SAVING BY CO-OPERATION.

An intelligent Englishman lately gave, in conversation, some facts in regard to the working of the co-operative system in several towns in Lancashire and Yorkshire, which seem to sustain the claim to the advantages of the system. In some of the woolen and cotton factories the majority of the employes are stockholders, the shares being only one pound. The internal economy practiced in these mills would surprise some of our manufacturers; the subject of waste making and waste saving being carried to its utmost practicable limits; and this without the enforcement of arbitrary rules, but by the willing and common consent of all the operatives. The quality of the goods produced is excellent, selling readily even on a generally dull market. These co-operative associations can easily obtain money, whenever it is needed, on two and a half per cent. But their influence on the operatives is fully as remarkable as is their financial success. Habits of economy have taken the place of the periodical (weekly) extravagance, the shillings before wasted at the "public" going into the fund to increase the stock holding of the operative. The most significant evidence of the combined moral and financial benefits of this system to the operatives and all concerned is the abolition of the "blue Monday." These co-operative establishments run six days in the week with a full complement of hands. The custom of Monday loafing to sleep off the effects of the Sunday debauch is fast passing away, in fact, has passed away in the co-operative mills; the operatives put in full time and also save their shillings.

Steam Heating.

The advantages of steam heating are set forth by Prof. W. P. Trowbridge in the *North American Review* as follows:

1. The almost absolute freedom from risk of fire when the boiler is outside of the walls of the building to be heated, and the comparative immunity under all circumstances.

2. When the mode of heating is the indirect system, with box coils or heaters in the basement, a most thorough ventilation may be secured, and it is in fact concomitant with the heating.

3. Whatever may be the distance of the rooms from the source of heat, a simple steam pipe of small diameter conveys the heat. From the indirect heaters underneath the apartments to be heated, a vertical flue to each apartment places the flow of the low heated currents of air under the absolute control of the occupants of the apartment. Uniformity of temperature, with certainty of control, may be thus secured.

4. Proper hygrometric conditions of the air are better attained. As this system supplies large volumes of air heated only slightly above the external temperature, there is but little change in the relative degree of moisture of the air as it passes through the apparatus.

5. No injurious gases can pass from the furnace into the air flues.

6. When the method of heating is by direct radiation in the rooms, the advantages of steadiness and control of temperature, sufficient moisture and good ventilation, are not always secured; but this is rather the fault of design, since all these requirements are quite within the reach of ordinary contrivances.

7. One of the conspicuous advantages of steam heating is that the most extensive buildings, whole blocks, and even large districts of a city, may be heated from one source, the steam at the same time furnishing power where needed for ventilation or other purposes, and being immediately available also for extinguishing fires, either directly or through force pumps.

Steel for Military Purposes.

The manufacture of steel and its application to military purposes was the subject of a lecture lately given at the R. A. Institution, Woolwich, by Captain G. Mackinlay, R. A.

The manufacture and progress of mild steel having been alluded to, a few words were said about the tests required by the Government from the manufacturers; the limits allowed being rather narrow and difficult to attain, especially when large ingots are provided, where the qualities of the upper and lower parts must of necessity differ considerably. During the last few months, however, the limits of temperature allowed for tempering in oil have been much widened. For gun steel, a comparatively low tenacity but considerable elongation before fracture is demanded, as safety is essential; it used to be said, until about fifteen months ago, when the system of wrought iron coils was given up, that though steel was strong, it could not be trusted. "Nous avons changé tout cela," and guns are now made altogether of steel. Every effort is made to insure safety, and the advances lately made in steel render this quite possible, though with the heaviest ordnance, for which very large masses of steel are forged, the greatest skill and care are needed.

With heavy gun carriages, cast steel is now largely employed as well as steel plate; for some purposes, however, as for instance for the trail eye of a field gun carriage, which is subjected to considerable vibration and jar, wrought iron is still preferred. Steel has been a good deal used in experimental armor piercing shells, but their high velocities and the increased hardness of armor have imposed strains upon them which they have not yet satisfactorily withstood, though more progress might doubtless be made, if money were granted for experiments on a large scale. It appears that considerable progress has been made on the Continent in this direction.

