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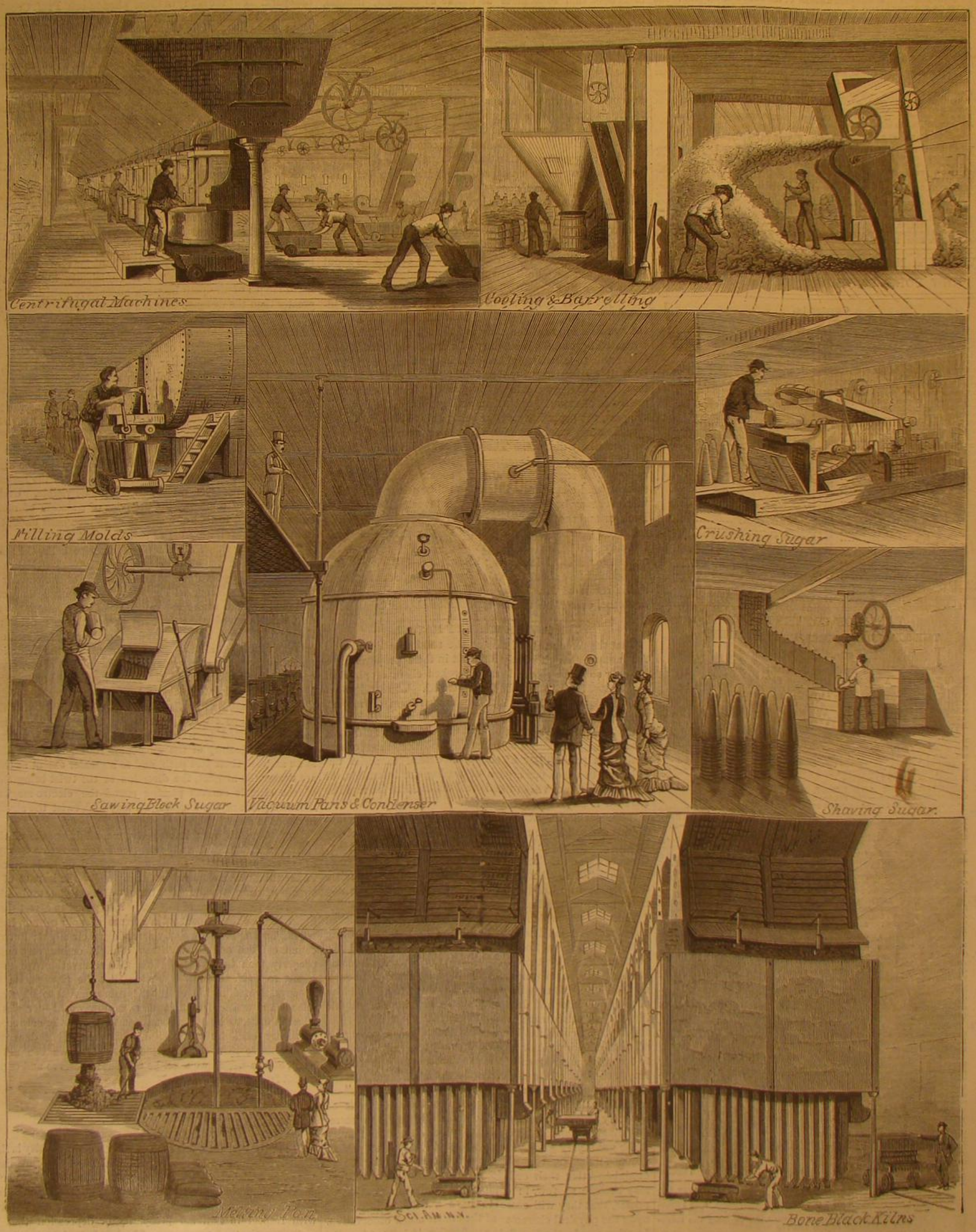

HAVEMEYERS & ELDER'S SUGAR REFINERY.—(See page 48.)

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(Illustrated articles are marked with an asterisk.)

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THE SCIENTIFIC AMERICAN SUPPLEMENT
No. 160,
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THE TRANSMUTATION OF ELEMENTS.

Not a little nonsense has been written with regard to Mr. Lockyer's recent assertions concerning the probable composite nature of several, possibly all, of the substances hitherto accounted elementary, and the probability that all the elements so called are but varying phases of some fundamental matter-stuff.

It has been commonly assumed that if these assertions should be verified, the dreams of the alchemists would come true, and chemists would be able to change one form of matter into another, as lead into gold or silver. This assumption is altogether gratuitous. In his studies of the spectra of different substances under varying conditions of heat and pressure, Mr. Lockyer has indeed come to doubt the integrity of the elements as commonly understood; and to believe that substances as unlike as calcium, lithium, iron, and hydrogen, may be not only not fundamentally distinct, but that they may be merely different aspects of some basic matter-stuff, of which hydrogen is the simplest form at command. As yet, however, the evidence he has offered is far from convincing; and able chemists who listened to his paper before the Royal Society, among them Professors Roscoe, Williamson, Frankland, and Gladstone, are of the opinion that he has merely demonstrated the presence of impurities in elements supposed to be perfectly pure.

But supposing these gentlemen to be wrong, and Mr. Lockyer right; supposing it true that all matter is fundamentally one—would we be any nearer to the practical realization of the alchemist's dream?

If matter be at bottom only hydrogen or some still simpler substance, the existence of strongly marked phases of matter, like oxygen, iron, gold, and so on, can be explained only by supposing them to be the result of a process of natural selection operating through past ages, under conditions about which we can have but the vaguest knowledge.

We know that life in all its phases is fundamentally the same, yet those phases are in the main, so far as we are concerned, unchangeable, certainly not transmutable. Even if the common origin of the horse and the zebra should be demonstrated beyond the possibility of a doubt, we should be no better able to transmute zebras into horses than we are now. So if it be demonstrably true that two phases of one matter-stuff, like silver and lead, have resulted from the cosmical processes of material evolution, acting through the cycles of the past, the probability of our being able to change the one into the other would be scarcely greater than if they were fundamentally distinct. The chemical behavior of the different sorts of matter is quite independent of any theoretical notions with regard to the ultimate constitution of such substances; and chemistry will remain substantially what it is, whatever may be the outcome of the investigations of Mr. Lockyer and those engaged in similar work. By this we do not mean that the prevailing theories and practices of chemists may not be materially changed—such changes are the necessary result of increasing knowledge—but simply that the popular talk about the radical overturning of the science, as the result of Mr. Lockyer's alleged discoveries, is sheer nonsense, even if his utmost expectation should be realized.

THE FOURTH STATE OF MATTER.

That the three states of matter, the solid, the liquid, and the gaseous, though widely different in their properties, are yet only so many stages in an unbroken chain of physical continuity, has been amply demonstrated. The solid passes into the liquid, the liquid into the gaseous form of matter, by insensible gradations; and there is nothing any more improbable in the supposition that these three states do not exhaust the possibilities of material condition, than in supposing the possibilities of sound to extend to aerial undulations to which our organs of hearing are insensible, or the possibilities of vision to ethereal undulations too rapid or too slow to affect our eyes as light.

Indeed, while Pictet and others have been converting into liquids and solids the most tenuous of gases, by successively shortening the range of their molecular movements, Prof. Crookes has, on the other hand, succeeded in refining gases to a condition so ethereal as to reach a state of matter fairly describable as ultra-gaseous, and exhibiting an entirely novel set of properties.

The means by which this remarkable result was achieved were exhibited and described by Prof. Crookes at a meeting of the British Royal Society early last December; and the processes by which the discovery was made were discussed at length in a paper unfortunately too long even to be summarized here. It may be possible, however, to give an idea of their character and drift without the aid either of graphic illustrations or abstrusely scientific terms.

Our readers need not be told that the physical properties of gases are due to their molecular condition; in other words, to the swing and impact of their molecules, and the average length of flight of the molecules between collisions. As the number of molecules in a given space is reduced by mechanical exhaustion, the frequency of molecules collision is of necessity reduced, and the mean molecular flight is correspondingly extended. Now it is obvious that if the tenuity of the gas is very greatly increased, as in the most perfect vacua attainable, the number of molecules may be so diminished that their collisions under favorable conditions may become so few, in comparison with the number of misses, that they will cease to have a determining effect upon the physical character of the matter under observation. In other words, the free flying molecules, if left to obey the laws of kinetic force without mutual interference, will cease to exhibit the properties characteristic of the gaseous state, and take on an entirely new set of properties. That this is a matter of fact, and not of theoretic speculation, is demonstrated by the researches of Prof. Crookes.

In his previous studies of molecular activity in connection with the radiometer, the molecules were set in motion by means of radiations producing heating effects. In the present series of experiments the molecular motion was determined or increased by the induced current from an induction coil. The investigation began by a study of the dark space which surrounds the negative pole when an induction spark is passed through rarefied gas. The width of this dark space was found to vary with the degree of exhaustion of the tube; with the kind of gas employed; with the temperature of the negative pole; and in a slight degree with the intensity of the spark. For the study of these phenomena Prof. Crookes devised a very ingenious instrument, which he calls an electrical radiometer, and a variety of other apparatus, of wonderful delicacy and power, by means of which he was able to illuminate lines of molecular pressure; to converge streams of molecules upon a focus, with the evolution of light and heat and mechanical action; to deflect streams of molecules by means of magnets; to study the laws of magnetic deflection; to observe molecular shadows, so called, and other novel and extremely interesting phenomena.

The nature of the dark space around the negative pole Prof. Crookes interprets as follows: The thickness of the dark space is the measure of the mean length of the path between successive collisions of the molecules. The extra velocity with which the molecules rebound from the excited pole keeps back the more slowly-moving molecules which are advancing toward the pole. The fight occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the collisions of the molecules. When the exhaustion is sufficiently high for the mean length of the path between successive collisions to be greater than the distance between the electrode and the glass, the swiftly-rebounding molecules spend their force, in part or in whole, on the sides of the vessel, and the production of light is the consequence of this sudden arrest of velocity. When streams of molecular discharge are focused upon a strip of platinum wire or foil, the metal becomes not only luminous but highly heated by the severity of the bombardment; so, too, the molecular impact upon the side of the inclosing glass may be sufficient to make the spot too hot to be borne by the finger.

The limits of our space forbid any attempt to describe at length the phenomena of magnetic deflection or the ingenious apparatus by means of which the action of the magnet upon the trajectory of molecules was made visible. Under the influence of a magnet the behavior of a stream of molecules is likened to that of a stream of cannon balls under the influence of gravitation. In Prof. Crookes' words:

"Comparing the free molecules to cannon balls, the magnetic pull to the earth's gravitation, and the electrical excitation of the negative pole to the explosion of the powder in the gun, the trajectory will be flat when no gravitation acts, and curved when under the influence of gravitation. It is, also, much curved when the balls pass through a dense resisting medium; it is less curved when the resisting medium gets rarer; and, as already shown, intensifying the induction spark, equivalent to increasing the charge of powder, gives greater initial velocity, and, therefore, flattens the trajectory. The parallelism is still closer when we compare the evolution of light seen when the shot strikes the target with the phosphorescence on the glass screen from molecular impacts." Applied to a stream of molecules the magnet twists the trajectory of the molecules round in a direction at an angle to their free path, and to a greater extent as they are nearer the magnet, the direction of the twist being that of the electric current passing round the electro-magnet. The two poles of the magnet, we may add, twist the stream in opposite directions.

Prof. Crookes, very improperly, we think, speaks of the stream of molecules thus brought under observation as rays of molecular light. True, light is evolved by their impact under suitable conditions; so it may be by the impact of a stream of cannon balls. The impact of the flying molecules raises the temperature of any body interposed to arrest their flight, just as the impact of a stream of cold cannon balls would heat a resisting body arresting their flight; but we cannot call the one stream a ray of light or heat any more properly than the other. With this reservation, we may assent to Prof. Crookes' assertion that the phenomena he has investigated in his exhausted tubes reveal to physical science a new field for exploration, a new world—"a world wherein matter exists in a fourth state, where the corpuscular theory of light holds good, and where light does not always move in a straight line, but where we can never enter, and in which we must be content to observe and experiment from without."

AMERICAN INDUSTRIES.—No. 3.

BY HAMILTON S. WICKS.

REFINING SUGAR.

One of the best thermometers of a nation's prosperity is the sugar it consumes. In epochs of great financial depression and commercial stagnation the consumption is small as compared with periods of general prosperity. Indeed the proportionate consumption of sugar is so accurately distributed with respect to national prosperity or depression that it really constitutes a true gauge of both. It is also a good test of civilization and cultured taste—the more civilized

nations consuming the most, and the consumption decreasing in regular ratio through the less cultured and semi-civilized nations to the barbaric. This ratio of consumption is explained on the principle that a luxury follows the means to procure it, and that with increased means there ensues an increased use. Sugar, although classed as a luxury when compared with breadstuffs, meats, and vegetables, has yet become essential to modern civilization through the multiplex uses it has been put to. The sugar industry ranks about seventh among American industries. Following close in importance on such leading national industries as flour and grist milling, lumber, the manufacture of boots and shoes, clothing, cotton and woolen goods, and forged and rolled iron, as determined by the amount and value of their products, it stands next to tobacco and spirits as a special governmental resource, paying into the national treasury, in conjunction with molasses and melada, fully one sixth the total annual revenue levied as import duties.

In the United States the sugar business is both an agricultural pursuit and a manufacturing industry. Louisiana is the largest grower of sugar cane among any of the Southern States, though Texas and Florida swell the aggregate annual yield considerably. These three States during the year 1861 produced more than 191,000 tons of sugar. The pursuit of cane-growing was abandoned during the war of the Rebellion, but after its close was taken up with renewed energy, Louisiana alone producing from 1869 to 1873, 61,863 tons. The principal foreign supply of sugar is derived from Cuba. In fact, the importation from all other foreign countries together amounts to less than half of that imported from the Great Antilles. None of our other imports, excepting bullion, can approach sugar in value or quantity. In the year 1877 the quantity aggregated over a billion and a half of pounds, and had all of it been carried in American bottoms it would have greatly assisted our shipping interests. The large bulk of this trade should be commanded by American ships, because Cuba, Brazil, and Porto Rico, countries which grow nearly two thirds of the world's sugar production, are eager for improved commercial relations with the United States.

The quality of all sugar is determined by the amount of saccharine it contains. The yield of saccharine from sugar cane is much superior to the yield from any other fruit or vegetable. The amount obtained from sugar beets is next to that obtained from the cane, and hardly distinguishable from it when refined. Besides these two sources sugar is derived from dates, sorghum, maple trees, and corn. The latter is called grape sugar or glucose, of which the public has lately heard so much in connection with adulteration. It is produced by the chemical change of the starch in the Indian corn, through the action of sulphuric acid. It contains less saccharine, and is much cheaper than other sugars. There are three varieties of sugar known to commerce and readily determined by experts; *i. e.*, the Muscovado, the clayed, and the centrifugal. The first two are made according to old methods, the last is the modern improvement.

It is the purpose of this article chiefly to consider sugar as a manufacturing industry. Coming as it does in a very crude state from the plantations, intermixed with dirt, sand, bits of cane, fungus, and animalcula infinitely more repulsive than those of our midsummer croton, it has to undergo a thorough refining to throw off all these impurities and yield an article fit for commercial and domestic use. This industry utilizes the services of an army of 15,000 men; profitably employs $25,000,000 capital; and dispenses in wages $9,000,000 annually.

To illustrate the methods of sugar refining the establishment of Havemeyers & Elder, in Williamsburg, L. I., has been selected. It is not only the largest, but has the most approved methods of any refinery in operation, although most of the machinery is the same as that adopted by the largest refineries the world over.

The illustrations on the first page, if carefully studied, will impart to the reader as general a knowledge of these methods as though he himself were shown through the mammoth works by the superintendent, as the writer of this article was. It is not intended to portray every little detail of mechanism; that would require a volume. Only the most important machinery is given, such as is essential to the different processes of refining, and illustrating the important steps in these processes.

Such a refinery as Havemeyers & Elder is a world of activity in itself. Each of the many departments has its separate force of laborers, with well defined duties, working toward a common result. One becomes bewildered in the intricacies of their vast buildings. The investigator is taken two stories underground, and eight above. He walks under the street, and traverses in the departments above, 16 acres of flooring. The machines and apparatus illustrated are distributed in various parts of the refinery. Most of these are duplicated many times, and all of them only indicate the magnitude of the rooms in which they are operated.

This refinery, in common with all others, takes the "raw sugar," in all its varieties, and first of all, dissolves this crude article in large mixing vats, one of which is shown in the illustration, entitled "Melting Pan." These vats each hold 2,500 gallons. About 46 parts of water is added at a temperature of 110°, and the small engine, also seen in the illustration, performs the mixing. The raw sugar is pumped up eight stories into the heating tanks, where it is partly clarified by the introduction of an albumen, and 210° Fah. is applied to it by steam pipes running through the bottom of the tanks. If from any cause the sugar is sour, this is corrected by the use of lime water. The heated liquor is run from the tanks, and received into filter bags, arranged underneath, which strain out all dirt, sticks, and coarse impurities. The strained liquor is then run into the boneblack filter, where it comes in contact with the boneblack, and is entirely decolorized. The illustration entitled "Bone-Black Kiln" shows the vastness of the retorts necessary to reburn the large quantities of boneblack used. At this point the processes diverge for the production of Soft and Hard sugars. In the former the decolorized sugar is taken to the Vacuum Pan, shown in the center of the illustration, and is cold-boiled to a grain from 2 to 6 hours, according to the quality. Valves on the bottom of the Vacuum Pan discharge the grained liquor into large receptacles over the centrifugal machines.

These machines are among the most wonderful modern inventions for expediting the manufacture of Soft sugar. The illustration gives a good idea of them. They consist of a strong steel basket, holding 230 pounds, inside of which is a sieve, and a plate, as finely perforated as one of Edison's phonograph foils. The sieve is between the basket and the plate, to protect the latter. The whole is protected by a solid wrought iron Curb, within which the basket revolves with its contents at the rate of 1,000 revolutions per minute, and the centrifugal action forces the sirup through the perforations, which are too small for the passage of the sugar grain, into the Curb. Havemeyers & Elder have 32 of these machines in operation. The sugar after undergoing this process is emptied into wagons underneath the centrifugal machine, and dumped into bucket elevators, which run up over a powerful fan, that throws the sugar against a partition near by, and cools and mixes it at the same time, after which the sugar is ready for barreling. The cooling and barreling will be seen in the illustration.

The processes for manufacturing Hard sugar are the same up to the time the raw liquor goes into the Vacuum Pans. It is boiled in a slightly different manner. After running into a receiver from the Vacuum Pans the mass is filled into conical iron moulds, 4 feet in height and 12 inches in diameter across mouth. Each has a hole in the bottom like a flower-pot. The moulds are allowed to stand in the filling room downstairs for 12 hours, with the holes plugged up, so as to allow the sugar to cool a little, and "set." They are then hoisted up into the drying rooms, and the plugs are taken out of the bottoms. They are placed on "bedsteads" and drain. After all the sirup runs off that will, the top of the moulds are brushed smooth, and a saturated solution of white sugar and water is poured on top and percolates through the Titlers (as the contents of the moulds are called), carrying off the remaining sirup. The discolored tips are now cut off, and they are placed into large ovens, heated by steam to 110°, where they remain one week, coming out ready for the crushing, pulverizing, and sawing processes. In the former the Titlers are crushed into irregular shape; in the second, it is finely pulverized; in the saw mill the titlers, which are like columns of granite, are sawed through horizontally into wheels, laterally into strips, and then are chipped into cubes. Illustrations of these processes are shown, and sufficiently indicate the manner in which the titlers are worked up for the market.

Soft sugar, by the use of the centrifugal machine, is refined in twenty-four hours, while hard sugar requires a fortnight.

