railways and wharfs—for 130 yards, finally coming out into a field, where the spoil is discharged. When the tanks are full, the holes on deck are closed with air tight doors, and the vessel made fast to the discharge pipe as described. Then air is pumped into the tanks from below—and, contrary to our anticipation, at no time during the discharge did the index mark more than 9 lbs. pressure—and the spoil rushes through until the tanks are empty. The tanks can be filled in from two to three hours; it rarely takes more than half an hour to empty them, and they were emptied in twenty-two minutes. Allowing 20 yards for matter which adheres to the sides of the tanks, this is at the rate of 10 cubic yards per minute. It might be supposed that stones, bricks, etc., would hardly pass through these pipes, but we saw some as large as a man's head rushing out of the outfall, and we were informed that much heavier--notably a 20-inch furnace bar, weighing 25 pounds—had been successfully carried through. As to expense, we were told that, even on the intermittent system of work necessary in docks, ten cargoes weekly could be dredged, equal to 2,200 cubic yards. The weekly bill for labor amounts to $66.75; for coal,$ 15; and allowing $100, or 10 per cent, for maintenance, the costof this would be $184.25,or 8·04 centsper cubic yard. This, we need hardly say, contrasts very favorably with the usual price of 10d. (20 cents) or 1s. (24 cents) per cubic yard; and of itself it proves that Mr. Duckham's invention deserves the attention of all who are interested in what is at best an unprofitable labor.—*Iron.*

Correspondence.

How Strikes are Originated.

To the Editor of the Scientific American:

What is your opinion of a person who advertises for a first class tool maker, and, when his advertisement is answered by a number of skilled workmen,selects the best one, as far as he can judge, and then offers him two dollars and fifty cents a day for his services? This, as the reporters say, "is no fancy sketch," but a stern reality,and happened very recently in this city. Indeed, I learn that a certain powerful corporation, a short distance from this city, will only give this miserable pittance to the men employed in their tool room. Now a tool maker, in the correct sense, is a person who is capable of doing the very finest work, as well as the heavier kinds, in metal. Theoretically, there exists no limit, either way, to the size of tools that may be demanded for various kinds of work. They may be as large as a house or as small as a fine needle; and the skilled tool maker is able to produce either of them, each one perfect in its way, from immense templates used in drilling heavy engine parts down to the marvelous combinations of jewels and hardened steel used in watch factories. He must be able to do a job at the forgethat would put many a blacksmith to the blush; he must be very familiar with the working of steel, besides being a competent worker of sheet metals, and have a thorough understanding of solders; he must be able to do a good job in pattern-making and other woodworking; he must have a correct knowledge of drawing and a decent smattering of foundery work: in fine there is nothing, I might almost say, that can be constructed from any known materials on the face of the globe but the first class tool maker is supposed to be, and in fact must be,able to construct. And all this for two dollars and fifty cents *per diem!*

"But," says the fortunate one to whom this offer is made, "I can do any kind of tool-making: I can make gages for you so perfect that the slightest variation in temperature between the parts will make a perceptible difference in their fitting. You surely cannot expect me to work for such wages as you offer!" "Well, sir, you can take my offer or not, as you see fit," answers the advertiser; "I can get plenty of tool makers at that price." This brings me to the main point, one which I have long and earnestly pondered upon. The employers say that the tendency of strikes is to compel the good workman to carry the poor workman on his shoulders; and yet,if they can hire the veriest fool that ever undertook to finish a V thread with a three cornered file (and I have seen this attempted) who chooses to call himself a tool maker, for two dollars and fifty cents a day, they will not give more to the competent workman.

I do not believe in strikes; I never was connected with any but once, and then I saved my employers and fellow workmen each a serious loss by my action in the matter; but as long as there is such a state of affairs as now exists, just so long will the strike disease be either epidemic or sporadic.

