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AN INDUSTRIAL UNIVERSITY.

BY PROF. JOHN E. SWEET.*

Constant applications at the rate of from one to a half a dozen a day, from bright young men, begging for opportunities to learn the machinist or foundry trade, compel me to think of the worn-out subject of the apprenticeship system, and the many times worn-out discussions upon it. Although not unmindful of the oft-repeated assertion, that no student or apprentice can learn a trade at school, and being so thoroughly convinced that such a conclusion is wrong, and that it not only can be done, but done better in the same time than has ever been done, even in the best of places, the country machine shop, the writer is impelled to revive the subject in an aggressive manner.

To insure a fair understanding of the following suggestions, it may be well to emphasize the fact that, for every mechanical engineer thoroughly employed, there must be from ten to one hundred workmen, including draftsmen, blacksmiths, foundrymen and machinists, and no matter what, or how extended, or thoroughly technical their education may be, while they are executing the work designed and planned by the engineer, they are workmen. And it is well, too, to take into consideration the fact that while there are men, and plenty of them, whose highest ambition it is to have a thoroughly classical education, there are other men, and plenty of them, whose highest ambition is to be thorough workmen of some special kind. Which may be the higher ambition of the two, few ever stop to think; quite likely this generation would be nearly unanimous one way, and possibly the next generation, (measuring the difference between the man who strives for a selfish aim and the one who works to improve things for the public good), be equally unanimous the other way. Be that as it may, workmen there certainly must be so long as industries go on as at present. So long as we inhabit the temperate zone, people must have houses and clothing, furniture and machinery, and whatever else may be done, there must be masons and carpenters, tailors and shoemakers, cabinetmakers and machinists, and we can never have these without they have first been apprentices somewhere, as trades can never be acquired in any possible way, except by years of direct and prolonged application in the use of tools, directed by constant and inquisitive thought. Proprietors of engineering establishments, machine shops and manufacturing industries are largely indisposed toward the old apprentice system. Binding out their sons for a term of years is not an agreeable thing to contemplate for most parents, and the result is often bad for all concerned. The trades unions, also, in many sections and industries, limit the number of apprentices to far below the number necessary to keep up the supply, and hamper those who are admitted, so the army of our workmen, if this nation is to keep pace with others, must be recruited either from foreign countries, or by some system of school education. As has been proven by the Industrial school in New York, where good workmen are trained in the art of bricklaying, stonecutting, plastering, plumbing, etc., the writer believes the same can be done equally well in the machinist and other trades, and offers the following hints as to a method of procedure.

Hundreds will be ready to claim that the thing has been tried over and over, with very indifferent success, or with no success at all. It is just here that will be found the greatest difference in opinion; for, according to the writer's idea, the thing has never been tried, or at least not to a fair extent, or in the right way. The trade schools are started as schools, conducted as schools, and aim to teach the use of tools, drawing, mechanics, the English language, mathematics, and many of them other things also. Our universities and colleges that have a mechanical course, and the technical institutes, are all schools with machine shop, foundry and laboratory attachments—all quite right in their way, where the aim is the production of mechanical engineers; but to expect to have a school succeed in doing something except just what it is designed to do, is an unreasonable expectation.

If a sufficient endowment, not greater than has already been given in many places for a like purpose, was at hand, and the objective point was to establish a school where an apprentice was to have an opportunity to learn the machinist's trade, and nothing else, the natural way to proceed would be to build a machine shop—a good one, but in no way extravagant or particularly different from any good shop—and stock it

*In the *American Machinist*, March 12, 1891.

with the regular machine tools, preferably of the various makes and kinds, adapted to a great variety of work, from bolt and pipe cutting to the grinding and measuring machine. Adjoining, or in an adjacent building, have rooms for drafting, recitations, lectures, and a library, and, reversing the usual order, make these features attachments to the shop. Select men for teachers and instructors for the shop proper, whose sole qualifications are that they know how to do work, how to go to work to do a job, who are ready in resources and know the kinks in the trade, entirely regardless of whether they know how to design machinery, whether they know what makes a steam engine go, or whether they can read or write, except if a man knows how to read he may be better able to find out other people's ways, and therefore be the better man for the place. Select for teachers in the drawing-rooms, class-rooms and lecture platform, men from the ranks, but never from the ranks of its own pupils. But shop, tools and men should all aim towards the objective point, educating young men to be good machinists (not engineers whose business it is to know how and why), but workmen who shall know how to do. In selecting the pupils avoid all educational tests, selecting, as would the manufacturer, boys for apprentices by their ability and disposition to work, and those who will take pride in their handicraft achievements. Let them understand that they keep their places by the result of their labor, and drop out those that fail, precisely as students are dropped from other schools, though not from any failure in their studies, but when they fail in their work. It is no more possible to make a good workman out of an inappropriate stock than it is anything else, animate or inanimate.

Avoid the two great evils of the present schools and colleges, that is, the examination and diplomas. Advance each young man as fast as his ability and energy will take him, and as soon as a reasonable opening offers, put the fellow best able to fill it in the place.

In the course of training require eight hours a day, five and one-half days in a week, and at least fifty weeks in a year of faithful shop work; two hours a day, five days in the week, for study, recitations or drawing, and two hours each evening, five days in the week, for writing, lectures and study. In this four hours a day not only all can be taught that that class of men who are to be the mechanics of the future can remember, and three or four years of training of this kind will not only make the best of workmen, but workmen educated up to the highest point that will ever be of any use to them. If a workman can figure whatever comes to him to do in his business, if he can write a good letter or a good description of what he has to do, or work with, and if he can read understandingly, he has about all that can do him any good, as a workman. If he is better educated he may be a better or a worse man, according as he makes use of that education; that it always makes him a better citizen is belied every day in the year; that it always makes him a more reliable voter is belied in every charter election. The only education that *never* fails to make a man better is that education that teaches him how to earn a living by work.

The educational facilities should be such as are necessary to fit a young man to enter a technical school, so that where one shows the ability and the inclination to go beyond the scope of the industrial branch, he would in no way be hindered, but rather fitted for it.

The library of the industrial college need not contain a book worth more than a dollar or two. Let the library be a free circulating one without a librarian, and the one or two thousand dollars usually paid to a librarian as salary be expended in buying half a thousand books to replace those carried off or worn out during the year. Make the entire machine shop a tool-room, and each and every apprentice a tool-room boy.

There is no reason why the whole place should not be managed with the same discipline as a school, except where in some respects the school rules would be useless.

As to the class of work, build the same things built in other shops, and sell them in the open market for what they will bring. As time expended on the work is an element of no cost, the work after the third year could be certainly as well done as the average shop work, and, too, as the work cost does not enter into the product, all sorts of machines and tools could be built, and one of the best places imaginable to test new ideas provided. By doing this class of work no antagonism would be engendered with the regular outside shops; furnishing them with good men would gain friendship and aid, and any opposition from the trades union would only arouse public indignation, against which nothing but right can succeed. We can readily anticipate a score of objections that will be raised to this proposition.

First, it will be said it cannot be made to pay; in dollars and cents, no one with experience would expect it could; no school pays in that sense; but with the tuition fees, with the work free, with shop tools and power furnished, with instructors at small salaries, the drain on the endowment would be nothing comparable to that of the literary or technical colleges of the same magnitude.

Second, it will be said, good and salable work cannot be done if nothing but apprentice labor is employed. In reply to that, it is only necessary to say that the work need not be wholly confined to apprentice labor. Besides, it is well known that at one time at Cornell University there was done, by student labor alone, and, too, students working but two hours a day, regular machine shop work comparable, and in some respects superior to the average work done in the regular shops. To keep the commercial side of the work before the apprentices, that is, to teach them how to do work, and how to do it in a paying time, teaching the best way at first, and during the last year compelling them to work by the piece, and giving them the benefit of their work, will do more than all talk, or all the outside experience possible, except where piece work is practiced.

Third, it will be doubted if enough young men can be found, whose parents will have the disposition, and can afford to pay the tuition fee, where the custom has been to have the compensation go the other way. But when it is understood that there are hundreds of apprentices in England, where hundreds of pounds are paid for the opportunity, and one receives constant offers of compensation, as we do, there need be no doubt on that score.

Fourth, it will be said that money cannot be raised to establish such an institution; but that depends. Wealthy people are constantly bestowing their gifts upon what they believe to be worthy objects. They usually do it from one or two motives; either the glory it brings, or the actual desire to do good. Even admitting that in many cases it is done from the first motive, there are others where it is not, and there are such men as Ezra Cornell, who if they became convinced that this was the most desirable thing to do, would that much the sooner give their money for such a purpose. Let a certain institution of this kind be established, and its work shown to be good, and other men would be ready to establish a foundry, a school of carpentry, of masonry, of carriage building, of cabinet making, and the like, and were these schools recognized by the state, and chartered as colleges, or the whole assembled and chartered as an industrial university, the title of this paper would be realized.

As to the question, Will it pay? Will it pay to further fill up the now over-crowded ranks of the professions, or the army of educated idlers, and leave our boys seeking an honest trade to fall into poverty and crime? Or had we better spend something to save them from debauchery, and fill our workshops with our own countrymen, preparing them for lives of usefulness, rather than food for our poorhouses and prisons, leaving our workshop the haven for foreign mechanics.

HINDRANCES TO INVENTIVE PROGRESS.

