fact that it is at present undergoing a wider range of experiments than any other crude material now serving as the subject of the analytical operations or as an ingredient in the compounding processes of the laboratory. In one of its variations it has proved a positive blessing to humanity; and did carbolic acid alone represent the sum total of virtue derivable from coal tar, still would this isolated fruit of the crucible well repay the time and toil expended in its discovery, and hold its place as one of the greatest material gifts of modern days. But the bituminous distillation flowing from the gas house retorts assumes other marked forms in the chemist's hands; and although they may not so directly contribute to the physical welfare of mankind, yet for certain purposes of utility they are unapproachable. Creosote oil, for instance, is certainly unequaled in its peculiar preservative qualities, which are none the less valuable because the revelation of these special properties is of comparatively recent date. The United States government annually purchases thousands of barrels of this liquid, using it on all wood work exposed to the weather, especially on gun carriages; 120,000 gallons were employed in saturating the timber composing the bulkheads in the St. Clair Flats, Detroit river. It is extensively used by railroad companies for the preservation of railroad ties, bridge timbers, and piles, and also upon the blocks constituting the wooden pavements of Washington, Pittsburgh, and other cities. The artificial oil of bitter almonds (oil of myrbane), of superior fragrance and flavor, is also extracted from the same viscid base, and is exclusively an American invention and manufacture. But the most remarkable product obtained from coal tar is the new article called anthracene, from which is produced the coloring matter known as alizarine, the identical substance which for two hundred years has been found solely in madder. It is only in the United States that coal tar has been made to yield anthracene in large quantities, several hundred pounds of which are daily manufactured in this country and shipped to Europe on orders from the manufacturers of alizarine, which is not yet numbered among our domestic productions. This article constitutes the base of all the madder colors—Turkey red, black, pink, and purple. It was first discovered in coal tar by the distinguished chemists Grieb and Leibermann of Berlin in 1867. More than $10,000,000 is invested in its manufacture. In several foreign countries, the pitch from coal tar is combined with coal dust and pressed into the form of bricks, and an excellent fuel is thus produced, a given amount of which, it is said, will generate a greater heat than can be obtained from the same quantity of any other combustible material employed for utility or comfort; while at the same time, it can be stored more compactly and in better shape than either wood or coal. It is understood that negotiations are in progress in New York, looking to the utilization, in the manner described, of the 40,000,000 tuns of valueless coal dust now lying in the vicinity of the coal mines and depots of Pennsylvania.

RECENT ORDNANCE TRIALS.

Some remarkable results have been obtained during recent trials of naval ordnance, carried on under the supervision of Mr. Norman Wiard, at Nut Island, in Boston Harbor. Mr. Wiard's improvement consists in rifling an ordinary smooth bore gun with two grooves, having for a 15 inch cannon a twist of one turn in 50 feet, and cut in the sides of the bore so as not to cross the bottom. The object of this arrangement is primarily to allow the gun to be used as if it were a smooth bore and with ordinary spherical projectiles, which, were the upper and lower surfaces of the interior rifled, would in balloting destroy the grooves and strain and weaken the piece, while the firing would besides be greatly impaired in accuracy.

The trials above referred to have, however, proved an unusual gain of penetrating force, due to this system of rifling. Two ordinary smooth bore guns, of 15 inch bore, were selected, one of which was grooved according to Mr. Wiard's plan and provided with conical projectiles. The other was left in its normal condition, and ordinary round shot employed. The extremely large charge of 140 pounds of powder was used, and the projectiles weighed 460 pounds each. Two targets, of wrought iron plates 15 inches in thickness, were erected side by side, 160 feet distant. The rifle was fired first, when its bolt went clear through the target, tearing off a huge fragment and throwing the same for considerable distance and then burying itself in a sand bank. The smooth bore shot entered the target for six and a half inches and there stuck.

The experiments were of course designed merely to determine penetrative power, and hence were made at very short range, but we understand that further experiments are to be inaugurated for the purpose of estimating the comparative distance and rapidity with which projectiles can be thrown from guns rifled after the Wiard pattern and smooth bores. It will be seen, however, that the results thus far obtained are better than those reached in the celebrated Tegel tests of the Krupp guns in Germany. Two of the cannon employed in that case were respectively of 11 and 10 inches bore. The range was 164 yards. The 11 inch gun with 88 pounds of powder drove a shell through a 12 inch plate backed by 26 inches of wood, but the 10 inch projectile did not penetrate. The English 11 inch gun, at 200 yards, with 88 pounds of powder, has sent shot through 13 inches of iron, 12 inches of wood and 1½ inches of skin, and *The Engineer* asserts that the shot of a 12 inch 35 tun piece, with 110 pounds of powder, at 330 feet, has entered, but not penetrated, 18½ inches of iron backed by 12 inches of teak. In the Glatton experiments, the 600 pound projectile of a 12 inch English gun, weighing 25 tuns, with 85 pounds of powder, at 200 yards, pierced 14 inches of iron and 6½ inches of oak. Our American 15 inch naval gun, it may be noted by way of comparison, is of about 23 tuns in weight. Until we obtain data based on range in connection with penetrative power, it will be hardly possible to draw more than a general parallel between the performances of our improved ordnance and that of foreign nations. We may here state that the official reports of the naval officers, witnessing the Nut Island tests, have created considerable interest in government circles, and it is believed that there is every probability of future experiments developing even more remarkable results. There is one all important fact, however, which places our gun, from a certain point of view, far ahead of its foreign competitors, and that is that it is made of simple cast iron; while the English and German pieces are either, in the former case of wrought iron elaborately built up or else steel, or in the latter instance, as is well known, of the cast steel from the celebrated Krupp foundery. It is unnecessary to point out the vast difference in the cost of such ordnance or the high superiority of American iron thus indicated.