The establishment of Havemeyers & Elder has an existence of half a century. It employs 1,000 hands, and turns out a million and a quarter pounds of sugar daily. The accusation of adulteration made by certain parties against several of our largest refiners of sugar has, according to Mr. Wells' recent report on the subject, no foundation in fact. Careful tests have been made by the highest chemical authorities, which seem to verify his statement. Furthermore, the establishment described in this article invites the most thorough investigation by any competent authority.

THE BILL TO DISCOURAGE INVENTIONS.

It is doubtful whether any section of the proposed amendment of the patent law (Senate bill 300) was so generally approved by those who appeared before the Congressional Committee on Patents last winter, as section 11; a marvelous illustration, it seems to us, of the proneness of men to clutch at the nearest remedy for a present evil, without stopping to think whether the remedy may not in the end be worse than the disease.

Our readers will remember that this section introduces the principle of cumulative fees, a radical innovation in the working of the American patent system. As we have shown in previous issues of the SCIENTIFIC AMERICAN, the principle is entirely at variance with the spirit of the patent law as it has been interpreted hitherto, and one calculated to work no little harm to inventors and purchasers of patents.

A careful examination of the reasons offered, in Congress and in the Committee room, for making this change, proves them to be in reality but varying statements of one complaint, which was succinctly expressed by Mr. Christy in these words:

"After a patent has got established and become successful, it is a common thing to hunt up similar prior issues, purchase the patents, and, under the facilities afforded by law as reissues, obtain a reissue patent covering what somebody else has invented, and then sue the real inventor. This (section 11) will wipe out at least 75 per cent of that class, and then we will have a great deal less trouble from that law."

The class of patents which Mr. Christy had been speaking of were those which Mr. Raymond had described as "trivial, impractical, and invalid patents," and "those which become of value late in their existence, and then only for the purpose of infringement suits and speculations."

The advantage to be derived from officially killing "trivial, impracticable, and invalid patents," is not very apparent. Such patents must, by their very nature, be dead to begin with, so far as their possible influence is concerned. No inventor of anything that is not trivial, impractical, or invalid, is likely to be worried about them or by them. There remain a small number of patents which become, rightly or wrongly, the occasion of infringement suits and other forms of litigation, the majority of which are reissues of the sort described by Mr. Christy. These are indeed the occasion of much trouble, the desire to get rid of which furnishes the only excuse for the proposed alteration of the law.

How large is the number of such mischief-making patents?

From the noise made in certain quarters one might suppose that a patent was little else than a summons to appear in court to begin or defend an infringement suit. In reality there is no species of property about which there is proportionally so little litigation.

It was shown in the Committee room, by an advocate of section 11, Mr. Chauncy Smith, that 60 per cent of the patent litigation of the country arises upon reissued patents, while the number of patents reissued is not over 4 per cent of the whole number of patents. How enormous, then, is the proportion of patents about which there is no litigation!

There is an old and pertinent story about the killing of a fly with a sledge hammer. The fly was an annoyance, truly; the sledge hammer most effectually smashed the fly. But the avenger had no further use for his nose. Improperly reissued patents, misused for speculative purposes, are flies on the face of the patent system. Section 11 is a sledge hammer, which may hit them. Is it a fit means for accomplishing the desired end?

Mr. Christy and others say that the section will enable us to get rid of 75 per cent of the obnoxious reissues; in other words, three of the four patents in the hundred, which occasion three fifths of the patent litigation. Mr. Raymond says that a similar provision in the English patent laws annuls 75 per cent of all the patents issued. That would be a terrible blow for so small a fly!

An amendment preventing the reissue of patents "covering what somebody else has invented," in other words, more than the original patent included, would seem to be a more suitable as well as more effective remedy.

It is claimed for the proposed amendment that, at its best, or worst, it will do away with not more than three fourths of the vicious reissues; this, at the cost of, let us say, one half of all the patents issued, as the proposed section is not quite so severe in its operation as the corresponding provision of the English law.

Consider the probable effect of annulling, in their early years, one half the patents issued in this country. The majority of inventors are poor men. The majority of those who make important and valuable inventions are poor men. The majority of important and valuable inventions require more than four years, or eight years, wherein to become firmly established and commercially successful. The proposed amendment would therefore discriminate against valuable inventions quite as surely as against the trivial. The nose would be hit severely, though the fly escaped.

Consider the injustice of imposing upon all inventors heavy penalties in the form of fees, which are uncalled for in all cases, and which, in many cases, must be equivalent to the practical confiscation of the inventor's rights, simply because he happens to be poor as well as meritorious. How often it happens that an inventor dies before his invention is financially developed! Shall the United States rob his family of their only inheritance because they are not able to work it up at once, or redeem it by the payment of special taxes?

Consider the impolicy of adding to the discouragements of inventors (toiling, it may be, under privation to develop and persuade the community to use improvements which may be of enormous public benefit) by compelling them to meet such arbitrary and needless demands on pain of forfeiture of their rights.

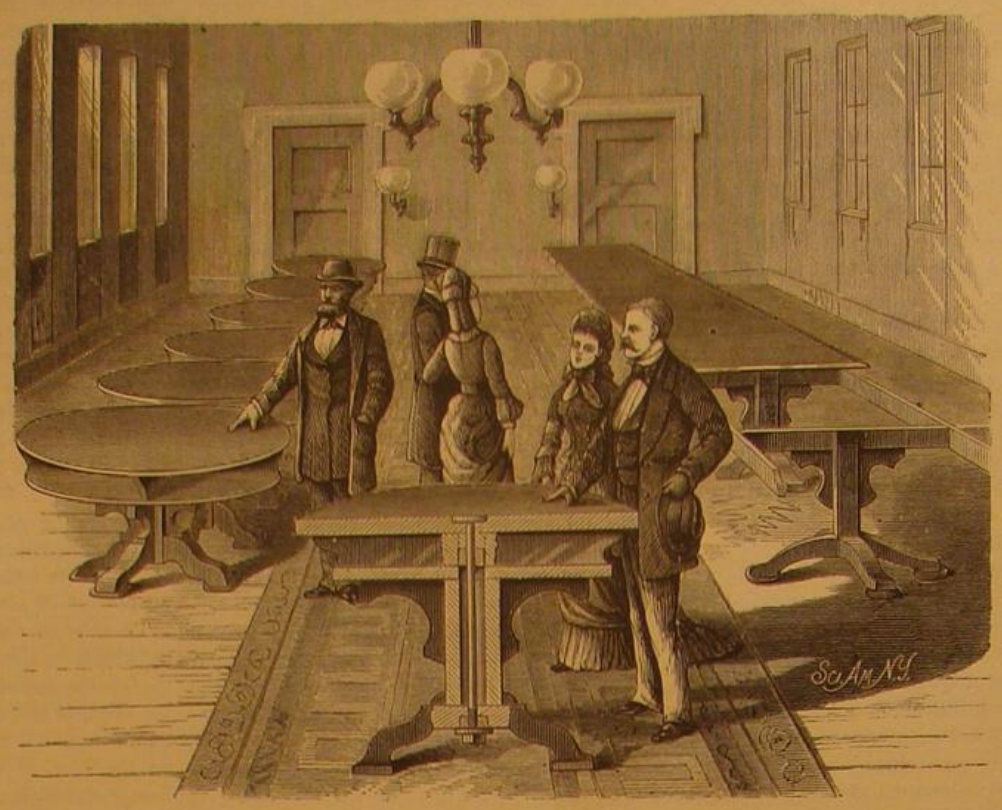
Consider, too, the door that would be opened by this section for injury to purchasers of limited patent rights, since it would make the permanence of their rights contingent upon the payment of successive fees by the inventor. As the law stands it is safe to purchase a manufacturer's or user's right under a patent for any State or locality, because a patent once issued and approved is unconditionally good for its whole period, and the buyer can estimate its value accordingly. Under the proposed amendment it would not be safe, for the inventor might, through willfulness, carelessness, or inability, neglect or fail to complete his title. The change proposed would, therefore, very seriously diminish the market value of all patented inventions the manufacture or use of which could not be monopolized by one firm, to the serious injury of a large number, perhaps the larger number, of patentees. And it would needlessly increase the risk of all who should undertake a new industry resting on such a precarious footing. Such a law might thus be fairly styled a law for the discouragement of progress in the arts.

Surely it would seem possible for Congressional wisdom to devise some plan for preventing or punishing the evil aimed at with greater certainty and with vastly less cost to the entire community.

AN IMPROVED TABLE.

The accompanying engraving represents an improved table recently patented by Mr. J. C. Melcher, of Black Jack Springs, Fayette county, Texas.

This table is designed for general use, being equally well adapted to the parlor, dining room, office, to steamboats, and to almost every other place where tables are used. Its novelty consists in features of construction which render it a very simple matter to either take it apart or put it together. This is of importance in an article of furniture as bulky as a table, especially when the matters of shipping and storage are considered. The legs cross each other at right angles, and upon them a hollow standard is placed, which is forked or slotted in two directions across the top for receiving the crosspieces, which cross each other at right angles and support the top. Below the crosspieces there is a shelf supported by brackets, which serves as a receptacle for small articles and as a supporter of the crosspieces. The brackets are fastened by an ingenious and simple arrangement of double wedges, and the top is secured by a long bolt that extends through the hollow standard and also through the legs. The construction of the table will be readily understood by reference to the sectional view in the foreground of the engraving. The long table at the right is a modification of the form just described, and is adapted to dining rooms, saloons, etc. The table is made without glue; the expense of manufacture is said to be less than that of ordinary tables. For further particulars address the inventor as above.



MELCHER'S TABLE.

Medals for Fairbanks' Scales.

Fairbanks & Co. have on exhibition in their window, No. 311 Broadway, the seven medals which they received at the Paris Exhibition, and which attract much attention from passers-by. They received five medals on scales—two gold, two silver, and one bronze; a gold medal on the type writer, and a bronze medal on oscillating pumps. They announce that they were awarded more medals than any other exhibitor at any world's fair. A recent test in Russia of their scales resulted in detecting an attempt to swindle the Saviour's Cathedral of Moscow out of $2,500, in stating that a bell weighed 64,800 lbs., when it really weighed only 59,562 lbs.

Who Invented the Torpedo Boat?

To the Editor of the Scientific American:

I notice in a recent number of the SCIENTIFIC AMERICAN an engraving of a torpedo boat recently constructed by Captain Ericsson, of which he claims being the inventor. Some 17 years since I submitted to the Naval Department plans for a torpedo boat, which I now send you for examination, and I think you will agree with me that there is great similarity between the two.

I must for the present decline making public the interior arrangements of my boat, the manner of working the spar, etc., but from what I can learn, Captain Ericsson's plans vary but little from mine.

RICHARD TEN EYCK.

New York, December 20, 1878.

[NOTE.—The accompanying engravings were made from the plans to which our correspondent refers as having been submitted by him to the Naval Department as long ago as 1861. A close similarity to the invention of Captain Ericsson, illustrated in these columns not long ago, is certainly observable; but whether the details in construction are alike or not we are unable to determine, as neither of the claimants to the invention seems inclined to make public the secrets of the internal arrangement of his craft.—ED.]

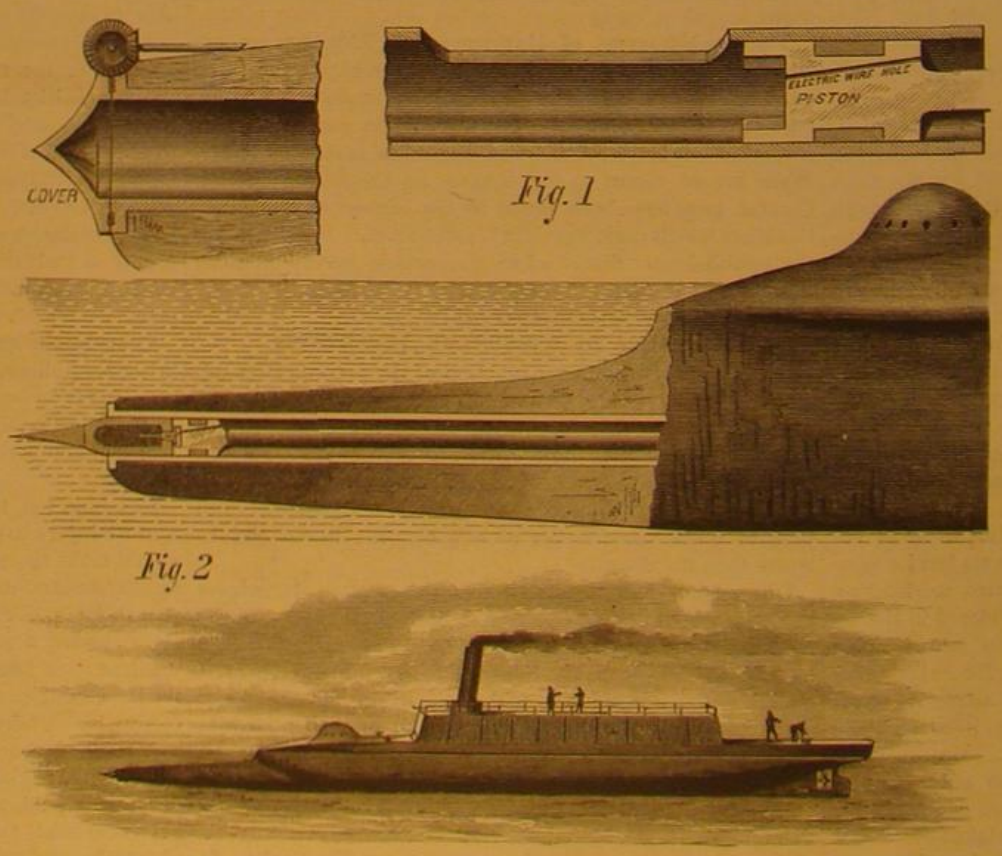


Fig. 1

Fig. 2

TEN EYCK'S TORPEDO BOAT.

The Largest Locomotive Engine.

The largest and most powerful locomotive engine ever built in this country, probably in the world, recently went West for service on a long and heavy grade on the Rocky Mountain section of the Southern Pacific Railroad. It is a 10 wheeel tank engine of consolidated pattern, having 8 driving wheels and a pony (2 wheel) truck. The cylinders measure 20 by 26 inches, and the driving wheels are but 42 inches diameter. The boiler is enormous, being straight, 58 inches diameter. It has 213 tubes, each over 11 feet long. The fire box is about 10 feet long. A water tank, almost the entire length of the boiler, rests on top of the engine, and when filled with water will add considerably to the weight. The truck wheels are 30 inches in diameter, and are of paper, with steel tires, similar to those now being used so extensively under the Pullman sleeping cars, and on the Metropolitan Elevated Railroad, New York. This engine, when in working order, will weigh 118,000 lbs. The great weight and size of the boiler and the small driving wheels combined form a tremendous power, well suited to the work the engine has to perform. The eight driving wheels are merely to distribute the weight, for if the weight rested on but four, no track ever laid could withstand the pressure. The weight is so great that the Western railroads, over which it must pass, would not permit it to go over their bridges, so it had to be taken to pieces and carried over in sections. The Pittsburg *Telegraph* says that it passed over all the bridges of the Pennsylvania road without being dismantled.

Catching Cod with Nets.

Professor Baird has made certain modifications on the Norwegian nets introduced by the United States Fish Commission at Gloucester. The latter having meshes proving too small for the purpose, Professor Baird is adopting the lake gill nets, with meshes 10 and 12 inch extension measurement, made of rather fine twine. At the first trial with the improved net, over 1,000 lbs. of cod were landed. This is the first capture of cod made with nets, as far as is known, on the coast of North America. Fishermen are, of course, very much interested, and have expressed their intention of having gangs of nets. There is no doubt that American ingenuity will very much improve on the Norwegian processes. In certain localities, by netting the fish, much larger hauls can be made, and the slower and more dangerous process of trawling can be done away with.

New Inventions.

Madame Claudine Ribod Weyer, of Lyons, France, has patented an improvement in Annealing Glass, which consists in first burying the glass when cold in powdered stone, plaster, lime, fire clay, or any substance capable of attaining the degree of heat necessary for the annealing operation and then raising it to the required temperature. The object of the process is to render articles of glass stronger and more capable of sustaining transitions of heat and cold.

Mr. William J. Hamill, of St. Catharine's, Ontario, Canada, has invented a Trotting Sulky, in which the thills are made with a bend or offset at a little distance from their rear ends. The frame is formed by the combination of the bent thills, two crossbars, the seat, the foot rests or stirrups, and the connecting braces.

Mr. Wm. H. Douty, of Shamokin, Pa., has patented a device for holding rolls of wrapping paper, so that the desired quantity may be drawn off the roll and torn from the sheet.

An improved Pump Valve has been patented by Mr. Eugene Hawkes, of San Diego, Cal. This pump valve is so constructed as to afford a direct and free passage to the water, to close quickly and with little shock or jar.

Mr. James P. Boesen, of Hoboken, N. J., has patented an improvement in that class of Line Fastenings used in connection with a line run from the window of the house to a pulley fixed outside the house, and where the clothing is strung on the line and drawn out by means of the pulley connection. The object is to enable the clothing to be hung on the line within the window, and thus avoid the danger and exposure of leaning out of the window to get at the line.

Mr. Parham B. Thaxton, of Jerseyville, Ill., has patented an improved Scraper for grading roads, lawns, etc., and for other purposes that require soil to be moved short distances. It consists of a double scoop pivoted so that one or the other of its scraping edges is always in position for use.

Mr. Charles Bellenot, of Richmond, Va., has patented an improved Sign for the class of street lamps which have separate name plates or signs (bearing the names of the streets on which the lamps are located) attached thereto.

Mr. Alphonse Bodart, of Huy, Belgium, has patented an improved Pipe Joint and Coupling, which consists in packing the joint with a leaden ring having an inner circumferential bead interposed between the two adjacent ends of the pipes, and securely packed and held in position by two external rings having an internal contour that permits the leaden ring to be wedged between it and the pipe, and securing the whole together by a hoop encircling the two iron rings, and a filling of cement on each side of the coupling.

An improved Reversible Melting Furnace has been patented by Mr. Albert Piat, of Paris, France. This is an improvement in portable and oscillating furnaces for melting metals, glass, etc. The crucibles are protected against injury from sudden changes of temperature, and the furnace may be handled with great ease. The furnace has a melting pot that is supported in an inclosing wall having detachable base portion and covers with air supply and exit holes.

Mr. Davenport Rogers, of Galion, Ohio, has patented an improved Apparatus for Separating Refined Petroleum into oils of different grades and fire tests. The object of the invention is to obtain from ordinary kerosene or refined petroleum a burning oil of less volatility, and which shall consequently give a higher flash or fire test.

Mr. Joshua Davies, of Muskegon, Mich., has devised an improved Hose Coupling, which consists in making a dovetail connection between the two parts and fastening them together by means of a flat spring working in a socket.

An improved Ruler for ruling parallel lines for section lining, and for various other purposes, has been patented by George Cousins, of Oswego, N. Y. It is simple and accurate.

M. Eugene Durand, of Paris, France, has invented an improved Machine for Cutting or Chopping Tobacco Leaf to make what is known as "picadura," such as is used in Spain, Havana, and in South America; also for cutting or chopping up herbs or medicinal plants designed to be used in the manufacture of chemical cigarettes or to be prepared for distilling purposes.

An improved Addressing Machine has been patented by Mr. John Piner, of Bonham, Texas. This invention is in

tended to furnish for newspaper offices, and business purposes in general, an addressing machine of exceedingly simple construction.

SATURATOR AND REGULATOR OF MEKARSKI'S COMPRESSED AIR MOTOR.

Many attempts have been made at locomotion by compressed air; but serious difficulties are encountered. Air absorbs heat or "produces cold," just in proportion as it produces work by its being used in a compressed state through a motor. This absorption of heat has many inconveniences. From a dynamic point of view, there is a considerable difference between the foot-pounds of work which the same amount of compressed air can furnish, according as the work is got out at a constant temperature or without addition of heat. From a physical point of view, the cooling causes the freezing of the water contained in the air, and of the oils and greases employed in the machine, and forms of the two a sort of mastic which prevents proper operation of the working parts.

