SCIENTIFIC CANADIAN
MECHANICS' MAGAZINE
AND
PATENT OFFICE RECORD

Vol. 8. JANUARY, 1880. No. 1.

GENERAL CONSIDERATIONS AFFECTING MODERN AND PUBLIC EDUCATION.

As the result of a radical change in the occupations and conditions of practical life, the present has become emphatically a period of agitation and revolution in all that relates to the training of children and youth. From the primary schools to high schools and universities, the instruction is subject to sharp vigorous criticism, with propositions and counter propositions looking to change and improvement. Nor is it a mere local system. Wherever any interest is felt in training children and youth, there we find a controversy as to what knowledge is of most worth, and as to the best methods of imparting instruction.

The feeling is gradually growing stronger that a readjustment of the courses of instruction in our public schools should take place to meet the demands of the times, and that physical and technical science should receive more consideration than hitherto has been given to it. It is technical education that the youth of Canada require, so that in a country where a great future depends upon its early development, there should be practical training of young men in technical schools, that they may be able to direct, with intelligence and economy, the expenditure of human labor in those vast constructive enterprises which characterize our times in all the varying fields of industry.

The first Napoleon was one of the earliest advocates of these schools, which have already become so numerous in Europe, and still are not found to be sufficient; hence Great Britain, France, Germany, Russia and other advanced European countries are enlarging the scope of their instruction, and giving particular attention to chemistry and mechanism. Now what we require in Canada is a modification of the teaching in our public schools of all grades, so that it shall have a much more direct and telling influence upon the common needs of practical life. It is our desire that when boys and girls, when they leave the public schools, shall carry with them those elements of knowledge, taste, and skill, that will prove of the most direct and essential service in the various pursuits in which nearly all of them must engage. These elements having been once mastered, further progress becomes comparatively easy in case any one, after leaving a public school, desires to continue his studies.

There is, of course, opposition to be expected to all proposed changes that spring in part from that natural inertness of the mind which stands out against all change; in fact from those who have learned to teach the old, and, in part, from a misconception of what it is that education owes to the requirements of practical life to-day, and in part, also, from the fact that change necessitates new studies on the part of the teachers and also an additional expenditure of money.

Within the last sixty years the occupations of men have everywhere greatly increased in number and greatly changed in character. Manufactures in Canada, as a specialty, were hardly known, the housewife did her spinning and the weaving; she also did the cutting and sewing of garments. The itinerant shoemaker went his annual round. The representatives of our present vast machine shops and foundries were nothing but cross road smithies. The rural surveyor was the sole civil engineer of the day. The draughtsman and the architect, with their working drawings, had scarcely made their appearance.

But not only were the occupations of the country few in number, they were rude in in character. The cultivation of the soil called for little more than muscular strength and persistent activity. The textile fabrics that came from the hands of the housewife, the products of the shoemaker, blacksmith, potter, wagon-maker, carpenter, could only boast of rough strength and durability. There were no marks of skill or taste. The day of the skilled mechanic and art workman had not arrived. Life was indeed simple in those days, and a simple education was enough to qualify for the ordinary avocations.

In sixty years what a change has come over the face of things! The use of labor-saving machinery and the practical applications of science have made it unnecessary for so large a part of the people to engage in the production of food. Every year muscle counts for less and, intelligence for more, in the cultivation of the soil, and the developement of our resources. Scientific knowledge, and the neutral discipline acquired by the proper study of science, become daily more essential to the success of the farmer. The few small and rude manufactures of the past have increased to vast dimensions, and have completely changed in character. The attainment of success in them has been rendered more difficult by the novel machinery employed, by the adoption of more delicate scientific processes and by the growing taste of the people.

As the result of new discoveries in science, and of new inventions in the industries; occupations have greatly increased in numbers, while manufacturers have so increased in variety, as well as in extent, that they now give employment to a very large proportion of the population of the country. Both cheapness and excellence are essential to prosperity; and so there is an ever-growing demand for more technical knowledge and for greater deftness of hand and finer taste on the part of the producer.

It may be said in general, that the education of a people should always confirm to their necessities; that, as the conditions of the life change, the education of a people should undergo a corresponding change; it may be one degree of character or it may be a change involving both. The present is a time when those who have the shaping of popular education in the Dominion of Canada should consider anew the practical application of this simple truth.

In our next issue we will return to this most important subject, in which lies much of the future greatness of Canada and the rapidity of the developement of its vast resources.

A PRINCIPLE WANTED.

Under the above heading, the Ottawa *Daily Citizen* makes some remarks on our leading article, which appeared in the November number of this MAGAZINE, on the responsibility of architects in respect to sanitary matters. The *Citizen* is of opinion that architects, builders and plumbers, can hardly be held responsible as to what "*is best to be done under all circumstances, when the teachers of sanitary science have not yet agreed on the best method for securing proper drainage and ventilation.*" Now it unfortunately happens that many of these teachers of sanitary science are mere theorists, and know very little of the result that would follow from the practical application of their ideas. The method of ventilation and drainage that would answer under certain circumstances, would be perfectly impracticable applied under different circumstances, and here it is that the architect, if competent, is the best judge how to act and should not be tied down to written rules. There are certain general principles, no doubt, which should never be severed from, and if these simple principles were carried out to the letter, we should have very little trouble, hereafter, with either the sewers, house drains or plumbing. But of what use is it spending immense sums upon drainage in the streets when almost every house drain admits the gasses of the sewer into the house, and the plumbing is defective?

Many City Councillors, as a rule, are full of sanitary theories, and delight in carrying them out to the detriment and cost of the inhabitants. If they attended more to the finances of a city and meddled less with the duties of their engineers and inspectors, the public would be benefitted to a great extent. The old adage that "a little learning is a dangerous thing," is very applicable to members of municipal bodies, who too often take advantage of their position to carry out some crude sanitary idea to the detriment of the people. We know too well the cause of the greater part of all zymotic diseases, which carries off so many of our citizens, and that cause is nothing else than imperfect house drains and bad plumbing. No such fatality arises, as some suppose, from gases escaping up from drains through the catch basins in the street, or from gases escaping from ventilators through the roof and being driven back into open windows. Gases carried off in this way are so soon dispensed and diluted in the atmosphere as to be incapable of doing much harm. We venture to say that more foul gas is breathed into the lungs of a family in one night in winter in a house with leaky joints and foul drains (when the ventilators in the street are closed with ice and snow), then is inhaled during the whole year from gases escaping from catch basins and ventilating shafts into the street.

We can expect no remedy to the crying evil until the Government take up this most important subject, and put the sanitary condition of all large cities under the control of a Sanitary Commissioner, with full power to act independent of the control of officious medlers in city corporations.

OUR ILLUSTRATED SHEETS OF TECHNICAL INSTRUCTION.

We desire to inform such of our subscribers who are mechanics, and for whose benefit and education these sheets will be furnished, that they can only be supplied to those who have paid their subscription in advance. As we are not aware of the trades of some of our subscribers who were on our subscription list previous to 1879, they will please notify to us what occupation they follow. No sheets will be furnished before the 1st February next.

IN consequence of the SCIENTIFIC CANADIAN being printed by the Lithograghic process, the publishers are unable to reprint odd numbers required to make up broken volumes, except at a great expense. For the future, therefore, no back numbers will be kept on hand, or sent as samples. The publishers are not answerable for numbers lost through the post-office. They are always sent from our office properly addressed. The reason why some numbers occasionally are not received by subscribers is, because when asking for their letters they forget to enquire for magazines and papers, and after the papers are left in the pigeon-holes of the post-office for a week the corners get torn off and thus the address is lost.

THE heavy expense the publishers have been put to during the past year in collecting subscriptions in arrears, renders it necessary to charge $2.25 per volume on all subscriptions not paid up before the 1st March next. The annual subscription is but a small amount, but if it will be a convenience to some machanics to make their payments half yearly in advance, they can do so.

SIMPLE SCIENTIFIC FOOD FOR THOUGHT.

"A LIVING BODY COMPARED WITH A STEAM ENGINE."*—We find ourselves on the outside of a large ball, which (carrying us with it) flies through space at the rate of about a thousand miles an hour. Below us we have the hard ground, around us and above us the thin air. On this ground we build our habitations with materials from within it; out of the ground, the water, and the air, we get the materials for our food. But the physical power of man seems little qualified to enable him to become the governor of the world; and we shall see that it is only by calling to his aid the forces already existing around him that he can control them.

Above the ground there is little but air and water; but in the ground itself we have endless variety of material: thus in England, we have below the superficial accumulation of our own times clay and sand, below these chalk and greensand, below these again limestone, then red sand, then limestone, then the coal measures, below these still more red sand, and still lower we have slates, and lowest of all is granite. In these lower beds, almost exclusively, we find also a variety of substances differing from earths (such as clay, sand, and lime) in many respects. These melt at comparatively low temperatures, can be easily polished so as to reflect light, are good conductors of heat and electricity, have such considerable cohesive power that they may, in some cases, be drawn into threads finer than hairs. These are called metals, and differ from earths not only as just described, but also in being of more elementary chemical character. They are usually, indeed, said to be elementary substances—*i. e.*, incapable of further decomposition; but this statement is probably a testimony to the imperfection rather than to the accuracy of our present knowledge.

On the surface of the ground, but attached to it by long fibres, is an immense variety of trees, shrubs, and grasses, which may be regarded as compounds of the materials of the earth, the sea, and the air. These are among the chief ministers to our wants—from them we get the chief of our food, our clothing, and in some cases our dwellings.

All these possess also the marvellous power of increasing in size, by absorbing additional materials from without. Commencing their lives as young leaves, they grow with time, apparently from within; but really, as in the case of men, by the appropriation of additional materials from without. It is common to say that the seed becomes a twig, and the twig a tree; but this is not the truth; the seed does not become a twig, the twig does not become a tree. The materials which become the tree are in the ground, the rain, and the air. The office of the seed is to bring these materials together, to enable them to combine so as to form a tree. It would be as true to say that a wire is made of the hole through which it is drawn as that a tree comes from its seed. The seed is to the tree what the hole is to the wire, except that it does the work itself, and does not require to be set going.

The whole world, then, consists of a vast variety of constituent substances; metals, earths, woods, are three groups that contain nearly the whole of the substances usually met with in the solid form: water, usually a liquid, and air as a gas, make up, with these metals, earths, and wood, nearly the whole of the world.

Yet all the varieties of earths and woods, together with water and air, may be treated as compounds of a very limited number of elementary substances some fifty or sixty in number, among which primary substances the metals themselves may be placed. Thus chalk is a compound of carbon, lime, and oxygen; lime is a mixture of calcium and oxygen; soda of sodium and oxygen; water of hydrogen and oxygen; flint of silicon and oxygen; copperas is a complicated mixture of iron, sulphur, hydrogen, and oxygen; vitriol a compound of sulphur, hydrogen, and oxygen.

It will be noticed in this list how frequently oxygen occurs. It is indeed a constituent in a vast number of the compounds found in the world. One fifth of the entire atmosphere is oxygen, one-third of all the water is the same. Indeed, it has been stated that oxygen forms nearly a fourth part of the entire contents of the globe. It has a wonderful power of combination with nearly all other substances; and while this gives much trouble when it is necessary to obtain any substance in a state of purity, it also frequently offers a means of this purification.

The whole world, then, being but a number of more or less complex substances, all acting and reacting, with differences of degree, upon each other, it becomes necessary to know something of the nature of their elementary substances, of the manner in which they affect each other, and of the circumstances which modify the mutual action. For it should be clearly borne in mind that all that is called work, and sometimes dignified with the title of man's power over external nature, is but the use of these properties. As has been clearly pointed out by one of our greatest writers, all that man can do is to move things from one place to another, that beyond this he can do nothing whatever.

Thus, if I wish to light a lamp, I move a lighted match to the wick; to light the match I moved it rapidly along some roughened surface. I can do no more. The nature of the oil in the lamp, and of the phosphorus and potassic chlorate on the end of the match, does the rest. A sculptor wishes to make a statue; he simply moves away the pieces that do not belong to the figure; and the difference between a good artist and a bad one consists in the degree of knowledge as to what pieces should be moved. A pudding is made by removing all the requisite materials into a cloth, the cloth into a saucepan, and the saucepan to the fire. To write a letter I move some ink from the inkstand on to some paper, and the postman moves the paper from me to the person to whom it is addressed. And so on through all the multifarious concerns of our life, whether of business or of pleasure, of work or of rest. The greatest orator, in his highest flights of eloquence, but moves his tongue and his mouth, beating the air that moves from him to our ears. The artilleryman, who deals out death to hundreds from his gaping cannon, but moves powder and ball into it, and then evokes the force of burning gunpowder to move them out again. The greatest painter but moves various colours on to his canvas; to walk we but move the muscles of our legs, and to work we but move the muscles of our arms. The carpenter moves a few pieces of wood together, and behold a table or a chair, a bookcase or a window-frame. The builder moves from place to place a certain number of bricks, pieces of wood, and of stone, together with sundry pieces of glass, iron, and pottery, and a house has risen under his hand.

This does not degrade man's work; on the contrary, it dignifies it. For out of this single power of moving things, and the possession of judgment to govern the moving, see what mighty results have been attained! One will delight the soul with music by moving a few ivory keys; another by moving a few roughened hairs over a few strings; a third by moving air through a brass tube. Think of the mighty power of so appealing to mankind, and of the woudrous power that enables us to understand and to delight in the appeal.

If, however, man can only move things from one place to another, there must be some power inherent in the things themselves, or no result would follow from the moving. I place a small piece of coal—say, two ounces—as fuel for a steam engine; if I can collect and utilise all the force so developed (without any loss in moving the machinery), I have power sufficient to raise a hundredweight through a distance of three miles—to lift it bodily from the foot of Mont Blanc to its summit. It becomes then a very important question to ask, Whence can coal derive this power of exerting force when burnt? Wood possesses the same power of giving out force when burnt; but wood and coal are practically the same.

It is a familiar fact that wood and coal burn because they contain carbon, that this carbon unites with oxygen in burning, that the union of the two forms carbonic acid. Therefore, since carbon unites with oxygen, when the two are placed in contact, it becomes necessary to ask, Whence is this power derived?

We cannot carry ourselves back through ages of time so as to see the trees of which our coal has been made; but trees are now as they were then; and we have but to go a few miles away from London to be in every circumstance, but that of actual time, among the sources of coal. The trees, the ground, the sun, the air, are the same in kind now as they ever were; and, standing under the old beeches of Epping Forest, let us ask them how they live? what food nourishes them? and how they obtain it?

Carbon is the combustible part of wood—that which burns and gives out force in burning; so that our chief concern is to know whence it derives this. Not from the ground, which usually contains but little; not from the rain, which contains none. Driven from land and from water, we have but the air to take refuge in; and here we find the true source of the carbon contained in our trees and our coal.

When I burn coal or wood, the carbon unites with oxygen to form carbonic acid; this floats about in the air, and forms an appreciable portion of its bulk. From this carbonic acid the trees derive their carbon. In some wonderful way, aided by sunlight, they separate these again into oxygen, which goes away, and carbon, which remains. Thus, the same carbon is burnt over and over again, giving out at each successive burning a certain amount of heat or force.

* Introduction to a small work, "Applied Mechanics," by W. Rossiter, F. R. A. S., &c.

So that it is actually the power that carbon has of combining with oxygen that is the source of the power obtained when we burn wood or coal; and it is the presence of carbon in these that fit them for the purpose of fuel. Coal contains from 40 to 90 per cent of carbon; and this is why its burning gives to our hands so much power.

But it is not sufficient to say that carbon unites readily with oxygen, and that it is found in trees, to explain why force is given out when the two combine. If I compress a spring, it has power to return to its original extent; if I stretch a piece of indiarubber, it has power to contract to its former size. But it is the compression that gives the spring power to extend again; extension that gives the indiarubber power to contract. So it is the force acting in the tree to withdraw the carbon from the carbonic acid that gives it the power again to combine with oxygen. And this force comes from the sun; for without sunlight the separation of carbonic acid into its constituents does not take place.

Therefore, it is the sunlight that makes wood and coal able to burn; it is the sunlight that enables us to travel by steam, to werm ourselves by fire, to cook our food; it is the sunlight which has given us nearly all the force we have in the world; and it is a solemn thought that a piece of coal is the storehouse of force that fell, millions of years ago, upon the earth—that it has preserved the force until now, that we can take out this force and use it, either now or at any future time. Just as a bottle may contain water to be poured out when wanted, so coal contains force which we can take out at will.

It is the being able to call forth this force, to use it when and how we will, that constitutes power. The driver of a locomotive engine, by turning a handle, makes the huge machine move this way or that at his pleasure—can make it travel as slowly as a tortoise or as swiftly as a swallow. A steam hammer can be made to mould iron almost like putty, or to crack a nut without touching the kernel; the steersman of a vessel can turn it hither or thither at his will, whether it be a tiny skiff or a Clyde steamer; the engineer uses the force of burning coal to pump water out of a mine, to raise coal, to move a railway train, a steamboat, or the numberless machines in a factory. In this way one man, by means of a pulley or a lever, will raise a load that without such aid ten men could not move. All these are instances of the power of man to collect force, to store it up, to accumulate it, to use it at his will; and we may define power as "the intelligent application of force."

But we must not regard coal or wood as containing a special kind of force; only as having the force, or potential power, which they contain compressed into a very small space, as compared with most other combustible substances. Phosphorus, pitch, potassium, all burn, and in burning give out force; but they do this so rapidly as to be both inconvenient and dangerous. Zinc, iron, and many other substances will burn when sufficiently heated; but the heat required is so great as to be inconvenient for many purposes, and also requires a great expenditure of fuel. Coal burns at a comparatively low temperature, is obtainable in any required quantity at a moderate cost, is easily broken into small pieces, and when burning gives out a considerable force, owing to its containing so much carbon; add to this that it can be moved when cold without any danger, is not likely to catch fire by accident, and may be kept for any period of time without loss or injury; and we see at once why it is so invaluable as fuel, alike for the domestic hearth and the furnace, for giving power to machinery in the mill or at the mine, and for moving trains of carriages upon roads or vessels upon the water.

Nor must we regard burning as the only method of obtaining force. In burning, carbon unites with oxygen so rapidly as to give out force, just as when I clap my hands together I give out force, and the air driven from between them will move any light substance in its way. So when carbon, phosphorus, potassium, or any other substance burns rapidly, force is given out, not as a chemical, but as a mechanical result of the burning. I use the terms chemical and mechanical as they are ordinarily accepted, though I think there can be but little doubt that eventually the distinction will be found to be quite untenable; and chemical result will be found to be identical with mechanical, when we are able to estimate correctly the size and weight of the bodies engaged in the former. That is, it will be found that chemical combinations are but refined examples of mechanics, in which the bodies concerned are of exceedingly small size and exceedingly numerous.

A water-mill is worked by the force of some brook or river; and it would seem that here we had an example of a continnous force, that required no other force to evoke it, of a gain without a corresponding loss. We set up a mill which is worked without any cost beyond that of the machinery; have we not here a kind of perpetual force which requires no preparation and no repair? The river comes down continuously (unless it be only a summer brook); what force is required to raise it before it falls? For it must be remembered that it is practically the same water that circulates continually from the ocean to the clouds as steam, from the clouds to the earth as rain, and from the earth to the sea as rivers. The rivers fall into the sea, and the rain that forms them falls to the earth by the force of gravitation. But the sea, in rising to the clouds as steam, has to overcome, or to be raised against, this force of gravitation. The sun it is that does this—that overcomes gravitation, so that in raising water from the sea, as steam, to form clouds, the sun gives but another instance of how much we owe to it.

But a mill may be worked by the water in a tidal creek—that is, the waters of a creek may rise and fall with the tide, so as to enable a reservoir to be filled every tide; and the water passing out from this, when the tide has fallen, may be made to work the mill. Has the sun done this? An example is given in the figure, a rough plan of the mill-pond, &c., at Wootton Bridge, in the Isle of Wight. The water in the creek, C, rises every tide, so as to fill the mill-pond, P, which is really only a part of the creek separated by the bridge, B, which is closed underneath by locks openings towards the pond, P. When the tide falls in C, the pond, P, remains full, and (unless the locks are purposely opened) is emptied only by a kind of tunnel, *m*, which passes through the mill, M, which it is made to work. Are the tides also owing to the action of the sun? Partly they are, but chiefly to that of the moon. The moon is very much smaller than the sun, but, being so much nearer, has more power to move the earth, and the movements caused by the sun or difference of the attractions of the sun and moon result in the rise and fall of the surface of the water, as compared with that of the land, to which we have given the name of tides. The highest tides occur when the sun and moon act in a line; the lowest, when they act at right angles. Whether the force of the moon, like its light, be but derived from that of the sun, is difficult to tell; but if so, then again we are, in the case of a tide-mill, driven to the sun as the origin of force.

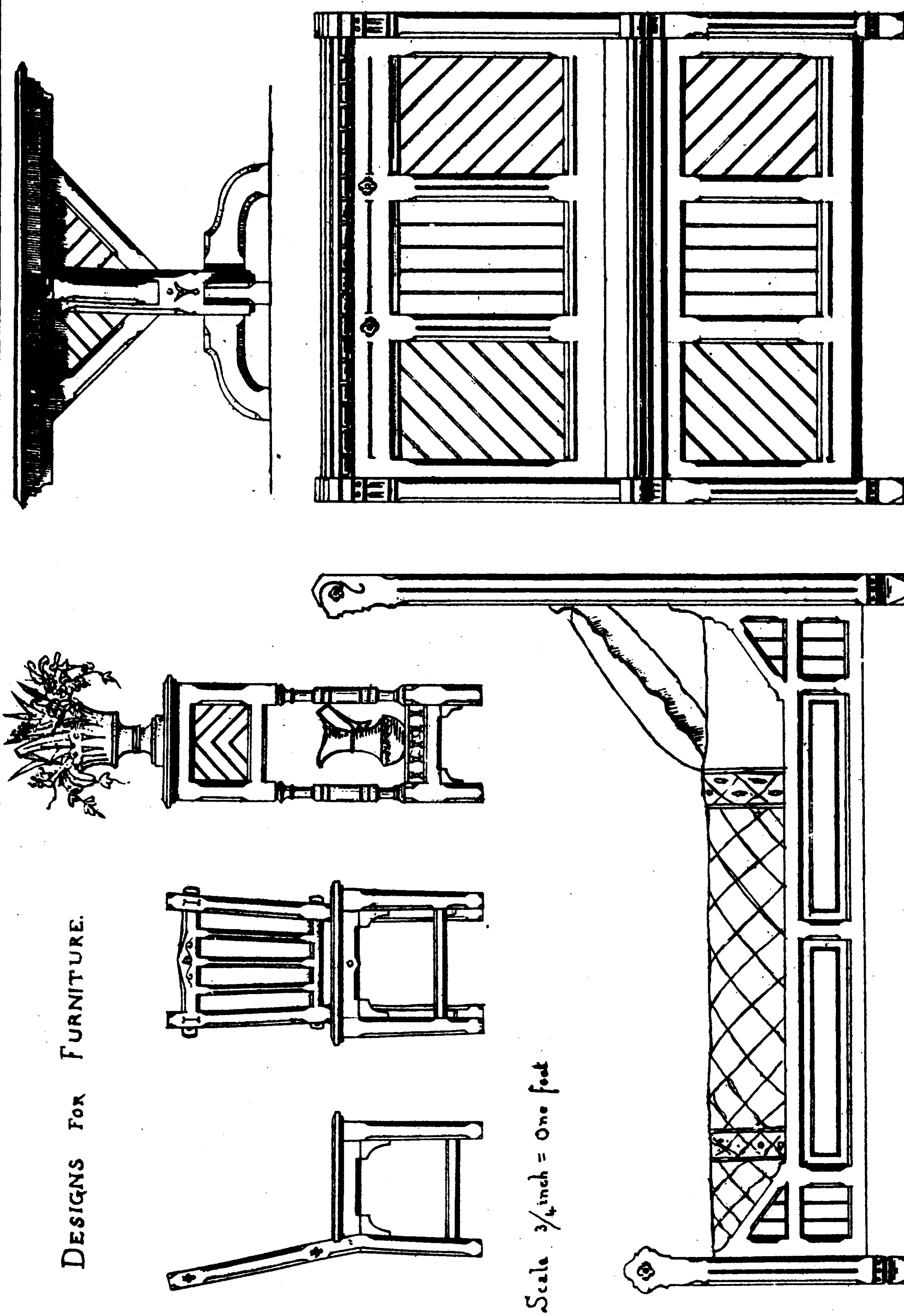
Again, an avalanche is but another example of the sun's power. The water raised as steam has been solidified by cold, and an immense accumulation of it sweeps away a village.

I climb a lofty mountain, carrying with me a small stone. I pick up another stone about the same size, and drop both together over the edge of the cliff. One I carried up, the other I found at the top; yet they are alike as to the force they exert upon anything that checks their fall. The one I carried up derived its force from being so carried; whence did the other derive its force? Assuming it to have been where I find it since the formation of the mountain, the question becomes, how was the mountain formed? For whatever force raised the mountain gave to each particular stone of it the power to fall. It is very probable that if we knew accurately the details of the past existence of our globe we should be able to trace the origin of all such force to the sun, just as I can the force that enables me to raise a pebble from the bottom of a hill to its top.

But we must carefully separate in our mind the force exerted and the means by which it is exerted. I throw a stone at a window and break it. My hand, the stone, the window are all as before, except that the stone has moved from one place to another, and that the glass is in pieces. But the size, weight, and nature of all these, whether of my hand, the stone, or the pieces of glass, are all unchanged. The force exerted is something quite independent of all those—something which can be transferred from one to another—which existed before any of them, and will probably outlive all.

It may at first surprise an unthinking person to be told that there is no force in the universe now that has not always existed; that all the vast changes in land and sea, all the storms and earthquakes, all the work of man, from his earliest existence until now, have been but-rearrangements of already existing substances, and transfers of already existing force.

