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THE IDEAL SMOKELESS POWDER.

Great as are the advantages of the best forms of nitroglycerine and guncotton smokeless powder, there is not one of them that can be called an ideal powder. They all suffer from an inherent and ineradicable defect, due to the presence of the nitroglycerine and the fact that its explosive qualities are affected by changes of temperature. The best of these powders might be considered ideal explosives, provided they were always used at exactly the right temperature; but they never or rarely ever are.

When it is stated that 19·5 pounds of cordite fired behind a 100-pound projectile in a 50-caliber 6-inch gun will produce a muzzle velocity of 2,642 feet a second, the statement is not altogether complete; since one of the elements effecting these results has been omitted—or rather, it is supposed to be understood. Strictly speaking, these results can only be obtained if the powder at the moment of firing is at the normal temperature of the atmosphere. If its temperature is lower, as it would be in the Arctic regions, the velocity will be lower, and if it should be higher, as during an engagement in the tropics, the velocity will be higher. Now between these extremes of cold and heat there will be a difference of velocity which will interfere with the accuracy of the gun; for the sights are adjusted for the velocities due to the powder when fired at normal temperatures.

The pressures, moreover, are even more liable to change than the velocities. It frequently happens that a gun becomes quite hot from firing or from being exposed to the rays of the sun. While in this heated condition a charge may be inserted and, for some reason, allowed to remain for some length of time in the chamber before being fired. The heat of the gun is imparted to the powder, and in this heated condition it is liable to produce abnormally high pressures, and may even detonate and destroy the weapon. It is a fact that in some makes of machine guns serious accidents have resulted from leaving the piece loaded for a few minutes when the gun was overheated.

These troubles are entirely due to the nitroglycerine, and they are inseparable from any powders that include this powerful agent as one of the constituents.

For these reasons several of the European nations have always opposed the use of nitroglycerine in any form, and a vast amount of experimental work has been done in the hope of producing a smokeless powder that should contain none of this explosive. We are reliably informed that a certain Austrian chemist, who is considered to be the greatest European expert on high explosives, has at last produced a smokeless powder which is entirely free from the defects alluded to and is as safe and reliable as the old black powder. It contains no nitroglycerine and it is affected very little by overheating. It is not only very effective, but it can be manufactured much more cheaply than smokeless powder of the ordinary type.

Our informant, who is perhaps the most noted expert in rapid-fire weapons in Europe, states that the discovery has produced a sensation in naval and military circles, and that great expectations are entertained regarding the new explosive, regarding which particulars will be made public early in the year.

FAILURE OF THE GATLING CAST-STEEL GUN.

The idea that a cast-steel gun can be produced which will have the same ratio of energy to weight of gun as the hooped or wire-wound gun, and stand the test of continued firing, dies hard. The latest attempt to work out a proposition which our artillery experts regard as, in the nature of things, impossible was embodied in the 8-inch cast-steel gun of Dr. Gatling, for the construction of which Congress appropriated $40,000. As we noted in a recent issue the gun was duly constructed according to the inventor's specifications and sent to the Sandy Hook proving-ground to be tested. A sum of $18,600 was allotted by the Board of Ordnance and Fortification for this purpose, and it was the intention to subject the weapon to three hundred rounds in all. These tests are commenced at the standard firing pressure used in the army guns of 37,000 pounds to the square inch, but before they are over it frequently happens that the pressures rise far above this figure, in some cases exceeding it by over 100 per cent. When a gun has stood three hundred rounds, during which the pressure may have risen as high as 82,858 pounds, as actually occurred in the case of the Brown wire gun, the ordnance experts do not hesitate to pass it as being perfectly satisfactory, as far as danger of rupture is concerned.

The Gatling gun had already resisted five rounds with ordinary charges in its first trials. During the second series of trials, which took place on January 4, ten rounds were fired with the same charges and pressures of about 37,000 pounds. At the tenth round of the series, or the fifteenth round for the gun, it failed completely, and is described as flying into many fragments.