The only remedy is, in my opinion, to have the trades legally recognized so far as to have a complete and perfect registry kept of all men who pretend to be skilled workmen, with a rating placed opposite each man's name; andlet each have a certificate in his possession, showing his rate in the register. A mixed board, composed of employers and employees, could from time to time fix the ratings and a schedule of wages therefor. The workman's certificate would be his recommendation, and he would get paid according to his ability and skill.

I should like to see a full and free discussion of this subject in the columns of the mechanic's friend, the SCIENTIFIC AMERICAN. D.

Harlem, N. Y.

A New Test for Boracic Acid.

To the Editor of the Scientific American:

While working with nickel and cobalt in connection with glycerin, a very unexpected result was obtained. A borax bead containing both nickel and cobalt was immersed while hot into glycerin; the bead, then heated gently before the blowpipe, gave at first a faint green coloration, then carbonized, giving off acrolein in abundance. The experiment was repeated, using only a cobalt bead, then a nickel bead; in both cases the result was a beautiful green flame. Thinking it very singular that such difficultly reducible metals as nickel and cobalt should give a coloration, the experiment was repeated, using only a borax bead and without the aid of the blowpipe

By gently heating the bead (after it was immersed in glycerin) in a Bunsen burner and then withdrawing,the glycerin caught fire and burned, first with a faint blue, then with a strong soda flame; finally the entire flame assumed a deep green color. Various other borates were then tried, with perfectly satisfactory results. A number of minerals containing boracic acid were next tested, and the result was satisfactory. In such minerals as tourmaline, where the test could hardly be expected to hold good. the green flame of the boracic acid was distinctly visible.

The following is the best mode of procedure: Finely powder the substance in an agate mortar: fill an elongated platinum loop with glycerin,introduce this into the fine powder, and gently heat in a Bunsen burner until the glycerin catches fire. If only a minute trace of boracic acid is present, it will be best seen by holding a piece of white paper as a background, and carefully watching just as the flame goes out.

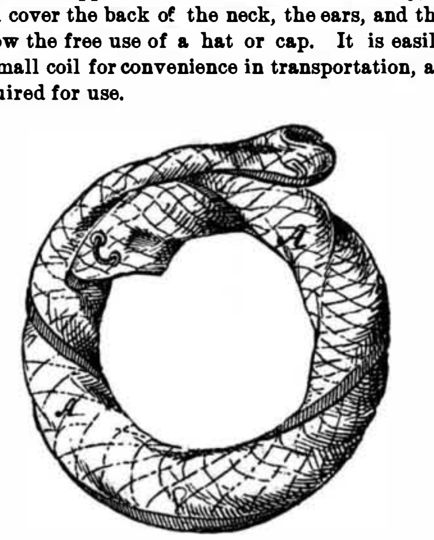
M. W. ILES.

School of Mines, Columbia College, New York city.

IMPROVED HEAD MUFF.

Mr. Heimann Fürst, of Williamsburgh, N. Y., has recently patented an improved neck, ear, and throat protector,

which, when applied to the head of a man or boy, will protect and cover the back of the neck, the ears, and the throat, and allow the free use of a hat or cap. It is easily folded into a small coil for convenience in transportation, and when not required for use.



The engravings show the article while worn and also when not in use.

The Moon.

Professor Soule recently lectured on this subject before the San Francisco School of Mechanic Arts. He said that,in using the immense telescopes of modern times, one is surprised at the exceedingly small area that can be examined at one time, and by the great diminution of light which appears to take place. A careful survey of the surface fills one with astonishment that the placid, silvery moon should be changed in a ragged, gray, wrinkled, and pockmarked heavenly body.

