indicate, the tide predictor somewhat resembles a clock. In fact, it contains one which records every day in the year, the pointer on the dial shown in the upper left hand corner of the illustration making a complete circle of the face of the dial once every twenty-four hours, but this is only one of several parts which might be termed clocks by reason of their mechanical construction and arrangement. There are clocks which serve to indicate when properly "set" the daily stage of tides, and the stage of the moon, so essential in calculating tidal movements. The center "clock," however, is of most importance, for by its manipulation the necessary computations are made with the aid of records obtained from the smaller ones.

The tide predictor contains nineteen mechanical elements or estimators, each consisting of an axle which is moved by a pulley and crank connected by delicately adjusted chains. All of the axles, however, are controlled by what might be called the governing axle located in the bottom of the framework of the predictor and moved by the handle shown in the illustration on the outside of the case at the left. It will be noted that the large dial in the center of the face of the predictor contains two sets of hands and incloses a small disk which has a single hand. The larger hands are called the lunar and solar indexes, for reasons which will be explained. The small index on the little dial serves merely to indicate the period of the day when the computation is made.

When it is desired to ascertain the height of the tide at a certain point on a specified date the operator of the machine first "sets" it so that the mechanism shows the approximate time at which high tide or low tide occurred on a given date in the past at this place. Then with the left hand the operator slowly turns the handle at the lower left-hand corner of the machine and this is what occurs: The hand on the large face in the center known as the lunar index changes its position until it points in the same direction as one of the pair of smaller hands or needles. The operator then notes the position of the solar index, as the other hand of this curious clock is termed. If the lunar index has assumed the same position as the upper needle, the solar index will indicate the time of the first high water at the seaport for which the computation is being made. To determine the height of the tide at the given time, the operator glances at the index at the left lower corner of the large face. Comparing the figures opposite its hand with the figures on the scale by its side gives the height of the tide.

To determine low tide the lunar index is moved by the handle until it is in the same position as the lower needle and the position of its companion, the solar index, is again observed. Thus the time of low tide is secured. In getting the measurement of the tide the index on the lower right-hand side is read and the figures compared with the right of the two measures seen in the lower part of the frame.

Fully to describe the workings of all the mechanism would require more space than can be given, but it should be remembered that when the handle controlling the governing axle is turned, all of the elements are set in motion at a speed proportioned to the work which they are to perform, regulating the various hands and needles so that no errors of importance can be made. As an indication of the accuracy of the machine it may be stated that the maximum deviation of the tide from what has been predicted is never over 0.3 foot, and it records the stage of tide within five minutes of the time when the tide reaches the stage, although, as stated, the prediction may be made a year or more in advance. The machine is a portion of the division of the bureau at Washington of which Mr. O. H. Tittmann is superintendent, and is called the Ferrel tide predictor after the late William Ferrel, by whom it was improved, the original invention being due to Lord Kelvin.

A fuller description of this type of predictor will be found in Scientific American Supplement No. 1464.

Variable Speed Turbine Engine.

A turbine has been patented in England which, by means of two sets of steam admission ports, into either of which steam may be admitted at will, it is claimed will give two different speeds of operation at the same efficiency. For the higher speed the steam is conducted from one set of ports through expanding nozzles to the rotor, where it encounters two sets of moving blades and one set of fixed blades, passing thence to the exhaust. For the lower speed, the steam takes the same path through the blades as before, and is then led from the second set of moving blades into a group of blades consisting of two fixed and two moving sets. This arrangement gives a speed about half that due to the other, the reason being doubtless that, the expansion being carried through a longer stage, the drop in pressure at each set of blades is but half what it was before, with consequent proportional speed factor.—**Iron Age.**

Correspondence.

Large Powder Chambers Reduce Erosion.