The ordinary spherical projectiles now in use are to be improved by the insertion of three brass pins in holes equidistant from each other on the surface, and hence in the form of a regular triangle. The pins are cut to support the shot exactly in the middle of the bore, so that the windage will be equal all around and the shot receive its impulse directly from the center of the exploding charge. The advantage gained is the prevention of the lodgments or indentation on the lower side of the bore, produced by the escape of the gas through the windage, before the ball has moved from its seat. The elasticity or crowding up of the metal causes the projectile to rebound, and, on its being carried forward by the charge to strike the upper surface of the bore, and there be reflected and re-reflected before it emerges. Of course these last three indentations, termed enlargements, become gradually deeper, and, besides rendering the firing inaccurate, eventually cause the gun to become unserviceable.

We understand that the Wiard improvement does not require the manufacture of new guns but simply a modification of those already in use. All the projectiles, equipments, etc., ordinarily employed are as available as ever, and in brief the idea is, merely by rifling the pieces, to give them the capabilities of both rifles and smooth bores, while besides materially adding to their range, penetrative power, and general efficiency.

SCIENTIFIC AND PRACTICAL INFORMATION.

TESTING STEAM BOILERS.

It is generally believed that steam boilers become weakened (for resistance to internal pressure) after continued use, from various known and unknown causes, so that the engineer cannot judge of the pressure to which his boiler can be worked with safety. But this he may determine by a very simple process and means which are always at his command. It is as follows: Let the boiler be filled entirely full of cold water even to the throttle and safety valves, and all closed tight to prevent any escape. Now, by lighting a fire under the boiler, the water will gradually expand and produce a pressure sufficient to even rupture the iron before the temperature of the water has reached the boiling point. While the pressure is increasing, let the steam gage or pressure indicator be watched; and when the test pressure (which may be twice or more as great as the working pressure) is reached, a portion of the water may be allowed to escape and the pressure reduced. The pressure results from the fact that water is expanded by heat more than iron. The process above given is attended with as much safety as the use of the hydrostatic press, unless the water be heated above 212°, which would not be required unless the boiler leaks. Below this temperature, no disastrous consequences would follow, even if the boiler should be torn asunder.

A GOOD FERTILIZER.

Farmers generally have to pay a high price for an article which, with a little skill, they could make themselves during the winter months or on rainy days, when they have little else to do. We give a recipe for a cheap, good fertilizer, which has been used successfully by farmers in Pennsylvania and Ohio. One recommends it especially for potatoes and wheat, and ends by saying that he has used it with success on corn and other products. It is as follows: Take 1,000 lbs. of good mold, sieve and screen it to get the gravel out and make it as fine as possible, then spread on a floor or some suitable place; add 100 lbs. sulphate of ammonia, 100 lbs. common salt, then mix with a rake. When thoroughly mixed, add 25 lbs. pearlash and 25 lbs. sulphate of soda, mix well, then add 400 lbs. ground bone, 25 lbs. best Peruvian guano, and 150 lbs. ground plaster. Mix the whole thoroughly, throw on a pile for forty-eight hours, and it is fit for use. If it is to be used for potatoes in districts where potato bugs are numerous, 5 gallons sulphuric acid may be sprinkled over the mass. Care must be taken not to use the acid in a confined place, as the fumes are bad for the health. If it is spilled on the floor, do not throw water on it, as it generates great heat when in contact with water. Sulphuric acid sprinkled on the ground will kill bugs of any kind, and its fumes are especially fatal to the potato bug.

REDUCTION OF GALENA AND OTHER LEAD ORES.