On turning to the brighter portions, we find everywhere mountains, volcanoes, crevasses, and precipices of vast hight or depth. It seems to be a picture of desolation, enthroned upon a pedestal of ashes. Those mountainous parts reflect a brilliant light on account of their volcanic nature, the rocks being often smooth and polished, and their jagged surfaces giving them power to catch and throw light in every direction. The southwestern portion is especially volcanic in its appearance. On close examination, however, we find long ranges of mountains exhibiting no signs of volcanic action, but in many respects similar to the Sierras, much steeper on one side than the other, and apparently formed by similar forces, though as a rule the volcanic element prevails. Many of these mountains are of immense size; thus Clavius is 120 miles in diameter, and has an area of 12,000 square miles, and turrets on its walls shooting to an altitude of 16,000 feet. We next notice the frequent occurrence of ringed mountains, not more than 10 to 15 miles in diameter, and almost perfectly circular in form. They are found alone upon the level country, or in groups, and even upon the ridges of the walled plain. There are also craters and pits, which differ chiefly from the others in their smaller dimensions. There is also another prominent feature which has puzzled astronomers, even in the present day. From many of the ringed mountains, notably from Tycho, Copernicus, and Kepler, are radiations, extending in some cases hundreds of miles, which at the full of the moon glisten with a remarkable brightness. They shine as brilliantly under the oblique as under the vertical rays of the sun—a fact yet unexplained; they pass over the tops and through the craters of volcanoes, and through the valleys in an uninterrupted course. Of the many theories concerning them, perhaps the most reasonable is that they are veins of matter ejected from below during some great volcanic or earthquake disturbances, and in many respects they resemble our own trap dykes and seines.

Since the time of Galileo, astronomers have painfully, patiently, and perseveringly mapped every detail of the moon's surface, until we have lunar topographical charts more accurately constructed than any hitherto constructed of the earth's surface. Photography has recently aided largely in this work.

By careful experiments, it has been proven that the light of the full moon is only $\frac{1}{600000}$ part of that of the sun, and that she gives only one sixth as much light as would a pure white disk; therefore she is nearer black than white. An equal sized globe of fire brick or clay thrown into the orbit of the moon would furnish us with light as bright as our own luminary.

As early as 1700, efforts were made to ascertain if any heat came from the moon, her rays being concentrated by means of a lens upon the bulb of a thermometer, with no effect, however; and other and later trials with improved apparatus gave the same result, or in some cases indicated that the moon was shedding negative heat, or cold. It was only after the invention of the thermopile that evidences of lunar heat were discovered. The amount was excessively small, however. Lord Rosse, with the aid of his three-foot reflecting telescope and Thompson's galvanometer, show that little, if any, of this heat comes from the interior of the moon, or, in other words, that the body of the luminary would be cold but from the heat absorbed from the sun. This borrowed heat has been shown to raise the exterior temperature of our satellite to at least 50° Fah. As the sun's heat and light cease to fall upon her surface and are lost for 15 days at a time; and the remaining heat being radiated into space, the alterations of temperature must be something startling, and the changes in the physical features of the body produced by the enormous expansions and contractions of her outer substance must be great and very destructive.

Intelligence and Labor.

The old delusion that education is unfavorable to labor has almost passed away. We no longer argue that the more a man thinks, the less he is inclined to work, nor fear that the material interests of our country will suffer through intellectual cultivation. We acknowledge that a well educated man may work as well as his neighbor who can hardly sign his name; and we even go a step further, and admit that a certain amount of education is necessary to secure the best kind of labor. Yet we are still far from appreciating the full effect of mental progress upon industrial employments, or estimating the vast debt which the latter owe to the former.

Intellectual culture, so far from unfitting men and women for exertion, actually excites them to it. Ignorance is the chief cause of indolence, and they are rarely separated. Savage tribes know but little of the benefits that industry can secure, and, having scarcely a motive beyond that of appeasing hunger, are proportionately idle. Educate them—show them the superiority of a house to a wigwam, and of a comfortable dress to a blanket—and the industry which can secure these benefits immediately begins to expand. Each fresh accession of civilized life demands a fresh accession of labor; and in proportion as the results of industry become more and more apparent, industry itself will more and more develop.