This explains the title of "Applied Mechanics:" the knowledge of the action of the laws of gravitation we call the science of mechanics. The study of how the observance of these laws may enable us to build houses, make roads and bridges, procure and prepare for use the materials, whether stones, timber, or metals, for these works—construct machines for spinning, weaving, printing, and performing other processes for fitting for our use the various materials we find around us—contrive engines for pumping, locomotion, moving machinery—is the study how to apply mechanics to useful purposes, and thus obtains the name of Applied Mechanics.



FURNITURE DESIGNS.—From the *American Builder*.

Scientific Items.

SCIENCE.

The term "Science," in its various significations, may mean—

1. In a *general* sense, knowledge, or certain knowledge, learning, erudition; the comprehension or understanding of truth or facts by the mind.
2. In *philosophy*, a collection of the general principles or leading truths relating to any subject arranged in systematic order.
3. Art derived from precepts or built on principles.
4. Any art or species of knowledge.
5. One of the seven liberal branches of knowledge, viz., grammar, logic, rhetoric, arithmetic, geometry, astronomy, and music. —*Johnson*.

Webster says: "Knowledge reduced to system—synonymous to literature; art. *Science* (from *Scientia*) is, literally, *knowledge*, but now denotes a systematic and orderly arrangement of knowledge, and hence we speak of reducing a subject to a *science*. In a more distinctive sense, science embraces those branches of knowledge which give a positive statement of truth as founded in the nature of things or established by observation and experiment. The term *literature* sometimes denotes all compositions not embraced under *science*, but is usually confined to the *belles-lettres* (*bel-let'ter*, elegant literature). *Art* is that which depends on practice and skill in performance."

Authors have not always been careful to use the terms *art* and *science* with due discrimination and precision. Music is an *art* as well as a *science*. In general an *art* is that which depends on practice or performance, and *science* that which depends on abstract or speculative principles. The *theory* of music is a *science*, the practice of it an *art*. *Art* is knowledge convertible to practical purposes. *Science* is a knowledge of the principles of art. The object of art is to produce certain effects by the action of bodies upon each other; that of the latter is to ascertain the uniform relations of substances. Art must be founded upon science, because art implies knowledge acquired. The man who prescribes for disease without having made a *fair induction* is a mere emperic.

Of the Study of the Physical Sciences.—Lord Bacon invites the true son of science to leave the antechambers of nature and enter with him into her inner chambers. To prepare himself for such an entry the student of science must approach the portal of nature reverently, and with his head bowed. He must throw off all pride of intellect at the very threshold. He must be patient, trustful, loving, earnest, full of a spirit of scrutiny, of research, of minute investigation. He must educate his mind to a condition of quick inference, combined with a steady balancing of opposite causes. He must forbear to theorise hastily and without full warrant, and he must purge his mind from inherent fancies—from the influence of preconceived opinion, and from the fallacies which may belong to his own peculiar attitude of thought. He cannot too often bear in mind that the senses are finite in their capability of observation—that they are devoted solely to the well-being of the organisms of which they form a part, and hence require careful usage when applied to the investigation of the external world. He must therefore examine an experiment with extreme scrupulosity before he admits it as absolute; his mind must be fortified by legitimate modes of operation suitable for such studies, and every influencing cause must be eliminated before the commencement of a precise deduction. He may use theory for marshaling troops of experimental results, but it is to be remembered that a bad general may cause the best soldiers to lose a battle. The true student of science is penetrated by an intense desire for truth, by a fervid spirit of inquiry. He knows not whither he is going, but he sees before him, dimly and in the distance, a clear and divine light. The tendency of the earlier systems of physical philosophy was to supernaturalise natural actions; the tendency of modern physical philosophy is to force into the phenomenal world that which must ever be ultra-phenomenal. The older writers on physical science delighted in symbolical designs, in which the forces of nature were represented each at his appointed work, and above all they placed a cloud, from which issued the hand of God directing the several agents of the universe, and introducing harmony into their various actions. Thus, too, the true son of science, while he is filed, with awe and wonder at the glory and immensity of creation, should ever bethink him of the great First Cause.

Professor Roscoe says, on scientific methods of study: "None of the great divisions of intellectual pursuits had a higher claim to consideration than that of physical science. None were so well qualified to impress the mind with clear habits of thought—to give that solidity to their conceptions and that exactitude to their ideas of which in the present day, as it seemed to him, they stood so much in need. This was an age of earnest thought and of active intellectual development. Subjects are now openly and boldly discussed which in the days of our fathers were either accepted without question or altogether ignored. Nothing could stop this onward critical movement. Whether it led to results favourable or unfavourable to the highest interests of humanity depended upon the spirit with which it was carried on. In the careful and widespread study of the great truths of nature we had, he maintained, the best guarantee that the progress would be sure, and that the conclusions at which they arrived would be founded on a firm basis; for those who were early trained to the exact observation of the phenomena with which they were surrounded would learn carefully to distinguish between fact and opinion. Their minds would be accustomed to give the proper importance to things which they actually knew, in contradistinction to things about which they had no such certain knowledge; for this, he took it, was the great difference between the scientific and non-scientific spirit. Far from believing, however, that the study of physical phenomena could cover all the ground of our complicated existences, the true man of science was fully aware of the smallness of his knowledge and the inadequacy of his powers to form an idea of, much less to grasp, the sum total of our being. The scientific habit of mind was, however, the only one which could give them unfailing help in their progress. Instead of being hostile to the highest truths of religion, science and scientific investigation had, as Sir John Lubbock so well pointed out, always exerted the most valuable purifying influence on the religious beliefs of humanity, and that they would continue to do so was beyond doubt. Indeed, were people more accustomed to consider questions from the scientific point of view, and did they more fully see the truth of the words of the poet—

> 'To the solid ground of nature
> Trusts the mind that builds for aye,'

they would find that less importance was attached to more works and forms—they would hear less of intolerance, and practice more of that greatest of all Christian virtues, charity."

Of the age of the various physical sciences Professor Rodwell says: "*Astronomy* is undoubtedly the most ancient of the sciences. An observational must ever precede an experimental science; and when, as in this case, observation is stimulated by the beauty and ever-presence of the objects of study, and by the desire to comprehend the nature of the mysterious and the unknown, we can quite understand why the contemplation of the heavenly bodies should recommend itself to mankind in the earliest ages. *Optics* follow Astronomy, and like Astronomy it permits, with great readiness, the application of mathematical reasoning." Next to Optics, the sciences of *Mechanics* and *Hydro-Mechanics*, comprising *statics*, *dynamics*, *hydrostatics*, and *hydrodynamics*, may perhaps claim precedence. *Chemistry* comes next in order, for although scientific chemistry undoubtedly originated with Lavoisier (b. 1743, d. 1794) there existed chemical treatises in the eighth century, and certain chemical processes were known to the ancient Egyptians. The birth of the science of *Electricity* is to be found in Gilbert's *De Magnete* (b. 1540, d. 1603). The same remarks apply to *Magnetism*. The science of *Pneumatics* did not exist before the discovery of the air-pump by Otto Van Guericke, in 1650. *Heat* is among the younger of the sciences, and may be dated from the commencement of this century. *Acoustics* is to be regarded as a recent science. The science of *Meteorology* was commenced soon after the invention of the barometer in 1643. *Voltaic-Electricity* dates as a science from the beginning of this century. *Electro-Magnetism* was discovered by Oersted in 1820, and Faraday announced his discovery of *Diamagnetism* in 1845.

The Object of all Science.—It is the object of all science to ascertain facts, and to trace relations. We know, for example, that a certain substance is a medicine, and we know that it acts upon the skin. These are two facts. With this knowledge, if nothing more can be ascertained, we must be satisfied. It is sufficient for all practical purposes.

The Duke of Argyll, in speaking on *Science* and *Speculation*, says: "The true spirit of science is to be found in the love of knowledge for its own sake. Applications are sure to follow applications infinitely greater in number and amount than any human imagination could conceive beforehand. But we pursue science for its own sake, thankful and grateful for the benefits to mankind which it scatters around with so lavish a hand. And let me say there should be no wall of partition between science, strictly so-called, and speculative philosophy. I am sure you will be inclined to agree with me when I say that one of the dangers of our modern science, arising from its very vitality and spirit and energy and growth, is the tendency to let speculation outrun knowledge. But the remedy for this is not to bar the way against abstract speculation of any kind, not to forbid or ostracise it in our halls of science, but rather to encourage it, and to remind scientific men, to remind ourselves, and to remind the world, that after all our discoveries how very little our knowledge is; and where science has discovered this she will recognise her proper sphere, and philosophy will be chastened and subdued."

Lord Beaconsfield uttered an opinion, at a banquet held at Glasgow, as to the share which science has had, during the present century, in moulding the world. Speaking of the last fifty years, he said: "How much has happened in these fifty years?—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of empires, the change of dynasties, the establishment of governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests, and all the codes, and all the legislators that ever lived."

Difference of the Sciences.—The sciences differ only in their matter, or the nature of their truths. In the physical sciences the relations we trace are uniform. Polarity, or turning towards the north, is a universal property of the magnet. But in those sciences in which we have to deal with the powers of living bodies, or mental operations, the true relations are not only difficult to discover, but even after we know them we may frequently be disappointed in the result we wish to produce. New causes sometimes intervene which sometimes elude observation. The constitutions and habits of human beings are different. A motive which influences one person fails to influence another. But by extensive observation we can trace a remarkable uniformity in the great operations of nature. The changes of the moon seem to be irregular to one whose observation is limited. Human life is *uncertain* as regards individuals, but *certain* as regards a number. Men, too, are possessed of certain uniform principles, which can be acted upon by certain moral truths, when they are brought into circumstances necessary for the due operation of those truths.

THE BRAIN OF AN ANTHROPOLOGIST.

M. Asseline, aged forty-nine, belonged to a "society for mutual autopsy," and the examination of his brain was made by his bereaved *cosociétaires*, who were prepared to find in it all the commonly received external indications of a highly refined and intellectual nature. He had been a republican and a materialist; possessed enormous capacity for work, great faculty of mental assimilation, and an extraordinary retentive memory; had a gentle, kindly disposition, keen susceptibilities, refined taste, and subtle wit. As a writer he had always displayed great learning, unusual force of style and elegance of diction; and in his intercourse with others he had been unassuming, sensitive, and even timid. But "the autopsy showed," says *Nature*, "such coarseness and thickness of the convolutions that M. Broc presumed them to be characteristic of an inferior brain. The fossæ or depressions regarded by Gratiolet as of a simian character and as a sign of cerebral inferiority, which are often found in women, and in some men of undoubted intellectual inferiority, were very much marked, especially on the left parieto-occipital. But the cranial bones were at some points so thin as to be translucent; the cerebral depressions were deeply marked, the frontal suture was not wholly ossified, a decided degree of asymetry was manifested in the greater prominence of the right frontal, while, moreover, the brain weighed 1,468 grammes—*i.e.*, about sixty grains above the average given by M. Broca for M. Asseline's age." The report was made by M. Thulié to the Paris Anthropological Society, of which the deceased M. Asseline was a member

ANTI-VACCINATION FOLLY.

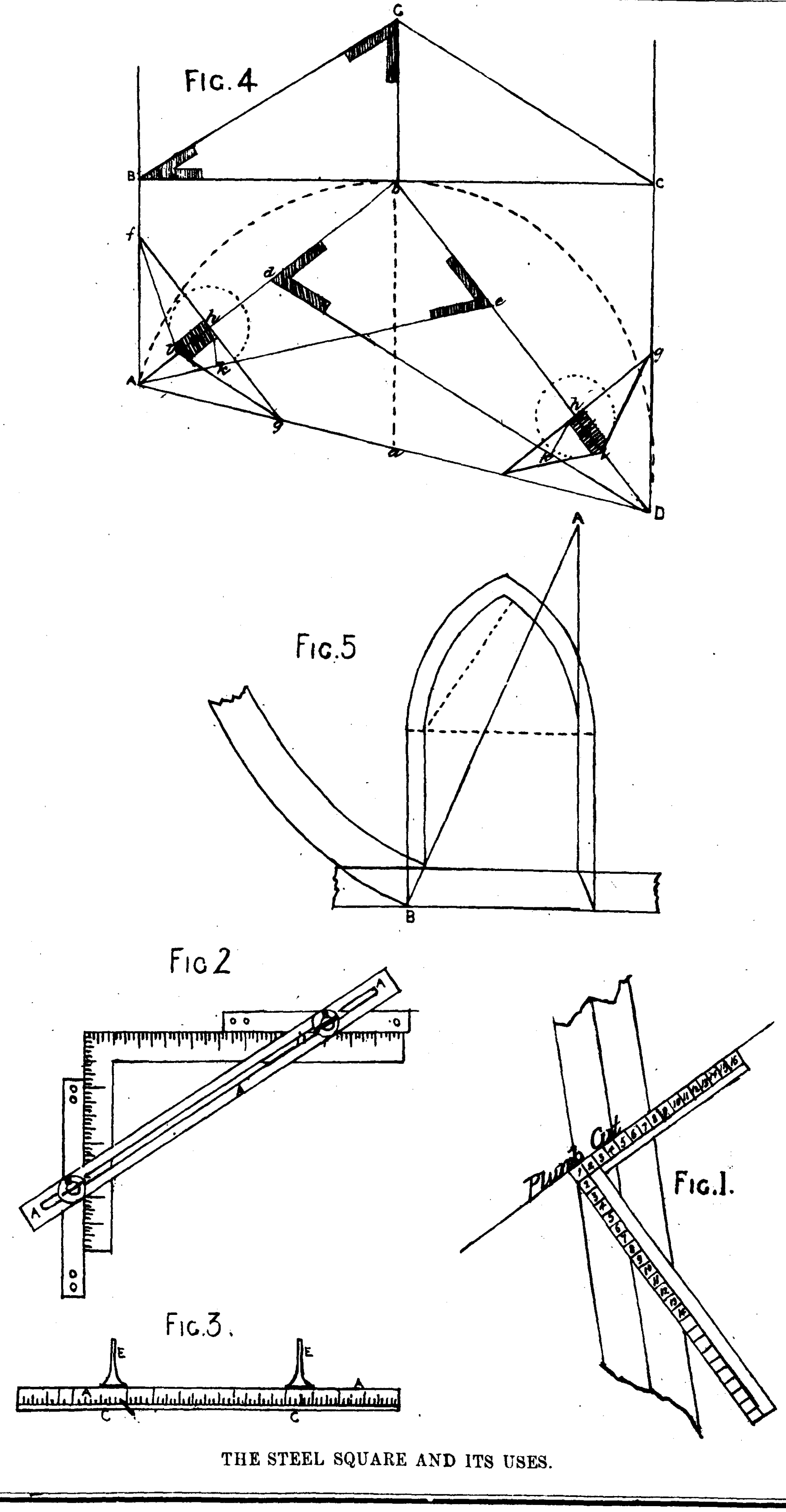
The coming of an English gentleman, with a craze against vaccination as a preventive of smallpox, has been made the occasion of an attempt to stir up opposition to the practices of our American physicians and boards of health in this connection. By parading a portentous array of figures to show that vaccination does not prevent smallpox and does entail a vast amount of disease through blood contamination, not a little feeling is aroused, especially among the ignorant; the anti-vaccination spirit prevailing in English and other European circles, embracing no inconsiderable body of the more intelligent classes, being urged as a reasonable ground for similar opposition here.

Those who have echoed the anti-vaccination cry, however, do not appear to be familiar with the circumstance that, owing to radically different methods of obtaining and using the vaccine virus here and in Europe, no argument based on European results can have any application here. The adverse statistics derived from European experience, or from American experience previous to the adoption by our physicians of correct methods and uncontaminated virus, may all be strictly true, and doubtless are substantially true; yet our confidence in proper vaccination need not be shaken in the least. Accordingly our European friends, instead of trying to propagate their notions here, would do much better to study the methods employed in this country and try them at home. Vaccine virus, not contaminated and stripped of its virtue by over-humanization—that is, by repeated transmission from man to man—is both free from risks and of certai efficacy. No better proof of this fact is required than the practical stamping out of smallpox in this great city. In view of the fact that by the general adoption of correct vaccination, smallpox, but lately one of the worst of human scourges, has been so thoroughly brought under subjection in this great city, that with 1,100,000 inhabitants there were last year but fourteen cases of the disease, it is manifestly as unwise as it is absurd for our newspapers to lend themselves to the propagation of anti-vaccination nonsense.

Replanting Teeth.—G. W. Weld, dental surgeon, recently read before the First District Dental Society of New York a paper on the subject of replanting teeth. The root of the tooth is first extracted and the decayed portion cut squarely off at or directly under the margin of the gum. A porcelain crown with a tapering screw made of platinum and iridium, which had been securely *baked* in the center perfectly paralled with its length, is then firmly screwed into the pulp-canal of the root, the nerve having first been removed and the canal enlarged by reaming out with an engine-reamer. To facilitate the introduction of the screw, a preparatory thread is cut in the root with a tap. This process establishes a very strong attachment between the natural root and the porcelain crown, and with the additional aid of cement in the canal, it is made perfect. When this operation is completed (which requires from 15 to 20 minutes) the socket is syringed out with tepid water, and the root with the new crown attached is gently but firmly pressed into its original position. Perfect reattachment ensues in from two to four weeks. There is seldom any pain attending the operation, and very little inflammation.

Blood of the Lobster.—Harless found copper in the blood of crustaceans, cephalopods and gasteropods. It has long been known that the blood of these three groups of invertebrates changes its color when it is exposed to the air. Jolyet and Reguard concluded that the blood of the crab contains two coloring subtances, one blue and the other red. The first is united with albumen, which, when coagulated by alcohol, has a clear blue tint; the red dye remains in solution in the alcoholic filtrate. Leon Fredericq finds the same principles in the blood of the lobster, but the red contains no metal; it does not change color in oxygen or in a vacuum; it is not always present. The blue seems to be identical with hemocyanine and contains copper. The saline portion of the blood has a composition almost identical with that of the water in which the lobster lives. The hemocyanine easily unites and parts with oxygen and thus acts as a stimulant to respiration, the nutritive functions of the blood being confined to blasma.—*Bull. de l'Acad. Roy. de Belgique.*

Another Cure for Sea-Sickness.—A writer, Mr. Chapham, says in the London *Lancet* that nitrite of amyl is a sure cure for sea-sickness. "With due attention to details the drug is curative in at least 90% of all cases treated." He directs that not more than three drops be taken at a time, inhaled from a handkerchief held close to the nose. It should not be used except under medical advice. The patient when under this treatment should lie in bed, because a good sleep is generally the first result, from which the person awakes wanting to eat. It is usually better to allow one fit of vomiting to occur before the treatment is commenced, "to insure the *bona fide* character of the seizure." Some, however, do not vomit at all, but are very ill, and with these Mr. Chapham considers the nitrate equally successful.



THE STEEL SQUARE AND ITS USES.

THE STEEL SQUARE AND ITS USES.

By F. T. Hodgson, Archt., Editor "American Builder."

How a rafter can be obtained by the square, when the width of the building to be covered contain odd feet, or a fraction of a foot.

Let us suppose that we have to make up a fraction of a foot, say 8 inches, the half of which would be four inches, or ⅓ of a foot; then, if our roof is quarter, all we have to do is to place the square, with the 4" mark on the blade, and the 2" mark on the tongue, on the centre line of the rafter, and the distance between these points is the extra length required, and the line down the tongue is the bevel at the point of the rafter. We show in Fig. 1 an application of this method. All other pitches and fractions can be treated in this manner without overtaxing the ingenuity of the student.

Figs. 2 and 3 show an instrument, which, curiously enough, appeared in the *Scientific American* as a patented device. One, George H. Bradshaw, of Fayettville, Tenn., claims to be the happy inventor. The practical operator will see in a moment that the simple wooden fence used by me, and shown in past numbers, is much more convenient to use than the patented device illustrated. The singularity of the thing, however, exists in the fact that the patented device makes its appearance September 26th, 1876; and my basswood wooden fence is, for the first time, I believe, introduced to the public on or about the first of August, 1876. The coincidence partakes somewhat of "fish," to say the least.

A represents a bar, upon the edge of which is formed a scale of division marks, numbered to represent the length of brace or rafter, and which should be made upon a scale of an inch to the foot to make it correspond with the division marks in an ordinary square. The bar, A, is slotted longitudinally to receive the clamping screws, B, which are sciewed into straight bars, C, placed upon the lower side of said bar, A, as shown. In using the instrument, the bar, A, is laid diagonally across the arms of an ordinary square, and is adjusted upon the long arm of the square at a point representing the half width of the building, and upon the short arm at a point representing the desired pitch of the rafters. The bars, C, are then adjusted against the edges of the arms of the square, and are clamped in place by the screws, B. The instrument is now set to give the length of the rafters and the bevel of their ends. The instrument may be used without a square by having lines drawn upon the inner side of the bar, A, to represent the different positions of the bars. C, for different lengths and pitches of rafters.

Fig. 4 shows the plan of a roof where the angles are not right-angles. This is published in compliance with a promise made in a previous number of the *Builder*

Bisect A D in a, and from a describe a semicircle A b D; draw a b parallel to the sides, A B, C D, and join A b, D b, for the seat of the hip-rafters. From b set off on b A, b D, the lengths b d, b e, equal to the height of the roof b c, and join A e, D d for the length of the hip-rafters. To find the backing of the rafters: In A e, take any point, k, and draw k h perpendicular to A e. Through h draw f h g perpendicular to A b, meeting A B, A D in f and g. Make h l equal to h k, and join f l, g l; the angle f l g is the backing of the hip.

Any diligent student will see at once that the above method will apply to any hip-roof, no matter what may be the plan of the building.

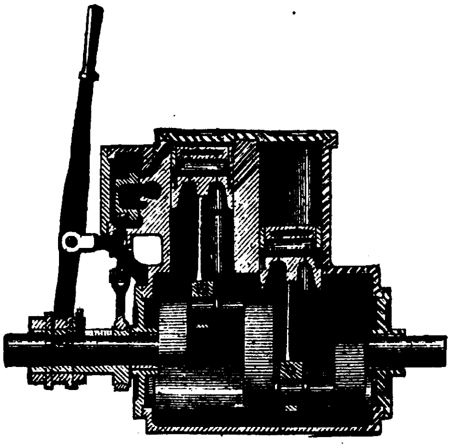
Fig. 5 is taken from Gould's valuable *Carpenter's and Builder's Assistant and Wood-Worker's Guide*, and may be of use to the young mechanic. It shows the method of finding a veneer for a gothic head jamb, splayed alike all round; the spray of the jamb, B, being produced to A, gives the radius to describe the veneer required to cover one side of the circular jamb.

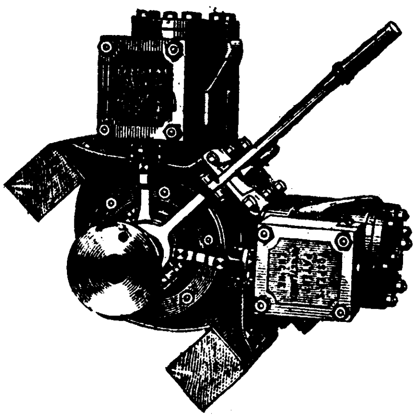
This paper closes the subject, and if I have been fortunate enough to awaken an interest in it in the mind of any mechanic, my efforts will not have been in vain. It is but just to say that I have drawn a grat deal of the pith of these papers from many and varied sources, and I may add further, that the subject is far from being exhausted as there are many things that can be performed with the steel square that have not been spoken of here; they may, however, be the subject of future papers.

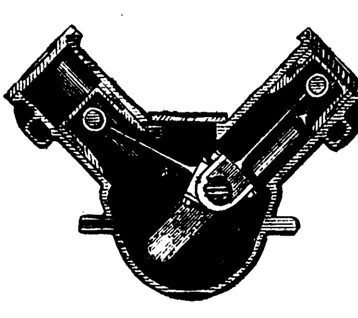
Potato Bugs Utilized.—Those who like to find "good in everything" will be gratified to learn that it appears from experiments described in the *Journal of Pharmacy* that the fresh powder of the potato bug yields about 1⅓% of pure cantharidin. This is a large product, and no doubt these pests will be increasingly used as a cheap source of this valuable remedy.

THE "VOSPER" FOUR-CYLINDER ENGINE.

There is still an unsatisfied demand in the market for a good fast speed launch engine. The "Brotherhood" three-cylinder engine was one of the first to be put on the market and the next that followed with any special distinguished features was the "Willans," made by Hunter & English. Both of these engines were excellent in their way, and were the forerunners of a large number of similar or approximately similar designs.







What is sought is an engine which in the smallest possible space and of the most simple construction shall keep a pressure as nearly as possible uniform upon the rotating crank. To effect this purpose well, at least three or four cylinders are requisite, and to render them compact the connecting rods are invariably centered on a pin passing through the piston. The advantages of this system are obvious in the matter of reducing the space required, but at the same time the great lateral thrust thus induced on the piston tends to great wear on those parts and considerable friction in the cylinders.

The "Vosper" engine, which we this month illustrate, has most of the usual features common to the multiple cylinder engines, but also some distinctive and advantageous features. The cylinders are four in number, arranged in two pairs at right angles to each other. This gives a very uniform and regular pressure on the crank, which has two throws, on each side of which operates one engine from each side, the throws being opposite one another.

This arrangement of cylinders brings the weight very low down and yet has no cylinder underneath the crank shaft, which can thus be fitted in an exceptionably low position in the vessel or launches. The compression pistons and connecting rods are of course used to enable the engine to run at a very high speed without noise of any kind. That is to say, all the cylinders are only single acting, and the work is thus all done by the alternate pressure of the steam on successive pistons. There is always sufficient back pressure or "cushion" on the exhaust stroke to keep the pistons and connecting rods home on the crank bearings.