All the means hitherto employed to combat these inconveniences have been so inefficacious that inventors had almost given up the idea, and, in consequence, the duty obtainable from compressed air machines remained very low. In the Mékarski system, which is illustrated in Figs. 1 and 2, these inconveniences are avoided by admitting to the driving cylinders air saturated with steam at a high temperature. This mixture is obtained by causing the air to pass, in the form of fine bubbles, through a column of hot water, inclosed in a receptacle at a temperature of about 150° to 160° C. at the commencement, and of which the volume is so calculated with respect to that of the air that the proportions of the mixture rest constant during the period of work. The proportion of vapor varies between $\frac{1}{3}$ and $\frac{1}{4}$. These conditions are easily realized; as, during the period of expenditure, the pressure of the air in the reservoir diminishes, as does also the temperature of the water; and, in consequence, the tension of its vapor diminishes in the saturating apparatus.

Fig. 1 shows part of this apparatus as applied to the platform of a locomotive driven by compressed air. It is without firebox, and is filled with hot water while the air reservoirs are being charged. After its force is spent the temperature is brought up again by an injection of steam. Coming from this reservoir, the gaseous mixture passes through the regulator, shown in Fig. 2. There is an orifice controlled by a conical valve, so arranged that it closes by the pressure of air in the reheater, and opens only when there is an opposite pressure put against it. This pressure can be produced by a flywheel connected with the piston of a small hydraulic press with air spring. The pressure is transmitted to the conical valve by a rubber diaphragm separating the two parts of the apparatus. The amount of flow being once determined, equilibrium will establish itself, when the pressures are the same above and below the diaphragm. Now the pressure above is that of the air spring of the hydraulic press;

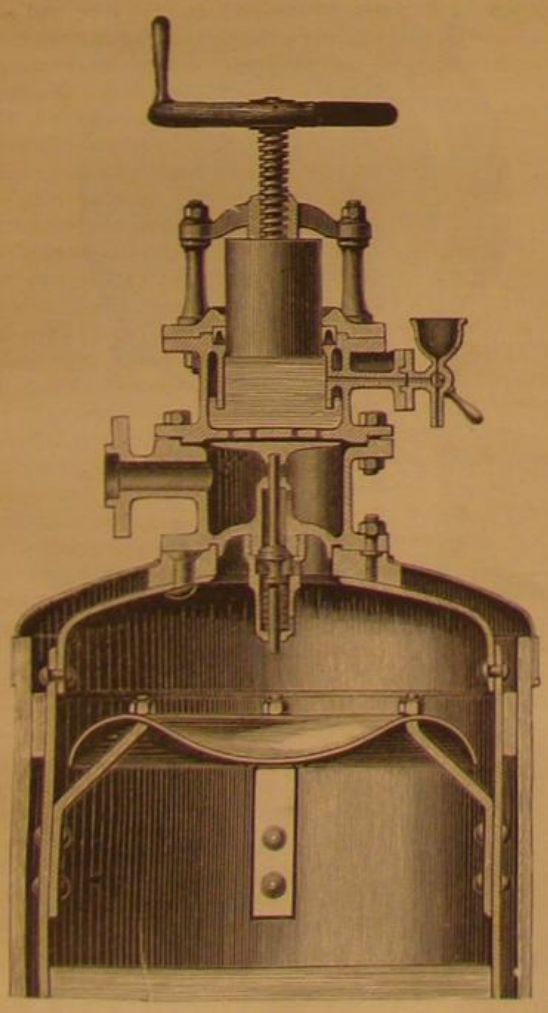
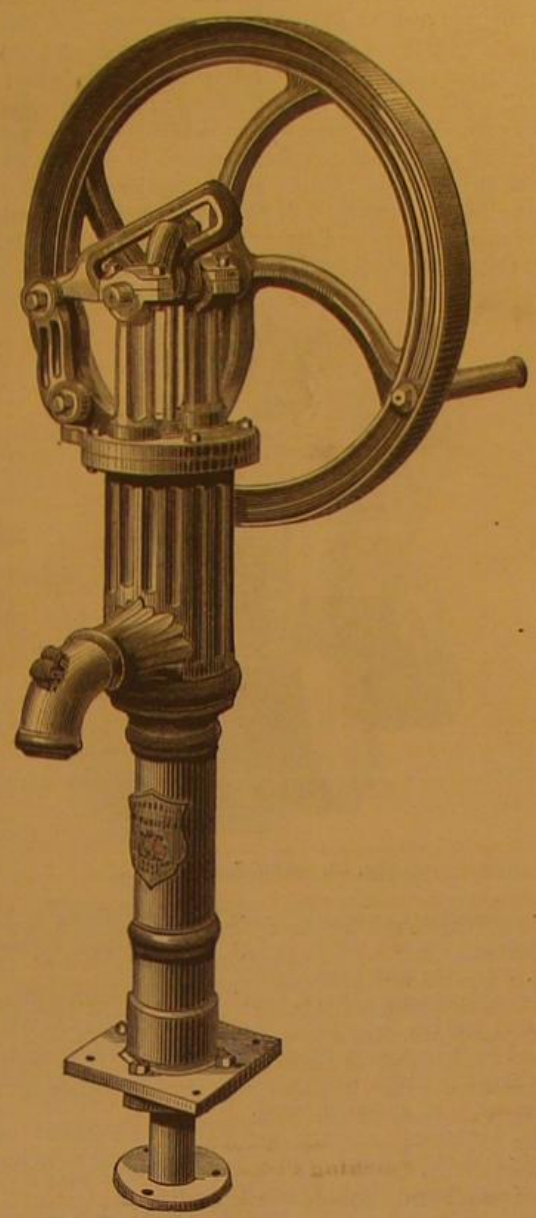


Fig. 1.—SATURATOR, MEKARSKI COMPRESSED AIR LOCOMOTIVE.

and that below is that of the supply of the gaseous mixture. This last will thus remain automatically constant as long as the air spring is kept at the same tension; and is thus varied at the will of the driver, who can compress the air spring more or less by means of the flywheel.

ROTARY LIFT PUMP.

Messrs. Henry Bamford & Sons, Uttoxeter, England, have introduced to public notice a new and improved rotary lift and force pump, for which they claim several features of importance. The engraving shows the general outline of the pump, which is strongly made and compact in all its parts.



ROTARY LIFT PUMP.

The makers state that it has a very powerful and smooth action, much more so than in any of the ordinary rotary pumps. Its specialty consists in a slow upward stroke and quick downward movement, thus equalizing the work. It has double bearings, and is adapted both for hand and steam power, to be used either for shallow or deep wells, or as a force pump. The position of the pump head is reversible, so that it may be worked on any side by hand or steam power to a depth of 25 feet. The head is arranged to form an air chamber. It is fitted with heavy flywheel, wrought iron crank and turned rod, brass stuffing box, draw-off tap, and retaining valve, screwed for iron tube. The barrels vary in diameter from 3 to 4 inches, and can be had with or without copper linings.

The Electric Light in London.

The first experiment of public lighting in London by means of electricity, commenced a short time ago at Billingsgate Market, has now received a very important extension on the Thames Embankment and the Holborn Viaduct. Between Westminster and Waterloo Bridges twenty Jablochkoff candles illuminate the Embankment and the river with a novel brilliancy, and turn the gas lamps—which perforce are kept burning—very yellow with their pure white brilliancy. On the west side of Charing Cross Railway Bridge, upon the Embankment, and about 50 yards from the river wall, a wooden shed has been erected containing the motive power and the machine. The former is supplied with one of Messrs. Ransomes, Sims & Head's semi-portable engines of 20 horse power nominal. This engine, which is an excellent example of workmanship, has two 10 inch cylinders of 13 inches stroke, and has 360 feet of heating surface. This engine is provided with a very sensitive automatic governor, and having a large margin of power beyond what is required for driving the machines now installed, is extremely well adapted for its purpose. It will, in fact, indicate from 60 to 70 horse power. At present it is worked with a steam pressure of 62 lbs., and at a speed of 140 revolutions. From the pulley on the engine a belt transmits power to an intermediate shaft mounted on a timber framing, and carrying, besides the pulley for the engine belt, two others, from one of which the Gramme continuous current machine is driven, and from the other the Gramme dividing machine. The speed at which the first machine is driven is 650 revolutions, while the dividing machine has a velocity of 700 revolutions. The current from this machine is divided into four circuits of five lights each, and the length of circuit is the greatest yet successfully reached, the furthest light being about 700 yards from the source of power, and the total distance between the extreme lights is 1,170 yards. The lamps are distributed so that there are ten between Westminster and Charing Cross Bridges, one under this bridge, and nine from this point to Waterloo. The lamps in the latter series are placed somewhat more closely together than those on the western side of Charing Cross Bridge.

Circuit No. 1 supplies the four lamps which extend from Waterloo Bridge to the Cleopatra Needle, and one on the west side of it. Circuit No. 2 provides for the remaining three lamps, east of Charing Cross Bridge, one under that bridge, and one on the west side of it. The other ten are connected with circuits 3 and 4. The wires from the machine are led underneath the road through a drain pipe into the Embankment subway. This pipe is 4 inches in diameter, and contains all the eight wires forming the four circuits. On reaching the subway the wires are taken right and left, and are attached to boards fastened to the side of the subway. Where each lamp occurs the wires are led up through the tubing let into the granite pedestal and so to the lamp. Each globe contains four candles, so as to secure a light for six hours. Circumstances rendered it necessary to place the commutator at the top of the lamp instead of near the base, a very awkward arrangement, since the attendant has now to mount a ladder to shunt the current, instead of doing so from the ground. The average distance apart of the light is 45 yards, but the spacing is irregular, the maximum distance being 120 yards between the lamp under Charing Cross Bridge and the adjacent one to it on the western side. The corresponding lamp on the eastern side is 115 yards away.

The Holborn Viaduct is illuminated by sixteen Jablochkoff candles, and are supplied from similar Gramme machines driven by a 20 horse power engine furnished by Messrs. Robey & Co. The machinery is placed in a wooden shed erected near the bridge. The wires are laid in pipes from the shed to the subway, and thence conducted to the lights. The commutators are here fixed near the ground level, a much more convenient arrangement.

The general effect produced by these lights both at the Viaduct and on the Embankment is, of course, extremely pleasing, and the contrast to the gas lamp very great. At the former place the conditions approximate to those on the Avenue de l'Opéra, in Paris, a wide street being illuminated by lamps on each side, while a good deal of reflected light is thrown from the adjacent houses. On the Embankment, however, the case is different. Here we have a single line of lamps with a great void of darkness on either side, on the one hand the river and on the other the width of the Embankment. Much of the available light is, therefore, lost, and all that radiated from the upper portion of the globes is distributed skywards, as is visible by the glow with which the air is filled for a considerable height above the ground, and more clearly by the bright illumination of the underside of the bridge. Probably when some alteration in this respect has been made, a considerable improvement will be obtained. Meantime the result can hardly be considered as highly satisfactory, more especially as an irregularity or pulsation in the light given, is too often noticeable. Possibly this defect may be overcome shortly, since at present the installation has scarcely passed out of the experimental stage. That

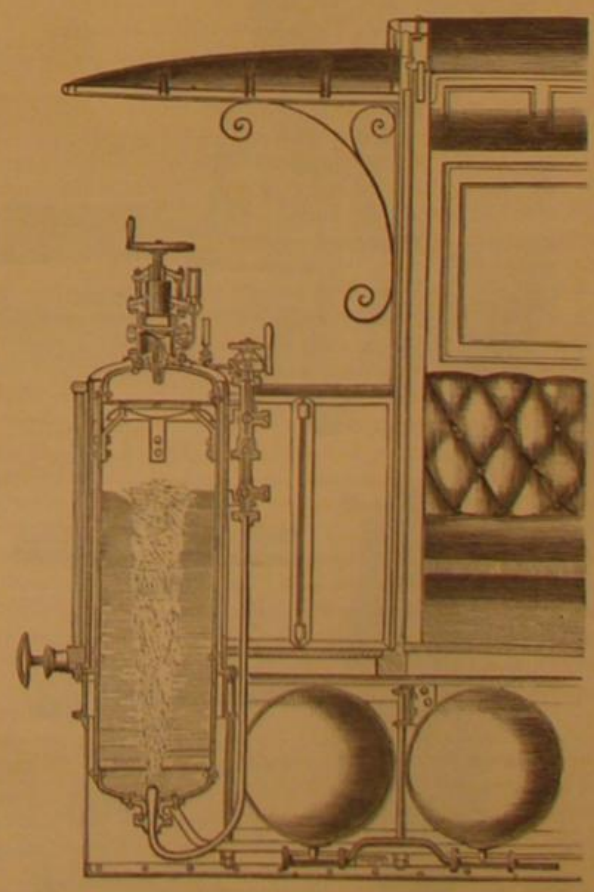


Fig. 2.—REGULATOR, MEKARSKI COMPRESSED AIR LOCOMOTIVE.

it must be overcome is certain before the light can be regarded as a success, and that this is possible appears evident from the good results obtained in many places.

When this has been satisfactorily adjusted, there will remain the important question of cost, and this question, which

has never yet been clearly answered, will doubtless receive the careful attention of the Board of Works. That it will cost far more than the present illumination of the Thames Embankment is clear, since at present the electric light there is actually supplementary to the gas lamps, still kept burning, and necessarily so. When the cost has been ascertained, two points will present themselves for consideration: first, whether the luxury of an increased light is worth paying for, and second, whether for the same extra expense an equal and better diffused light cannot be obtained by gas. Meanwhile we are glad to see that in many directions, both in the metropolis and the provinces, a wide experience will be gained in the course of the next few months with the electric light, especially with the Jablochkoff system, which for the present appears to be the most suitable for general lighting purposes that has yet been introduced.

We should not omit to mention that the installations both on the Viaduct and the Embankment have been thoroughly carried out by Messrs. Wells & Co., of Shoreditch, under the superintendence of M. J. A. Berley, the representative of the Société Générale d'Electricité, at Paris.—*Engineering.*

AMATEUR MECHANICS.

CHUCKING.

In spite of all possible appliances to be used in a general way for chucking work in the lathe, a degree of inventive skill is often required to accomplish it quickly and securely.

The accompanying cuts are designed to aid the amateur in chucking, but after all is said, there is a world of knowledge that can be gained by experience only.

The arrangement of a metal disk in the lathe so that it can be turned on its face, and upon its edge, cannot well be accomplished by means of chucks; for this purpose recourse is frequently had to cement. A good cement for this purpose consists of Burgundy pitch, 2 pounds; resin, 2 pounds; yellow wax, 2 ounces; dried whiting, 2 pounds; melt together the pitch, resin, and wax, and stir in the whiting.

To chuck work with this cement, apply a small portion of it to a face plate devoted especially to this purpose; heat the plate so that the cement will cover the greater portion of its surface. The plate may be allowed to cool. Whenever it is desirable to chuck a metallic disk, it is heated and placed against the cement on the face plate, and allowed to remain until the cement begins to stiffen, when a tool having a right-angled notch is applied to the edge of the disk, as shown in the cut, the lathe being rotated until, by the compound action of the tool pressure and the rotary motion, the disk becomes perfectly true.

To chuck a spindle or any similar object a cement chuck like that shown in section in Fig. 2 is sometimes used. The larger portion is screwed on the lathe mandrel, and the inner end of the hole in the outer portion terminates conically. The hole is filled with cement, and the article to be chucked is warmed and introduced. It may sometimes be necessary to heat the chuck with an alcohol or gas flame. The lathe is rotated and the spindle is held lightly until it becomes true and the cement begins to harden.

To remove the work from a cement chuck, it must be warmed by means of a lamp or otherwise. Most of the cement adhering to the work may be wiped off after heating it; whatever remains may be removed with a little turpentine.

A common method of chucking work on the face plate is shown in Fig. 3; the wheel is temporarily retained in place by a pointed rod, A, which is forced against the wheel by the tail spindle. A little rapping one way or the other readily centers the wheel. A piece of crayon held in a crayon holder supported by the tool rest may be used to discover which side of the wheel is "out." After the wheel is trued, it is fastened by the short bars, B, whose outer ends rest upon any convenient blocking while they are drawn by the bolts, so as to clamp the wheel firmly to the face plate.

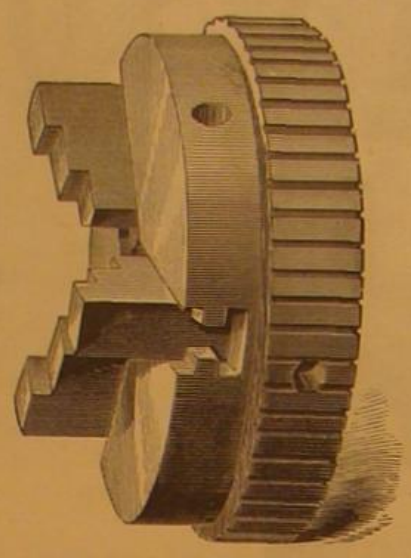


Fig. 14.—SCROLL CHUCK.

It is sometimes preferable to use the yoke shown in Fig. 4 instead of the bars shown in Fig. 3; it is placed diametrically across the wheel and secured by two bolts.

Fig. 5 represents a chuck, consisting of a wooden disk, *c*, bored to receive the wooden hoop, *d*, which may be forced inward by the common wood screws, *e*, which bear upon it. This chuck is useful where a considerable number of similar pieces are to be turned or bored.

Fig. 6 represents a simple and well known chuck. It is simply a block of wood secured to a face plate by a screw center and turned out to fit the work.

Fig. 7 represents an easily made chuck, which is useful for holding plugs of wood to be turned or bored. It consists of a piece of hard wood fitted to the mandrel, turned, bored, and split longitudinally, as shown in the engraving. Its outer end is tapered, and to it is fitted a metallic ring that serves to contract the chuck when it is forced on.

Fig. 8 represents a tapered and split mandrel, which may be either of metal or wood according to the purpose to which it is to be applied. The part F is bored conically at the smaller end before splitting, and to this hole is fitted the conical plug, G, which being forced in expands the mandrel.

In Fig. 9 the mandrel, C, has permanently attached to it the cone, D, and upon it is placed the movable cone, E, which is forced against the work held between the two cones by a nut which turns on the threaded end of the mandrel.

In Fig. 10 the manner of chucking work on the angle plate, H, is shown so clearly as to require no explanation. It may be well, however, to state that when the work is rotated rapidly a counterbalance should be attached to the face plate on the side diametrically opposite the angle plate.

Fig. 11 shows a jaw for attachment to the face plate, which consists of a right angled piece, I, a jaw, J, which has two guide pins, entering holes in the piece, I, and the screw, K, which passes through a tapped hole in the piece, I, and bears against the jaw, J. The piece, I, has a dowel, *a*, that keeps it from turning, and a screw, *b*, by which it is secured to the face plate.