When in contact with metallic zinc, galena is readily decomposed by acids. Even oxalic, acetic, and dilute sulphuric acids are capable, when hot, of decomposing galena, metallic lead being deposited and sulphuretted hydrogen gas set free; while with chlorhydric acid, the decomposition is peculiarly rapid and complete. Galena is easily decomposed, also, even in the cold, by dilute nitric acid in presence of zinc, but the reaction differs in this case from that just described, not metallic lead but free sulphur being deposited, while nitrate of lead goes into solution. The reaction with zinc and chlorhydric acid may be employed with advantage for assaying galena, particularly the common American variety, which contains no heavy metal besides lead. The details of the process are as follows: Weigh out 30 or 40 grains or more of the finely powdered galena. Place the powder in a tall beaker, together with a smooth lump of pure metallic zinc. Pour upon the mixture 6 or 8 cubic inches of dilute chlorhydric acid which has been previously warmed to 40° or 50° C.; cover the beaker with a watch glass or broad funnel, and put it in a moderately warm place. Chlorhydric acid, fit for the purpose, may be prepared by diluting 1 volume of the ordinary commercial acid with 4 volumes of water. For the quantity of galena above indicated, the lumps of zinc should be one inch in diameter by a quarter of an inch thick; they may be readily obtained by dropping melted zinc upon a smooth surface of wood or metal. The zinc and acid should be allowed to act upon the mineral for fifteen or twenty minutes in order to insure complete decomposition. Any particle of galena which may be thrown up against the cover or sides of the beaker should, of course, be washed back into the liquid. It is well, moreover, to stir the mixture from time to time with a glass rod.

When all the galena has been decomposed, as may be determined by the facts that the liquid has become clear and that no more sulphuretted hydrogen is evolved, decant the liquid from the beaker into a tolerably large filter of smooth paper, in which a small piece of metallic zinc has been placed. Wash the lead and zinc in the beaker as quickly as possible with hot water, by decantation, until the liquid from the filter ceases to give an acid reaction with litmus paper; then transfer the lead from the beaker to a weighed porcelain crucible. In order to remove any portion of lead which may adhere to the lump of zinc, the latter may be rubbed gently with a glass rod, and afterwards with the fingers, if need be. Wash out the filter into an evaporating dish, remove the zinc, and add the particles of lead thus collected to the crucible. Finally dry the lead, at a moderate heat, in a current of ordinary illuminating gas, and weigh.

A THERMOMETER MOTOR.

M. de Paz, at a recent session of the French Academy of Sciences, proposed an odd though original idea, which it is needless to remark is hardly susceptible of any useful application. He places around the circumference of a wheel, the axle of which is horizontal, a series of precisely similar thermometers. Then he exposes one half the wheel to the sun, and shades the other half. The result, he says, is that the mercury in the exposed instruments dilates and carries their centers of gravity further from the center of suspension, consequently the effect, he believes, is as if the thermometers on one side became heavier, and hence the wheel turns around.

THE INFLUENCE OF GASES AND OF CARBOLIC ACID ON THE CONSERVATION OF EGGS.

According to M. Calvert, if an egg be placed in dry oxygen, no alteration takes place; but if the gas be moist, at the end of three weeks or a month, the egg becomes covered with white filaments, some 3 inches each in length. Its interior, however, shows no signs of decomposition. If, however, at the end of the egg a small needle hole be made, putrescence takes place in dry oxygen, attended with the disengagement of nitrogen and carbonic acid, and also the formation of great quantities of vibrions and microzymas. In damp nitrogen, eggs, whether pierced or not, may be kept perfectly for three months: and although a light deposit of *penicillium* appears on the exterior, the contents do not decompose. In hydrogen, the same effect is noticed. In carbonic acid, the conservation is perfect as above, but without a trace of *penicillium*, whether the gas be moist or dry. Similar results to the latter are obtained with ordinary illuminating gases.

New laid eggs were also plunged in weak solutions (1-500) of chlorine, of hypochlorite of lime, of sulphite of lime, and of carbolic acid; but the author gives no results except as relating to the latter substance, in the liquor containing which, the eggs kept perfectly for three months.

WET PLATING FOR BRASS, IRON, ZINC, ETC.

C. Paul says: Brass, copper, and German silver are tinned by boiling with granulated tin and cream of tartar. Iron must first be cleaned by a mixture of 1 part of sulphuric or nitric acid with 10 parts of water, and then coppered by adding a solution of some copper salt, moistening with a solution of 1 part of protochloride of tin in 2 parts of water and 2 parts muriatic acid, and subsequent immersion in a solution of ammonium copper sulphate. Brass, copper, and German silver, and iron or zinc, which have been coated with copper, can be silvered by rubbing with the following mixture; 14 grains of silver are dissolved in 26 grains of nitric acid and 120 grains of potassium cyanide in 4 cubic inches of water; the solutions are mixed and 24 grains of whiting added.

PROFESSOR JOSEPH HENRY, Secretary of the Smithsonian Institution, has received from the French Government a superb porcelain vase, as a testimonial of his services as the United States representative of the commission on the international standard meter.

THE first patent issued in the United States, of which there is any record, was granted to Samuel Hopkins, on July 31, 1790, for making pot and pearl ashes. The second was to James Stacey Sampson, on August 6, 1790, for making candles; and the third and last for the year 1790 was to Oliver Evans, for making flour and meal. The latter bears date December 18, 1790.