"In this "Vosper" engine each pair of cylinders is worked by one slide valve only of the ordinary 3 port or slide valve. One steam port leads to the nearest cylinder, the centre port is the exhaust, and the other steam port is carried round in a pocket to the second cylinder. This is a considerable economy of parts compared with a valve to each cylinder, and owing to their relative position, both slide valves are worked by the same eccentric, which is again a very simplified arrangement.

Owing also to the arrangement of the cylinders in pairs, and that each pair is operated by one valve, it is very easy to compound each pair, and thus, when their size is sufficient, to render them very economical in the use of steam.

It is well known that one of the chief objections to many of the multiple cylinder high speed engines has been the use of cone or plate valves, which in the case of the former never wear true, and in the case of the latter offer too much friction to rotation from the large area under pressure and the high speed of movement.

The application in the "Vosper" engine of the ordinary slide valve which has so little motion, and is known to wear so well, may be considered a special and distinctive advantage.

This engine is being brought out by Mr. C. R. Okes, of 39 Queen Victoria street, who is the sole London agent.

DRAWING-ROOM PAPER.

Walls to a room should be regarded only in the light of a frame-work to what the room contains, and should be decorated so as to bring into prominence and not eclipse the other parts of the chamber. Nothing destroys the effect of a room so much as a handsome but staring wall paper, or a wall so profusely ornamented as to strike upon the eye to the exclusion of the rest of the decorations, thus bringing forward what should be the background into the most conspicuous place. A modern drawing is always difficult to decorate artistically, because of the taste of its builders for heavy cornices, prominent mantelpieces, and rooms too lofty for their size; and as all these misnamed "embellishments" are too costly to remove by tenants, the only plan to pursue is to destroy their effects by excercising both taste and ingenuity. First, with regard to the ceiling, the ornamental boss in its center should be removed, and the ceiling tinted a color that harmonizes with the wall paper, as no harmonies can be hoped for when what produces them is surmounted with the glaring white of an ordinary ceiling. The tint used must be one that softens into the wall paper, not one that contrasts; thus, if the tone of the room is that of a soft grey blue, the ceiling should be a clear flesh pink; or should a grey green picked out with black be the chosen color, then it should be colored a subdued lemon.

Some people cover their ceilings with a whole colored paper, and border it with a stencilled pattern representing the thin garlands so familiar upon Queen Anne decorations, but this is a more troublesome plan than the simple coloring, which answers all the purposes. The walls, if they are lofty, require a high dado. These high dados give a look of comfort and "home" that is absent from the modern high pitched rooms papered with one uniform pattern. The dado is divided 3ft. to 4ft. from the ceiling, and the coloring of the lower portion must always be heavier than that used on the upper or a top heavy look will be given to the room. When many pictures are to be hung up the lower part of the dado should be of a whole color, either a whole colored paper or a painted wall, as pictures are only shown off upon such a background. Where a whole tint is used for the lower part of the dado, the upper portion should be decorated with a frieze paper of a good bold pattern, but of subduced coloring and of tint that harmonizes with the lower. Thus, the color used about the frieze should be the same as that on the lower part, but of a lighter shade, intermixed with some other colors that form a harmonious link between the two shades. Contrasts must be carefully avoided, but pale pinks, blue and ambers, can be blended together above a subdued grey-blue ground. The two portions of the dado should be joined together with a light wooden (black or brown) railing, or with a line of paint.

The dado decorations can be altered by placing the pattern paper upon the lower part and leaving the upper plain-colored with or without a stencilled pattern upon it. This will suit a room where not many pictures are required, or that is already rather dark. Some part of the wall should always be in plain color, as the eye requires rest; and no pattern however subdued in hue, can give the relief to the mind that a bit of plain coloring affords, and this scarcity of ornament in one part of a room is amply repaid by the effect it gives to such parts as are bright and should be bright. The true theory of effect is to use but one or two bright colors in a room, and to surround them by soft and subdued tints that throw up and do not destroy their brilliancy; a number of bright colors placed together destroy each other, and leave no impression upon the mind but glare and vulgarity. Having settled upon your paper and ceiling, have the woodwork and cornice of the room painted either a shade lighter or darker than the walls, and shroud up the mantelpiece with curtains, etc., of satin sheeting embroidered with crewels, and instead of the usual looking glass over the fire-place, have a mirror surrounded with brackets holding china; or have a black wooden mantelpiece made with squares of looking-glass let-in. The back-ground, of your room being thus completed in a manner really to be a back-ground, your furniture will look twice as well as if it were stared out of countenance by the walls, and one need hardly add that all your friends will delight in a room that throws up and brings out their dresses and faces, instead of killing them by its glaring tints.

PANEL PAINTING.

Select woods for water color painting that are close of grain and texture. Ebony is the best, but as that is expensive, mahogany stained black is generally used as a substitute. Pear, mahogany, cedar and oak are all suitable. Greywood, which is merely white wood steeped in mineral water, can be employed as panels most effectively when decorating rooms where the general coloring is subdued in tone. Have chosen and good close wood; see that it is smoothly planed and remove any splinters or raw edges with fine sandpaper; also be careful that the grain of the wood runs length ways and is straight. Commence by sizing your panel with either a coating of patent size, or with two of isinglass that has been dissolved in hot water. This sizing prevents the water colors from sinking into the wood and losing their brilliancy, and also checks the paint running and becoming ragged at its edges. When the size is dry, draw the outline of your painting upon the wood. The best plan for this is to make your sketch upon a piece of paper and perfect it upon that, and then trace it upon tracing paper and transfer it to the wood by putting blue or red carbonized paper between it and the panel and going over the outline with a fine pointed pencil.

Should you be working upon dark wood, fill in the whole of your design with Chinese white before attempting to color it, and this is also a good method when painting upon light woods should you wish an illuminating appearance given to your design or desire to execute it in body colors. The Chinese white should always form the foundation color for fading leaves, grasses, etc., as the subdued tints necessary for these will not stand out upon wood without the under white paint. The Chinese white will also destroy any irregularities of surface caused by the grain of the wood; but many think it an improvement to the painting to allow the veins and marks in the wood to show. Paint as in ordinary water-color painting, but make your highest lights and deepest shadows brighter than usual, as the varnish will diminish the brightness of the coloring, so that it is better to slightly exaggerate the effects. Never work over a color until it is perfectly dry, and stipple in the deepest shadows. Should the colors not run freely, add a very little oxgall to them, but this medium is rarely needed when the wood has been properly sized.

Glaze with a thin wash of a lighter color over a dark to give brilliancy to your painting, and mark out veins of leaves after they are finished by laying a foundation of Chinese white and putting the light color over it. Faded leaves and grasses improve a painting very much, and should always be used where possible;

they should be painted as if in the background. When your painting is finished leave it to dry for some days, then size it with two coats of patent size (allow the first coat to dry before applying the second) and varnish with white spirit varnish. The sizing is put on from top to bottom, and every part gone over, and the varnish must be laid on in the same manner. White wood can be stained black thus: Boil logwood for twenty minutes in enough water to cover the chips, lay it on to the wood while hot, and while it is still wet apply a coating of pyrolignite of iron. When dry, repeat this process, and when again dry, put on another coating of pyrolignite of iron. Sandpaper your surface with a fine paper until it is perfectly smooth; dust away the sand and varnish, mixing lampblack with the varnish if you want a dull black surface. If you do not wish to varnish your wood but wax polish it, lay wax and turpentine upon it, and leave for twenty-four hours, then rub the surface smooth with pieces of cork.

CERTAIN PROPERTIES OF OIL PAINTS.

(Extracts from an Article by the celebrated French chemist, M. Chevreul

Painting is done with two objects in view—either to change the natural colour of the surfaces of various articles, or to protect those articles by rendering their surfaces less easily altered by air, rain, dust, &c. Three conditions must be fulfilled:—

1. The paint must possess sufficient fluidity to spread with a brush, and also be viscous enough to adhere to the surface without running, and to leave coats of equal thickness when the surfaces are inclined or even vertical.

2. The applied paint become hard.

3. After hardening it must adhere firmly to the surface on which it has been applied.

I have proved that the hardening of white lead or zinc-white paints is due to the absorption of the oxygen of the atmospheric air. And since pure oil hardens we see that the hardening is the effect of a primary cause which is independent of the drier, white lead, or zinc-white. Besides, my experiments demonstrate that white lead and oxide of zinc manifest a drying property in many cases, and that this property exists also in certain substances which are painted—lead, for instance. The painter, therefore, who is desirous of knowing, at least approximately, the length of time necessary for his work to become dry will have to consider all the causes which produce that effect. Consequently a *drier* will not be considered as the *only cause* of the drying phenomenon, since this phenomenon is assisted by several substances having also the property of drying under certain circumstances. Moreover, there is this remarkable fact, that the *resultante* or sum of the activities (drying powers) of each of the substances entering into the composition of the paint cannot be reckoned by the sum of the activities of each substance. Thus, pure linseed oil, the drying power of which is represented by 1·985, and oil treated by manganese, with an activity of 4·719, will, when mixed, possess an activity of 30·828. If there are substances which increase the drying properties of pure linseed oil there are others which act in an opposite direction. For instance, if one coat of linseed oil is applied upon glass it will dry after seventeen days; but if the same oil is mixed with oxide of antimony it will take twenty-six days to dry. In this case the oxide of antimony acts as an anti-dryer. Linseed oil, mixed with oxide of antimony and applied upon a cloth painted with white lead, will dry after fourteen days; the same oil, mixed with the arseniate of protoxide of tin and applied upon the same cloth, will not harden for six days. Oak appears to possess an anti-drying property to a high degree, since, in the experiment of 22nd December, 1849, three coats of oil took 159 days to dry. In the experiment of 10th May, 1850, a first coat of linseed oil was dry only on the surface ofter thirty-two days. Poplar seems to be less anti-drying than oak, and Norway fir less than poplar. In the experiment of 10th May, 1850, three coats of linseed oil took twenty-seven days to dry for poplar, and twenty-three days for Norway fir. If there be a drying activity and a contrary one in certain substances, I have no doubt that there are also circumstances under which linseed oil is not influenced by the nature of the surface on which it has been spread. For instance, in the experiments of 10th May, 1850, one coat of linseed oil was given upon surfaces of copper, brass, zinc, iron, porcelain, and glass, and in every case the oil was dry after forty-eight hours. I hasten to say that I do not pretend to classify all the substances, when in contact with linseed oil, or any other drying oil, into drying, anti-drying, and neutral, because the circumstances under which these substances are placed may cause variations in their properties. I believe that a substance may be drying or anti-drying under different circumstances—whether it be due to the temperature or the presence or absence of another substance, &c. For instance, metallic lead is drying towards pure linseed oil, whereas white lead, which is well known to possess drying properties, is anti-drying towards linseed oil applied upon metallic lead. If painters desire to understand their operations well, they must consider the drying of their painting in the same manner as I have just pointed out. By so doing, and in certain determined cases differing one from the other, they will be enabled to modify and improve their ordinary methods. Linseed oil is naturally drying, and this property increases almost always by its admixture with white lead, and in certain cases with oxide of zinc. If the mixture be not sufficiently drying, recourse is to be had to an addition of oil boiled with litharge or manganese. At the same time it is necessary to consider the nature of the surfaces painted over—whether it be a first, second, or third coat, the temperature of the air, the light, &c. From our present point of view, drying oil, boiled with litharge or manganese, loses part of its importance, because it may be dispensed with for the second and third coats, and even for the first one if the natural drying is added by the temperature. Moreover, pigments themselves may act as substitutes, as in the case of light colours, which are altered by yellows or browns, if the painter has derived profit from some of the observations indicated in this article. Thus linseed oil, exposed to the air and to light, becomes drying, and loses its colour; it may therefore be employed with white lead or zinc-white without impairing the whiteness of either. Since by associating oxide of zinc with carbonate of zinc it is possible to dispense with a drier, we have a new way of avoiding the inconvenience of coloured driers; at the same time it gives a hope that new combinations of colourless substances will be found, presenting greater advantages than those just noted. My experiments demonstrate that the processes generally followed by colour manufacturers for rendering oils drying—that is, by heating them with metallic oxides—are open to objections of waste of fuel and colouration of the product. Indeed, I have shown—(1) that oil kept at a temperature of 70° C. for eight hours had its drying powers considerably increased; (2) that if peroxide of manganese be added to the oil kept at this temperature it becomes sufficiently drying for use; (3) that a very drying oil will be obtained by heating linseed oil, for three hours only, with 15 per cent of metallic oxide, and at the temperature generally adopted by the colour merchants. My experiments explain perfectly well the effect of linseed oil, or, more generally speaking, of drying oil, in painting. Indeed, when oleic acid is mixed with metallic oxide it passes instantaneously from the liquid to the solid state, and there is no uniformity in the *ensemble* of the molecules of the oleate. The effect is different when a drying oil, absorbing oxygen, passes progressively to the solid state. The slowness with which the change takes place allows of the symmetrical arrangement of the oily molecules, which would appear transparent if there were not opaque molecules between them. But if the latter do not predominate the arrangement is such that the painting is glittering, and even brilliant, because the light is reflected by the dry oil as by a looking-glass.

MR. RICHARD PROCTOR, the eminent English astronomer, in a recent lecture spoke briefly of a new theory regarding the pyramids. He stated that some time since he endeavored to place himself in the position of those making astronomical observations without the assistance of telescopes, with the object of studying their requirements and the best methods possible with the means at their command. The result was a structure very similar to the pyramids, which he believes were obviously built originally for astronomical purposes. He exhibited a section of one of the great pyramids, and called particular attention to two galleries ascending toward the north and the south, which must have served the purpose now fulfilled by the transit instrument indicating the exact moment when the leading stars were in the meridian.

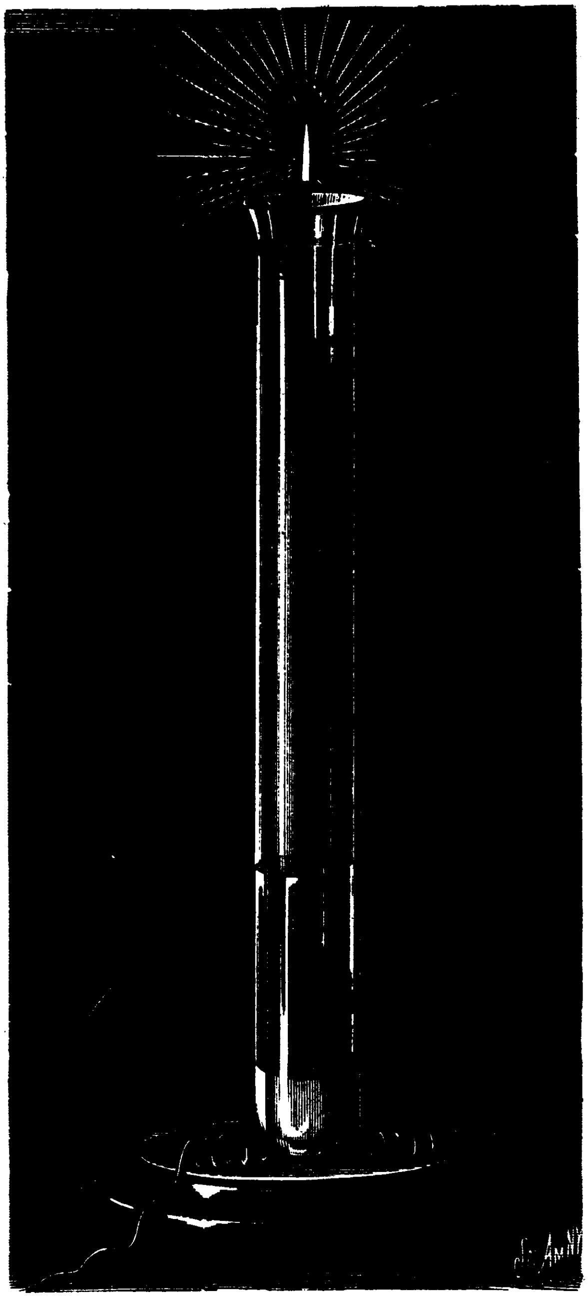
PAPER HANGING.—To prepare the walls, make a size of glue and water, then give the walls a coat of a very weak solution of the same. To make a paste, take two pounds of fine flour, put in a pail; add cold water, and stir it up together in a thick paste. Take a piece of alum about the size of a small chestnut, pound it fine and throw it into the paste; mix well. Then provide about six quarts of boiling water and mix while hot with the paste until the whole is brought to a proper consistency. This makes an excellent paste and fit for use when cold.

MOTHS.—A little spirits of turpentine added to water with which floors are washed will prevent the ravages of moths.

MODIFICATION OF THE REYNIER AND WERDERMANN ELECTRIC LAMP.

BY GEO. M. HOPKINS.

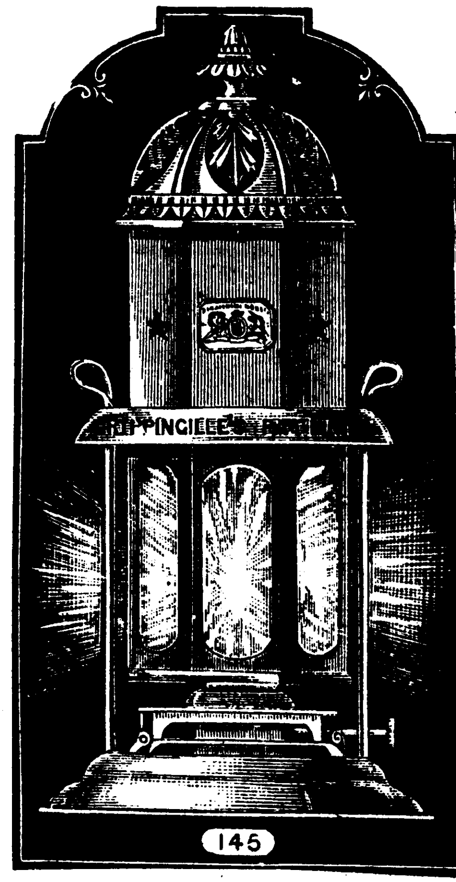
In the Reynier and Werdermann systems of electric lighting the light is produced by the incandescence of a slender pencil of carbon and by a small voltaic arc between the end of the pencil and the carbon block forming one of the electrodes. In the Reynier system the carbon block is in the form of a wheel that



SIMPLE ELECTRIC LAMP.

revolves slowly by contact with the end of the carbon pencil. In the Werdermann system the carbon block is stationary. In both systems the pencil is carried forward as it is consumed, by gravity of a simple weight or of the parts of the lamp and the pencil, and Mr. Reynier, in a recent description of his lamp, proposes to employ hydrostatic pressure as a means of carrying forward the pencil. This is not a new idea, the principle having been already applied to feeding carbons in electric lamps.

The lamp shown in the accompanying engraving embodies the principle of the Werdermann and the Reynier, and the carbon



pencil is carried upward by a float which creates the required pressure between the electrodes and presents a ready means of moving the carbon with a gentle, continuous pressure.

This lamp is as simple in its construction as any having means of feeding the carbons, and it is as inexpensive as it is simple. With appropriate battery power it will give a light equal to at least two five-foot gas burners.

The test tube which contains the water and the cork float, is 9 inches high and about 1⅛ inch in diameter. From the base rise two wires, which are formed into a circular loop at the top for receiving the carbon button forming one of the electrodes. This carbon button is circular and somewhat conical, and is held in place by simply crowding it into the loop. It is arranged eccentrically in relation to the top of the test tube, to admit of turning it so as to present a new surface to the end of the carbon pencil, and it is inclined so that the upward pressure of the carbon pencil will insure a contact between the button and the pencil, and between the pencil and the small carbon block below and in front of the button. This block is inserted in the coil formed on the end of the wire which extends over the side of the test tube and downward to the base, where it is connected with one of the battery wires.

The looped wire that supports the carbon button and the wire supporting the carbon block are inserted in the base, and form a support for the test tube.

The carbon pencil is $\frac{1}{16}$ inch in diameter and 9 inches long. The cork that buoys it up has in its center a small tube for receiving the lower end of the carbon pencil; for this tube a very small quill answers well.

The carbon button and the carbon block are cut from a hard piece of battery carbon or from a piece of gas retort carbon.

The test tube is nearly filled with water, which bears up the cork float and brings the upper end of the carbon pencil into contact with the carbon button; the pressure of the pencil against the inclined surface of the button throws the pencil into contact with the carbon block, completing the electrical circuit.

Six cells of Grenet battery, each consisting of a zinc plate, 3x6 inches, placed between two carbon plates of the same size, will afford a splendid light for a short time, but this form of battery soon polarizes. For a continuous light some form of constant battery is desirable, although a greater number of elements will be required.

In the published descriptions of the Reynier lamp it is stated that four Bunsen elements will afford a clear white light, and that with a battery of thirty-six elements, grouped in two series of eighteen elements each, four lamps may be placed in a single circuit. The writer's experience has been that this lamp, as well as most of the other simple lamps, requires more battery power than the inventors claim to use.

To obtain the maximum result from one of these simple lamps it is probably safe to say that at least eight Bunsen elements will be required.

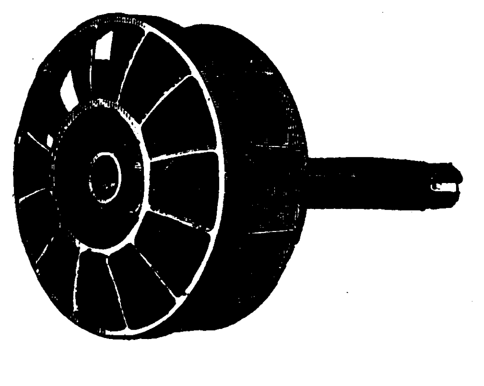
The lamp shown in the engraving seems to yield results equal to those obtained from the more expensive apparatus, and by a comparison with another lamp of more complicated and costly construction the writer was forced to believe that the results were even better. Whether this is attributable to the combustion of the gases resulting from the decomposition of steam by the intense heat of the incandescent carbon remains to be determined by future experiment.

BURNHAM'S STANDARD TURBINE WHEEL.

The illustrations we give in this article will enable our readers to gain an excellent idea to the features of N. F. Burnham's Standard turbine. There is an interesting history connected with the water wheel, which we give in Mr. Burnham's own language, as follows ;

"At first I manufactured and superintended putting into operation the French Jonval turbine wheel, but being complicated in construction, it soon wore out and leaked. From the experience had with this wheel I invented and patented, February 22, 1859, my improved Jonval turbine, which was very simply constructed and yielded a greater percentage of power than the French Jonval turbine. Hundreds of these improved which were put into operation between the years 1859 and 1868 are still in use, and the gates now shut off the water as tight as when new. In 1860 I commenced experimenting with different forms of buckets and chutes, and after making several diffrently constructed wheels and using them for a number of years, I selected the best one and obtained a patent for it, March 3, 1868, and called it "My Turbine," which I improved nnd patented May 9, 1871. This new turbine consisted of my former improved Jonvel wheel hub and buckets, a new circular case, and new form of chutes, having a register gate entirely surrounding the case, and having apertures corresponding to those in the case for admitting water to the wheel. This register gate was moved by means of a segment and pinion. This "New Turbine" soon superceeded all other turbines in the market in percentage of power and durability. On the 15th of November, 1873, the first was made with the Standard turbine case, chutes and gates, using the same movable wheel which was tested August 14th. Twenty-three tests were made at this trial, and the speed of this (18-inch) was changed by the weights on scale beam from 166 to 188 revolutions per minute, and not one percentage out of the 23 tests was less than 11,10. The best percentage obtained at this test was on the 10th trial, when the wheel was running 180 revolutions per minute under 6.39 feet head, and 82.47 per cent. obtained. November 22, 1873, the same Standard turbine case, chutes and gate, as tested on the 15th, with the same form of hub and buckets, that I now make, was tested 24 times. The lowest per cent. was 81.19 when running 168½ revolutions per minute, under 6.36 feet working head of water. The best percentage was 84.09, when running 183 revolutions per minnte, under 6.41 feet working head of water. Application was then made for a patent, which was granted March 31, 1874."

Mr. Burnham has introduced important improvements, which may be described as follows: In making the straight part of the concave hub one-half longer (or deeper) than he formerly made it, extending the inside part of the buckets down to correspond with the extended wall of the hub, and curving the lower part of them up to the original length at the periphery of the wheel. In forming a water-tight groove or recess in the upper projecting rim on the gate, to prevent sand or dirt from being drawn into the parts of the gate. In operating the gate by an eccentric wheel, instead of cog gearing or levers. In supporting the upper bearing box on brackets, the lower end of them resting on the cover, directly over the body of the case, forming an upper bearing for the wheel shaft. In placing a packing box under the bearing, which prevents the forcing of sand, by the water, down into the journal box.



Burnham's wheel is manufactured and for sale by the Christiana Machine Co., Christiana, Pa., and our readers will see, by the card in another place that one office of Mr. B. is at Richmond, Va. and the other at the works at Christiana. Send for pamphlets, etc., as per addresses given.

SOLDERING BROKEN FILES.

A writer in the *English Mechanic*, who had broken the only half-round file he had by him, says: "After trying to use the broken end (it was broken about the middle), I was about to give up in despair, when I thought I would try soldering; and, to my suprise, it not only stood while I completed the small job I was then doing, but is in use still, and will stand all the force such a file needs to have applied to it in ordinary use. I used ordinary solder, Baker's soldering fluid, and a Bunsen burner. The temper is injured only at the very joint. Of course I was careful not to heat it more than requisite to melt the solder."

[Baker's soldering fluid is, we presume, a solution of zinc in hydrochloric acid.—Ed.]

A New Cement.—Asbestos powder made into a thick paste with the liquid silicate of soda, according to a leading English authority, is stated to be found to be of great advantage for making joints, fitting taps, connecting pipes, and filling cracks in retorts. It is said to be of great service in the manufacture of nitric acid, sulphuric acid, and other products, because it can be as easily made as applied, hardens rapidly, and prevents the escape of acid vapors.

A CHAPTER ON BOILERS.