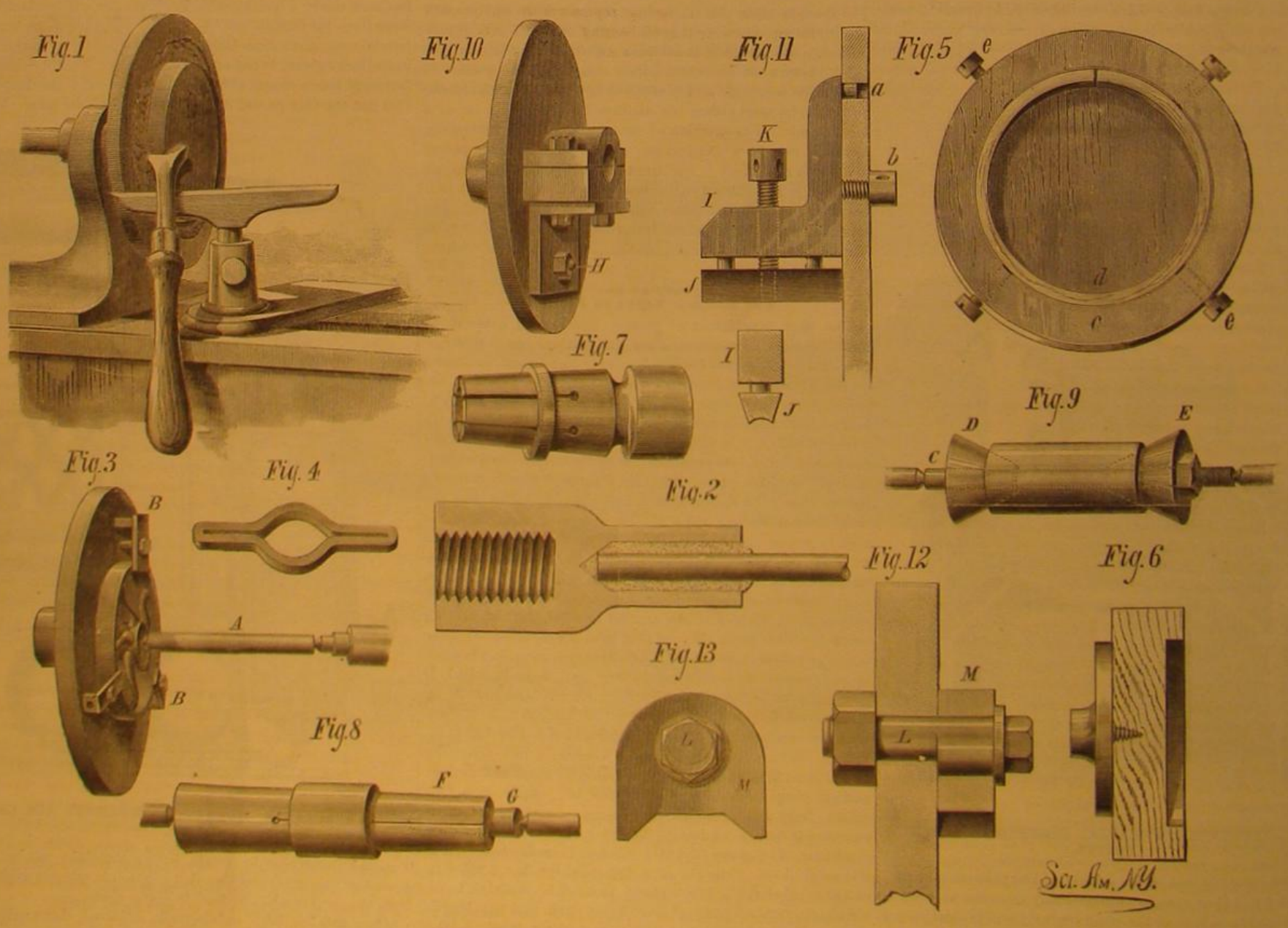
In Figs. 12 and 13 the pin, L, is fitted to the face plate, and has formed on its projecting end an eccentric which fits the jaw, M. It has also a hexagonal head for receiving the wrench by which it is turned. Three pins, L, are fitted to the face plate, which is quite thick. Two of the pins need not be turned after being adjusted for a certain kind of work; the third is loosened and turned when work is put in and taken out of the lathe. After the work is clamped tightly by turning the eccentric the nut on the back of the face plate is tightened.

In Fig. 14 is shown a type of the most convenient and most universally useful chuck in existence. Its construction and use are so well known as to need no description.

M.

Kerosene Dangers.

A correspondent mentions a source of danger in the use of kerosene lamps which seems to have been generally overlooked, namely the habit of allowing lamps to stand near hot stoves, on mantelpieces, and in other places where they become heated sufficiently to convert the oil into gas. Not unfrequently persons engaged in cooking or other work about the stove will stand the lamp on an adjacent mantelpiece, or even on the top of a raised oven; or when ironing will set the lamp near the stand on which the heated iron rests. It is needless to enlarge upon the risky character of such practices.



CHUCKS AND METHODS OF CHUCKING.

The Microphone.

Thomas S. Tait, of Baroda, India, communicates to *Nature* a suggestion as to new uses for the microphone. Two subjects of interest in connection with the practical application of the microphone have lately been brought to my notice, says the writer, by Raja Sir T. Madava Row, K.C.S.I., Dewan of Baroda. In the hope of securing a little assistance from some of your scientific readers I hasten to lay them before you.

The first question is with reference to the use of a microphone as a stethoscope. It seems that native ladies of high position decline altogether to allow a doctor to examine the chest in the ordinary manner. Sooner than submit to such an examination they would prefer to die—certainly rather a staggering fact for those imbued with European ideas. In the cause of humanity it is therefore desirable to do something for those whose position and caste would be imperiled by direct examination. If the microphone could be so delicately arranged as to transmit the auscultatory sounds, a medical ear, even at a distance, would surely be able to detect the existence of any disease of the heart or lungs. In the few experiments that we have made with our limited appliances we have been able to hear the ticking of a watch at a distance of about 200 yards, and the roar of a black ant when attacked by his companion, but as yet we have heard no internal sounds from the human breast. Perhaps with better devised instruments some one may have been able to obtain that which has yet been denied to us. I am sure many native ladies would be glad to get an affirmative answer to the question, "Can the microphone be used as a stethoscope?"

The second subject seems to be a more difficult one to grapple with:

"In the undulating region of Travancore, where the water bearing strata heave and fall according to the locality concerned, I have come across a set of professional men who are generally consulted by those who wish to sink wells in view to ascertain whether, at a given spot, a well may be sunk with the probability of finding water near enough. These professional men undertake to predict where the springs will be found near, and where they will be found at great depth, and their predictions are generally verified with great accuracy. I took some trouble to ascertain how these men are enabled to predict the proximity, or otherwise, of the springs underground. Brushing aside the ceremonies and incantations they perform in view to deceive others and perhaps themselves also, I found that they detect the proximity of the subterranean springs by lying down on the bare ground in the dead silence of night, with the ear in contact with the ground, and trying to hear the sound of the flow of water in the strata beneath. By practice the ear is made very sensitive, and the degree of distinctness with which they hear the sound of flowing water enables them approximately to predict the depth of the springs. It is in this manner that appropriate spots are selected for sinking wells.

"Now, would any of the instruments you are experimenting with magnify the sound of the subterranean flow of water so as to greatly facilitate the process I have described? If so, it may be a considerable practical gain."

To this query I have hitherto been able to return no other answer than a negative one. Both the subjects are practical ones, and I only hope that there will be before long some light cast upon them.

Le Conte's Theory of Mountain Formation.

Dr. Joseph Le Conte, in his "Elements of Geology," lately published, gives a very complete theory of mountain formation, based upon the supposition that the earth is solid.

The earth is regarded as made up of concentric isothermal shells, each cooling by conduction to the next outer, and the outermost by radiation into space. For a long time the outermost would cool fastest. But a time would come when the outermost would become of a nearly fixed temperature, receiving heat from external and internal sources, while the interior would still continue to cool by conduction. The interior, because cooling faster, and also because the amount of contraction for equal cooling is greater at high than at low temperature, would contract faster than the exterior. The interior would tend therefore to shrink away from the exterior, which, following it down, would be subjected to powerful horizontal pressure, and must finally yield somewhere. Mountain chains are the lines along which the yielding of the surface to horizontal thrust has taken place. This yielding is not by upbending into an arch, leaving a hollow space beneath, nor yet into such an arch, filled and supported by an interior liquid, as usually supposed; but by mashing or crushing together horizontally, like dough or plastic clay, with foldings of the strata, and an upswelling and thickening of the whole squeezed mass.

The theory here presented accounts for all the principal facts associated in mountain chains. This is the true test of its general truth. It explains satisfactorily the following facts: 1. The most usual position of mountain chains on the borders of continents. 2. When there are several ranges belonging to one system, these have been formed successively coastward. 3. Mountain chains are masses of immensely thick sediments. 4. The strata of which mountain chains are composed, are strongly folded, and, where the materials are suitable, are affected with slaty cleavage; both the folds and the cleavage being usually parallel to the chain. 5. The strata of mountain chains are usually affected with metamorphism, which is great in proportion to the height of the chain and the complexity of the foldings. 6. Great fissure eruptions and volcanoes are usually associated with mountain chains. 7. Many other minor phenomena, such as fissures, slips, and earthquakes, it equally accounts for.

A NOVEL BRIDLE BIT.

We illustrate herewith a novel bridle bit recently patented by Dr. J. G. Peterson, of Morganton, N. C. It consists of a single piece of steel wire doubled and bent at right angles with the bar and twisted together, as clearly shown in the engraving. An expert blacksmith can make these bits very rapidly, as no forging is required; and the bit, when finished, is very strong, and is claimed to be equal if not superior to the more expensive kind.

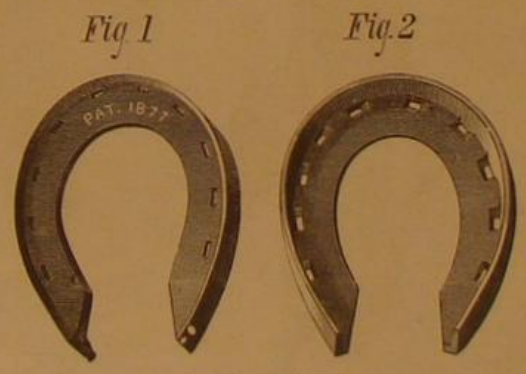
PETERSON'S BIT.

It is said that Americans can make anything out of wire; this bit is another example that goes to prove the statement true. Further particulars may be obtained by addressing J. G. Peterson, M. D., as above.

A NEW CONTINUOUS CALK HORSESHOE.

When a prominent horseman states that in the city of New York there are not ten horses in a hundred that have been upon our street pavements one year that have sound feet, and when eminent veterinary surgeons say that nearly all of their business comes from the present mode of shoeing horses, it becomes a matter of serious consideration to owners of horses to know whether there is a way of avoiding the evil. The remedy seems to lie in the adoption of a shoe of standard form adapted to the peculiarities of the horse's foot and capable of being easily applied by any blacksmith. A shoe which, we are informed, fulfills all requirements has been recently patented by Mr. John D. Billings, and is manufactured by the John D. Billings Patent Horseshoe Company, 265 Broadway, New York.

Fig. 1, in the engraving, represents the shoe as seen from the top, showing a level bearing surface. Fig. 2 shows the under or calk side of the shoe.



BILLINGS' HORSESHOE.

This shoe is made from an L shaped bar of steel, the steel being, by a patented process of manufacture, completely enveloped in a coating of tough iron, which renders it capable of being bent hot or cold, and imparts to it the desirable qualities of lightness, strength, durability, and elasticity. The bars being cut into suitable lengths and the ends of the pieces sheared off, they are then bent into shape around forms or dies made from drawings of the foot; the nail holes are then punched, and the shoe is complete.

The shoe has a continuous calk, which is similar in form to the crust or wall of the hoof, and is, therefore, the most natural, and, as stated by the manufacturers, the most efficient shape for a horseshoe. The upper surface of the shoe has a narrow beveled edge or rim, which takes the place of the clip in the ordinary shoe.

It is stated that the peculiar form of the shoe adapts it to all kinds and conditions of feet. The manufacturers state that it has cured tender feet, when existing, in every instance where the shoe has been tried; and the change which takes place in the tender footed animal, that has had an old shoe replaced by this, is said to be quite remarkable. While formerly he gave expression to the uneasiness and pain from which he suffered, by frequently shifting his weight alternately from one foot to the other, with the new shoe he stood squarely upon his feet without a sign of discomfort, showing clearly that he was at his ease.

The many advantages claimed for this shoe cannot be well enumerated here, but we are informed by thema nufacturers that it is largely in use, and is giving excellent satisfaction.

Correspondence.

The Black Spot of Jupiter's Disk.

To the Editor of the Scientific American:

The call for information through your columns relative to the black spot on Jupiter's disk seems to elicit but little attention. In the last number of the SCIENTIFIC AMERICAN I notice that Mr. R. D. Schimpff, in reply to Mr. Eadie, says that "it was unquestionably the shadow of one of Jupiter's moons," from which any reader would infer that it could not possibly be anything else. By reference to any good work on astronomy, it will be seen that both bright and dark spots have been observed in Jupiter's belt at irregular intervals for the last two centuries. It was by watching these that the rotation of the planet on its axis was ascertained. One of these spots, first noticed in 1665, disappeared and reappeared regularly in the same form for more than 40 years.

On the night of August 23, the writer, while watching a transit of one of Jupiter's satellites, noticed the appearance of the black spot above mentioned. It came into view at 8:54 P.M., some time before the shadow of the moon had left the planet, and disappeared at 12:13. The next night at 8 P.M. it was plainly visible near the middle of the northern belt, the planet having made about 2 3-10 revolutions. On the night of the 10th inst. I saw it again. It is distinguishable from the shadow of a satellite by being both larger and darker, in fact black. As to what it is, or the cause of its existence, we do not pretend to say, but we do say that it is a veritable spot, and by no means the first one ever seen.

A. S. HOWREN.

Corsicana, Texas, Nov. 23, 1878.

Shifting of the Grain Belt.

The Bureau of Agriculture furnishes some very interesting tables, illustrating the westward movement of the centers of grain production. The product of wheat per capita, in New England, has fallen between 1849 and 1877 from four tenths to three tenths. In the same period in the Southern and South Atlantic States, the per capita has risen from 2·38 bushels to 6·11 bushels, so that those States, from buyers, have become sellers of wheat. In the Ohio and trans-Mississippi States, in the same period, the per capita produced has increased from 12·65 bushels to 30·49, and in the Pacific States from 2·16 bushels to 27·49 bushels. The wheat crop of 1849 was 100,485,944 bushels, divided into equal volumes by the lines of 81° west from Greenwich. In 1877 the crop was 365,094,800 bushels, and the center line of production the meridian of 89° 6′ west. In 1849 the corn product was 591,071,104 bushels, and the central line in the 85° west longitude. In 1877 the corn product was 1,342,558,000 bushels, and the center line 89° 6′. In 28 years the movement westward has been: for wheat, 8° 6′ (about 500 miles), or from the eastern line of Ohio nearly to the center of Illinois; for corn, 4° 6′ (250 miles), or from the eastern line of counties in Indiana nearly to the longitude of Cairo.

The Antiquity of Weaving.

The earliest records of the art of weaving are to be found in the Old Testament. Pharaoh arrayed Joseph in "vestures of fine linen," and Job lamented that his days were swifter than the weaver's shuttle, the use of the simile proving that the shuttle was a common and well known object at the time. Portions of woven cloth and a weaver's shuttle have been found among the remains of the Lake dwellings, and as the latter are believed to belong to the stone age, the origin of the art may possibly have been nearly coincident with the existence of man. Few if any savage races have been discovered altogether ignorant of the art, and many of them have brought it to a considerable degree of perfection; while the relics of the ancient Peruvians and Egyptians show that they were skilled weavers. Some fragments of Egyptian cloth were found on examination to be woven with threads of about 100 hanks to the pound, with 140 threads to the inch in the warp, and 64 in the woof. Although the art was practiced extensively, and with no mean skill, in very ancient times, it progressed slowly and gradually—by small steps at long intervals. The great advances in the art of weaving have been made during the past 300 years, mainly during the past century.

New Coral Beds Near Sicily.

During the past year a new and valuable coral bed was discovered on the southwest of Sicily, between Sciacca and Porto Empedocle. The coral is not only abundant, but of excellent quality. One coral merchant of Torre del Greco, having fifty barks employed on the bed, secured in a few days ten tons of coral of the very finest quality. The Algerian coral grounds have been nearly deserted on account of the new finds.

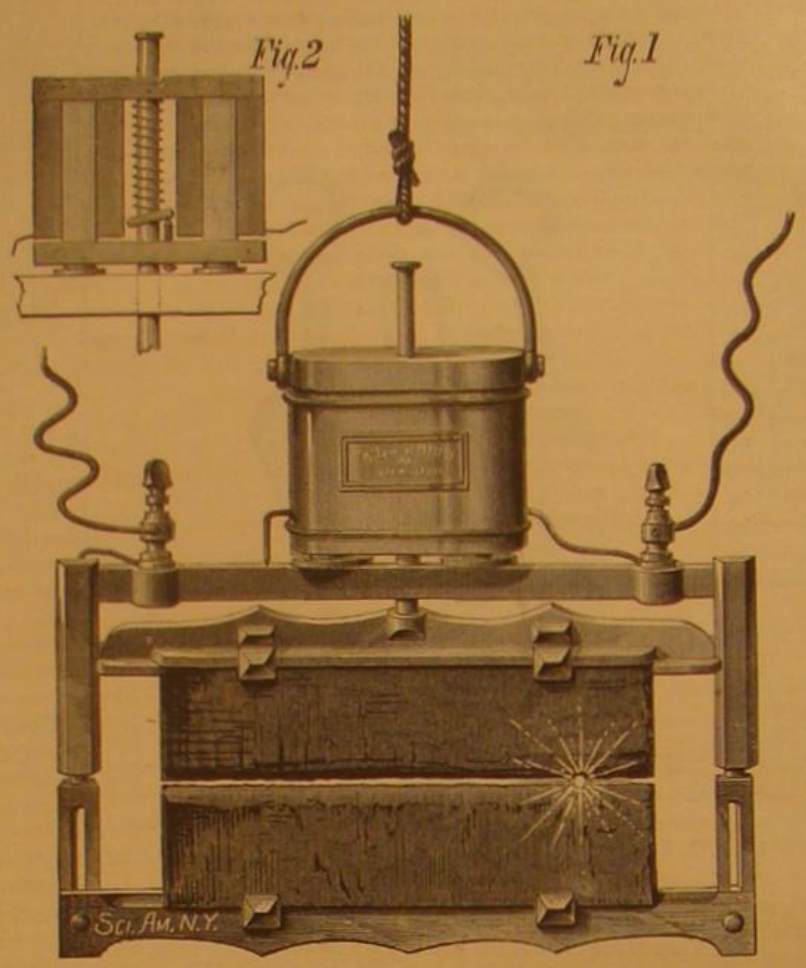
Military Improvements Wanted.

The Board on Army Equipment, in session in Washington, invites brief communications from persons in the military service regarding any improvements that can be made in the general equipment of troops, which have been suggested by observation and experience, and requests inventors and manufacturers to send to the Board samples, accompanied by drawings and specifications, of any improvements made in the equipment of troops, keeping in view the lessening of weight to be carried by the soldier, increasing his efficiency, and at the same time preserving and increasing the durability of the articles to be used.

THE WALLACE-FARMER ELECTRIC LIGHT.

The Wallace-Farmer system of electric lighting has been brought prominently forward in England within the last few weeks, and is quietly being pushed forward in this country. The lamp, which is the subject of the accompanying illustration—Fig. 1 being a perspective view and Fig. 2 a sectional view of the magnet—consists of a metal frame of brass, fitted with terminals for the current, as shown. This frame carries the two gas carbons forming the electric wick. These carbons are in the form of short rods or slabs about 9 inches long by 3 inches broad, the upper, or positive, being about half an inch thick, and the lower, or negative, being only about a quarter of an inch thick. The lower carbon is fixed to the bottom of the frame, and the upper is carried by a crosspiece, which can slide up or down in grooves in the sides of the frame. The upper carbon is therefore movable, and can be drawn apart from the lower one to any adjusted distance, say one eighth of an inch, so as to determine the luminous arc. When the lamp is not in use, this upper carbon is let down into contact with the lower one, and rests upon it; but the act of putting on the current raises the upper carbon one eighth of an inch and establishes the light. This is effected by means of an ingenious electro-magnetic contrivance, supported above the frame and shown in Fig. 2. The vertical stem, which is fixed to the sliding crosspiece carrying the upper carbon, passes between the two bobbins of a double poled electro-magnet, shown in section. This magnet is inverted, the free poles and movable armature being undermost. This armature, which is perforated to allow the stem to pass through it, carries a screw, which, when the armature is attracted upward by the current, tilts a small metal ring, or washer, hung from a spiral spring, and inclosing the stem into an inclined position, so that it jams the stem tight and holds it fast in the manner delineated. The first act of the current, then, after it is put on, is to attract the armature until it jams the stem attached to the upper carbon, and the armature being further attracted into contact with the poles of the electro-magnet, it lifts the stem with it, and raises the upper carbon plate until its lower edge is about one eighth of an inch above the upper edge of the lower plate. The arc then either establishes itself at the points of least resistance between the two carbons, or it may be established at any place desired, say at one corner, by inserting a metal conductor for a moment between the two carbon edges. The arc once started continues to subsist at that point until the consumption of carbon widens it to such a degree that a shorter and less resisting path for the current is to be found at a neighboring point. The current then chooses this point, and the arc is established there, until waste of the carbons causes it to shift its place as before. In this way the arc travels slowly along the whole edge of the carbons, and when it reaches the other end it turns and comes back again. For 100 hours the light can, in this way, be maintained without change of carbons and at a cost of about two cents per hour per lamp for the latter. When the current is cut off, the armature falls away from the poles of the electro-magnet, the screw releases the clamping washer, the vertical stem is freed, and the upper carbon drops down into contact with the lower carbon. When the distance between the carbons becomes at any time too great and the current is enfeebled, the armature will of itself fall away from the poles, and the carbons will close up to each other in this manner. This causes the current to regain its full strength, and the armature being again raised, the upper carbon is again withdrawn from the lower and clamped, and the light thus restored automatically.