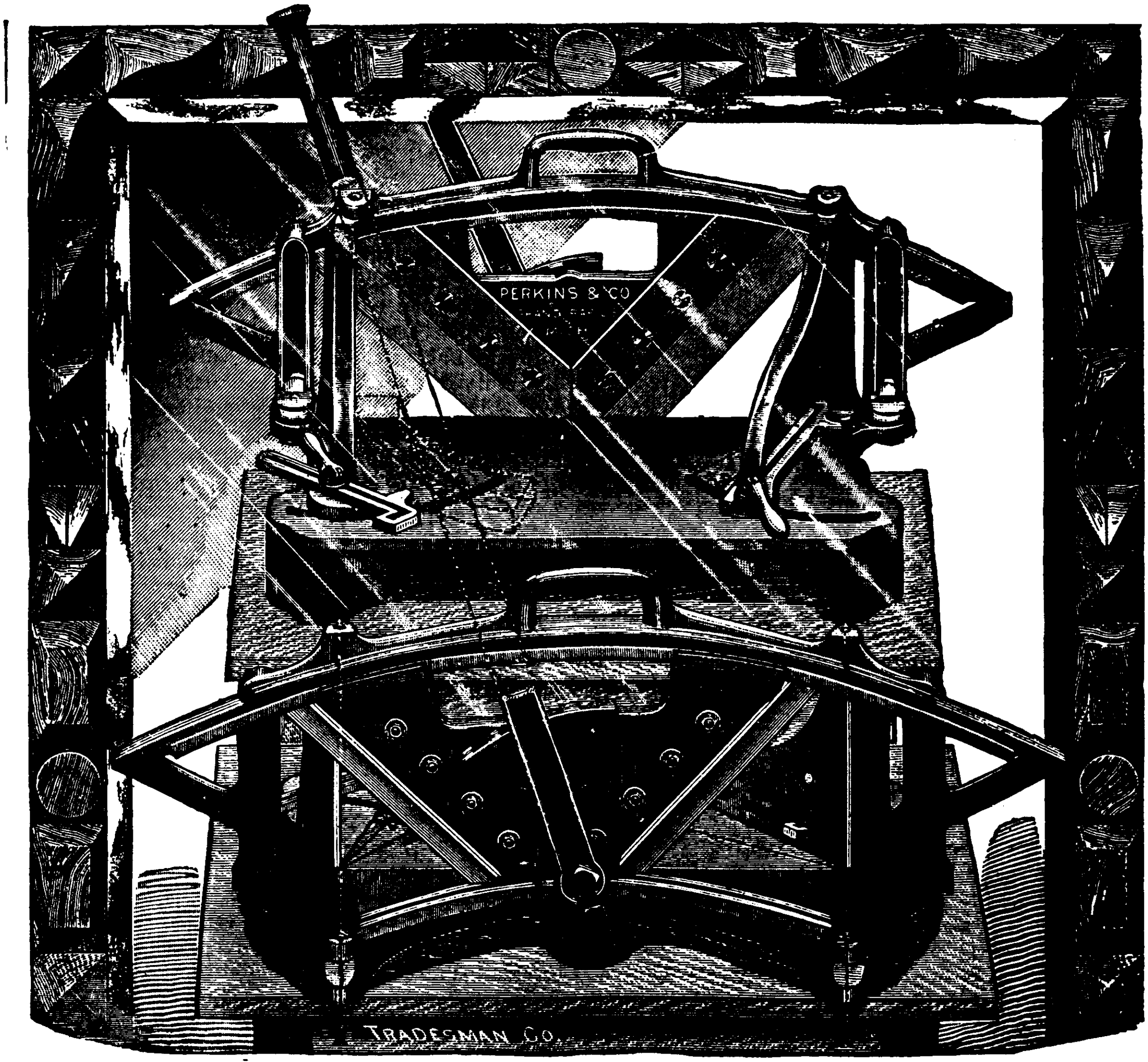
What are the chief discouragements to inventive progress? One of these is the hindrance imposed by the existence of inferior methods for accomplishing works of the same class to which improved means would apply. To this is allied the suppression of valuable patented devices in the interest of monopolies, their suppression in the interest of labor, and the competition among inventions themselves. Great as the influence of the patent system has been and is, in the encouragement of invention, it has nevertheless been very considerably abused in enabling the purchase and suppression of valuable inventions by parties interested in maintaining methods that the new means would otherwise supplant. Persons controlling corporations, or exerting, either directly or through connections, a powerful influence therein, are often enabled to secure a preference for one device over something that may be far superior. Great corporations enjoying monopolies of their business are likely to be indifferent to the improvement of their service in the interest of their patrons and the employment of better means for the convenience of the latter, unless they have been thoroughly taught that it is for their interest to do so. The telegraph and telephone monopolies in this country are instances of this; the former resting upon the assimilating capacity of a large accumulation of capital in one enterprise, and the latter upon the proprietorship of a basic invention. The practical adoption of any improvement in the telegraph or telephone would not at present be possible without the consent of these companies. The supplanting of one form of machinery by an improved form, and the injury or destruction of enterprises with their capital invested in the old, is one of the greatest elements of cost or waste in the modern production, and manufacturers are obliged often to figure very closely to see whether it would profit them to adopt some improved method.

It frequently happens that no sooner has a new way of doing something been perfected and set in operation than some one else comes forward with still another means of reaching the same result, and either by his competition prevents the other from reaping fully the anticipated harvest of his skill, or supersedes the former method entirely and ruins the enterprise. The opposition of labor to the introduction of new inventions is very old. From the early days of the power loom and the railway down to the present time the story has been the same—on the part of the workers the most strenuous opposition to the employment of labor-saving devices, for fear of being thrown out of work. Experience has shown us that, on the whole, there has been no loss of occupation for the working classes from this cause, since the increased production attendant upon the use of labor-saving machinery and the creation of new industries causes a demand for labor under the new conditions at least equal to that existing before. Yet nearly every mechanical device that does the work formerly performed by several persons can hardly fail to effect great injury to many individuals, and even to large classes of workingmen, by reducing them from the ranks of skilled to unskilled laborers, and disturbing the equilibrium of industry.

The progress of invention would be, doubtless, very much more rapid were it not for this opposition on the part of labour, and production would be correspondingly cheapened. Organized labor has of late years exerted a powerful influence against the substitution of mechanical processes for the more slow and costly hand work. That strong organization in the boot and shoe industry, for instance, the lasters' union, forbids the employment of machinery to do any part of the work within its province, and, in consequence, some very costly devices in shoe shops have been compelled to stand idle. Owing to the objection of the Knights of Labor, the use of power presses in the engraving department of the National Bureau of Engraving and Printing at Washington is not allowed, although the cost of production is enormously increased to the government by the employment of hand presses. Labor cannot be blamed for this opposition in its own behalf, any more than capital can be blamed for combating any measures that tend to limit its liberty of action—*Sylvester Baxter, in the Cosmopolitan for April.*

A NOVEL METHOD OF PRESENTING PICTURES OF MACHINERY, ETC.

At first glance, the engraving herewith shown will be likely to puzzle the reader, as it puzzled the writer, and it was not until it had been closely inspected that the mystery was cleared up. The artist in this case has presented two views of the machine—a front and rear view, one above the other, aligned accurately in perspective, so as to show one directly above the other, with the object in view of exhibiting the construction and operation of the mechanism more clearly. As a matter of fact, this plan of illustration may in



DRAW-STROKE TRIMMER.

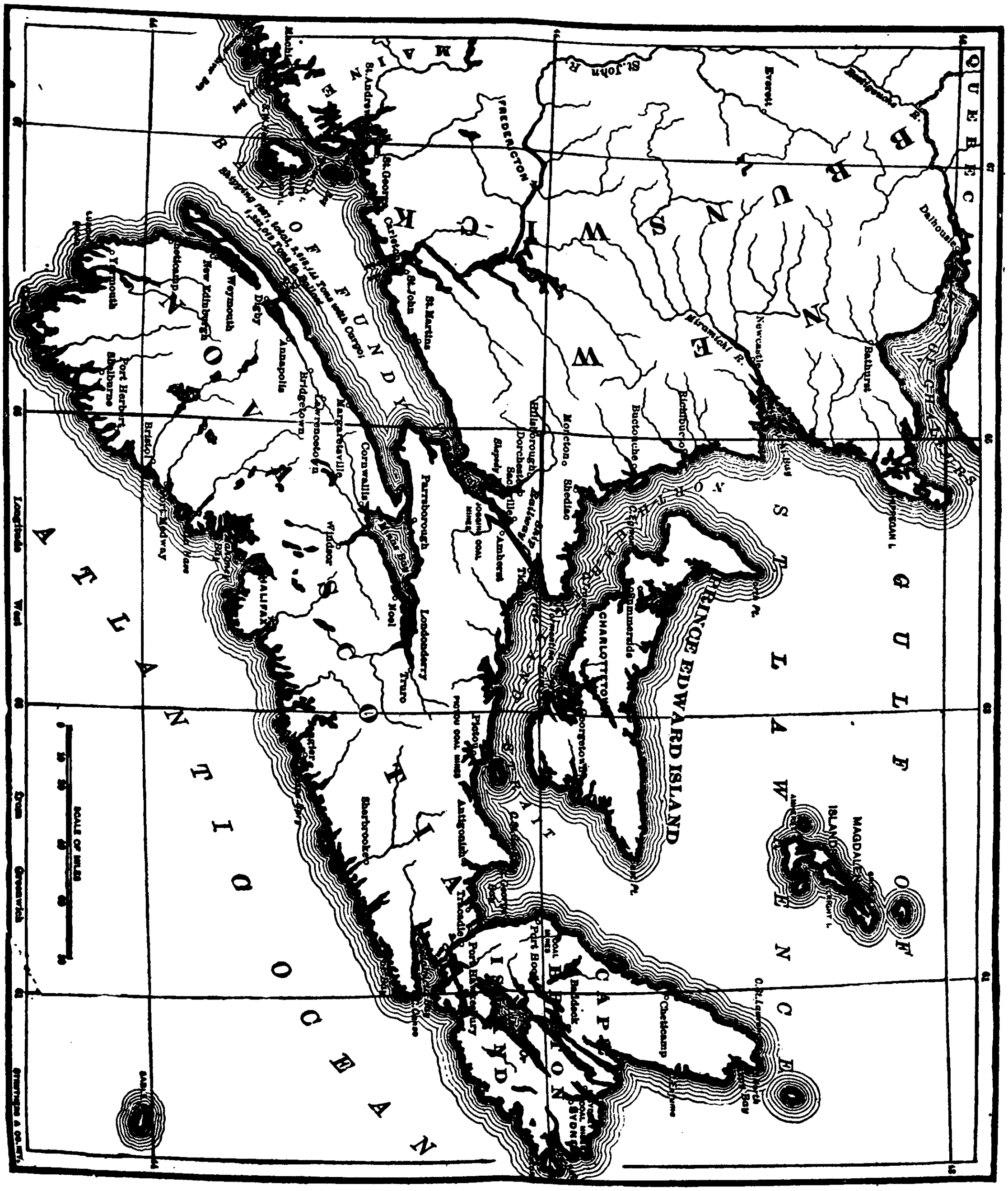
many cases be found extremely useful, especially when the details of a highly complicated piece of mechanism are required to be shown, which, if engraved separately, might not be so clear or comprehensible as when exhibited in this way. It is a useful hint which engravers of machinery may profit by.