On being interviewed, Dr. Gatling stated that the failure did not surprise him, because he was aware that there was a mishap at one stage of the manufacture. He avers that tests of the metal of the gun showed that the breech was considerably weaker than the muzzle of the gun, the defect being due to the fact that the breech was subjected to a high temperature for three days longer than it should have been. As a result, the strength of the breech compared with the muzzle was about as six to ten, the metal at the muzzle representing the strength which was designed to be secured for the whole gun.

If these are the facts, though we confess the statement needs elucidation, it is greatly to be regretted that the weapon was not rejected and another cast. Every one, and none more than ordnance officers, is anxious to know the exact possibilities of cast ordnance. The present failure, notwithstanding the alleged mishap in the manufacture, will tend to strengthen the prejudice which undoubtedly exists against the type.

EDUCATION BY CORRESPONDENCE.

Elsewhere in our columns will be found a letter from a Russian correspondent, Mr. N. A. Shishkov, giving the rough outline of a new scheme of education which he desires to bring prominently into public notice, with a view to its general circulation and discussion. The writer will doubtless be remembered by many of our readers as the author of an article ("The Horrors of Hunger") describing the great famine in Russia, which appeared in the Nineteenth Century in 1892, and was largely instrumental in arousing the practical sympathy which was shown both in this country and Europe with the distressed Russian peasantry. Speaking broadly of the proposed scheme, without consideration of the difficulties of organization and detail which would be encountered in carrying it out, we think the spirit and purpose of Mr. Shishkov's ideas are to be commended. Work along somewhat the same lines has been started in this country in the schools and colleges of correspondence, which have proved to be so successful, and though their organization differs in important particulars from the present proposal, they are so nearly allied to it in principle as to afford reason to expect that education by correspondence, if carried out on an international scale, might, by the valuable benefits conferred, commend itself to universal favor.

The first and obvious question that will suggest itself to the average overworked and brain-weary citizen in this utilitarian age is: How could any one be expected without adequate compensation to devote valuable time to answering the many questions which such a scheme might bring? To the commercial mind, the objection is a serious one, and does violence to the trading instincts of an age which has a way of demanding *quid pro quo* in all the ventures or occupations of life.

To which it is sufficient to reply that it requires a broad intelligence, a liberal mind, and a progressive spirit to appreciate the actual benefits—should it prove to be practical—of all such schemes as that outlined by Mr. Shishkov.

Another and perhaps more serious difficulty would be that of diversity of language; for, unless the sources of income of the association were more fruitful than we think those suggested by our correspondent would prove to be, it would be impossible to maintain anything like the corps of translators that would be necessary to cope with an international correspondence of the magnitude which this association would presumably carry on. On the other hand, it is probable that one of the best results of the undertaking would be that it would greatly stimulate the mutual study of the three great languages, English, French, and German, adopted for the uses of the association.

It will, moreover, suggest itself to our readers that the need for such a medium of information is probably more apparent in the great country to which our correspondent belongs than in some others. Speaking for the United States, we can say that, in addition to the schools of correspondence above mentioned, there is a splendid field for the mutual exchange of information afforded by the press of the country. In the half century of its existence the SCIENTIFIC AMERICAN has devoted a column or more of each issue to this form of instruction under the head of "Notes and Queries;" and by this medium and by letter some 5,000 items of information emanate from this office alone each year.

This method of conveying information is practiced in some degree by other journals throughout the country, and it is probable that the items thus secured by correspondence exceed in themselves and far exceed in the numbers of their readers those that would pass to and fro in a system of correspondence between individuals.

At the same time we fully realize that information by correspondence through the press is of a national and therefore somewhat local character; whereas Mr. Shishkov's scheme is formed on the broadest international lines.

NEW SUSPENSION BRIDGE AT NIAGARA.

During the next three months a large force of men will be at work erecting a new suspension bridge across the Niagara River, a short distance above the village of Lewiston, on the New York side, and the village of Queenston, Ont., on the Canadian side. This bridge is to be built by the New Jersey Steel and Iron Company for the Lewiston Connecting Bridge Company and the Queenston Heights Bridge Company. The consulting engineer is L. L. Buck and the engineer R. S. Buck. James Stewart & Company had the contract for the substructure, which is about completed.