Tubular steel is now used for a variety of purposes, *e. g.*, for shells of large capacity, for parts of torpedoes, electric contact mines, rocket cases, axle trees, etc.

Compound armor is composed of about one-third of steel of a harder quality than that used for guns (about 0·8 per cent of carbon), as by its hardness it is intended to break up a shell on striking, while the toughness of the wrought iron, of which the rest of the plate is made, tends to hold the mass together and to prevent cracking.

Although Great Britain produces a great deal more steel than any other nation of the world, it seems that some French and German works can make ingots of greater weight than any produced in England, and the plant of some continental works is on a larger scale than any English; for instance, the 100 ton hammer of Le Creusot is larger than any English one; as the successful forging of large masses of steel necessary for very heavy guns appears to need very powerful plants, this point seems to be worth considering, from a military point of view.

A short discussion then ensued, when Captain Orde Browne drew attention to a 9 inch shell of Sir J. Whitworth's which had penetrated 18 inches of wrought iron, at an experiment last year for the Brazilian Government, when Mr. Whinfield stated that no similar projectiles had yet been made for that foreign power.

The departments of the Royal Arsenal and Royal Small Arms Factory, Enfield, exhibited a variety of steel articles; the only other manufactory represented being the Royal Gun Factory, which sent a gun hoop and a complete set of test pieces for a gun tube.

Small pieces of compound armor plates were sent by the only English manufacturers, Messrs. Cammell & Co., and Sir J. Browne & Co.; Sir J. Whitworth exhibited a fine long 9 inch shell, whose performance is already recorded. The Landore-Siemens Steel Company showed mild steel bars tied into complicated knots. The Steel Company of Scotland, test pieces used for shipbuilding purposes. Messrs. Hadfield & Co., a large number of fine castings which had borne rough usage by bending without being broken. The dephosphorizing process was illustrated by two samples of steel rails from Messrs. Bolckow, Vaughan & Co., and also by specimens made in various places and sent by Mr. P. Gilchrist. The ingenious tubular shells with drawn out heads and folded in bases of Mr. Delward attracted a good deal of attention, and Mr. Welsh (Royal Gun Factory) showed some beautiful specimens of nearly pure iron which had been melted in small crucibles. Diagrams, etc., were kindly lent by the School of Mines, South Kensington Museum.

The Origin of Ore.

The following extracts are from a lecture by Prof. John A. Church, delivered to the pupils of the public schools in Tombstone, Arizona:

No one has ever seen ore in process of formation, but something has been learned of its formation, and I will try and tell you how it is deposited in Tombstone. In the human frame there is a circulation of blood passing from the heart through the system and back to the heart. In plants there is a circulation of the sap; the earth has its circulation—water comes to it, passes through it, and rises again to its surface in the form of springs. The first thing to be observed is the rainfall passing into the rocks. Rain penetrates more than twenty miles into the crust of the earth; it dissolves substances—ore as well as sugar. When we wish to extract the silver, we add salt and bluestone; every substance can be dissolved in the water, even the quartz; limestone is readily dissolved. Rain water in passing through the earth takes up minerals—lime, iron, potash, etc.—which are deposited in the interior of the earth, and then return again in the form of springs. The rainfall is pure, but the springs are not pure, for they have taken up these mineral substances. Air also circulates in the earth; it takes up oxygen and nitrogen. When these combine with a solid rock, the rock is said to be hydrated. This air is passed upward through the rocks as the water passes downward. These form springs.

In addition to water and gas, the earth has a circulation of solids; sea waves beat on the rocks and wear them away—where those particles are coarse, we have pebbles; where smaller, we have coarse sand; smaller yet, mud, portions of limestone. Sea beaches are found in the mines of Tombstone.

When these particles are first worn off they are borne away—the finest particles borne far away, and called shale. In the mines of Tombstone are found limestone, quartz, and shale; which proves that where we now stand, on the hills of Tombstone, it was once deep water.

This history of a rocky sea cliff is the history of a whole world. The world was originally composed of gas, much heated and then cooled, like the volcanoes of the present day, where the top goes to the bottom and the bottom comes to the top.