From the time of James Watt, until quite recently, boilers have been looked upon as mere appendages to steam engines, necessary, indeed, but more as receptacles for storing up steam than as requiring any ingenuity in their design or mechanical knowledge in their construction ; and so long as the pressure was from that of the atmosphere up to 15 pounds great strength was not required, valves even being placed on the boilers to prevent collapse when the pressure fell below that of the atmosphere. When the use of steam had become an acknowledged success and promised to extend with great rapidity into all branches of industry, and in all parts of the world, the engine being composed of moving parts, attracted the notice of engineers toward itself, to complete exclusion of the boiler ; and it has up to the present time absorbed more than its fair share of attention.

The first steam boiler—made probably by the well-known Captain Savery—was of the "billycock" shape. This was a weak form, but sufficient for the required purpose. It was used by Watt at the commencement of his experiments, but after a time he gave preference to the "wagon" shaped boiler, which may yet be seen in some out of-the-way parts of the country. These he strengthened by stays ; but the form was essentially weak, and, in comparison with modern boilers, caused extravagance in fuel. The advantages of working steam at high pressure, and expansively, could not long remain hidden, and boilers were soon required which would withstand pressure up to 40 pounds to 50 pounds to the square inch ; even then the engine was looked upon as the motor, and the boiler as a steam reservoir made sufficiently strong, it not being generally considered that the latter had any effect upon economical steam generation. But of late years the conviction has gradually forced itself upon the minds of leading engineers, more particularly in this country, that there are boilers and boilers, that is boilers which scarcely deserve the name, and boilers which claim to rank as specimens of engineering, being made on scientific principles and calculated—

1. To be throughly safe in their working.
2. Economical in fuel.
3. Durable, requiring few repairs.

When the demand arose for stronger boilers, the first improvement was the externally-fired egg-ended boiler, which is a longitudinal cylinder, with rounded ends, containing no internal flue ; but the greatest step, both in durability and economy, was the introduction of the Cornish boiler by the celebrated Engineer, Trevithick, the novelties and advantages of which consisted—

a. In the internal flue, whereby the heat is utilized to a far greater extent than was before possible.

b. The flat ends, which were stayed by the tube.

c. And the removal of the hottest part of the fire from underneath the boiler, where the sediment naturally collects, and which is consequently a dangerous part to have near a hot fire.

The boiler was still further improved by the late Mr. Fairbain in his well-known Lancashire boiler, by adopting two flue-tubes in the place of the one heretofore used. This gave greater evaporative power to the boiler by increasing the grate area. The other improvements consisted in the consumption of smoke through the gases meeting at the termination of the flues ; in the greater space underneath between the tubes, giving room for thoroughly clensing the boiler ; and the economy for fuel.

But although these inventions were great strides toward the utmost economy in fuel, still it was found that the boiler was by no means perfect, being weak in the flue for high pressures, and allowing a great amount of heat to pass away.

To remedy the first defect Mr. Fairbain proposed rings of T iron to be placed round the furnaces at proper distances, as the flue is strong in inverse proportion to its length, and these rings have the effect of dividing the boiler into so many sections ; thus, if two rings are introduced, the boiler is three times as strong as before, and so on. These rings have, however, been ascertained as liable to crack, even although attached with the greatest care, on account of two thicknesses of metal coming in contact with the fire, and not giving room for the necessary expansion and contraction which are requisite in all boilers.

Flanged seams and ridge-hoops are now universally adopted in first-class establishments, which answer admirably, although care must be exercised in their manufacture. To remedy the second defect tubes were early introduced, mostly parallel ; but of late years the cone tubes made by Messrs. Galloway and others have been well received, as it is evident they receive the best heat from the fire, and, if placed by competent men, do not check the draught. Other means have been tried with the same view, such as placing pockets in the flues, but none receive such flavor as the tubes. The desire to introduce as many of these tubes as possible, without crowding them so as to check the draught, or make the boiler difficult to clean, probably led to the idea of joining the two furnaces behind the fires into one flue, and placing the tubes vertically in this flue. This plan has been tried with several minor differences in form, but the well known "Galloway" boiler, which, we believe, has been recently improved, may be taken as the type. There are boilers also made with two furnaces, then a short combination chamber behind, after which a row of loco tubes about four feet long is placed, through which the flame passes. These boilers give a great amount of steam in a small compass, and require but little setting ; still the loco tubes are apt to spring and leak, and should be avoided whenever possible.

Yet another modification of the same plan is working in the north, and, we believe satisfactory. It consists of a combustion chamber as above, with some of the cone tubes and some of the loco tubes, but all vertical, the heat passing between the tubes. It is quite evident, however, that muddy or limy water would have a great effect upon the loco tubes, which are only three to four inches diameter, and frequent cleaning and examination are required.

We have gone this much into particulars of the Lancashire boiler and its offshoots, feeling convinced that it is the best boiler that can be put down, considering all conditions ; although a complicated boiler, such as those with loco tubes, gives steam economically and plentifully, still where space can be obtained these advantages are completely nullified by the difficulties of cleaning, the inconvenience of leaking, and the frequent repairs, entailing stoppage of work.

Of late years the desire of the principal boiler-makers has been, not so much to introduce new descriptions of boilers, or to design improvements upon the old forms, so as to secure accuracy and solidity of workmanship, which will defy for a long period the continual strain unavoidable while the boiler is working. With this object machinery is made use of whenever possible, as, if properly attended to, errors and imperfections are almost impossible, strength of work is secured, and, as a consequence, great durability. Riveting is done by machinery wherever practicable, for a planed section of the riveted joint shows that machine work closes up the holes perfectly by the pressure used, while hand-work frequently leaves small spaces, the blows from the hand-hammer being insufficient to press the rivet so as to completely fill the hole. Manufacturers in purchasing boilers should take note of this, and should also see that the pressure is not a blow, but a steady push, as the former may burst the plate, or cause the rivet-head to be so insecure as to come off with the slightest disturbance. Few first-class boiler-makers now chalk the plates with a narrow-edged tool ; they plant the edges of the plates to a slight bevel, and close them up with a broad tool. This insures the edge of the plate being perfectly straight ; the rivet-holes are consequently equi-distant from the edge, any imperfections existing there are detected, and a neat appearance is obtained. This neat appearance some persons consider unnecessary ; but workmen who have a neat and well-made article will, as a natural consequence, take more pride in preserving it intact and in better order. The flues, which were formerly riveted up, are now universally welded, which, when done well, is a great improvement ; it insures the perfect circular form of the tube, and when the plates are flanged (which should be also done by machinery), no rivets can exist in the furnaces, consequently the joints remain tight. Those who have inspected riveted flues of boilers will testify that, with a very slight tap with a hammer, rivet-heads will drop off, showing that the least increase of pressure would cause a dangerous explosion.

The engineer of the Boiler Insurance and Steam Power Company (limited), Manchester, has recently made extensive experiments, which are about being published, the result of which shows that in the longitudinal seams of boiler-shells the double riveting should be so arranged that the rivet in each row comes opposite the rivet in the other end, not opposite the space between the rivets, as was formerly considered strongest. When these experiments are published we shall doubtless be able to see the reasons for changing the system, and the extra amount of strength which is gained thereby. Steel boilers have frequently been made, but such difficulty was experienced in getting plates of an uniform quality that it fell into disrepute. No fears need now be entertained on this head, as the recent great improvements in steel manufacture enable makers to roll plates of any required length, tenacity and ductility ; they can also be welded with as much certainty as iron, and the advantage of steel is that it is from 30 to 50 per cent. stronger than iron, so that a ⅜-inch steel shell is quite as strong as a ½-inch or 9-16-inch iron plate; in fact, steel offers so many advantages that ere many years we may look for it to supersede iron in the great bulk of our manufactures, and steel makers are now engaged in trials in order that they may turn out steel at the least possible cost.

Few boilers, at any rate those in large concerns, are now worked without being inspected by an engineer of one of the great insurance companies, the three principal of which have their head offices at Manchester. We would recommend all steam-users to have their boilers inspected by one of the companies, and boiler-tenters will find that it frequently relieves their mind of great responsibility; the cost is, moreover, very trifling, and as the men have such great experience they are enabled to advise in the most awkward cases. The question of pressures is at the present time a vexed one, some preferring to work at the 100 pounds to the square inch, or even higher; others maintain that 70 pounds to 80 pounds will give the best result. Theoretically, there is a slight gain by using the higher pressures, but practically, considering the great difficulty to keep joints tight, the wearing away of the various working parts, etc., it is doubtful whether higher pressures are really more economical.—*English Mechanic.*

BRAZING, OR HARD SOLDERING.

The following practical instructions are taken from an excellent little work, published at the "Bazaar" Office, 170, Strand, London, called "Working in Sheet Metal." Price 6d.

The simplest form of brazing or hard soldering, which should be the one first attempted, is the junction of iron to iron by means of fused brass wire. Take, for instance, two large nails. File one surface of each bright; smear the cleaned faces with borax made into a paste with water; tie the two together with iron wire (binding wire) in one or two places, just sufficiently to prevent slipping, but not by successive coils one over the other; and then wind round several coils of brass wire, smearing more borax upon these. All you now have to do is to hold them over a bright coke fire, or over a forge fire, or even lay them on any fire in a close stove of good draught, and presently the brass will melt and run into the joint, and the work will be complete. You may then file off any superfluous metal, and the job will be seen to be neat and of great strength. Just as the brass melts you will see a blue flame arise. This is the spelter or zinc of the brass, which is thus dissipated, and is a sign that the work is complete. You may thus mend all sorts of broken iron (keys, for instance, which frequently get broken in the bit or the ring), and will gain some practice in manipulation. But when brass or copper require to be brazed it is plain you will not be able to use the same as solder, because you would fuse the article itself, a feat not usually desirable. The solder used in this case bears the name of spelter, and is made of equal parts of zinc and copper. It is, in fact, itself a softer kind of brass, and there are two qualities even in this, viz., hard and soft spelter. The latter will be bought in the form of bright granules, the colour of gold, and can be had at most tool shops. The borax—a salt composed of boracic acid and soda, the chemical name being borate of soda—swells up in a wonderful manner when heated, and may possibly displace the solder. It is better, therefore, to heat it first of all until the swelling has subsided by the total omission of its water of crystallisation; it can then be pounded and kept for use. Suppose it is desired to form a tube or cylinder of sheet brass. If very thin—as paper—let it be soldered and do not attempt to braze; but if as thick as stout card proceed as follows: Cut the necessary strip and take special care the edges are straight, so that when the piece is folded into the cylindrical form they may come together accurately. Before folding scrape or file bright the sides of the strip for a width of a ¼in. or so. Thus, when folded, there will be a clean strip of metal ½in. wide from end to end of the tube. Let this be inside; bind the tube in position with a ring of iron wire placed here and there, or when heated the seam will open; now smear the borax paste along the bright part, and also drop along it the little granules of spelter, and gently heat till the borax holds the bits of solder, as it soon will. The fire to be used must be clear and bright—flame and smoke are inadmissible for this work—and if no forge can be got at a temporary fireplace should be made with a few bricks, and the fire (of small pieces of coke or coke and charcoal) should be urged with a pair of bellows. An assistant should be impressed to use the latter, if possible, as the manipulation of the brass tube is of a delicate nature, and indeed some jobs of this kind demand the greatest possible skill to insure satisfactory results. Let the tube in the present case be warmed all round, first of all, and then held in a pair of light tongs over, but not touching, the hottest part of the fire, moving it to and from so that the whole length shall be equally heated. After a few minutes the blue flame will arise, and the whole must be instantly removed or the tube itself will melt. If it is tapped so as to shake it the solder will flow the more readily into the seam. The danger in this case, remember, arises from the fact that the melting point of spelter is not much below that of the brass itself. Hard spelter, indeed, should never be used unless the workman is an adept. It is "no end of a sell" to melt the work, especially if it be the property of a friend who has intrusted it to your well-known skill (?) instead of more judiciously sending it to the smith or brazier.

Copper is brazed in precisely the same way, but it will bear about 60 degrees more heat than brass before it begins to melt, making it rather more easy, therefore, to manipulate in the above operation. Brass fuses at 1,859 degrees; copper at 1,923 degrees; but the fusing point of brass, it must be remembered, varies according to quality, so much so that one kind might be used to braze another. Very often, in works of copper, the joint is not made merely by bringing the edges into contact, but by snipping the edges at intervals and cutting out pieces in each, so that they can be made to interface, so to speak; or one edge is clipped in this way, and the intermediate bits between the cuts are alternately bent so as to form a kind of channel into which the opposite edge, which is not thus cut, is placed, these little bits being then hammered down. This procludes the necessity of the wire ties while the work is being done, and as copper is not so springy as brass the tube is not so prone to fly open while being heated. The joint, too, is perhaps somewhat stronger, but not much, for the spelter enters into close combination with the metal in such cases, so much so that a tube of brass thus made can be drawn to a considerable length without danger of such seam opening. Copper is so malleable that hardly any raised seam need appear, and when the spelter has run the whole may be hammered and filed quite level.

French Imitation of Gold.—One of the most remarkable achievements in the production of an alloy for perfectly imitating gold, is said to have been made by M. Meiffren, of Marseilles, the alloy standing a very acid test, and its specific gravity being also extremely close to that of gold of the fineness indicated by the acid test—being, therefore, peculiarly adapted to the manufacture of jewelry. The method of production in this case is to place in a crucible, copper as pure as possible, platinum and tungstic acid in proportions as follows: Copper, 800 grammes, 25 of platinum, 10 of tungstic acid, 175 of gold; when these metals are completely melted they are stirred and granulated by being run into water containing 500 grammes of slacked lime and the same of carbonate of potash for every cubic meter of water, this mixture, dissolved in water, having the property of rendering the alloy still purer. The granulated metal is next collected, dried and, after remelting in a crucible, a certain quantity of fine gold is added. In this way an alloy results which, when run into ingots, presents the appearance of red gold of the standard of 750-1,000ths. The color of the alloy may be changed by varying the proportions of the different metals. As a flux, boric acid, nitrate of soda and chloride of sodium, previously melted together in equal proportion, are used, the proportion of flux employed being 25 grammes per kilogramme of the alloy.

Meats Cooked by Cold.—It seems unlikely at first thought, yet it is a fact that extreme cold produces in organic substances effects closely resembling those of heat. Thus, contact with frozen mercury gives the same sensation as contact with fire; and meat that has been exposed to very low temperature assumes a condition like that produced by heat. This action of intense cold has been turned to account for economical uses by Dr. Sawiczevosky, a Hungarian chemist, as we learn from *La Nature.* He subjects fresh meats to a temperature of minus 33° Fahrenheit, and having thus "cooked them by cold," seals them hermetically in tin cans. The results are represented as being entirely satisfactory. The meat, when taken out of the can a long time afterward, is found to be, as regards its appearance and its odor, in all respects as inviting as at first. A German government commission has made experiments with this process, and in consequence two naval vessels dispatched on a voyage of circumnavigation were provided with meat prepared in this way. Hungary has an establishment for preserving meats by this process.

BLASTING BY COMPRESSED AIR.

Extensive experiments are now being made at the Pemberton colliery, near Liverpool, in the Reuss system of blasting with compressed air. The plan consists in boring a hole in the coal, inserting a cast-iron cartridge 16 inches long and 3 inches in diameter, and exploding it by compressing air into it. The cartridge is ½ inch thick, and is connected to the air pumps by weldless steel pipes ½ inch outside diameter, and a bare ⅛ inch bore. The explosion takes place when a pressure of about 8,500 pounds per square inch is reached. The air pumps are mounted on a small trolly which can accommodate its gauge from a minimum of 20 inches upward, the total height of the machine being 33 inches, the width 4 feet 3 inches, and the weight 8 cwt. There are six pumps worked by three cranks on one shaft, and although the enormous pressure required is quickly gained, the pumps are perfectly independent, and the stage process is not used. They are driven by crank handles worked by two colliers and geared three to one on the pumps, which latter made 54 to 60 strokes per minute. The rams are ¾-inch in diameter by 10-inch stroke, and work in the barrels without any packing, which is certainly a most remarkable feat considering the pressure attained. There are no suction valves, the admission of the air taking place through holes in the sides of each barrel, which are uncovered when the plunger is at the top of its stroke. The delivery valves are of lead, and are placed close to the bottoms of the pump barrels, which are all screwed into one block of gun metal, from which the delivery pipes start. The bases of the pumps work in water to keep them cool. A great deal of the success of the operation depends on the truth with which the hole is bored in the coal for the reception of the cast-iron cartridge, and to accomplish this Mr. Reuss uses a small universal hand-drilling machine, the supporting bar for which is made fast to the face of the coal by expanding wedged at its foot let into a hole jumped in the coal for this purpose. The cutter for making the cartridge hole has a diamond-pointed center, and cuts on both sides, and clears itself well at the edges. It makes holes about 40 inches deep, into which the cartridges are placed, and well tamped with sagger clay and the borings from the holes just made. The pipes connecting the pumps and the cartridge are joined together with couplings, having soft copper washers placed between the ends of the pipes to insure tight joints, and the last length of pipe is screwed into the end of the cartridge, which is increased in thickness for this purpose.

A PLASTIC CEMENT.

Amongst the many useful purposes which glycerine has served, there are probably none of greater utility than its combinations with other substances, by which compounds with peculiar properties have been produced. A plastic cement is the latest invention, in which glycerine forms the important ingredient; it is known as Jannin's cement, from the name of the patentee, a resident of Paris. The cement is simply a mixture in suitable proportions of yellow oxide of lead (the quality known as massicot being preferable) with glycerine. Several other metallic oxides and matters may be mixed with the cement, so as to suit the quality or the colour of the cement to the nature of the work to be produced, but the two essential compounds are yellow oxide of lead and glycerine. The proportions of oxide of lead and glycerine vary according to the consistency of the cement it is desired to produce. The proportion of glycerine will of course be larger for a very soft cement than for a stiff cement; it is not necessary, therefore, to specify the exact proportion of each of the two essential compounds. This cement is specially adapted for moulding those objects which require an extreme delicacy in the lines of the cast, such as engraved blocks and plates, forms of printing type, photoglyptic plates, &c. Under the influence of gentle heat it sets in a few minutes, and then resists perfectly both pressure and heat. When set, it is also a very good substitute for natural lithographic stones, and it can replace them for many practical purposes. It can also be used for artistic reproductions, such as facsimiles of terra cotta, whose colour and sonorous quality it possesses. Though setting to great hardness in a few minutes it does not shrink. Massicot it may be observed is an old name for litharge, but the term is more generally applied to the yellow oxide of lead, prepared from the scum of the molten metal by roasting until the colour is fully developed. For purposes in which the colour is of no moment, the scum itself would doubtless answer, provided it is thorougly oxidised.

FIRE-PROOF CONSTRUCTION.

[A paper by F. Schumann, C. E., read at the Eleventh Convention of the American Institute of Architects.]

GENERAL REMARKS.

No material used in building construction, except brick or burnt clay, is practically fire-proof. A building constructed of incombustable material throughout, and stored with only small quantities of combustable and inflammable matter, can be considered fire-proof. Warehouses for the storage of miscellaneous merchandise cannot, with our present knowledge, be constructed absolutely fire-proof; we can only apply devices that diminish the danger by confining and localizing the conflagration. Generally, public places of amusement, churches, schools, offices, or dwellings do not contain so much inflammable matter, such as furniture, etc., as to materially injure or endanger the building when properly constructed. Warehouses, when stored with inflammable matter, even if constructed entirely of brick, but without precautionary subdividing walls, forming compartments, will succumb to the heat, by reason of the great expansion causing a movement of the walls and ultimate collapse of the floor arches.

All constructive iron-work in buildings, except those having small quantities of combustible furniture in them, should be protected from the direct action of a fire by some fire-proof and non-conducting coating, securely fastened to the member it is intended to protect.

The maximum temperature of a vigorous fire, raging in a building fed by combustible and inflammable matter stored therein, may be correctly assumed at 2,000°,—equal to that in brick furnaces. It is found that the strength of iron is diminished about 60% when at a dull red heat, or a temperature of 977°; at this temperature, iron-work proportioned to three times safety, would be at the point of failure. We will compute, approximately, the time required to raising to 977° the temperature of a cast-iron plate one foot square and one inch thick, representing the side of a squared column. The amount of heat required to raise the temperature of the plate to 977° is—the specific heat of cast-iron being 0.13 units, and the weight of the plate 40 pounds—997°x0.13x40, = 50,804 units. The conducting power of the plate, under the existing circumstances, is 233 (2,000—977) = 238,359 units per hour, and as we have only 50,804 units to conduct the time will be $\frac{50804}{238359}$ = 0.213 hours = 13 minutes. If the plate be protected by a layer or coating of ordinary plaster, one inch thick, the amount of heat conducted will be only 3.86 (2,000 — 977) = 3,949 units per hour, or $\frac{50804}{3949}$ = 13 hours longer; when protected by 4½ inches of brickwork, only $\frac{483(2000-977)}{45}$ = 1,100 units per hour will be conducted, or $\frac{50804}{1100}$ = 46 hours longer.

Buildings stored with large quantities of inflammable matter may have cast-iron columns of square cross section, of the necessary dimensions to carry the superimposed weight, with skewbacks cast on, for supporting brick arches between the columns that carry the floors; the column is enveloped by 4½ inches of brickwork, as a protecting layer only. This method, shown by Fig. 7, admits a considerable reduction of the size of piers from those built of brick only; for example: The height of a pier is 18 feet, and the weight to be carried 100 tons; a cast iron column 10 inches square, with thickness of metal 1 inch, will carry the weight with eight times safety; 4½ inches of brickwork will increase the size of pier to 19 inches. A solid brick pier, allowing 70 pounds per square inch as its safe resistance to crushing, will carry only $\frac{192\times70}{2000}$ = 12.7 tons. To support a weight of 100 tons, the pier would have to be $\sqrt{\frac{100\times2000}{70\times144}} = \sqrt{19\ 91}$ = 4′ 6″ square.

It is asserted that iron is unsuitable for fire-proof construction, by reason of its failure when exposed to a certain degree of heat. That this is so is of course admitted; but, nevertheless, it is the only material at our disposal suited to modern requirements; and the architect will meet with more satisfactory results in devising means and methods for its protection against the destructive effects of fire, than by discarding it.

Columns or girders of wood resist the destructive effects of fire much longer than if made of iron exposed. The necessary dimensions, however, except for comparatively light structures, are such as to make the use of wood for those purposes impracticable; for example: A column of oak 18 feet high and one foot square will support with safety 25 tons, while a hollow cast-iron column, one foot square and one inch thickness, of metal, will support 119 tons. So, also, will a beam of yellow pine 15 inches

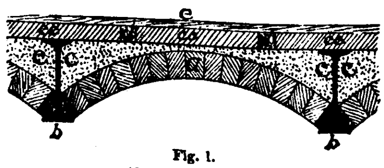
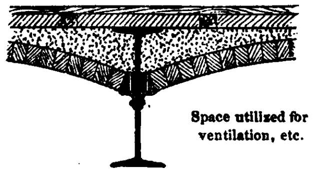


Fig. 1.

ARCHES OF BRICK.

Weight of construction from 60 to 100 lbs. per sq. ft.; *a*, single rim arches of brick, up to 8 ft. span; rise of arch, $\frac{1}{12}$ of span; *b*, rolled-iron beams; *c*, concrete filling; *d*, strips of wood 2″ × 2″, about 16″ from centres; *e*, flooring nailed to strips *d*; *cc*, filling between strips.



Space utilized for ventilation, etc.

Fig. 1′.

The arches may be supported on angle irons riveted to webs of deep beams.

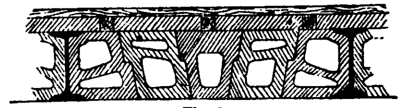


Fig. 2.

FLAT ARCH OF HOLLOW TILE, FROM 6 TO 14 INCHES DEEP.

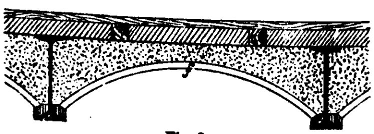


Fig. 3.

ARCHES OF CORRUGATED SHEET IRON, ABOUT NO. 20, B. W. G.

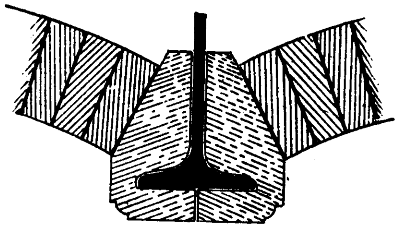
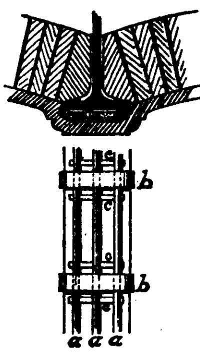


Fig. 4.



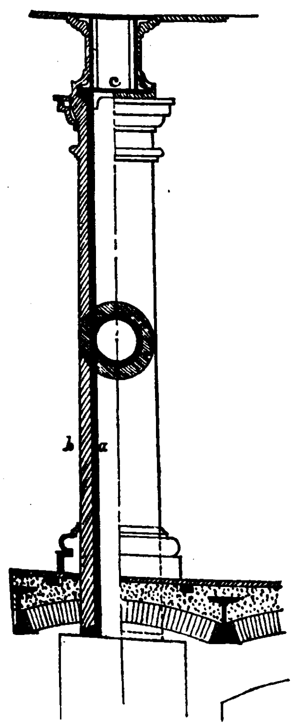


Fig. 6.

Inner shell of shaft *a* of cast-iron; *b*, protecting envelope of a fire-proof, non-conducting material.

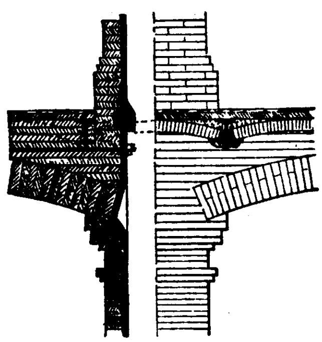


Fig. 7.

