheel has revealed to us that our natural powers of locomotion have been multiplied. "Two blades have been made to grow where but one grew before."

The draught upon our strength necessary to walk a mile is sufficient to enable us on wheel to travel five miles or more. Astride of it "magnificent distances" become insignificant.

What a glorious feeling of freedom comes over us when the countryside, smiling and gay, brings to the rider a sort of contagious happiness! What independence! We have not had to be carried there by the horse or the railroad and we are proud to say, "I did it!"

Inventors of auxiliary power appliances for bicycles should take notice of the fact that the secret to-day of the bicycle's popularity is not merely because a person is enabled to ride fast or far, but because the riding was without foreign assistance. Vanity and egotism cut a considerable figure in the wheel's popularity. To say "I rode on an electric motor bicycle to Albany to-day," would mean the same as to say, "I rode on a railroad train to Albany to-day." But to say, "I rode my wheel to Albany to-day," means something entirely different. The rider who did this in fast time would be hailed with great applause, and the telegraph would announce the fact to the world.

In improving the bicycle the main idea is to get the most results out of the least power applied by man to the pedals. Auxiliary power has nothing to do with bicycle improvement. It belongs to a class of inventions designed to carry or convey, not to those by which man carries himself.—The Wheel.

The Philosophy of Pumping.

The limit of atmospheric pressure being 33 feet, water will rise from that depth if the air is wholly removed from its surface. This is simply the law of gravitation. The ordinary device for removing the air is the pump. As the air to be removed is in weight as the height of the column, it is plain that the same amount of work is required to displace it as to lift or force a column of water an equal height theoretically. Practically the water can be lifted with less labor because of its density and lubricating qualities. This is too often forgotten and leads to a common error in placing pumps in wells.

It is thought that if we exhaust a cylinder, the air will rush upward to fill the space thus exhausted. It will, but the air leaves a space, too, that the law of gravitation causes to press downward and produces a load or weight which is increased at every stroke of the piston in the cylinder, and which, when the pressure above and the draught below are more than equal, will cause the elastic air above to rush through any existing imperfections of the piston or cylinder to effect an equilibrium below. When this occurs, it is plain to be seen no water will rise.

A writer on the subject puts it this way: "To see why a pump will not draw water more than 33 feet vertically, suppose the pump cylinder to be 40 feet above the water, commence the process of pumping, the air will be pumped out of the pipe, the pressure of the atmosphere will force the water up the pipe until the pressure inside and outside is equal. It becomes equal when the water has reached the height at which the column of water weighs the same per square inch as the pressure of the atmosphere. When this point is reached the water will be lifted no higher by atmospheric pressure, even though a perfect vacuum be maintained above it. Therefore, if it is desired to lift water further than this distance, it becomes necessary to place the cylinder or working parts of the pump within the limits of atmospheric pressure."

A perfect pump does not long remain so, whether it be used or unused. So as to avoid trouble and annoyance, when making calculations for placing a pump, trust nothing to suction, but rather place the cylinder far enough above the bottom to insure a prompt action of the valves, and near enough to the water to avoid the necessity of an absolutely perfect airtight piston, except as the water shall make it so.

A practical rule that experience has taught is for wells of all depths greater than 15 feet to place the cylinder within 12 feet of the bottom and let the pipe extend, with a foot valve on end, to within 6 to 8 inches of the bottom.

This is as near a perfect pumping outfit for wells as can be made. The plunger is made to fit close at all times by water surrounding it, and the valves act promptly, insuring against loss by water running past them. Such a pump is always ready for use. If there is any water in the well, no priming is necessary. Care should be taken to not commit the common error of using pipe that is too small. Too large pipe cannot be used, that is the work is not increased by the use of large pipes; on the contrary, it is much diminished, because the particles of water being globular in form roll over each other with less friction than when in contact with a foreign substance, and the size of the valves being the limit of the moving column the height to which it is raised, plus the quantity, being the only measure of weight, it will be seen the larger the pipes the less labor will be required to raise a given quantity a stated height. This is combined in the old rule of half the diameter of the cylinder for the whole diameter of the pipe.