To the Editor of the Scientific American:

Referring to your mention, in the Scientific American Review of the Year, of the high velocity secured at Sandy Hook with the Brown wire gun, which is officially reported as 3,740 feet per second, I beg to draw your attention to the fact that there were some important truths established during these tests, which show the great advantage to our government of high-powered guns, such as the department or Crozier gun and the Brown wire gun, viz.:

If these guns were fired with what the government considers service velocities for the 6-inch guns now in use, the pressures would be so exceedingly low that, with properly banded shells, they would last for an indefinite number of rounds, before being rendered unserviceable on account of erosion; and at least as long as any of the low-velocity guns now recommended by the department, so far as the life of the gun is concerned.

A study of the government record shows: The third round, Brown 6-inch gun, with 59 pounds of powder and 28,475 pounds pressure per square inch, gave 2,879 foot seconds velocity. The fourth round in Crozier gun, which also has an unusually large powder chamber, with 69 pounds of powder and 30,810 pounds pressure, gave 2,938 foot seconds.

These records prove, therefore, that the large powder chambers in the high-powered guns, so far from being undesirable, are a very great advantage; since such guns give higher velocities with lower mean pressures than the 6-inch guns now in use. This is possible because more powder can be burned, and a larger volume of gas secured, without producing excessive pressures. As a matter of fact, nearly 10,000 pounds less pressure per square inch is required than in the 6-inch service gun, to secure the same velocities. Hence, erosion would be correspondingly reduced.

Another important advantage in the high-power gun is that, even if fired with the usual 6-inch service charge, it possesses tremendous reserve energy, to be available in an emergency, when long-range firing may be of inestimable value to cripple the enemy before he could approach near enough to strike.

Gen. Crozier, Chief of Ordnance, implies, in his annual report recently published, the possibility of eliminating erosion, in which event, with these high-powered guns, the government would be in possession of guns of far greater efficiency and range than any other guns within our knowledge, while on the other hand, if our government has low-powered guns only, and erosion should be cured, as it undoubtedly will be, we would be left with a large number of inefficient and obsolete guns.

The government star gaging records show that in the last ten excessive pressure shots from the Brown 6-inch gun there was practically no erosion at all in the last 14 feet of the muzzle end of the gun, because the shells had been properly banded to meet the changed conditions which were required in the gun in order to secure such remarkable results in pressures and velocities.

If all the shells had been banded at the beginning of the test, as the last ten were, both the Crozier gun and the 6-inch Brown wire gun could easily have been fired the 250 rounds originally proposed and been in better condition at the finish than they are to-day.

The greatest erosion occurred during the early part of the test, when the narrow bands were used, as the star gaging shows, and was no fault of the system of construction. It was claimed at the start that the shells were not properly banded for such high pressures and velocities, but the department insisted that the service bands for low-powered guns must be used in this test of the high-powered guns.

The last ten shots (88th to 98th) fired in the Brown 6-inch gun gave an average pressure of over 55,000 pounds per square inch and an average velocity of over 3,600 feet per second with perfect safety to the gun. John H. Brown.

New York, January 8, 1907.

The Exploration of the Atmosphere at Sea.

To the Editor of the Scientific American:

In your issue of December 22, 1906, your German correspondent speaks of the research boat "Planet," belonging to the German marine, as if she were the first vessel to make atmospheric soundings with kites and balloons. Permit me to say that kites were used by me to obtain meteorological observations at sea, independently of the natural wind, in 1901, as was related in the Scientific American, vol. 91, page 479. The same year, after this method had been proved successful on a transatlantic steamer, I proposed (in a paper read before the Glasgow meeting of the British Association) to extend it to the trade-wind region. In order to organize such an expedition, applications for aid were addressed in 1902 to the Prince of Monaco, and in 1903 to the Carnegie Institution, but in neither case was the desired assistance obtained. However, Prof. Hergesell, president of the International Committee for Scientific Aeronautics, of which I am also a member, succeeded in interesting the Prince of Monaco in the scheme, and upon his yacht, the "Princesse Alice," during the summer of 1904, kite flights were made in the region bounded by Spain, the Azores, and the Canaries. Although a height exceeding that of the Peak of Teneriffe was several times attained, the southwest or return trade, which had been observed on this mountain, was not found, leading Prof. Hergesell to conclude that it was due to the disturbing effect of the mountain itself.