No one has ever seen the original earth. It cooled gradually from a gas to a solid. In this way the chemist tries to obtain pure water: He takes water as pure as he can find it, heats it, then cools the steam and repeats the process until he gets a pure water. In this way quicksilver is purified, and camphor gum. So, a gas will condense into a solid, and a solid may be heated until it becomes a gas.

This earth was once a gas, heated and then cooled, until it became a solid. It is by these circulations of water and air that the ores are collected together and found in one place. If we were to see the original earth, unacted upon by the circulations which I have attempted to explain to you, we should find the quantity of metals in rock very, very small.

At Comstock Lode, Nevada, are found volcanic rocks which contain 55 per cent silver, and gold 45 per cent. So in the eruptive rocks of Leadville, Colorado, the proportions of gold and silver have been found to be similar. The geologists have been able to show how many tons of rock must have been dissolved to give this per cent of precious metal. The waters found holes, or crevices, where they could deposit the metals they had taken up, all of which are not deposited 3,300 feet or one mile below the surface of the earth, so that mining for these metals will not be carried any farther than one mile below the earth's surface, though the water penetrates 20 miles into the earth; the deeper the water goes the more the pressure, and when you increase the pressure you must increase the power of solution; releasing the pressure also releases the metals; the waters passing through the rock are forced now slowly, now more rapidly, and when such waters reach the crevices there is much less speed of the waters, and the metals are deposited there. In regard to the deposition of ores, scientists show us that the rocks have been acted upon again and again by water, and in this way the ore is collected. It is difficult to distinguish the age of the rocks, but they have shown where the first concentration of the metals in the oldest rocks known gave a yield of only one-half cent to the ton. The part of the circulation which collects metals is called the function of the circulation.

No one knows why the precious metals are deposited in veins or in beds; but one thing can be shown—that where these ores are found there are eruptive rocks. In the western part of our country this is especially true.

Where not only shales but dikes are found, where melted rock has been forced to the surface, but by the action of water has been carried beneath the surface, which shows eruptive forces at work, so it is in the hills of Tombstone—forces as simple as the ordinary forces that work in every housekeeper's kitchen or chemist's laboratory.—*Republican.*

Georges Leschot, Inventor of the Diamond Drill.

Georges Auguste Leschot, who died at Paris on the 4th of February at the age of eighty-four years, was a very remarkable man. It is to him that we owe the plan of employing the black Brazilian diamonds, or "carbonados," for piercing rocks, an invention which has proved of immense value. Leschot was the son of a skillful mechanician, Jean Frederic Leschot by name, whose automata, singing birds, artificial limbs, and so on were the admiration of the celebrated Vaucanson. He also effected great improvements in the manufacture of watches by mechanical means, in connection with the Geneva house of Vacheron and Constantine, receiving in 1845 a prize from the French Academy of Sciences in recognition of his services. In 1861, the black, amorphous, but very hard diamonds of Brazil, known as "carbonados," came to Europe, and Leschot's son, being then engaged in Italian railway work for the house of Vitali, Picard, et Cie., knowing the idea of his father that diamonds might be used instead of steel tools to cut rocks (an idea which had occurred to him in examining the fine striations cut in some specimens of ancient red porphyry), communicated with his father on the subject, and the result was that Leschot devised the diamond perforator, which has been in use ever since, especially in England, Germany, and America.

Illuminating Gas from Fermenting Manure.

M. Gayon has demonstrated to the Paris Academie des Sciences the possibility of obtaining illuminating gas in considerable quantity from the fermentation of cow and horse droppings. This material is subject to fermentations of different orders, accordingly as it is kept in a close receptacle or allowed free access of air. In the latter case its temperature rises rapidly, and there is a great evolution of carbonic acid; while in the former the temperature remains fairly constant, and there is an active production of carbureted hydrogen mixed with carbonic acid. The evolution of carbureted hydrogen is ascribed to the agency of organisms infinitely small, but differing in kind from those found in aerated manure. These have been isolated, and have been observed to occasion the evolution of the same gases from pure cellulose. The carbureted hydrogen disengaged from fresh manure kept in a close box, one meter square, has been collected by M. Gayon and burnt before a scientific society at Bordeaux. The volume of carbureted hydrogen given off by 1 cubic meter of fresh horse droppings is about 100 liters, or 3·53 cubic feet, per twenty-four hours. M. Pasteur suggests that as this method of preserving manure in close storage retains ammonia, it is possible that in certain circumstances it might be utilized for the purpose of supplying a useful heating and lighting gas without injury to the value of the fertilizer.

