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MECHANICAL PROGRESS—THE PAST AND PRESENT CONTRASTED*

BY GEORGE B. PRICE, M.E.

The purpose of this paper is to indicate something of the wonderful growth of our manufacturing industries in the last twenty years, and to call attention to the wide difference in systems, marking this from previous epochs; especially the introduction of the draughting room as one of, if not the chief factor in promoting this unparalleled growth of mechanic arts.

To show the invariable superiority of one method over all others for accomplishing a purpose, and to be able to prove by many notable examples the unquestionable value of such method, is to show, at once, the road by which the live men of to-day are winning a deserved success, and a very possible cause of partial failure to those who are yet unacquainted with the very radical change in the situation.

Nothing is truer to this century than the oft-heard phrase, "the world moves on."

Time was when men were satisfied with candle light.

The ship in which Columbus sailed was doubtless looked upon as a noble craft. Men, for centuries, plowed the earth with wooden plowshares, and the smith at his forge was the nobleman in mechanical skill.

Our century, with its myriad wheels of invention, looks back upon those times as upon a world in its infancy. It was in its infancy. Then men toiled as best they knew how; and with commendable zeal constructed the argosies that have floated humanity to the portals of a new age.

From those portals a new light is shining, with promise of untold wealth. The rapid accretion of knowledge in the scientific world has evolved principles that men knew nothing of, even a century ago; but which, being recognized and practically applied, are stimulating the great world of industries, abrogating the old and instituting revised methods, to such an extent that men have now grown p rfectly familiar with the quotation that "things are not now done as they used to be." How very true! Instead of a small wooden hull, drifting uncertainly upon an almost impassable sea, we have now the advantage of swift and massive "ocean greyhounds," whose grace and perfection tell of a new world of mechanic arts. The smith at his forge, toiling with scarce-requited labor, to express in rude form the conceptions of his individual brain, has given place to our splendid machine shops and great foundries, equipped with "plant" that now makes easily possible what once had been more than a Utopian dream.

The secret of all this change, this wonderful accretion of the wealth of the world, is the genius of invention, controlled by scientific knowledge and wrought out by the subdivision of labor.

This means, when practically applied to our present subject: First, the conception, in one or more minds, of the elementary ideas of an invention. To embody this invention is the work, next, of the mechanical engineer, whose province it is to consider the various principles of construction that enter into the combination; to adjust the different parts to each other and to the whole, having regard to the required solidity, stability, flexibility, simplicity and economy, as well as the most approved or possible methods of casting, welding, finishing and joining those parts, considerations which may not only affect the ultimate practicability of the inventi‿n, but, according to the manner in which the subject is treated, will depend largely the grace, symmetry, and perfection of the machine.

The position of the mechanical engineer, in this early stage of the work, is as unique as it is important. He is like the doctor who is versed in the principles of medicine, but who, according to his appreciation of the conditions of the case, not less than the ingenuity of his resources, may often build up the patient speedily and lastingly, or only partially and imperfectly.

The physician of known ability is quite likely to be the cheapest in the end; so the timely employment of the engineer is almost certain to mean the best construction of the work proposed, in the shortest time, and with the most economy in ultimate cost.

From the hands of the engineer (who should follow up and superintend the subsequent construction) the plans and specifications go into those of the several workmen who are individually instructed, by the drawings, as to the proper way of working up their respective details. There is in this way no clashing

*Read at a Meeting of the Franklin Institute. From the *Journal*.

or confusion, each man being responsible only for the correct production of his part.

Such seems to be the true explanation of the economic principles of the subdivision of labor.

Men have found out *principles*, and that the most progress is made and wealth more rapidly accumulated when the several stages of any piece of work are each guided and controlled by those who have made *that part* their special study.

We have a very limited idea of the subdivision of labor when we think of it only as of a number of men being divided into groups for the several manual operations in forming, say, a pin. This, indeed, is subdivision of labor; but it should mean more than this. It presupposes antecedent skill and varied ability of a high order.

Before the finished product was possible, an intricate piece of machinery had to be built; which further presupposes not only skilled mechanics, but an inventive genius, and an ability, of somebody, to understand the requirements and correctly portray on paper the many parts, in detail, and as a whole. The designer was quite as necessary as the inventor or the workman.

Let it be remembered, then, that the workshop, though necessary for the practical embodiment of the invention, is yet distinct from the invention. The rule of true progress here is plain. The invention must first be clearly conceived and plainly drawn on paper, clearly and in detail, carefully and studiously designed according to the principles governing the particular construction; in short, it should be wholly created and visibly expressed in every detail, by one who is master of the subject, before it is put into the hands of a single workman.

How many ambitious, bright, but over-sanguine men have conceived a general notion of some invention, involving mechanical principles of which, most likely, they knew little or nothing, and have thrown away time and hundreds—perhaps thousands—of dollars in blundering along—time and money that might have been saved had they started aright. Most assuredly it can be said, with emphasis, no matter how great or how small the new work proposed, construct it first on paper!

Progressive manufacturers and machinists everywhere are every year recognizing more forcibly the value of this method, and recognizing it, are growing richer. Look into our best work-shops of to-day; the great foundries and machine works that turn out our exact machinery, our fine locomotives, our floating palaces; in all you will find—not "a rule of thumb" and endless experiment, but a well-constituted, thoroughly superintended drawing room. Here the work is first really constructed, on paper, the varied problems carefully thought out, the many parts fitted and proportioned to their several functions; then the various artisans and workers are given their parts, and the whole structure grows uniformly, rapidly, to perfect completion. This is the new way. It has come to stay.

It might be interesting to some to have described the actual working routine of one of our largest and most successful manufacturing establishments—the great locomotive works, whose world-wide reputation has made the American locomotive famous as a competitor on almost every line of railroad in the civilized world. One might naturally conclude that the system preferred by such a firm, after years of fruitful experience—the system which turns out two complete locomotives a day—ought to have superior merit; and if any doubt of this should remain in any one's mind, it should be fully dispersed by the further announcement that the virtues of that same system are being appreciated, and as far as possible imitated, by competitive concerns, whose capacity and business are being rapidly enlarged in consequence.

Let us, then, take a swift glance through the said establishment, beginning with the draughting-room, properly the starting place for our inspection. Here, in a well-lighted, ample apartment, are a number of draughtsmen, many of them brought up in the service. These are under the supervision and direction of a superintendent, who originally decides upon the plan of each locomotive to be built, estimating its capabilities and requirements. Instructions and a specification are then given to a draughtsman in charge, who carefully constructs on paper elevations and sections necessary to the complete locomotive. The detail drawings are then executed on stiff cardboards, or other materials suited to stand shop wear, and after passing satisfactory inspection of the examiner of drawings, are given out, carefully numbered and registered, to the respective shops. No work can be done in any of the shops until this is done, thus manifesting the high importance which this successful establishment attaches to correct drawings as the starting point for all construction.

In the shops, the many details are each carefully wrought out, in strict conformity to the drawing, and, as completed, sent to the erecting shop, where, under competent foremen, the various parts are rapidly adjusted, each falling into its proper place, and in an incredibly short time the completed locomotive is breathed into by the breath of its steam life, and starts upon its career, a giant of force and monument of engineering skill.

Time was when a complete preliminary drawing was hardly known in a machine shop. Then, men blundered, and blunders are always costly. Time will be soon, when a machine shop without its drawing room, its superintending engineer, will be but a lingering reminder of an experimental age before men had learned the true source of progress and wealth.

Those that still cling, like the smith of old, to the methods of a by-gone age, are falling behind in the race, for while, in a sense, they may be laboriously building up a small trade, others taking advantage of the proved better methods of success, will be forging ahead into enviable wealth.

The former has been left behind, not because of inferior ability, in his line, but because he has lost time in trying himself to do what another could have better done, at less expense to him.

There is another and concluding thought that should give hope to every man in the mechanic world.

As his craft grows into closer relationship with the great world of science about and above him, it will certainly lift him to a higher plane. Men are everywhere realizing, as never before, the everlasting truth of fixed principles and universal law governing all things. If a house falls, a bridge gives way, a dam bursts its confines, it is no longer an unaccountable event. Something was deficient. The capacity to detect the cause, the power to avert the evil by a scientific knowledge of the principles of construction, is, of all knowledge, the most useful, while its possession, in proportion to its completeness, should raise its possessor to the first ranks among men.

A PASTE WHICH WILL STICK ANYTHING.

A paste which will stick anything is said by Professor Winchell to be made as follows: Take two ounces of clear gum arabic, one and a half ounces of fine starch, and half an ounce of white sugar. Dissolve the gum arabic in as much water as the laundress would use for the quantity of starch indicated. Mix the starch and sugar with the mucilage. Then cook the mixture in a vessel suspended in boiling water until the starch becomes clear. The cement should be as thick as tar, and kept so. It can be kept from spoiling by the addition of camphor or a little oil of cloves.

CEMENTS OF RUBBER AND GUTTA PERCHA.

The number of rubber cements in use all over the world is something remarkable. Almost all of them have as the base either gutta percha or India rubber, and some cheap solvent. Gutta percha tissue, to be sure, is used as a cement without the addition of any solvent, its sticking properties being brought out by the application of heat. This may be noticed in the application of the bindings that go around the bottoms of trousers and the stamp marks in hats and other work of a similar nature. In making a cement, one should know pretty thoroughly what is to be expected of it before they could advise upon it. For instance, an ordinary rubber cement will hold on a host of different surfaces and with the best of success, except where there is continued dampness. For holding to damp walls, or surfaces where there is a constant presence of moisture, there is nothing equal to Jeffry's marine glue, the formula for which has been published and republished all over the world. It consists of: India rubber, 1 part; asphaltum, 2 parts; coal tar, 12 parts.

The rubber, after having been massed, is dissolved in the undistilled coal tar, and the asphaltum is then added. This glue, as its name indicates, is oftentimes used for mending articles at sea, or patches, for instance, that are to be laid on surfaces that are to be under water, and it has been found to be a most excellent thing. Of glass cements there are a great many, the rubber as a rule being dissolved in some very volatile solvent and some hard drying gum is added.

A gutta percha cement for leather is obtained by mixing the following. It is used hot: Gutta percha, 100 parts; black pitch or asphaltum, 100 parts; oil of turpentine, 15 parts. An elastic gutta percha cement, especially useful for attaching the soles of boots and shoes, as on account of its great elasticity it is not liable to break or crack when bent. To make it adhere tightly the surface of the leather is slightly roughened. It is prepared as follows: By dissolving 10 parts of gutta percha in 100 parts of benzin. The clear solution from this is then poured into another bottle containing 100 parts of linseed oil varnish, and well shaken together.

Davy's universal cement is made by melting 4 parts of common pitch with 4 parts of gutta percha in an iron vessel, and mixing well. It must be kept fluid, under water, or in a dry, hard state.

A very adhesive cement, especially adapted for leather driving belts, is made by taking bisulphide of carbon, 10 parts; oil of turpentine, 1 part; and dissolving in this sufficient gutta percha to form a paste. The manner of using this cement is to remove any grease that may be present in the leather by placing on the leather a piece of rag and then rubbing it over with a hot iron. The rag thus absorbs the grease, and the two pieces are then roughened and the cement lightly spread on. The two pieces are then joined, and subjected till dry to a slight pressure.

A solution of gutta percha for shoemakers is made by taking pieces of waste gutta percha, first prepared by soaking in boiling water till soft. It is then cut into small pieces and placed in a vessel and covered with coal tar oil. It is then tightly corked to prevent evaporation, and allowed to stand for twenty-four hours. It is then melted by standing in hot water till perfectly fluid, and well stirred. Before using it must be warmed as before by standing in hot water.

A cement for uniting India rubber is composed as follows: 100 parts of finely chopped rubber, 15 parts of resin, 10 parts of shellac; these are dissolved in bisulphide of carbon.

Another India rubber cement is made of: 15 grains of India rubber, 2 ounces of chloroform, 4 drachms of mastic; first mix the India rubber and chloroform together, and when dissolved the mastic is added in powder; it is then allowed to stand by for a week or two before using.

Cement for sticking on leather patches and for attaching rubber soles to boots and shoes is prepared from virgin or native India rubber, but cutting it into small pieces or else shredding it up; a bottle is filled with this to about one-tenth of its capacity, benzin is then poured on till about three-parts full, but be certain that the benzin is free from oil; it is then kept till thoroughly dissolved and of a thick consistency; if it turns out too thick or thin, suitable quantities must be added of either material to make as required.

An elastic cement is made by mixing together, and allowing to dissolve, the following: 4 ounces of bisulphide of carbon, 1 ounce of fine India rubber, 2 drachms of isinglass, ½ ounce of gutta percha; this cement is used for cementing leather and rubber, and when to be used, the leather is roughened and a thin coat of the cement is applied. It is allowed to completely dry, then the two surfaces to be joined are warmed and then placed together and allowed to dry.

Cement used for repairing holes in rubber boots and shoes is made of the following solution: *a.* Caoutchouc, 10 parts; chloroform, 280 parts; this is simply prepared by allowing the caoutchouc to dissolve in the chloroform. *b.* Caoutchouc, 10 parts; resin, 4 parts; gum turpentine, 40 parts; for this solution the caoutchouc is shaved into small pieces and melted up with the resin, the turpentine is then added, and all is then dissolved in the oil of turpentine; the two solutions are then mixed together to repair the shoe with this cement. First wash the hole over with it; then a piece of linen dipped in it is placed over it; as soon as the linen adheres to the sole, the cement is then applied as thickly as required.—*The India Rubber World.*

SENSITIVE REACTION OF TARTARIC ACID.

If we throw a few crystals of tartaric acid into a sulphuric solution of full strength containing one per cent of resorcine, and apply heat, there is produced at about 125 deg. a fine violet red coloration which may be preserved indefinitely on dilution with acetic acid, but which is at once destroyed on adding water. In order to detect $\frac{1}{100}$ milligramme of tartaric acid, it is needful to evaporate the liquid to dryness in a small porcelain capsule, to moisten the residue with 1 c. c. of the sulpho-resorcine reagent, and to raise the temperature gradually from 125 deg. to 130 deg. Reddish stripes appear first at the bottom of the capsule, and the entire liquid becomes colored. The reagent has no action upon succinic, malic, citric, and benzoic acids. The mineral acids do not interfere, except nitric and nitrous acids, which give with resorcine a blue color so intense as to mask the reaction.—*Ed. Mohler.*

WHAT DOES TRUE LEVEL MEAN?

The circumference of the earth being spherical in shape and attracting all adjacent matter toward its center, raises some very interesting questions in the distinction between what is known as water level and straight line level. It may be a matter of dispute

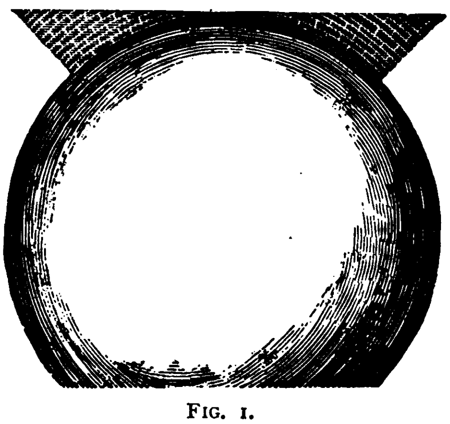


FIG. 1.

whether there can be any other than surface or water level, which is in fact convex, and we are not in the habit of calling convex surfaces level surfaces. Certain it is, however, that in practice, the curvature of the earth's surface determined accurately by the surface of still water presents a species of level which is exceedingly popular with the masses, and which can be relied on for all practical purposes. Notwithstanding all this, it is exceedingly interesting to theorize and note some apparent paradoxical features. These can best be set forth by a few illustrations.

In Fig. 1 we have the earth represented in its approximately spherical form, with a straight track, surface or plane superimposed thereon. This plane is represented in its extent equal to the diameter of the

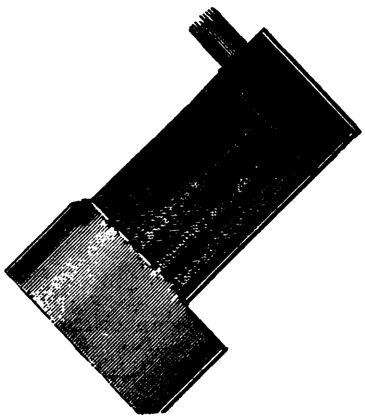


FIG. 2.

earth, say about 8,000 miles. The concentric lines or strata of supporting masonry are architecturally level or water level. The ends of the walls are what is known as perpendicular, being in radial alignment with the center of the earth. Now it is clearly and indisputably obvious that the superimposed plane is a straight line level as we understand the term in the abstract. From the middle to the extremity in either direction is 4,000 miles. Suppose a railroad track is laid along the level (?) plane—a locomotive is started from the middle and proceeds toward the extremity. As it progresses, the track becomes more and more inclined from the earth's surface, the inclination rela-

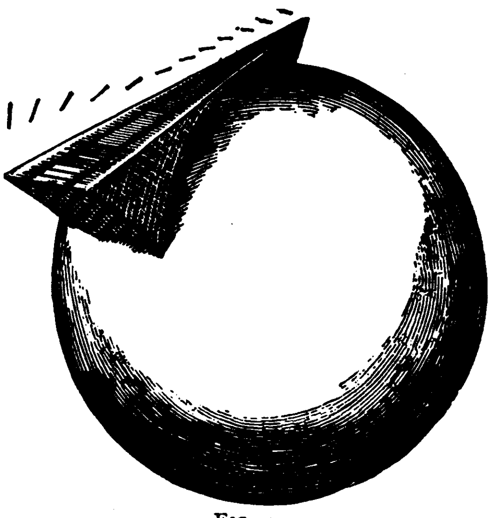


FIG. 3.

tively increasing toward the extremity, until the engine is practically ascending a hill or inclination very steep, and as the water in the boiler will always maintain the surface level it would assume the position shown in Fig. 2.