This conclusion, which involved so important a matter as the existence of the return trade, led to another expedition being sent out in the summer of 1905 by M. Teisserenc de Bort, director of the Observatory for Dynamic Meteorology at Trappes, near Paris, and by the writer. Mr. Clayton, of the Blue Hill Observatory, in proceeding from Boston to Gibraltar executed with kites the first line of atmospheric soundings across this part of the Atlantic to an average height of 3,000 feet. At Gibraltar Mr. Clayton joined the steam yacht "Otaria," a vessel of 350 tons, purchased and equipped by M. Teisserenc de Bort expressly for exploring the atmosphere, and having on board M. Maurice, of Trappes Observatory. This vessel went as far south as latitude 10 deg. N. and as far west as longitude 30 deg. W., and in seventeen kite flights the barometric pressure, air temperature, relative humidity, and wind velocity were continuously recorded, and the wind direction observed by measuring the azimuth of the kites. To obtain the direction and speed of the wind at greater heights, eleven hydrogen balloons were liberated from several of the islands, from which they were measured trigonometrically, and within the region of the northeast trade all indicated the expected south or southwest return trade above the height of about two miles. The same year Prof. Hergesell made another cruise on the "Princesse Alice," employing for the first time at sea the tandem balloons of rubber, which your correspondent describes as forming part of the equipment of the "Planet," and in this way the first temperatures and humidities were obtained up to an extreme height of about ten miles above the ocean. During the past winter and summer, the "Otaria," equipped with these *ballons-sondes*, captive balloons, and kites, has made two cruises, proceeding across the equator to Ascension Island, at the mutual expense of her owner and the writer. The existence of the southwest current above the northeast trade, and of the northwest current above the southeast trade, was demonstrated, and the hitherto unsuspected fact revealed that in summer at a height of eight miles above the thermal equator a temperature of about 100 deg. F. below zero prevails, which is lower than it is in winter at corresponding heights in temperate regions.

Mention of these researches shows that your correspondent is greatly in error in assuming that the "Planet" has an unknown field to explore, because the conditions in the higher atmosphere over the ocean "are known only through a few observations made in the North Atlantic"; but I entirely agree with him that "these conditions are not as simple as theory has heretofore assumed," and that further observations are desirable. A. Lawrence Rotch,

Director of Blue Hill Meteorological Observatory.

Hyde Park, Mass., December 27, 1906.

The Wireless Telegraph Situation.

To the Editor of the Scientific American:

I read with great interest your editorial review of the scientific and engineering work for the year 1906. May I be permitted to make a few corrections to the *résumé* of wireless telegraphy work, as the writer of this part of the review seems to be somewhat out of touch with recent developments?

In the first place, the work of the National Electric Signaling Company on transatlantic telegraphy is so very far from having been futile, that uninterrupted communication, with the exception of one day, was maintained between Scotland and Massachusetts from October 1 to December 5, and preparations were being made for placing these stations on a commercial basis when the tower at Machrihanish fell, owing to a defective joint in one of the guys made by an expert engaged from a Glasgow firm. The working up to the date of the accident was, however, so successful that the directors of the National Electric Signaling Company have decided that it is unnecessary to carry on the experimental developments any further, and specifications are now being drawn up for the erection of five stations for doing transatlantic and other cable work, and a commercial permit is being applied for in England.

