Mr. Gennaro Rossi, of New York, has patented a paint composition for woodwork, walls, and the bottoms of vessels, to produce a waterproof surface, and on vessels to prevent the adherence of barnacles and grass.

Mr. William L. Gerard, of Junction City, Kan, has patented an improved tether, which permits of keeping the animals within a limited space without requiring a long rope or strap or strong and insurmountable fences. The invention consists in an anchor or like device attached to the halter strap of the animal, so that if the animal steps over the low fence surrounding its pasture the anchor catches on the top wire of the fence, thus holding the animal.

An improved holder for tape, braid, etc., has been patented by Mr. Edward P. Haff, of New York city. It is formed of a U-shaped spring clamp, with a double slitted cross piece and roughened or serrated shanks adapted to clasp the sides of the material.

Messrs. Jules and Charles Schmerber, of Paterson, N. J., and Jules A. Arrault, of New York city, have patented a machine for grinding and mixing plastic compositions or substances, such as pyroxyline compounds or others of which the solvents or part of the ingredients, being volatile, require working in closed apparatus to prevent loss of the volatile portions The inventors make use of a hollow cylinder for receiving the plastic material, formed with a steam jacket and fitted with a piston that is to be reciprocated by suitable power, and the cylinder is connected by passages at its opposite ends with the grinding machine, so that by the movement of the piston the material is forced back and forth, through the grinder until the operation of mixing and grinding is completed.

Messrs. William Cornwall, Sr., William Cornwall, Jr., and Aaron Cornwall, of Louisville, Ky., have recently patented an improved machine for mixing materials suitable for making soap, also for mixing other plastic or pulverulent materials for other purposes. The improvement consists in the construction and arrangement of the rotating arms employed for creating currents, which move in opposite directions, but in different parts of the materials placed in the mixing vessel or receptacle.

Mr. Hollis C. Trout, of Minneapolis, Minn., has patented a receptacle for mail matter, so arranged that its interior can be quickly and easily inspected without opening the cover. The sides of the box are formed of wire gauze or of glass, or glass protected by an exterior covering of wire gauze or any material that will permit a quick inspection of the box through the sides. The box is intended principally for the use of residences and stores as a receptacle for newspapers, but it may also be used as a receptacle for other mail matter.

## YELLOW AND RED PHOSPHORUS IN THE MANUFACTURE OF MATCHES.

BY DR. E. EICHLER.

Phosphorus is an element, that is to say, a simple chemical substance. The ease with which it ignites and the fact of its shining in the dark (to which it owes its name, from the Greek words signifying "light bearer"), have made it at all times an object of general interest. Uncombined phosphorus does not occur in nature, its chemical properties rendering it impossible for it to remain in a free state during the formation of the solid crust of the earth. Its occurrence is limited to compounds of its acid, "phosphoric acid," with alkalies, especially with lime. Apatite, which occurs in the oldest formations, is chiefly composed of phosphate of lime; then, too, there is wavellite, a hydrous phosphate of alumina, and pyromorphite or phosphate of lead.

In 1669, Brand, of Hamburg, accidentally discovered phosphorus while experimenting with urine, and Kunkel first described a method for its preparation from the same material. Until the middle of the last century urine was the only source of making phosphorus; hence it could be prepared only in small quantities, which made it very expensive. In 1737 Hellot obtained from 3 oxhoft (about 700 liters) only 1 ounce of phosphorus, which was then worth 10 ducats in England and 16 in Amsterdam.

In the second half of the last century Scheele discovered that bones consist for the greatest part of phosphate of lime, and thus opened an abundant source for phosphorus, which is still in use to-day. In recent times, too, important beds of phosphate of lime have been discovered.

Since phosphorus has found much technical use it is prepared on a large scale in chemical works. In its manufacture either bone-ash or the natural phosphate of lime from the mineral kingdom is employed. Its preparation depends on the reduction of phosphoric acid by means of coal at a white heat. The neutral phosphates furnished by nature cannot be directly employed, since only the acid phosphates are reducible by carbon. To obtain such a reducible acid phosphate the ordinary phosphate is covered with dilute sulphuric acid and warmed. The sulphuric acid deprives the phosphoric acid of two-thirds of its lime, forming with it an almost insoluble sulphate of lime (gypsum), while the acid phosphate formed goes into solution and can be separated from the gypsum by decanting and pressing. The solution is concentrated in leaden vessels, and then mixed with pulverized wood charcoal and heated in clay retorts, at first gently, then to a strong red heat. These retorts are connected with earthen receivers containing water, in which the gaseous phosphorus is condensed and collected under water. The crude product thus obtained is still very impure, and is purified by repeated distillation in iron retorts. Phosphorus generally comes into market in sticks formed by sucking the phosphorus, which has been melted under warm water, into conical glass tubes, which are then closed at both ends and dipped into a cylinder of cold water. The phosphorus soon solidifies and can be pushed out of the tubes.