In Fig. 3 we have a perspective view of the straight level track, the series of short inclined lines above, indicating the successive water levels toward the extremities. The real question hinges on which is to be regarded as the straight line—the earth's surface level which is a curved line, or the geometrically straight line which gives such decidedly up hill results. Now take the same or similar example (Fig. 4) and regard it as a vast circular plane or platform, and pour, pump, or otherwise put on (or in) a quantity of water. Following out the natural law of gravitation, the water will promptly arrange itself in conformity with the rotundity of the earth and assume a convex form upwardly. Refer now to the dotted lines at the water's edge. These lines represent the perpendicular

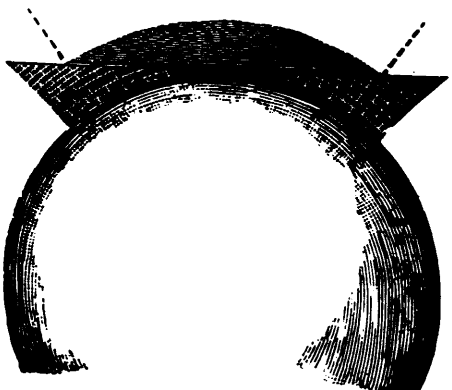


Fig. 4.

and the outlying margin of the level plane represents in practice the inclined walls of a vessel or pan – we may say inclined because of the fact that the water is deeper in the center, and the angle of incidence between the water surface and the margin of the pan (or plane), gives unmistakable inclination. Thus it is, that the really and truly level plane surface is in fact a hollow or concave surface to all intents and purposes. Fig. 5—Another aspect presents itself, in comparing the perpendicular extremities of the supporting walls. We say a right angle is 90 degrees from the horizontal. Comparing the base line of these respective perpendiculars it will be seen that there is a bad misfit. If we regard the base line as a vertical curve or surface level, it is not strictly speak-

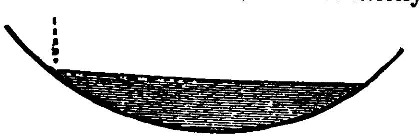


Fig. 5.

ing, a consistent right angle, and if it is continued geometrically straight, it curves upward in its practical effect according to the demonstrations herewith presented. Another thought presents itself. The examples here given, if they were actual realities, would present some remarkable physical aspects. The superimposed structure would present enormous protuberances extending far out into cold space. The perpetual snow line would be very near the base and even the atmosphere limit would be left far below the protruding points that would stick out into space, bare, frigid, cheerless and practically unavailable.

MODERN INVENTIVE ACTIVITY.

One of our valuable exchanges remarks that down to the beginning of the last century men had invented very little. They had necessarily contrived a great deal. They learned to make boats so far back in the legendary ages that history could only find a place for beginning after men had been taught to navigate the sea. But, then, the boat is only an evolution of the log floating on the water, and it came into form by such easy gradations through the raft that it is hardly to be called an invention. So with most of the household implements, and even of the tools of mechanics that have long been in use. They grew by such slow processes from the crudest beginning that no man could be called their inventor. As we look back beyond the beginning of the last century we discover barely more than a half-dozen new devices that could justly be called inventions. The art of printing is the most conspicuous of these few; but even this invention was so simple that one cannot help feeling that the old monks who copied manuscripts for centuries must have been exceedingly stupid or they would have created the art at a much earlier date.

But the inventive activity of the present age is a source of continual wonder, and it is difficult to explain the impulse that leads to its indulgence. Much is attributed, and much doubtless is due to the patent right system; but this will not explain everything. A few fortunes have been made by inventors; but it is notoriously true that the authors of new inventions rarely realize much for their happy thoughts, and few men would ever think of turning their attention to invention as a profession. Vastly the larger number of inventions are the work of men who have merely conceived a good idea, and then proceeded to put it in mechanical form because their idea has made them enthusiastic. In such cases they may have been stimulated somewhat by the hope of pecuniary reward; but it was not this hope that gave the impulse to their labor.

Neither can it be justly said that the intellectual activity of the current age is greater than that of any preceding period in the world's history. In some departments of human endeavor we are less active than the men of the renaissance period and the years immediately following the renaissance. We are producing no Shakespeares, Dantes, Tassos, Miltons, Michael Angelos and Raphaels at the present time, and considering the models from which those men were forced to draw their instruction, they were so immeasurably superior to their successors in corresponding fields that no comparison is possible. Considering nothing indeed, they were superior, and Herschel, Galileo and Newton, estimated according to their opportunities, were greater than the men of scientific research to-day. The present generation has reached its high ground more largely through the labors of past generations than through its own endeavor, and we cannot say that men have become more inventive because their brains are more active.

Is it not more reasonable to say that invention, which is largely science applied, is a characteristic of the highest civilization? It is the last manifestation of human activity following after all the fine and industrial arts and literature have reached their highest degree of perfection. Great writers, great painters and great actors are all imitators. However great they may be they are only doing what men have done before, and they think themselves most happy when they can trace some sort of resemblance between their own works and the works of their exemplars. But the inventor comes nearer to the production of something absolutely original than the worker in any other field of intellectual activity, and we take it that the search after the new is a pursuit most congenial to the most advanced society. Men have got tired of learning. Some of them tire too early in life, but we are all growing tired of accomplished facts and want novelty.—*American Engineer.*

ON THE PRESERVATION OF NATURAL OBJECTS IN ALCOHOLIC AND OTHER SOLUTIONS.

NICOLAS PIKE.

Collections of specimens of natural history are of comparatively little use to either student or scientist unless the greatest care is observed in their preparation and preservation. The naturalist Swainton said that "collections of natural objects in public and private museums are to the naturalist what a library is to the critic and scholar, yet with this remarkable difference, that one draws his knowledge from the works of man, and the other from those of God."

Now I go still further — museums are of the greatest utility not only to the naturalist, but when well managed to the people at large. Besides being places of resort for recreation and amusement, they are also an education in themselves to toiling men and women who have no time for study at home. Thousands of objects are brought together from all parts of the world, and when carefully prepared are invaluable in imparting a fund of knowledge no books could give. Every one knows the difference between seeing an object and reading of it, even when fairly described.

In some of the museums I have visited in the old world and in others of our own country I have noticed that many of the rarest and finest specimens were ruined from having been badly prepared in the first instance, and others from a lack of knowledge as to their keeping. This is especially true of objects preserved in alcoholic and other solutions.

When in Mauritius, I made a very large collection of the fish of the Indian Ocean and sent them to the museum of comparative zoology at Cambridge, Mass. When they reached their destination, though many of them had been in alcohol for over a year, they somewhat surprised the distinguished scientists there, for all were fine, and many had retained some of their colors and markings so well they were easily recognized. I have reptiles, batrachians, spiders, etc., now, that have been for years in bottles, and they are firm and fresh. So many friends and naturalists have asked and written to me about my methods of preservation that I give the following formulas, which I have proved to be the best I am acquainted with. They are simple and do not differ much from the ordinary ways naturalists have preserved for years—yet the slight differences mean success or failure.

Taking fish, for instance, and I proceed as follows: When first drawn from the water I kill it by severing the vertebra near the tail, as I have proved beyond a doubt that a fish dispatched as soon as caught keeps better than one left to die a natural death. All but very small fish should have an incision made near the vent to allow the gases to escape, and alcohol be injected through the vent and mouth. All extraneous matter is to be carefully washed from the fish with fresh water and then it must be placed in strong alcohol, the stronger the better. Four to six days are generally enough to render the flesh firm and all slimy matter exuded, but practice and judgment on this point are required. When ready, wipe the fish and place it in the following solution, and it will keep for years if good alcohol be used:

Alcohol (95 per cent)	8 parts
Distilled water	2 "

If the fish are small, three or four days suffice to harden them, and the following is a better solution for them, viz.:

Alcohol	6 parts
Distilled water	2 "

Reptiles, rodentia, etc., can be also preserved in the same manner. The first alcoholic bath can be used over and over again for the same purpose if strained and well corked, as alcohol is an expensive item in collections.

It is but too prevalent a custom to keep specimens of natural history in the strongest alcohol and place them on the shelves of a museum or cabinet exposed to a bright light. This is ruin to them, as every one knows it is impossible to expose any matter to the sun's rays without its being influenced by their action.

For the preservation of tadpoles, young frogs, salamanders and similar objects, take 1 pound sulphate of zinc, 2 drachms burnt alum and mix well together.

When wanted for use, take one drachm by weight of the above and put it into forty-two ounces of pure spring water, and when all is dissolved, filter and let it stand five or six days, then filter again and decant, when it should be a bright and sparkling fluid. The above small animals are to be placed for a short time in alcohol to harden. When taken out they must be well washed in clean water and left to dry a little, so that all traces of the alcohol may be evaporated. When placed in the above solution, they must be corked immediately. Specimens thus prepared are really beautiful, more so than when put in any alcoholic mixture.

The following solution for larvæ of insects, spiders, and other small delicate objects will be found very valuable:

Glycerine	1 oz.
Common salt	1 dr.
Saltpeter	1 dr.
Distilled water	8 oz.

Mix well together.

When wanted for use, take two ounces of pure alcohol and add one ounce of the mixture, shake well, and filter.

There is another solution I use for delicate objects I intend for dissection or anatomical specimens, as it keeps them fresh and flaccid without the least contraction. I have adopted the formula given below as the very best preservative for the above purposes, after years of patient experimenting. I have larvæ of insects, worms, spiders with soft bodies, etc., over ten years in this solution, and they are in excellent condition, and have never shown the least sign of decomposition. Take of chloral in crystals one ounce and dissolve it in five ounces of distilled water:

Alcohol (95 per cent)	1½ oz.
Glycerine	1½ dr.
Rock salt	15 grs.
Saltpeter	30 grs.

Dissolve the glycerine, salt and saltpeter in the alcohol, and when well mixed add to the chloral solution, shake well till thoroughly incorporated, filter, and it is ready for use. Specimens intended to be preserved in this solution should be placed for a day or two in alcohol, but if wanted for dissection quickly, or only to be kept a few weeks, the alcoholic bath may be omitted. Do not crowd the specimens either with this or any other of the solutions, but see well to the corking and that they are quite covered with the fluid.

The tadpoles of frogs and salamanders can be preserved in this method by omitting the bath and placing them at once in the solution. This is invaluable for medical students, entomologists, and scientists, as it not only preserves objects, but in many instances the colors are retained if kept in a cool, dark place.

I tried the Wickersheimer process, but it failed in my hands completely. Goadby's solution I find after a time makes a white deposit on the specimens, thereby spoiling them.

I keep my reptiles in a cool place with a paper cap over each bottle, and can recommend this plan. The smaller objects are shut in closed cabinets. Where the paper cap cannot be used, I would suggest that a curtain be drawn in front of shelves containing alcoholic specimens when not required for exhibition. By following the above directions, success is pretty certain, though, as I said before, judgment and practice are requisite to insure it—simple as it appears.

I would say a word to those who collect with the intention of presenting their catch to some institution. Never forget that it is the first manipulation of the various objects that requires attention as no after care can wholly undo the effects of negligence or ignorance in that stage. Especially be particular to place your name, date, and locality on your labels.

THE LARGEST HAMMER AND ANVIL IN THE WORLD.

The hammer shop, now in process of completion at South Bethlehem, will probably be regarded as more remarkable for evidence of power than any mechanical contrivances yet constructed by man. It is here that the plates are to be prepared for our growing navy. This building includes furnaces and a vast tank for tempering the plates. They will be lowered into it by traveling cranes. The tank is divided into compartments, enabling several plates to be treated at once.

The hammer is, however, the most marvelous object in the hammer shop. It was designed by Mr. John Fritz, chief engineer and general superintendent, who has been connected with the works from the beginning, and has invented or improved many of the appliances in use at South Bethlehem.

In the designs for the hammer proper, Mr. Fritz consulted the plans of Le Creuzot, following them as far as they met the conditions of construction already adopted. The entire foundation of the hammer-room is actually laid on what two years ago was the bed of the Lehigh River, which was deflected from its course, and the anvil and hammer frame rest on piles. Above these, a mass of cyclopean masonry has been built, and upon that the anvil, consisting of a bed of solid iron capped by a bed of steel, is superimposed. This anvil represents the trifling amount of 1,400 tons of solid metal. Over the anvil springs the colossal frame which supports the hammer. This frame bears a certain resemblance in shape to a truncated tower of Eiffel. It springs to a height of 90 feet from a spreading base whose foundations are clamped deep in the earth. This huge structure contains 475 tons of iron.

The tap of the hammer is a square solid block of iron faced with steel. It runs in a groove, like the hammer of a pile-driver, is raised by steam, and has a hoist of 18 feet. It weighs 125 tons. The total weight of iron in this stupendous hammer, frame and anvil reaches the enormous sum of 2,000 tons. One can perhaps more clearly realize what the direct plunge of a weight of 125 tons means if he considers that it is equal to the weight of two regiments of soldiers, or 1,700 men, but having even more impetus, because concentrated in a solid mass of so many cubic feet. It is with this mighty engine that the armor plates of our ships of war are to be forged.—*Harper's Weekly*.

BLEACH AND CAUSTIC SODA FROM SALT.

The process by which bleaching powder and caustic soda is manufactured from common salt is quite simple, as well as economical. The salt is introduced into a still constructed of stone and provided with suitable tubes for heating, and a sufficient amount of nitric acid is added to transform it into nitrate of soda. Upon applying a gentle heat, the decomposition begins, and the nitrate of soda is rapidly formed. As the nitrate of soda is extremely soluble in a hot solution, the operation is so conducted that the solution of nitrate of soda in the still is saturated at the boiling temperature. The solution is then run out from the still and cooled. Owing to the great difference in the solubility of nitrate of soda in hot and cold solutions, a great mass of the salt is deposited on cooling. Over half of the quantity of nitrate of soda in solution at one hundred and ten degrees to one hundred and twenty degrees Centigrade is deposited on cooling the solution down to twenty degrees Centigrade. The crystals obtained by this cooling are separated from the mother liquor, which, together with more salt and nitric acid, is again sent to a still, and the operations repeated.

The gases resulting from the reaction in the still, composed principally of nitrosyl chloride and chlorine, pass into a vessel containing nitric acid and manganese dioxide in suspension, where nitrate of manganese is formed and chlorine is given off. The chlorine evolved passes through a washer, and then into a bleaching powder apparatus.

In this process all of the chlorine combined with the sodium in salt is obtained in the form of bleaching powder, and the gas passing to the bleaching powder chamber is pure chlorine gas, thus avoiding the weak and impure chlorine obtained in all magnesia processes, and avoiding the loss of two-thirds of the chlorine which is incurred in the Weldon process.

The crystals of nitrate of soda obtained by cooling the nitrate of soda solution coming from the still are mixed with two or three times their own weight of oxide of iron. The mixture is then heated to a red heat in a current of air in a cylindrical furnace. The nitrate of soda is completely decomposed and the gases evolved with an excess of air are passed over an oxidizing substance, such as manganese dioxide, a manganite, a manganate, or a permanganate of the alkalies or of the alkaline earths.

The nitrate of manganese liquor is heated and evaporated to a plastic consistency by the hot gases coming from decomposition of the nitrate of soda. The nitrous gases coming from the decomposition of nitrate of soda and nitrate of manganese finally pass, after treatment with air and steam, into the usual apparatus for condensation of nitric acid. Nitrate of manganese evaporated to the plastic condition mentioned contains about ninty per cent MnO—2. It will thus be seen that both the nitric acid and manganese are recovered. The mixture of iron oxide and soda is taken from the furnace and lixiviated. If the heat has not been carried too high, the mixture is in good condition for lixiviation. If lixiviated with hot water, a caustic liquor of thirty to forty degrees Baume may be obtained practically free from carbonate of soda, so that when this liquor is evaporated and made into caustic soda, an extremely high test of caustic soda may be obtained.—*American Paper Trade.*

CASTROGRAPHY.

Do not look for the word *castrography* in the dictionary, for it is a neologism created to designate a new art. Castrography (from the Greek, meaning to write by cutting) consists in writing or drawing in relief in the substance of a sheet of thin cardboard, by means of the blade of a penknife. In was devised by Mr. Mills, an American, who exhibited the process at Paris in a public establishment. This artist traces the drawing or writing by means of incisions made in the substance of the card. As the knife blade makes a very sharp angle with the card, these incisions may be very deep. In measure as they are made, the operator, with the back of the blade, raises the upper part that he has just cut, so that its outline is at once converted into a sort of bass-relief. On illuminating the card, thus prepared, sideways, it exhibits, in fact, the high lights, tones and half tones and the true and projected shadows of sculpture. As for the rapidity of execution, it will suffice for us to say that the specimens prepared specially before our eyes by the artist for the readers of *La Nature*, were executed in less than a minute by the watch. (See accompanying figure.) Mr. Mills varies the style of his delicate compositions *ad infinitum*.. Here we see flowers, such as eglantines and forget-me-nots, here ornamental designs, and here again birds, ornamental plants, etc., rising suddenly under the blade of the rapid knife. In the time that it would take a draughtsman to put a sketch upon paper, Mr. Mills gives us not only the contour, but also the shadows, obtained by the play of light upon the bass-relief.

Bass-reliefs made in Cards with the Blade of a Penknife.

This process is scarcely capable of furnishing anything but fancy work, visiting cards, bills of fare, out of the ordinary line of decoration, etc. A goodly number of our readers who are fond of manual recreations might practice it in their turn. They will find that it is very difficult to incise a sheet of Bristol board without the knife's point passing clear through it, but we believe that with a little exercise, and provided they do not try to work too fast, they will be able to obtain satisfactory results.—*La Nature.*

HYDRAULIC MONITORS.

One of the most noteworthy features in many portions of the gold region is the elaborate system of water supply for the use of the hydraulic mines and the tremendous changes which were the result of the few years during which hydraulicking was at its height. So great have been these changes—hills washed away, valleys filled up, others created—that in many localities the entire landscape has been altered. The old proverb ascribing the power to remove mountains to such as had faith only to the amount of a grain of mustard seed has never been exemplified, but the hydraulic miners have afforded the most ample demonstration of their ability to move mountains in the search of wealth. Lofty mountains have in fact been brought low through no other agency than the pipe line, the monitor and the sluice, and the tremendous power of water never received such an exemplification as in the history of the hydraulic mines of California.

There are, indeed, so many remarkable facts connected therewith that, were they not abundantly substantiated, one might well be pardoned for receiving their relation with incredulity. One might not believe that a stream of water issuing from a nozzle or pipe six inches in diameter, and with no other force but gravity behind it, would have much effect at any considerable distance from the aperture, yet such an apparently insignificant stream, with a fall behind it of 375 feet, will carry away a solid bowlder weighing a ton or more at a distance of 50 to 100 feet, while at a less distance it will toss such a bowlder about as a boy would throw a pebble.