SLATED ROOF.

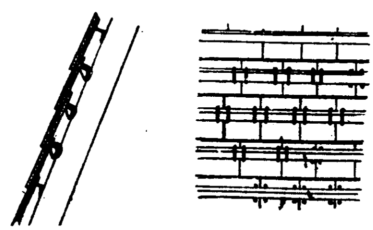


Fig. 8.

INSIDE VIEW OF SLATE AND PURLINS.

Slate fastened to L or T shaped rolled iron purlins with No. 16 B. W. G. copper.

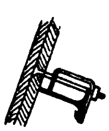


Fig. 9.

Wrought-iron countersunk bolt, 3-16″ diameter, and hook, 1″ x 1-8″, hanging to purlin.

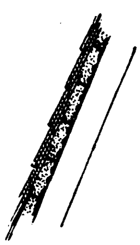


Fig. 10.

Slate fastened to corrugated sheet-iron by wrought-iron counter sunk pins. Slate is also bedded in a layer of cement applied to corrugated iron.

Fig. 11.

ARCHES OF CORRUGATED SHEET IRON NO 20 B. W. G.

Weight of construction from 40 to 60 lbs. per sq. ft. *a*. corrugated iron arch; *b*, rolled beams; *c*, concrete filling; *d*, layer of cement; *e*, metal tags for fastening metal cover

Fig. 16.

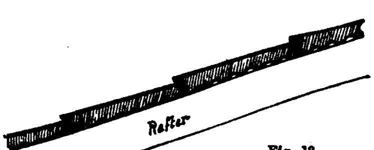


Fig. 13.

METAL BOXES FROM 6 TO 8 FT LONG, 2 TO 3 FT. WIDE, AND 2 TO 3 INS. DEEP.

Weight of construction from 12 to 15 lbs. Boxes are filled with non-conducting fire-proof material.

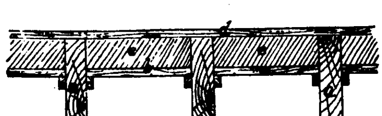


Fig. 14.

ORDINARY FLOORS.

Maximum weight 40 lbs. per sq. ft. The filling may consist of clay mixed with cut straw. *a*, joist; *b*, counter-ceiling; *c*, wooden ceiling; *d*, flooring; *e*, fire-proof, non-conducting filling.

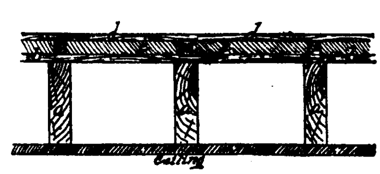


Fig. 15.

ORDINARY FLOORS.

Maximum weight 30 lbs.; is more effective than Fig. 14 against fire from below.

square, 15 feet span, and uniformly loaded, carry 16 tons, while three 15-inch light-rolled iron beams, lying side by side and occuping about the same space, will carry 69 tons.

CLASSIFICATION OF FIRE-PROOF STRUCTURES.

I divide fire-proof buildings into three classes :—

Class I. embraces those structures in the construction of which only incombustible material is used, and all constructive ironwork is properly protected against the action of fire.

Class II. embraces those structures into the construction of which incombustible material enters, but the iron-work *not* protected by fire-proof and non-conducting coatings. Suitable for buildings not containing so much inflammable matter as to injure or weaken the iron in case of fire.

Class III. comprises all buildings in the construction of which combustible material is used, but all vital members protected by fire-proofing.

DETAILS OF CONSTRUCTION.

Class I. or II. In the construction of Class I. all combustible material is rigorously excluded, except for doors, window-sashes, stair-rails, flooring and skirting. The external faces of outside walls may be either of brick, sandstone, or granite ; the backing to be of brick with a hollow space two inches wide, located one brick distant from the inner face of the wall. All openings in the brickwork to be arched. Roof construction, furring, and lathing, of iron. The floors to be constructed of iron beams, supporting arches of brick (Fig. 1), hollow tile (Fig. 2), or corrugated sheet iron (Fig. 3) ; the haunches and crown to be filled with concrete, level with the tops of the beams.

When floor-tiles are used, they should be bedded in about one inch of cement, spread over the concrete ; when of wood, wooden strips two by two inches, to which the flooring is nailed, are bedded on the concrete from sixteen inches to two feet apart ; the spaces between the strips being filled with cement mixed with fragments of porous brick. Practically there is no difference between the above methods as to strength, but considerable in weight, the order being as follows, commencing with the lightest : hollow tile, corrugated sheet-iron, brick. When ceilings are to be plastered, the plaster is applied directly to the brick arches and hollow tile ; the corrugated iron arches are merely painted. When flat ceilings are required, iron lath is riveted to small ⅃ or T irons that run from and rest on the bottom flanges of the beam ; the hollow tile is generally made for flat ceilings.

It is important that the soffits of beam and lath to iron girders receive a coat of some good fire-proof and non-conducting material, not less than one inch thick, and securely fastened on. A mixture of asbestos and pipe-clay is very effective. The soffits of floor-beams may also be protected by the brick skewbacks of arches being made in such a form as to lap the lower flanges of beams. (See Figs. 4 and 5.)

The shafts of cast-iron columns should be continuous from middle to middle of the floor thickness, enveloped with not less than one inch of some fire-proof, non-conducting material, securely held to the shaft by buttons or ribs imbedded in the material. The capital and base should be of cast or sheet iron, fastened to lugs or bosses cast on the shaft, and long enough to pass through the envelope. (See Figs. 6 and 7.)

If light partitions are required, such as do not start from the foundation, and for which common brick would be impracticable by reason of its weight, hollow terra-cotta tile or brick can be used. Another method, more expensive, but admitting a construction which is self-supporting, consists of light I-beams, generally four inches deep, placed vertically two feet from centres, with the ends riveted or bolted to plates or channel-irons secured to the floor and ceiling ; to these beams the iron lath is bolted for receiving the plaster. These partitions can be readily trussed, so that they add no weight to the floor from which they start.

All steep parts of slated roofs are provided with rolled iron purlins T or L shaped, weighing about two pounds per linear foot, riveted to the jack-rafters or trusses. The spans of these purlins should not exceed six feet for slate weighing ten pounds each. The distance between centres of purlins depends upon and is always equal to the weathering of the slate ; one purlin is required for each line of slate ; for example ; a slate 12x24 inches, showing ten inches to the weather, with four inches lap, requires the purlins to be ten inches from centres. The slate is fastened to purlins by No. 16 B. W. G. copper wire passing through two holes in the tail of the slate and around the purlin. (See Fig. 8.) Another method, more expensive, but in proportion to its greater security, consists of two $\frac{3}{16}$ inch diameter bolts with heads countersunk in the slate, and fastened with a nut to a hook hanging to the purlins. (See Fig. 9.) Instead of purlins, corrugated sheet-iron is sometimes used, running from rafter to rafter ; to this the slate is fastened by wrought-iron pins, countersunk and passing through the slate and corrugated sheets, where they are bent so as to form a hook or clinch ; the slate may also be bedded in a layer of cement applied to the corrugated iron. (See Fig. 10.)

Flat parts of roof are covered with either cement, copper, lead, zinc, tin, or galvanized sheet-iron ; either one of the metal coverings are fastened to a layer of cement, about one inch thick, overlying concrete supported by corrugated sheet-iron arches, by the tags imbedded therein. (See Fig. 11.) The supporting material may also consist of burnt clay tile, resting on T-irons. (See Fig. 12.) Another very good method consists of metal boxes filled with fire-proof material ; the boxes are about two feet wide, from two to three inches deep, and of lengths up to eight feet spans ; the bottom, sides, and ends are formed of galvanized sheet-iron, and the top of copper or galvanized sheet-iron ; the boxes are placed alongside of each other and fastened to the beams of the roof. This method possesses an advantage in that it is light, strong, overcomes the difficulties from expansion and contraction, and forms a smooth ceiling. (See Fig. 13.)

Fire-proof doors and shutters are indispensable. They consist either of sheet-iron boxes filled with fire-proof material, or layers of corrugated sheet-iron riveted together ; they are also made of a sheet-iron plate surrounded by an iron frame forming an open box, into which a fire-proof preparation is filled and secured by lath of a peculiar construction ; this is an effective shutter or door, in that the fire-proof material is directly exposed to an encroaching fire, and no part of the metallic construction is in danger of warping and the material falling out. It is essential, to insure a proper working condition of shutters in warehouses or factories, to so construct the shutter that it can be attached to the glazed sash, and that both will slide on the same bar or track, so that the sash cannot be opened without also moving the shutter. In buildings where subdividing fire-walls are made use of, it would be well to so arrange the shutters that they can be operated from an adjoining room or compartments by means of rods or endless chains.

Class III. All girders, joists, struts, and roof timbers to be of wood, and, if possible, of large scantling. All floors to be counter-ceiled so that not less than two inches of non-conducting material will lie between the flooring and counter-ceiling. The spaces between the scantlings of partitions to be filled with mortar or a mixture of clay and cut straw not less than one foot above floor level. (See Figs. 14, 15, 16.)

The roof construction may be of wood. For the slated parts strips of wood 2x2 inches are nailed horizontally to the sheathing boards ; the spaces between strips being filled, level with their tops, by a mixture of clay and cut straw or any other fire-proof non-conducting preparation. The same method is also used for flat parts of roofs, the metal tags for holding roof covering being nailed to strips.

The sketches hereto attached illustrate the various methods described.

ELECTRICITY IN FLOWERS.—Last evening a gentleman of this city accidentally made a most singular discovery respecting the electrical influence of the ordinary morning glory vines. Seated near the lattice work, over which the vine was twined, his attention was attracted to a single little branch tipped with a growing line extending straight out from the rest, and speculated within himself whether the tiny hairs with which the stem was clothed were not placed there for the purpose of conducting the electric fluid of the atmosphere to the plant. In order to continue this investigation he approached his finger within a half inch of it, and was amazed to observe a slight—almost imperceptible—yet unmistakable motion of the stem. As he pushed his finger a little nearer the stem trembled very visibly and was seemingly attracted and repelled from him. The hairs which he noticed before did not move, but remained erect. There was no wind at the time and the motion was purely an induced one. After this interesting experiment he placed the end of his finger within a short distance of the growing bud and slowly moved in a circular direction. The stem followed the motion until it was bent in the shape of a letter C, and when the finger was withdrawn instantly regained its former straight position. This last experiment was witnessed by several persons, all of whom tried it with varying success.—*Lafayette (Ind.) Courier.*

Mechanics.

BRASS.

Corinthian brass was said to be a mixture of gold, silver and copper, formed by the running together of statues, melted in the flames of the city of Corinth, when it was burned by its Roman captors. It brought a very high price for generations afterward. The name "brass" was commonly applied among the ancients to what is now known as bell or gun metal, a mixture of copper and tin. The alloy of copper and zinc was known and used ages before the mixture of the latter metal was discovered; and it is even said that the use of brass was discovered before that of iron. A mass of zinc ore, mingled with charcoal and plunged into melted copper will yield the metal, which will be at once dissolved by the copper. This was the ancient process, the only one till 1781, and is still in use. Modern modes consist in melting the zinc and adding copper in thin strips, or in a fused state; or in melting copper and plunging into it lumps of zinc, held below the surface with iron tongs. At the temperature of melted copper, zinc is very apt to evaporate, and despite layers of fine charcoal or glass on top of the fluid metal, so much zinc passes off that chemical analysis alone can determine the proportion of each metal in the product. The usual proportion is a pound of copper to eight ounces of zinc. "Prince's metal," a beautiful yellow combination, contains equal weights of each ingredient. "Muntz's patent sheating, or yellow metal," is made of about two pounds of zinc to three pounds of copper. Bath metal, Pinchback, or Manuheim metal, is made of three or four ounces of zinc to a pound of copper. The addition of zinc hardens and whitens the copper. Oreide is also a combination of copper and zinc in the ratio of 100 to 17. Brass can be precipitated from a solution of sulphurets of the two ingredients mixed with cyanide of potassium, by using a galvanic battery with a brass plate attached to the negative pole.—*N. Y. Mercantile Journal.*

LARGE CRANK SHAFTS.

At the late meeting of the Institution of Mechanical Engineers, at Glasgow, a paper was read "On the Forging of Crank Shafts," by Mr. W. L. E. McLean, of the Lancefield Forge. The author gave an interesting account, well illustrated by diagrams, of the methods of forging large crank shafts generally in use, and especially of the building-up system, which had for many years been adopted at the Lancefield Forge, an establishment which, as is well known, has a high reputation for this class of work. In the discussion that followed, Mr. Jamieson believed that at no very distant day the Atlantic steamship service would be such that it would be possible to leave Great Britain early in the week and arrive in New York at the end of the week; but this, of course, would necessitate the employment of larger vessels and more powerful engines. He had had considerable experience in the building up of large shafts in several pieces, and the firm with which he had lately been connected (Messrs. J. Elder & Co.) had constructed in this way a shaft weighing 56 tons, this being a three-throw shaft and built up of fifteen pieces. Within the next ten years, shafts weighing 100 tons would, he considered, probably be required, and he believed that the proper way to construct such shafts was to build them up, a shaft so built up involving much less loss of time for repairs or renewal, in the event of failure, than would be the case with the old shafts.

SLAG CEMENT.

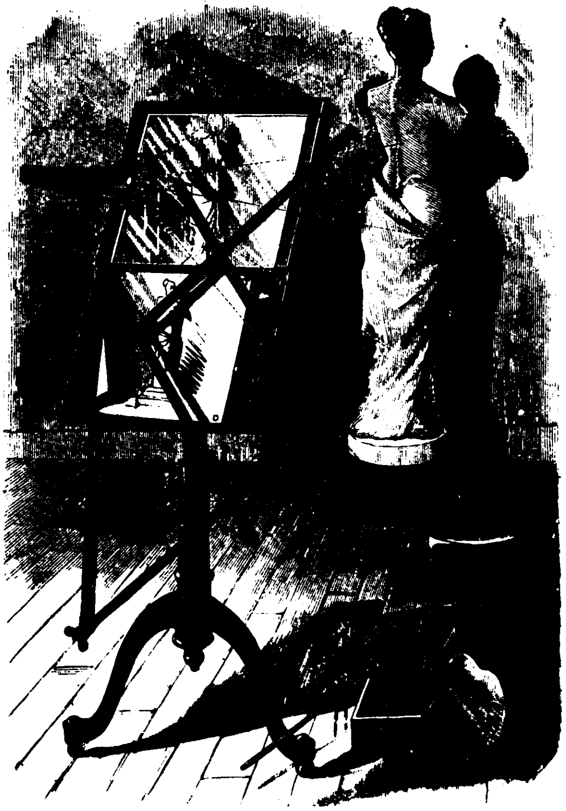
Mr. Frederick Ransome, of England, has discovered that blast-furnace slag furnishes a cement which is free from the objections made to the Portland cement, when used for decorative purposes. From blast-furnace slag he produces a cement which is perfectly white, and in addition, possesses a strength greater than that of Portland cement. Although the new cement is colorless in itself, it is capable of receiving and retaining any tint that may be imparted to it, which is a valuab e feature. The slag is reduced to sand or granulated and then mixed with from one to two parts by weight of chalk or limestone, and burned at a moderate temperature. The result is an excellent hydraulic cement, possessing great strength, and having a pure white appearance. Owing to the circumstance that the slag-sand has already undergone a process of burning in the blast furnace, the cement does not require so high a temperature to be used in its manufacture as it otherwise might. From a series of comparative experiments recently carried out with slag and Portland cements, it was found that samples of Portland cement two days old gave way at 510 pounds, whilst samples of Mr. Ransome's cement of the same age did not give way until 740 pounds had been reached. In another instance, a sample of the Ransome cement 21 days old gave a breaking strain of 1,440 pounds, whilst a sample of Portland cement seven years old only stood up to 1,327 pounds, and then broke. The samples were all one and a half inches square at the breaking point, thus giving a sectional area of two and one-quarter square inches.

GLUE.

Glue which will stand damp is a desideratum. Few, however, know how to judge of quality, except by the price they pay for it. But price is no criterion, neither is color, upon which so many depend. Its adhesive and lasting properties depend more upon the material from which it is made, and the method of securing purity in the raw material, for if that is inferior and not well cleansed the product will have to be unduly charged with alum, or some other antiseptic, to make it keep during the drying process. Weathered glue is that which has experienced unfavorable weather while drying, at which time it is rather a delicate substance. To resist damp atmosphere well, it should contain as little saline matter as possible. When buying the article apply the tongue to it, and if it tastes salt or acid reject it for anything but the commonest purpose. The same operation will also bring out any bad smell the glue may have. These are simple and ready tests, and are the ones usually adopted by dealers and large consumers. Another good test is to soak a weighed portion of dry glue in cold water for twenty-four hours, then dry again, and weigh. The nearer it approaches to its original weight, the better glue it is, thereby showing its degree of insolubility. Glue frequently cracks because of the dryness of the air in rooms warmed by stoves. An Austrian paper recommeuds the addition of a little chloride of calcium to glue to prevent this.—*Capital and Labor.*

Hints Concerning Saws.—A saw just large enough to cut through a board will require less power than a saw larger, the number of teeth, speed and thickness being equal in each. The more teeth, the more power, provided the thickness, speed and feed are equal. There is, however, a limit, or a point where a few teeth will not answer the place of a large number. The thinner the saw, the more teeth will be required to carry an equal amount of feed to each revolution of the saw, but always at the expense of power. When bench-saws are used, and the sawing is done by a gauge, the lumber is often inclined to clatter and to raise up the back of the saw, when pushed hard. The reason is that the back half of the saw, having an upward motion, has a tendency to lift and raise the piece being sawn, especially when its springs and pinches on the saw, or, crowds between the saw and the gauge; while the cut at the front of the saw has the opposite tendency of holding that part of the piece down. The hook or pitch of a saw-tooth should be on a line from one-quarter to one-fifth the diameter of the saw; a one-quarter pitch is mostly used for hard, and a one-fifth for softer timber. For very fine tooth saws designed for heavy work, such as sawing shingles, ete., even from soft wood, one quarter pitch is best.

Connecting-Links for Chains, Etc.—The following method of constructing chain-links is suggested by Herren S. & M. Rosenberg, of Cassel: A link, similar in form to that of an ordinary chain-link, is split or divided into two separate parts at a slight angle to its two flat faces, so that each part is somewhat thicker on one side than on the other. On the thicker side of each half is an undercut projection of a thickness and form corresponding to that of the transverse section of the complete link, and on the other side there is a gap or opening corresponding exactly with such projection, so that when the two halves are slid on to each other, the projection on the one half fits into the gap of the other half, and thus the two halves are secured firmly together, the ends of the gap of the one part being dove-tailed so as to fit into the corresponding dove-tailed ends of the projection on the other part. For securing together the two ends or parts of a chain, or the two eyes or loops of a rod or bar by means of this link, the two halves are first separated, and the links to be connected having peen inserted through the gaps thereof, the halves are slid together as described, whereupon they will securely hold the chain until again slid apart by hand.



NEW PERSPECTIVE DRAWING APPARATUS

While the artist can in an off-hand way, sketch a perspective which will appear perfect to the eye, and which, in the majority of cases, will be found nearly if not quite perfect, it is only the artist dealing with an artistic subject that can do this. The draughtsman who is required to make all kinds of drawings, not only quickly but accurately, often finds it an exceedingly difficult matter to make a perspective drawing without some kind of mechanical aid.

The instrument shown in the accompanying engraving is intended for drawing perspectives easily and accurately. It is the invention of Mr. George Rosquist, Brooklyn, N. Y.

The drawing table is pivoted to a standard so that it may be inclined at different angles, and it is provided with an adjustable bar that supports one arm of an ordinary pantograph. The lower half of the table, which is wood, is designed to receive the paper on which the drawing is made. The upper half of the table is of transparent glass, and a perforated sight piece is supported by a right-angled arm directly in front of the middle of the glass. The tracing point may be moved along the surface of the glass, and the pencil moves in the same way over the paper on the lower part of the table.

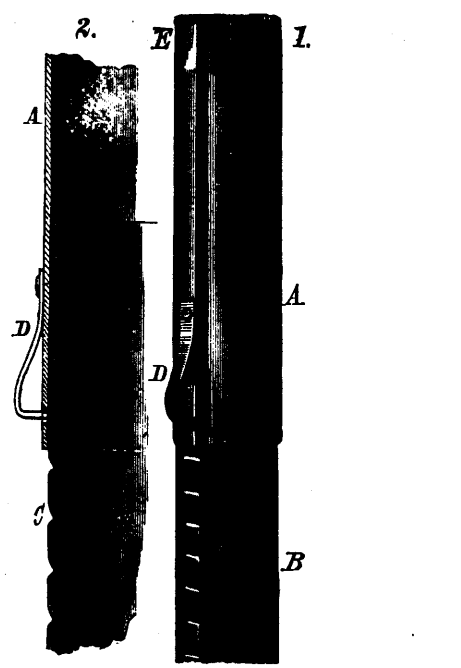
The object to be sketched is placed a suitable distance from the instrument, and the eye is placed at the aperture of the sight piece; the outline of the object is followed by the tracing point of the pantograph, the glass affording a guide for the point and keeping the pantograph in a true place. As the tracing point is moved the pencil carried by the pantograph over the paper traces the outline of the object either larger or smaller than it appears through the sight piece. After the sketch is finished the drawing table may be turned down into a horizontal position when the sketch may be inked in the usual way.

AN ADJUSTABLE STOVE-PIPE.

The inventor of the adjustable stovepipe shown in the accompanying engraving has endeavored to relieve those who are unfortunate enough to have to use stovepipe, from the trials and vexations incident to taking down and setting up stoves, by providing a single length of stovepipe which may be extended or contracted like a telescope, and which is formed at the ends so as to fit pipes whose sizes vary within reasonable limits.

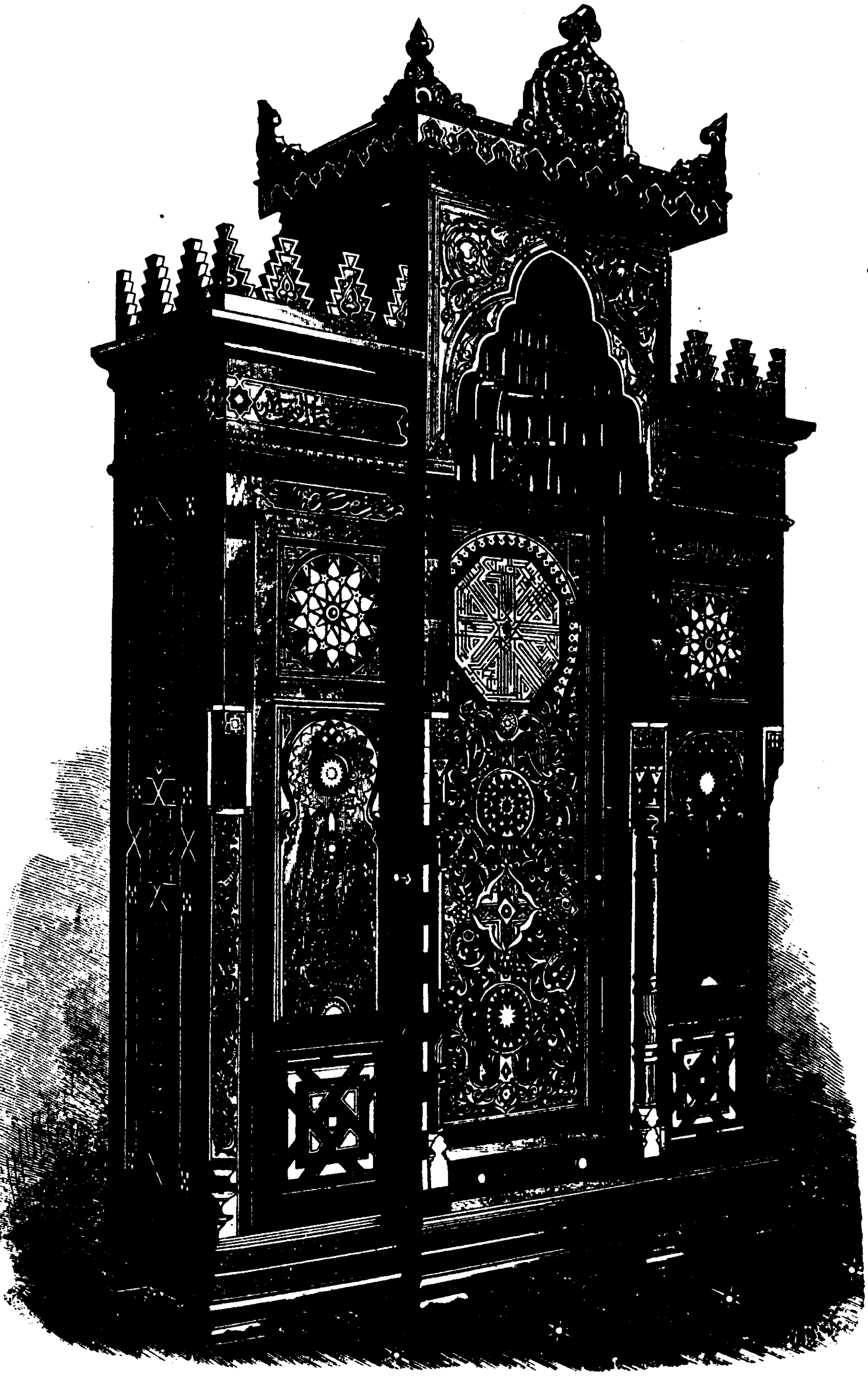
The section A, is of sufficient size to permit the section, B, to slide freely in it, and it is provided with a spring pawl, D, that fits into notches formed in the seam, C, of the section, B. By means of this arrangement the two lengths may be held in any position relative to each other, and the compound length may be easily fitted into a space in a stove-pipe of nominally the same size. The exterior appearance of the pipe is clearly shown in Fig. 1, and the arrangement of the different parts will be seen in Fig. 2. The end of the outer section is corrugated to admit of easily contracting or expanding it to adapt it to various sizes of pipe.