The friction in pipes is as the square of velocity; velocity increases as the squares of the diameters. The deduction from these rules is that the velocity of a given volume of water flowing through a two inch pipe would be increased four times if made to flow through a one inch pipe; the friction by the same law would be increased sixteen times; hence the advantage of using large pipes. Whatever kind of pump is used, place it as near the source of water supply as possible. If this cannot be done, then use as large pipes as possible. It is poor economy to try to make a small pump do the work of a large one by crowding it. It shortens the life and efficiency of the pump without corresponding benefit.—Rural Mechanic.

DECISIONS RELATING TO PATENTS.

United States Circuit Court—Western District of Michigan, Southern Division.

UNITED STATES PRINTING COMPANY VS. AMERICAN PLAYING CARD COMPANY.

Sage, J.:

Letters patent No. 381,716, granted April 24, 1888, to Samuel J. Murray for an improvement in a machine for printing cards, considered and Held valid and infringed.

Where it appears that all the elements of the combination claimed in the patent are old, but a new and valuable result has been obtained, the safety and efficiency of the machine greatly enhanced, and the profits resulting from its operation greatly increased, Held that the combination itself displays invention.

Damages can be collected from the manufacturer of a machine, and further damages from a subsequent purchaser and user of the same machine. The payment of damages for making an infringing machine does not give any right to the future use of the machine; but this may be restrained by injunction, and when the whole machine is an infringement, it may be ordered to be delivered up and destroyed. (Birdsell vs. Shaliol, 39 O. G., 261; 112 U. S., 485.)

Where a patentee takes a decree for profits against a manufacturing infringer, he sets the manufactured machine free. The profits of the infringer are full compensation to the complainant for the wrong done him; but a judgment for damages covers only damages in the past and has no relation to the future.

Where it was objected that defendant was not liable because the patented machine was not marked with notice of the patent, Held that such defense to be available must be set up in the answer and established by proof. (Rob. on Pat., sec. 1046; Goodyear vs. Allyn, 6 Blatchf., 38.)

The Stopping of Steamers.

Mr. William Dixon Weaver, late Assistant Engineer United States Navy, gives, in the London Engineer, some interesting calculations as to the length of time and distance required to stop a steam vessel going full speed ahead when the propelling machinery is reversed. Omitting the mathematical formulas, we come to Mr. Weaver's conclusions, which are given in the following table for the Cunarder Etruria, the Italian ironclad Lepanto, the United States naval vessels Columbia, Yorktown, Bancroft and Cushing, and the Russian torpedo boat Wiborg:

	Displacement.	Horse Power.	Speed.	Distance, Feet.	Time, Seconds.
Etruria........	9,680	14,321	20·18	2,464	167
Lepanto........	14,680	15,040	18	2,522	192
Columbia........	7,350	17,991	22·8	2,147	135
Yorktown.......	1,700	3,205	16·14	989	83·9
Bancroft	832	1,170	14·52	965	91
Cushmg.........	105	1,754	22·48	301	18·4
Wiborg.....	138	1,303	19·96	373	25·6

Twenty-seven Whales Ashore.

A lucky discovery was made on the morning of July 4 by two Maoris outside the north head of the Kaipara Harbor, New Zealand, when no fewer than twenty-seven sperm whales were found on the shore, all within a few miles radius. It being the breeding season for sperm whales, they usually leave the cold latitudes of the Antarctic until the calves are strong enough to return, and it is assumed that in one of these voyages, being confronted by fierce gales, they endeavored to take shelter, but suddenly found themselves in shallow water, where the receding tide soon left them an easy prey for the hands of man. An enterprising firm, Messrs. Allison Brothers, of Auckland, have commenced the boiling down process, though their plant is somewhat inadequate for such a gigantic undertaking. A horseman who was riding along the beach soon after the discovery was lucky enough to find a large quantity of ambergris, valued at about £3,000. Many seekers are now on the ground expecting each tide to bring them a fortune.