The velocity and force of such a stream as it issues from the nozzle of the monitor is something terrific. The column of water is solid—so solid that if one were to undertake to thrust any object into it, it would make no more impression than if it were iron instead of liquid. If a crowbar or other heavy object be thrust against the stream, it would be snatched from the hand and thrown to a great distance as if it were a feather-weight, while the man who should firmly grasp an axe and attempt to cut through the stream would undergo an experience that he would remember for many a day.

If a man were to receive the full force of such a stream at a distance of a couple of hundred feet, even though the impact be momentary, he would be killed as quickly as though struck by a cannon ball. He might escape being mangled, but the breath would be most effectually and suddenly expelled from his body.

At 400 feet from the nozzle, a six inch stream with 375 feet fall, swung momentarily against the trunk of a tree, will denude it in a second of the heaviest bark as cleanly as if an axe had been used. Whenever such a stream is turned against a gravel bank it cuts and burrows into it in every direction, gouging out great caves, causing thousands of tons of earth to fall, which is in turn quickly disintegrated and washed into the sluices. Bowlders so heavy that a man can scarcely lift them are tossed about like chaff, stumps and trunks of trees are thrown to one side like straws, and the work of destruction goes on at a pace that is appalling. If one who has never seen a monitor in operation under full head could imagine the ordinary stream from a fire hose magnified about a thousand times, he would be able to form some conception of its power.

The water is brought in open ditches or flumes, sometimes from a great distance, around mountain sides, and across valleys and ravines. When the vicinity of the mine is reached a box is put in, from which a pipe conducts the water to the point where it is to be used. It is the distance between this box and the level of the monitor that gives the pressure. With from 300 to 450 feet fall the execution done is tremendous. At the monitor the water is conducted into a still smaller pipe with nozzle about one-third the size of the supply pipe, the compression giving it still greater force. The monitor is constructed something like the ordinary hose nozzle, but has a ball joint that permits it to be swung in any direction. It is balanced with weights, and by means of an ingenious device known as a deflector the tremendous stream can be turned in any direction by the slightest force. Almost the weight of a finger will suffice to direct the movement.

Easily as it is managed, however, the monitor sometimes becomes uncontrollable, and when this happens a scene of destruction and even death ensues. The pipe sways to and fro at its own volitation, and the stream flies first in one direction and then in another. If the miners are not warned in time to get out of range, they may be mowed down as if by the discharge of a volley of grape. Sometimes the runaway monitor seems as if manipulated by some bloodthirsty monster, and appears to be deliberately turned upon the fleeing men, following them as they flee in every direction and overtaking them before they can reach a place of safety. In one case a sluice tender, hearing an unusual noise, raised himself above the edge of the cut in which the sluices ran just in time to receive the full stream square in his face and chest. He was knocked down, thrown into the sluice, and washed away. When found his body had not a stitch of clothes upon it, and apparently every bone in it was broken.

When a monitor gets away from control in this manner, there are two things that can be done. The water may be shut off at the head gate, a process involving much delay and perhaps loss, or some brave man may rush in and get to the monitor without being struck by the stream. To do this requires agility and pluck. The stream is liable to box the compass inside of a minute, and its course must be watched and the probable direction noted. Then over the rough surface the man must hasten, careful not to make a misstep, and at the same time ready to flee should the erratic stream betray a tendency to change its course so as to endanger life. There have been many hairbreadth escapes and some thrilling exhibitions of bravery under such circumstances as these, and it has been only by the exercise of the greatest coolness and bravery that great loss of property and life has been prevented.

A. J. Bowie, of this city, in his work on hydraulic mining, states that the stream from a six inch nozzle, with a 450 feet vertical pressure, delivers a blow equal to 588,735 foot pounds per second, equivalent to 1,070 horse power. When one comprehends this fact, he will be abundantly prepared to believe almost anything that could be said about the power exerted by such a stream.

With a force such as that exerted by the stream from a monitor, it is apparent that a tremendous amount of material can be washed away in a very short time. The quantity removed depends, of course, upon its nature, whether loose soil, ordinary gravel, or cement gravel. In some places, under favorable circumstances, as high as thirty-six cubic yards to each inch of water have been removed in twenty-four hours. With a flow of 500 inches the bulk removed each day is thus seen to be enormous. In cement gravel the amount handled daily is as little as three cubic yards per inch. The quantity handled daily is, however, almost entirely dependent upon the grade of the sluices. In the case of the highest amount just mentioned the stream had a fall or head of 350 feet, the banks were 100 feet high, and the sluices had a grade of one inch to the foot, while 1,000 inches of water were used. Under such conditions and with such results it must be apparent that the removal of mountains is only a question of time—and not a very long time, either.

Some idea of the immense amount of earth and gravel moved by the hydraulic mines of this State can be gathered from some recently published statistics upon this point. During the height of the hydraulic industry there were in use from the Feather, Yuba, Bear, and American Rivers, Butte Creek, and the two Dry Creeks, a total of 10,650,505 miner's inches of water each twenty-four hours. At an average of 3½ thus cubic yards of gravel to the inch there was washed away daily 38,600,000 yards of material. This is a low estimate. As an actual fact much more was carried away. But the amount stated represents a mass of earth 500 yards long, 386 yards wide, and 200 yards high. With such a tremendous quantity washed away every twenty-four hours, it can readily be understood that no great length of time need elapse literally to remove mountains and cast them into the sea.—*San Francisco Chronicle.*

THE ODOR OF THE SOIL AFTER A SHOWER.

This subject, with which I was occupied more than twenty-five years ago, appears from a paragraph in a late number of the *Chemical News* to have recently attracted the attention of Professor Berthelot and M. Andre. I find, on referring to my old notes, which are dated 1865, that it is doubtful whether I ever published the results of these observations; and as the distinguished chemists I have just named have not quite solved the problem, I hasten to give the results I obtained so long ago.

After a considerable number of observations, I arrived at the conclusion that the odor emitted by soils and sedimentary strata after a heavy shower of rain in summer was due to the presence of organic substances closely related to the essential oils of plants, and it appeared evident to me that, during the hot dry weather, these porous surfaces absorb the fragrance emitted by thousands of flowers, and give it up again when the rain penetrates into these pores and displaces the various volatile substances imprisoned therein, which are only very slightly soluble in water. I believe that many kinds of soil possess this property, but those on which my observations were first made were the chalk soils of Picardy, in France. I found that not only chalk, but also marls, compact limestones, phosphatic rocks, and some kinds of schists and amphibolites are porous enough to possess it to such a degree as to emit a decided odor when they are strongly breathed upon.

Finding the property of which I speak very remarkable in certain chalk rocks of Picardy I endeavored to ascertain the nature of the substance, or substances, to which it was owed. I dissolved a very large quantity of the chalk in dilute hydrochloric acid, and passed the carbonic acid through various media, water, alcohol, weak potash solution, and dilute acid; but none of these liquids appeared to arrest the passage of the odoriferous substance. The only liquid which I found would retain it was an aqueous solution of bromine. This arrested it, and when the bromine solution was afterward carefully evaporated at a low temperature, a yellowish product, soluble in alcohol, and having a strong odor of cedar wood, was obtained, which, from its chemical and physical properties, appeared to be very similar to, if not identical with, bromo-cedren, derived from essence of cedar.—By Dr. T. L. Phipson, F.C.S. in the *Scientific American.*

A SPLENDID TELESCOPE.

The great equatorial, recently erected at the Paris observatory, is mechanically, as well as scientifically, a great wonder. It is the invention of M. Maurice Loewy, a member of the French Institute. Its mechanism, though quite massive, weighing some 25,500 pounds, is as perfect as a piece of watch work, and can be operated by a power no greater than an infant's. The polar axis of this equatorial is 59 feet long, and the curve which turns around this axis is 13 feet. The large tube rests on a pillar of masonry. At its top the elbow has a mirror and an object glass about two feet in diameter, the field of which is lit up by a light shown on a plate joined to the tube.

The fact of this mechanical perfection, and that the great instrument will aid in the advancement of photography, makes it an object of great interest to inventors equally as well as to scientists or students of astronomy. This equatorial has two object glasses of the same dimensions: one for looking directly at the heavens, the other intended for photographing the skies. The first is achromatized for chemical rays, that is to say, to destroy the primitive colors that accompany the image of the objective. Thanks to the other objective glass, the observer can take instantaneous photographs. Views of the moon, measuring about six inches in diameter, can be taken, and these the instrument enlarges by projection, making them in diameter as much as thirty-nine inches.

The observer is placed at a height of forty-five feet, the ocular glass is inside the room, but the rest of the instrument is in open sky. A star can be followed in its sidereal movements—that is to say, from its rise to its setting behind the horizon—without the observer having to leave his arm chair. An isochrome movement makes the instrument revolve as the star moves, so that it is always before the objective glass. With ordinary telescopes astronomers are obliged to move from their places constantly, so as to follow a star, and sometimes they have to assume positions that are inconvenient, and necessarily prejudicial to the exactitude of their observations. For fixed stars which have a movement of their own, a mechanical arrangement of this sort permits of their not being lost sight of for a single instant. The edifice is a square tower sixty-five feet high; a movable tent covers the whole apparatus when not in use, and it rests on rails on which it slides when needed for astronomical observations.

IS A PERPETUAL MOTION POSSIBLE?

What is a perpetual motion? As yet it is but an idea—so much will be admitted by the most enthusiastic advocate of its practicability. The utmost claim is that, according to physical law, it might be; no one claims that it is or ever has been. But millions of attempts, all ending in failure, only create a strong presumption that the thing attempted is an impossibility. They do not put it absolutely beyond doubt. Do the laws of nature make it eternally impossible?

The evident answer is that nature is herself a perpetual motion. The clouds and the winds, the waves, the flowing streams and mighty currents of electrical and other forces are in ceaseless flux and reflux. It follows, therefore, that any machine constantly played upon by any one of these perpetual forces would maintain a perpetual motion—as for instance a paddle-wheel moved by an unfailing stream of water—the motion continuing till the materials wore out, which fills the conditions of the problem. This much, then, is conceded: a machine which could receive continual accessions of power from sources outside of itself—that is, from the inexhaustible store of nature's dynamics—would be a perpetual motion.

But that is not what the projectors mean by their use of the phrase "perpetual motion." Their argument (if such it may be called) assumes the possibility of a machine which itself generates the power that runs it. In other words, a machine which *creates* power—that is, a machine which generates *more* power than it expends: namely, power enough to re-supply the original power and overcome friction besides. And such a machine is, by the eternal laws of physics, an eternal impossibility. No matter how simple or how complex, no matter how delicately adjusted or how slight the friction, this inexorable law remains—the force which originally moves the machine must generate another force equal to itself (for any force less than that would not keep the machine in motion) and *some* additional force to overcome the friction.

And the law is the same, no matter what device be adopted. Suppose it be (as in many attempts it has been) a series of falling weights on one side of a wheel; those weights must rise exactly as high on the other side of the wheel, and let the combination be what it may they must pass through as many rising curves as falling curves—that is, as many units of movement against as with gravitation—and the friction of the wheel be overcome besides. Suppose it were possible to reduce friction to a minimum of one unit in a machine whose power was ten million units—then the power of 10,000,000 would have to generate 10,000,001 to prevent a stoppage.

For further illustration take the device of a horizontal wheel, the original power applied at a point *A* on its circumference; *A* moves around to its original place, there an equal power must be applied to send it around again (for, of course, whatever power sent it around once will be needed for each successive round), and whatever extra power is needed to overcome the friction. Put the original power at 100, then that 100 power must generate a power equal to 100 plus friction. Algebraically stated, your problem is to make $100 = 100 + f$. Of course, f might be reduced to a very small amount, and it is barely conceivable that a place might be found where there is no f,—but not on this earth.

In a perfect vacuum—assuming the production of it to be possible—a top would run a surprisingly long time, there being no friction on the air; but it must rest on something, and that means friction. If a top could be suspended in mid-air, with some attractive force above it which exactly balanced gravitation, and then set in motion in a perfect vacuum, the thing might be accomplished; but such a condition is obviously impossible. On this earth there is no motion without friction, and where there is friction a perpetual motion is an eternal impossibility.—*By J. H. Beadle in the Mechanical News.*

THE BIRTH OF THE MECHANICAL AGE.

When the mechanical history of the world is written and a fair and full account is given of the steps by which the human race has reached its present mechanical skill, we shall have a work more entrancingly interesting than any which has yet come from the pen of man.

Progress which in the beginning was so slow as not to be observable has, in these latter days, reached a speed that is startling even to those most intimately acquainted with it.

The Mechanical Age, that age in which complex mechanical contrivances and machines are universally used, is young. Most men of middle age can remember almost its beginning. It may be said to have had its dawn in the '60s when the need of the mower or reaper was felt on every little mountain farm, and when the poorest households awoke to the fact that they must have a sewing machine. Labor saving machinery called for cheap and easily applied power. For ten years Ericsson had been making and selling small engines available for any and every purpose, under all conditions, both at home and abroad. Manufacturers of small steam engines sprang up all over the country, to gather a part of the harvest which he had prepared and was reaping. Americans were feeling the need of labor-saving machinery in every branch of business. It was no longer satisfactory to have a machine work automatically. It must also be self-feeding. In a word it must be automatic from the raw material to the finished product. Years before this demand had been made in cotton spinning, in engines for pumping water and in other applications of power on a large scale.

To-day the sewing machine is in every house in the land. The mechanical idea has become so generally familiar and mechanical facility, to coin a term, so universal that sewing machines are sold across the counter with a book of instructions just as a bottle of patent medicine or a package of baking powder might be. Yet less than 30 years ago unlimited instruction at the purchaser's residence had to be promised in order to make sales, and grave doubts were expressed in regard to the practicability of women generally learning to take care of such complex machines. Now a girl learns to use a sewing machine, as some one said of reading and writing, "by nature."

But it is not in America alone that this spread of mechanical knowledge has taken place. Caravan loads of sewing machines are sent into the heart of Asia. The wildest tribes of India and Arabia prize the breech-loader and the revolver. Kipling in one of his vivid photographs of "the hills" tells of a native tribe that counted Martini-Henrys worth their weight in silver and paid for them at that rate. Even in Africa the breechloader is making its way against the flint lock, and Winchesters are objects of desire, while native gunsmiths the world over are learning to make the more simple repairs of these complex arms.

One day last fall, standing by the side of a friend on the rugged eastern side of Inwood hill in the city of New York, he picked up, at the mouth of a little cave that had been a dwelling in the stone age, the fragment of slate shown in Fig. 1, which is a rough sketch from memory. Our friend, Mr. Schenowith, explained that it was a part of the stone

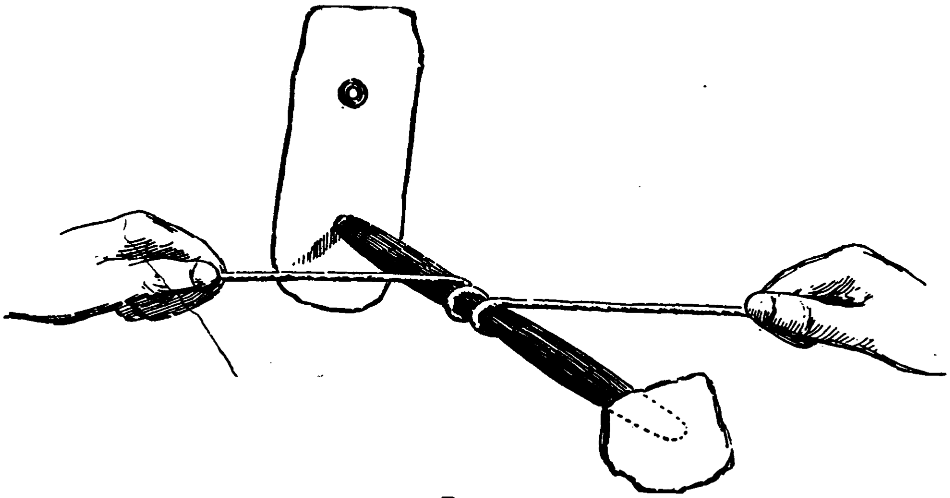


FIG. 3.

guard which the hunters of that age fastened upon the left wrist to protect it from the recoil of the bow string. When complete there are two holes. One of these has been lost in the part broken off. The remaining hole, clean and round, was very much like that made by a rose bit and was perfectly circular. The scores, which can be seen in the engraving, showed the method of working.

FIG. 1.

Here, in one of the unfrequented portions of a great city, was a fragment of the stone age. This would afford an interesting subject for the essayist who would write on human progress or give the poet a theme when he would sing of the old times and the new. But to the mechanical engineer the little truly circular hole in the fragment of slate was more interesting because it told of the age in which one of the fundamental tools was invented. The next illustration shows the first drill press. That this was the earliest method of boring a round hole, we know from a variety of evidence. The scores in the hole itself, clear cut and circular, point to sand as the cutting material. The work must have been done by a revolving tool or the hole would not have been perfectly round, nor the rings, or scores, parallel with the circumference. We also know that this form of tool was used in the stone age. Indeed, among some primitive people where the stone age still lingers, as in Northern Australia, this tool is in use to-day. Among these simple people this is the form of drill and the apparatus for making fire.

Given the dust of quartz or corundum and the hardest substances may be penetrated with only a piece of wood hardened in the fire, or a splinter of bone, for a tool. Pieces of crystal five or six inches long were often pierced with narrow holes by the ancient workmen who had only this very simple method of operation.

But improvement began in the earliest ages, even though the primitive patent office made no effort to encourage invention. It did not take long for the man of the stone age to wrap a thong about the spindle of his drill. Then the time between the reversals of motion was greatly extended. With his bare hands the "length of stroke" could not much exceed six inches in any case; with the thong held in both hands it might become thirty inches. So the stone to be perforated was held between the knees or with the feet, for the primitive man used his feet for hands like the native of India to-day. To prevent the drill from perforating his bare skin and to secure a suitable "feed" he puts a piece of stone, or shell, against his stomach, rests the end of his drill against it and works the cord with his two hands. Thus in Fig. 3 we have the essential features of the drill press—a tool rotated by a belt and a feed to keep the tool up to its work. It is the fundamental drill.