Mr. R. R. Pattison, 300 N. Fourth street, Terre Haute, Ind., is the patentee.



PATTISON'S EXTENSION STOVEPIPE.

THE CAMPHOR EDDIES.—If a small bit of camphor is laid upon water it begins turning and moving about with great rapidity. If a few grains of locopodium or other light powder have been previously scattered on the water they are drawn towards the camphor by eddies in an inverse direction. These phenomena were first observed in 1748 by Romien, who attributed them to the difference of electricity between the water and the camphor. Subsequent investigators thought they might be due to the camphor vapor striking the water and producing a recoil. M. Cassamajor has resumed the study of the question and adopted the views of Romien. He instanees the following crucial experiment. At the same time that the bits of camphor are thrown upon the water insert a glass rod which has been rubbed with flannel; the motion immediately stops. If the electricity is removed from the rod by rubbing it with tin foil, it loses its power of checking the eddies.—*Les Mondes.*



ARABESQUE CABINET.

The accompanying engraving represents a cabinet in the style of the purest Arabic, made by the celebrated Parvis of Cairo, whose *atelier* is well known to all art lovers who have visited the interesting city of the East. This fine example of the cabinet-maker's skill is made of sycamore wood and ebony. It is inlaid with ivory and mother-of-pearl, in those highly effective patterns that are at once the admiration and the wonder of other nations. Every detail has worked up and studied from the specimens of the best period of the Arabic art. Nothing could be more effective than the result. There is but little carving—none indeed in high relief—and yet an effect has been produced more ornate than any carving. The richness of the tracery in the central panel is particularly fine, and taken as a whole it deserves commendation of the highest description. The possessor of such a piece of work as this cabinet would never tire of it, simply because the harmony of its parts would be constantly asserting themselves, and like in a good picture, new beauties would constantly be revealing themselves.

This form of decoration, consisting of fantastic combinations of flowers, fruits, and branches, or, indeed, of almost any intertwinings of graceful forms and lines in a repetition of the same pattern, is a characterestic of Moorish architecture, that has been given a destinctive name, arabesque. Ornamentation of this kind either in sculpture or painting, has been found wonderfully effective; but it requires the exercise of the nicest discrimination.

THE NECESSITY OF SANITARY REFORM.

The public are gradually realizing the vast extent to which "crooked" plumbing is sapping the health of the community. New facts daily come to light, showing the shocking way in which drains are laid and pipes put together in all kinds of buildings. The reports of the tenement house inspectors reveal a deplorable neglect of health and decency in these houses. As like defects, only in a less degree, exist in the bulk of the better class of city residences, it is apparent that reform is imperative.

Mere wholesale denunciation of plumbers only confounds good men with bad, and if anything, helps the latter to get work. What is necessary is to summarily put a stop to the employment of incompetent and unscrupulous men who do the scamped work so common everywhere. The whole tendency of sanitary thought and discussion in this country is in this direction.

Authority must be had to examine and pass upon all work in new buildings before they can be occupied. In order to have intelligent action and practical results it is necessary to have a comprehensive code of rules. We publish below with much pleasure some excellent rules laid down by the "Sanitary Engineer" of New York.

REQUIREMENTS FOR THE DRAINAGE OF EVERY HOUSE.

From The Plumbers and Sanitary Engineer, Sept. 1st.

In the light of present knowledge, the following seem to us the essential requirements for the drainage of every house. Time and further experience may suggest other features or modifications of these. We invite our readers to criticise or ask for more detailed explanation of any section not fully understood or concurred in :

* Every house drain should have an inlet for fresh air entering at a point inside the main trap, and carried to a convenient location *out-of-doors*, not too near windows.

A trap should be placed on every main drain to disconnect the house from the sewer or cesspool. In places liable to unusual pressure from the sewer it should be a double trap, with vent from between the two traps, running up full size above the roof; or, where the pressure from sewer is only occasional and the rigor of climate will permit, this vent may be carried to the sidewalk orea, at a safe distance from windows. If the first trap is forced the gas can gain easier exit through this pipe than through the second trap.

Every vertical soil or waste pipe should be extended at least full size through the roof.

No traps should be placed at the foot of vertical soil pipes to impede circulation.

Traps should be placed under all sinks, basins, baths, wash trays, water closets, etc., and as near to these features as practicable.

† All traps under fixtures, wherever practicable, should be separately ventilated in order to guard against syphonage. Such vent pipes should not branch into a soil pipe below where any drainage enters it. In some cases it is preferable to carry it to outer air independently.

Rain-water leaders should not be used as soil pipes, and when connected with house drains they should be made of cast iron in preference to galvanized sheet iron or tin, there being less liability of corrosion. Joints should be gas and water-tight, to preclude possibility of drain air entering open windows.

No safe waste should connect wirh any drain, but it should be carried down independently to a point where its discharge would indicate the existence of a leak or any overflow above.

No waste from a refrigerator should be connected with a drain.

Unless the water supply is ample, so that it will rise to every part of a building, ensuring at all times the proper flushing of fixtures and traps, a cistern should be provided into which the water will rise at night, or into which it may be pumped. Said cistern should be large enough to hold an ample daily supply, be kept clean, covered, and properly ventilated. The overflow pipe from it should *never* be run into any drain *under any circumstances*. The supply for drinking-water should not be drawn from it, but from a direct supply, *i. e.*, direct from the street main.

Water closets should not be supplied directly from street pressure or by a pipe from which branches are taken for drinking-water. Where the valve closets are preferred to those that are supplied from a small cistern immediately over them, then the supply should be taken to a storage tank, from which it can be conveyed to the valves on the closets, thereby ensuring an equable pressure and securing more reliability in their working.

All drain pipes within a house should be of *metal* in preference to stoneware, owing to the liability of the latter to crack and the difficulty of keeping the joints tight. It is best to run them along the cellar wall or ceiling with a good incline. They should *never* be hidden underground, as then leaks will not be perceptible. In some places it is common to paint pipes white so that any leakage will show itself to the most careless observer.

All drains should be kept at all times free from deposit ; and if this cannot be effected without flushing, special flushing arrangements should be provided so as to effectuatly remove all foul matter from the house drains to the public sewers.

All drains should be laid in a straight line, with proper falls, and should be carefully jointed and made water tight. No right angled junction should be allowed, except in the case of a drain discharging into a vertical shaft.

No drain should be constructed so as to pass under a dwelling house, except where absolutely necessary ; and then it should be constructed of cast iron pipes, with lead caulked joints laid so as to be readily accessible for inspection, and ventilated at each end.

Whenever dampness of site exists it should be remedied by laying subsoil drains, which should not pass directly to the sewer, but should have a suitable break or disconnection.

Water supply and drain pipes should be concentrated as much as possible, and not scattered about a building. Horizontal pipes are objectionable.

Plumbing fixtures should not be hidden behind walls and partitions where their condition is never apparent. They ought properly to be open to view and so situated that any leak would be readily detected. It is also well to have a plan of the plumbing of each house for the tenants' or owner's convenience and guidance in any emergency.

In planning house drains they should be got outside the walls of the house as quickly as possible, so that there may be few joints of pipe, and the smallest chance of leakage from defects or accidents ; taking proper precautions in locating to guard against freezing.

* This pipe will relieve the smaller house traps from pressure occasioned by a descending column of water that would otherwise be likely to force the seals of these traps. The air drawn through this inlet to the lower part of the drainage system assists the circulation within the drains, and is essential to ensure the diffusion of the gases generated within them.

† The extension of soil pipe full size through the roof is not a certain protection against syphonage of traps branching into it, and no protection when traps are on a horizontal pipe a distance from the vertical soil pipe.

THE CANADA FASHION.

(So the *St. Louis Miller* says.)

In Canada it is quite a prevalent custom among mill-proprietors to not only pay their employes stated wages or salaries, but to also allow them *pro-rata* percentages in the profits of the business. For instance, one book-keeper last year received in this way, besides, his salary, the large sum of $4,000. This was, of course, a phenomenal case. Undoubtedly these millers find that it pays them to adopt this policy or they would not do it. It stands to reason that it should pay to have every employe feel a pecuniary interest in a business where a little negligence may occasion great loss or wastage.

[We have no doubt but that the above was quite a phenomenal case.—Ed. C. S.]

Destruction of Fire-Damp.—A mining student of Freiberg has invented an improved lamp for the protection of life against explosions of fire-damp. It is based upon the property possessed by ethiops of platinum of condensing on its surface not only oxygen but also light carbureted hydrogen, even when only small quantities of it exist in the atmosphere, and in this close contact of the two gases effecting a dark combustion of the carbureted hydrogen. A wire gauze lamp is charged with pieces of pumice stone, impregnated with ethiops of platinum. These lamps are surrounded by coke to protect them, and enclosed in the lamp, which is then ready. In the presence of fire-damp the ethiops of platinum attracts the gas, which is gradually and harmlessly destroyed, the consumption being within the gauze and not of a nature to ignite a surrounding explosive atmosphere. Mr. Korner, the inventor, points out that a great advantage of this safety inflammable air-consuming lamp consists in its not requiring continuous attention and maintenance, as the ethiops of platinum will consume a large quantity of the light carbureted hydrogen without losing its properties. Control of the lamp is effected through the escaping heat. Lamps as described may be advantageously used in all places where there is inflammable air.

ACCIDENTS TO MACHINE HANDS.

The frequent accidents which happen to persons who use wood-working machinery led us to inquire the cause of them, and, if possible suggest a remedy. In looking over the matter carefully we conclude that a large number of the accidents which occur are either the result of carelessness or timidity. A few days ago the writer was in a mill where a man, who was rather timid about machinery, started up the circular saw and started to rip a round block in halves, and not having a very tight hold it slipped through his fingers and struck him a violent blow in the face, and at the same time his finger slipped on to the saw, cutting a gash in his middle finger; score one for timidity. In the same mill, a few weeks ago, a man backed up against a rapidly revolving band saw, and the result was a very severe gash, which came very near being a slice of ham that would not have been desirable. We naturally set this down on the side of carelessness. From these two cases we conclude that careless and timid persons should either leave machinery alone or change their habits; occasionally there are unavoidable accidents, such as result from the breaking of machinery, but of those we can only say that many of them might be prevented by a periodical, critical inspection of the machinery. The accidents enumerated above suggested the idea that it would be well for every mill to have on hand a supply of linen rags, sticking plaster, and lint, so that in case of an accident the flow of blood could be stopped and the wound could be temporarily dressed until medical assistance could be secured; these things should be in charge of a competent person, who would not be shocked by the sight of blood, and who has a general idea of the mode of procedure in cases of flesh wounds; but for the information of those who have not had any experience in this matter we will give the benefit of our observations: With a soft sponge clean off the parts, and have a pad made by folding a cloth together the size required, and press this against the wound to stop the flow of blood if possible and dry it off; cut some strips of plaster, and, after warming them, put across the wound as many as are required, always being careful to leave a small opening that the blood may ooze out. With these directions the majority of cases can be treated until medical aid can be secured.

GEOGRAPHY—GEOLOGY.

NORDENSKJOLD'S DISCOVERIES.—From several recently published accounts, we have been able to glean some facts of considerable geographical and commercial interest in connection with the recent remarkable expedition of Prof. Nordenskjold in traversing the Polar Sea from the Scandinavian Peninsula to the Japan Islands. He notices that the coast of Siberia west of the Lena is a vast treeless plain. The absence of Islands is unfortunate for the navigation of these waters, since this circumstance favors the driving of the ice-floes by the wind down upon the shore. For several hundred miles about the mouth of the Lena, the presence of the warmer currents proceeding from it and neighboring rivers, and of a chain of Islands, acts as a barrier to the ice. Toward Behring's Strait, however, the conditions are again unfavorable. The most interesting of Prof. Nordenskjold discoveries is that of a group of new Islands off the Siberian coast which has been called the New Siberian Group, which are remarkable for the immense abundance of fossil remains with which they are strewn.

Prof Nordenskjold sums up the result of his discoveries in their commercial aspect as follows: He is of opinion that the northeast passage from the Athlantic to the Pacific may be made (probably) every year, and that it will certainly be often repeated. At the same time, he acknowledges that trade between the two oceans can only indirectly benefit by his discoveries. He believes that he has effectually demonstrated that a properly-organised trade communication between Europe and Yenesei is practicable, and that such commerce can be conducted in such a manner that underwriters will as willingly take risks on vessels engaged in it as they now insure against the perils of the China Sea. Further than this, he holds that experienced navigators need fear no serious obstacles in the way of passing yearly, from the Pacific on one side and the Athlantic on the other, to the mouths of the Lena. He deems Siberia, with its vast extent of Territory, its immense rivers, the richness of its soil, and its other natural resources, to be comparable to the same conditions in North America 150 years ago, and thinks that the future development of this rich tract of Asia may yet equal that attained in the past by the United States.

IMITATION TERRA COTTA.

The following recipe from the *Magasin Pittoresque* will enable our readers to convert plaster casts into excellent imitations of terra cotta ware: The colors required are brick red, lampblack zinc white, and yellow ochre, all in powder. The object to be treated is first carefully rubbed with "0 0" sandpaper, so as to remove all roughness of the surface or ridges indicating where the parts of the mold have been joined. The mixed color consists of yellow ochre two parts, brick red two parts, and black one part. These are well rubbed together. Then three parts of zinc white are separately mixed with a little milk to paste. All the ingredients are then combined in a mortar with eight or ten parts of milk, and the resulting mixture is passed through a fine sieve to remove any particles of the white. A soft brush is then used to spread the stain over the object, care being taken to lay it on evenly. After 24 hours' drying, a second coat is applied. When the article is completely dry, rubbing with the fingers will eliminate the brush marks.

TO CRYSTALLIZE PAPER AND GLASS.

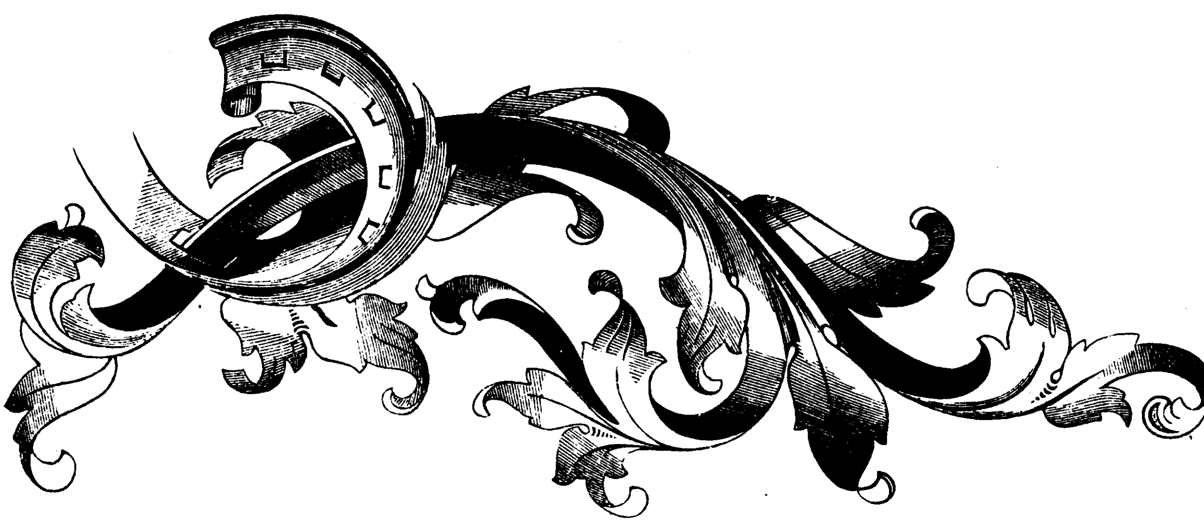
The following process is recommended by Professor Bottger: Mix a very concentrated cold solution of salt with dextrine, and by means of a broad, soft brush, lay the thinnest possible coating of the fluid on the surface to be covered. After drying, the surface has a beautiful, bright mother-of-pearl appearance. To make the coating adhere to glass, it is only necessary to varnish it with an alcoholic solution of shellac. The following salts give the finest crystallizations: Sulphate of magnesia, acetate of soda and sulphate of tin. Colored glass thus prepared gives a good effect by transmitted light.

A NEW FACTOR in the determination of the minimum limit to the age of the earth has been pointed out by Mr. T. Mellard Reade, in a series of papers lately published in England under the title of "Chemical Denudation in Relation to Geological Time." The results of this author's calculations in his estimation of the amount of solid matter conveyed away annually in solutions by the river waters to the sea are quite curious. We will follow the writer in one of his introductory examples: "If we imagine the area of England and Wales, consisting of 58,300 square miles, to form one river basin, the delivery of water by such river would be 68,450,936,960 tons, or 18·3 inches per annum, containing a total of 8,370,630 tons of solids in solution, representing a general lowering of the surface from that cause alone of ·0077 of a foot per century, or one foot in 12,978 years." Taking the "soluble denudation" of other parts of the world into consideration, Mr. Reade is of opinion that "about 100 tons of rocky matter are dissolved by rain per (English) square mile per annum." This amount, he estimates, will contain 50 tons of carbonate of lime and 20 tons of sulphate of lime, etc., and the inference drawn is thus presented: "If, as is generally supposed, the sea contains only what is washed into it from the land, and we can estimate its numerical contents in tons, we at once get a minimum measure for the age of the earth." Taking Frankland's figures of the composition of sea-water, Herschel's figure for its total quantity, and combining them with Humphrey and Abbott's figures of the amount of visible sediment brought down mechanically by the rivers, the author obtains for the whole globe 600 tons of denuded matter per year. Upon this basis he goes back in time, and allowing for coast erosion, glaciers, etc., finds that the 10 miles of sedimentary strata must have occupied 526 millions of years in accumulation.

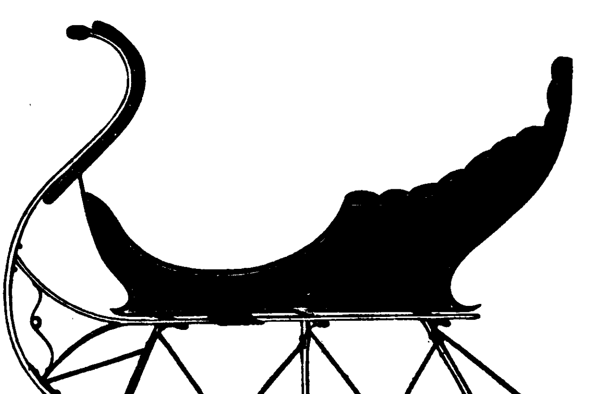
FROM a lengthened series of experiments, M. Hermann Herwigg concludes that no two continuous molecular layers of water can be more than 1.86 of a millionth of a millimeter apart, and that the same is true also of the mean distance between the centers of adjacent molecules. Sir William Thompson's previous estimate of the least value of the same distance is 0.05 millionths of a millimeter; so that the true value lies between these two estimates. This is what *Engineering News* calls the *coarse grainedness* of water.

TO TEST PORTLAND CEMENT, weigh a cubic foot of it while dry. If good it should weigh from 80 to 100 pounds. The color of good Portland cement should be a warm bluish gray. The cement should be quite dry, free from all lumpiness or tendency to caking. When you take up a handful and squeese it, it should have a soft *silky* feel, and be free from grit. It should not cake in your hand when squeesed.

CARRIAGE BUILDER'S WORK.



SCROLL DESIGNS.



THE AMERICAN SLEIGH.

AN AMERICAN SLEIGH.—This sleigh was much admired in the locality where it was. The sides are made of three-quarter inch white wood, and the toe and back boards put in straight, with three inches flare on sides. It can be made at a moderate figure.

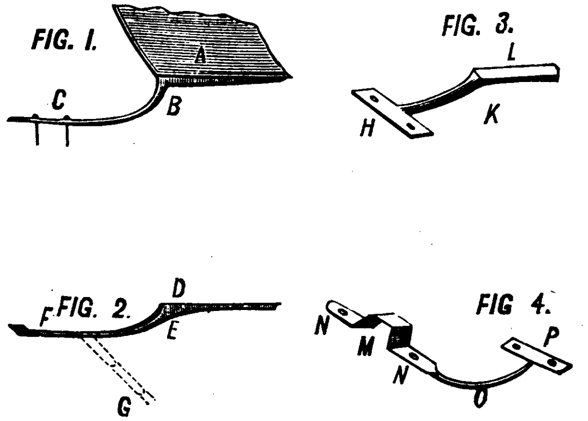
Painting.—Body : a very light brown, stripped with vermillion and glazed with carmine. Runners : cream color, striped with two fine lines of red.

Trimming.—Red plush ; cushion back, plain ; plain fall ; buttons covered with same material ; no raisers on cushion fall.

STATIONARY LAZY-BACK FOR STOCK SEAT.—Fig. 1 presents the best method we know for a lazy-back of the kind mentioned. A represents that portion of the standard between the rail and seat bottom ; B B is a projection on either side to secure the rail, which prevents the rim from breaking, as if made the old way ; D D is the flat portion to which the back is secured ; C, the neck between the seat rail and the back pin ; G is the foot furnished with projections ; F F by which it is secured to the seat-bottom ; A should rest against one of the seat-stocks, and flat where it joins the seat-stick, and rounded on the other portion ; G and F F should be rounded on the upper side ; C should be oval.

To make the upper and lower portions, proceed as in Fig. 2 ; fuller at H, H, H, H, and from B B and F F of K of L, make C D and G of M ; make A and weld at centre.

Carriage Builder's Work.



Suspending Back End of Phætons.—A subscriber asks how to suspend the back end of phætons, when the construction is such as to require blocking behind and do away with blocks.

In reply we offer, that when an iron brake or "pump handle" is used, it may be done very readily as described in Fig. 1. A, section of back-quarter ; B, outline of loop, which may be fuller or flatter, as the case may require. C, being the part where the brake is attached or secured to the springs.

When the body rests on a traverse bar at the back and then proceed as in Fig. 2. D bearing portion of back bar ; E sweep in same, reducing bulk and improving appearance ; F, where the bar rests on the spring ; G, section of spring outline. Plate the under side of the bar with a thin plate, as Fig. 3 ; L, section of center ; H, that portion which goes under top half of spring ; K, a slight boss on the bottom to give a level bearing to the securing bolt ; Fig. 4, stay ; M, clip over bar ; N, N, securing points ; O, stay ; P, *a* T, which screws to the body. This stay may have one or two ends.

To Prevent Jack Clips and Check Straps from Wearing on the Axle-Bed.—A subscriber asks how he may prevent his jack clips and shaft check strap from wearing in the axle-bed, to which we reply that the best method to prevent the troubles complained of with jack-clips is to make the strap portion of his jack-clip as we illustrate. A, of Fig. 1, represents that portion of the clip favored with the ears. B is that portion covering the upper portion of the axle-bed, and so widened as to embrace a good or great amount of the wood, which produces the desired effects.

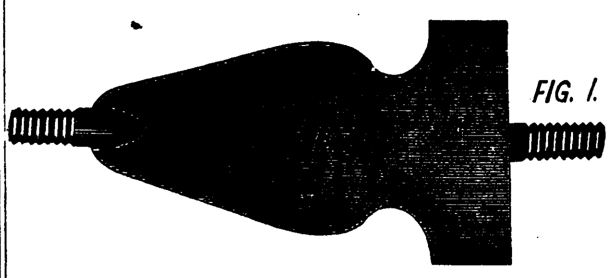


FIG. I.

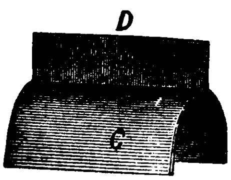


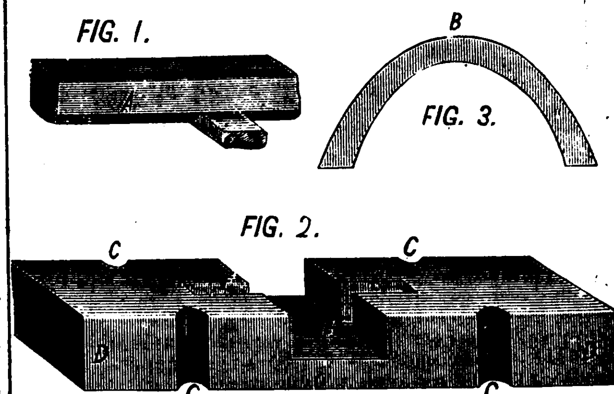
FIG. 2.

To prevent the shaft chuck, or safety strap, from wearing in the axle-bed, we present Fig. 2. C representing a thin plate so bent as to encircle the upper portion of the axle-bed, as per recess F. D is a small staple attached to the plate, forming a loop for the passage of the strap ; the plate is secured to the wood by the means of two small screws. With this appliance the strap cannot wear in wood.

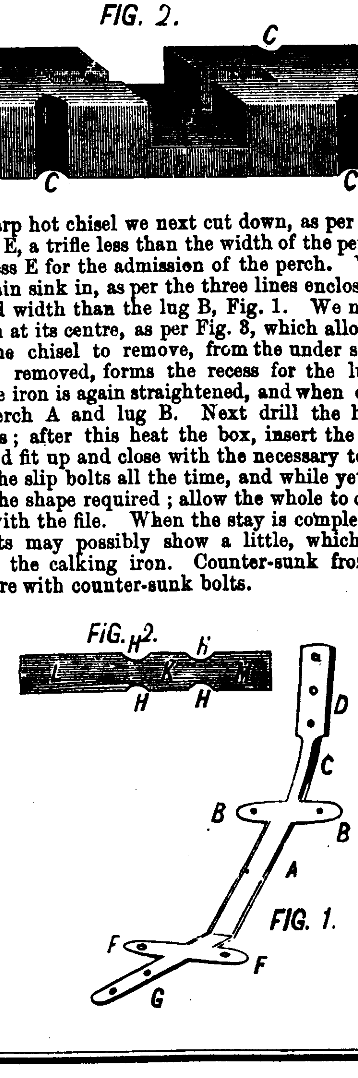
In setting solid axles do not heat the collar or spindle, and give the set on the bed back of the collar. This will prevent springing the spindle.

