ENGINEERING.

The engineers who built the Cortlandt Street tunnel below the Hudson River are justly proud of the fact that the whole 5,900 feet of pnuematic work was driven through without the serious injury through air pressure of a single workman. The tunnel was built under air pressures of from 25 to 35 pounds to the square inch, and the enviable freedom of the workmen from attacks of the "bends" is due mainly to a searching medical examination of all candidates for the compressed-air work.

The facts regarding the improvement in gunnery in the British navy are readily ascertainable, thanks to the government practice of regularly publishing this information. In 1905 the percentage of hits to rounds fired in the navy was 20.02; in 1906 it rose to 34.60; in 1907 it was 35.81; and last year there was a big jump to 58.32. The number of hits per gun per minute in 1908 was 0.56 for the 10 and 12-inch guns; 2.20 for the 9.2-inch; 2.51 for the 7.5-inch; 3.98 for the 6-inch, and 3.32 for the 4.7-inch and 4-inch.

The January rainfall at the Panama Canal was the heaviest on record for that month since American occupation. The average at fifteen stations was 4.34 inches as against 1.19, 0.87, and 1.04 inches in the three preceding months. The total excavation for the month was 2,924,551 cubic yards, which is 391,316 yards less than the December output. There was a temporary disturbance of the work on the central division, due to a heavy freshet of the Chagres River, when a maximum height of 66 feet above sea level was reached. No serious damage was done to the work.

The United States and Canada nave decided to limit the total amount of water that may be taken from Niagara River for power purposes. The average discharge of the river is 250,000 cubic feet per second; and if the total fall from Lake Erie to Lake Ontario were utilized, it would represent about 7,000,000 horse-power. The total available horse-power at the Falls is estimated at about 4,000,000. According to the treaty, the power companies on the Canadian side are to be limited to 36,000 cubic feet per second, and those on the American side to 20,000.

The various steamship companies are taking steps to apply to their wireless apparatus the lessons learned from the "Republic" disaster. It will be remembered that the flooding of the engine room put out of commission the generator which supplied the current for the wireless plant of that ship; and this fact has shown the necessity for providing an auxiliary source of current supply, located preferably on one of the upper decks. The North German Lloyd Company use for this purpose two dynamos in separate compartments, and two emergency dynamos located in the Marconi house on the boat deck. To this equipment is added two sets of storage batteries. This is characteristic German thoroughness; it should serve as a model for all transatlantic passenger ships.

Since the London and South-Western Railway Company took over the dock system of Southampton, seventeen years ago, the development of the port has been extraordinarily rapid. Then, 5,000 tons was the displacement of the largest liner entering the port. In a few years the tonnage had increased to 10,000. It soon rose to 12,000, and now, with the advent of the White Star Line, the latter figures have more than doubled. Within the next three years, the 25,000-ton "Adriatic," the largest vessel at present entering the port, will be dwarfed by the two 60,000-ton leviathans, which are being built for the White Star Line at Belfast.

A large blast-furnace gas engine of the Nürnberg type, recently erected for the Barrow Haematite Iron and Steel Company, is representative of the latest practice in this direction. The engine, which works on the Otto cycle, is double acting, with two cylinders placed in tandem. The gas cylinder is 35 inches diameter by 43¼ inches stroke, and the engine develops 1,100 brake-horse-power at 90 revolutions per minute. The piston rod, piston, and exhaust valve chambers and outlet valves are cooled by water under pressure, and the gas mixture is ignited by current taken from a small accumulator battery. The governor of the blowing engine controls a small safety governor, which throws out the ignition when the engine exceeds 95 revolutions.

One of the limitations set upon the securing of high speed in ships of the navy and merchant marine is the difficulty, particularly on the last day of a run, of getting the coal from the bunkers to the furnaces as fast as the latter require. The best solution of the problem would seem to be the use of some form of mechanical conveyer; and that this mechanism may be successfully applied has been proved in the case of the "Minnesota," one of the largest steamships in the world, which is now running in the service of the Great Northern Steamship Company. A conveyer of the link-belt type has been installed, which is so located as to deliver coal at the rate of 45 tons an hour directly in front of the boilers.