But the next invention gave us *the* tool which more than all others dominates the mechanical world of to-day; which has a wider range and variety of uses than any other. Lay the drill upon its side, remove the cutting edge, apply a tool to what has been the stock of the drill, and we have at once the lathe. Primitive to be sure, it is, but observe the fact that

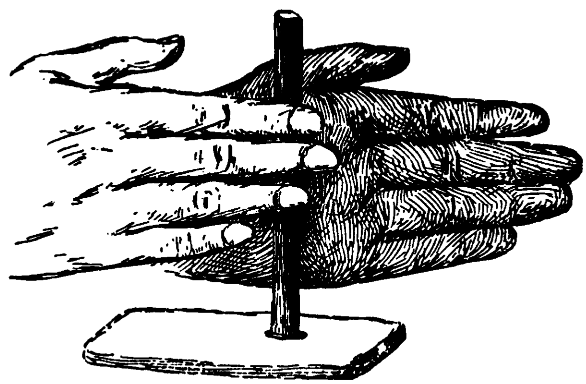


FIG. 2.

the work is turned between "dead centres." A perfect circular section is possible. Our last figure shows just how it was done in India within the memory of man. Perhaps to this day there are workmen who are using this form of machine or one equally simple, the father of all machines and machine tools.

The first lathe was not difficult to construct. Nature furnished foundation, bed-plate and shears. It was only necessary to select two trees at the proper distance apart. Through

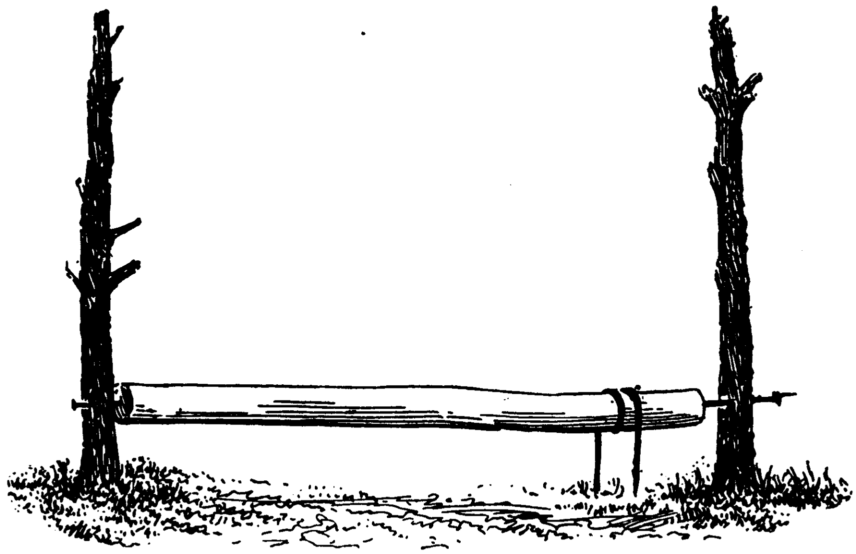


FIG. 4.

them, at a proper height from the ground, pins were driven. In the later days these were of iron. In the earlier times bone would have answered for centres, and the drill would have made the holes through the trees. The stick to be turned was put in place, and the centres driven up until it was held securely. Then a rope or thong was wrapped once or twice around the stick. And here, perhaps, was the first case of the division of labor. One man stood or sat, and holding the ends of the thongs in his hands, by alternate motions turned the stick back and forth. The turner meantime cut a score for the cord at one end of the stick. When this was finished the cord was slipped into its place, and the work began.

As the work revolved alternately from and toward the tool, cutting was done only while the work was turning toward the workman. In the far East the turner and the man who furnished the motive power sat while work was in progress. Sitting thus upon the ground the bare foot was used for a rest and guide, the tool being held by the great toe.

Here the turner, who used his feet as freely as his hands, had, as we may say, four hands, with employment for only two or three. A labor-saving device came into use for light work. The second man was dispensed with, and one end of the cord or thong was taken to the top of a neighboring sapling. The other end was held in the left hand. There was a more satisfactory distribution of labor; the left hand drove the lathe, the foot and the right hand held the tool and took care of the feed. The other foot, as a rule, had nothing to do.

This simple form of the machine is not to be despised. The most delicate work in ivory has been produced by it, and it is still in use in some parts of the far East for fine turning.

In towns and places where trees of the suitable size and at the proper distances were not to be found, it was a natural and easy step to drive two posts into the ground just where they were wanted, and set up a bamboo in the earth to take the place of a sapling. Such trifling modifications would be suggested by the mechanical judgment of even primitive man.

In these simple forms, so free from complication that they can hardly be dignified with the name of machines, we have the fundamental forms, the essential elements of our modern machine tools. With them alone it is but a few short steps to the most complex of the machine-tools of our day. Given a master of mechanical manipulation, and with files and chisels he can produce a straight edge or plane a surface. With this lathe he can turn a shaft true, or make a screw two or three inches in diameter and many feet long. With a few levers and beams, and a screw, cut with a hand-made chaser for a feed, he can bore, true, and fit a 20-foot fly-wheel. With apparatus so simple that when dismounted it looks like a pile of blocking, he can bore out a 90-inch cylinder and turn off the flanges. After boring, a set of guide bars for a locomotive can be finished completely and to perfection with no tools but files and scrapers. The feats which the wise and skilled mechanic of the semi-civilized races has performed with his own simple tools and unlimited time can hardly be credited until the different steps have been described. If it be a question of accuracy he can feel and fit to fractions of a thousandth of an inch. His trouble is to find the standard. The boy with a file and a few strips of brass can, in an hour's time, make a tool by which he can measure differences of diameter as closely as the best micrometer caliper. But there is this difference—one can only show the difference, the other can refer to a standard.

Few modern-bred engineers stop to think how closely these simple, primitive tools come to the present day. It is not generally understood how short a time has elapsed since all machines were built and not manufactured. The writer remembers having seen in his childhood a pole lathe, and one of a very complex character, too. It was used for business, and was not a remnant of a past age. All the older engineers in New York remember when a marine engine was built one piece at a time, and when the "long connecting-rod" was never cut off and the ends welded up until the "A frame" and main center with the pillow-blocks was in position, so that distances "between centres" could be measured.

There were good tools and good engines built long before the Mechanical Age began to dawn. Steam-engines built before the time of Watt have run regularly till within half-a-dozen years—perhaps are still running. Instruments of precision were made in the past which are admirable to this day. Some of the fine things now in use in our laboratories are the hand work of the last generation. And some of the best things of our own day are hand work.

The radical difference, the real gulf that separates our Mechanical Age, the work of the present period, from the productions of the primitive man and his tools is interchangeability. The Blanchard lathe, and the whole host of machines which turn out interchangeable pieces have revolutionized the world.

When the traditional workman boasted that his trade was safe, and a lathe could not turn an octagon gun-barrel, it was the death-chant of the old and the birth of a new age. From wood Blanchard went to metal, and the present age became a possibility.—*By W. E. Partridge in the Mechanical News.*

DUST AND FRESH AIR.*

It is curious to contemplate how patiently the world puts up with small miseries, and never even asks the question whether they can be done away with. The entrance of dirt, *i.e.* dust, into rooms, cupboards, closets, cases and drawers is so universal, worst in smoky towns, but not entirely absent in the country, is such a source of labor, discomfort and expense that the wonder is that, as a public question, it has never been made a subject of serious enquiry and study. The cost of dust to the whole country is enormous, whether we consider our museums or the cupboards and drawers in private houses. The subject may be best treated in two divisions—one that of closed cases, cupboards and drawers; the second that of rooms containing a fireplace. The first division is perhaps the most far-reaching and important, and may be taken first. In dealing with closed spaces I may take it for granted that, do what we will, have as good workmanship as we can get, dust will get in. It is barely possible by mere "fitting" alone to keep out the dust. Grant me this, and we have a starting-point of common agreement, which will perhaps be but strengthened by any exceptional instances in a contrary direction, which prove, or put to the test, the general rule. Our next point is to inquire, How does the dust get in?

There are probably none of my audience who have not heard of the barometer. Many are in the habit of observing its movements day by day, and not a few, no doubt, understand the reason of the rise and fall of the quicksilver in the glass. What do these changes mean and what do they record? When the air around us becomes condensed, shrinks into a smaller volume, it becomes heavier, puts greater pressure on the surface of the mercury, and makes it ascend in the tube. Then the barometer is said to rise. When the air expands, swells into a larger volume, it becomes lighter, the pressure on the mercury is less, the mercury sinks in the tube, and the barometer is said to fall. Therefore, every change of height of the quicksilver which we observe is a sign and a measure of a change in the volume of the air around us. Further, this change in volume tells no less upon the air inside our cases and cupboards. When the barometer falls, the air around expands into a larger volume, and the air inside the cupboard also expands, and forces itself out at every minute crevice. When the barometer rises again, the air inside the cupboard, as well as outside, condenses, shrinks, and air is forced back into the cupboard again to equalise the pressure; and, along with the air, in goes the dust. The smaller the crevice the stronger the jet of air, and the farther goes the dirt. Witness the dirt-tracks so often seen in imperfectly framed engravings or photographs. Remember, ladies and gentlemen, whenever you see the barometer rising, that an additional charge of dust is entering your cupboards and drawers. So much for the barometer, which is a very restless creature, rarely stationary for many hours together. But this is not all. We also have the thermometer. The temperature of our rooms varies daily, often considerably between midday and midnight, and greatly between summer and winter. What does the thermometer tell us? Not less than the barometer does it tell of change of volume of the air, though it is probably not so rapid in its effect upon air in enclosed spaces as is the change of volume indicated by the barometer. Most of you are familiar with a fire balloon. The heated air filling the balloon expands and becomes lighter than the surrounding air, and up goes the balloon, until, the source of heat having become exhausted, the contained air cools, contracts, becomes as heavy as the surrounding air, and down comes the balloon again. So also as temperature rises outside our cases, the increased warmth is slowly conducted to the air inside the case, when the air expands and escapes through the crevices. Then, when the turn for cooling comes, the air inside slowly contracts, and back rushes the air through the crevices, and again in goes the dust. Thus we see we have two factors constantly acting, one or other tending to produce daily, nay, hourly, changes of volume of our dirt-carrying air. In order to inform myself of the amount of change of volume that could, under extreme conditions, possibly take place, I asked Professor Rucker to kindly calculate for me the change of volume that would take place in 100 cubic feet of air between a temperature of 30 degrees, *i.e.* just about freezing point, in combination with the barometer standing at 30 inches, or about "fair"; and a temperature of 60 degrees combined with the barometer standing at 29 inches, or "stormy." He told me that the difference would be about 10 cubic feet, or one-tenth; in other words, that a closed case of 100 cubic feet, if hermetically sealed at a temperature of 30 degrees, with the barometer standing at 30 inches, would have to resist the pressure equivalent to the addition of 10 cubic feet, when temperature rose to 60 degrees, and the barometer fell to 29 inches. Have we not now discovered the reason why dirt enters closed spaces? What shall be the remedy? Seeing that air will find an entrance, and in the nature of things must get in, why, then, you must let it in, not at innumerable uncovenanted small crevices, but at your own selected opening, specially provided. Then you are in a position to shut off the dust by providing your selected opening with a screen, which acts as a filter. But, you will say, there are still the crevices; will not the dust enter by these as before? Probably not to any great extent if you have fulfilled this one condition—that you have provided entrance for air through your screen, which is easier than entrance through crevices. This is approximately true for narrow chinks, and wide crevices are bad workmanship and inexcusable. But, you may ask, what grounds have I for thinking that air will not squeeze through narrow channels if it has an opportunity of going through much larger ones? Let me remind you of a diagram of an experiment in my book, "Dangers to Health," plate III. You can make the experiment yourselves on your return home. In a room with a good fire and doors and windows shut, take a candle and hold it opposite an open keyhole, so that the flame, though blown horizontally, is not quite extinguished. Then let someone slowly open the window. As the window opens the flame gradually recovers an upright position, and as soon as the window has been opened to the extent of 3 or 4 inches the flame will be at rest. The air current through the keyhole has been as effectively stopped as if the keyhole had been plugged. This observation seems to lead to two important

*A lecture by Mr. T. Pridgin Teale, delivered before the members of the Leeds Philosophical and Literary Society.

points which, however, my experiments have hitherto failed to establish—one, that if we can ascertain what for each instance, or for a given cubic space, is a sufficient screened opening, we can prevent the entrance of dust-laden air by the uncovenanted narrow chinks and small openings; the other, which is the converse, that if we can make our fittings nearly air-tight we can in such instances afford to admit the air through a comparatively small area of screen. I fully believe the principle to be true; but I have not yet discovered how to secure its perfect application in detail. These, then, are the general principles on which we must act. The rest is a question of detail. The details range themselves under three heads:—1. What is the most effective, or the most generally applicable, filtering material? 2. Given the filtering material, what ought to be the proportion between the area of the screened opening and the cubic contents of the case to which it has to be fitted? 3. What, in any particular instance is the best situation for the filter?

A—FILTERING MATERIAL.

What is needed in our filtering material is that it shall readily allow air to pass through, and shall also possess the quality of arresting in its meshes fine particles of dust. For some purposes it may suffice to use a coarse canvas, the threads of which are not too closely twisted, and have an abundance of fine fibers projecting from them, thereby reducing the small squares of the woven texture to a still finer mesh. The material I have used most frequently is "bunting," but it has disappointed me. When examined by the microscope, many of the small squares of mesh are deficient in delicate fibres standing out from the threads, which would enhance the filtering power of the texture. Lately I have tried other materials, velvet, demette, flannel and cotton wool between layers of muslin, such as is used for dressing wounds under the name of Gamgee tissue. Cotton wool is probably the most perfect filter. Indeed, so perfect is it that in the new science of bacteriology it is used as a most effective means of excluding dust and germs from flasks in which experiments are carried on. In order to put various textures to an exact comparative test, experiment was tried. A series of boxes were made, 1 foot square by 2 feet in length, open at each end. One end of each was closed by a square of glass loosely fixed by small nails, to imitate a badly-fitting door. The other end was closed, in the case of one by wood, to represent the ordinary unventilated cupboard, in the case of a second with bunting, of a third with flannel, of a fourth with cotton velvet, of a fifth with cotton wool. In each were placed slides and cards on which dust might settle. The slides were placed in the boxes on December 14, and were removed February 26, *i.e.* at the end of nine weeks; but the results are imperfect, chiefly owing to the contraction of the wood, which in three instances broke the glass, and so invalidated the experiment. But some facts of importance come out. First and foremost, the fact that in nine weeks a serious amount of dust entered several of the boxes. The box without a filter had by far the most dust. The box with cotton wool had the least. This is about all that can be said about an experiment which, with reference to this lecture, is perhaps a failure, but will prove an incentive and a guide to further experiments in the same direction. Failure in detail not unfrequently points the way to eventual vindication of principle.

B.—THE PROPORTION BETWEEN THE FILTERING OPENING AND THE CUBIC CAPACITY.

This is a question which experience alone can decide. Doubtless the larger the area of screened opening, the more effective the filtration. For a bookcase with glazed front probably the whole of the back might be made of canvas stretched over the necessary skeleton framework. For a cupboard or closet, every panel should be replaced by screen. If the closet have a window, all crevices and joints in the window should be pasted up to exclude the soot, otherwise the wind from the outside, or the fires of the house from the inside, will force the air and soot through.

C.—THE SITUATION OF THE SCREENED OPENING.

Where shall we place our screen? This is a question which admits of a variety of answers, and gives scope for endless ingenuity. In anything which is being newly made, such as the cupboards and closets of a new house, or in new furniture, we are masters of the situation. In many of them we may substitute at the back our filtering texture for wooden boards, and perhaps even save expense thereby. In closets we may replace the panels of the door by filtering texture, guarding the closet, if necessary, against thieves by wire netting or iron bars fixed on the inner side. As a rule chests of drawers may have the filter over the whole surface at the back, care being taken that the back of each drawer falls half an inch short of the top of the drawer to allow free entrance of air from the screen at the back. In one set of drawers, so placed that I could not get at the back, the difficulty was got over in this way. In the front of each drawer a series of about twenty holes of an inch diameter was made for admission of air. The filter, on a frame, was fixed on the inner surface of the front of the drawer so that the material should stand half an inch away from the holes. A somewhat similar plan was adopted in a mahogany bureau. About twenty large holes, 2 inches in diameter, were cut in the woodwork at the back, some of the holes being opposite drawers, some opposite pigeon-holes. Then the whole was covered with bunting, on a frame so arranged that the bunting was fully half or two-thirds of an inch away from the wood. Another method has been adopted at the Yorkshire College for some of the cases. The filter was applied at the roof, somewhat after the fashion of a weaving-shed roof, the vertical face being filled in by the screen. Again, Mr. Branson has provided a roof filter for a case of scientific instruments by placing the screen in the roof of the case, and protecting it by a false roof 2 inches above it, to prevent its being choked by falling dust.