The method followed by the engraver in this case, was to place the machine before a mirror inclined at such an angle that the reflected image of the back of the machine, and the direct image of the front, when photographed together, should appear superposed in the picture. The result is seen in the engraving referred to, in which the front and back of the machine are shown at a single glance. The artist in this case has gone a little further, and has exercised his ingenuity by making the frame of the mirror of the various shaped blocks that the machine is capable of forming, showing thus its adaptability for cutting bevels, outside circles, etc.

So much for the mode of making the picture, and a few words about the machine itself may not be amiss. It is the Perkins draw-stroke trimmer, and is a useful and convenient machine for the work of cutting angles, circles, miters, bevels, etc., on patterns, straight work, moldings, irregular designs; for making perfect fits, glue joints, etc., for which it is specially adapted to the wants of pattern-makers, ship-builders, cabinet-makers, piano and organ builders, car-builders, and general wood-workers.

The front view of the machine exhibits clearly the curved track described by the knife, the downward inclination of which motion gives the draw to the stroke which is necessary to make a clean cut. The dotted lines show the axis on which the gauge is pivoted. It is also the plane of travel of the cutting edge of the knife, so that the shifting of the gauge to any degree with the knife, in determining the angle at which to cut the stock, does not alter the relative positions of the knife and the shearing edge of the gauge. This presentation of relative positions is necessary to insure cleanness of cut in the work.

In cutting stock having an irregular face, as a segment of a circle (shown in dotted lines), the link is fastened in the position shown in the reflected view at the left, forming a stop for the outer end of the



MAP SHOWING THE LOCATION OF THE CHIGNECTO SHIP RAILWAY.

work to rest against, and not changing the relation of the gauge to the knife or bed.

The gauge has a slot in it, through which a projection on one end of the link is adapted to pass (see the lower right-hand gauge), so as to form an abutment, and is useful in determining the size of a number of small pieces; when turned round and extended outward, the projection on the opposite side of the link forms a similar stop by which to gauge longer pieces. A lever movement actuates the knife by means of an anti-friction roll, engaging with the raceway on the knife-head. The handle is made detachable by a very simple lock integral with it, consisting of a slot in the end and a lug projecting midway from the side; the lug engages with suitable indentations in a segment of an arm, which is pivoted to the machine frame. To adjust the handle, it is only necessary to remove and shift its engagement with the segment.

To protect the operator from injury, the knife is shielded by the projecting ends of the slideways. The travel of the knife, finally, is limited by a suitable stop.—*Manufacturer and Builder.*

THE CHIGNECTO SHIP RAILWAY.

We give a map showing the location of an interesting and novel engineering enterprise which is now under construction in Canada. The proposal to carry ships by railway has been frequently discussed and elaborated before, notably in connection with the Isthmus of Panama and the adjacent Honduras and Nicaragua interoceanic routes, but the Chignecto ship railway is the first practical attempt to supersede canal communication by means of railway lines.

The narrow neck of land connecting the Province of Nova Scotia with the mainland of Canada has long been considered as a suitable site for a canal, to obviate the long and dangerous coasting voyage either by the Straits of Canso or that outside Cape Breton Island, a saving of some 300 or 700 miles respectively. The route has frequently been surveyed by engineers, but the heavy cost of cutting the canal and the practical difficulties connected with the extraordinary rise of the tides (some seventy feet at springs) in the Bay of Fundy have prevented the execution of the work. The scheme of Mr. Ketchum, C.E., for a ship railway, was finally adopted, and the Chignecto Marine Transport Railway was incorporated by special act of the Dominion Parliament, with a share capital of $2,000,000, and an authorized debenture capital of $3,500,000. The Canadian government, in consideration of the advantages to accrue to the maritime provinces and the intercolonial trade generally, granted to the company a subsidy of $175,000 a year for twenty years from the opening of the line. The capital was raised in London, and a contract made with Messrs. Jno. G. Meiggs & Son for the work. Construction was commenced in September, 1888. Sir John Fowler and Sir Benjamin Baker, the well-known engineers of the Forth bridge, are associated with Mr. Ketchum in the superintendence of the works, which it is expected will be completed in the autumn of the present year, 1891. The principal portions of the great work are now approaching completion.

The map which we give shows the position of the railway and the great saving of distance to be effected by the use of the new route, which will moreover permit the use of lake-going vessels in the coasting trade between New England and Canadian ports. A basin 500 feet long and 300 feet wide is constructed at the Bay of Fundy end of the line, with a gate to inclose the water when the tide is out. Leading from this basin is a lifting dock 230 feet by 60 feet, containing twenty hydraulic presses for lifting vessels with their cargoes a height of forty feet. The vessel is floated into position between the presses and immediately over a gridiron and cradle, the whole being then raised by the lift until the rails supporting them are brought up to the level of the rails on the railway. The vessel and the cradle (which rest on wheels) will then be hauled off, by hydraulic apparatus, to the railway track. The extreme weight proposed to be raised is 3,500 tons, including the gridiron cradle and a loaded vessel of 2,000 tons displacement, or 1,000 tons register.

The railway is a double track, seventeen miles long, perfectly straight and on almost a dead level, the steel rails weighing 110 lb. to the yard. The large number of wheels carrying the cradle will distribute the load, so that each wheel only carries a comparatively small burden. Two locomotives, one on each track, are calculated to move with ease the largest vessel proposed to be carried across, at the rate of ten miles an hour. On arriving at the terminus a reversal of the process will lower the vessel to the water level, the whole transit occupying a period of two hours.

It seems probable that, when the practicability of the system has been demonstrated on the Chignecto railway, the transport of ships by rail may be adopted on several routes where for various reasons waterways cannot be provided. Theoretical objections to the scheme meantime have little weight in face of the opinion of the eminent engineers who have planned and now superintend the work, and of the support of the Canadian government, evidenced by the guarantee given to the capital. In subsequent numbers we intend to illustrate the details of this remarkable work.—*Scientific American.*

RIGHTS OF EMPLOYERS TO INVENTIONS MADE BY THEIR EMPLOYES.

An interesting patent case was decided not long ago by the Supreme Court of the United States in which the rights of employers with respect to inventions made by their employes, at the expense and in the time of the employer, are set forth. This was a suit brought by Solomons, assignee of Clark, against the United States, to recover damages for the use of a self-canceling revenue stamp, invented and patented by Clark.

It appears that during the years 1867 and 1868, Spencer M. Clark was in the employ of the government as Chief of the Bureau of Engraving and Printing. While so employed he was called officially into consultation with the Secretary of the Treasury, commissioners, and the committee of the House of Representatives, and to him was assigned the duty of devising a stamp. In these consultations it was mutually understood that Mr. Clark was acting in his official capacity, as Chief of the Bureau of Engraving and Printing.

Mr. Clark laid before the Commissioner and committee a self-canceling revenue stamp as being, in his opinion, a very desirable stamp for the prevention of fraud. This stamp was satisfactory to the Committee on Ways and Means and to the Commissioner of Internal Revenue.

No bargain, agreement, contract, or understanding was ever entered into or reached between the officers of the government and Mr. Clark concerning the right of the government to use the invention, or concerning the remuneration, if any, which should be paid for it. Neither did Mr. Clark give notice or intimate that he intended to protect the same by letters patent, or that he would expect to be paid a royalty if the government should manufacture and use stamps of his invention. Before the final adoption of the stamp by the Commissioner of Internal Revenue, he stated to him that the design was his own, but that he should make no charge to the government therefor, as he was employed on a salary by the government, and had used the machinery and other property of the government in the perfection of the stamp. No express license to use the invention was ever given by Mr. Clark to the government, nor any notice prohibiting its use, or intimating that he would demand a royalty.

Before Mr. Clark had filed an application for a patent, the Commissioner of Internal Revenue adopted the stamp as the one to be used in the collection of the tax on whisky and distilled spirits. It was adopted by the Commissioner on the recommendation of Mr. Clark, and engraved and made in the Bureau of Engraving and Printing and approved by the Committee of Ways and Means. The government then proceeded to manufacture at the Bureau of Engraving and Printing large quantities of these stamps. On Dec. 21 1869, a patent was granted to Solomon, as assignee of Clark, for the invention.