Phosphorus as it comes into commerce in sticks (the yellow white, or common form) is colorless, or yellowish, and translucent; at ordinary temperature it can be cut with a knife, and exhibits a waxy luster on the cut surface. It is insoluble in water and alcohol; ether, ethereal, and fatty oils take it up in small quantity. The best solvent for it is sulphide of carbon; chloride of sulphur and sulphide of phosphorus dissolve it readily. It melts at 44° C. (111° Fah.), expanding considerably, and then refracts the light strongly. It boils at 290° C. (554° Fah). When heated in the air but little above its melting point it burns with a very luminous flame to phosphoric acid (anhydride). Exposed to the air at lower temperatures its also oxidizes and burns without flame to phosphorous acid, which forms a luminous vapor in the dark, and the phosphorus gives out an alliaceous odor; hence it must always be kept under water.

We have already said that phosphorus is luminous in the dark, hence its name. All the last mentioned properties are due to its great affinity for oxygen.

Phosphorus belongs to the most violent poisons, even very small quantities proving fatal. Burns on the skin may result fatally if the wound is not well washed out and caused to bleed freely. Employment in phosphorus factories is highly detrimental to the health of workmen, but especially for those that have bad teeth. The phosphorus necrosis caused by its vapor produces a destruction of the jaw bone.

If yellow phosphorus is exposed to the action of light, especially direct sunlight, under all circumstances and in all media, it gradually turns red. This red substance is not a compound of phosphorus; it is nothing but pure phosphorus, the so-called *red phosphorus*, *i. e.*, an allotropic modification of phosphorus. By allotropy we understand an unexplained property that certain elements possess of assuming different conditions with totally unlike properties.

Schroetter first made the observation that *heat* effects the same change of common phosphorus into the red that light does. When the former, or yellow, is heated for a long time in an atmosphere of carbonic acid to 240° or 250° C. it is gradually converted into the latter, or red. This conversion takes place far more rapidly by heating common phosphorus to 300° C. in closed iron vessels; no increase or decrease of weight takes place. The substance thus obtained has the following properties:

Red phosphorus does not change in the air, hence it is non-luminous; it is *insoluble* in sulphide of carbon; if perfectly free from common phosphorus it is not poisonous. In its tendency to chemical union it is far behind the other kind; rubbed with oxidizing substances it takes fire only at high temperature; except with chlorate of potash it explodes easily and with violence. Heated in carbonic acid at ordinary pressure to 261° C., it is reconverted into ordinary phosphorus; near this temperature it ignites by access of air.

Red phosphorus is now made in large quantities by continued heating of the yellow phosphorus. To obtain it perfectly pure the unconverted yellow phosphorus is dissolved out with sulphide of carbon, which leaves the red form uneffected.

Both modifications find their chief use in match making. The yellow is used in common matches, the red in so-called Swedish (or safety) matches.

In the former case the phosphorus is on the head of the match, which ignites by rubbing it on any rough surface, the slight heat thus generated being sufficient to ignite the phosphorus. As conveyance to carry the flame to the wood they generally use sulphur, which is applied to the wood beneath the phosphorus.

In the second case the match heads contain no phosphorus, but substances that readily yield oxygen and favor combustion (chlorate and chromate of potash with sulphide of antimony). These matches do not ignite on every surface, but only on such as are covered with red phosphorus.

Against ordinary matches the very justifiable charge can be made that they are very hazardous as regards fire, and that the mass is highly poisonous. Even the health of operatives employed in their manufacture is injured; the strictest precaution of excluding all workmen with defective teeth is but little use; in all match factories there are frequent cases of phosphorus necrosis, often attended with fatal results. Besides, how many children have been poisoned by phosphorus matches? Then there are cases where pieces of burning phosphorus fly from a match head and cause dangerous or fatal burns.

To show the amount of damage done in the last ten years by the careless use of phosphorus matches we give the estimate made by the *Chemiker Zeitung*, that in the years 1862 to 1871 inclusive, in Germany alone, the damages paid by public insurance companies for injury done to buildings through carelessness with matches amounted to $2,120,000. Add to this damages to furniture and to uninsured buildings the probable sum of $2,250,000, we have for the grand total of damage from careless use of phosphorus matches in ten years $4,370,000.