ELECTRICITY.

Visitors to Niagara Falls last summer, who were enthusiastic in their admiration of the electrical illumination, will be glad to learn that prominent citizens of Niagara are endeavoring to raise a fund to pay for the permanent illumination of the Falls during summer seasons.

In connection with his new system of wireless telephony, Prof. Q. Majorana uses a liquid microphone. This consists of a small tube attached to the diaphragm of the microphone and through which a stream of water flows between a pair of platinum electrodes. The water is slightly acidulated so as to complete the circuit between the electrodes. However, when the microphone is vibrated by the voice the stream of liquid fluctuates, varying the electrical resistance in accordance with the sound of the voice.

A grout mixing machine is in use by the United Railways Company of St. Louis. It consists of an old mail car, one-half of the body of which has been removed to make room for a mixing tank. The latter is furnished with paddles driven by an electric motor, which keep the sand and cement thoroughly mixed while the car is traveling to the point where the grout is to be used. When the car arrives at its destination water is added and the mixture is immediately ready to be discharged through a spout to the desired point.

The Aero Club of New England is fitting the dirigible balloon "Massachusetts" with a wireless telegraph plant so that it can communicate with a land station located in the city. It has often been suggested that wireless telegraphy could be used to advantage in communicating with airships, but the danger of igniting the hydrogen gas of the balloon with the sparks used in the telegraph apparatus has deterred experiments of this sort. However, it would seem a simple matter to incase the telegraph apparatus in such a way as to obviate all danger.

According to daily press reports wireless telephony has not proved an unqualified success on the battleship fleet. It was impossible to send messages over any great distance except under the most favorable conditions, and when the telephone was in use the telegraph had to keep silent. Wireless telephony is still in its infancy and cannot be expected to compete with wireless telegraphy at the present time. The main trouble seems to be the difficulty of controlling in so delicate an instrument as a telephone transmitter the powerful currents necessary in any spark-gap system.

One of the principal objections to the use of the telephone for railroad dispatching is the fact that many vocal sounds are lost or very poorly transmitted by the very best of instruments now in use. For this reason it is often necessary to repeat a word or spell it out before it can be understood. Mr. Edison has recently been endeavoring to improve the telephone so that all sounds can be transmitted with perfect clearness. He is experimenting with a new transmitter of "variable pressure type with novel electrodes," with which he expects to obtain the desired result.

An electrical anemometer has recently been devised which is based on the fact that the resistance of platinum varies in proportion to its temperature. Prof. R. B. Goldschmidt, of the University of Brussels, is the inventor of this apparatus. It consists of two wires, one of which is exposed to the wind, while the other is shielded from currents of air, but yet is subject to the surrounding temperature. The wires form two branches of a Wheatstone bridge, and the galvanometer connecting the bridge is not affected when there is no wind, as the temperature of the two wires must remain the same whether the surrounding temperature rises or falls. In case of a current of air striking the wire, there will be a difference of temperature which will be recorded by the galvanometer. The direction of the wind is indicated by a recording weather vane, which is used in connection with the anemometer.

The principle on which silicon, perikon, and molybdenite detectors operate is discussed by their inventor, G. W. Pickard, in a recent number of the Electrical Review and Western Electrician. He finds that the crystals used act as rectifiers, permitting the current to flow in one direction, provided the contact points at opposite sides of the crystals are unequal in area. In order to get the maximum effect, the crystal is imbedded in lead so as to provide a large contact surface, while the other contact is microscopic in character, consisting of a fine metallic point resting against the opposite side of the crystal. The current then flows from the small point to the large contact area. A hydraulic analogue is adduced to explain the phenomenon. It is quite possible that this explanation may clear away the mystery of the electrolytic detector, the precise action of which is still in dispute, some claiming that it is thermal in character, and others that it is electrolytic.

SCIENCE.