It will be understood from our description that the upper carbon cannot be withdrawn in this manner from the lower one to a distance over one eighth of an inch, the determined range through which the armature can move. Thus, however much the carbons may have been wasted away, at the resetting of the arc they are always withdrawn one eighth of an inch apart.

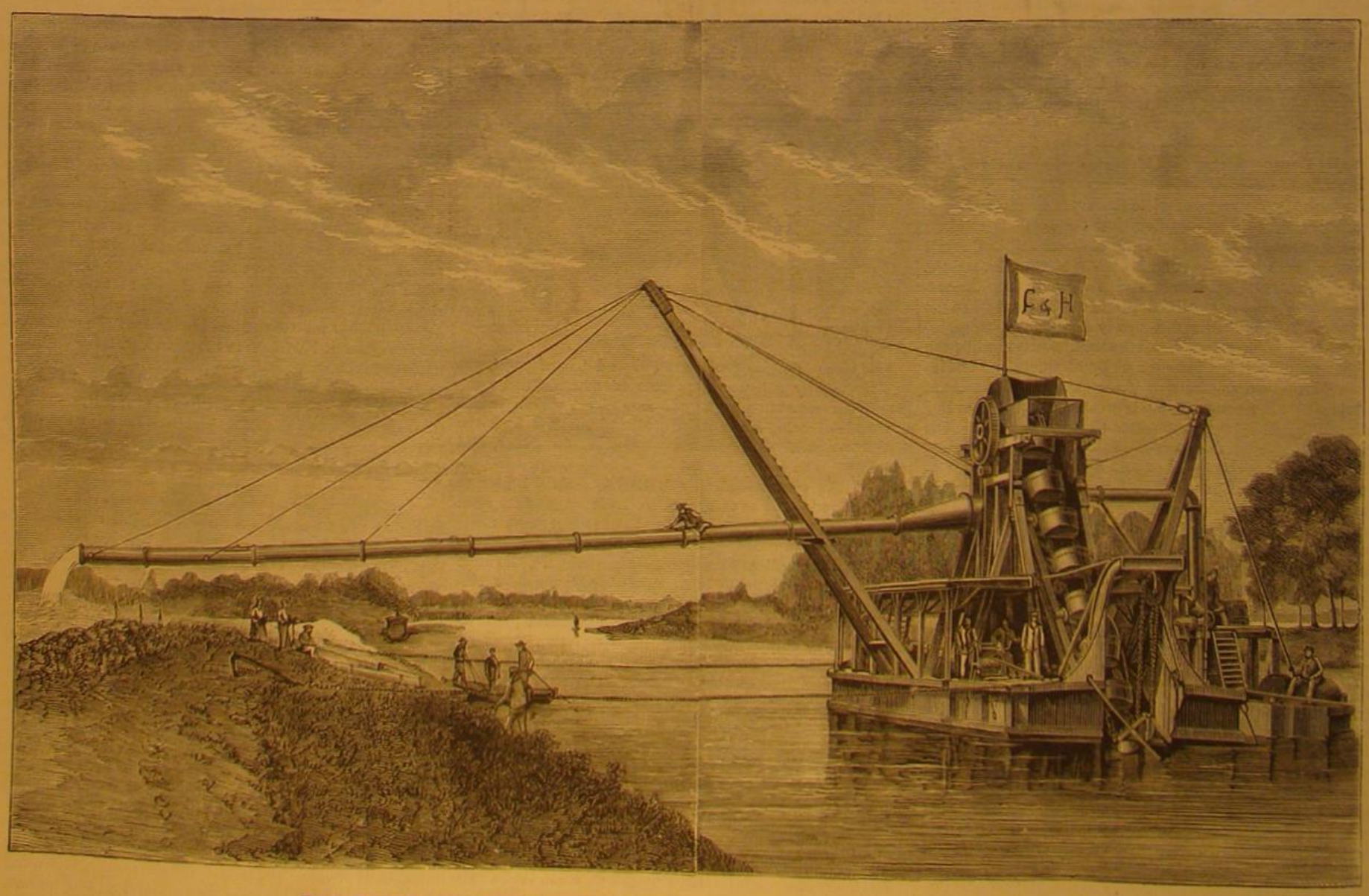


THE WALLACE-FARMER ELECTRIC LAMP.

EXCAVATOR ON THE GHENT AND TERNEUZEN SHIP CANAL, BELGIUM.

The floating dredgers employed in making the excavations on the Ghent and Terneuzen ship canal are 88 feet 7 inches long, 19 feet 8 inches wide, and 7 feet 9 inches deep; the arm is 39 feet 4 inches long, and passes through the hull. The axis of the driving wheel of the bucket chain is 26 feet 3 inches above the water level. A simple conductor has been used by which the sand and mud excavated can be delivered at a point 140 feet and 150 feet from the dredge and at a height of 13 feet above the water line. The excavated materials fall into the concave conductor, 6 feet below the point of their discharge, and, on falling, they encounter the action of a stream of water which is constantly pumped along the conductor, and by which they are converted into semi-liquid mud; the slope of the conductors is generally 1 in 2,000; it is supported by cables attached to a staging connected with the framing of the dredge, and the base of which rests on the deck of the vessel; the conductor is counterbalanced by a platform, on which is placed the portable engine and pump used for lifting the water into the conductor. This platform is suspended to the dredge in the same manner as the conductor itself, and the general arrangement is shown in the engraving. The supply and the maximum incline depend on the facility of disintegrating the ground, and on the quantity of water contained in the mixture. The proportions generally used are three parts of water to one of sand.

The floating excavators are placed on two hulls, carrying an iron framework on which is mounted the staging supporting the bucket wheel. The engines and boilers are installed in one of the hulls, and in the other is placed the pump and engine for driving it. The upper level of the conductor is 78 inches below the bucket wheel. The con-



EXCAVATOR ON THE GHENT AND TERNEUZEN SHIP CANAL BELGIUM.

ductor, 100 feet in length, is of the section corresponding to that of the buckets, 17¾ inches in diameter. It is supported by three cables attached to a staging, resting on the boat and secured to the bucket wheel frame. The slope is 1 in 400, which allows the material to be deposited at a level 22 feet 8 inches above that of the water.

The position of the depots often involves the necessity of transporting the dredged material to distances of 1,200 feet or 1,500 feet from the excavator. In such cases supplementary conductors are added. These are open, and are laid on the ground with a slope of 1 in 1,000. When this mode of transport cannot be adopted, barges are employed to receive the dredged material and remove it to convenient points of discharge.

The contractors for this work have adopted an arrangement which consists of a system of pipes with flexible joints floating on the surface of the water, and connected at one end with a well in the excavator, into which is discharged the dredged material mixed with water to reduce it to the desired consistency, and at the other end with a conduit on the bank where the contents are discharged. This arrangement, only recently adopted, has given every satisfaction.

THE PENCILED EAR HOG.

The Red River hog was described for the first time in the year 1848, by Professor H. Schinz, in his book on mammals as *Sus penicillatus*. Two years later a living specimen was brought to Liverpool from the River Comoro, and was bought in September, 1852, by the Zoological Society of London for their gardens. Mr. J. E. Gray described it in the "Annals of Natural History," in 1852, under the name of *Chœropotamus pictus*. As he, however, soon afterward found out that Cuvier had already given this to a fossil member of the hog family, he changed the original description to *Potamochœrus*. The *Potamochœrus pictus* and *Sus penicillatus* are one and the same animal, which Gray has established without doubt in the "Annals" of the year 1855, and the name "penciled siver hog" has remained as a generic title. The color of the "penciled ear hog" varies very much, and Du Chaillu has met with a white-faced one, which Dr. Gray has declared to be simply a variety of the species.

Milk Snake Swallowing a Striped Snake.

Mr. John M. Howey, of Canandaigua, N. Y., states that, in last August, while mowing out fence corners with a scythe, a milk snake (*Ophibolus*) started out of the grass in front of him. He struck it and cut it into two parts, the scythe passing within about three inches of its head. "Imagine," he says, "my surprise when a tail stuck out of the wound. I pulled it out and found it to be a snake of the common 'striped' variety (*Eutænia*), and about two thirds as long as the milk snake. It had, of course, been swallowed head first, and the head was nearly digested."

American Dinosaurs.

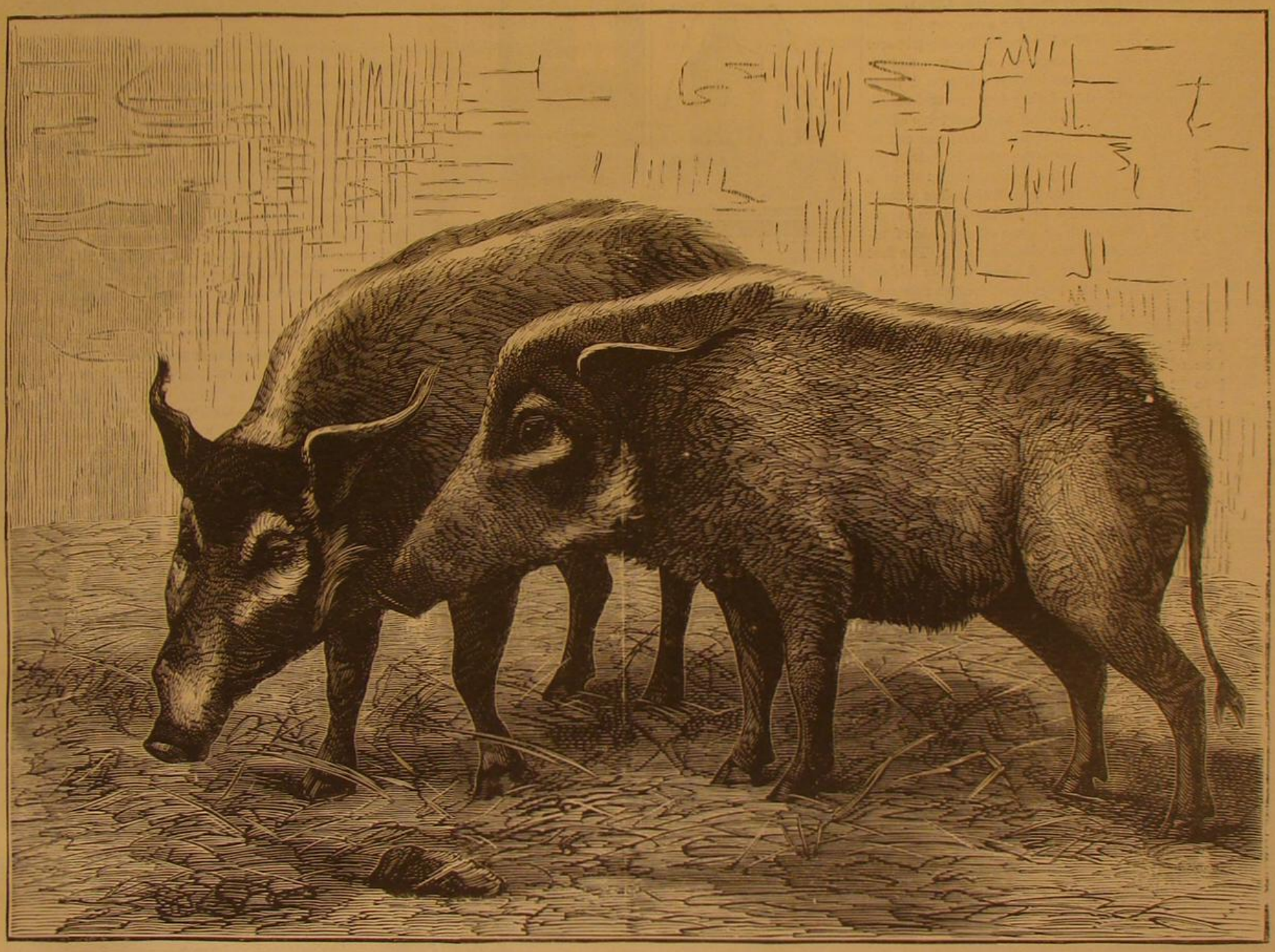
On the flanks of the Rocky Mountains a narrow belt can be traced for several hundred miles, which is always marked by the bones of gigantic dinosaurs. The strata consist mainly of estuary deposits of shale and sandstone, and the horizon is clearly Upper Jurassic; the dinosaurian remains in this series of strata are mostly of enormous size, and indicate the largest land animals hitherto known. One new species (*Atlantosaurus immanis*) must have been at least 80 feet in length, and several others nearly equaled it in bulk. With these monsters occur the most diminutive dinosaurs yet found, one (*Nanosaurus*) not being larger than a cat. Some of these new forms differ so widely from typical dinosauria that Professor Marsh has established a new sub-order to receive them, called *Sauropida*, from the general character of the feet. They are the least specialized forms of the order, and in some of their characters show such an approach to the Mesozoic crocodiles as to suggest a common ancestry at no very remote period. In them the front and hind limbs are nearly equal in size; the feet are plantigrade, with five toes on each foot. The carpal and tarsal bones are distinct; the precaudal vertebræ contain large, apparently pneumatic cavities; the sacral vertebræ do not exceed four, and each supports its own transverse process. The pubic bones unite in front by a ventral symphysis; the limb bones are solid. One of the species described and partly figured in Professor Marsh's paper, in the *American Journal of Science and Arts*, for November, is called *Morosaurus grandis;* when alive it was about 40 feet in length; it walked on all four legs, was probably very sluggish in its movements, and had a brain proportionately smaller than any known vertebrate

Cattle Raising in Montana.

While Montana is chiefly noted for its mineral wealth, it is claimed that not a little of its future glory will result from its value as a grazing country. The winters are long, yet horses, sheep, and cattle find subsistence on the nutritious grasses for which the Montana valleys are remarkable, and almost without care or attention. In the assessment for 1877 the enumeration of cattle was 182,659 head, all ages, valued at more than $2,000,000. To this amount must be added fully 50 per centum for 1878, and then far less than the real value will be covered.

A writer, who professes to be personally acquainted with the business, says that there are not less than 300,000 head of cattle now in the territory. There are several herds numbering from 3,000 to 5,000 head, and one now reaches fully 7,000 head. The average increase ought to be 80 per centum of the number of cows, but one third probably comes nearer the general increase. Four-year-old steers are considered beeves and 25,000 have been driven out of the Territory this year. Montana beef will soon take rank among the staple meats of the Eastern markets.

In making purchases for stocking a ranch a cow and calf would count as one, a yearling one, two-year-old one, and sometimes in making large purchases three-year-olds are included, and the whole would cost from $13 to $15 a head. If there were many of the three-year-olds this last price would be demanded. Beeves readily sell for $25. The larger the herd, the less the proportionate cost of keeping. In one case 50 cents a head a year will fully cover the cost, including taxes, but 75 cents would be nearer the truth generally. The grand "round up" for about six weeks in the spring and one month during the autumn, when the assorting takes place and the calves are branded, is the chief item of expense. Two years ago a gentleman bought 500 or 600 head of yearling steers at an average cost of $9 each. They were kept near his sheep range, and the expense of keeping was not more than $2 per head. They sold readily this year at $25 each, leaving a clear profit of not less than $14 a head. The profits resulting from this industry, at the lowest possible estimate, are more than 2 per centum a month on the capital invested. Indeed, many persons have borrowed money at that rate of interest and still made a handsome profit.



PENCILED EAR PIGS AT THE ZOOLOGICAL GARDENS, REGENT'S PARK, LONDON.

Popular Errors Regarding Papyrus.

In Adams' "Roman Antiquities" the Egyptian papyrus plant is described as about ten cubits high, and as having several coats or skins one above another like an onion, which coats were peeled off with a pin in the process of paper making. In Smith's "Dictionary of Greek and Roman Antiquities," it is said that the papyrus tree grows in swamps to the height of ten feet or more, and paper was prepared from the thin coats or pellicles which surround the plant. Liddell & Scott's Greek Lexicon says that paper was made of the inner bark of the papyrus. And similarly other works of high character, encyclopedias and the like, give a false account of this interesting plant.

Calling attention to these misstatements, in the *Library Journal*, Mr. Ezra Abbott, of Harvard University, says: "The papyrus plant (*Cyperus papyrus* of Linnæus, or *Papyrus antiquorum*, Willd.) belongs to the family of *Cyperaceæ*

or Sedges; it is an endogenous plant, with a triangular stem; and to talk about its "inner bark," and "layers" like the coats of an onion, is a simple absurdity. One might as well speak of "the inner bark" of a stalk of Indian corn or of a bulrush. The error has originated from ignorance or forgetfulness of the elements of botany, and the consequent misinterpretation of the passage in Pliny (*Hist. Nat.*, xiii. 11–13, al. 21–27), which is our chief source of information about the ancient manufacture of paper from this plant. One of the words which Pliny uses to describe the very thin strips into which the cellular substance of the stem was sliced in making the paper is *philyra*, which strictly denotes the inner bark of the linden tree, also employed as a writing material. Hence the papyrus has been conceived of as an exogenous plant, with its outer and inner bark, and has actually been called a "tree." The botanists of course have not made such a mistake.

Mr. Abbott points out a still more absurd mistake in the English translation of Guhl & Koner's "Life of the Greeks and Romans," which says: "The stalk . . . was cut longitudinally, after which the outer bark was first taken off; the remaining layers of bark, about twenty in number (*philyra*), were carefully severed with a pin; and, afterward, the single strips plaited crosswise; by means of pressing and permeating the whole with lime water, the necessary consistency of the material was obtained." The word mistranslated lime water is *Leimwasser*, which means glue water.

Nitric Acid Produced by the Electric Light.

Mr. T. Wills, F.C.S., has been making some experiments on the production of oxides of nitrogen in the electric arc. The atmosphere of course consists mainly of oxygen and nitrogen, but simply in a state of mechanical mixture; if these gases become chemically combined, they form several oxides of nitrogen, most of which are strong and corrosive acids. At a high temperature small quantities of these gases can be made to unite. This is the case when electric sparks are passed through air; also during the combustion in air of a very hot flame, such as that of hydrogen; it therefore seemed probable that, as the temperature of the electric arc is undoubtedly very high, nitric acid, or some other oxide of nitrogen, might be produced by the electric light. The first experiment was rather surprising. A glass cylinder placed over an electric lamp (Foucault's regulator) for two minutes, and afterward examined, was seen to contain a perceptible amount of red fumes, due to peroxide of nitrogen (N_2O_4). The air surrounding the lamp was next drawn through a solution of potash, and the amount of nitric acid estimated; this gave 10 to 12 grains of nitric acid produced per hour (it may eventually prove to be more, the difficulty being to collect the whole of it). The next step in the research will be to examine the various forms of electric light, with a view to determine the amount of nitric acid produced by each. One of the advantages heretofore claimed for the electric light over gas light has been that the products of combustion of the former were harmless, while gas light produces the deadly carbonic acid.