COTTON-SEED hulls are being substituted for cotton waste for packing journal boxes of railway cars, and are said to effect a saving of fully one-half the cost and to answer a good purpose.

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THE BRIDGE OVER CATSKILL CREEK.

The accompanying engraving represents one of the most picturesquely located bridges on the New York, West Shore, and Buffalo Railway; it spans Catskill Creek, a small stream flowing from the mountains and emptying into the Hudson River.

The bridge consists of eight double deck spans, six of which measure 167 feet each from center to center of end piers, are 26 feet deep, center to center of chords, 20 feet wide, center to center of trusses, 13 feet, center to center of tracks; the two end panels are 16 feet 10 inches, and the eight intermediate panels are each 16 feet 8 inches. There is one span of 103 feet 6 inches between centers of end piers, and 20 feet 11 inches deep; each of the six panels measures 17 feet 3 inches. The remaining span is 97 feet 6 inches long and 20 feet 11 inches deep; the end panels are 17 feet 3 inches; and the four intermediate ones each 15 feet 9 inches. The actual weight of the six 167-foot spans is 2,340,000 pounds, or 390,000 pounds per span; the next span weighs 180,000 pounds, and the third 173,500 pounds; the total weight of the eight spans being 2,693,500 pounds.

The bridge is proportioned to carry (1) the weight of iron in the structure; (2) a floor weighing 400 pounds per lineal foot of track, consisting of rails, ties, and guards only; and (3) a moving load for each track, consisting of two "consolidation" engines coupled, each weighing 80 tons, followed by a train weighing 2,240 pounds per running foot. The maximum strains due to all positions of this live load, and of the dead load, are taken to proportion all the parts of the structure.

To provide for wind strains and vibrations the top lateral bracing is proportioned to resist a lateral force of 450 pounds per foot of span; 300 pounds of this being treated as a moving load. The bottom lateral bracing is proportioned to resist a lateral force of 150 pounds per foot. Variations in temperature to the extent of 150 degrees are provided for.

The bridge was built by Clarke, Reeves & Co., Phœnixville (Pa.) Bridge Works.

Preparation of Collodion Cotton.