As regards the question of interference, this ceased to be a vital question two years ago. The Electrical Review of July 6, 13, 20, and 27, 1906, published the results of independent tests of government officials, which showed that it was possible to cut out interference even when the interfering station was only 216 yards away. You will note that the transatlantic stations have been operating without interference, although there are no less than six stations within a radius of thirty miles. As an illustration of the extent to which tuning has been carried, I would say that the transatlantic stations referred to cut out all interference outside of one-quarter of one per cent, and that with one of the later developments a test was recently made in which it was found impossible to receive the messages when the frequency varied more than one part in one million—in fact, signals could only be obtained by raising the frequency to about one-tenth of one per cent too high and then gradually lowering it to about one-tenth of one per cent too low, a few signals being caught at the instant when the frequencies coincided. It may be taken as an absolute fact that the trouble at the present time is not in cutting out interference, but in getting the two stations which are to communicate to maintain their frequencies sufficiently regularly. At the present time it has not been found possible to maintain the frequencies of the two stations closer than one-tenth of one per cent, and this is the problem at which our company is now working, i. e., not to cut out interference, but to maintain the frequencies of the intercommunicating stations sufficiently close, so that the messages will not be lost. So far from other stations being able to interfere, with the method at present in use messages are received on the *same aerial* on which messages at the same time are being transmitted.

As regards the so-called Poulsen system, this is nothing more than an inferior form of a type of apparatus which has been in use in the United States for nearly five years. Elihu Thomson in 1892 discovered this beautiful and ingenious method of generating high-frequency oscillations. I inclose a figure taken from his U. S. patent 500,630, filed July 18, 1892 (see Fig. 1, page 68). This method was first applied to wireless telegraphy by the National Electric Signaling Company in 1901, and broad patents have been issued to that company, covering not only the broad method of wireless telegraphy by means of continuous generated oscillations, but also broadly generating electro-magnetic waves by means of an arc and a continuous current source. For example, claim 20 of U. S. patent 706,737, filed May 29, 1901, covers broadly "A system of transmission of energy by electromagnetic waves including in combination a radiating-conductor and a source of alternating electrical energy or potential, said radiating-conductor and source being co-ordinated and relatively adjusted to generate and radiate a substantially continuous stream of electromagnetic waves."

Improved methods of using an arc and for wireless telegraphy were covered by U. S. patent 706,742, filed June 6, 1902; 730,753, filed April 9, 1903; and 793,649, filed March 30, 1905. Claim 22 of the latter patent reads as follows: "In a system of signaling by electromagnetic waves, the combination of a radiating-conductor operatively connected to a discharge-gap, a source of practically-constant voltage, and means for charging and discharging the discharge-gap circuit without an appreciable time interval between charging and discharging."

It will be seen that the so-called Duddell-Poulsen method is really the Elihu Thomson-National Electric Signaling Company method, and it may be mentioned that this method is covered not only broadly but in all its modifications and improvements by patents issued to the National Electric Signaling Company, not only in the United States, but in England, France, Germany, Canada, and practically all foreign countries, most of the patents dating since 1902.

The two great obstacles to wireless telegraphy at present are atmospheric absorption and the action of the governments in refusing permits for working. Atmospheric absorption, though marked, is not very important up to distances of one thousand miles, but at distances beyond this constitutes a considerable difficulty. This, however, can be overcome by using more power and in other ways. As regards the actions of the governments, this is the real important obstacle to the development of wireless telegraphy. The National Electric Signaling Company has been trying for more than four years to obtain permits to operate in different countries, but up to date without success in a single instance. This "hold-up" works a great injury to the business interests of the different countries. As an illustration, if permits could have been obtained, wireless telegraphy would have been in operation all through the West Indies, including Cuba, Jamaica, Trinidad, and Demerara, also in Bermuda, Sable Islands, New Zealand, Tasmania, India, and elsewhere; but though applications were made for permits, and a considerable amount of money spent in endeavoring to obtain them, in no instance was the request granted, although no subsidies were asked for and reduced rates were promised in every case. Nevertheless, in not a single instance was it possible to obtain a permit.