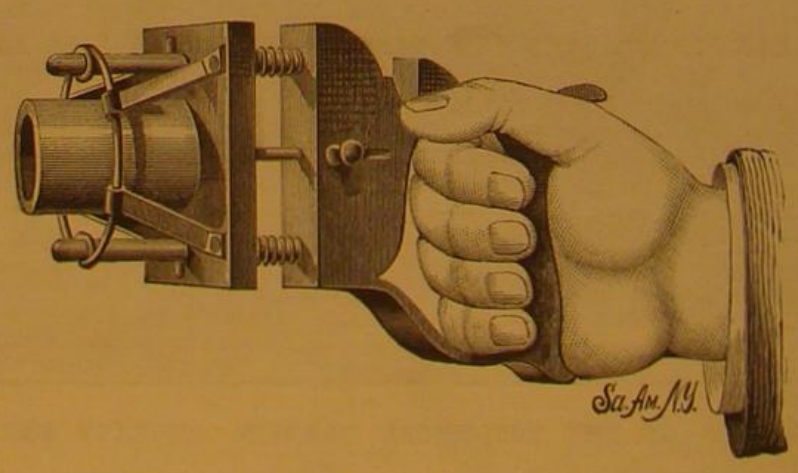
A NEW FIREARM.

The novel firearm shown in the accompanying engraving consists of a short barrel attached to a base plate that slides upon two rods projecting from the handle. The barrel is pressed forward by spiral springs which surround the guide rods. The handle or stock is similar to a saw handle, and contains a lock or spring mechanism which throws the needle forward into the cartridge when the trigger is pulled.

The recoil which follows the discharge of the weapon is taken up by the spiral springs, thus relieving the hand from the shocks which generally follow the discharge of firearms.

This weapon would seem to be especially useful in fighting at close quarters, as in the case of a marine engagement. Its large caliber enables it to carry formidable and effective ammunition, while its length is such that it can be used when rifles and ordinary pistols are useless. Either shot or shells may be used.

This firearm was recently patented by Mr. Jarvis Royal, of Rochelle, Ill., from whom further information may be obtained.



ROYAL'S IMPROVED FIREARM.

Wine from Oranges.

Experiments have recently been in progress in countries ravaged by the phylloxera, in regard to the substitution of orange juice for grape juice in wine making. The first wine made from oranges, in Spain, has just made its appearance in the market of Valencia. Four kinds have been produced, one of them a sparkling wine. They are all said to be of an attractive color, perfectly clear, of an agreeable, sweet, slightly acid flavor, and of an alcoholic strength of about 15 per cent.

A Little Seaport's Monopoly.

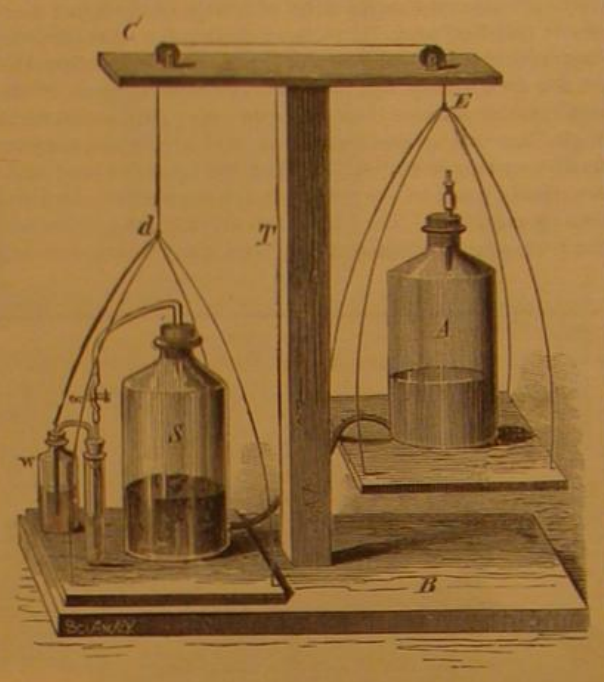
The little seaport of Scituate, Mass., is almost the only place in the country where "carrageen," or Irish moss, is gathered and cured, although it may be found everywhere along the coast of eastern New England. Scituate is the great center of the moss business, and supplies the entire Union from its beaches. The moss is gathered by means of long rakes into dories, and the wives and daughters of the boatmen prepare it for the market. Everybody knows its use in jellies and blanc mange, and it is also largely used in the manufacture of lager beer. The annual product is 10,000 or 15,000 barrels, worth to the producers about $50,000. About 150 families are engaged in harvesting the moss.—*Worcester (Mass.) Spy.*

A NEW FORM OF SULPHURETED HYDROGEN APPARATUS.

BY LE R. C. COOLEY, PH.D.

Since hydric sulphide is one of the most indispensable and troublesome of chemical reagents, no apparatus can be more welcome to the chemist than one which is able to yield an abundant supply of this gas and at the same time shield the laboratory from invasion by its disgusting odor.

To furnish the gas at any moment, to generate it only when in use, to retain the excess, which escaping in bubbles from the fluid under examination contaminates the atmosphere, and at the same time to be easily and cheaply constructed and conveniently used; these are the most desirable qualities of the apparatus, but qualities which hitherto have been found very difficult to combine. Believing that no other form is at once so efficient, so nearly odorless, so cheap, and so convenient in use, I offer the following description of an arrangement represented in the accompanying cut:



Notice, first, the plain but strong wooden frame, consisting of the base board, B, the standard, T, supporting the crosspiece, C, on top of which, near its ends, are two iron pulleys.

Notice, next, two platforms, each provided with four stiff curved iron wires, which meeting at the points, D and E, are fastened to the opposite ends of a strong cord passing over the pulleys at the top. By this means the two platforms, like a pair of scale pans, have a free vertical motion.

The materials for generating the gas are placed in two bottles, A and B, one on each platform. These bottles being tubulated near the bottom are connected by means of a piece of thick rubber tubing, which is rendered more impervious to gas by immersion in melted paraffine. The bottle, A, is to be filled to one half its capacity with the dilute acid, while in the other bottle, S, fragments of the ferrous sulphide rest upon a thick layer of broken glass or of silicious pebbles.

The gas bottle, S, is provided with a tightly fitting rubber or paraffined cork stopper, through which passes the delivery tube, which may be opened and closed at pleasure by means of the usual nipper-tap arrangement shown in the cut.

At the lower end of the delivery tube is a long tapering rubber stopper perforated with two holes. One of these holes is lined with a piece of rubber tubing, the ends of which project a little beyond the stopper. The end of the delivery tube is thrust into this rubber tube until it reaches half way through the stopper. This arrangement permits the insertion of a separate piece of glass tube into the lower end of the stopper, by which a solution may be fed with gas, and its removal for cleansing after each operation. From the other perforation of the stopper a bent tube passes over into a bottle of ammonia water, W. The cut represents this apparatus in operation.

The fluid to be tested is placed in either a test tube or flask. For small quantities the tube is very convenient. The operation is as follows:

Insert the short glass tube into the lower end of the stopper. Press the tube or flask containing the fluid up until its mouth is tightly closed by the tapering stopper. Depress the platform carrying the gas bottle, and carefully open the nipper tap. The acid flowing from the bottle presses the gas from the bottle, S. It bubbles through the liquid in the tube or flask, and the excess then passes over into the bottle, W, where it is completely absorbed by the ammonia. Close the nipper tap, lift the platform carrying the gas bottle, remove the test tube or flask and also the short delivery tube from the stopper; the apparatus is then ready for the next experiment.

Whether the apparatus is used continuously or at intervals, the joints being well made and the foregoing directions carefully followed, the laboratory will be free from the odor of the noxious gas, except that due to the small quantity that remains filling the tube or flask when it is removed.

A single apparatus with bottles of one gallon capacity has furnished the gas needed in the Vassar laboratory for the last three years, the classes numbering from 25 to 50 students. The exhausted acid is easily replaced, and the ammonia removed from time to time, as may be necessary.

Brier Root Pipes.

Much of the wood used for making the so-called "brier root" pipes is derived, it appears, from Corsica. The white heath, or *bruyère* (of which "brier" is a corruption), grows in great luxuriance and very abundantly among the trees and shrubs which form what is called the "maquis" covering the mountain sides.

In the course of the last few years, since brier wood pipes have become such a large article of trade, the heath trees have become a source of lucrative industry. The roots are dug up and cut into rough forms of tobacco pipes by circular saws worked by the water power of the mountain streams. The pieces, when cut up, are sent in sacks to France, and thence to America, to be eventually manufactured into "brier root pipes."

Cincinnati Faience.

The fine enameled ware known as Cincinnati faience originated with Miss M. Louise McLaughlin, of that city, whose experiments were first successful in 1877. It is fired in a kiln at the temperature of 9,000°, the famed Limoges faience of France being fired to no more 5,400°. The enamel of Cincinnati faience is exceedingly brilliant in color, and so hard that the point of any steel instrument is said to make no impression upon it. This invention is indirectly a result of the excellent schools of design for which Cincinnati is justly honored.

New Mechanical Inventions.

Mr. Christian Bissmann, of New York city, has patented an improved Spring Balance that takes up less space than the ordinary weights and pulleys, and by which the raising and lowering of the sash are accomplished easily and without noise.

An improved Alarm Bell has been patented by Mr. Charley H. Smith, of Delphos, Ohio. This is an improved fire alarm, which is simple in construction and is easily and conveniently operated.

An improved Cane Shaving Machine has been patented by Messrs. Charles L. Jones, James W. Smith, and Henry H. Adams, of Gardner, Mass. The object of this invention is to construct a cane splitting machine that will permit of changing the knives without loss of time, and also to make the knives adjustable according to the size of the cylinder.

Mr. Julius Bluemel, of San Francisco, Cal., has patented an improvement in Breech Loading Firearms, the object of which is to obtain rapidity in loading and firing shotguns and rifles, and prevent liability of accidental discharges.

Mr. Hosea T. Stock, of Toledo, O., has patented an improvement in Supporting Frames for Excavating Machines, which can be loaded, supported, and moved from place to place on a railroad track, upon an ordinary flat or platform car. Only certain portions need be removed in order to enable the apparatus to be transported like an ordinary railroad car.

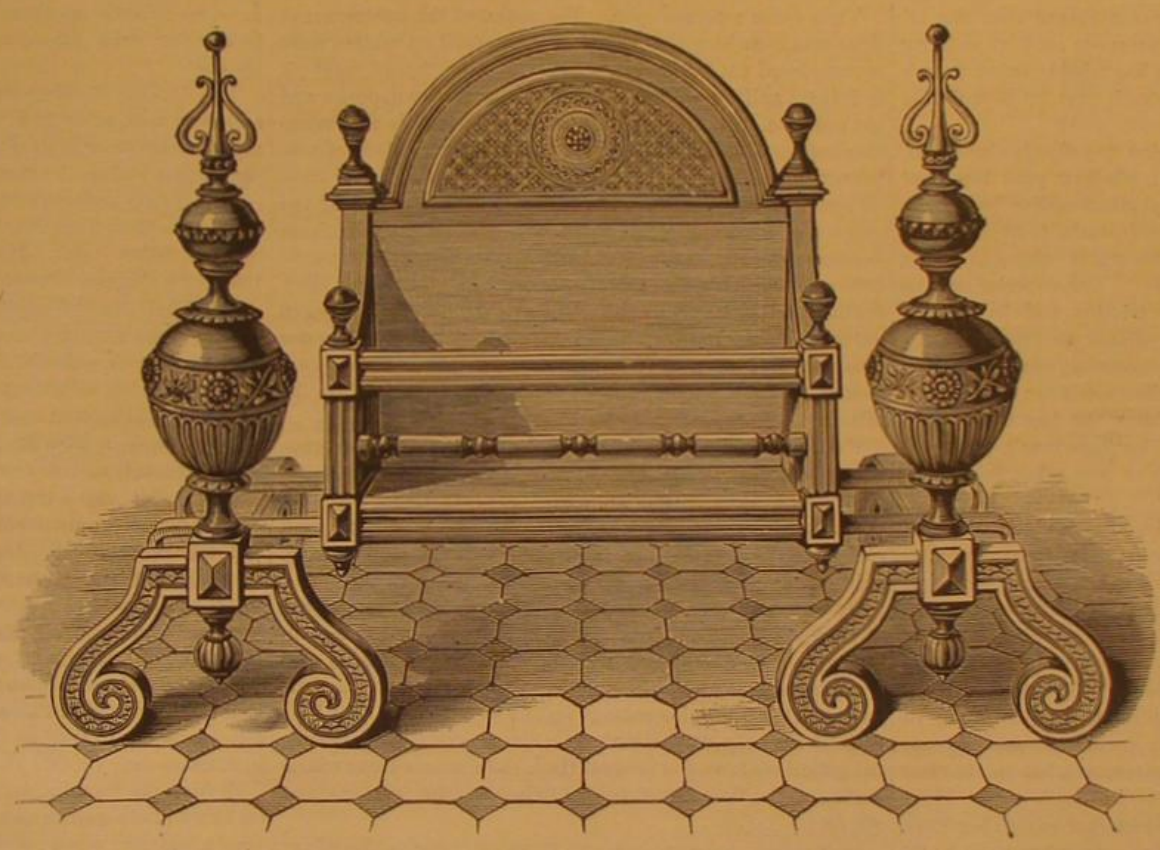
New Caustics.

Two caustics, which promise to be most valuable, have recently been introduced to the notice of the medical profession by Dr. B. W. Richardson. They are sodium and potassium alcohols. When applied to the skin these alcohols are said to cause "gradual destruction of tissue, which may be so moderated as hardly to be perceptible, and may be so intensified as to act almost like a cutting instrument."

These caustics have the advantage that they will dissolve opium, like ordinary alcohol, and also that their action can be stopped immediately by dropping on the eschar a little chloroform, which decomposes the caustic into chloride of the metal and triethylic ether, which is inert locally.

ELIZABETHAN FIREPLACE.

The accompanying engraving represents an Elizabethan fireplace from the factory of Messrs. Barnard, Bishop & Barnard, of Norwich, England. This admirable specimen of ironwork was a part of the furniture of the Elizabethan house placed at the disposal of the Prince of Wales at the Paris Exhibition.



ELIZABETHAN FIREPLACE IN THE PRINCE OF WALES' PAVILION, PARIS EXHIBITION.

The American Potteries.

A *World* reporter has gathered some interesting facts regarding the growth of the pottery industry in this country during the last twenty-five years, and the present condition of that industry, from which we extract:

At the last convention of pottery manufacturers, held in Trenton a few weeks ago, forty firms were represented, including manufacturers of yellow and Rockingham wares, of cream colored china, of white granite ware, and of pure china and decorated goods. Pottery, as a distinct and important industry, was not known in this country twenty-five years ago. There were potteries then, but they turned out only the most common articles and of a poor quality. At that time the tariff on imported pottery, exclusive of the best china and decorated ware, was 20 per cent, and so it remained until 1861, when it was raised to 25 per cent. The protection thus afforded, although small, gave an impetus to the trade, and better wares were immediately put upon the market. When the tariff was finally raised to 40 per cent the industry leaped up, and at present there are enough potteries in operation to produce twice the quantity of wares imported from Europe and Asia. The result, the potters claim, has been, in a general way, to reduce the price of wares, so that jobbers can sell them 18 per cent cheaper than they could in 1860, and to improve the quality of the goods themselves.

A minor hinderance to the progress of the industry has been the high price of clay, flint, and spar, the materials most largely used in manufacture. The difficulty in this respect is not yet altogether obviated, for the best imported qualities may be obtained at less cost in this city than the best qualities from Missouri. Such a condition of affairs will soon end, however, if the project of the convention—to co-operate with the owners of the best mines and clay beds to the extent of encouraging them to wash the ball clay—should be carried out with success. The manufacture of yellow and Rockingham wares, which is conducted chiefly in the West, was the first step toward introducing home products into the market. These wares are of the cheapest and most common order. Cream colored ware, which is manufactured chiefly at East Liverpool, Ohio, Jersey City, and Trenton, is next in the order of superiority. It includes common table ware and household crockery. Next in the order of manufacture comes "white granite," sometimes known as "American china." It is the best porous bodied ware, and is superior to cream colored ware chiefly because it has a vitreous glaze. It also is manufactured in Trenton, where there are sixteen potteries, and in other places in a smaller way. The manufacture of china is confined almost exclusively to Greenpoint, where it was first tried as an experiment in 1863, although no goods were put upon the market for two years afterward. The superiority of china to other wares for household use is due to its homogeneity in body and glaze, neither of which is porous. Experiments in designing and decoration were from the first quite expensive, and had it not been for the high prices which prevailed for all sorts of ware during and soon after the war, the manufacturers would have abandoned them. Their aim has been to supersede not only imported ware, but foreign designs, and to give to the decorated goods that leave the factory a distinctive American character. The Century Vase, for instance, which was exhibited at the Centennial, has a central figure in relief of Washington, medallion style, embellished at the corners with small pictures representing the chief industries of the country. Tea and dinner sets are decorated with native leaves or ferns, or in a style pronounced and original.

MALLEABLE BRASS.—A German periodical is responsible for the following method of making malleable brass: Thirty-three parts of copper and twenty-five of zinc are alloyed, the copper being first put into the crucible, which is loosely covered. As soon as the copper is melted, zinc, purified by sulphur, is added. The alloy is then cast into moulding sand in the shape of bars, which, when still hot, will be found to be malleable and capable of being brought into any shape without showing cracks.

Weatherproof Houses.

The conditions essential to what may be called comfortable house building—just now forced upon us by the weather—seem, if not misunderstood, to be willfully misapplied by some architects and builders. The gospel of true economy has been preached to them with unremitting zeal, but as far as house construction is concerned, with little or no good result. We constantly see houses built with the intention, apparently, of wasting heat and space, and these two fundamentals are considered to be provided for if the grates are not made too deep or large, and the front passages or halls are squeezed to the narrowest proportions. The most commodious of all forms in which a house can be built is a square. Now it must be noticed the builder adopts this shape of house because it saves the expense of outside walling and expensive roofing, and the architect abhors it because it is inartistic. The consequence of which is that the square or bungalow form of dwelling, even in the suburbs of towns, where it is most appropriate, has grown unpopular of late years, more especially since Gothic has been the prevailing style. It is satisfactory to find a return to it, though economy has less to do with the matter than fashion. Now, we believe economical house building near all large towns must ultimately adopt the square or rectangle. But there is something more in the square plan than a saving of walling and roofs. It is the only form that economizes the warmth of a house, as the larger proportion of the wall surfaces are internal. In the irregular and picturesque style the outer walling is so much more cold surface added to the work the fires have to perform; and we may say the waste of heat in the fashionable villa residences is quite 30 per cent more than in houses built in the row. The "picturesque loving" architect—and who is there that does not admire the accidental grouping and succession of breaks and gables in an old manor house of the later Tudor or the Stuart period?—increases his external walling by every projection and recession he makes; in fact, one of the articles of his creed is to pronounce his separate rooms, which cannot be done except by adding to their outer exposed surfaces. All these charms of piquancy and outline are unfortunately bought at the cost of fuel and comfort, and we may appeal to every candid and outspoken member of the profession in whom the man of science is not irretrievably lost in the enthusiast for style, whether a house of the square form is not more comfortable than the irregular and gabled villa or chateau? But the principle is self-evident that in a plan of square form the outside walls are minimized, and the internal warmth of a central stove-heated hall or the internal fireplaces equably diffused throughout every part of the building. The advantage of well built hollow walls, and the importance of damp-proof courses, we need not in a professional journal insist upon. In considering walls, however, the question of a facing occurs; and the profession generally have set their faces against cement as an external covering.

We are not inclined to enter again into a controversy that has been waged so often—a correspondent the other day in our journal discussed the subject from a practical point of view—but we think that there has been a great amount of absurd prejudice entertained by architects of the muscular Gothic school against the use of Portland cement. The fact is the material was so abused by a former generation—it covered up such vices of construction—that a well founded contempt for stucco sprang up. But why should a valuable material suffer because of its ignorant employment? For Portland cement is a most valuable ally to the architect when employed rationally, and for the outer surfaces of rough brick or concrete walls it is often absolutely necessary. The great evil of its use, we have always contended, is its being made to represent such features as stone cornices, trusses, and other details for which stone or bricks can be only rightly used; but if used for the plain surfaces of walls it admits of many forms of appropriate decoration.