Education benefits industry, not alone by exciting and increasing it. It has an equally direct and powerful influence upon it in raising and improving its quality. How is the soil made most productive? Not by an unthinking routine of drudgery upon it, but rather by a knowledge of its nature and requirements; a study of the laws which govern vegetation; a thoughtful consideration of the relations which subsist between human needs and the powers of agriculture to supply them. The success of manufactures is due almost wholly to the busy thoughts that are ever planning improvements; making new inventions; constructing machinery; combining and regulating labor, and adapting all the various means within reach to the highest and most productive ends. Commerce, too, owes its very existence to the same source. The more forethought, judgment, discretion, and knowledge the merchant possesses, the more certain we may be of his ultimate success.

The same is true of those occupations which we are accustomed to consider wholly manual. The mechanic or laborer who thinks out the meaning of his work, who enters into its spirit, who devises improved plans for its execution, and

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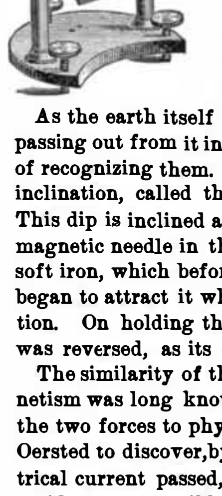
sends a thought with every stroke, has tenfold the value of one who only bestows physical strength upon his work. In the province of domestic service, every housekeeper knows that the great lack is of mental, not bodily, power. There are plenty of girls who have the requisite muscle, but few who can furnish the judgment, care, forethought, and economy which are so needful in the kitchen and the nursery. Each laborer, whatever be his sphere of action, needs to understand the laws which govern his department of labor, and so to adapt his efforts as to conform with them. If he does not, his work must be to that extent unproductive and unsuccessful. These laws, however, are so entwined with those of other branches, and so dependent upon those of life in general, that a thorough education upon a broad basis is the best preparation for any kind of labor, and a continued mental discipline the best safeguard for its success. No industry can afford to slight the intellect; no man or woman who is a mere machine can ever give out his full value to the world, no nation or community can ever emerge from indolence, except in so far as they emerge from ignorance. In this country, where the opportunities of education are so numerous and so widely spread, it would hardly seem necessary to urge their acceptance; yet it is of the highest importance to our national prosperity and personal well-being that we all recognize the intimate connection between the growth of intelligence and the value of labor.—*Philadelphia Ledger*.

PRODUCTION OF LIGHT FROM MECHANICAL FORCE.

LECTURE DELIVERED AT THE STEVENS INSTITUTE OF TECHNOLOGY, BY DR. GEORGE F. BARKER, OF THE UNIVERSITY OF PENNSYLVANIA.

Proceeding on the principle that nothing should be taken for granted, the lecturer began by an explanation of the properties of magnets, dwelling particularly upon those which were necessary to a correct understanding of the subject. The name magnet is derived from the name of the ancient town Magnesia, where two important minerals were found, one, white, which is employed in medicine, and the other the black magnetic oxide of iron. This latter has the remarkable property of attracting iron: remarkable because it is not confined to the ore itself but emanates from it in all directions, thus enveloping it as it were with an atmosphere of force. This was illustrated by the familiar experiment of magnetizing a bar of soft iron by bringing the lodestone near it without touching. Upon removing the lodestone, the bar no longer attracted iron. It had lost its magnetism; a steel bar would have retained it permanently. It is of the utmost consequence to understand the manner in which the force emanates from a magnet, and it has been found that it obeys the same law as the force of gravitation, namely, that it diminishes precisely as the square of the distance from the source. If we measure this force at a certain distance from the magnet in one direction, and then find points in other directions where the force is exactly the same, we obtain what is called an equipotential surface; and by repeating this process at various distances, we map out what physicists have named the magnetic field. The direction of the lines of force was beautifully shown by means of an experiment of Professor Mayer's. Iron filings were sprinkled upon a glass plate, and this was placed upon a little bar magnet in the vertical attachment to the magic lantern represented in Fig. 1,

Fig. 1.



in which the light passing through the glass plate was reflected on the screen by a mirror. On slightly tapping the glass plate to give the particles of iron an opportunity of falling back upon the plate in obedience to the attraction of the magnet, they arranged themselves in symmetrical curves about the poles, forming an appearance designated as the magnetic spectrum. The particles in arranging themselves move at right angles to the lines of force. This was shown by means of a small needle suspended by a fine thread and introduced in the lantern. On gradually moving it around the magnet, it constantly changed its inclination so as always to preserve a position perpendicular to the lines of iron filings which represented the lines of attraction of the magnet.