We are now in a position to ask two questions. Has the plan been tried? Does it answer? To the first, I may reply that I have tried it more or less for twelve years, my earliest views having been published in 1879, in the first edition of "Dangers to Health," when my first experiment was made in the entrance hall of this building. To the second, Does it answer? I may reply that I can hardly give a more convincing proof of my confidence in its value than this, that I have gradually applied a filter to nearly every cupboard and closet that I possess. In drawers so treated at my chambers at Cookridge Street, I can now leave papers and books uncovered, whereas formerly they had to be carefully wrapped up and labelled. The same statement may be made as to a large closet in the same house, where I have placed bunting panels, and have pasted up the window crevices. My house at Headingley being absolutely devoid of a boxroom, I erected some ten years ago a large box-closet in the granary—a dusty place, if there is one. It was constructed of a wooden frame work, covered with coarse canvas, the roof being made of boards. In this closet portmanteaux and boxes can lie for months without becoming either dusty or mouldy. Perhaps the most perfect proof of the accuracy of these views that I possess is the following. Some five years ago, by the advice of a friend, I doubled the panes of glass in the north window of my bedroom. in order the better to keep out the cold, or, more correctly speaking, perhaps, to keep in the heat. Each new pane was fixed inside the old pane at a distance of two-thirds of an inch. The new pane was made to rest against a rim of wood about a quarter of an inch in width. In order to keep out dust, I had the rim against which the pane rested covered with cotton velvet. The pane was simply fixed against the velvet by about eight small nails. The whole of these years the inner surface of the panes has remained perfectly clean, and they have never been removed for cleansing. Ladies and gentlemen, you have seen, and I hope have admired, the very effective pictures thrown upon the screen by the lantern. I could not have achieved this important part of my lecture of myself; but I—may I not say we?—are greatly indebted to Mr. Branson for his aid and suggestions in bringing out in such perfection these illustrations, and to Mr. Waite, the assistant-curator of this hall, for most effective aid in carrying out experiments in the collection of dust in boxes and cases. I may here just mention a few illustrations that occur to me, bearing out to some degree what I have been saying. I once suggested to the late Mr. Bell, watchmaker, the idea I have just mentioned for excluding dust from his cases containing watches and other valuables. I am afraid I did not persuade him to adopt it; but he was a very thoughtful man, and he told me it explained a thing he had often remarked, namely, that old-fashioned clocks which had open framework backs covered with silk always kept very clean. The silk had evidently acted as a filter. Then, not long ago a member of my family made the remark that there was very little dust in ottomans, and on examining their structure, you will find a framework of wood with nothing but some textile material outside which admits the air and acts as a filter. I was once on the point of buying an ice safe in London, and while looking at some I was told that it was necessary to put a ventilator into these safes, and that it had been found that if cotton wool was filled into the ventilator the meat in the safe kept much better than if it was left open to the air. Another point many of you will have noticed are the marks on a ceiling —the dark and white streaks. I believe these will be found to occur in a bedroom which is just under the open roof. The air is drawn through the plaster, and some dust filters through with it; but where the beams are the air cannot get through, and the ceiling is left clean. Then, as to the dust marks on pictures, caused by dust drawn in owing to the changing volume of air, I am told that in the new museum at Berlin every case is fitted with a cotton-wool filter with a view of excluding dust.

EXCLUSION OF DUST FROM ROOMS.

The second division of my subject deals with the exclusion of dust and soot from rooms containing a fire-place. Let us pause for a moment and consider what idiotic arrangements we submit to. First of all, we have the fireplace and chimney. The chimney throat, instead of being contracted, is generally a yawning chasm, providing the best attainable opportunity for smoking. Suppose we have a fire, as we must have for nine or ten months of the year. The fire draws up the chimney about 150 cubic feet of air per minute. Whence come the 150 cubic feet of air? If the windows fit well, as is sometimes the case in a new house, in vain the fire pulls upon the windows. If the door and floor boards and skirting boards fit they are appealed to in vain, and the poor fire has no other chance left but to smoke, and smoke, and smoke, until a charitable individual opens a door or a window. After a while no doubt woodwork shrinks, crevices and chinks open out, and our fire wins its much-wanted supply, and then, perhaps, ceases to smoke. But what next? In a town with an atmosphere laden with soot, in come the blacks, and cover our window-sills, our papers, our tables, and our books. Why do we submit to this? You may ask, Can it be avoided? I reply that it can. First provide an inlet for the air which has to supply the chimney, so that cold air coming in shall not be a draught. The best device that I know of for achieving this is the "Harding diffuser." It was patented. After a while the patentees ceased to make it. Then the patent lapsed, and now it is open to all the world to make. The Harding diffuser delivers the fresh air near the ceiling in a series of small jets, which mix with the warm air of the top of the room, and do not form a cascade of cold air, such as is produced by a Tobin's tube. At the same time it is but fair to say we have learnt much from Tobin; firstly, that we ought to provide a definite inlet of fresh air to every room; and secondly, that we may mitigate the ill effects of a current of cold air by studying how to give it a harmless direction. Having provided for the entrance of air without producing draught, the next step is to filter the air and cleanse it. This is done by making the opening through the wall about 5 feet from the floor, and carrying the air up to the "diffuser" in a flat shaft, about 18 inches broad and 4 inches deep, and about 4 feet in length, in which is placed diagonally a screen of canvas or other filtering material, through which the air must pass on its way to the "diffuser." The screen should be taken out and brushed with a soft brush at least once a week. This need of vigilance and attention to cleansing is the one drawback to the system. Having thus secured the entrance of cleansed air, the next point is to stop the window crevices. If the window can be cleaned from the outside, this may easily be done by putty, glue and strips of canvas. If the window cannot be cleaned from the outside—well. If you are putting in new windows, why not make them air-tight and wind-tight; do away with sashes and their abominations, and make the middle part on hinges to open inwards, so that the other parts can be cleaned without going outside? I trust, ladies and gentlemen, that I have now said enough to make you uncomfortable and dissatisfied when you see your toilet table covered with smuts or your drawers patterned in dust. Such things, I fully believe, need not be, ought not to be; and if you, the public, instruct yourselves and demand it, it will not be.

TO CLEAN A DIRTY ENGINE.

Dissolve a pound of concentrated lye in about two gallons of water, and with a mop saturate the engine with the liquid —being careful that it does not get into the oil holes of the journals and bearings. After the lye has eaten all the grease and gum from surfaces, clean perfectly by scraping and brushing, and apply after the iron is dry and free from grease, a thin coat of lead paint. And after this is thoroughly "set," paint the iron a deep black, and varnish heavily—coloring, striping or decorating according to taste, can be done afterward. Then the greater part of the works can be easily and quickly cleaned with a dusting brush or cloth; and escaped oil can be mopped off thoroughly with but little trouble. A very small outlay of money and work thus invested will obviate work that is frequently done to no advantageous purpose in a futile attempt to keep the engine clean.—*St. Louis Miller.*

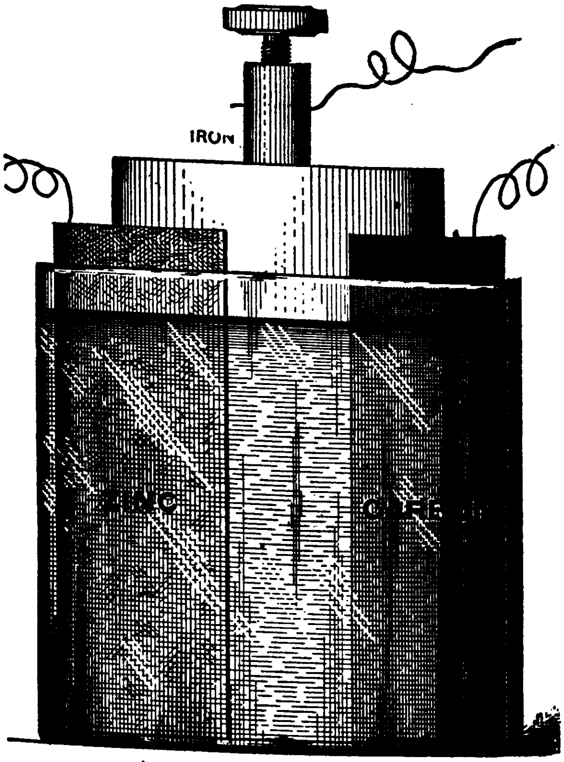
ELECTRICAL

A THOUGHT IN A LEISURE MOMENT.

BY WM. S. EATON.

While in my laboratory, one day, I had occasion to await the development of a chemical operation then in progress. Casting about for something to occupy an idle moment, my gaze rested upon a small pile of iron turnings, some carbon plates, porous cups and various other odds and ends, and this is what I did.

In the centre of a porous cup I placed a bar of ½-inch round wrought iron and rammed about it the iron turnings, to a depth of perhaps one-half an inch; then I dusted in some rouge, then more iron turnings, and so on, until the cup was full of the metal and rouge. By way of explanation, I will say that I did not stop to consider whether, or not, the rouge would be of any service; it was simply close at hand and in it went; nitro-glycerine or hair-oil would, in all probability, have taken the same road, had it been as accessible as the rouge.



AN EXPERIMENTAL BATTERY.

My next move was to immerse the porous cup in a weak solution of sulphuric acid and water and pour a little extra into the porous cup for good measure. Next I inserted in the dilute solution, outside the porous cup, a plate of carbon and a plate of zinc, the arrangement being shown in the accompanying illustration. I connected the wire from the zinc and iron electrode to a small vibrating bell and "let 'er go." It went; not very strong at first, but better after a little while, and in a few hours stopped.

The iron which had been the negative element of the battery became evidently as oxidizable as the zinc; so I disconnected the zinc and attached the carbon, thus making the iron the positive. This, of course, gave a stronger current than the first. Finally, this ran down and I switched back to the zinc again and got a better result than at the first trial; it seemed to run longer and give a better current. And so I kept changing from zinc to carbon alternately making the iron positive and negative.

For a single fluid battery I must say it did very well, and my recollection of it (this occurred many months ago) is that it ran with the iron as negative element, from Saturday noon until Monday morning. By that time its energy was almost gone; but I got a strong current when I switched the wires again, making the iron once more the positive element. It seemed to me that the iron filings had accumulated considerable electrical energy, and as soon as it was permitted it discharged itself. If such is the case, no doubt there was a large resistance when the zinc-iron elements were connected, which tended to reduce the effectiveness of the battery very materially. When the iron and carbon were connected there seemed to be a powerful rush of current for a short time. I never had the time to make any tests, and after a number of days I dropped it. These facts are as I remember them, and are in the main correct.

Although this experiment was ended almost as soon as begun, yet it made me consider the feasibility of employing, in primary or secondary batteries, some of the material usually accumulated in machine shops and elsewhere, and generally regarded as of no value. I also thought that the effectiveness of storage batteries might be increased, the weight reduced, and the cost lessened, by making up the electrodes of granulated, shaved, or otherwise prepared lead, instead of the plates and grids usually employed in that class of cells. I can see no great difficulty in forming a secondary battery of thin dividing partitions of porous earthenware, ramming in the lead turnings and adding the litharge and minium so as to incorporate the whole thoroughly. It is well known that in storage batteries generally the whole of the lead plate is not doing useful work. In the case of lead shavings, however, we get a greatly increased surface, and simplify the mechanical construction. We also avoid that fruitful source of trouble, buckling in the plates, and I think the weight would be diminished. It is equally true that there may be grave disadvantages attending such construction; yet, as the secondary battery has already proved its usefulness, any idea looking toward an improvement would appear to be worth an investigation.—*Electrical Engineer.*

EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

(From Houston's Dictionary.)

Astatic Needle.—A magnetic needle consisting of two magnets rigidly connected together and placed parallel and directly over each other, with opposite poles opposed.

An astatic needle is shown in Fig. 26. The two magnets N S, and S′ N′, are directly opposed in their polarities, and are rigidly connected together by means of the axis *a a*. So disposed, the two magnets act as a very weak single needle when placed in a magnetic field.

Were the two magnets N S, and S′ N′, of exactly equal strength, with their poles placed in exactly the same vertical plane, they would completely neutralize each other, and the needle would have no directive tendency. Such a system would form an *Astatic Pair* or *Couple.*

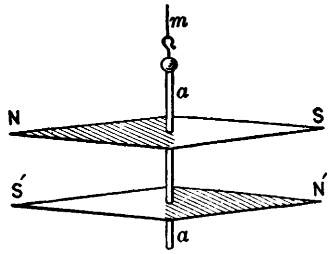


FIG. 26.

In practice it is impossible to do this, so that the needle has a directive tendency, which is often east and west.

The cause of the east and west directive tendency of an unequally balanced astatic system will be understood from an inspection of Fig. 27 *a*. Unless the two needles, *n s*, and *s′ n′*, are exactly opposed, they will form a single short magnet, N N N N, S S S S, the poles of which are on the sides of the needle. The system pointing with its sides due N. and S. will appear to have an east and west direction.

An astatic needle possesses the valuable property of requiring a smaller force to deflect it than a single needle with more powerful poles. Its magnetism is not as easily lost or reversed as that of a weaker magnet.

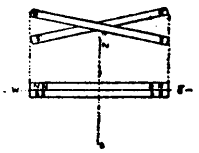


FIG. 27*a*.

The principal use of the astatic needle is in the *astatic galvanometer,* in which the needle is deflected by the passage of an electric current through a conductor placed near the needle. Therefore it is evident that one of the needles must be outside and the other inside the coil. In the most sensitive form of galvanometer there is also a coil surrounding the upper needle, the two coils being oppositely connected, so that the deflection on both needles is in the same direction, and the deflecting power is equal to the sum of the two coils, while the directive power of the needles is the difference of their magnetic intensities.

Atmosphere, An.—A pressure of a gas or fluid equal to about 15 pounds to the square inch.

At the level of the sea the atmosphere exerts a pressure of about 15 pounds avoirdupois on every square inch of the earth's surface. This has therefore been taken as a unit of fluid pressure.

For more accurate measurements pounds to the square inch are employed.

Atmospheric pressures are measured by instruments called ***Manometers.***

Atmospheric Electricity.—The free electricity almost always present in the atmosphere.

The free electricity of the atmosphere is generally positive, but often changes to negative on the approach of fogs and clouds. It exists in greater quantity in the higher regions of the air than near the earth's surface. It is stronger when the air is still than when the wind is blowing. It is subject to yearly and daily changes in its intensity, being stronger in winter than in summer, and at the middle of the day than either at the beginning or the close.

Atmospheric Electricity, Origin of.—The exact cause of the free electricity of the atmosphere is unknown.

Peltier ascribes the cause of the free electricity of the atmosphere to a negatively excited earth, which charges the atmosphere by *induction.* It has been ascribed to the evaporation of water ; to the condensation of vapor ; to the friction of the wind ; to the motion of terrestrial objects through the earth's magnetic field ; to induction from the sun and other heavenly bodies ; to differences of temperature ; to combustion ; and to gradual oxidation of plant and animal life. It is possible that all these causes may have some effect in producing the free electricity of the atmosphere.

Whatever the cause of the free electricity of the atmosphere, there can be but little doubt that it is to the condensation of aqueous vapor that the high *difference of potential* of the lightning flash is due. As the clouds move through the air they collect the free electricity on the surfaces of the minute drops of water of which clouds are composed, and when many thousands of these subsequently collect in larger drops the difference of potential is enormously increased in consequence of the equally enormous decrease in the surface of the single drop over the sum of the surfaces of the coalescing drops.

Attraction, Electro-Dynamic.—The mutual attraction of electric currents, or of conductors through which electric currents are passing.

Attraction, Electro-Magnetic.—The mutual attraction of the unlike poles of electro-magnets.

Attraction, Electrostatic.—The mutual attraction exerted between unlike electric charges, or bodies possessing unlike electric charges.

For example, the pith ball supported on an insulated string is attracted, as shown at A, Fig. 29, by a bit of sulphur which has been briskly rubbed by a piece of silk. As soon, however, as it touches the sulphur and receives a charge, it is repelled, as shown at B, Fig. 29*a*.

These attractions and repulsions are due to the effects of *electrostatic induction.*

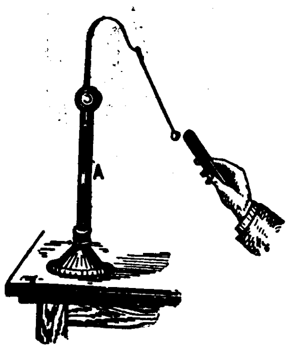


FIG. 29.

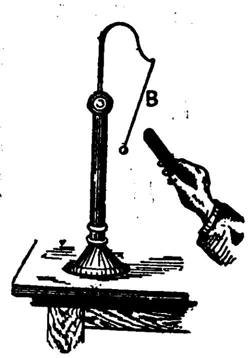


FIG. 29*a*.

Attraction, Magnetic.—The mutual attraction exerted between unlike magnet poles.

Magnetic attractions and repulsions are best shown by means of the *magnetic needle* N S, shown in Fig. 30. The N. pole of an approached magnet attracts the S. pole of the needle, but repels the N. pole.

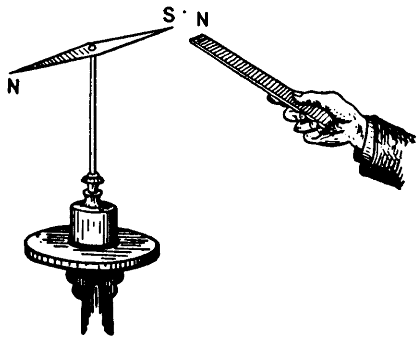


FIG. 30.

The laws of magnetic attraction and repulsion may be stated as follows, viz.:—

(1) Magnet poles of the same polarity repel each other.

(2) Magnet poles of unlike names attract each other.

FIG. 31.

A small bar magnet, N S, Fig. 31, laid on the top of a light vessel floating on the surface of a liquid, may be readily employed to illustrate the laws of magnetic attraction and repulsion.

Aurora Borealis.—Literally, the Northern Light. Luminous sheets, columns, arches, or pillars of a pale flashing light, generally of a red color, seen in the northern heavens.

The auroral light assumes a great variety of appearances, to which the terms *auroral arch*, *bands*, *coronæ*, *curtains*, and *streamers* are applied.

The exact cause of the aurora is not as yet known. It would appear, however, beyond any reasonable doubt, that the aurora flashes are due to the passage of electrical currents or discharges through the upper, and therefore rarer, regions of the atmosphere. The intermittent flashes of light are probably due to the discharges being influenced by the earth's magnetism.

Auroras are frequently accompanied by *magnetic storms*.

The occurrence of auroras is often simultaneous with that of an unusual number of *sun spots*. Auroras are therefore probably connected with outbursts of the solar energy.

The auroral light examined by the spectroscope gives a *spectrum* characteristic of luminous gaseous matter, *i.e.*, contains a few bright lines; but, according to S. P. Thompson, this spectrum is produced by matter that is not referable with certainty to that of any known substance on the earth.

Whatever may be the exact cause of auroras, their appearance is almost exactly reproduced by the passage of electric discharges through vacuous spaces.

Aurora Australis.—The Southern Light. A name given to an appearance in the southern heavens similar to that of the *Aurora Borealis*.

Austral Pole.—A name sometimes employed in France for the *north-seeking pole* of a magnet.

That pole of a magnet which points to the earth's geographical north.

It will be observed that the French regard the magnetism of the earth's Northern Hemisphere as north, and so name the *north-seeking pole* of the needle, the *austral* or *south pole*.

The *south-seeking* pole of the magnet is sometimes called the *boreal* or *north pole*.

Automatic Cut-Out, Electric.—A device by means of which an electric circuit is either opened or short circuited, whenever the current passing might injure the *electro-receptive devices*.

The safety devices for arc lights, or series circuits, differ in their construction and operation from those for incandescent lights, or multiple circuits.