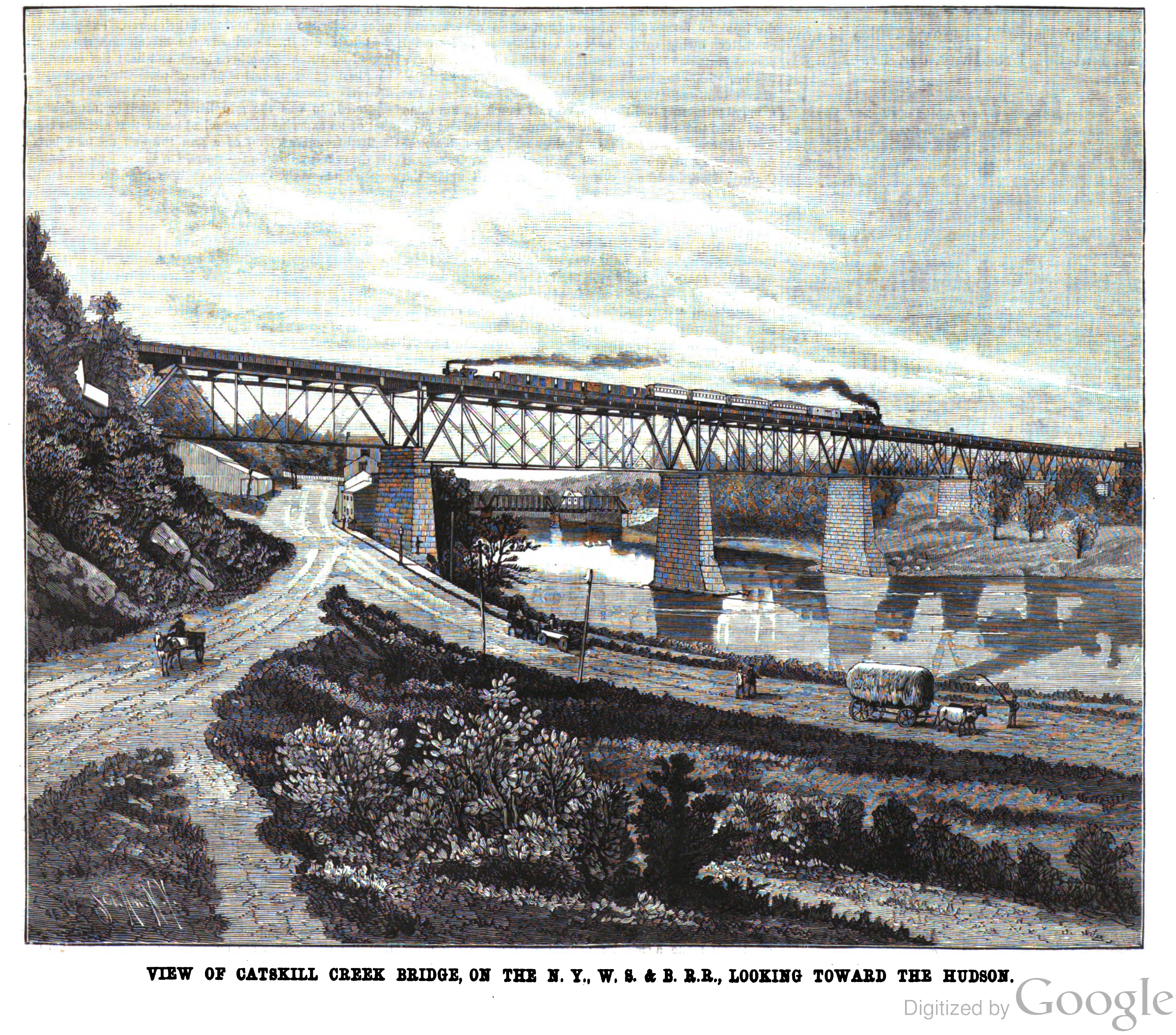
In the preparation of pyroxylene for making collodion, F. A. Katschursky recommends the following process: Three parts of chemically pure sulphuric acid, specific gravity 1·84, are mixed with one part of distilled water and poured (slowly) into three parts of fuming nitric acid, specific gravity 1·48. When the mixture is cold he introduces one part of the purest cotton, from which all traces of grease have been removed. The method of introducing the cotton is peculiar, in that it is twisted loosely around the end of a glass rod, and left in the acids *three days*. The effect of the acid is at first to harden the cotton; when it begins to lose this quality it is taken out of the acid, carefully dried, and washed in water acidified with fuming nitric acid, afterward with distilled water. It is advisable not to put more than 35 grammes (1¼ oz.) of cotton in one vessel, as the heat is so great with larger quantities that it may take fire.

According to *Rundschau*, still better results are obtained by the following: Two parts of purified cotton are wound about a glass rod and dipped into a mixture of twenty-seven parts of sulphuric acid, specific gravity 1·49, with 13 parts of purified nitric acid, specific gravity 1·40. It is left there 1½ hours, then taken out and dried, washed in acidified water, and afterward in distilled water.—*Polytechnisches Notizblatt.*

Professor Hughes on Magnetism.

In his recent paper to the Royal Society, Professor Hughes dealt with the discovery he has made of the presence, in the interior of a magnet, of waves of opposite magnetic polarity, which balance each other when there is neutrality. In a magnet the polarity at the poles is of one name across the bar, but when the iron is neutral the poles run N S N S . . . . across the bar. He also deduces the practical result that very thin magnets have greater residual magnetism than thick ones; thick ones have more magnetic inertia, and take longer to magnetize. Bundles of wires are better than solid cores, because they take a higher degree of magnetization, owing to surface exposure; and this is not proportionately counteracted by their higher residual magnetism.

Professor Hughes is also of opinion that all matter, and even ether, has inherent magnetic polarity and a saturation point. The curve of saturation for the atmosphere is the same in character as that of iron.



VIEW OF CATSKILL CREEK BRIDGE, ON THE N. Y., W. S. & B. R.R., LOOKING TOWARD THE HUDSON.