As the earth itself is a great magnet, lines of force are passing out from it in every direction, and we have the means of recognizing them. A piece of soft iron held at a certain inclination, called the magnetic dip, becomes a magnet. This dip is inclined about 73° to the vertical. By placing a magnetic needle in the lantern, it was shown that a bar of soft iron, which before had no magnetic effect on the needle, began to attract it when held near it at the requisite inclination. On holding the other end of the bar up, its polarity was reversed, as its opposite effect on the needle proved.

The similarity of the action of electricity to that of magnetism was long known without suggesting the identity of the two forces to physicists. It was reserved for Professor Oersted to discover, by accident, that a wire, in which an electrical current passed, attracted the magnetic needle. Such accidents are possible only to men of profound insight, whose powers of observation have been trained by long habits of study. It required a Newton to perceive anything extraordinary in the fall of an apple. Professor Oersted's experiment was shown by placing a magnetic needle in the lantern, surrounding it by a coil of wire, and passing a current of electricity through the latter; the needle immediately began to move. On reversing the current, the needle began to swing in the opposite direction. To answer the question whether it was really magnetism which caused the deflection of the needle, and not some other force: in other words, whether the wire carrying the current had become a real magnet: the experiment with the iron filings was repeated, substituting a wire, through which a current passed, for the small bar magnet of the first experiment. The reflection of this wire on the screen was vertical; and when the plate was tapped, the iron filings arranged themselves in horizontal lines. As in the case of the magnet, therefore, they were perpendicular to the lines of force, and it was evident that the copper wire had become a magnet, having its poles along its sides. By making a coil of the wire, we multiply the effect, because we multiply the lines of force; and this is the way to obtain

Fig. 2.

the most powerful magnets. A bar of iron thrust into such a coil, as in Fig. 2, will occupy a position perpendicular to all the lines of force in it, and therefore capable of yielding the maximum effect. A diminutive piece of iron in horseshoe form surrounded by wire was then introduced in the lantern, and it attracted its armature every time a current was sent through the wire. In the next experiment the same little magnet was used with iron filings to show that the magnetic spectrum of these electro-magnets is similar to that of ordinary magnets. The immense electro-magnet of the Stevens Institute, which was mounted upon the stage, formed an amusing contrast to the little bit of iron used in the lantern.

Great as was the discovery that electricity can be converted into magnetism, it must yield in importance to the one that magnetism can be converted into electricity. Arago was the first to observe that, when a copper disk is rapidly rotated under a magnetic needle, from which it is separated by a glass plate, the needle gradually begins to swing with it, following its rotation. His apparatus is represented in

Fig. 3.