Automatic Regulation.—Such a regulation of a dynamo-electric machine as will preserve constant either the current or the electro-motive force generated by it.

The automatic regulation of dynamo-electric machines may be accomplished in the following ways, viz.:—

(1) By a *Compound Winding* of the machine.

This method is particularly applicable to constant-potential machines. By this winding the magnetic strength of the shunt-coils is constant, while that of the series-coils varies proportionally to the load on the machine. The series-coils are preferably wound close to the poles of the machine, and the shunt-coils nearer the yoke of the magnets. Custom, however, varies in this respect, and very generally the shunt-coils are placed nearer the poles than the series-coils.

(2) By Shifting the Position of the Collecting Brushes.

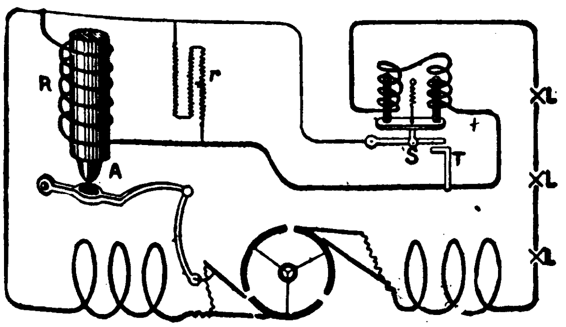


FIG. 33.

In the Thomson-Houston system the current is kept practically constant by the following devices: The collecting brushes are fixed to levers moved by the *regulator magnet* R, as shown in Fig. 33, the armature of which is provided with an opening for the entrance of the paraboloidal pole piece A. A *dash-pot* is provided to prevent too sudden movement.

When the current is normal, the coil of the regulator magnet is short-circuited by contact points at S T which act as a shunt of very low resistance. These contact points are operated by the solenoid coils of the *Controller* traversed by the main current. The cores of this solenoid are suspended by a spring. When the current becomes too strong the contact point is opened, and the current, traversing the coil of the regulator magnet A attracts its armature, which shifts the collecting brushes into a position at which a smaller current is taken off. A carbon shunt, *r*, of high resistance, is provided to lessen the spark at the contact points S T, which occurs on opening the circuit.

In operation the contact points are continually opening and closing, thus maintaining a practically constant current in the external circuit.

(3) *By the Automatic Variation of a Resistance* shunting the field magnets of the machine, as in the Brush System.

In Fig. 34, the variable resistance C forms a part of the shunt circuit around the field magnets F M. This resistance is formed of a pile of carbon plates. On an increase of the current, such, for example, as would result from turning out some of the lamps, the electro-magnet B, placed in the main circuit, attracts its armature A, and, compressing the pile of carbon plates C, lowers their resistance, thus diverting a proportionally larger portion of the current from the field magnet coils F M, and maintaining the current practically constant.

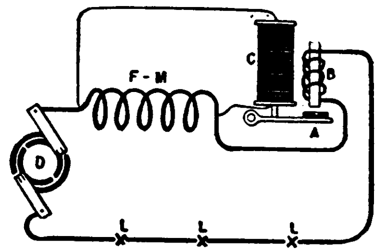


FIG. 34.

In some machines the same thing is done by hand, but this is objectionable, since it requires the presence of an attendant.

(4) *By the Introduction of a Variable Resistance* into the shunt circuit of the machine, as in the Edison and other systems.

This resistance may be adjusted either automatically by an electro-magnet whose coils are in an independent shunt across the mains, or may be operated by hand.

In Fig. 35, the variable resistance is shown at R, the lever switch being in this case operated by hand whenever the potential rises or falls below the proper value.

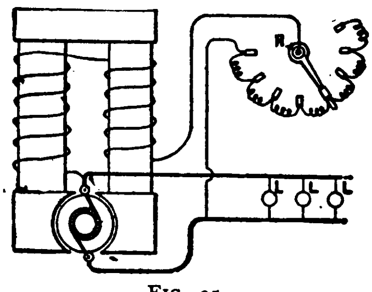


FIG. 35.

The machine shown is thus enabled to maintain a *constant potential* on the leads to which the lamps, L L L, etc., are connected in multiple-arc.

(5) *Dynamometric Governing*, in which a series dynamo is made to yield a constant current by governing the steam engine that drives it, by means of a dynamometric governor that maintains a constant *torque* or turning moment, instead of the usual centrifugal governor which maintains a constant speed.

(6) *Electric Governing* of the *Driving Engine*, in which the governor is regulated by the current itself instead of by the speed of rotation as usual.

Average Electro-Motive Force.—The mean value of a number of separate electro-motive forces of different values.

When a wire in the armature of a dynamo-electric machine cuts the lines of magnetic force in the field of the machine, the electro-motive forces produced depend on the number of lines of force cut per second. This will vary for different positions of the coil. The mean of the varying E. M. F.'s is the average E. M. F.

Azimuth.—In astronomy, the angular distance between an azimuth circle and the meridian.

The azimuth of a heavenly body in the Northern Hemisphere is measured on the arc of the horizon intercepted between the north point of the horizon, and the point where the great circle that passes through the heavenly body cuts the horizon.

Azimuth Compass.—A compass employed by navigators for measuring the horizontal distance of the sun or a star from the magnetic meridian.

Azimuth, Magnetic.—The arc intercepted on the horizon between the magnetic meridian and a great circle passing through the observed body.

A DISC CARBON ARC LAMP.

Among the novelties in lamps that are being introduced in the electrical field, the Russell Disc Carbon Arc Lamp is engaging a large share of attention, and where it is already in use is rendering satisfactory service, and specimens of this lamp are scattered through many of the chief cities of this country.

The manufacturers, in placing this new device on the market, state that simplicity and efficiency have been constantly studied in designing it, and they now claim that they have a lamp unusually simple and efficient.

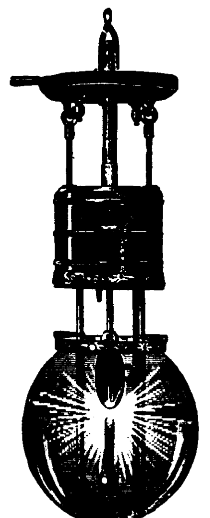


FIG. 1.

The mechanism in control of the feeding consists merely of two magnets, main and shunt, a balanced armature and a ring clutch. There are no clockwork, dash-pots, solenoids, complicated clutches or uncertain cut-outs. All adjustment of the arc is done by moving the face of the armature nearer to, or farther from, the poles of the main magnet. This is claimed to be the simplest adjustment it is possible to put in any lamp and the most efficient. A lamp wound for TEN can be adjusted to run on SIX amperes in a few minutes, often a great advantage.

It is, however, on the combination of the disc and pencil that the makers rest their strongest claim for superiority. The pencil is fixed in the bottom of the lamp frame the same as any ordinary negative pencil; while the disc is supported in the bifurcated end of the carbon rod, and is revolved by means of a rack cut in the hanger rod on one side, and a pinion on the end of the disc carbon-holder. This revolution is very slow, an average of about once in an hour and three quarters. The disc is easily removed for trimming, and the lamp actually requires less time to trim than a double pencil lamp.

Such a combination gives unequalled distribution of light, as on account of the superincumbent mass of the disc there is no light wasted upward. Moreover, by the use of the disc a much shorter lamp is obtained, as the long positive pencil is dispensed with, and the shortened lamp can be hung in low-studded rooms where hitherto the arc has been unavailable on account of its length. The time is greatly increased also, and a lamp the same length as the ordinary eight-hour lamp will burn twenty-four hours with one trimming, thus rendering unnecessary the use of double carbon lamps or any crude substitutes.

To convey a clearer idea of this new lamp to our readers, we publish herewith several cuts and a more detailed and accurate description, every single part being lettered so that its function can be understood easily and intelligently.

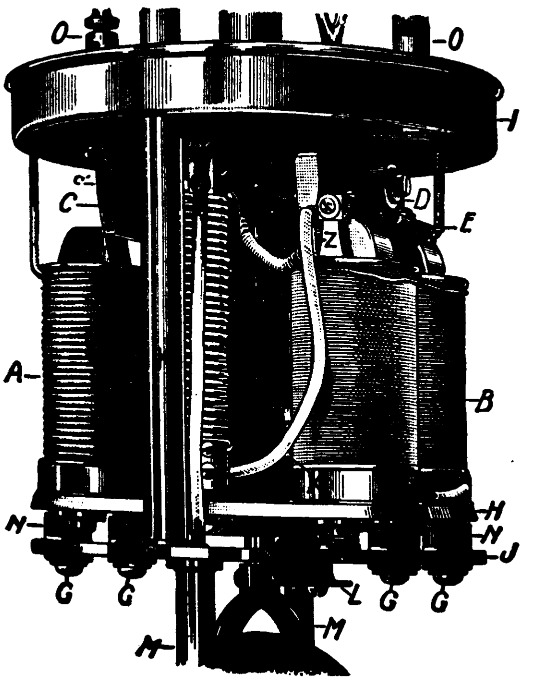


FIG. 2.

Fig. 1 shows the general appearance of the lamp, showing the disc carbon used for the positive pole.

The action of the lamp will be readily understood by reference to Fig. 2. When the current goes through the series magnets A, the armature C is attracted, which opens the cut-out E, by lifting out the metallic button D, and lifts the carbon rod by a link, and thereby strikes the arc. As the arc lengthens, its resistance is increased, and more current goes through the shunt magnet B, attracting its armature, and thereby allowing the carbon rod to drop a little. It will be seen that thus there is an electrical balance maintained at all times between the two armatures, C and D, of the series and shunt magnets. The armatures are attached to the rocking lever by a small screw, which can be adjusted to bring the armature more or less into the field of the magnet, and by means of which a most delicate adjustment of the lamp can be obtained.

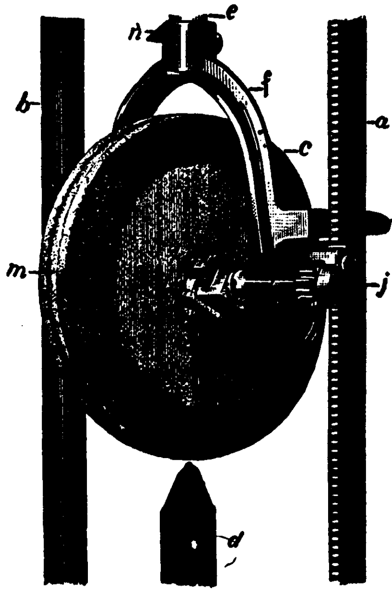


FIG. 3.

Fig. 3 shows the details of the revolving feed for the disc carbon. The carbon rod *e* enters the socket *n* of the yolk *f*, which carries the spindle *i*, carrying a small pinion *h* gearing into a ratchet on one of the frames of the lamp *a*. The disc carbon is renewed by unscrewing the nut *l*, which allows the two parts *k k* to contract, when the disc can easily be slipped off or on. The arc is maintained between the disc and the negative carbon *d*; and as the lamp feeds, the disc drops, and is at the same time revolved by the pinion gearing into the rack, the lug *g* always keeping the pinion in close gear with the rack.

These lamps develop 1,200 or 2,000 candle power by actual photometer test, taking 6 8-10 amperes or 9 6-10 amperes, respectively, with an average voltage of 46 volts. They are made in four different sizes, to burn different periods of time. The lamp calculated to burn 8 hours is 32½ inches long, and uses a disc carbon 3 inches in diameter; the 12-hour lamp is 35 inches long, with a 4-inch disc; the 18-hour lamp is 42 inches long, with a 4½ inch disc; and the 24-hour lamp is 49 inches long, with a 4½ inch disc. The disc carbons are all ⅝ inch thick, and the negative carbon is ⅝ inch diameter, although smaller carbons can be used successfully.

The lamp is made of the best material and workmanship, and is all machine made, each part being interchangeable.

This lamp is manufactured by the Russell Electric Company, whose chief office is at 85 Water Street, Boston, with factory at Ballard Vale, on the Boston and Lowell Railroad. A large number of electrical experts and others visited the factory two or three weeks ago, and many very favorable reports have been received of the lamp's efficiency, economy and the all-round satisfactory results attained by it everywhere.—*Modern Light and Heat.*

ELECTRIC FORGING.

Since Prof. Elihu Thomson's first patents on electric welding were granted, there have been a number of inventors enter the electric metal working field with various methods of utilizing the electric current in the metal industries. Mr. George D. Burton of Boston early paid attention to the subject of forging by means of electricity, and has finally succeeded in perfecting what is believed to be a commercially practicable system. On the 18th inst., Prof. Carl Hering, Prof. Spangler, Prof. Hermann Hering, Prof. C. W. Pike, and Mr. Bellerg, all of Philadelphia, visited Boston, at the invitation of Mr. Burton, to inspect the apparatus for, and witness experiments in, electric forging, as a committee from the Franklin Institute.

The apparatus consists of an Eddy alternate current dynamo, of about 80,000 watts output, at 1,600 volts, and a transformer, somewhat similar in design to a Thomson welder, which reduces the pressure to about four volts, and to the terminals of the secondary of which are fixed strong, bronze clamps for holding the pieces of metal to be heated. Bars of iron and steel were heated with facility to almost any temperature, specimens being melted and even fused to show the power of the apparatus. Pieces of nine-sixteenths inch steel were raised to white heat, placed in a lathe, and formed into different shapes. In one case a little round ball was formed on the end of a half-inch rod of steel, and pieces of copper were twisted and bent into a variety of forms. Knife blades were made, all ground and sharpened, from a round rod of steel, inside of ten minutes. All of the experiments were very satisfactory, and the committee returned to the Quaker City well pleased with their visit and the results of their investigations.

It is understood that a company has been formed to push the new process commercially, and that active manufacturing of apparatus will soon be begun.—*Modern Light and Heat.*

THE SOURCE AND FORCE OF ELECTRICITY.

"All the energy in the world," said Dr. C. F. Chandler, in a recent lecture before the Columbia School of Mines, "comes from sunshine. Even the energy in the electric battery that rings the door bells of our homes has its origin in the light of the great solar system. The force in the copper wire that sets the bell to ringing comes from the zinc plate in the battery jar. The energy in the zinc plate comes from the anthracite coal with which it was burned when taken from the mines, and, finally, the energy in the anthracite coal was put there by the sunlight that fed and nourished it when it existed, ages ago, as trees and plants.

"An interesting misapprehension that exists in the minds of a good many persons is concerning the vital dangers that lurk in the pressure of say a thousand volts. The newspapers often tell us that a man has been killed by such a pressure, whereas, in fact, such a pressure alone couldn't kill a humming bird. I have frequently caught in my hand sparks possessing an electro-motive force of 100,000 volts without feeling anything more than a very slight burn.

"The danger arises only when the volts are re-enforced by a good many amperes or currents, as when one takes hold of a charged wire. Then one feels a shock that is unmistakable, because the force of a great many currents in the wire suddenly decomposes all the fluids in his body. The salt in the blood at once turns to chlorine gas, and the man whose veins are charged with this deadly poison cannot in reason be expected to live long."—*Scientific American.*

THE THEATROPHONE.

There was founded last year at Paris, the "Theatrophone Company," the object of which is the institution of a telephonic theatrical service. The company has erected in the various public places, such as cafés, clubs, restaurants, etc., a certain number of automatic telephone receivers by which, on introducing a fifty centimes piece, one is placed in communication, for five minutes, with theatres or concerts indicated on the apparatus. At present the Opera Comique, the Bouffes, and the Nouveautés are the only theatres in connection with the system, but the number will be soon increased. The Theatrophone Company intends to supplement this public service by a private service, available for all subscribers to the State telephone system. By means of the monthly subscriptions of fifteen francs, and a payment of fifteen francs per evening for this service, a subscriber to the Paris system can enjoy telephonic communication with a given theatre, selected from among those connected with the service, during the entire performance, and for any number of listeners. The prices given above are for two receivers. The addition of extra telephones, so that several persons may hear at once, entails a further charge of two francs per pair per month.—*Electrical Engineer.*

THE SING SING EXECUTION PLANT.

Warden Brush, of the State Prison, who retires from his position on May 1st, will leave behind him an execution plant that he believes to be perfect in its way. He has built a small wing to the building in which capital prisoners are confined, as an execution chamber. This wing is divided into two rooms. In the first is the death chair, which is of heavy oak, and in which the culprit can be securely strapped in less than one minute. Back of the chair is a small closet, built out from the partition. On one side of this is the switchboard, with the voltmeter, resistance box, etc. Over this are 20 incandescent lights in series, calling for 2000 volts when run at full power.

The warden, standing at the chair, can give the signal to the man at the switchboard. The pressure of the button signaling the dynamo room will bring the full current to the incandescent lights. None goes to the chair until the warden gives another signal, when the operator in the closet, who cannot be seen by anybody present, switches the full current from the lamps to the wires leading to the chair. The dynamo is now 1,000 feet away from the execution chamber; but it is intended to bring it up to the room adjoining that in which the chair stands, so that the whole apparatus will be in charge of men within reach of the warden's voice.—*Electrical Engineer.*

COPYING BOOK ILLUSTRATIONS AND OTHER SIMILAR SUBJECTS BY MEANS OF ARTIFICIAL LIGHT.

Although, undoubtedly, the most important part in the operation of photographing such subjects as china, silver plate, glass vessels, coins, etc., is the employment of a proper method of lighting the objects—for owing to the great dissimilarity in the shapes of such articles, hardly any two objects being alike, or fail to be treated in precisely the same manner—still of almost equal importance is the preparation of preliminary treatment of many such articles preparatory to their being copied; and here we have a very wide field for the operator to exercise his ingenuity in.

In the case of such articles as glass jugs, tumblers, or decanters, where the main object is not only to show off the beauty of shape, but likewise to depict in many instances the exquisite designs cut upon their surfaces, it stands to reason that were any one to proceed and merely photograph the same straight away, without having resource to some method of preventing the designs on the further planes of the glass articles from interfering with that on the immediate side next the lens, nothing but a confusion of the various designs would ensue by the one overlapping or interfering with the other. Hence one of the first steps to be taken is to so arrange the vessel as to prevent this. And in cases where the shape of the article is such as to permit of its being filled with a liquid, perhaps there is no better plan than that of filling it up with some semi-opaque liquid, which acts virtually as a backing or background to sides of the vessel. In the selection of such liquids a proper discrimination should be shown in the choice only of such liquids as are in keeping with the nature and shape of the various articles being photographed. It will require but little thought for an intelligent worker to understand that what would be quite suitable in the case of such an article as a cream jug would be quite out of place in the case of a wine decanter. Hence the necessity of selecting only such liquids as are in keeping with the articles being copied. There are, however, numerous fluids to choose from. Skim milk, in some cases, comes in very handy, so also does claret, port, and sherry wine in others, and an intelligent worker will, doubtless, be able to think of many more quite as suitable, such as beer and stout.