In the Court of Claims judgment was entered in favor of the government. From such judgment an appeal was brought to the Supreme Court.

Mr. Justice Brewer delivered the opinion of the Court, from which we abstract the following:

The government has used the invention of Mr. Clark, and has profited by such use. It was an invention of value. The claimant and appellant is the owner of such patent, and has never consented to its use by the government. From these facts, standing alone, an obligation on the part of the government to pay naturally arises. The government has no more power to appropriate a man's property invested in a patent than it has to take his property invested in real estate; nor does the mere fact that an inventor is, at the time of his invention, in the employ of the government transfer to it any title to or interest therein. An employe, performing all the duties assigned to him in his department of service, may exercise his inventive faculties in any direction he chooses, with the assurance that whatever invention he may thus conceive and perfect is his individual property. There is no difference between the government and any other employer in this respect. But this general rule is subject to these limitations:

If one is employed to devise or perfect an instrument, or a means for accomplishing a prescribed result, he cannot, after successfully accomplishing the work for which he was employed, plead title thereto as against his employer. That which he has been employed and paid to accomplish becomes, when accomplished, the property of his employer. Whatever rights as an individual he may have had in and to his inventive powers, and that which they are able to accomplish, he has sold in advance to his employer.

So, also, when one is in the employ of another in a certain line of work, and devises an improved method or instrument for doing that work, and uses the property of his employer, and the services of other employes to develop and put in practicable form his invention, and explicitly assents to the use by his employer of such invention, a jury, or a court, trying the facts, is warranted in finding that he has so far recognized the obligations of service flowing from his employment and the benefits resulting from his use of the property, and the assistance of the co-employes, of his employer, as to have given to such employer an irrevocable license to use such invention.

The case of *McClurg v. Kingsland* (1 How., 202) is in point. In that case was presented the question as to the right of the defendants to use an invention made and patented by one Harley. The facts as stated and the rulings of the court are these:

That Harley was employed by the defendants at their foundry in Pittsburg, receiving wages from them by the week. While so employed, he claimed to have invented the improvement patented, and, after several unsuccessful experiments, made a successful one in October, 1834. The experiments were made in the defendants' foundry, and wholly at their expense, while Harley was receiving his wages, which were increased on account of the useful result. Harley continued in their employment on wages until January or February, 1835, during all of which time he made rollers for them. He often spoke about procuring a patent, and prepared more than one set of papers for the purpose; made his application the 17th February, 1835, for a patent. It was granted on the 3d of March, and assigned to the plaintiffs on the 16th of March, pursuant to an agreement made in January. While Harley continued in the defendants' employment he proposed that they should take out a patent, and purchase his right, which they declined. He made no demand on them for any compensation for using his improvement, nor gave them any notice not to use it, till, on some misunderstanding on another subject, he gave them such notice, about the time of his leaving their foundry and after making the agreement with the plaintiffs, who owned a foundry in Pittsburg, for an assignment to them of his right.

The defendants continuing to make rollers on Harley's plan, the present action was brought in October, 1835, without any previous notice by them. The court left it to the jury to decide what the facts of the case were, but, if they were as testified, charged that they would fully justify the presumption of license, a special privilege, or grant to the defendants to use the invention; and the facts amounted to "a consent and allowance of such use," and show such a consideration as would support an express license or grant, or call for the presumption of one to meet the justice of the case, by exempting them from liability, having equal effect with a license, and giving the defendants a right to the continued use of the invention.

On review in this court, the rulings of the trial court were sustained. That case is decisive of this. Clark was in the employ of the government when he made this invention. His experiments were wholly at the expense of the government. He was consulted as to the proper stamp to be used, and it was adopted on his recommendation. He notified the government that he would make no charge if it adopted his recommendation, and used his stamp; and for the express reason that he was in the government employ, and had used the government machinery in perfecting his stamp. He never pretended, personally, to make any charge against the government. Indeed, there is but one difference between that case and this. In that Harley's wages were increased on account of his invention; in this, Clark's were not; but such difference does not seem vital. We think, therefore, the rulings of the Court of Claims were correct, and its judgment is affirmed.

BEAUTIFUL EXAMPLE OF DIFFRACTION.

BY GEO. M. HOPKINS.

Diffraction, as is well known, is the change which light undergoes when passing the edge of a body, or in passing through a narrow slit or aperture in an opaque body. The rays appear to become bent so as to penetrate into the shadow of the body. A common example of this phenomenon is the experiment in which a beam of light is made to pass across the edge of a sharp instrument, a razor, for example.

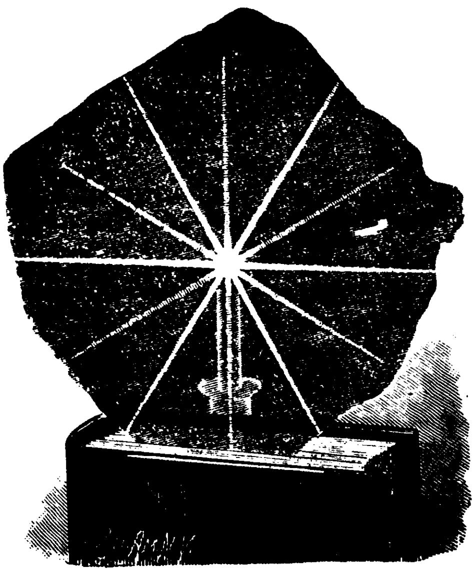


FIG. 1.—STAR MICA.

The most beautiful example of diffraction phenomena is given by the gratings used for producing the spectrum. As we have at present nothing to do with the purely scientific application of this phenomenon, we confine ourselves to a single example, as shown in the mineral commonly known as star mica (phlogopite). A thin plate of this mineral placed opposite a point of light, such as a candle flame or a small gas flame, exhibits six radial bands of light emanating from a point opposite the flame, and arranged symmetrically at the angle of 60 deg. These bands rotate with the plate when it is turned in its own plane; often more than six such bands are shown, but the number is always a multiple of six.

In Fig. 1 is shown a star-like figure produced in the manner described, which is really composed of two like figures each having six radial bands, one figure being much stronger than the other. Microscopic examination of the plate shows a multitude of minute, needle-like crystals. The light passing over the edges of these crystals is diffracted or bent, so that the rays which reach the outer edge of the plate, as well as those passing through the central portions, are bent inward in their passage, so that they meet in the eye and produce the phenomenon described. It has been ascertained that these minute crystals are "hemimorphic crystals of rutile elongated in the direction of the vertical axis." This phenomenon was noticed by G. Rose as early as 1862, but the nature of the crystals was ascertained by Lacroix.

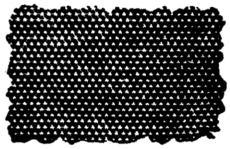


FIG. 2.—LINES SHOWING THE ARRANGEMENT OF CRYSTALS PRODUCING SIX RADIAL BANDS.

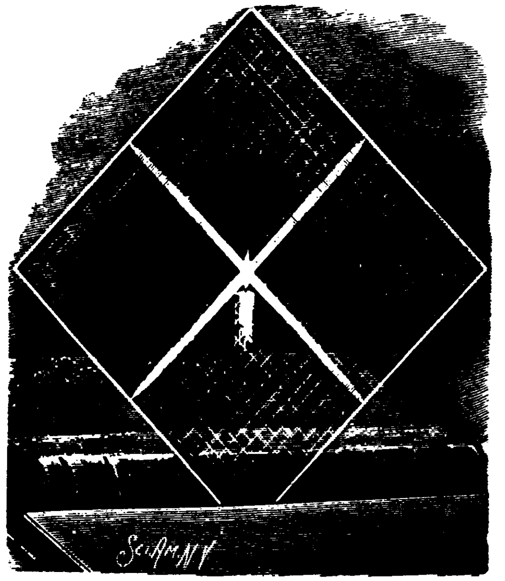


FIG. 3.—GLASS SCRATCHED IN TWO DIRECTIONS. ANGLE OF 90°

The diffraction phenomenon shown by the star mica may be produced artificially by forming minute scratches in the surface of glass; the diffraction bands are of course at right angles to the lines or scratches by which they are formed, therefore if the plate is scratched in one direction, one band will be produced reaching across the plate at right angles to the scratches; if scratched in two directions, two bands will be produced, as shown in Fig. 3; and Fig. 4 represents a glass plate scratched in four directions, the lines being at the angle of 45 deg., thus producing eight radial bands when the plate is placed in front of a point of light.

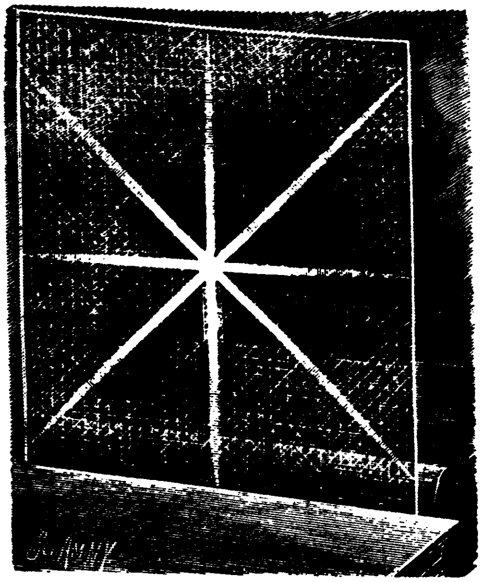


FIG. 4.—GLASS SCRATCHED IN FOUR DIRECTIONS. ANGLE OF 45°

It is obvious that by the proper arrangement of the lines any number of radial bands might be produced. The scratches in the glass are almost imperceptible; they are readily produced by rubbing the glass lengthwise and crosswise by a block covered with fine emery paper, the block being guided by a rule.