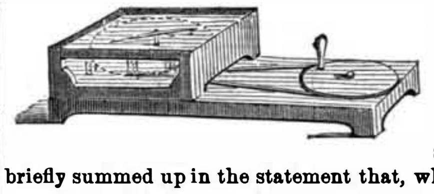
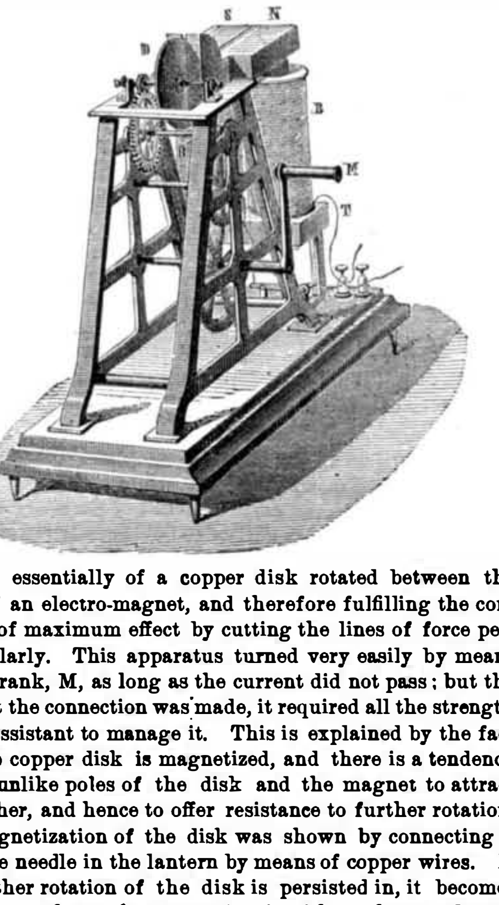


Fig. 3. It was left to other physicists, and especially to Faraday, to explain the phenomenon. Their conclusions may be briefly summed up in the statement that, whenever any substance capable of conducting electricity is moved across a magnetic field, a current of electricity is generated in that substance; and this current is the more powerful, the more nearly the motion is perpendicular to the lines of magnetic force. To show this fact, the large electro-magnet of the Institute was used. A wire connected with a galvanometer in the lantern was moved up and down in front of one of the poles of the magnet, so as to cut some of the lines of force proceeding from it in every direction. The effect was that every such motion caused a deflection of the needle, showing that an electrical current was generated.

An interesting experiment to illustrate the same principle was made with the apparatus represented in Fig. 4, which

Fig. 4.

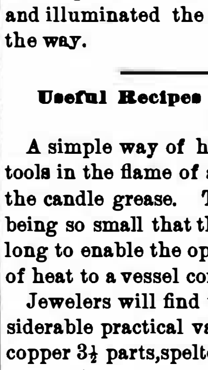


consists essentially of a copper disk rotated between the poles of an electro-magnet, and therefore fulfilling the conditions of maximum effect by cutting the lines of force perpendicularly. This apparatus turned very easily by means of the crank, M, as long as the current did not pass; but the moment the connection was made, it required all the strength of the assistant to manage it. This is explained by the fact that the copper disk is magnetized, and there is a tendency of the unlike poles of the disk and the magnet to attract each other, and hence to offer resistance to further rotation. The magnetization of the disk was shown by connecting it with the needle in the lantern by means of copper wires. If the further rotation of the disk is persisted in, it becomes hot, as was shown by connecting it with a thermo-electric pile and the galvanometer in the lantern. The resistance experienced by the copper disk was excellently shown by means of another experiment of Professor Mayer's, in which a large thin copper disk was made to swing to and fro, like a pendulum, between the two poles of the large electro-magnet. The moment the current passed around the coils of the magnet, the motion of the copper disk was arrested between the poles.

If, then, we are able to obtain an electrical current by cutting the field of a magnet, we ought to be able to do the same by cutting the lines of force of the earth. This the lecturer accomplished before the audience, by moving a coil of wire, of large diameter, across the line of dip, and showing the effect on a galvanometer needle connected with the coil; every time the coil moved, an oscillation was imparted to the needle, which was distinctly visible upon the screen. The utilization of this force of the earth, like that of the sunlight for mechanical work, belongs to the future.