The location of the bridge will be on the site of a suspension bridge erected in 1850–51, and will adhere pretty closely to the lines of the old bridge, which was wrecked by a hurricane on February 1, 1864, and never since rebuilt, because of the fact that it was an unprofitable investment. As the great suspension bridges which stood further up the gorge have given place to new steel arches, this suspension bridge will be the only structure of the kind spanning the Niagara. The cable span of the new bridge will be 1,040 feet and the span of the stiffening truss 800 feet. From center to center of trusses the width will be 28 feet clear and the roadway will have a clear width of 25 feet. The versed sine of the cables will be 87 feet and the height of the superstructure above high water mark will be 65 feet. The height of the bridge above the tracks of the Niagara Falls & Lewiston Electric Road will be about 15 feet. The stiffening truss will extend about 4 feet above the floor and the only railing will be light strips of iron flats reinforced by oak half rounds. The floor will be of 2 inch oak plank laid crosswise. A single track for trolley cars will be laid through the center, the width of the bridge affording ample room for vehicles to pass on either side of the track. There will be no walk for pedestrians, as the point of the bridge's location is such that there is not likely to be much travel on foot.

The towers for the bridge have been completed, and are four in number, two on each side of the river. The towers on the New York side have a height of 26 feet, bases of 13 feet square, and they are located 28 feet back from the edge of the bluff. The towers on the Canadian side have a height of 18 feet, with bases 12 feet square, and are located 15 feet back from the edge of the bluff, the ledge on the Canadian side being more firm than on the New York side. In the construction of these towers it was found possible to use a great part of the old towers in the new bases, and the old inscription stones of the towers on both sides of the river were preserved and have place in the new towers. The new stone used in the towers on the New York side came from the Buffalo quarries, and that in the Canadian towers from the Queenston, Ont., quarries.

Four cables will form the main support of the bridge. Each of these cables will be composed of fourteen 2¼ inch galvanized cast steel wire ropes. These cables once formed a part of the old suspension bridge that stood close to the falls, and which was taken down in the early part of last year. The span of the upper suspension bridge was so great and the anchorages so far back from the towers that it has been found possible to cut the old cables in half, and thus use them on the shorter span of this new bridge at Lewiston. However, when so cut they are hardly long enough to fill out the entire span and reach back to the anchorages, and for this reason about 75 feet at each end of the cable span will be made up of eye-bars. The cables will be anchored in solid rock about 150 feet back from the towers, the shafts to be filled with concrete. The suspended span will be connected to the river banks by two approach spans, the one on the New York side to be 34 feet 6 inches long and the one on the Canadian side to have a length of 19 feet 6 inches.

On each side of the river the bridge will have long approaches on which double tracks will be laid for electric cars passing on and off the bridge. These approaches are about 25 feet wide, and the one on the Canadian side is about 1,000 feet long and the one on the New York side about 800 feet long. Both approaches have face walls to prevent the native shale disintegrating under the weather. The approach wall on the New York side runs close beside the tracks of the Niagara Falls & Lewiston Electric Road. Its highest part is about 19 feet, and for 660 feet it drops at a 1 per cent grade and then for 200 feet at a 2 per cent grade. The high part is laid in cement and the remainder is laid dry. These approach walls form the bridge landings. It is expected that the Niagara Falls & Lewiston Road will connect its tracks with the bridge on the New York side and the Niagara Falls Park & River Railway with the bridge at the Canadian end. This will make it possible for passengers to travel around the beautiful gorge without leaving their seats in the electric cars. Starting from the New York State Reservation, the trip would consist of crossing the river over the magnificent new upper steel arch in a car of the Niagara Falls Park & River Road; passing down that line along the top of the high bank on the Canadian side to Queenston, there crossing on the new suspension bridge to the New York side, where the tracks of the Niagara Falls & Lewiston Road would be taken back along the water's edge and up the bank to the point of starting, thus allowing passengers to view the river and banks from above and below, all forming a most delightful trip.