When following out this plan, it will be found that more natural results are secured when the vessels are not filled right up to the top.

So much for glass vessels. Now let me refer to the copying of silver cups and plate. In this class of work the main thing to overcome is the bright reflections of the burnished portions of the objects. Some writers advocate the use of ice when such is practicable, others recommend that the burnished parts receive an application of putty to deaden the surface and prevent the objectionable flare spots. I have used both these expedients with success, but latterly have discarded the use of them for a much simpler method. Simpler because it does not necessitate any tampering with the objects being copied, and, in cases where such are of a very delicate order, this becomes an important item, for with putty there is always a fear of damaging the surfaces.

The plan I adopt is merely to keep breathing on the object. This requires to be renewed after every few seconds during or at intervals in the exposure, but the cap of the lens can be easily put on and off to permit of the breathing being applied.

With some commercial firms, when any important object is being manufactured, and it is desired to have the same photographed, it is generally arranged for such being accomplished previously to the burnishing of the parts. This is a great advantage, but, of course, is not feasible in the great majority of cases.

When developing silver objects, the amount of pyro used should be very small, and the exposure given a very full one, and I have always got the best results on a dark background.

Medals and coins r quire some consideration in the selection of suitable backgrounds also, and the mode of their being held *in situ*. My best results with bronze medals and coins are got by using as a background a sheet of opal glass, and by placing the medals right on the surface with the aid of a very thick solution of powdered gum, almost to a jelly. Silver medals are best fixed up in the same way against a sheet of ordinary plain glass, while at some distance behind is placed a black velvet background. Gold medals and coins are best on opal, because they get more relief. China plates, and such like are best relieved by black velvet placed at a distance.

So much for the necessary arrangements as to suitable backgrounds. When the best results are to be obtained, attention must be given to this point.

In lighting, there are numerous points to be considered, and here, at the outset, the first thing to be thought of is the shape of the object being photographed. When using artificial light, I know of no better place for an amateur, or professional either for that matter, to use than his long dining room table placed under his gasalier. From such he may with convenience lead the gas to his Argand burners on their pedestals on the table by means of the rubber tubing, and when it is deemed expedient to throw in as much top light as possible, the gasalier, when fully lit, will render good help in this respect. Some objects are best lit by reflected light alone. In my practice I use my own invention, which is a plaster of Paris chamber when copying some classes of subjects, but a very good and simple makeshift can be rigged up by any one without any great cost. Say it is desired to copy a china plate so as to show off the design. Now here we have just a case in point that is best done by reflected light. This I would put into my chamber and so arrange matters that the lights are not in front of the object, but that the strong, bottled-up light brilliantly surrounded it.

A similar mode of lighting can be arranged for by merely cutting out a center in a large mounting board. This aperture should only be large enough to permit of the lens viewing the plate through. The china plate is then placed in position, and the two Argand lamps, one at each side, but not in front, so as to throw only reflected light upon the white cardboard on it. In very many cases, when photographing by artificial light, it will be found that this intervening screen, placed so as to reflect light only on the object, will give much better results than by throwing the light directly from the gas lamps in front. One great advantage is that reflections are not nearly so liable to arise, and if the brass fittings of the camera and lens are covered up with a black cloth, there should be no reflections at all to contend with.—*T. N. Armstrong, British Journal of Photography.*

SOAP FOR METAL WORK.

The soaps used for cleaning metal work usually consist of mixtures of vaseline, oleic acid, and fat, mixed with a small quantity of rouge. When freshly prepared, they leave nothing to be desired; but, unfortunately, such mixtures soon turn rancid, and become unfit for use. A new soap for metal work, which is stated to be free from this objection, is made from cocoanut butter in the following way: 2·5 kilogrammes of the butter are melted in an iron vessel, together with a little water, and to the mixture is added, with constant stirring, 180 grammes of chalk, 87·5 grammes of alum, 87·5 grammes of cream of tartar, and 87·5 grammes of white lead. This mixture is then poured into moulds and allowed to solidify. The soap so obtained is made into a paste with water and rubbed over the metal to be cleaned, and finally removed by a dry rag or chamois leather.

ON FIRING WITH SOFT COAL.

It is too generally assumed, in firing steam boilers, that the fuel is burned under conditions over which the fireman or engineer has little or no control; and that any man who can keep up a proper supply of steam is equally good with any other man. That such an opinion is very erroneous is fully shown by many almost daily observations; and one case in point will be enough to illustrate the fact. In a certain plant of three or four hundred horse-power the water for the boilers was passed through a meter, the coal was carefully weighed, and the fire-room log was kept by a competent man. In this way it was easily shown that Mr. A evaporated less than eight pounds of water per pound of fuel, while Mr. B, apparently just the same kind of a man, evaporated over nine pounds, the difference between the two results being exactly two pounds of water per pound of coal in favor of Mr. B.

It is also a fact that much of the waste generally attributed to the steam engine is in reality due to lack of knowledge and skill in the boiler room. That a certain quantity of air is necessary in order to secure perfect combustion, is well known; that too much air detracts from the economy and injures the boiler, is also well known; and the skilled and experienced engineer needs no anemometer to tell him when he has reached the delicate point where the air supply is just right. A glance at his fires, a knowledge of his chimney draft, a look at his dampers, and an understanding of the work his boilers are doing, are sufficient to guide him. But there are boilers and boilers, not all of which are cared for or fired in this manner; and it is to those that are not that our illustrations apply.

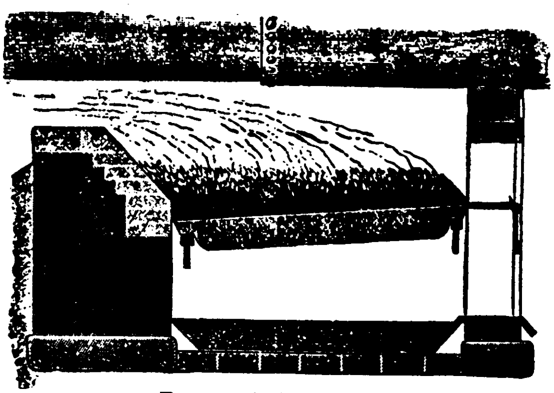


FIG. 1.—A GOOD FIRE.

In Fig. 1 a bituminous coal fire is shown, from six to nine inches thick. It is kept thicker at the back end and along the furnace walls and in the corners, because the heat radiated from the side walls and the bridge causes the coal in these places to burn faster than that on the rest of the grate. It is kept solid and in form by quickly sprinkling a thin uniform layer of coal on alternative sides of the furnace at frequent intervals, and by filling in such parts as may burn hollow. If the fire is neglected for a short time it is morally certain to burn hollow, and holes will develop, through which the cool air in the ash-pit will pour up freely, chilling the hot gases of combustion and materially lessening the efficiency of the boiler.

Fig. 2 illustrates what is called coke firing. The grate is covered with incandescent fuel as in Fig. 1, except near the doors, where a windrow eighteen inches wide, and built of fresh coal, extends entirely across the front of the furnace. The heat to which this windrow is exposed causes it to coke as it would in a retort in a gas works, and to give off the inflammable gases that it contains, which are burned as they pass back over the incandescent bed of fuel. When fresh fuel is required this mass of coke is broken up and distributed evenly over the grate, bearing in mind the necessity of keeping a good supply on those portions of the fire which tend to burn the fastest. When the fire has again become incandescent, fresh coal is put to coke, and so the firing continues. In this method of running a fire it is all-important to prevent holes from burning through, and admitting undue quantities of air into the furnace.

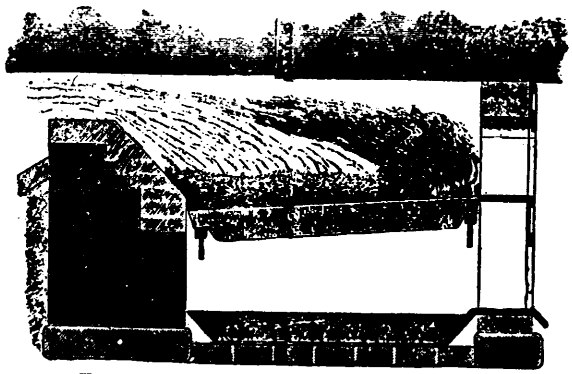


FIG. 2.—COKE FIRING WITH SOFT COAL.

Other methods of firing are often seen. One is, to fire only at considerable intervals, throwing on coal so heavily as to almost shut off the draft for a time. Fires run in this way and then left to themselves, burn hollow, and air rushes through the holes, burning the fuel away around the edges of them, and thus constantly enlarging them until after a time a strong current of cool air passes unchecked up through the grates, along the side walls and the bridge, and the hot gases coming from the coal are so chilled by it that it is almost impossible to make steam. The same result follows when the coal is heaped upon the center of the grate like a haycock; and in both cases the invariable result is a hard-worked fireman, laboring to keep up steam, and a bitter complaint from the office at the cost of the fuel consumed. The cold air that passes up through the empty places on the grate, and which must be heated and passed out at the chimney, puts a constant drain upon the coal piles and a constant effort upon the muscles of the fireman, who punches and works away fretting at the poor steaming qualities of the boilers and at his inability to keep up steam.

To burn bituminous coal without smoke has long been the hope of inventors and engineers, for it is generally admitted that an enormous waste occurs when any considerable amount of smoke issues from the chimney. It is true that smoke is a sure indication of imperfect combustion, but the vapor ordinarily seen coming from the chimney is not all smoke. The dense black smoke sometimes seen consists almost entirely of unconsumed carbon, but the composition of the lighter smoke is very different. Most coal contains a considerable quantity of moisture, especially bituminous coal, and this moisture is, of course, evaporated by the heat of the fire, and driven off as steam, in company with other products of combustion, giving the light vapor usually seen issuing from the chimneys. Even the densest smoke contains but a small quantity of unconsumed carbon, though of course it is likely to contain a considerable quantity of invisible gases that would have been burned and utilized had the combustion been more perfect.

The black smoke is usually given off when long flames of a yellowish or reddish hue lap along the whole length of the boiler and perhaps pass into the flues. When the damper is right, and the draft good, and the fires well laid, so that all parts of the grate are evenly covered, the lazy smoky flame is changed to a short flame of intense brightness.

Too much air is as capable of producing smoke as too little; for by its chilling action, previously explained, it makes perfect combustion impossible, and causes the same dense cloud to appear at the stack.

In charging fresh coal it is a good plan to leave the furnace door ajar slightly until the fire has burned up a little, so as to admit an extra supply of air, that which passes up through the grate being checked for a few moments by the fresh fuel. If the door is kept *wide open* the boiler will be cooled down and may be severely strained, and a big column of cold air will pass right over the fire in a body, and up the chimney; but if the door is kept half or three-quarters of an inch ajar the air that is admitted will distribute itself through the furnace pretty uniformly, and will consume the gases given off by the fresh coal. As soon as these gases burn off the door should again be tightly shut.—*The Locomotive.*

MAKING AND TEMPERING SPIRAL SPRINGS.

When the steel spiral spring of an instrument gets broken, it is much more satisfactory to make one than to send the instrument off, and be without it for a week or more.

To make them use the best spring steel wire; select a smooth iron rod the size of the spring to be made; carefully draw the temper from the wire; fasten the rod and one end of the wire in a bench vise. Now wind the wire evenly and closely around the rod, until you get the length of the wire required for the spring. Take the rod out of the vise; fasten one end of the spring to the rod; taking hold of the other end, draw it along the rod until the spirals are the correct distance apart. To give the amount of spring wanted, fasten it firmly to the rod, then make the spring and rod red hot, and quickly plunge them into cold water. After drying, rub them all over carefully with oil, and move them about in the flame of a lamp until the oil takes fire, which will give the spring the proper temper. I know there are some who make springs direct from tempered wire; but they are much more durable if shaped and *then* tempered.—*Dr. Wm. H. Steele, in Items of Interest.*

THE PERFUME INDUSTRY IN THE UNITED STATES.

During the recent development of horticulture in Florida and California many experiments have been made in the production of perfumes from flowers, and many of these have resulted successfully. There is little wonder, therefore, that inquiries are often made as to the possibility of growing flowers at a profit for manufacturing purposes in the genial climate of these and other States. Many of these inquiries are evidently from persons who have not even a vague idea of the result to be arrived at, not to speak of the details to be pursued, so that perhaps a few hints from one familiar with the products may be useful. Despite all the triumphs of modern chemical science, which has produced synthetically many odors which are more or less useful, it still remains the fact that all high class floral extracts, by whatever name known, are composed, to a greater or less extent, of one or more of the following odors: violet, rose, jasmine, acacia, orange, tuberose, and jonquil. With one or more of these in combination with some resins, oils and animal secretions, the skilful perfumer is able to imitate the odor of any other flower and produce pleasing bouquets. These odors are bought by the perfumer in the form of pomades, experience having taught that this is the only feasible means of securing them properly. Practically, then, our citizens have this problem before them very clearly, namely, to produce a highly charged pomade at a price which will enable them to compete with the flower farmers of Southern France, who at present supply the world's markets. This pomade is marketed in eleven and twenty-two pound tins, varying in price according to quality. It pays fifty per cent duty, and the present wholesale price is about $2.50 per pound for violet, and $1.50 to $1.65 for the others.

Like all manufactures, the making of pomade cannot be taught by books, but a few hints may help the experimenter. The process of extracting odors is known as *enfleurage*, and it is carried on either with or without heat. Jasmine and tuberose flowers are exposed to lard spread thinly on sheets of glass in suitable frames; this soon absorbs the odor, and by renewing the flowers the grease becomes saturated. The perfume of the other flowers is extracted by hot *enfleurage*. In this case an addition of beef fat is made to the lard (insuring a higher melting point); this mixture is heated to the melting point, when the flowers are thrown in and rapidly stirred through the grease; the semi-liquid mass is put under a strong press with suitable filtering material until the flowers are separated. The process is continued till the grease is practically saturated with odor. These processes are simple, and with a supply of flowers there is no reason why a good pomade cannot be produced in this country.

Judging from some inquiries, however, it does not seem to be generally understood that the process depends primarily on securing perfectly pure and odorless lard, which is by no means the same as the lard of commerce. No amount of perfume will make impure grease fragrant, and the perfumer will not buy an article of the kind at any price. In his laboratory the perfumer is one of the most practical of men, and buys his materials on their merits. It is just as important to have his pomades free from false odors as that his spirits should have no trace of fusel oil.

The process of securing lard free from albumen, membrane and blood, is as follows: Cut up the fat in small portions, separating the membranes as far as possible by hand, and wash till the water runs clear. Melt with a gentle heat in an iron or copper vessel over a water bath and continue till it becomes anhydrous, or free from water, which may be known by its becoming perfectly clear. Finish by filtering through a clean cloth. This lard will retain an odor which may be removed by remelting and adding a small portion of alum or common salt, and keeping it over the fire till a scum rises, which should be skimmed off. The salt must then be washed out and the lard again rendered anhydrous. Such lard is kept in a moderate temperature in tin, sealed from the air, and it will remain sweet as long as is usually necessary.

It will be well for one who intends to try the perfume industry to secure a sample of the French pomade from some perfumer, so that an idea may be had of the strength of odor desired in the market. The prospect of success offered by this industry can only be learned by experiment, but it is certain that no careless methods will answer. As in other things, there is room at the top, and high class products are certain of a market.—J. N., *in Garden and Forest.*

WHOLESOME SUGGESTIONS.

1. Never start your fires before you are sure that you have sufficient water.

2. Do not start your fires with the damper shut, nor while the manhole is off.

3. Don't fail to lift your safety valve off its seat at least once a day.

4. When using shavings or soft coal clean your flues twice a week.

5. Do not fail to try your guage cocks every hour when you are depending on the glass guage.

6. With pea or buckwheat coal carry your fires about 4 inches deep, with egg or lump from 6 to 8 ins. with natural draught. With forced draught double the above depth.

7. Never let a stranger drop in and fire for you without watching him.

8. Never start your engine with the cylinder cocks closed, nor the governor belt off, nor the piston rod gland out.

9. Never break up your fire any more than you can possibly help when slicing it.

10. Never hang your coat or fire tools on the safety valve lever, unless you desire the attendance of the coroner.

11. Never try to stop a ball governor with your head, nor measure the shortest distance with your head between the cross-head and cylinder-head, or the result will be a smashed head.

12. Test your steam gauge at least once ever six months.

13. Never start your pump before opening your delivery valve on the boiler.

14. Open your main stop valves gradually and before leaving at night close them.

15. When your pump refuses to deliver water don't cuss its maker or his mother-in-law ; don't get off your balance even should the water be out of sight or hearing. Cover your fires heavy, closing ash-pit and leaving furnace doors open. See that you are in your normal condition and self-possessed. If necessary shut down the engine. Lock the engine room door on the pump side ; call the fireman and form an investigating committee and go to work.

The Frenchman rejoices by reason of his hours of toil having been reduced from 11 to 10, the wonder is are the engineers included ?—OMEGA, *in American Engineer.*

STEEL PENS "INVENTED" ACCIDENTALLY.

Joseph Gillott was a Birmingham working jeweler in 1830. One day he accidentally split one of his fine steel tools, and being suddenly required to sign a receipt, not finding his quill pen at hand, he used the split tool as a ready substitute. This happy accident led to the idea of making pens of metal. It was carried out with secrecy and promptitude, and the pens of Gillott became famous. The manufacture of metal pens has been as important as any invention connected with business and education since that of printing. There are now numerous firms which produce as many pens every day as all the geese in England could have supplied in a year. There is still, however, a large demand for quills and quill pens ; but for common use, in these days of universal education, the importance of Gillott's first invention is incalculable.—*Leisure Hour.*

CARE OF STEAM PLANTS.*

HOW THEY SHOULD BE MANAGED.