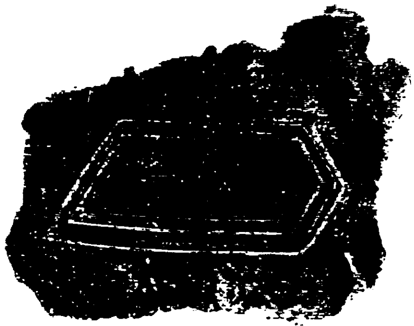


FIG. 5.—ARRANGEMENT OF CRYSTALS IN MICA.

A beautiful example of the intergrowth of the fine crystals is shown in Fig. 5; the dark and light bands here represented are formed by these crystals, which curiously enough arrange themselves along lines parallel with the sides of the mica crystals in which they are contained. For this example of crystal the writer is indebted to Mr. S. G. Burn, mining engineer.

Some of the points on the star mica were furnished by Mr. L. P. Gratacap, Assistant Curator of the American Museum of Natural History.

THE SHIPS OF THE FUTURE.

There are many and multiplying evidences that the arts of the marine engineer and of the naval architect are neither lost nor inactive. There has probably never been a period when so much enterprise, such bold and original conceptions, and such far-reaching designs were being put forward as there are at the present day. It might have been supposed that, after the enormous development that has taken place in the shipbuilder's art during the last twenty years, there was little more to be said or done, and that both shipbuilders and shipowners had only to rest and be thankful. Instead of this, however, we find that the heights already "reached and kept" by the marine engineer are only regarded as gentle eminences from which to view the promised land that lies far away, and that there is no idea of finality in the possibilities of the future. Only a few months ago Sir Nathaniel Barnaby expressed his opinion that "we shall get the mastery over the seas, and shall live more happily in a marine residence capable of steaming 15 knots an hour than we can ever live in seaside towns." As a contribution towards this end, he proposed to construct a vessel 1,000ft. long and 300ft. broad, with engines of 60,000 horse-power, and capable of steaming at 15 knots. Such a ship would be, in point of fact, a steel island, incapable of entering any dock, and having still-water harbours or docks within the vessel herself, entered by gates in the sides, where she would carry loaded barges and tugs. Sir Nathaniel has satisfied himself that such a ship could be made absolutely secure against fatal injury arising from perforation, but she would require to be fortified and garrisoned like a town. This is undoubtedly a bold idea, and one that opens up a wide vista of possibilities in the future. Lord Brassey, in his admirable paper read last week at the meeting of the Institution of Naval Architects, defined the requisites that were, in his opinion, called for in different types of warships, and indicated the desirability of keeping the dimensions of warships within 10,500 tons, rather than increasing them to 14,000 tons, which has been considered in some quarters a practicable limit. One advantage of such an arrangement would be that the same tonnage would, by a reduction of the maximum, give eight ships instead of six. This view of the future policy of warship construction has been approved by Sir N. Barnaby, who says that "a large naval Power, having very widely spread interests, and subject to modern modes of attack, would suffer more in a war from fewness of ships than from comparative smallness of size of ships and of crews." In the next sentence the same authority appears to draw a sharp distinction between warships and merchant vessels, in reference to the question of dimensions, for he adds that "the advantages arising from size in a passenger ship seem to be so great that I do not see where we shall stop."

It appears, therefore, as if the shipbuilding programme of the future were to be directed to increasing still further the size of passenger or merchant ships, and decreasing the size of war vessels. This policy has, indeed, received the sanction of the most eminent naval authorities of the day, and it is sanctioned by the accumulated experience of the greatest naval power in Europe. The main object of a navy like ours is that of protecting our commerce, which, as Lord Brassey told his audience last week, is always afloat to the value of over 150 millions sterling. That commerce is likely to be much more effectually protected if the merchantmen which compose the mainstay of British commerce are to be increased in size, so as to limit their number relatively to the work to be done, and if the warships which are to protect them are so far increased in number as to be more widely scattered over the wide dominions belonging to the English Crown. According to a table submitted by Lord Brassey, the total strength of the British navy at the present time is 170 vessels of all kinds—of which 32 are first-class and 13 are second-class battle-ships—having a total tonnage of 921,000. The average tonnage of the first-class battle-ships is rather over 11,000, so that it exceeds the limit fixed by Lord Brassey as most convenient and desirable. It is probable that this limit will be steadily reduced in the Admiralty programme of the future, and that our naval administrators will aim rather at a handy, easily manageable size of vessel, possessed of adequate speed and sufficient coal endurance, rather than a naval colossus, with armaments that may, indeed, be powerful on paper, but which experience has proved to be wanting in power in cases of emergency. The future marine architect must study compressibility, and must secure the maximum of speed and of fighting power with the minimum of size.

But the remarkable scheme for a new type of merchantman propounded by Sir Nathaniel Barnaby appears to point to the possibility of a ship that will be competent to undertake either aggressive or defensive warfare. He speaks of a vessel "fortified and garrisoned like a town" Such a ship would probably be able to undertake its own defence, and to give a good account of itself in any emergency that it might be called upon to face. In such an event, how far would our naval strength be required for defensive purposes? There would seem to be a possibility of having each individual merchantman constructed like and as a fortress, with both carrying and defensive capacities far in excess of anything hitherto dreamt of, but unlimited in speed by reason of its unwieldly proportions. In merchant ships, as in factories and workshops, economy of working is a concomitant of size, and it is hardly to be doubted that a "floating island," like the vessel contemplated by Sir N. Barnaby, if practicable at all, would be more economically worked than a number of smaller vessels of nominally the same carrying power. There is only one serious drawback to this magnificent scheme. It is doubtful whether the "floating island" could even approach some of the principal docks and harbours, although Sir N. Barnaby appears to think that a draught of 26ft. of water would be sufficient; but even if this were so, there are not many ports that could furnish the cargoes necessary to fill up such a structure, and hence it could only be used, if used at all, between the largest ports, such, for example, as those of Liverpool and New York. The idea of a vessel of 1,000ft. in length engaging in the business of an "ocean tramp" is hardly to be seriously entertained. If it should be found that a structure like that described should be the ship of the future, and if it should appear that by some vast leviathan the mastery over the seas is to be obtained, the future would be likely to witness developments of shipbuilding and marine engineering far more notable than anything hitherto attempted or achieved.—*Industries.*

HOW TO MAKE A BLACKBOARD.

Select seasoned pine lumber of the first quality and good width. Plane it well, joint nicely, and glue a sufficient number of boards together to make the required blackboard four feet in breadth. For end pieces use scantling which will dress two by three inches; saw them a few inches longer than the proposed width of the board; cut a slot through the pieces on the flat side, so as to admit the ends of the board, with an inch to spare at the top; into this spare space insert a key, and drive home. To hold the end pieces in position the board may be dovetailed at its lower edge. Form a chalk trough by nailing a strip of half inch stuff, five inches wide, to the lower edge of the board, and nailing to this strip, on its outer edge, a similar one two and one-half inches wide. Bevel or round off the inner edges of the end pieces in a workmanlike manner, and smooth the surface of the board with fine sand-paper before painting. The board may be supported by leather straps attached to the top. No nails or screws are used, because they compel the forming of cracks whenever there is shrinkage, by holding the several boards apart; by leaving the whole free to slide in the slot, and following up all shrinkage with a key, occasionally tightened, a perfect surface is secured.

DIRECTIONS AND RECIPES FOR PAINTING.

No paint in which there is oil should be used. Holbrook's, Sherwood's, "Alpha," and "Eureka" liquid slatings are first class paints. They come in pint, quart, and gallon cans, and are ready to use at any moment, and can be kept for years if tightly corked. One gallon will paint 250 square feet, and costs $6 to $8. Any school furnishing house will fill orders.

The following is taken from Wickersham's "School Economy."

"To make one gallon of paint take 10 ounces pulverized pumice stone, six ounces pulverized rotten stone, three-quarters pound of lamp black, and mix with alcohol enough to make a thick paste. Grind the mixture thoroughly, and then dissolve 14 ounces of shellac in the remainder of the gallon of alcohol. Stir the whole together and the paint is ready for use."

The composition named below has been tried up on old boards and new with excellent success. Dissolve gum shellac in alcohol, and mix with it lamp black and flour of emery. No more lamp black and flour of emery should be used than is necessary to give the required black and abrading surface, and sufficient gum to hold the materials together, and confine the composition to the board. The thinner the mixture, the better. The lamp black should first be ground with a small quantity of alcohol to free it from lumps. Apply with a common painter's brush, and when dry smooth with pumice stone.

A still cheaper preparation, though hardly as durable, may be made and applied by any school teacher before nine o'clock on a summer morning, and used in a half hour thereafter. For fifty square feet of board take four ounces of common glue, three ounces flour of emery, and just lamp black enough to give an inky color to the preparation. Dissolve the glue in three-quarters of a quart of warm water, put in the lamp black and emery, and stir until there are no lumps, then apply to the board with a woolen rag smoothly rolled. Put on two or three coats, evenly, and you have a nice surface at a cost of about thirty cents for material. You may call this the "Poor District's Paint."

Caution. No pupil should be allowed to erase with his hand, or a wet eraser, from this or any other board.

Quoting again from Wickersham: A cheap and serviceable black surface may be made by the following recipe: four pecks of white finish or white coating; four pecks of fine sharp sand, four pecks of ground plaster; four pounds of lamp black; four gallons of alcohol or good whisky. This quantity will make a mixture sufficient to cover twenty square yards. A little flower of emery will prevent the mixture from "setting" immediately, thus giving time to put it on the wall with the necessary care. If emery be not used, only a small quantity of the mixture can be put on at a time, and this is, perhaps, the better way.