The capacity of the new suspension bridge is to be such that it will accommodate the heaviest of trolley cars, together with a uniformly distributed load of 40 pounds to the square foot over the entire structure. About 800 tons of metal will be used in its construction, and the cables will weigh about 200 tons. Connection between the cliffs will soon be made, and after the cables are strung, the work of erecting the superstructure will start at the New York State end and progress rapidly until the river is spanned. It is expected that the superstructure can be thrown across the river in sixty days, so that the bridge will be ready for travel next summer.

THE GROWTH OF OUR OIL TRADE.

BY WILLIAM GILBERT IRWIN.

In the oil regions there always has existed and always will exist a speculative fever. The risks, the possibilities, the ebb and flow of fortunes, the periodic frenzies and the fluctuating prices of the product all add to the romance and interest of the oil fields, and help them to create their own atmosphere.

The story of the rise of this great industry has an absorbing interest. During the last half century hundreds of millions of dollars have been expended in opening this vast dormant source of wealth.

The latest available statistics (for 1896) place our annual production of petroleum at 60,960,361 barrels. The foreign product for the same year was 47,552,886 barrels, which makes a grand total production of 108,512,947 barrels. The value of this product is upward of one hundred million dollars, and after having passed through the refining processes and the complex processes of modern chemistry, this crude oil represents a myriad of diversified finished products of industry and its total value is enormous.

Like other similar branches of trade, all this vastness has sprung from the work of some farseeing genius and the work of some few pioneers who lived in the van of their time. Northwestern Pennsylvania can well claim the honor for the inauguration of the oil trade, and 1849 was the year of its birth. The existence of oil in Northwestern Pennsylvania and Western New York was known to the Indians from the earliest days. When first the French came to this region they were shown the oil springs, and the earliest English settlers were aware of the presence of those on Oil Creek. In the year 1819 the presence of petroleum was noticed in salt wells sunk along the Ohio. In the early days of the century a few gallons were occasionally gathered from the surface of springs and taken to Pittsburg by the lumbermen with their rafts, and the product became widely known under such names as "Seneca oil," "British oil," "Genesee oil," etc. In the early forties Samuel Kier began the preparation and sale of the oil, and, bottled and prepared for medical purposes, it attained a wide sale. His supply was obtained from an old salt well at Salina, on the Kiskiminetas.

But as yet the product had no real commercial value. The crude oil was not fit for lighting purposes on account of its dark smoke, and its use for heating purposes was also impossible. As a lubricant it was used only in a small way. The first lease of oil lands, with a view to putting down an oil well, ever made in this country, was that of a tract containing an old oil spring, located in Cherrytree Township, Venango County, Pa., and it was made by J. D. Angier to Brewer, Watson & Company, in the year 1853. The lease was for five years.

But this venture was not destined to have an immediate success. In 1854 Dr. F. B. Brewer, a son of the senior member of this pioneer oil firm, went to Hanover, Mass., taking with him a bottle of the oil for medicinal purposes. There Dr. Brewer presented the oil to his relative, Prof. Crosby, of Dartmouth College, and shortly afterward it came to the notice of George H. Bissell, a New York lawyer. A visit to the spring was the result, and Bissell and his partner, Jonathan G. Eveleth, purchased from Watson, Brewer & Company 105 acres of the land they had leased. In the same year (1854) the Pennsylvania Rock Oil Company was incorporated under the laws of the State of New York, but, owing to legal complications and the prostration of the money markets, which had taken up the stock, the project was delayed for several years.

Up to this time the idea of boring for oil had not been thought of; but in 1856, when Bissell went to see Kier, and learned that his preparation was obtained from a salt well, 400 feet deep, the idea at once came to his mind, and in 1858 Edward Drake, a stockholder in the Pennsylvania Rock Oil Company, was engaged to drill a well. In the meanwhile, the Pennsylvania Rock Oil Company was succeeded by the Seneca Oil Company, of which concern Drake became president.