It is time to end all this talk about the disabilities and defects of wireless telegraphy. Wireless telegraphy is able to compete with cables to-day in any part of the world, and to give better service and at lower prices. The sole and only reason why the public are not sending cable messages for half the present price is because the cable companies and other interested parties have sufficient influence to prevent wireless companies from obtaining permits to operate. Let there be less talk about the deficiencies of wireless telegraphy, and a little more attention paid to the way the present methods of government control act to throttle new industries.

To give a couple of instances of this right here in the United States, the National Electric Signaling Company decided several years ago to construct a line of stations from Maine to Panama, and ordered the masts and equipment for these stations. Contracts were under way with shipping companies representing more than two hundred vessels, when the United States government came out with an announcement that it proposed to make wireless telegraphy a government monopoly to transmit messages free and to forbid private companies from operating on the coast. So all contracts were dropped, the masts and equipment for the stations are now rotting in a shipyard, and the apparatus is in storage. As another instance, the National Electric Signaling Company offered to equip and guarantee the operation of stations between Nome and St. Michaels in Alaska. This tender was refused, and apparatus was constructed by the Signal Corps which did not work. The United States Signal Corps then adopted the National Electric Signaling Company's apparatus, and installed it without paying the company a cent; and though one of these patents has been adjudicated not less than six times, the government is still using it, and in fact manufacturing it itself.

To conclude, the sole and only obstacle to the general use of wireless telegraphy and the taking of telegraphic communications is the stupid and very frequently dishonest course of action taken by the various governments. This can probably only be cured by the formation of a general wireless trust, which will have sufficient political pull in the various countries to secure sensible and fair treatment. It is, however, to be hoped that this will not be forced upon the wireless companies, for the reason that not only the interests of the public at large would be injured by such a trust, but also the development of wireless telegraphy would not proceed at as rapid a rate as it would if there were a number of competing companies. Those companies which, like the National Electric Signaling Company, are opposed to the formation of any such trust, are holding out in the hope that sooner or later public opinion will be awakened in the matter, and wireless telegraphy may get a fair chance to show what it can do. R. A. Fessenden.

Western Tower, Brant Rock, Mass., January 8, 1907.

Position Occupied by the United States in the World's Iron Production.

According to the Rheinish-Westphalian Times, a leading technical paper of the German Empire, the world's iron production in 1903 was 40,004,837 tons; in 1904, 45,225,928 tons; in 1905, the last year for which figures were furnished, 53,997,965 tons. The United States is striding forward so fast in the production of iron that it promises to not only lead the great iron-producing countries, but to lead the rest of the world combined. The following table gives the ton production of the countries named during the years indicated:

Country.	1903.	1904.	1905.
	Tons.	*Tons.*	*Tons.*
U. S. of America...	18,009,252	16,497,033	22,992,380
Germany	10,085,634	10,103,941	10,987,623
England	8,811,204	8,562,658	9,592,737
France	2,827,668	2,999,787	3,076,550
Russia	2,402,500	2,855,032	2,765,000
Austria-Hungary ...	1,321,695	1,450,658	1,514,840
Belgium	1,299,211	1,307,399	1,310,290
Sweden	489,700	516,900	527,300
Spain	380,284	420,000	385,000
Canada	265,418	270,249	468,003
Italy	45,000	88,965	140,825
Japan	36,515	112,328	190,375
India	30,756	40,978	47,042

While the absolute gain in the United States is almost equal to the entire gain between 1904 and 1905, the advance in Canada in 1905 over 1903 is remarkable. The output nearly doubled. Still more remarkable is the advance in Japan, a gain in the two years of nearly 600 per cent. At the present rate of production the world's visible supply of iron, 10,000,000,000 tons, according to a Swedish expert's estimate, must soon be exhausted. Luckily these figures are believed to be far from the truth, as the United States alone is said to have more than 4,000,000,000 tons in mines that have been located. If this is true, it is more than probable that the vast deposits of Canada, Mexico, Central and South America were neglected by the Swedish scientist.

Engineering Notes.