The wall which is intended to be covered with the black surface ahould be plastered like the rest of the room, with the exception that the black mixture takes the place of the white coating, and is put on in the same manner. After the black surface is on the wall, it must be carefully dampened and rubbed in order to fill up the pores, and make the surface hard and smooth. If the old surface be well moistened, a new surface, composed of the same mixture, may be applied. It must be remembered that the black surface requires much more working with the smoothing trowel than the white finish.

PLASTER BLACK WALL.

Nearly or quite all black walls in this portion of the State, made within wooden buildings, have failed to stand. The mortar seems of poor quality, and the lath, constantly springing beneath the pressure of the hand while marking, causes the plastering to crack and fall in a very short time. To prevent this the room should be sheeted inside the studding, furred and lathed on that, and the first coat of plastering pressed in against the sheeting with great care. A very firm wall is thus secured. The black belt should be four feet wide, and come within two and one-half feet of the floor. It should surround the room. A chalk trough should extend its entire length, and it should be bounded at its upper edge by a simple moulding.

PAPER BLACK SURFACE.

When care has been taken to secure a good wall, strong manila paper, which is manufactured for the purpose, may be smoothly pasted on "hard finish," and then painted with liquid slating. It has proved durable in some instances, its durability depending, however, very largely on a smooth surface beneath. —*Minn. Teacher.*

THE FAITH OF INVENTORS.

Unshaken faith in their ideas and a determined perseverance to overcome obstacles are gifts with which inventors have been endowed, or, in common parlance, they have their inventions "on the brain" —mount their hobbies and ride them continually. If they were influenced by rewards, or hopes of reward ultimately, it would seem in the eyes of the world at large, that there was a "method in their madness," and that the tangibility of wealth was the terminus of the "hobby" race. But we find a large proportion of inventors unbiased and uninfluenced by any hope of wealth, money or reward. They labor and experiment as though their existence depended upon it; they labor with the hope only of ultimate success in accomplishing what they proposed to perform, and that labor is with them a labor of life and love. This labor is ever constant to their minds, ever uppermost in their thoughts, ever exerting itself in every movement and every action. They are determined, in overcoming every resistance. It is an example of the power of mind over matter—of intelligence over the powers of nature.

And what does the world not owe to inventors? Civilization, arts, and commerce are the fruits of the inventors' "hobbies," and the greater part of these fruits have been the product of toil, many years of labor, at a cost of life, privation, and poverty; yet such was the inventors' faith that all obstacles have been overcome, and often after the results are obtained the fruit is left for others to mature and gather. Galileo declared the world "did move," and a prison was the result. Columbus, on the eve of his discovery, was nearly being thrown overboard by his discontented mariners. Harvey, the discoverer of the circulation of the blood, and Jenner, who first practiced vaccination, may be cited as examples of how great discoverers may be treated by the world before their discoveries are appreciated. Among the mechanics of a later day, Fulton, who was declared crazy; Colt, who had to mortgage his little stock of tools to obtain money to make his pistol; Goodyear patiently toiling to obtain his results in the manufacture of rubber; Howe, bravely meeting all adversity to finish and introduce the sewing machine, may be cited as a few—very few—examples of struggling but afterward successful inventors. The list might be extended almost *ad infinitum.* Yet when success is achieved and the true value of the invention appreciated, the tardy meed of praise is tendered to the persistent faith of the inventor who accomplished the results.

Nor are poverty and adversity all that tries the inventor's faith in his projects. The ridicule of the masses and the sneers of the ignorant are perhaps as great discouragements as the former. Want of appreciation must be the only excuse for such undeserved and unmerited echoes, which rebound upon the faith of the inventor.

We might say that all workers are inventors, few in the extreme, but all in a degree. He is an inventor who produces a cheaper product or goods of a better quality—who brings about a better result; he who simplifies a process—who modifies proportions of ingredients, or he who excludes an unnecessary portion from a machine, producing like results with fewer parts and motions. Anything of benefit to humanity is invention, and the author or producer is an inventor. A test of invention is the faculty to adapt means to an end without complexity, and an ability to advance human knowledge. Faith in this ability is omnipotent and tantamount to success, and this success is purchased with self-sacrificing and energetic action, and a zeal to introduce the blessing of the results of their inventions and labors.

It is well the inventor has faith in the project of his brain, and the prospect of ultimate success is ever before him, and the dream of each night is that the morrow will produce the brilliant results which his dreams have depicted. It is well that it is so; for were it otherwise—were there no inventors—the world would be even now a barbaric chaos.—*The American Engineer.*

IRRESISTIBLE FORCE VS. REGULATING RESISTANCE.

Although the above heading is somewhat of a "bull" of celtic suggestion, yet in the department of applied mechanical forces, we may witness operations that strongly bring the above named conditions to mind and excite admiration for the inventive genius that has developed means to overcome, seemingly, insurmountable obstacles, bringing force against resistance to a degree limited only by the structural or cohesive endurance of the operating parts. This question has been and is now being largely considered in the development of armor plating and

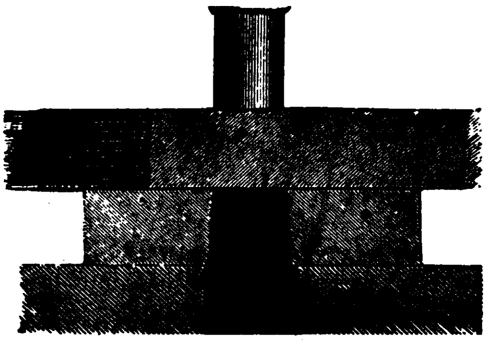


FIG. 1.

heavy ordnance projectiles, which, however, is not the purpose of the present article to detail, but to present some common mechanical operations that possess very interesting phases. As a good example of the employment of powerful mechanical force to the most stubborn resistance, in which resistance yields, the punching machine is here considered. To thousands of people who may not have opportunity for observation, it may not be known that the large thick bolt nuts are punched out of cold iron, also heavy iron plates and bars are perforated by the punch with a facility largely accounting for the cheapness of modern metal construction. By means of the punching machine with its infinite assortment of dies, the countless variety of metallic articles in common use are formed quickly, cheaply and in exact uniformity, each after its kind. When a thick iron plate or bar is punched, the thickness being equal to the diameter of the punch, the operation is

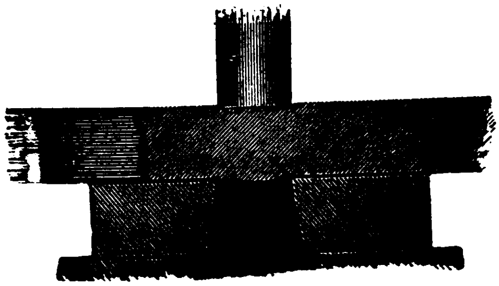


FIG. 2.

of interest in several ways. The bar, as it lies across the die block, seems invulnerable. The enormous mass of iron constituting the body of the punching machine presents a solid rigidity that strongly asserts itself. The punch operated by a powerful cam movement, prodigiously reinforced by the accumulated momentum of a ponderous fly wheel, comes down gently, quietly and touches the iron bar; a momentary pause during which the fly wheel gearing gathers up the slack, and with a grunt accompanied by a slight tremor throughout the machine, the "plug" starts, promptly sinks through the newly

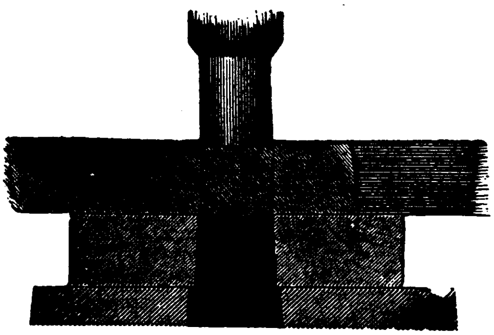


FIG. 3.

born hole and drops among hundreds of its like beneath. This much is visible to the common observer who may be impressed with the interesting sight, but the operation is still more interesting when we analyze the different stages, and it raises some questions of scientific interest. In figure 1 we have a sectional view of a die block with a heavy iron bar or plate laid across, and the punch just descended in contact. It is at this point that the momentary pause occurs while the machine gathers its force, and in a brief instant the fly wheel gearing has "caught on" and the punch settles into the surface of the iron. At this stage a pressure of circumstances is brought to bear that permits no delay—something must give. The "plug" is still integral with the bar; there is no defined line of separation through the iron, but suddenly under the intolerable force, a cylindrical line of definition strikes through the metal and with the aforesaid grunt the plug starts. The critical strain is over and the further descent of the punch expels the plug. The action of punching dies is rendered analogous to a shearing operation by having the engaging face of the punch slightly inclined so that the point of first contact will begin to cut before the whole surface engages, and this greatly relieves the requirements of force, but while it is easy to see the advantage of this arrangement in general practice in sheet metal stamping, yet in the example here shown, it is difficult to account for the line of separation developing through such a thick

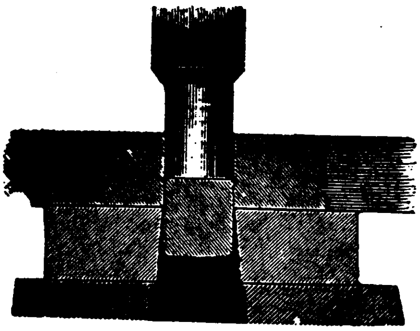


FIG. 4.