Saturday, August 28, 1859, is a day justly celebrated in oil country history, for on that day oil was struck in the Drake well at a depth of 70 feet. Two days later the well was producing 20 barrels per day. This was the beginning of the oil excitement, the history of which has scarce a parallel in history. The story that oil was being pumped from the earth as freely as water was at first scouted, then accepted as a curious phenomenon, and finally it came to be believed as a fact.

When it became known a little later that oil gushed from the earth of its own power by the hundreds of barrels, the excitement became a wild mania. The desire to speculate in oil and oil lands became general. The sober farmer who received fabulous prices for his poor farm joined in the frenzy. Fortunes of gigantic proportions were won and lost in a short space of time.

Titusville grew in a few weeks from a town of 100 people to a city of 15,000. The region of the oil excitement extended rapidly, until nearly the entire Northwestern Pennsylvania was one vast oil field. Everywhere towns and cities sprang up as if by magic. While hundreds of these were mushroomlike and have long ago been effaced from the earth, others were stable and remain to this day as memorials to the rise of this great industry. In time great oil fields were opened up close to Pittsburg. Then the Washington and Greene County fields in Southwestern Pennsylvania were brought in, and later the West Virginia fields were opened up. The Lima field of Ohio and the fields of Indiana in their turn were opened up, and other States joined in the procession.

For over a quarter of a century from the time of its opening the New York and Pennsylvania region of the Appalachian field stood alone in the production of petroleum, and there was not a producing oil well outside the Appalachian field until the opening of the Lima field, begun in the year 1885. In 1849 about 2,000 barrels of oil were produced about Titusville, Pennsylvania. The production of that region in the year 1860 was 500,000 barrels, and ten years later Pennsylvania was producing upward of 5,000,000 barrels annually. The production of the New York and Pennsylvania region in the year 1880 was 26,027,631 barrels, and in 1882, when this region produced 30,053,500 barrels, the climax was reached. The production of this region in 1890 was 28,458,208 barrels and in 1896 20,484,421 barrels were produced. Titusville, Oil City, Franklin, Pithole, and other towns have successively been the center of this oil country, and ever since the first well was put down there has been a constant shifting of the center of the industry. Within the last decade the oil territory developed about Pittsburg and in Southwestern Pennsylvania has virtually made Pittsburg the center of the oil business, and the development of the West Virginia region has assisted Pittsburg in retaining her mastery.

While oil in considerable quantities was produced in West Virginia as early as 1875, it was not until the year 1885 that the oil business in that mountain State was really begun in earnest. West Virginia's production in that year was 91,000 barrels. In 1890 that State produced 492,578 barrels, and the next year the Sisterville region was brought in, and the production of that State was increased to 2,406,218 barrels, and the production for 1896 was 10,019,770 barrels. The Southern Ohio region, included in the Appalachian field, was an early oil-producing section. In 1880 it produced 38,490 barrels, and in 1885, when the Lima field was developed, Ohio produced 661,580 barrels. In 1890 Ohio produced 16,124,656 barrels and in 1896 she led all other States, having a production in that year of 23,941,169 barrels. California produced oil as early as 1875. The California field is located in the southern part of that State. Its production in 1880 was 40,552 barrels. In 1890 California produced 307,360 barrels and in 1896 its production was 1,252,777 barrels. The first recorded production of the Colorado field was in 1897, when the production was 76,295 barrels. In 1890 that mountain State produced 368,842 barrels. Its production in 1892 was 824,000 barrels, and in 1896 this had dwindled to 361,450 barrels. The production of Kentucky and Tennessee never was large, and very little oil is now produced in these States. The Indiana part of the Lima field was developed in 1889, and that year Indiana produced 33,375 barrels. New regions were developed in 1893, and Indiana's production in that year was 2,335,293 barrels and in 1896 it produced 4,680,732 barrels.

Thus have we given in detail the opening and production of the oil fields of our country and the production of the different States at different periods in the growth and development of the industry. It will be seen that the Lima and Indiana fields now lead all others, having in 1896 produced 33,970,222 barrels, against the 25,255,870 barrels produced in the Appalachian field. It is only when we pause to consider the magnitude of the work required to extract from the bowels of the earth the great latent store of Nature's contribution to modern industry that the magnitude of the oil trade becomes fully settled in the mind. There are to-day not less than 20,000 producing wells in this country, and every year thousands are being added to these. The "dry holes," it must be remembered, far outnumber the producing wells, and in these millions of dollars are lost every year.