The next important feature in a weather-proof house is the roof. Here, again, the advantages of a plan in which the external boundaries partake of a square are obvious to every practical builder, but for like reasons to those at which we have hinted in regard to irregular houses, the fact is disregarded by the "artistic architect." A square trough shaped roof is both unpleasing and easily choked up, and a lofty pyramidal roof is quite as ungainly and ugly. But both these evils can be obviated by making one or two slight breaks, by which a rectangular arrangement of two or more span roofs may be gained, always remembering that the simpler the roof is, and the fewer its component parts, and therefore gutters, valleys and hips, the better. It is somewhat amusing to find this rule disobeyed, all conceivable jumbles of steep roofs, flats, and gables being adopted to produce piquant bits of effect by the young architect, though it is by no means a laughing matter with tenants who have to do external repairs. The bad arrangement of roofs with respect to aspect is one of the commonest defects. It is not unfrequently that one sees a house with the valleys opening toward the most exposed quarter, or a series of open gutters in such a position that every wind would convert them into eddying troughs. Hopper-shaped roofs and inclosed gutters are arrangements always better avoided, and the principle should be to expose as little roof surface to the wind and wet as possible. The conformation of a roof we believe to be of immense importance to the comfort and security of a house, and no part thereof should be open to the attacks of heavy rainfalls or severe gales. For duchess or countess slates a lap of 3 inches is not too much for ordinary pitches, and 2 inches is much too small; each slate should be secured with two nails, and these ought always to be of copper, zinc, galvanized iron, or dipped in oil. Again, lead should be of at least from 6 lbs. to 7 lbs., the latter in the flat gutters and the former in the hips and valleys. Patent ridge and hip rolls, made of slate, fastened with screws set in oil putty, are next to lead in effectiveness, and it should ever be remembered that cheap roofs are the dearest in the end.

There is also an immense amount of ignorance about chimney building, or as to what constitutes a good drawing and what a bad drawing chimney. We know it is perfectly useless to frame a code of rules on chimney building, when the exigencies of house design have to be consulted, but when nothing interferes all chimneys should be placed on the sheltered sides, as internal stacks undoubtedly draw the best. Chimney stacks should always be built high enough to clear the effects of obstructing roofs, as a "blow down" is often experienced in flues that barely overtop an adjacent roof, and in those in a valley between two roofs. Of course, the inducing currents must be considered in reference to the prevailing winds, and not from the lee sides. One common error is to make flues too capacious, and to build them with large throats, the consequence of which is the upward currents or gases are cooled down and the velocity retarded. The heated gases ascend in the center of the flue, which, if too large, cause down currents to be established, and the phenomena of smoky chimneys are greatly due to this cause. We might extend these remarks to the best position for fireplaces, upon which much might be said; but, as we have just remarked, the exigencies of plan are paramount, and the builder or architect has to consider rather the least objectionable of modes than the adoption of the best course.—*Building News.*

Staining Floors.

THE London *Furniture Gazette* commends the following method of staining floors in oak or walnut colors: Put 1 oz. Vandyke brown in oil, 3 ozs. pearlash, and 2 drms. dragon's blood, into an earthenware pan or large pitcher; pour on the mixture 1 quart of boiling water; stir with a piece of wood. The stain may be used hot or cold. The boards should be smoothed with a plane and glass-papered; fill up the cracks with plaster of Paris; take a stiff brush, dip in the stain, and rub this in well; the brush should not be rubbed across the boards, but lengthwise. Only a small piece should be done at a time. By rubbing in one place more than another an appearance of oak or walnut is more apparent; when quite dry the boards should be sized with glue size, made by boiling glue in water, and brushing it in the boards hot. When this is dry the boards should be papered smooth and

varnished with brown hard varnish or oak varnish; the brown hard varnish will wear better and dry quicker; it should be thinned with a little French polish, and laid on the boards with a smooth brush.

THE LURAY CAVERN.

BY H. C. HOVEY.

(*Continued from page 37.*)

At the southern end of the area known as the Elfin Ramble begins Stonewall Avenue, not yet thoroughly explored, but seeming to lead toward Ruffner's Cave. Its chief attractions are Brand's Cascade, unsullied alabaster, and the most beautiful formation of its kind in this locality; the Twin Lakes, united by a tunnel; a curiously carved and inlaid floor; a bank with a profusion of mottled drapery; and also various grotesque similitudes.

On returning we cross a natural bridge to the Imperial Spring, 16 feet deep, in a grotto 35 feet long and 25 wide. Brown columns form the wall, with white stalagmitic statuettes set in niches, and between them snowy alabaster gushes out and over the rocks below. The roof slants from front to rear, and is set as thickly as possible with stalactites about a foot long, and averaging by count 64 to the square foot. Calculating on this basis, there are within this little grot 44,800 pendants, each tip glistening with a pearly drop. What millions there must be in the whole cavern!

One of its distinguishing features is the existence of these pools. There are hundreds of them. None of true springs, and none are large enough to be called lakes, though both terms are used. The basins vary in size, from 6 inches to 50 feet in diameter. They are often found in strange places; on a ledge, on top of a mound, or on an overgrown stalagmite. The water is so absolutely transparent that the incautious explorer may learn of its presence only by walking directly into it; and more than one has tried to drink from a bowl that had run dry. This purity is due to percolation through the rocks.

The refined carbonates in solution are slowly deposited. Where continuous trickling into a shallow pool has kept the water in a state of agitation, spherical bodies have been formed. These concretions are called pearls, marbles, birds' eggs, and snowballs, according to their size; there is a very large one called the "cannon ball." The exterior of the nodules is often highly polished by friction, and the interior, on fracture, exhibits a shining, radiated structure. They become attached to the bottom whenever aqueous agitation ceases; and, if the drip meanwhile continues, they often grow up into a cone. This explains the fact that stalagmites frequently rise out of pools. The same result, however, would ensue if a bit of limestone or any other hard substance should fall into the water.

It was some time before we realized the fact that all these calcareous basins were built up by deposits from the water they contained. The beautiful crystals, drusy, feathery, fern-like, lining the sides and bottom of every water-filled cavity, are not mere ornaments. They are the materials of which the walls are made. Under the microscope grains from the substance of the wall are identical with the lining crystals, in shape as well as composition. Many of the well known varieties of calcite are found; and in some of the long crystals a prismatic development led us to class them as aragonite.

The more rapid evaporation at the surface so aids the work of crystallization as to make the edges grow over the water and give the exterior of the basin a remarkable curve, of which a beautiful illustration is given in the structure of the Coral Cascade, near the farther end of the cave. Ten little terraces, with ruffled margins, rise in succession, each catching the overflow of the one next above, and the upper one is over three feet deep, with the front greatly curved. The appearance of the crystals is not unlike the grouping of corals.

The variations of water level are strongly marked by rings or ridges, especially in some of the larger pools. Brodus Lake, for instance, not only reposes on a bed of crystals, overarched by a vault bristling with stalactites, but it is girdled by a crystalline strand once covered by its bright water. It is now 50 feet across, but was formerly twice as wide and 5 feet deeper, judging from the curved rampart, whose margin it must have touched, and whose horizontal folds clearly indicate the changes of level. To the same cause are due the outgrowths about the roots of some rich buff stalagmites slashed with white, and others less conspicuous. These are flat on top and rounded underneath like varieties of woody fungus. They vary in size from one to 8 inches, and some of them have a velvety coat of olive-tinted crystals and are tipped with red and purple.

When the excess of carbonic acid, by which the carbonate of lime is held in solution, evaporates rapidly, besides the crystal crust below, a sheet, like a film of ice, is also shot across the surface. A fine example of this is found at the Fairy Spring, whose brim nearly meets the stout stalactites that hang above it; and whose surface, 12 feet broad, only shows half its extent, the rest being concealed by such an icy film as that described.

We nowhere found the acicular crystals of sulphate of magnesia, nor the gypsum rosettes, for which the caves of Kentucky and Indiana are so celebrated.

But we are lingering too long amid the sparkling pools and their calcite gems. We cross Pluto's Chasm, near its southern end, where a curious palisade of stalagmites grows to bulky dimensions on the further margin. By the bridge stands Proserpine's Pillar, one half brown and the other white. Down the dark gorge a specter seems to wave its arms. It is only another snowy column.

On the left a sloping ascent of red clay, deeply furrowed, shows that we are not far from the surface. As a visitor was writing up his notes, near this point, a rabbit sprang by, upsetting his lamp, and disappeared up the slope. A pit of considerable size, not far away, together with our subsequent survey of the surface, indicates that the locality is directly under the great sink northwest of the entrance.

After admiring the charming formations of Oberon's Grot, and especially the Crown and Fairy Veil, an elegant bit of transparent drapery, we pass beyond a stalagmitic curtain, only 6 inches thick at the edge, but 30 feet wide and 50 high, and find ourselves in the Giants' Hall, of whose concourse of wonders no clear idea can be had without repeated visits.

Seated on this Fallen Column, that looks like a prostrate and moss-grown oak in the forest, let us study cave history.

The popular notion that volcanic upheavals caused these subterranean cañons is correct probably only as to the original rift in the rocks; all else was done by the chemical and mechanical action of acidulated water. This subtle agent sought out the joints, seams, and other lines of weakness, till the water-swept channels deepened into what is now Pluto's Chasm. Softened ledges were dislodged, successive floors undermined and cut through, walls between this and other chasms broken down, until cavities were finally scooped out far more prodigious than those now visible; and the axis of erosion was S. W. to N. E. Branches at different levels were also excavated.

Room was made by this means for calcareous deposits, and the vast halls began to be slowly filled up by stalactites and stalagmites, many of them growing to great size.

Then came a catastrophe. The outlet of the subterranean river was somehow obstructed, and the pent up waters were accumulated till the entire cavern was filled from lowest pit to loftiest gallery—a fact proved by the earthy deposits and the uniform erosion of dripstone. (Dripstone is a term authorized by English geologists, representing all kinds of cave formations.) During this period, whose duration we have no means of conjecturing, the carbonic acid absorbed by the rain water from the atmosphere, and more especially from decomposing vegetation and surface soil, would be brought into contact with the calcareous deposits, destroying their texture and causing a species of decay. Under the blackened exterior of this Fallen Column is what once was alabaster firm as ivory, but now it is transformed into a chalky substance, through which a knife blade can be thrust to the hilt.

Finally a new outlet was found, independent of the original system of drainage, and supposed to be in the deep spring near Blackford's Furnace. There is every indication that the waters departed with violence, tearing down loosened rocks, hurling stalactites to the ground, and felling huge columns like trees in the tornado's path.

On an eminence to our right stands a sublime monument of aqueous energy. It is the Hollow Column, 100 feet in circumference and 40 feet high. Finding it too rugged and compact to be overturned, the fierce waters pierced its marrow, leaving a tubular passage from top to bottom that is at present the only way of access to the extensive and beautiful galleries above the Giants' Hall, the distance from whose ceiling to the floor below is said to be in certain places about 160 feet.

In Stebbins Avenue, near the entrance, besides the Silver Lake and other attractions, is the Leaning Tower, a mass of stalagmite, whose enormous weight broke down the ledge of limestone, 3 feet thick, on which it had been created. The waters undermined it, and it fell about 6 feet into the depression, where it now stands amid a broad pool; it was not overturned, only tilted like the Campanile of Pisa.

The flow of subsiding waters became gentler toward the last, merely removing the softened exterior of the dripstone, leaving a wavy surface with sharp angles and polished sinuosities, often exhibiting diversified layers like the gnarled grain of precious woods.

The volumes flooding the cavern from the funnel-shaped sink overhead brought in, first and last, a quantity of clay and soil equal to the dimensions of the sink, plus the washings from the upper hillside. The sink is now about 800 feet across and 40 feet deep, and may have been larger before the general surface was lowered. Hence the sum total of alluvial filling is many thousand cubic yards. This cause, together with the decomposition of dripstone, accounts for the embankments in the Elfin Ramble, whereby that portion narrowly escaped obliteration.

Quiet having been restored, and the water trickling instead of rushing, a totally new set of stalactites came into existence. Some of them were formed, as usual, from the crude materials furnished by limestone; but others from the refined substance already once used in the older formations.

Thus originated very striking contrasts. How grandly the Angel's Wing, with snowy plumage, sweeps out from the dingy and corroded mass whose inner substance it only recasts! Those softly-draped and tinted figures in the Saracen's Tent really owe their being to the grim ogers that guard them. The finest of them all, 8 feet high, and lovely as a Houri, has its rippled and dimpled contour, because the pellucid alabaster so faithfully followed the wrinkles, while it rounded the angles of the ancient and worn form that it incases.

Before leaving the Fallen Column let us take its measure and ask its age. It is exactly 12 feet in diameter and 21 feet long as it lies, with its butt lower than its tip, shortened at least 15 feet by the fall. By burning magnesium we discern far above us the scar made when it was wrenched away and fell swaying to and fro. Time enough has elapsed for a cluster of stalactites to form hanging transversely from the end now uppermost. They are 11 inches wide and 4 feet and 5 inches long. According to long-continued observation of the rate of stalactitic growth in Wyandot Cave the age of this group would be exactly 1,325 years. But the only way to tell the age of Luray Cavern is by a series of local experiments; and even then only an approximation can be made.

Music may be had in these subterranean halls. Mellow tones, like tolling bells, follow blows on the Chimes. Another large group of musical stalactites is well named the Organ. It fell, with the ledge on which it grew, points downward, into the mud, leaving many of its 56 pipes free and sonorous. They are solid, not tubular, and vibrations of the larger ones last a full minute. The entire musical scale can be produced by striking selected stalactites, and simple airs may be played by a skillful hand.

Space is desired for more than the mere mention of Babel, with its 22 stories rising on dwarf colonnades; the Mosque, with its domes and minarets; the Bridal Chamber and its alabaster floor; the Turbaned Sultana; the Empress Column, white, with a pink capital; and many a stately but nameless shaft. A secret way leads back from the Spectral Column to the Empress, and on to the Pavilion.

The Swords of the Titans are monstrous blades, 40 feet long, suspended from aloft, and keen of edge. Their hollow structure can be seen where was once broken off a section that has now disappeared. Their origin, and also that of the delicate scarfs already described, is in trickling limestreams, running together on a sloping surface and then growing downward till the curved sides meet in one edge. Acids have made some specimens in the cave look like sides of leather or even like threadbare blankets and flimsy old shawls.

The Double Column is surrounded by the Naiads' Bath, and is as unique as it is grand. A stalactite, 50 feet long, tapers to the floor with unbroken longitudinal grooves. Its companion stalagmite, instead of meeting it point to point, rises in joints and stories 30 feet and holds it in an embrace.

The Pavilion is approached through a corridor walled in by huge fallen rocks. It is circular, with many alcoves; is 100 feet wide, and is floored for the use of assemblies.

The Chalcedony Cascade, at the entrance of this room, is a mass of mammillary alabaster, 25 feet high and 30 wide, a continuation of a similar formation above, that can only be seen by difficult climbing. It is semicircular and remarkable for its variegated hues: brown, yellow, steel-gray, ashes-of-roses, drab, milk-white, and blue. It is a new formation upon the old, and a row of stalactitic teeth 4 feet long, ancient relics, skirts the base.

By a perilous ascent over stubby stalagmites we gained admittance to Campbell's Hall, and a noble room to its right. In the former stands the Mermaid, 5 feet high, tapering from 2 feet at the base to 1 at the flat white top. Strings of shining beads adorn the sides downward, growing into scales like those of a pine cone, only pearly instead of brown, and with pink edges. Increasing still in size they turn to a lead-blue. Dispersed about the base are little white stalagmites seeming to float on milk. Brown mossy crystals grow in clusters near by this marvel of beauty.

Beyond the Pavilion is the Coral Cascade, and still further on an exquisite grotto named in honor of Mr. J. J. Collins, whose graphic word-painting and ingenious theories have interested so many thousands in the scenes of Luray Cavern.

The distance from the entrance directly to Collins' Grotto does not exceed 1,500 yards, and might be shortened. But the tunnels, catacombs, and galleries expand into a labyrinth, for exploring whose intricacies many days are required. The task will be much abridged when the proprietors carry out their plans for making every portion easily accessible.

(*To be Continued.*)

New Agricultural Inventions.

Messrs. R. S. Squires and Frank Kaiser, of Kansas City, Mo., have patented an improved Baling Press for baling hay, straw, cotton, for pressing pomace, grapes, etc., in cider and wine making, and for other similar uses. It is simple, convenient, and effective.

Messrs. John J. Reicherts and David Tipton, of Delaware, Ohio, have patented an improved Field Roller and Planter, by which the seed is dropped by simple mechanism, and then covered by the roller, the ground at the same time being crushed and broken and left in good condition for after operations.

Mr. Robert L. Patterson, of Belle Plaine, Kan., has patented an improved Attachment for Corn Planters, which is so constructed that the dropping slide is operated by the advance of the machine to drop the seed at uniform distances apart.

Mr. Horace W. Thompson, of Bellows Falls, Vt., has patented an improved Scythe Snath Fastening, in which the ferrule attached to the end of a snath has a projecting head or plate, in whose outer end is formed an arc-shaped slot to receive and permit lateral adjustment of the loop or eyebolt which clamps the shank of the scythe.

Mr. Henry Hardick, of Liberty, N. Y., has patented an improved Fence. The invention consists in a metallic post having an anchoring crossbar or foot cast upon its lower end, and buttons upon one of its vertical sides, for the attachment of the wire rails; an intermediate stay post is also provided which anchors a vertical cross tie connecting the longitudinal wire rails.

NEW BOOKS AND PUBLICATIONS.

DIE TECHNOLOGIE DER WIRKEREI, FUR TECHNISCHE LEHRANSTALTEN UND ZUM SELBSTUNTERRICHT. Leipzig: Arthur Felix. 2 vols. 8vo.

In this work, the author, Mr. G. Willkomm, Director of the College of Textile Industry, in Limbach, near Chemnitz, Saxony, has laid down the experience of a life of practical labor and theoretical study. Part I., which appeared in 1875, treats of the elements of knitting, looping, embroidering, etc., as well as of the more simple machinery and appliances used in handworking. Of great practical value is the second chapter, which gives a detailed description of all goods of this character occurring in the market and their relative value. A brief sketch refers to the early history of that branch of textile industry. Part II., just issued, treats principally of weaving machinery, describing about one hundred of the best machines now in use in Europe and the United States. The illustrations are very carefully executed, some of the smaller parts of the machinery being shown two or three times their natural size. For each illustration the exact proportions are given. There are 24 large plates, containing not less than 550 illustrations. Great pains have been taken by the author to add to all the technical terms in German the corresponding expressions in English and French. This feature will make the book valuable to those who, possessing only a superficial knowledge of the language, are not acquainted with German technical terms. A special index connects the drawings with the corresponding passages in the text. On the whole, the book will be found of great value as a handbook for the manufacturer and mechanical engineer, and also as a text book for the student of textile mechanics.

SAW AND PLANING MILL DIRECTORY OF THE UNITED STATES AND CANADAS. Milwaukee, Wis.: Publication Office of the *United States Miller*. $5.

A useful directory giving the names of all the sawmills and planing mills in the United States, Canada, New Brunswick, etc., with the names of their owners. The publishers of the *Miller* have also issued a similar directory of the flour mill owners of the United States and the Canadian Dominion.

Notes & Queries

(1) H. M. P. asks how to prepare artists' canvas. A. Dampen the canvas, tack it on the stretcher, apply a thin coating of starch sizing, when dry apply thick paint of the desired tint.