body and seemingly knowing just where to land. When the inclined lip of the punch is forced in, compacting the metal beneath, there is still a thick medium to penetrate, which must be effected by a practically simultaneous parting of the metal structure. It is well known that the die plate aperture, to do its best and easiest work, must be in exact correspondence with the punch in size and outline. Suppose the die plate aperture were considerably larger than the punch, as in the following example. It will be seen that a very unharmonious condition

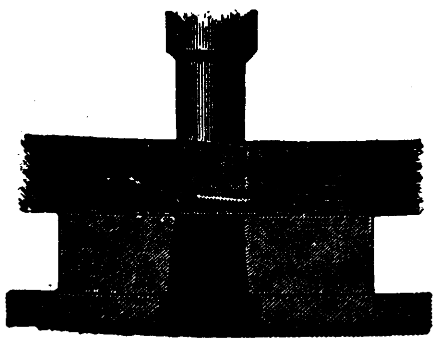


FIG. 5.

results, and that the plug is unable to make up its mind as to what its outline and limit shall be, but as no d lay is possible, it is promptly torn out, leaving a ragged aperture and requiring enormous force with unsatisfactory results. As this example, however, is not in general use, it only serves to show the importance of proper die fitting. The generally accepted form of construction adopted in die punching machines illustrates the vast difference between the tensile and the compression strength of metal. Cast iron being mostly used for the body of the machine, and the neck portion being curved over to afford working clearance, the front portion or throat is made very massive. A machine adapted for working a punch an inch in diameter would require, roughly speaking, a transverse area or thickness of perhaps a

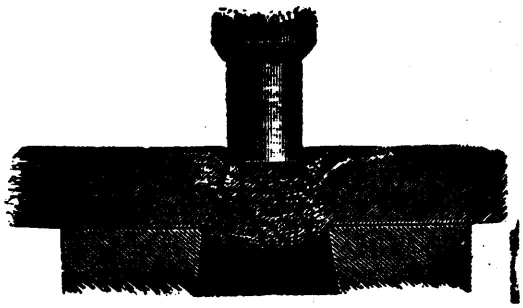


FIG. 6.

hundred square inches to be reliably strong against possible contingencies, a suitable portion of the metal being extended back to form a deep web flange, whose greater breadth affords greater rigidity. A part of this strength must go to offset a certain amount of leverage the punch exerts by reason of its relative position. It is, indeed, a fortunate circumstance that cold iron possesses the property of yielding to the action of the punch or shear, and the peculiar stability of hard, well tempered steel is no less essential. These conditions brought into exercise through means devised by inventive skill has achieved incalculable results in useful construction. —*The World's Progress.*

MECHANICAL LUBRICANTS.

Several very interesting articles have appeared within the past few months in various technical journals upon the subject of mechanical lubricants, says *Invention.* The subject has attracted also considerable attention in the United States. It would appear that, according to American practices a much higher degree of viscosity is deemed suitable to passenger than to freight traffic. In other words, a thick compound of the density of lard or neatsfoot is supplied to the bearings of fast trains in which the axle friction is obviously great, while petroleum, which is perhaps the most "insinuating," of all oleagenous substances, is preferred for freight or slow trains. Owing to the weights supported by the wheels, railway carriages suffer more from the wearing away of bearings than any other known machine. No scientific reason for this preference appears to have ever been assigned, nor, we believe, has the distinction been to any important extent observed in this country, the same axle grease being, as a rule, used with all trains. As, however, machinists of so observant and ingenious a character as our American cousins have for many years maintained the advantages of a discrimination, such as we describe, it is interesting to learn that so good an authority as Professor James E. Denton has, after testing various lubricants in an apparatus constructed for the purpose, arrived at the conclusion that any belief in the advantages of great viscosity is based upon erroneous assumptions. He states that from extensive experiments with this apparatus, supplemented with minor devices, it results that any lubricant, even those of extreme fluidity for spindle lubrication (that is, the lightest paraffins), run for hours by feeding through a pad and wicks, afford the minimum amount of friction at axle loads as great as 10,000 lbs., with an area of only two square inches of bearing, so long as no accidental abrasion or cutting of the rubbing surface occurs. He, therefore, concludes that so far as mere pressure is concerned between smooth surfaces, there is no basis for discrimination of value among current lubricants for car service, assuming them all capable of being applied in fair quantity to the rubbing surfaces.

The matter is one of some interest to railway men inasmuch as the cost of the lubricant is an appreciable item in the yearly bill, and paraffin is considerably cheaper than the mixture now in use on most of the principal lines. It would be interesting to learn the result of actual experiment on one of our principal railways. In view of Professor Denton's report, it does not seem that any danger of heated bearings need be feared where paraffin alone is used. The matter seems worth consideration by railway authorities.

THREE HUNDRED FEET INTO THE AIR.

In chimney climbing, as in most things else, says the *Pall Mall Budget*, the old order changes.

Time was when the dexterous flying of kites was the initial step in the ascent of a chimney or a church steeple. In addition to the cord by which it was flown, the kite was furnished with a second cord which hung down vertically. The manipulators of the kite having, to the best of their judgment, got it directly over the apex of the chimney, both cords were steadily hauled upon, and in that way a thin line of communication was established. To one end of that line a rope was fastened, and this in turn was drawn over the steeple. Then to the rope was attached a light chain with a pulley block and tackle affixed. The block was hauled up to the top, and by means of the pulley and tackle the steeple jack, seated in a "bo'sun's chair," made his perilous ascent. Between this time-honored method and that by which Vauxhall chimney in Liverpool has recently been climbed there is a wide gulf fixed, the difference representing an immeasurable increase both of security and of facility for carrying on what repairing work may have to be done. By a system equally ingenious and simple, a ladder is run up outside the chimney at a uniform distance of 2 feet 6 inches from its face, to which it is pinned at regular intervals of 6 feet by firm iron brackets. The climber, mounting the inner side of the ladder, thus makes his ascent within a kind of skeleton cage. While, therefore, the element of risk is not removed, it is greatly lessened. A false step would precipitate him to the earth, but he is less likely to make it in that the liability to become dazed is greatly diminished by the sense of security afforded. What is to be guarded against in chimney climbing is a failure of nerve, and this end is clearly to be attained in proportion as the conditions of the ascent are rendered to the eyes less fearful. Vauxhall chimney—a giant among its neighbors—extends aloft to a height of 310 feet. The elevation of its site above the Old Dock sill is 70 feet. The total height of the chimney, therefore, above that well known datum is 380 feet. Everton Church—the highest point of Liverpool—is 250 feet above the Old Dock sill. The elevation of the Monument in London is only 202 feet. Sightseers priviliged to ascend the Vauxhall chimney would have the advantage of an additional 108 feet.

The apparatus has been fixed by Mr. W. J. Whitehead, of Red Rock Street, a man young in years, but of ample experience as a "steeple jack," and in conversation with him some interesting facts concerning chimney and steeple climbing may be gathered. The system he adopts has now been employed on many occasions, and is probably, taken all round, the best yet invented. Each ladder is twelve feet in length, and is furnished with four iron arms for attachment to the wall. The process of fixing is extraordinarily rapid. The whole height of Vauxhall chimney was scaled in something less than six hours, although two separate days were taken for the purpose, inasmuch as after a considerable elevation had been attained the first day, the wind became so strong as to render further work dangerous. The process of fixing is after this fashion : Four iron sockets are driven into the base of the chimney, and to these the first ladder is attached by means of its arms. Mounting the ladder so fixed, the operator places a plank across the upper pair of arms, and thus provides himself with a small platform on which he can stand. He then drives in the sockets for the next ladder, hoists it up, and fits it in its position. This ladder, being in its turn made secure, becomes the base of operations for the next, and so the work is carried to the top, the whole, when completed, being a structure of remarkable rigidity. Its qualities, indeed, in this regard are said to be phenomenal. It is claimed that each ladder of itself is pinned so securely to the wall that in case of need—that is, in the invent of tackling an exceptionally high chimney, or of a dearth of plant—the ladders can be successively detached from below, and used to continue the ascent above.

The prime reason for climbing Vauxhall chimney on the present occasion is to repair the lightning conductor. A steeple jack, however, is frequently called upon to preform much more difficult work. Chimneys are frequently increased in height. Huge blocks of stone and iron have to be manipulated. Scaffolds have to be constructed for the purpose, and herein lies perhaps the most risky portion of the undertaking. It is easy to build a scaffold springing from the solid basis of Mother Earth. A vastly different undertaking it is to play topsy-turvy with the laws of gravity, and construct one from the top, downward. The task demands not only nerve, but a knowledge of mechanics and emgineering. It is accomplished, however, despite all obstacles, not forgetting the primary one that every batten, plank, and pole employed has to be hauled up to the summit and handled with the most gingerly care. Mr. Whitehead's highest climb hitherto has been a chimney at the Cuncorn Soap and Alkali Companies' works at Weston, the height of which is 330 feet. Mr. Whitehead confesses to a full sense of the dangers that are run, but is thankful that hitherto his nerve has never failed him, and he has met with no accident.

They are sometimes odd experiences that he has up in the clouds. A high wind, it appears, will cause a tall chimney like Vauxhall not merely to vibrate at the top, but actually to swing over a space of 6 inches or 8 inches, and this without any impairing of its stability. Of course at such times remaining at the top is out of the question. Wind is an invariable danger. A calm day is a *sine qua non* for the work, and meteorologists may perhaps be interested to know that if they suppose the wind at an elevation of 300 feet to be steadier than at the surface level, they are mistaken. It is both more gusty in its character and more variable in its direction.

ORIGIN OF VEHICLE NAMES.

The origin of the names of the various styles of wheeled conveyances used in this country and England is a rather interesting study. Take, for example, the ordinary everyday "hacks." Originally they were termed hackney coaches, because they were drawn by hackneys—a name applied to easy-going, safe-pacing horses.