How to Make a Concealed Joint for Stays of an Iron Perch Job.—Fig. 1 shows a section of the perch ; A, the perch ; B, one of the side lugs or projections. This lug is formed by welding a cross piece on the under side of the perch, which is afterwards dressed up to the exact shape and size ; a trifle narrower at the bottom, so as to allow a proper draw.

To make the box of the joint, or central portion of the stay, we form from Norway iron, or its equivalent, a piece of iron of the proper size—the average is about $1\frac{1}{4}$ x 1—as per Fig. 2. This piece we fuller on each side and at each end as per C, C, C, C, and draw down and swage the ends D, D, to the proper size, or to a size which will allow of the proper amount of waste from heating and welding on the main portion of the stay.



With a sharp hot chisel we next cut down, as per the line on either side of E, a trifle less than the width of the perch, and thus form the recess E for the admission of the perch. With the hot chisel we again sink in, as per the three lines enclosing F F, less in length and width than the lug B, Fig. 1. We next heat and bend the iron at its centre, as per Fig. 3, which allows of the insertion of the chisel to remove, from the under side, the iron, which, when removed, forms the recess for the lug B, Fig. 1. After this the iron is again straightened, and when cold is made to fit the perch A and lug B. Next drill the holes and fit "slip" bolts ; after this heat the box, insert the screw up the slit bolts, and fit up and close with the necessary tools, keeping a straw in the slip bolts all the time, and while yet warm, form the ends to the shape required ; allow the whole to cool together, and finish with the file. When the stay is completed throughout, the joints may possibly show a little, which may be remedied with the calking iron. Counter-sunk from the upper side and secure with counter-sunk bolts.



ITEMS ABOUT STEEL, &c.

STEEL TEMPERING.—As the tempering of tools and the treatment of steel by fire is of daily occurrence in the workshop, the following will be of interest: Steel wire springs of pianofortes are very commonly annealed by making the wire red-hot, and then plunging it into boiling water. Ordinary experience would suggest that this must harden the steel in some degree, but it has been tried upon many samples of steel, including mild Bessemer steel, shear steel of different qualities, and the hardest Sheffield crucible steel, and it has been found that in every case, when the operation was properly performed, the steel was remarkably annealed. Samples have been cut from the same bar and heated and then slowly cooled—one by burying in ashes under a furnace-grate, the other by immersion in boiling water. When subjected to bending tests that cooled in the boiling water sustained a more severe flexure without cracking than the piece which had been more slowly cooled in ashes. It was not so soft, but tougher and more reliable when subjected while cold to violent bending blows of a hammer. The process is said to be more effectual than "oil toughening" or slow cooling. Considerable care is necessary. The water should be quite at the boiling point, and the steel at a bright red heat; and, secondly, the steel, should be fairly surrounded by the water. These conditions being fulfilled, the steel remains red-hot under water for some time—it seems to be surrounded by a film of vapour, and is not in actual contact with the water. The latter thus assumes the so-called "spheroidal state," and continues in that condition until the metal has lost much of the heat. The toughening, it is thought, is due to the uniformity of cooling thus effected.

In hardening and tempering steel, a clean charcoal, anthracite, or coked bituminous coal fire is required; such as is fit for taking a welding heat on iron is entirely unfit for hardening purpoees. The sulphur contained in the coal combines with the steel to form sulphuret of iron and ruins its texture.

One of the greatest difficulties to a smith is the welding of cast steel, and is an operation in which he rarely succeeds. A mass of ingredients and receipts is sold for the purpose of welding cast steel, but the simplest and best method is, according to the *Revue Industrielle*, the one employed by M. A. Fiala, of Prague, Bohemia. He uses pulverised white marble for the purpose. The two pieces to be welded together are heated, and, after rolling the same in marble dust, are promptly joined and subjected to a good hammering. By this means he is able to weld the smallest pieces together.

A French mechanic has discovered that by keeping his turning ools constantly wetted with petroleum he was enabled to cut metals and alloys with them, although when the tools were used without the oil their edges soon turned and dulled. The hardest steel can be turned easily if the tools be thus moistened with at mixture of two parts of petroleum and one of turpentine. So the Frenchman says. We have not tried it.

STEEL IRON.—A German firm, Asbeck, Osthaus, & Co., is manufacturing a substance they term steel iron, in five different varieties, so that they can furnish steel upon iron, iron between two layers of steel, steel between two layers of iron, steel core and iron skin, or iron core and steel skin. It is made in an iron shell, divided into two compartments by an iron plate. Before melting, both the steel and malleable iron are cleansed from any substance which would impede their welding. In the casting they are run at the same moment into the shell, in such a manner that the separating diaphragm serves to weld the two metals together, which form an inseparable mass when cooled. The process is recommended for rails, anvils, armour-plates, &c., and it is said to have been known some time since in France.

TREATMENT OF NEW WOODEN UTENSILS.—Wooden vessels for containing articles of food, wine, etc., also wooden vessels for culinary purposes, can be rendered fit for immediate use by the removal of the unpleasant extractive matters by treatment with a solution of washing soda, thus: An ordinary barrel should be filled half full of water, and a solution of about two pounds of soda in as much water as will dissolve it poured in, and the liquids thoroughly mixed by shaking the barrel, which should then be filled to the bung with water, and allowed to remain from 12 to 14 hours; then, after withdrawing the discolored liquid, it should be well rinsed and filled with pure water, and should remain a ew hours more, when it will be fit for use. Other wooden utensils may be similarly treated.

A RAPID PROGRESS FOR DIRECT PRINTING AND ENLARGEMENT.

Place in a half-gallon bottle an ounce of nitro-glucose, and pour over it 2oz. of sulphuric ether. When the glucose is dissolved, add to it an ounce of chloride of ammonium, dissolved in as little water as possible, with sufficient strong alcohol afterwards added to make in all 48oz. of solution. The addition of forty-eight grains of citric acid to the above mixture completes the preparation of the salting solution, which is applied to the paper by means of a brush, the operation being quickly performed. When dry, the paper will keep, ready for exciting, for several months. Paper thus salted may be employed either for direct printing in the pressure frame, or for developed enlargements. For ordinary printing the paper should be floated for a minute on a sixty grain silver bath. When dry it is exposed to the fumes of ammonia for about fifteen minutes, and then exposed under the negative. The author of the process says that with paper so prepared he has obtained from a clear intense negative, in sunshine, a print in half a minute. "It was clear, round and brilliant, and the details were wonderfully soft and deep. Altogether it was just the kind of print operatives strive to make, and, when made, feel justly proud of their success." The sensitiveness implied in the above must strike one as being very great. The toning and fixing are effected as usual. When the paper is intended for developed enlargements a greater degree of vigour and roundness is obtained if the quantity of citric acid in the glucose salting solution be doubled. It is excited by floating it upon a forty-grain silver bath, which before and after using should be placed in the sun, in order to cause the organic matter to be deposited. The exposure is continued until he image be faintly visible, and the print is developed by the following:—

Pyrogallic acid	1 grain.
Citric acid	1 "
Water	1 ounce.

If the exposure has been properly timed, the development of the print will be completed in little over a minute, after which it is washed, toned, and fixed by the usual means.

MINERAL OILS AS LUBRICANTS.

At a late meeting of the Railway Master Mechanick's Association of the United States, there was rendered a report of a committee appointed to examine into and report on the subject of lubricants. They recommended a good quality of natural earth oils as the best to use for lubricating machinery and journal boxes. It was less expensive, and of a better quality than other oils. When treated so as to reach 28° of gravity, it was found to work with perfect success, even on so sandy a road as the Lake Shore. It had been reported favorably on from Canada in the north to Kentucky in the south. A test of various oils had been made with the oil tester on the Lake Shore; sperm, lard and tallow were used, and none of them were found to possess qualities which render their use advisable. In their experiments the committee used a machine the size of a regular axle box, and 50 drops were poured in at a temperature of 60o, and the wheel was allowed to revolve at a rate of speed equalling 35 miles per hour, until a temperature of 200° was reached. The length of time, number of revolutions and amount of friction were all noted and placed in the form of a table. Attention was called to the result obtained from tests with paraffine, which costs from 25 to 30 cents per gallon, and which has been used on railroads in preference to lard oil. Paraffine costing 25 cents, with which six experiments bad been made, showed that 24 minutes were required to reach the maximum temperature, during which time it gave 11,685 revolutions; castor oil costing $1.25, which required 28 minutes to reach the temperature allowed, gave 12,946 revolutions; manufactured oils, A, B and C, costing 35 cents 90 cents and 25 cents respectively, required 19½ minutes, giving from 9,285 to 9,653 revolutions; sperm and tallow required only 17 minutes to reach 260° temperature, with less than 8,000 revolutions.

ANCIENT TIMBER.—The oldest timber in the world which has been used by man, is supposed to be that found in the ancient temples of Egypt. It is found as dowelpims in connection with stonework which is known to be at least 4,000 years old, these dowels appear to be of tamarisk or shittimwood, of which the ark is said to have been constructed, a sacred tree in ancient Egypt, and now rarely found in the valley of the Nile.

TECHNICAL EDUCATION.

Education in order to meet the requirements of modern days, should comprehend technical instruction. A knowledge of the history and theory of the fine arts is no doubt a necessity in the higher education, but the hand must be educated as well as the brain—the practical is quite as valuable and important as the theoretical aspect of art; and Lord Beaconsfield in directing public attention to this question. has undoubtedly hit the blot in our present system of education. Handicrafts are not in the high epute they formerly enjoyed; there is no recognized system of technical education; there are no professors' chairs, no endowments or rewards for the skilled handicraftsman. While instruction in the fine arts is to be obtained in every large town, there is a sad deficiency in schools for thorough technical instruction, and there can be no doubt that, in allowing the guilds and systems of appaent ships to become obsolete, or in terminating them, society and the state have made a great mistake in not affording at the sametime a substitute for them. The asolated efforts of a few city companies, however commendable in themselves, are, after all, but slight evidence of the appreciation by the general public, of the defect in a system of education, which, while professing to be national, igunores an indespensable element of success.

It is strange that advocates of a national system of technical educaaion should find it necessary to speak apologetically of their cause if the public mind is prepared to accept it. This disassociation of the theory and the practice, which has undobtedly been the result of the system of education hitherto persued, has resulted in a degradation of all technical skill, It ought surely to be unneeessaay to point out that "principles which are applicable to arts of utility, that the same appositeness, the same fitness and finish are necessary." Observations such as these are called forth by a conciousness of the existence of a generally received idea that the man who works with his hands, however skilful he may be, is of necessity inferior socially to the clerk, the journrlists, or the lawyer. A society in which opinions are prevalent must ultimately be the loser of all industrial competitions. however high may be the standard of theoretical instruction or intellectual attainment. Any system of education, therefore, which indirectly discourages technical and mechanical excellence, by refusing to accord thereto a fair proportion of public approbation and reward, must be regarded as manifestly incomplete, if not actually injurious to society.—*London Architect.*

Gunter's Chain.—About the beginning of the seventeenth century Edmund Gunter devised the lineal measure called "Gunter's Chain," to facilitate the measurement of land and the computation of acreage. He made the chain consist of 100 straight links, each 7·92 inches long, in order that square links may be at once converted into acres by shifting the decimal point. For 7·92 inches = ·22 of a yard, and the square of this = ·0484 of a square yard = the 100000th part of 4840 square yards, or of 1 acre; so that square links are converted into acres by dividing by 100000 or by merely removing the decimal point five places to the left. (*Ex.* A rectangular field measures 825 links by 430.. How many acres does it contain? 825 square links ÷ 430 = 354750 square links. Now 1 acre being 100000 square links, the area just found, being divided by 100000, or what is the same thing, having a decimal point inserted before the fifth figure from the right, becomes 3·5475 acres, or 3 acres 2 rods 7·6 perches. *Ans.*) Gunter's chain is the land surveyor's general instrument for measuring the distance between two extreme points of a field. The hundred links into which it is divided are joined by rings, and at every tenth link, from each end to the middle, is attached a notched piece of brass, that at 10 links having one notch, that at 20 links having two, &c., and that at 50 links, the middle of the chain, having a plain circular piece of brass. For measuring short side distances perpendicular to the main line of measurement a staff, usually 10 links in length, is used, called an offset staff.

Puddler's Shield.—There has recently been introduced at the mill of Phillips, Nimick and Co., Pittsburgh, a large apron made of hollow sheet iron, which is hung in front of puddling furnaces so protect the workmen from the great heat. The apron is hung by pulleys on a bar, so that it can be easily slid to one side when charging or drawing the iron, and it is filled with water constantly running from a hose. This apron, thus filled with running water, is a perfect non-conductor, having only the small opening for the puddler's tools uncovered.

Queries.

[1000.]—Will some of your readers kindly inform me how to fix chalk drawings?—Young Artist,

[1001.]—I should be glad to obtain information through your columns as to the best way to take buckles out of a saw.—Amateur.

[1002].—I have been trying to make black and gold picture frames, but have not been able to produce a perfect or a smooth surface, any information Mr. Editor you can afford me on this subject will be most acceptable.—W. S.

[1003.]—Can you inform me where I could get a catalogue of useful Technical Instruction? The short catalogue given in the Magazine although very useful, is not full enough. There are many cheap manuals printed in England, but I have no means of obtaining a catalogue.

[1004.]—There are several cases of virulent scarlet fever and diptheria in the village where I reside, and as I have a family of young children, will you kindly inform me what is the best preventive to these terrible diseases and what are the premonitory systems?—M. C.

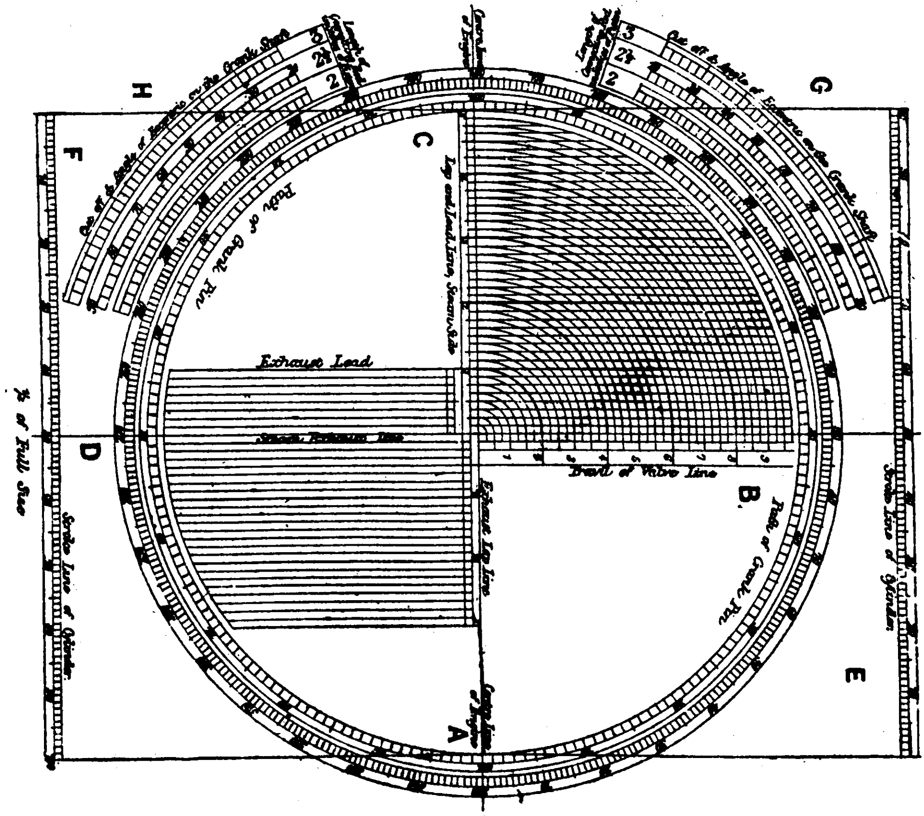
[1005.]—I have been informed that veneers can be dyed through and through; is this so? If so, will you or some fellow reader explain the process?

[1006.]—Furnace for Burning Slabs and Sawdust.—I have a steam-boiler 19 feet long and 3 feet in diameter, furnishing steam for a saw. I wish to burn sawdust and slabs, and therefore would like to know the size of grate to use, the amount of grate area, width of opening between bars, thickness of bars, width of bars, and length of sections; also diameter and height of smoke-stack. The boiler is rather small for the work required of it.—J. W. G.

[1007.]—A Perpetual Cold in the Head.—Are not "J. S.'s" eyes to blame, and not his head? Doesn't the cold air make his eyes water, and as a consequence his nose to run? Let him try if such is not the case by carefully protecting his forehead and eyes, and if so, then he may strengthen his eyes with the cold douche, or by putting his head and eyes under water, opening the latter, and repeating the same as often as convenient till they bear the cold wind unaffected.—C. O.

Rabies in Dogs'—A contribution to knowledge of this disorder has been recently made by M. Galtier (*Comtes Rendus*). The most important of the conclusions which he draws from his experiments is that the saliva of a mad dog, obtained from the living animal and kept in water, continues virulent five, fourteen, and even twenty-four hours afterwards. This fact has consequences which everybody should be aware of. Thus it seems that the water of a vessel in which a mad dog may have dropped some of its saliva in attempting to drink should be considered virulent at least during twenty-four hours; and next, that as the salivea of a mad dog which hus succumbed to the malady or has been killed does not lose its properties through mere cooling of the body, it is important in examining the cavities of the mouth and throat after death, to guard against the pos ible danger of inoculation. M. Galtier tested Rabbits with regard to rabies, and fonnd it transmissable to them from the dog; also, the rabbits' rabies from them to animals of the same species. The chief symptoms are paralysis and convulsions. The animal may live from a few hours to four days after the disease has declared itself. It is notable that the period of incubation is much shorter in the rabbit than in other animals, and this makes the rabbit a useful reagent for determining the virulence of a particular liquid. M. Galtier found salicylic acid, injected daily under the skin, powerless to prevent the developement of the disorder in rabbits.

The Eyestone is a small calcareous plate of shell, circular and plano-convex in form. It is a carbonate of lime; and, if put into a saucer with a little vinegar, it will move about as if on legs. This is owing to the union of the vinegar with the lime, which sets the carbonate acid gas free in the form of minute bubbles, thus giving motion to the stone; and this is the mystery of its life.

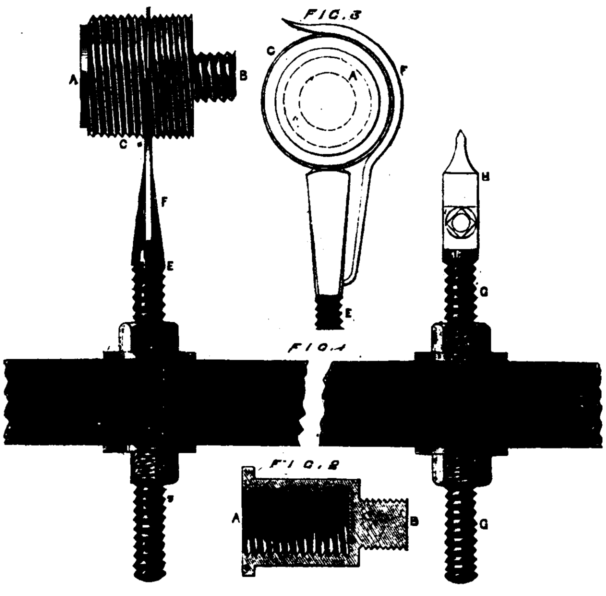


KING'S SLIDE-VALVE DESIGNER'S AND SETTER'S GUIDE.

The most useful invention shown at the late Westminster Industrial Exhibition, at all events, so far as the mechanical section was concerned, was the ingenious diagram designed and patented by Mr. J. King, of 15, Church street, Horselydown, S.E., by means of which the slide-valve designer can find with perfect accuracy any data he may require for carrying out his work. In the limits of a short article we cannot hope to convey any adequate idea of the value of this diagram and its accessories, and, as a matter of fact, the book of explanatory text and illustrations accompanying the apparatus consists of some 60 or so pages. We can, however, with the assistance of the diagram, give some idea of the manifold uses to which it may be put; but, at any rate, we shall have little difficulty in convincing mechanics who have to deal with steam engines of their great utility to them. At the Westminster Exhibition the device was shown engraved in large scale on a slab of slate, and probably if it had been properly understood by the judges it would have received a higher award than the silver medal; but it required explanation, and as that would have taken about a week of fast talking, the patience of the adjudicators might have been exhausted. The diagram, it will be seen, consists of a piece of cardboard, at the top and bottom of which is the stroke line of cylinder, decimally divided. The inner circle is 10in. in diameter, and represents the path of the crank-pin. It also is divided decimally with index figues from 10 to 100 for each semicircle, corresponding to the forward and backward stroke of the piston. Just outside the crank-pin circle we have another divided into 360 degrees, which is used for showing the angle of the crank in any part of the crank-pin's path, and therefore for setting the eccentries at the proper angle for any given amount of lap and lead of the valve. We need scarcely say that the diagram can also be used as a protractor for setting out any angles that may be required for other purposes. The line A C is the centre line of engine, with which the cylinder stroke line at top and bottom correspond, the latter being used for finding the position of the piston in the cylinder in percentages of the stroke. By an ingenious applications of cards cut to curves of different radii, to adapt them to the more usual lengths of connecting-rod, the place of the piston and the position of the crank-pin on its circle are both shown at a glance, so that the veriest tyro can understand and follow a lecturer, for which reason this device will commend itself to teachers of science classes, whose business it is to explain the mysteries of cut-off, expansion, lap and lead, and compression, all of which, with many other data, are exhibited diagramatically. Within the crank-pin circle are four radical lines, A B C D, which are divided and used in the following manner:—On line A, commencing from the centre of the circle, three inches are marked off and divided into eights, forming an "exhaust lap line," from which we can show the additional amount of expansion and compression due to any given amount of lap on the exhaust side of valve. On line B we find the travel of the valve; it is divided into ⅛in., ¼in., and ½in., each ½in. division being numbered. These divisions are radii of eccentric circles, from which arcs are drawn to the "lap and lead" line C; from the points of intersection with that line perpendiculars are erected to the crank-pin circle, which, however, for the sake of clearness they do not touch. Outside of the two circles are arcs of circles G and H, each divided into 70 numbered divisions, and adapted to lengths of connecting-rod of 2, 2½, and 3 times the length of stroke. The first inch of the line C is used for finding the exhaust lead, perpendiculars being dropped to within an eighth of an inch of the crank pin circular. So far we have merely explained the lines on the diagram, but those who are accustomed to similar illustrations will by this time have seen that if we take any given size of valve we can easily find the lap and travel necessary for any desired cut-off; then for any desired cut-off the diagram will show the angle, in advance of the crank, of the eccentrics, and consequently their proper position on the shaft. For the same reason, if any alteration of the action of the valve is desired, the diagram will show exactly the amount the eccentrics must be shifted, and at the same time the effect upon the distribution of steam with the cylinder. Given the cut-off at which the engine is to work, a few lines drawn on our diagram will give the following data at a glance:—When the port is full open; how much it has opened; when it has closed and expansion commences; percentage of stroke before steam was cut off; percentage of stroke performed by expansion; when exhaust takes place ; and the percentage of stroke to be performed during compression after the exhaust has closed. It will be readily understood that a diagram which will show so much must necessarily exhibit a great deal more; for instance, when the eccentric centre line is drawn from the centre of the diagram (*i.e.*, of the crank shaft) through the desired cut-off on the arc G or H, on the same line can be found any travel of valve from ½in. to 10in., graduating by quarters ; any lap of valve from ¼in. to 4½in. graduating by sixteenths, and any opening of port from ⅛in. to 3½in. graduating by sixteenths. Any required opening of port with the requisit travel and lap of valve can therefore be selected for the point of cut-off fixed upon. To the designer of steam-engines the diagram is necessarily of considerable value, for by its aid he can find the exact sizes of the eccentrics and the slide valve, and obtain a graphic representation of the effect of different lengths of connecting-rod upon the distribution of steam with any given amount of lap and lead, and, *per contra*, can view the effects of different amounts of lap and lead. For use in classes the diagram should certainly be engraved upon slate (the inventor himself recommends slate where a little extra cost is no object), because lines can be clearly shown and as readily removed ; the teacher, in fact, drawing the eccentric to the exact size required and afterwards the valve, thus giving an ocular demonstration of the value of the diagram. The ordinary cardboard set up in a neat box will, however, answer all the purposes of the mechanic and slide-valve designer without requiring any knowledge of mathematics, or, for that matter, of even arithmetic, though as the scale is made for a stroke-line of 10in., and is divided into 100 parts, a little multiplication will be necessary when its applied for ascertaining the distribution of steam in engines of any other stroke. This fact is not the least feature of merit in the invention, for we cannot doubt that if the slide-valve were properly understood by those who own or have charge of engines, or even by those who make them, great improvement and a consequent economy of fuel would be the result. With this diagram and the accessories which accompany it, including the book of instructions, no one can fail to understand the working of the valve gear, while to those engaged in the construction of engines, it is at once a ready reckoner and an unerring draughtsman.

IMPROVEMENTS IN SCREW-CUTTING.