We have seen (in Fig. 4) the conversion of the mechanical power of the arm into heat and magnetism, and also the equivalence of magnetism and electricity. There remains the problem to turn these forces into the incomparably more subtle one of light. As in business, so in Science, it is the problem to convert raw material into high-priced products in the most economical way. A pound of cast steel of trifling value is worth thousands of dollars when converted into hair springs for watches. In the production of light, the great difficulty is to utilize our force. Even in the steam engine, only about ten per cent of the fuel is utilized as mechanical force; but when we come to light, that most imponderable of all the forces, we can scarcely utilize two per cent. When a powerful current of electricity is passed through an adequate conductor, it flows along peaceably and without unusual manifestations; but if the conductor is too thin, and it is obliged, as it were, to "crowd and elbow its way through it, it becomes red in the face, and we have the phenomenon of red heat; interrupt the conductor altogether, and make it leap over an empty space, and it becomes white in the face, emitting a brilliant light." The latter is the case in the electric lamp, Fig. 5. One of these lamps was placed upon the

Fig. 5.



stage in connection with the Gramme magneto-electric machine, in which a powerful current of electricity is generated by causing the rapid revolution of one electro-magnet between the poles of several larger ones, by means of steam power derived from an engine in the basement of the Institute. This machine will be explained in the next lecture: suffice it to say, for the present, that the light obtained was equal to about 1,600 candle power. It inundated the hall with a flood of light, and illuminated the fronts of the houses on both sides of the way.

C. F. K.

Useful Recipes for the Shop, the Household, and the Farm.

A simple way of hardening small watch drills: Heat the tools in the flame of a candle and then plunge suddenly in the candle grease. This is done on account of the drills being so small that they will not retain their heat sufficiently long to enable the operator to remove them from the source of heat to a vessel containing water used for hardening.

Jewelers will find the annexed list of silver solders of considerable practical value. Hard solder: Pure silver 16 parts, copper 3½ parts, spelter ½ part. Medium: Fine silver 15 parts copper 4 parts, spelter 1 part. Easy solder: Fine silver 14 parts, copper 4½ parts, spelter, 1½ parts. Common hard solder: Fine silver, 12½ parts, copper 6 parts, spelter 1½ parts. Common easy solder: Fine silver 11½ parts, copper 6½ parts, spelter 2 parts. The fusing points of these solders are as follows: No. 1, 1,866° Fah; No. 2, 1,843°: No. 3, 1818°; No. 4, 1,826°; and No. 5, 1,802°.

The following is an iron cement which is unaffected by red heat; 4 parts by weight iron filings, 2 parts clay, 1 part fragments of Hessian crucible. Reduce to the size of rape seed and mix together, working the whole into a stiff paste with a saturated solution of salt. A piece of firebrick can be used instead of the Hessian crucible.

Böttger suggests the following process for dyeing cotton pure blue: Heat a mixture of 137 grains Paris blue, 137 grains tartaric acid, ½ fluid oz. ammonia water, and 2½ fluid ozs. water, and filter after cooling. Add to the deep blue filtrate a solution of caustic soda, until it is decolorised and after some time assumes a light yellow tint. Impregnate the cotton with this solution and pass it (best after allowing it to dry) through a warm, very dilute solution of sulphuric acid, and it will immediately assume a beautiful blue color and needs only to be washed in water. The sulphuric acid may be so diluted that it has scarcely a perceptibly sour taste.

The best material for hot beds is horse manure well turned and mixed with about one third its bulk of oak leaves. Another excellent mixture is the above with cotton waste, one half waste and leaves, the other half manure. The middle of March is the proper time to start the bed in northern States, and a mild day should be selected for the work. Dig a pit about 3 feet deep in front, 8 inches deeper at the back, and 6 feet wide. This affords an opportunity for adding linings if it be deemed necessary, when the heat in the bed decreases.

The Western tannin plant (*polygonum amphibium*), which grows luxuriantly in the Missouri Valley, seems destined to replace oak bark in tanning. It contains 18 per cent of tannin, while the best bark contains but 12 per cent; and large establishments employing it in Chicago find that one third more leather can be obtained with it than with a like quantity of bark. The process of tanning with it is identical with that with bark, but the leather is tougher, finer, and more durable, and receives a finer finish. The plant is an annual, and can be mowed, dried, and stacked like hay.

To prevent pumps freezing, place a small tack just under one edge of the leather valve which retains the water, sinking the tack into the leather to hold it. This will cause a small leak, and the water will not remain long enough to freeze

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