The fineness to which the rags are ground has no direct influence on the durability of the paper, for even broken cells of linen and hemp remain unchanged for thousands of years in favorable conditions. The employment of strong alkalies and of starch size appears to be the cause of rag paper becoming yellow and brittle, while neutral or mildly alkaline treatment and animal size favor durability. Great discoloration and "water stains" are probably due to excessive rotting and liming. Air drying favors the durability of paper. Even the best rag papers are injured, if not destroyed, by soaking or excessive dampness. It is impossible to speak with certainty of the durability of modern papers containing few or no rags, as the ultimate effect of the new process of making, sizing, loading, and calendering cannot be foreseen. Many new papers have already proved their lack of permanence. Very few newspapers, for example, are likely to survive many years.

The French physicists Bethisy, Fonchard, and Vignes are said to have succeeded in making an incombustible substitute for celluloid. The material is made from tetranitrocellulose, containing about 40 to 45 per cent of water; a product of a liquid hydrocarbon. After thorough mixing of the mass, the water is expressed therefrom, and the remaining material changed, by treatment with albumen, vinegar, ether, acetone, amylacetate, and alcohol, into a plastic mass. After standing twenty-four hours it is worked into rods between hot rolls, until it is of a firm consistence; is then cooled, and next denitrized by suitable means. The working with rollers is then repeated, and the sheets thus obtained are worked for six hours in a steam chamber under a hydraulic pressure of 150 atmospheres (2,250 pounds per square inch). The pressure is then increased to 200 atmospheres; and instead of steam, cold water is employed. This process brings the material into the form of very hard blocks, which are then cut into sheets and dried. In order to make tubes, rods, etc., the material is shaped in suitable molds.

The last year of the American Museum of Natural History has been the most notable in the history of the institution. In the last eight years the museum has expended directly $932,008 on its explorations and collections. The estimated total value of the collections secured during this period by exploration, by purchase, and by gift to the museum is more than $2,000,000. For every dollar which has been expended by the city more than a dollar has been added to the enlargement of the collections. The present endowment fund, including the Jesup bequest, is $2,048,156.61. To keep pace with the very rapid growth of the city and the demands it is making for public scientific education, an endowment fund of $5,000,000 is sought. In every part of the world the advance of civilization and the spread of firearms are rendering more scarce the objects of natural history of all kinds, including the works of the primitive races of men. It is deemed vitally important to push the explorations of the Museum in all parts of the world, while it is still possible to secure these fast vanishing works of nature and of primitive man.

Recent discoveries in regard to the nature of soil fertility have suggested the employment of various novel fertilizers. Manganese has been applied with success, and now M. Rigaux has published an account of a series of experiments, made in Belgium, in the employment of magnesia as a fertilizer for cereals, potatoes, beets, and leguminous crops. The magnesia was applied in the form of kainit, or Stassfurt potash salt, which contains 14 per cent of magnesium sulphate. Rigaux had previously proved that the quantity of magnesia in arable land is smaller than is generally supposed, and that the surface soil always contains less magnesia than the subsoil. Magnesia is found in plants in considerable quantities, constituting, for example, 13 per cent of the ash of wheat and 8 per cent of the ash of oats. Hence, if no magnesian fertilizer is applied, repeated cropping must exhaust the magnesia of the soil, to the detriment of succeeding crops. It appeared probable, therefore, that the application of magnesia would produce a beneficial effect. This theoretical conclusion was fully confirmed by the experiments. The yield of sugar beets was increased by 4,500 pounds per acre, and the percentage of sugar was not diminished. With grains, the increase varied from one-seventh to one-fifth of the total crop. On barley magnesia had the peculiar effect of diminishing the proportion of nitrogenous constituents. This property is of advantage to brewers, who find great difficulty in making beer of good keeping qualities from barley rich in nitrogen. The crop of potatoes was increased from 21,000 to 27,000 pounds per acre and was rendered immune to the attacks of the *Peronospora* (mildew fungus), which infested the part of the field on which no kainit was used. Finally, the yield of hay from natural meadow land was increased from 3,000 to 4,150 pounds per acre.