A somewhat novel way of arranging the guide for screw-cutting has been patented by Mr. W. R. Olivey, of Stormont-road, Lavender-hill, S.W. To the mandrel of a lathe he fits a chuck, say, about the length of an ordinary chuck and the screw of the mandrel combined. On the end of this chuck is a screw the same size and depth as that on the mandrel, to take on it any of the other chucks belonging to the lathe. The remainder of the chuck is turned to receive a hollow cylinder, on the outside of which is cut the screw to be copied, leaving on the chuck a rim to catch the end of the cylinder. Then having cut the screw to be copied on a cylinder of any suitable metal, he fixes it for use on the first-mentioned chuck in either of the following ways :— First, by inserting a small stud just in front of the rim to fit into a slot in the inside of the cylinder, in which case the cylinder is made just long enough to reach the insides of either of the other chucks when screwed against it ; or, secondly, by dispensing with the stud and letting the cylinder project just far enough over the end of the first-mentioned chuck to be kept in position by either of the other chucks being screwed on against it. To obviate the necessity of removing the work, the cylinder can be placed on the back of the chuck and secured by suitable means, such as a screw tapped into the chuck. A frame of wood or metal with a slot in it carries the guide and the tool-holder, the guide being provided with a spring clip to run in the grooves of the screw of the cylinder, and thus obviates the necessity of a rest. It is obvious that the guide can be made without the clip, and work upon any ordinary rest. The tool-holder and the guide are tapped with threads running nearly their whole length, so that they can be adjusted to the length required in accordance with the work. The tool-holder is flattened at the end to receive the tool on to which it is screwed so that the cutter can be placed to cut an outside or inside screw. The action is as follows :—The cylinder is placed on the chuck, the work being screwed up against or on the chuck in the ordinary way. The guide and the tool-holder being placed in proper position, the guide-clip is placed in the screw-grooves on the cylinder, and the tool against the work to be operated on. As the guide travels in the grooves of the thread the tool cuts a similar thread on the work, and this is repeated until the screw is finished. The cutter is either a single point or a chaser of the same pitched screw as the guide. Ordinary chucks can be used with these arrangements by dispensing with the rim on the back of the chuck, and putting the cylinder on from the back and confining it by a screw or spring. Fig. 1 is a plan, Fig. 2 a sectional view of chuck, and Fig. 3 end elevation, showing hollow cylinder with screw to be copied with guide and spring-clip. In these Figures A is the shuck, with screw B ; C, hollow cylinder, on which is cut the thread to be copied ; D, frame of wood or metal, with slot ; E, guide tapped with threads, as shown, so as to be adjusted to the length required ; F, spring clip to run in the grooves of the screw ; G, tool-holder tapped with threads, as shown, so that same can be adjuusted to the length required in accordance with the work ; M, cutting-tool screwed or secured on to the flattened end of the holder. The cutting-tool can be fixed to work an outside thread, as shown in Fig. 1, on an inside thread. The hollow cylinder C, with the thread thereon to be copied, is fixed on the chuck A, as before described ; the work is then screwed up against or on the chuck A in the ordinary way. The guide E with the spring clip F, and also the tool-holder G with the cutting-tool H, is then brought into position, as shown in Figs. 1 and 2, and as the guide E tavels in the grooves of the thread, the tool H cuts a live thread on the work, and this repeated until the screw is finished.



Hot and Cold Blast Iron.—Cold-blast is rather stronger than hot-blast iron, and mixtures are rather stronger than simple irons. This is the opinion of Bindon B. Stoney, C.E., and the following are the conclusions which the late Mr. Robert Stephenson deduced from a series of experiments on the transverse strength of cast-iron bars, made preparatory to the commencement of the High Level Bridge at Newcastle : (1) Hot-blast is less certain in its results than cold-blast ; (2) mixtures of cold-blast are more uniform than those of hot-blast ; (3) mixtures of hot and cold-blast give the best results ; (4) simple samples do not run so solid as mixtures ; (5) simple samples sometimes run too hard and sometimes too soft for practical purposes. From these conclusions Mr. Stoney says : "Having regard to the fact that hot-blast iron is now in general use, and that it seems to improve some kinds of iron—probably those of a hard nature—the best plant for the engineer to adopt is to specify the test which he requires the iron to stand, and let the founder bear the responsibility of producing the required result."

Fuel-Saving Inventions.—Among the American fuel-saving inventions are the following : A boiler advertised which saves 33 per cent of fuel, a valve which saves 15 per cent, a governor which saves 10 per cent, a cut-off which saves 10 per cent, a grate which saves 20 per cent, a metal packing which saves 12 per cent, and a lubricator which saves 1 per cent ; total, 101 per cent. Combining all these improvements, an engine would *run itself*, and produce a balance of fuel for culinary purposes !

Miscellaneous Items.

THE DANGERS OF ENGINE-DRIVING.—At the meeting of the London Association of Foremen Engineers and Draughtsmen, held some weeks ago, Mr. M. Reynolds read a paper "On Practical Engine-driving, Locomotive and Stationery." He said that there were many dangers on railways to be provided against, for there were coral reefs and sand banks. and traps of all kinds—trap points, trap sidings, and gullets. They were put in for the public safety, but if a man who did not know the road was driving an engine they would trap the train-man, carriages, and passengers. The drivers in charge of passenger trains had in many instances met with ugly traps in their earlier life, but having served for some years on good trains, they had become qualified to take charge of the more responsible part of the traffic. The rank and value of every engineman was in proportion to the labour and study he had bestowed on railway traps. If he had not the hidden rocks upon his chart he drove by chance, and a railway was of all places in the world the one where chance should not be in force. Locomotive-driving, he considered, should be based upon certain rules and principles, which, if followed out, would enable drivers to keep time without cutting too deeply into the coals. Without such rules and principles all was uncertainty; the hand trembled upon the regulator, the eye watched with painful anxiety the needle of the pressure-gauge, and the driver, though looking into a white fire for a moment, became colour blind. He then referred at length to the rules and principles, which, he urged, should be carried out, and remarked that engines should be properly organised, both on and off the pit before joining a train. Attention should be given to both water and steam; the fire should be properly constructed, the engine should be properly oiled, and precautionary measures to prevent heating should be taken. He observed that the history of the locomotive failures was instructive for at least two-thirds occurred through preventable causes, and those failures would have been prevented had the engineers systematically and thoroughly examined their engines before joining the train.

In the battle of the guns it is as well to consider their relative cost. It is stated that Krupp's 70-ton costs £22,000, the Armstrong 100-ton, £16,000, and the Woolwhich 80-ton only £10,000.

According to a paper in *Polybiblion*, the following are the laws of meteorology as affected by forests:—1. It rains more abundantly under identical circumstances, over forests than over non-wooded ground, and most abundantly over forest with trees in a green condition. 2. The degree of saturation of the air by moisture is greater above forests than over non-wooded ground, and much greater over masses of *Pinus sylvestris* than over masses of leaved species. 3. The leafage and branches of leafed trees intercept one-third, and those of resinous trees the half of the rain-water, which afterwards returns to the atmosphere by evaporation. On the other hand, these same leaves and branches restrain the evaporation of the water which reaches the ground, and that evaporation is nearly four times less under a mass of leafed forest than in the open, and two and one-third times only under a mass of pines. 4. The laws of the change of temperature out of and under wood are similar to those which result from the observations of M. Mathieu. The general conclusion seems to be that forests regulate the function of water, and exercise on the temperature, as on the atmosphere, an effect of "ponderation" and equilibrium.

CHEAP BLACK FOR WOOL.—The cheapest black for wool is obtained by treating the wool in a mixture of dilute sulphuric acid and dichromate of potassium, or of sulphuric acid, potassium bitartrate and copper sulphate, and subsequently dyeing with logwood. Reimann now proposes to use, instead of either mixture, one of chrome-alum and bitartrate with logwood. For the chrome-alum, the impure solutions of it obtained as lye-products in many nanufactures may be used. The iron-alum in the process not only serves as an oxidizing agent, taking the place of chromic acid and copper sulphate in the first two mixtures, but also deepens the black by itself forming a compound with the logwood. Tbe advantages of the first new process are: (1) there being no chromic acid in the mixture, the wool is not oxidized, and remains soft to the touch; and (2) the black is a mixture of chrome and iron-black, and while free from the drawbacks of either, possesses the good qualities of both. Chrome-black is unaffected by acids, but is injured by alkali and exposure to light; iron-black has exactly opposite properties.

NEW CLOTHING MATERIAL.—A Berlin inventor has patented a new kind of cloth, which consists principally or entirely of sponges. The sponges are first thoroughly beaten with a heavy hammer, in order to crush all the mineral and vegetable impurities, so that they can be easily washed out. They are then dried and pared like a potatoe, with a sharp knife, the parings being sewed together. The fabric which is thus obtained is free from all the danger which sometimes arises from the absortion of poisonous dyes into the system; it absorbs without checking the perspiration, so as to diminish the danger of taking cold; it is a bad conductor and therefore helps to maintain a uniform surface temperature; it can be more readily cleansed than the ordinary woollen garments; its flexibility diminishes the liability of chafing; the ease with which it can be employed in shoes, stockings, drawers, undershirts, hat-linings and other articles of clothing.

SUMMER AND ITS DISEASES.—This is a bright volume of the *Health Primer* series, published by Lindsay & Blakiston, Philadelphia, and for sale by A. L. Bancroft & Co., S. F. It is, however, more adapted to a variable climate, where "the changing seasons remind man that the seed is not quickened except to die, and each one brings to him, as it comes with its many blessings, some new suffering and sickness." The book aims to point out the causes of summer sickness, and by proper warnings enabling all to avoid those combination of causes which bring about so many death strokes in summer. "Preventive medecine is the highest developement of the healing art." We can avoid occasions much more easily than we can eombat maladies already established. The series may be considered a "blessing" in litterature. Dr. Wilson is the author of this last one, and all stand upon the highest medical and scientific authority.

Wood acts with tremendous force when wetted, and advantage has been taken of this fact in splitting blocks of granite. After a mass of granite has been sent from the mountain by blasting, it is measured in every direction to see how best to divide it into smaller blocks. These are traced out by straight lines on the surface, and a series of holes are drilled at short intervals along this line. Wedges of dry wood are then tightly driven into the holes and wetted, and the combined action of the swelling wood splits the block in the direction required, and without any destructive violence. The same process is then carried out upon the other faces, and the roughly shapen block finished with the hammer and chisel. The action of the wood is due to capillary attraction—the same as that which draws the sap through the small tubes or pores of the growing tree.

According to a German authority, sponge-growing may be made a profitable branch of industry. The method of cultivation consists in cutting the live sponges into small pieces, attaching the same to a wooden frame-work, and sinking it in the sea in locations favorable to their natural growth. In three years such pieces will have attained a marketable size. The total cost of raising 4,000 sponges (including interest on capital expended) is estimated to be $45, and the income for their sale $80, leaving a net profit of $35. As the growing of sponges, after their first immersion, require no attention, it will be readily perceived that the quantity thus probagated could be indefinitely increased. As the Gulf coast and Florida Keys annually produce over $100,000 worth of sponges naturally, it is very probable that their income might be largely increased by judicious cultivation.

SULPHIDE OF CARBON is now largely used in Paris for extinction of chimney fires. Dr Heeren has remarked in the Hanover Society of Engineers that, according to his experiments, 100 grammes of the sulphide, consumed in a shallow open dish, with free access of air, require fully six minutes, and the sulphurous and sulphuric acids formed most undoubtedly be much diluted by the large amount of nitrogen in the air required for combustion, while they must also be greatly expanded by the high temperature. Dr. Heeren therefore recommends the use of condensed sulphurous acid as a powerful agent for the purpose in question.

TO CLEAN ENGRAVINGS.—Put the engraving on a smooth board, cover it thinly with common salt finely pounded; sqeese lemou juice upon the salt so as to dissolve a considerable proportion of it; elevate one end of the board, so that it may form an angle of about 45 or 50 degrees with the horison. Pour on the engraving boiling water with a tea-kettle until the salt and lemon juice be all washed off; the engraving will then be perfectly clean, and free from stains. It must be dried on the board, or on some smooth surface, gradually. If dried by the fire or the sun it will be tinged with a yellow colour.

THE INDICATOR.

"*What the stethoscope is to the physician the indicator is to the skilful engineer, revealing the secret workings of the inner system and detecting minute derangements in parts obscurely situate.*"

The importance and usefulness of the indicator to all concerned in the proper working of the steam engine, and especially to the working engineer, can scarcely be overrated. It is used to ascertain the internal condition of the engine, the state of the vacuum, the amount and variations in the pressure of steam at every part of the stroke, the condition of the valves, whether too much or too little lap or lead—in fact, it tells us the power and all the faults by which that power is impaired. It may also be attached to the air-pump, the hot well, the condenser, &c., when it will tell us the nature of the pressures there existing.

Without the indicator (says Mr. Ingham) nine-tenths of the operations and adjustments of the most experienced engineer are the interest groping and guess-work, and not infrequently they are attended with the most serious blunders and mishaps. Take, for instance the process of valve-setting. Such is the difference of capacity in thoroughfares and clearance, between one end of the cylinder and the other, and between one engine and another, that, however careful and experienced a person may be by the mere "rack of the eye" or with the two-foot rule, in nineteen cases out of twenty the valves, will be more or less inaccurately set. There will either be too much or too little "lead" in the steam or in the exhaust of both valves, or inequality betwixt the one and the other, and a corresponding irregularity and imperfection in the working of the engine, the true nature of which can only be discovered by means of the indicator and diagrams taken from the engine whilst working. Again, should an engine gradually or suddenly refuse to perform its accustomed duty, instead of begining to take its several parts to pieces, and perhaps expend hours or even nights of laborious toil to find out the defect, by placing the indicator upon the engine and taking a diagram the defect or derangement is at once discovered and the remedy prepared by the next time the engine stops, and thus much useless labour and expense are thereby prevented.

By an acquaintance with the indicator an intelligent engineer may acquire more real practical and theoretical knowledge and experience of a steam engine in twelve months than used to be acquired under the "old school" during a seven years' apprenticeship. I would therefore urge upon every person who has the charge of one or more steam engines the absolute necessity of an immediate and complete acquaintance with it in all its bearings, or otherwise he may rest assured that this, the most intellectual portion of an engineer's duties, will gradually pass out of his hands into those of the manager. To avoid this, and in order that working engineers may keep pace with the improvements and progress of the age, the following description of the mechanism and the principle on which it works is extracted from the work, "The Engine Room, and who should be in it and what they should do," by an Old Hand. Published by Mr. T. L. Ainsley, South Shields, who has kindly supplied the block for the frontispiece :—

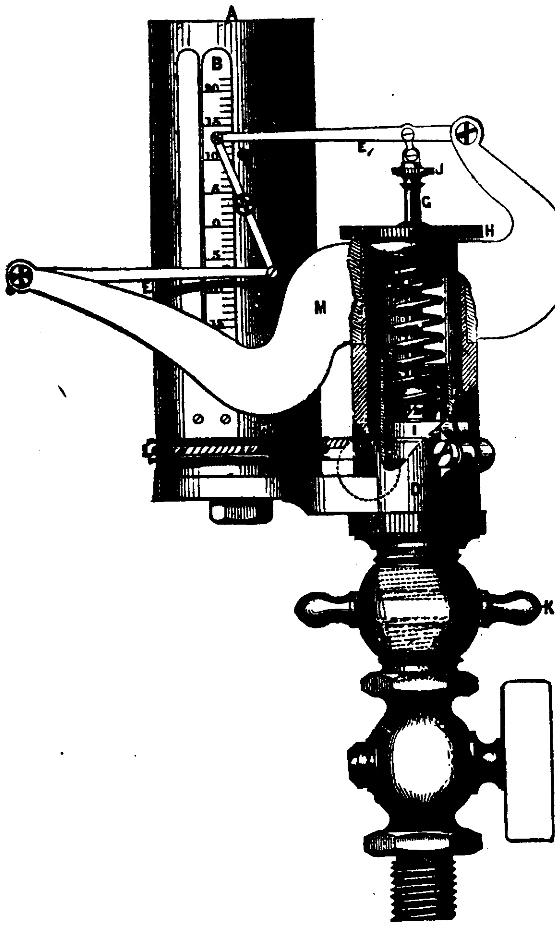
Mechanism of the Indicator.—The brass barrel A, having the split graduated scale B attached, is called the paper cylinder. On it the diagram paper is fixed. This paper cylinder can be detached from the instrument by pulling it upwards. On being detached another barrel is seen, having the horizontal pulley L on its bottom end, and a small coiled spring contained in a drum at the top. It will be observed that on pulling the cord the pulley barrel will revolve until it comes against a stop; on slackening the cord the coiled spring will bring it back. At the bottom of this pulley barrel will be seen a small projection C. Now, when the paper cylinder is replaced, and the notch in it fitting this projection, the revolving and return motions of the paper cylinder will be clearly understood. On the upper end of the barrel D the lever arm M is carried. These levers E E are connected by the link F; this link is the pencil carrier. This metallic pencil is held by a screw, which regulates its distance from the paper cylinder. The lever E is attached by a swivel at J to the piston-rod G. On unscrewing the top milled cap H the level arm can be detached from the barrel D, bringing with it the piston-rod and also the spring used. Within the barrel D is contained the small cylinder in which the piston I works. To shift the spring, unscrew the round miled nut J on the end of the piston-rod, then unscrew the milled cap H from the nut on the end of the spring; the piston-rod is then free, and the spring can then be unscrewed from the piston I. It will be observed that the springs have a brass nut on each end; on one nut is marked the limit pressures, thus, $\frac{47}{15}$—47lb. steam, 15lb. vacuum; on the other the scale strength of the spring, thus, $\frac{1}{20}$. On putting the small piston into the cylinder it will be seen that it is an accurate fit. Great care must therefore be taken to keep the cylinder perfectly clean. On the bottom end of the barrel D is the conical stem having the tightening nut K attached. This nut has two small arms on it. The conical stem is a ground fit into the top end of the cock supplied with each indicator. This cock has its conical seat protected by a brass cap; unscrew this cap and insert the conical stem, screw down the tightening nut, and as this nut has its threads of different pitches it firmly secures the indicator to the cock. The communication between the top and bottom of the engine cylinder is obtained by means of a pipe attached to each end and coupled in the centre to a cock; this cock has a projection on it which is tapped to suit the indicator cock.

Principle on which the Indicator Works.—From the foregoing description of the mechanism of the indicator it is at once apparent that if a pressure is brought to bear on the under side of the small piston the spring will be compressed, and if on the upper, or spring side, it will be extented; therefore, as the pressure of the steam varies in the cylinders of the engines so will the position of the indicator piston vary in its cylinder—the slightest increase of pressure occasions a rising, the slightest diminution a falling. The position the piston (or pencil) is in when unacted upon by any pressure, *i.e.*, having the pressure of the atmosphere on both sides of the piston, is called the zero position. From this position the atmospheric line is marked.

Now suppose communication to be opened to either the top or bottom of the cylinder of the engine, we find that when the port is opening for steam the indicator piston will shoot upwards and remain so until the port is closing; when closed, and by reason of the steam expanding and losing its pressure, the spring will force the small piston downwards, and on the port being opened to the condenser the pressure of the atmosphere acts on the upper side of the small piston and extends the spring, and if a pencil was attached to the end of the indicator piston-rod it would mark a straight line—the top end of this line would indicate the greatest pressure, the bottom the least. From the zero position upwards would be the steam pressure, below it atmospheric pressure. But the straight line would not tell us of the varying pressures going on in the cylinder of the engine, therefore, to obtain this, we must have recourse to the paper cylinder, which receives its reduced motion from some part of the engine, and as it revolves from right to left, or *vice versa* (the indicator cock being open to either end of the cylinder of the engine), a figure or diagram is marked upon the paper by the metallic pencil, faithfully representing and recording the "varying pressures within the cylinder at any part of the stroke." From this diagram the total pressure upon the piston, or the mean pressure throughout the stroke, can be obtained; for as the various springs used are made to suit the pressure carried in the boiler, the strength or amount of compression of the spring under a given weight being known, it is a very easy matter to calculate the pressure by the diagram. The strength of each spring is marked on it, and if a $\frac{1}{16}$ spring is used a $\frac{1}{16}$ of an inch up or down on the diagram represents 1lb. pressure; if a $\frac{1}{20}$, a $\frac{1}{20}$ of an each is 1lb., and so on. One great advantage of Richard's indicator is in its having a short travel of piston in comparison to its pencil; a stiffer spring is used, thereby a more correct diagram is obtained, and also greater sensitiveness under varying pressures.

Method of Taking Diagrams.—To fix the paper: Detach the paper cylinder from the indicator, and enter one corner of the paper under the split scale, leaving about half-an-inch projecting; turn the paper round on the cylinder and enter the other corner; take hold of the two corners and pull the paper gently down for about one inch with the finger and thumb; make the two ends of the paper assume, as near as possible, the form of the part entered on the cylinder—this will tend to prevent the ends of the scale cutting the paper. Now draw the paper down to the bottom of the scale, and have it lying even and tight on the cylinder; the paper being on, replace the cylinder, taking care that the projection C on the pulley barrel is in the notch on the paper cylinder. Before screwing the indicator cock on to the pipe cock open the pipe cock to each end of the cylinder so as to blow out any grease or dirt that may be in the pipe; having done so, screw on the indicator cock; then fix the indicator by means of the tightening nut K; make a loop on one end of the cord (this cord should be hard and having no stretch), reeve the other end through a strip of brass, say 1½in. long, ½in. broad, by ⅛in. thick, having three small holes in it, thus:—

By this means a ready adjustment of the cord is obtained. Ascertain if the hook on the lower end has a travel of about five inches (this should be about the length of the diagram); now



THE INDICATOR.

put the loop end of the cord on to the lever hook, and put the other (or adjusting lop) on to the hook of the pulley barrel cord; adjust the cord by the brass strip until the paper cylinder revolves free. There must be no slack in the cord, and the paper cylinder must not touch the stop. Having got the motion regulated open the pipe cock to either end of the cylinder, and then open the indicator cock, allowing the indicator to work a few revolutions before putting the pencil on to the paper, for the double purpose of heating the indicator and ascertaining if its piston and spring work freely; turn the lever arm towards the paper so that the pencil will mark a distinct line, and having made the diagram for that end of the cylinder turn the pipe cock for the other end and make its diagram, then shut the indicator cock; when this is done the atmosphere acts equally on both sides of the indicator piston; put the pencil on to the paper again and a horizontal line will be traced; this line is the atmospheric line. Now detach the cord from the pulley barrel hook, lift off the paper cylinder, and take off the diagram paper. To a beginner this manipulation may appear very difficult and tedious, but it is not so. He should repeat the operation until he is thoroughly "up" in putting on the paper, adjusting the cord, and tracing the diagram. A few trials is quite sufficient to make him an expert at it. Thist must always be remembered when taking diagrams—"any inaccuracy in the adjustment of the indicator affects the diagram most seriously."

THE marble manufacturers of New York held an informal meeting on Monday last and agreed upon the following advance per foot in prices of marbles to take effect on and after November 1st: Italian, 5 per cent.; Virginia, 10 to 12 per cent.; Tennessee, 10 to 13 per cent and Shell, about 10 per cent.

THE cabinet makers of San Francisco have inaugurated a general strike for an advance of twenty-five cents.

NEW RECORDING POCKETBOOK.

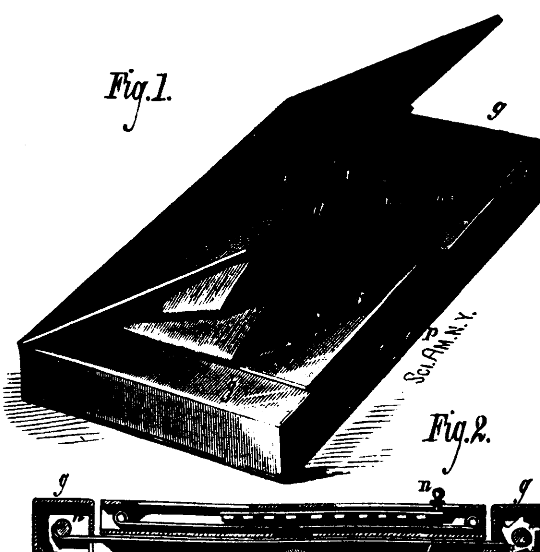
The pocketbook shown in the accompanying engraving is the invention of Mr. Hugh C. Baker, of Hamilton, Ont., Canada. It is fitted with devices for registering or printing figures on a strip of paper by the act of closing the pocketbook, the object being to keep an accurate account of money taken from the pocketbook from time to time without using pen or pencil.

Fig. 1 is a perspective view representing the book open. Fig. 2 is a longitudinal section of the recording apparatus. The bottom, back, and hinged leaf or cover, *c*, are preferably made of thin sheet metal and covered and lined with leather or other material. At each end of the bottom plate there is a hinged box, *g*, each containing a roller for carrying a strip of paper two feet long that extends beneath the box, *f*. One roller is provided with a milled disk for convenience in turning it; the other has a ratchet wheel, *k*, that is engaged by a spring whenever the book is closed, thus moving the paper strip so as to present a fresh surface to the type.

The pocketbook shown in the engraving has three lines of type, each containing the number from 0 to 9, so that any sum below 1,000 in dollars, or any sum below $10 in cents, may be recorded. The types are carried by three flat strips that move under the top of the box, *f*, and each is provided with a stud, *n*, by which it is moved. In the underside of the box, *f*, there is a transverse slot, *o*, and immediately below this there is an elastic pad, *p*. The ink ribbon is carried by rollers at the ends of the box, *f*, and extends under the type and over the paper strip, and is moved by turning the small knobs seen projecting from the inner side of the box *f*.

The cover, *c*, is provided with a projecting edge, *t*, that presses upon the upper side of the box, *f*, first moving it downward so as to cause the rotation of the ratchet wheel, then carrying it still further until the type, the ink ribbon, and the paper are brought to bear upon the pad, *p*, thus making an impression of the types upon the paper. The ordinary pressure used in closing the purse is sufficient to make the impression. The backs of the strips carrying the types carry figures of the same value as the types underneath, so that the types may be readily adjusted.

The pocketbook is simple in its construction, and all of the parts are readily accessible for adjustment. The paper strip, in addition to the use already mentioned, may be used as a memorandum, as it extends across the book. If desired items may be jotted down opposite the figures.



BAKER'S RECORDING POCKETBOOK.