The first thing in a steam plant is to get everything about it clean. Never allow any bright work to gum up or rust; never allow your paint work to become smutty and blacked up ; keep it clean and well varnished. See that your valves and packing are as steam tight as you can get them ; keep your valves square ; see that the cuts-off at both ends of cylinder are the same. The rocker arm should vibrate equal. Valve stems and pistons should be kept fresh packed ; that is do not allow your packing, whether it be hemp, asbestos, metallic or any other kind, to be kept screwed up until it becomes hard and flutes the pistons. Valve seats and piston heads should be well lubricated with sight feeders, which feed while steam is being used. The

BEST LUBRICANT

for any cylinder is refined tallow ; it can be bettered by using a little beeswax. The proportion is one pound of refined tallow to one ounce of beeswax. This used in any cylinder, is, in my opinion, the best lubricant that can be used in a hot cylinder ; it matters not what kind of packing you use in a cylinder your valves and packing will last longer and run longer without any repairs ; providing your engine does not work water to get any grit in cylinder or valve seat. Have your engine run as it should be, and use this lubricant, and I will guarantee you can run any engine night and day for twenty years, and you need not face valve seats nor band out cylinders. This also makes a great saving on your piston valve, stems and glands.

All journals on your plant should be kept a neat fit to the boxes. All journal box bolts should be double nutted and screwed down close to the journal so there will be no play, but journals should be kept just loose, so it can be turned over from the fly wheel, being turned by hand. All lock nuts should be screwed hard and tight ; by this means you hold your journal caps in the proper place, and prevent all pounding on those bearings. Your engine should not have more than five-sixteenths of an inch clearance at each end of cylinder, and you should be careful to keep your main, or as commonly called Pittman rod, the proper length. Keep your valves square, and then you will be sure to get all the power your engine is capable of furnishing. To keep the brasses properly you should leave the cross-head end filed open about one-sixth or even one-eighth of an inch apart. Your crank end should be filed to fit crank pin and come together brass and brass, and never allow them more than enough to key. Once when rod brasses are kept this way, crosshead and crank pins will last many years if kept well oiled.

Now my advice to all owners of steam plants is to keep

A FIRST CLASS MECHANICAL ENGINEER,

one who is strictly temperate, pay him good wages, and give him the necessary material to take proper care of your steam plant ; then you will never be troubled with stoppages and loss of time.

AS TO THE CARE OF BOILERS.

You should have a first class boiler feed, either a good pump or injector, and this should be connected to a good heater and your water feed to boiler as hot as you can work it ; heat and

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cold cause too much contraction and expansion, which causes vibrations in seams of boilers and makes them weak at those points. For example, if one hundred pounds of steam will do your work, never carry any more nor any less; get your damper so you can regulate draft and see that your fireman attends to his duties; he must burn only enough fuel to keep this amount of steam; never open fire door to cool your boiler down, as cold air causes too much contraction; rather than open your door if she gets too much steam, allow her to blow off from safety valve which will not in any way injure boiler. A boiler should be washed out as often as necessary so as to keep all sediment from forming scale in boiler, it matters not if this should occur twice a week, it should be done. A good way to keep a boiler from scaling fast is to put about one pint of black oil in boiler once a week if only run for ten hours. If run for twenty-four hours put a pint in one day and the second night another pint in. This is cheap. You must never allow your ashes to accumulate; keep your ash pit clean. If burning coal, keep clinkers off of grate bars; if wood, do not allow ashes to back up in furnace, as it will deter draft. Try your safety or pop valve every day and see that it is not stuck. Keep your guage cocks and water guage well blowed out. When stopping engine to lay up for ten hours or more, blow all gauge cocks out, also water guage, then after boiler gets cooled you will find all cocks open and not stopped up with mud.

A boiler, either steel or iron, should never be blowed out with higher pressure than fifty pounds, then it should stand until perfectly cold or to the same temperature of the water that it is to be filled with, then no expansion or contraction will take place. If you have mud drum on boiler, you should blow her out once in twenty-four hours. All parts of boilers exposed to the air and iron chimneys should be kept well painted with coal tar or any good stack black. All steam pipes should be covered with mineral wool or asbestos; this keeps down condensation and furnishes dry steam to cylinder.

SHAFTING AND BELTING.

Shafting of any kind should be kept in perfect line, it should be free in boxes and allowed loose action. Hangers should be keyed and bottled up tight, and be in perfect line and kept well oiled with good oil. All hangers' bearings should be furnished with self-lubricator oil cups. All leather belts should be put on pulley with hair side next to face of pulley. Belts should be properly adjusted to pulleys, never too tight nor too loose. All heavy belts should be thrown off of pulleys when plant stops. All belts contract and expand with the weather. All belts should be run in a good dry place, and the room in which belts run should be kept as near the same temperature as possible.

E. S. Campbell,
Supt. M. P. and Machinery.

Houston, Texas.

JAPANESE SKILL IN METAL WORKING.

The Japanese are past masters in the treatment of alloys both in texture and color, and no better guides exist. They achieve their grand result by the simplest means—a judicious blending of various metals, inlaying and pickling. Copper is the basis of their chief alloys, and by incorporating with it certain proportions of gold and silver they obtain remarkable results in color through the pickling process.

But not only do they get striking effects from their alloys and pickling—their mode of working up the metals is a thing to be studied. For instance, they will take six or seven plates of different metals and alloys, weld them together, and then, by drilling, punching-up and filling, get a surface in which all the metals show in a manner which is truly wonderful. By the range of tints at their command they can work out on a metal surface scenes of animal life, landscapes, etc., with effect never dreamt of by metal workers in the Western world. Among some examples recently shown in England was a knife handle on which was a representation of a duck dipping its head under the water of a stream on which it was swimming, the arrangement of the different alloys by which it was composed and the pickling being so well arranged that the neck of the duck was seen as under the water when the handle was held in a certain light. Another example was a sword hilt on which some minnows not more than one-sixteenth of an inch in length, and each having a pair of gold eyes, were swimming upon a gray stream, the effect of their being actually below the surface of the water being suggested with marvellous skill; imitations of wood, grain and marbles were also shown.—*Jewellers' Weekly.*

A SINGULAR INCIDENT FROM THE SCRAP HEAP.

A curious phenomenon recently occurred at the Frankfort shops of the West Shore Railroad, which is vouched for by the superintendent of motive power, James M. Boon, few men being better known in railroad circles.

A cast iron piston, eighteen inches in diameter, having been worn out, was removed from an engine and thrown in the scrap pile. Some time afterward it was taken from the pile with other scrap, and being too large to use in the cupola, was carried to the breaker. On being struck it broke in two parts and immediately began to act in a remarkable manner. The iron turned to a red heat and from that to a sparkling white, while from the hollow parts a flame arose to the height of three or four feet, throwing out sparks as though it were filled with damp gunpowder.

The man who broke the piston became frightened and threw a pail of water on it, which deadened the flame somewhat, but it continued to glow and throw out sparks for some time, to the amazement of the twenty or more men who stood looking on.

J. R. Slack, the chief draughtsman of the West Shore, has referred the case to various scientific men, but has received few satisfactory replies.

One opinion is that cylinder oil worked into the hollow part of the piston around the plugs which filled the core holes, and under the high temperature and pressure to which it was subjected, united with some of the core sand remaining in the piston, formed a highly combustible compound, which ignited spontaneously on exposure to the air.

Another theory is that the loose core sand, being thrown backward and forward by the motion of the piston, wore off a considerable amount of iron in an exceedingly finely divided condition, which ignited on exposure.

It is well known that a great many substances, iron among others, may be so finely divided that, when thrown into the air, they will take fire spontaneously, but it does not seem possible there could have been enough atomized iron in this case to cause the excessive amount of heat shown.

Whatever the cause may have been, the facts are as stated above, and, as far as we know, it is the only case of the kind on record; and any solution of what has proved so far a complete mystery will be gladly received for publication by the editor of *The Safety Valve*, from which the above is copied.

THE BLOW-OFF.

In making connections of the blow-off, opinions vary as to the best place. Some will put it on front head, side of hand hole plate, not because it entails more labor, or any desire to slight work, but, as they explain, it is more handy to blow out a gauge of water occasionally. Others will put it in back head because they can get it placed at lower point than in front, owing to hand hole plate being there; and they explain that it is preferable to bottom owing to its being exposed to less heat as they claim, and usually these are 2" pipes, very often less. Both are bad locations. The reasons are that when the water is run off, that is as low as lower part of pipe or hand plate, here still remains some 3" or 4" of water in the bottom, making it impossible almost to get deposit or sediment out without blowing out boilers under pressure, which at least is very bad practice. To siphon it out by hose requires time and patience, and that is a virtue which is very scarce, especially when time is limited. Often good and new boilers are damaged by burnt and bagged bottoms, often necessitating new plates, or even worse—patching—through the blow-off pipe being connected as above.

When cleaning a boiler, by washing or scraping, the deposit will invariably be pushed to rear end ot boiler, and there to collect around lower rows of tubes and rivets and flanges of heads, causing the burning or bagging of plates, and leakage of tubes.

The most practical blow-off is the 4" connected to wrought iron flange, rivetted to bottom of shell, and placed as near back head as possible. It contains a larger body of water to protect the pipe, receives much of the deposit or sediment, which can be drawn off by reduced pipe outside of brickwork. It completely drains the bottom of water, and any deposit or sediment remaining can easily be seen and removed.—By STEPHEN CHRISTIE in the *American Engineer*.

COMPARATIVE COST OF WATER POWER AND STEAM POWER.

A very thorough examination into the relative cost of water power and steam power has been made by Chas. H. Manning, of Manchester, N.H., in a paper recently read before the American Society of Mechanical Engineers. The author takes the water powers at Manchester, N. H., and at Lawrence and Lowell, Mass., as his standards for that side of the calculation, and for steam power he takes the steam engines used in the same towns for manufacturing purposes, where the cost of coal is $4.50 per ton. The conditions greatly favor the water power side, although all these water power privileges are permanently capitalized, and under the original leases paid $10.55 at Lawrence and $10.42 at Manchester per horse power. Under recent leases their prices have been advanced at Lawrence to $14.08 per horse power.

After making elaborate calculations as to the practical additions and abatements required in putting both to use, the author sums up the cost in each case and says: "In the water power plant we paid $14 for the cost of the water, simply, per horse power per annum; add to which $8.62 for attendance and supplies, we have a total cost for water power of $22.62 per horse power per annum." And taking for steam a low pressure plant of 1,110 horse power, with compound engines run on one and three-quarters pound of coal per horse power, with coal at $4.50 per ton, the total cost for steam is given at $21.16 per horse power per annum.

"On a 1,000 horse power plant the difference in cost saves an engineer's wages." We doubt not, says *Iron*, this decision in favor of the cheaper steam power will surprise many who have supposed that the cities on the Merrimack had a great advantage over our Pennsylvania towns in the cheapness of water power as compared with our coal. As coal is obtained for steam power much below $4.50 per ton, it is evident that our advantages are much greater than those claimed for steam in Massachusetts.

GOOD ROADS.

At a recent meeting of the Engineers' Club of Philadelphia, Mr. Thomas G. Janvier read a paper on "The Engineering Features of the Road Question."

This branch of the road question should be divided into three parts: 1st, location; 2nd, preparing the road-bed; 3rd, laying the pavement.

Location.—The item of expense should be well considered. In this connection, grading, land damages, etc., should not be overlooked. The line should be as direct as possible, remembering that a slight deflection to the right or left, or an easy curve, might save considerable expense in the matter of excavation, embankment or bridging. The grades should be made as easy as possible, not exceeding seven feet per hundred, or less than eight inches per hundred feet. Excessive excavations and embankments should be avoided.

The full width should not be less than forty nor more than sixty feet, but the paved portion need only be from eighteen to twenty-four feet.

The road-bed, or sub-grade, should have the same shape as finished grade.

Pavement.—If intended for very heavy travel, the Telford pavement should be put down, but if for ordinary travel, McAdam will answer. The difference in cost of these two pavements is but slight, and the Telford being much superior, should be given the preference.

A Telford or McAdam road thoroughly constructed and properly maintained will never need reconstruction. The best system of maintenance is that of constant daily attention and repairs. All dirt roads intersecting a paved road should be paved several hundred feet from the intersection, in order that as little mud and dirt as possible shall be carried on to the paved road.

Important points to be observed for keeping a road in good condition:

1. All dirt and mud removed as frequently as possible.
2. The entire drainage system carefully maintained.
3. Constant daily repairs and patches wherever and whenever ruts or depressions begin to show.
4. Careful sprinkling three or four times a day in dry weather.
5. The frequent use of a two-and-a-half-ton roller.

SUCCESS AND FAILURE AMONG ADVERTISERS.

Recent statistics, according to Bradstreet's Commercial Directory, show that in all lines of industrial life more than four-fifths, or over eighty-two per cent of all who failed in business in the United States last year were brought to that condition primarily because of lack of equipment, either natural or acquired, mental or financial, or through lack of special education in their respective lines of trade.

It is clear and plainly evident that poor and superficial preparation for business life is the one great weakness of our present industrial training—the broadest of all avenues leading to failure. It is this lack of proper equipment which causes certain advertisers to fail, while others gradually work their way to eminent success and great wealth. The great study with the advertiser, therefore, should be how to start right, how to go on right, how to constantly keep fully equipped.

Advertising is a science. What would be thought of a young man or youth who developed a genius for mathematics who said, "I will not study arithmetic, or algebra, or geometry. I will not give time to the teaching of the professors and masters of that great science, but I will work all out for myself, arriving at better methods, through the power of my own intellect and genius." However great his natural ability he could not progress far in a lifetime. But if he availed himself of the knowledge left to all as a heritage—treasure accumulated by thousands of great minds in the years and ages past—then might he become great in the profound science, and possibly renowned through some advance or improvement or simplifying of method.

The same holds true in the science of advertising; the man who becomes great in it must possess genius of a certain description; and he must ever be a student—first, to secure the wisdom of the past and present; second, to keep in the van, to be a leader in the rapid march of progress.

As the ordinary youth readily learns enough of mathematics to very well serve the purposes of ordinary business life, so may the ordinary advertiser succeed moderately well with the same half careless study and the same lack of genius.

Hard, patient work accomplishes much. In one sense industry and research are the parents of genius. Thus, advertisers without much genius, who study the science moderately, succeed fairly while those who have natural genius in a high degree, but who will not work to learn from others, almost invariably fail. But great success is the result of the happy union of natural genius and careful, patient study and investigation.

Printers' Ink, published weekly, at $2 a year, by George P. Rowell & Co., New York.

This little magazine is an educator; it teaches the science of advertising. From an editorial standpoint it is able. Its contributors are, in the main, the most successful advertisers and advertising experts. Its advertisers are very largely the ablest advertising agencies and the liveliest and most valuable advertising mediums. Its proprietor, the strong, leading advertising agency, of whom that progressive, thoughtful student and teacher of the science of advertising, Mr. George P. Rowell, is the head. The reader is constantly brought in contact with many of the brightest and ablest minds who are interested in advertising. Such interchange of thought means constant progress.

It is an exchange for the promotion of the science of advertising through bringing together, in free discussion, the ablest minds. As a publication calculated to successfuly educate and develop the advertiser, it stands entirely unequaled and unrivaled in this or any other country. Issued weekly, its teaching and influence are continuous on the reader; thus are men guided and developed almost without realizing it. This continuous education means continuous progress for the great field of advertisers. Do not understand me as saying that all wisdom in the art is to be found in this magazine, but I do say that more is to be found there than in any other single channel in the world. The chart is a little thing, but on it much of the safety of the mariner depends. *Printers' Ink* is the chart or guide to whom many advertisers already owe much of their safety and success.

For twenty years I have constantly advertised. Successful at the start, through the value of an original, popular idea, I was weak enough to fancy that I knew something about advertising. The loss of over one hundred thousand dollars in 1872 made a profound impression on me, to the effect that I knew nothing about it. I went to work to try to learn the art, and, by constant endeavor and study, I have been able to hold a place in the ranks of success.

Could I have had at that time such a magazine, such an exchange of thought, such a teacher and educator as *Printers' Ink*, I think I should have saved over one hundred thousand dollars in 1872. I also believe I should have made more money, and with less worry and care, as the years rolled by.

The reader doubtless infers that I would pay a very high price for *Printers' Ink* if necessary. I would pay one thousand dollars a year for it, if it could not be secured for less, simply because I believe it to be worth more than that sum to me in my business.

The successful lawyer studies the *Law Reporter*, the successful physician and surgeon the *Medical and Surgical Review*, and the successful advertiser *Printers' Ink*.

Mistake not, reader. This article is not intended to flatter and does not flatter. Flattery imitates as nearly as possible the form of honest, deserved merit, and the one is only too frequently taken for the other. Happy are those whose keen perceptions enable them to clearly distinguish the true and substantial from the false and hollow.

E. C. Allen.

BOOK FOR ADVERTISERS.

Geo. P. Rowell & Co., of New York, publishers of the American Newspaper Directory and of *Printers' Ink*, a journal for advertisers—the oldest and best known of all the advertising agencies—conduct their business in such a way as to make it a material benefit to both advertiser and newspaper publisher.

They furnish plans for an advertiser and prepare his advertisement. For their services—designing his advertisement and preparing his estimate—they make a sufficient charge to pay for the required service of persons competent to do the work well. They tell the advertiser what papers he should use and what the price will be. If the advertiser wishes them to place the advertisement in the papers, they do as he directs, and for that service the newspapers pay them. If the advertiser wishes to place his advertising through some other advertising agency, or to contract with the publishers, he is at liberty to do so, and the estimate furnished by Messrs. Rowell & Co. serves as a guide. It tells him where he is securing a bargain and where he is paying more than he ought.

Every one who is in need of information on the subject of advertising will do well to obtain a copy of Geo. P. Rowell & Co's "Book for Advertisers," 368 pages, price one dollar. It is mailed, postage paid, on receipt of price, and contains a careful compilation from the American Newspaper Directory of all the best papers in the United States and Canada. It gives the circulation rating of every one and a good deal of information about rates and other matters pertaining to the business of advertising.

Whoever has made himself acquainted with what may be learned from this book will admit that from its pages one may gather pretty much all the information that is needed to perfect an intelligent plan of advertising. It is not a complete newspaper directory. It is much better; for although it names barely one-third of the newspapers published, it does enumerate every one of the best and all that a general advertiser is likely to have occasion to use.

Among the papers named in it the Canadian Magazine of Science and Patent Office Record occupies the position to which its merits entitle it.