None of these evils and dangers accompany the use of so-called Swedish matches (invented by Prof. Boettger in 1848), since they are not poisonous and only ignite on prepared surfaces. (They ignite when rubbed on smooth porcelain or glazed paper.—*Trans.*) Although the use of these is already very large (in Germany), they are still very far from having totally displaced the old sulphur match. That the latter are somewhat cheaper causes many people to use them and many factories make them. It can be suppressed only by law. On December 23, 1879, Switzerland passed a law forbidding the introduction and sale of matches and tapers on which the common yellow phosphorus is used. In spite of all the agitation against this law it has been strictly enforced. Germany, too, is taking action in the matter, and the German Parliament of June 27 of this year proposed to check the use of yellow phosphorus by increasing the tax thereon.—*Badische Gewerbezeit.*

[The American parlor match is as little known in Germany as the Swedish match is here. The parlor match possesses so many advantages of being convenient and certain that our people seem willing to incur the extra danger rather than inconvenience themselves by the use of a match that will ignite only on the box, involving the inconvenience for smokers of always carrying the prepared surface in the pocket. One of the chief objections to parlor matches is the ease with which the heads fly off, carrying a spark perhaps to some dark corner, where it smoulders for hours, or lies innocently on the pavement until exploded by the foot of the unsuspecting pedestrian, who, if a lady, is in danger of having her skirts set on fire thereby.—ED.]

### Hydraulic Pumping on the Comstock.

News from the Comstock announces that the Requa shaft is to be supplied with hydraulic pumping apparatus, a fact which marks just as great a change in the engineering of the famous lode as any which has preceded it.

The present system of pumping is by direct-acting compound engines, using steam at 100 to 110 pounds, and a vacuum of 26 or 27 inches. The Davey differential valve gear is used with the poppet valves introduced by Mr. Patton, the able designer of all the new Comstock machinery, and superintendent of the northern group of mines. Steam cylinders of 32 and 64 inches diameter, and pump cylinders of 13, 14, and 15 inches diameter and 7 to 10 foot stroke, complete this splendid system of drainage. One of the series of pumps—in fact, the one which is now doing duty in the Requa shaft—has a double line of pump cylinders, 14 inches by 10 feet.

It is a sign of the remarkable difficulties which are presented in mining at the depth of 3,000 feet, that the immense powers of this pump should have proved unequal to the task of draining the mine, and tanks have lately been running that raised the water to the surface, while the pump lifted it only from the 2,400 level to the Sutro tunnel, 800 feet above. Together, the two modes of drainage are reported to have raised 2,000,000 gallons, or 8,000 tons, of water daily, a quantity which is probably exaggerated. Even with this extraction of water, the work of the mine has been seriously impeded by the fear of flooding. It is true that the Requa shaft is now handling that remarkably persistent "water bonanza" that flooded the Savage so long.

At these great depths it has been found extremely troublesome to maintain the ponderous spear rods which the old system of pumping required. They are made of Oregon pine, in sections 80 feet long, and usually 14 x 14 inches in section; but with all their strength, they have broken repeatedly in the Comstock mines. Especially when the water is most abundant, and in those up-cast mines where labor is most severe in the shaft, are the breaks likely to occur.

Hydraulic pumping has been proposed for years as a remedy for these difficulties, and we are glad to see that the step of introducing it is to be taken at last. The details of the scheme have not reached us; but it is reported that the new pumps will be much more powerful than the old. In any event, it is probable that it will be more effective in the peculiar circumstances of the Comstock than the present system. The new apparatus will be ready, it is said, before the end of the year.—*Eng. and Min. Journal.*

### Iron Tops not a Protection for Oil Tanks.

*To the Editor of the Scientific American:*

In your paper of July 17, is an article written by D. B. Mason, of Pittsburg, Pa., in which he states the remedy for protecting oil tanks from being struck by lightning has long since been solved—the use of iron tops instead of wood—and adds there has never been a tank of oil with iron top burned by lightning. This was believed to be true until this season. Mr. M. is sadly mistaken. There were three oil tanks in this vicinity (all iron tops) struck by lightning and burned, as well as others in other sections of the oil regions. We would be only too glad to learn of some method other than the old theory by which we could protect our property from lightning, as that has been demonstrated beyond a doubt to be a failure. We want information on the subject.

J. C. M.

Bradford, Pa., August 5, 1880.

Mr. Daniel C. Beard tells us of a remarkable feat in gastronomy performed by the huge batrachian whose portrait we presented to our readers some time since. Then his tidbit was a common mouse, but now his epicurean taste is to be satisfied only with alligators, not of the largest size to be sure, but alligators nevertheless. Mr. Beard placed an alligator 11¼ inches long in the aquarium occupied by the bull frog. After a brief battle—the bull frog being the victor—the process of swallowing the vanquished began, and in due course the alligator passed from view.