The conditions which will beset the engineer of the twentieth century will be exacting beyond anything we now know. The importance of a strong foundation in scientific principles cannot be overestimated, for scientific principles are only the laws of nature. These principles cannot be learned readily after a man has begun his life work. His whole energy will then be devoted to applying these principles correctly, not in acquiring them laboriously. It will be a prime necessity for the technical college of the future to lay these foundations broad and deep. It will be regarded as a weakness for a college to teach its students only the knacks of the profession, only just enough to be an ordinary draftsman, a tolerable surveyor, or first-class linesman.

For operating gas engines on board ship, producers must have means for keeping up the temperature in the producer while the engine is running at slow speeds or stopping, since otherwise it will not start up again on account of lack of suitable gas. This can be readily obtained by keeping up the rate of gasification through the exhausting fan and returning the gas into the producer where it is consumed again, there being practically no loss but that of the sensible heat of the gas radiating through the piping and, of course, the power required for driving the fan. No producer can be regarded as up to date that does not embody means for automatically adjusting the amount of water or steam admitted together with the air into the fire bed in fixed proportions according to the load, since without this arrangement, the fire will grow dead at the lower loads and the engine will not be able to pull up to a higher load again when necessary. There are a great many questions that are yet unsettled, and await solution in producer theory and practice.

According to a notice in the German technical press, tests are being made on a large scale with a view to electrifying the Baden state railways. Current is to be supplied from a power station under construction at Wyhlen-Augst, where a turbine with an output of 1,500 horse-power is to be rented. It is calculated that an aggregate of 2,400,000 kilowatt hours will be required to supply the energy necessary for the electric operation. Three schemes have been suggested. That of the Siemens-Schuckert Works provides continuous current operation at 3,000 volts, with 40 ton, four-axle locomotives driven by 150 horse-power motors at two main speeds. The scheme of the Allgemeine Elektrizitäts-Gesellschaft provides single-phase current with three-axle locomotives at only one main speed. The former company estimate the cost of installation at 2,720,000 marks (about $680,000) and the working expenses at 331,087 marks (about $83,000), while the corresponding figures given by the Allgemeine Elektrizitäts-Gesellschaft are 2,281,000 and 349,700 marks (about $570,000 and $87,000) respectively. It may be said that the present cost of steam operation is 363,522 marks (over $90,000). It is expected that electric service will commence at the end of 1909.

An invention which will prove of widespread utility to the textile industry has recently been devised conjointly by three English engineers for tow-carding upon an extensive scale. The machine is essentially of the labor-saving class, it being possible to accomplish as much therewith as has hitherto required fifteen hands. Tow, the by-product of flax, has heretofore always necessitated hand-feeding into the carding machines—one hand to each card. With this machine, however, this requisition is dispensed with. The tow to be carded is sorted and weighed, and then discharged through a shoot on to the table of the machine below. The operator here controls the feeding of the tow into the machine. The material is drawn into the lapper, as it is called, by a sheet and shell feed roller. It is then struck sharply by a rapidly-revolving cylinder, and discharged on to a traveling lattice sheet, which carries it forward to a set of pressing rollers. It is here formed into a large sliver, and is then lapped on to a wood core some 18 inches in diameter. When finished on the core the laps are doffed by hand, the full lap being withdrawn and the new core inserted without stopping the machine. The lap, which is 56 pounds in weight, is placed on a carrier, and transported by an elevated railroad to the carding machines and deposited where required. This lap is then laid on the sheet upon which formerly the tow had to be spread by hand, and the slow revolving of this sheet feeds the tow into the machine, the lap itself revolving as it unwinds its coil. Two of these machines are already in operation at one mill, and here thirty cards are fed entirely by them, only four hands being necessary to attend to the operation, as compared with thirty previously required. Even in this instance only three operators would be wanted if the two machines were installed in the same room. It is stated that owing to the saving in labor and time effected by these two machines, each has nearly repaid the initial outlay in the course of twelve months, while the work is more even and regular than what is obtainable by hand spreading.