America led in the opening of her oil fields. Since the development of the industry in this country oil-producing fields have been developed in foreign countries. More than two thousand years ago petroleum in its crude state was known to the Greeks and Romans, and for centuries the springs and wells of the Rangoon district, on the Irrawaddy, have supplied the entire population of British India. Baku, now the center of the great Russian oil fields, has supplied Persia with artificial light, and for more than two centuries Parma and Modena have furnished Italy with petroleum. The product is found in Trinidad and Cuba, it is to be seen floating upon the surface of the water in the vicinity of volcanoes, and old Vesuvius has her oil springs; but no attempt at the utilization of this fuel product was made in the old world until after it had undergone its early stages in our own country, and even to this day we lead all the world in the production of petroleum. Against our production of 60,960,361 barrels for the year 1896 the entire foreign product was but 47,552,866. Russia leads the foreign countries with 39,882,122 barrels and the production of the other countries for the year 1896 was as follows: Austria-Hungary, 2,443,080; Great Britain, 1,500,000; Canada, 801,725; Japan, 1,324,850; Java, 505,029; Germany, 145,061; India, 371,830; Italy, 20,841; Peru, 15,000; Sumatra, 4,380,000.

The large production of mineral oils in other parts of the world, while it has not reduced our exportation, has probably reduced the prices which our producers and exporters have been able to realize. The exports of oil in the year 1898 were practically double those of 1888 and three times those of 1878, but the money received for them was only about 25 per cent greater than that received either in 1878 or 1888. The total receipts for the 1,034,269,676 gallons of oil exported in 1898 were $56,126,578, while for the 578,351,638 gallons exported in 1888 the receipts were $47,042,409, and for the 338,841,303 gallons exported in 1878 the receipts were $46,574,974. The average export value of refined illuminating oil was, in 1872, 24·9 cents per gallon; in 1878, 14·4 cents per gallon; in 1888, 7·9 cents per gallon; and in 1898, 5·2 cents per gallon; having thus fallen from 24·9 cents to 5·2 cents from 1872 to 1898. Notwithstanding this steady fall, the production and exportation continue to increase, the exports having increased over 60,000,000 gallons in the past year over that of the preceding year, and over 100,000,000 gallons over that of any earlier year, while the production for 1897 was 2,528,067,984 gallons, against 2,033,331,972 in 1894; 1,476,867,546 in 1890; 1,017,174,396 in 1885; 836,394,132 in 1880; and 510,825,588 in 1876. Thus, while the price has been steadily and rapidly falling, the quantity produced and the quantity exported have as steadily and rapidly increased. The production in 1897 was five times that of 1876 and the exportation of last year nearly five times that of 1876. Great as the fall in price has been, the exports of illuminating oil bring over a million dollars a week into the country and have in the past twenty years added a round billion of dollars to our foreign sales.

Our oil products reach every continent and all the principal islands of the earth. They go to every European country, to China, Japan, Australia, Egypt, Transvaal, and Brazil. With every year our trade in oil, both foreign and domestic, is increasing, and, unlike the gas fields, our oil fields are so far from exhaustion that that event has not yet been given a serious consideration.

EVERY farmer of the State of New York may now avail himself of the privileges of the Nixon bill providing for the university extension of agricultural knowledge by addressing the Reading Course, College of Agriculture, Ithaca, N. Y., for plans of the Farmers' Course of Reading during the winter. Several thousand farmers are now following the course. The topics relate to the farmers' occupation. After the reading course a discussion with the College of Agriculture will follow, and suggestions are given for the formation of reading circles. A great deal has been said about the practical nature of scientific agriculture, and in these times of fierce competition the strong are constantly becoming stronger, and no farmer should neglect any chance of improving himself. Under the Nixon bill there is no expense to those taking up this course, as the reading matter is furnished.