(2) G. B. asks: 1. Why is it that a wagon wheel travels faster at the top than at the bottom when running along the ground? A. See p. 394, issue of December 21 last. 2. What gases have not been liquefied by any means? A. MM. Pictet and Cailletet have recently succeeded in liquefying all of the so-called permanent gases. See pp. 64, 71, 73, 111, 147, and 186, vol. 38, SCIENTIFIC AMERICAN. 3. If sulphuric acid be poured into a jar containing strong nitric acid, will there be an explosion? A. No, the acids should, however, be mixed gradually to avoid overheating, which would otherwise occur. 4. What is the composition of gun cotton? A. According to the best chemical analysis, gun cotton is trinitro-cellulose ($C_6H_7(NO_2)_3O_5$), consequently it is cotton considered in a pure state as cellulose, $C_6H_{10}O_5$, 3 atoms of the hydrogen of which have been replaced by 3 atoms of hyponitric acid. 100 parts of gun cotton contain: Carbon, 24·34; hydrogen, 2·36; oxygen, 59·26; nitrogen, 14·14; total, 100.00.

(3) L. R. asks: What would remove stains of olive oil from glazed printed paper? A. Moisten the spots with benzole and cover immediately with warm, dry pipe clay for a time. Repeat this treatment several times if necessary, using pressure.

(4) L. C. S. asks: What would make a good cement or paste for fastening gum covering on an iron roller? A. Melt together in an iron vessel over a gentle fire, pitch and guttapercha in about equal parts; use hot, but not too hot.

(5) C. S. asks (1) for a good remedy for weak eyes. A. Better consult a good physician. 2. Does wood dust cause the eyes to get weak? A. Yes, under some circumstances.

(6) H. G. C asks for a recipe for making a prepared marking ink, such as is used by the drygoods stores in writing show cards and marking boxes. A. A concentrated solution of the soluble aniline black in water makes an excellent ink for this purpose. Use hot water to make the solution.

(7) S. D. M.—The curious hairlike substance is similar to the mineral wool now largely made from molten blast furnace slag by contact with a jet of hot air or steam.

(8) A. J. L. asks for list of books on both theoretical and practical chemistry, for one who is about to enter the study of chemistry to become an analytical chemist. A. The following are among the best: Theoretical Chemistry—Remsen, Cooke, and Hofmann. Inorganic Chemistry—Wohler, Gorup-Besanez, and Miller. Organic Chemistry—Fittig's edition of Wohler's Organic Chemistry, and A. Butterow. Analytical Chemistry—Fresenius' Qualitative and Quantitative, Eliot and Storer, H. Will, and Thorpe.

(9) F. N. (Beyrout, Syria).—The sample of thread is sized with taploca starch and glazed in the finishing machine. Your other inquiries will be referred to subsequently.

(10) W. P. asks: Can you tell me the object of putting sal ammoniac in the packing, or iron scales, which surround the castings to be annealed in malleable iron? A. The ammonium chloride is added to the castings after annealing and while still hot to rerust the hematite and magnetic oxide of iron used, so that they can be used again. It has nothing to do with the malleability of the castings. The whole process is described in "A Practical Treatise on Casting," pp. 281-289.

(11) A. K. asks: 1. What are the materials used to make oxygen gas by the generator shown on p. 42, vol. 39? A. The apparatus is not used for the manufacture of oxygen. 2. Can carbonic acid gas be made by the same process? A. Use small lumps of marble and hydrochloric or sulphuric acid diluted with two or three volumes of water.

(12) M. S. P.—It is the strained and dried jelly of Irish or Carrageen moss (*Chondrus crispus*). The jelly is prepared by boiling the dry moss in water.

(13) J. Q. asks what are the uses of sodium (metallic) and aluminum, also of the demand for them in the American markets. A. Sodium is chiefly used as a reducing agent in some metallurgical operations, as in the separation of aluminum and magnesium from their ores. It is also used in Crooke's silver amalgamation process, and occasionally in the reduction and purification of zinc, and in certain chemical operations. It is quoted in New York at $0.65 per ounce. Aluminum is principally used for small weight, light tubes for optical instruments, also to some extent for surgical instruments and appliances, and for the production of aluminum bronze, for bells, etc. It sells for $1.30 in New York. The market for both of these metals is very limited.

(14) "Reader" asks what is meant by so many parts of this or that in the receipts given in the SCIENTIFIC AMERICAN. A. A part is a unit of quantity; for example, it may be weight, as so many pounds or ounces, or it may be measure, so many gallons, quarts, pints, or ounces.

(15) H. G. A. writes: Suppose I place an engine in position for the forward stroke, and move it until the crosshead is at half stroke, does the crank stand 90° from the dead center line? If not can you explain why not? A. It does not, on account of the angularity of the connecting rod. You will find the matter fully explained in Auchincloss' "Link and Valve Motions."

(16) W. V. asks (1) for a receipt for reputting files with acid. A. Dip them for a short time in dilute sulphuric acid. 2. Can you tell me what the tolu sold in drugstores is made of? A. Tolu, or balsam of tolu, is an exudation from incisions in the bark of *Myroxylon toluifera;* it closely resembles balsam of Peru, but is more susceptible of resinification. Old hard balsam of tolu is a convenient source of cinnamic acid, which is extracted by the same process as that by which benzoic acid is obtained from benzoin, namely, ebullition with alkali, filtration, and precipitation with hydrochloric acid. 3. How is paraffine extracted from coal tar? A. It would require too much space to describe the process here; you will find a comprehensive article on the subject in Wagner's Chemical Technology, pp. 588-593.

(17) H. W. asks: Would the lenses of a camera answer for an object glass for a telescope? A. Yes, but not so well as lenses of a longer focus.

(18) M. A. N. writes: 1. I am making a phonograph, have made the shaft ¾ inch diameter, thread cut on 5 inches in length, 10 threads to inch; would an iron cylinder give better results than a plaster of Paris one? A. Yes. 2. How deep must the thread be cut on the cylinder? A. 1/16 inch or more.

(19) J. E. F. says: I should like to know of some remedy for the prevention of sweat on show windows, especially visible after the gas has been lighted. A. To prevent the condensation of moisture on show window glasses, the interior of the show window should have free communication, top and bottom, with the external air. If the air within the show window is kept nearly as cold as the external air, no condensation will take place.

(20) T. C. asks: 1. What is the difference between an ordinary induction coil and a Ruhmkorff coil? A. The difference lies in the perfection of the insulation, the employment of a condenser, and a somewhat different mode of winding. See how to make induction coils in SCIENTIFIC AMERICAN SUPPLEMENT, No. 160. 2. How is the coil constructed that is used to increase the current in a telephone, and how is it connected with the telephone? A. The induction coil described on p. 208 (14), vol. 39 of the SCIENTIFIC AMERICAN will answer; place the transmitter in the primary circuit and the receiver in the secondary. 3. Am I right in saying that there is no current induced in the secondary coil unless the primary circuit is broken. A. The current in the primary wire acts inductively on the secondary wire whenever it is opened or closed or varied in intensity or quantity.

(21) W. S. C. asks: How far will water fall in one second? A. About 16 1/12 feet.

(22) J. M. asks: Under the same conditions which of two steam radiators having the same exterior surface, will be the most effective, one having thick or thin sides? A. We think there will be a slight advantage in the case of the thin radiator.

(23) W. S. H.—The fact that a stone falls more rapidly than a feather, is due solely to the unequal resistance opposed by the air to the descent of these bodies. In a vacuum all bodies fall with equa rapidity.

(24) C. W. W. asks: 1. Is it not true that earthquakes are becoming less numerous? A. No. 2. Is it not acknowledged by our best scientists that the earth's crust, as we understand it, is growing thicker as time advances, and if possible give approximate ratio of increase or decrease? A. Savants consider the earth solid. 3. Where can I procure a work that will answer questions of a geological nature (like above)? A. Dana's *Manual*.

(25) "Subscriber" writes: I am building a boat 16 feet long, 30 inches wide at the bottom, is decked all over, but 6 feet long, 1½ feet wide through the middle, and 13 inches high; what I want is a sail that would suit it, and how large should it be? A. If you employ the usual cat rig, a safe sail would be about 12 feet long on the boom and 9 feet hoist.

(26) C. W. J. asks: What is the smallest power, in foot pounds, that will answer for the motor to drive a family sewing machine at work? A. About ⅛ of a horse power.

(27) A. M. asks: What diameter should the piston be for a piston blower for a furnace 6 inches in diameter and 16 inches to the top of the brick, what length of stroke, and at what speed should it be driven? A. Proportion it so that it can deliver about one cubic foot of air per minute.

(28) F. W. P. asks: From which does heat radiate the better, a smooth or a rough surface; in other words, which heats a room the quicker, a highly polished or a rusty, rough stove? A. Melloni's experiments show that a rough metallic plate is a better radiator than a polished one, other things being equal.

(29) M. M. asks: What is good to clean and polish the silver cases of watches? A. Well prepared rouge, or infusorial earth, rotten stone, tripoli, etc., are among the best. Well burnished silver requires no after polishing.

(30) Charley asks for directions for making a small horizontal steam engine. A. It would be well for you to copy some style of large engine, making your selection from the numerous illustrations in the back numbers of the SCIENTIFIC AMERICAN. You can buy nearly all the working parts, ready to put together. See our advertising columns.

(31) C. C. W. and others.—The principal difficulty with phonographs made by amateurs lies in the damping of the diaphragm. In some instances, the diaphragm is so thoroughly damped as to almost entirely prevent vibration; while in other cases the diaphragm is almost as free to vibrate as if no attempt at damping had been made. It is difficult to give directions that would apply in all cases; we therefore recommend experiment. The best size of needle is the common carpet needle, and the needle spring should be fully as heavy as represented in the drawings accompanying the directions for making a phonograph contained in SCIENTIFIC AMERICAN SUPPLEMENT No. 133. Make your needle spring like that in the drawings; if it is a little stronger it will do no harm. Carefully adjust the damping of the diaphragm, and speak very loudly and distinctly into the mouthpiece.

(32) F. W. T. asks: 1. Can I make an electric light with 30 cells of Callaud's gravity battery? A. No. 2. If not, what form of battery is best? A. Grove's or Bunsen's. 3. What lamp is best to use? A. There are a number of lamps which seem to be equally good. 4 I have a chemical laboratory at command as well as machinists' tools. Can I make the lamp illustrated in last SCIENTIFIC AMERICAN, the Sawyer-Man lamp, from drawing and description there given? A. We think so. 5. If not, is there some form of lamp more easily constructed, and where is it described? A. The Werdermann, described on p. 373, vol. 39, of SCIENTIFIC AMERICAN. 6. I have made a phonograph, from drawings in No. 133 of SCIENTIFIC AMERICAN SUPPLEMENT, which is not quite satisfactory. I send needle and sample of foil; can you suggest the difficulty? I have followed drawings given. A. Needle not sharp enough. See reply to C. C. W. and others on this page. 7. In making a microphone I have used carbon that had been used in a battery. Does it make any difference, or must I have new carbons for that purpose? A. We think the carbon will do, but it should be soaked in warm water for a time. 8. Of what material are the carbon holders and diaphragms in the Sawyer-Man lamp? A. Carbon.

(33) G. M. asks how to insulate wire for magnets and other uses? A. A coating of thick shellac varnish will answer if the wire is wound before it becomes so thoroughly dry as to crack on bending the wire; it is better, however, to wind the wire with silk or cotton.

(34) M. G. W.—SCIENTIFIC AMERICAN SUPPLEMENTS Nos. 94 and 98 treat on warming and ventilation.

(35) A. B. asks: 1. How can I make a simple and cheap electric battery? A. See SCIENTIFIC AMERICAN SUPPLEMENT No. 157. 2. Can a galvanic chain or belt be made? If so, how? A. By connecting together alternating plates of zinc and copper.

(36) J. J. F.—For cement recipes, see SCIENTIFIC AMERICAN SUPPLEMENT No. 158.

(37) R. M. asks if emery is porous. A. Emery is corundum of black or grayish black color, and contains magnetite or hematite intimately mixed. There are gradations from the evenly fine grained emery to the kinds in which the corundum is in distinct crystals. It cannot be considered a porous body.

(38) "Dairy."—For description of the process of making artificial butter, see SCIENTIFIC AMERICAN SUPPLEMENTS Nos. 48 and 49.

(39) G. H. L. writes: I am having a sail boat built 32 feet over all, about 26 feet keel, and 12 feet beam, 15 to 18 inches draught of water. 1. Would it be too large for a cat rig? A. We know of cat boats of the size you state. 2. If not too large for a cat rig, what should be the dimensions of the sail, boom, gaff, and hoist? A. Boom, 32 feet, hoist, 23 feet, peak, 35 feet high in a vertical line.

(40) W. B. K. asks: Can you give me the numbers of the SCIENTIFIC AMERICAN that have the receipts for making matches? A. Waterproof matches, vol. xxxiv., p. 251; safety matches, vol. xxxv., p. 379; composition matches, xxxvii., p. 315, of the SCIENTIFIC AMERICAN.

(41) G. M. G. asks: Do the apparent changes in the moon, namely, new moon, first quarter, full moon, and third quarter, produce any visible change in the condition of the weather, such as to cause storms or to prevent them? A. The question has never been absolutely settled: the weight of evidence, however, is rather against the doctrine that the weather is measurably influenced by the phases of the moon.

(42) J. S. asks: 1. What is the horse power of a locomotive boiler having a fire box 36x24 inches, number of flues 28, size of flues, 3 inches, length of same 6 feet, shell outside diameter, 30 inches? A. There is no standard rule for estimating the horse power of a boiler. 2. One of the flues leaked, and the flue sheet appears thin below the lower flues. Size of flue sheet at thin place, one eighth to three sixteenths inch, space 4 inches, tested with cold water hydrostatic pressure to 90 lbs. to the square inch. Am I safe to run from 45 to 50 lbs. per square inch? A. We think so, f you have stopped the leak.

(43) W. E. C. writes: I wish to make a thermometer with an open end. Can I take an ordinary glass tube not blown out into a bulb, fill this with mercury, and use it as a thermometer? I wish the open end for making a register. What makes the difference in different sized thermometers—the size of the tube or height of the mercury? I would like to have the mercury size 1 inch to 5 degrees. A. Yes, but the tube would require to be very long. The mean coefficient of expansion for temperatures between the freezing and boiling points for pure mercury is 0·00010085 for each degree Fahrenheit—that is, it expands about 1-9916 its volume for each degree increase of temperature. From this datum the size of tube and amount of mercury required may be readily ascertained. The rate of expansion in thermometer tubes is increased by making the bulb or reservoir larger, or the bore of the tube smaller in proportion. For large thermometers the bulb reservoirs will not answer, as much time is required for the large body of mercury to assume the temperature of surrounding bodies. In its place the tube is usually wound closely upon itself in the form of a spiral.

(43) D. J. T. O. asks: Is there any way to bore a hole through a circular piece of plate glass, for a plate electrical machine? I have tried a bow drill with no effect. A. Use a copper tube in place of the drill, and keep it charged with emery and water.

(44) F. W. M. asks if increasing the strength of the magnets in a telephone will increase the volume of sound. A. It has been determined that there is a maximum strength for telephone magnets beyond which nothing is gained by using larger or stronger magnets.

(45) A. W. E. asks: 1. How much weight will a permanent magnet, 2 inches x 3-16 inch, hold up? A. It depends much upon its temper, form, and magnetization. 2. Would two fastened together be twice as strong, or should there be a space between? A. As we understand you, no; but a magnet formed by a number of thin magnets joined, like poles together, presents a much stronger magnetic field than a solid bar of the same weight under like conditions. You will find a description of a powerful magnet of this kind, invented by M. Jamin, on pp. 227-232, *Science Record*, 1874. 3. Can an electro-magnet have more power than a permanent magnet of the same size? A. Yes, much greater. 4. How can I make an explosive that will adhere to paper and explode by tearing the paper through it. Would it be better to add a few grains of sand? A. Reduce separately, by trituration, 4 parts of potassium chlorate, and 1 part of amorphous (red) phosphorus to powder. Moisten with water, cautiously mix the ingredients together, in small quantities at a time, and dry at a very gentle heat. Coat the paper with glue and a little sharp quartz sand. Another explosive mixture is prepared in a similar manner from 16 parts potassium chlorate, 8 parts black antimony sulphide, 4 parts flour of sulphur, and 1 part charcoal, moistened with gum or sugar water.

(47) H. C. B. asks for a receipt for making a cheap airtight and waterproof cloth. A. Boiled oil, 5 parts; wax, 1 part; turpentine, q. s., to form a uniform sirupy varnish. Through this slowly pass the cloth, first thoroughly dried and moistened with turpentine. Press out excess between weighted rollers.

MINERALS, ETC.—Specimens have been received from the following correspondents, and examined, with the results stated:

J. S. L.—The sample of clay is nearly free from iron, but contains a small quantity of lime, magnesia, and silica. If properly washed it may prove of some value for the manufacture of fine pottery, etc.

Any numbers of the SCIENTIFIC AMERICAN SUPPLEMENT referred to in these columns may be had at this office. Price 10 cents each.

COMMUNICATIONS RECEIVED.

The Editor of the SCIENTIFIC AMERICAN acknowledges with much pleasure the receipt of original papers and contributions on the following subjects:

On Small Steamboats. By D. L.
Secret of the Whitehead Torpedo. By I. H. D.
On Flour Mill Explosions. By G. M.
On Electric Light. By A. G. B.

HINTS TO CORRESPONDENTS.

We renew our request that correspondents, in referring to former answers or articles, will be kind enough to name the date of the paper and the page, or the number of the question.

Many of our correspondents make inquiries which cannot properly be answered in these columns. Such inquiries, if signed by initials only, are liable to be cast into the waste basket.

Persons desiring special information which is purely of a personal character, and not of general interest, should remit from $1 to $5, according to the subject, as we cannot be expected to spend time and labor to obtain such information without remuneration.

[OFFICIAL.

INDEX OF INVENTIONS

FOR WHICH

Letters Patent of the United States were Granted in the Week Ending

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AND EACH BEARING THAT DATE.

[Those marked (r) are reissued patents.]

A complete copy of any patent in the annexed list, including both the specifications and drawings, will be furnished from this office for one dollar. In ordering, please state the number and date of the patent desired, and remit to Munn & Co., 37 Park Row, New York city

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Spinning machine spindle, F. J. Rabbeth 210,357, 210,358
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Spring, vehicle, J. Krehbiel 210,260
Stamp, dating and canceling, C. Armstrong *et al.* 210,286
Steam gauge, R. C. Blake 210,179
Steam generator, J. & G. Firmenich 210,312
Steam meter, C. Holly 210,328
Stench trap, H. R. Frisbie 210,196
Stove pipe damper and regulator, T. C. Phelan 213,354
Table, M. E. Converse 210,187
Tank, petroleum, iron, E. E. Hendrick 210,324
Thermometer case, F. A. Stohlmann 210,274
Tire tightener, J. Fox 210,195
Tobacco, chewing, H. N. Rittenhouse 210,363
Tobacco granulator, N. Du Brul 210,191
Tongs, pipe, J. A. White 210,383
Toy torpedo, W. H. Reiff 210,267
Trough, hog, W. H. Tucker 210,276
Urn and water bottom, J. Miller 210,207
Valve gear for engines, B. P. Perry 213,253
Valve seat for steam cylinders, H. Watkeys 210,279
Valve, tap, M. Walz 210,227
Velocipede, A. Q. Ross 210,271
Washing machine, A. R. Dickason 210,302
Water meter, rotary, T. Walsh 210,378
Water wheel, A. G. Cline 210,298
Water wheel, current, W. W. Cleaveland 210,184
Weather strip, P. England 210,309
Wood, manufacturing articles of, G. F. White 210,229

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Medicinal preparation, J. F. Kendall 6,840
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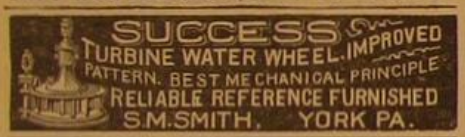

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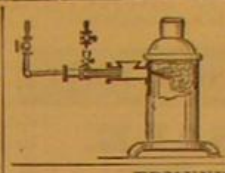

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