The term coach is derived from the French *coche*, a diminutive form of the Latin *conchula*, a shell, in which form the body of such conveyances was originally fashioned.

Seldom, if ever, is the full term omnibus applied to those heavy lumbering vehicles found in many large cities. With the characteristic brevity of English-speaking races the title has been changed to bus. These were first seen in Paris in 1827, and the original name of omnibus is derived from the fact that it appeared on the sides of each conveyance—being nothing more than the Latin word signifying "for all."

Cab is an abbreviation of the Italian Capriola, which is changed to cabriolet (cabriolay) in French. Both words have a common derivative—cabriole—signifying a goat's leap. The exact reason for giving it this strange appellation is unknown, unless because of the lightness and springiness of the vehicle in its original form.

In many instances the names of special forms of carriages are derived from the titles of the persons who introduced them. A striking example is the brougham, which was first used by the famous Lord Brougham. William IV., who, prior to becoming King of England, had been the Duke of Clarence, gave the latter name to his favorite mode of conveyance. The popular hansom derives its distinguishing title from a certain Mr. Hansom, and the particular form of carriage known as the tilbury—at one time very fashionable, but now seldom seen—was so called from a sporting gentleman of London who rejoiced in the cognomen of Tilbury.

Landau, a city in Germany, was the locality in which was first made the style of vehicle bearing that name.

The word sulky, as applied to a wheeled conveyance, had its origin in the fact that when it first appeared the person who saw it considered that none but a sulky, selfish man would ride in such an affair, which afforded accommodations to but one individual. The strange title was never changed.

Coupe is French in origin, being devised from the verb *couper* (coopay), to cut. This was considered an appropriate designation because it greatly resembled a coach with the front part cut off

The old-fashioned gig was given that name from its peculiar jumping and rocking motion, the word being taken from the French *gigue*, signifying a jig, a lively dance.

Other instances could be quoted, but those given relate to the best known vehicles, and are considered sufficient to show the peculiarities of carriage nomenclature.

TREATMENT OF DIPHTHERIA.

Dr. Guntz, of Dresden, has had great success in the treatment of diphtheria with bichromate of potash in water containing carbonic acid, which he has found by numerous experiments on animals, as well as in the course of extensive clinical observation, to be entirely harmless. For an adult 600 grammes (about a pint) are ordered per diem, in which are dissolved three centigrammes (about half a grain) of potassium bichromate. The whole quantity is directed to be taken in about half a dozen doses, regarding which it is important to observe that they must not be taken on an empty stomach; a little milk or gruel should therefore be swallowed before each dose. Children, of course, take smaller quantities, according to age. They can be given the medicine in a tumbler mixed with some fruit syrup, and they do not generally object to it. At the commencement of the disease Dr. Guntz washes the mouth out with a 1 per cent solution of permanganate of potash containing 0·1 per cent of thymol, or with a corrosive sublimate sulution of the strength of 1 in 3,000, taking care, in the latter case, that none is swallowed, and that the mouth is well rinsed with water afterwards. In the case of young children the pharynx must be brushed out with the solution. Sometimes iodoform is employed, being applied on the tip of the finger to the affected spots. Dr. Guntz specially remarks that potassium bichromate, though harmless in the way described, is by no means so when in pills, powders, or in solution in non-carbonated water.—*The Lancet.*

LARGEST CLOCK IN THE WORLD.

The English House of Parliament, in London, has the largest clock in the world. The dials, four in number, are thirty-two feet in diameter, and the minute hand moves nearly fourteen inches in sixty seconds. It takes two hours to wind up this clock, and when once wound it goes for eight and a half days. The pendulum is fifteen feet long; the wheels are of cast iron. The hour bell is eight feet in diameter and weighs nearly fifteen tons, the hammer alone weighing over 450 pounds. This clock strikes the quarter-hour, and at every alarm the shorthand reporters of the Parliament buildings change off, a fresh man taking notes, while the other retires to write out what he has heard in the quarter-hour just passed.—*Detroit Free Press.*

ELECTRICAL

THE GIBBS DENTAL MALLET.

The relief obtained by the dentist in the substitution of electric drills and mallets in place of those driven by foot power, as heretofore, has made the former the favorite method, and no dentist who pretends to keep up with the times is now without an electrical outfit. The dental mallet has been the subject of a variety of designs and modifications, but one of the most simple and efficient which has come under our observation is that designed and manufactured by Mr. Wm. E. Gibbs, of New York. This mallet is illustrated in the accompanying engraving, and its operation is as follows :—

The current entering the lower binding screw, shown in the illustration, passes through a circuit breaker into the coil of an electro-magnet, which slides easily in the hollow handle, thence through a retractile spring connecting the lower end of this magnet with the heavy iron nozzle of the instrument, and traverses the case itself to the other binding screw. The movable mallet being magnetized by the action of the current is drawn down suddenly, and delivers a blow upon the inner end of the chuck which holds the point, at the same time breaking the circuit and allowing the retractile spring to push it back to its original position, when, the circuit being again complete, the blow is repeated.

THE GIBBS DENTAL MALLET.

In order that the circuit shall not be too quickly broken, and also to provide means for regulating the force and rapidity of the blow, the circuit breaker is made of iron and follows the mallet by magnetic attraction until stopped by a shoulder, when a spring takes it back to its former position. The set screw in the head regulates this movement.

Being round and smooth, and without external coils or projections of any kind, the mallet accommodates itself readily to the hand of the operator. The blow is rapid and positive, and its force and rapidity may be regulated from the lightest and quickest, to the heaviest and slowest, in a moment by means of the adjustment screw between the binding posts, and further increased or diminished by the amount of hand pressure exerted upon the filling in the tooth.

A push-button of convenient shape lies near the chair, within easy reach of the foot, and the current is supplied by twelve cells of No. 2 Samson battery.—*Electrical Engineer.*

Electricity for passenger service, steam for freight trains. That, so some good authorities declare, will be the apportionment of the rival energies on the railroad of the future. Steam at high speed requires quantities of coal and water, thus largely increasing the weight to be carried, while the wear and tear of the generating apparatus is thought to be almost doubled when continuously forced. With electricity, on the other hand, it is quite otherwise. The faster you go, the greater is the economy over steam. Indeed, as the speed increases, the relative value of electric propulsion increases enormously, an expert before a recent meeting of the Institute of Electrical Engineers declaring that at 120 miles an hour it is something like six times more economical than steam. "If," said he, "you can get 90 per cent efficiency out of your electric service and have a frequent service at 20 miles an hour, electric propulsion is even then slightly more economical than steam propulsion." One of the best known electric motor manufacturers recently declared it to be his belief that in the future express trains between populous centres like New York and Philadelphia would consist of two electric cars, to be started every ten minutes, and running at a speed of a mile a minute.—*Scientific American.*

A NEW BATTERY.

Our readers may perhaps be interested to hear of the novel little battery recently introduced in New York by the Nassau Electrical Co. and called the Nassau Capsule Battery, of which a cut is here given, actual size. It was patented on August 19th, 1890, the makers claiming that it will mark a new departure in the construction of primary batteries. This will probably be the case to a certain extent, as it works very well and is perfectly dry.

ACTUAL SIZE.

Owing to its diminutive size, $2\frac{1}{2}$ in $\times \frac{5}{8}$ in, this battery will prove useful in places where it might be inconvenient to place batteries of the usual dimensions. The power remains constant until the battery is exhausted, it therefore cannot become polarized. It gives an E. M. F. of a little over a volt and a current of 2·2 amperes. When exhausted the battery may be recharged for a moderate sum by returning the empty capsule to the Nassau Co.

ELECTRICITY IN MINING.

One of the Marvin electric percussion drills manufactured by the Edison General Electric Co., was successfully tried before a large number of prominent mining engineers of this province in the rear of McGill University on Wednesday, the 29th of April. Unfortunately the rock into which the drill was thrust was extremely hard and full of seams, so that it was almost impossible to drill a perfectly round even hole, nevertheless, in spite of the chipping of the rock, the result was good, and the general opinion seemed to be that it was a success.

Before witnessing the practical working of the drill the engineers listened to two exceedingly interesting papers on electricity as applied to mining by Mr. H. Ward Leonard, of the Edison General Manufacturing Co., and Mr. J. W. Kurklend of the Thompson-Houston Electric Co.

Mr. Leonard spoke of several forms of drills,—more particularly the Marvin drill, explaining its construction, and use in mines. Dwelling upon the practicability and economy of using electricity in mines, he showed its adaptation to ventilating-fans, hoists, locomotives, and the lighting of the mine and adjacent buildings by arc and incandescent lamps.

Mr. Leonard was well applauded for his paper. Mr. Kurklend next took the platform and read an interesting paper explaining the action of another form of drill manufactured by the Thompson-Van Depoele Electric Mining Co. He also spoke of the Electric hoist and Electric locomotive, manufactured by that company, illustrating his remarks by passing around several photographs as well as presenting three photo-prints of the Electric drill, locomotive, and hoist respectively, to all of his hearers.

Mr. Kurklend complimented the miners of Quebec on the large number of waterfalls throughout the country, many of which are wasting their tenetic energy in close proximity to the mines. These he showed could be made to supply the necessary power for dynamo-electric machines, thus obtaining electricity at a moderate cost. He also complimented the Quebec miner on the abundance of cheap fuel in Canada, whose vast forests may be utilized so easily. Mr. Kurklend's paper was also well applauded, although some parts of it were rather too technical for many who were present.

Of course the lectures could not close without a slight discussion between these two representatives of the greatest rival companies of the United States, yet this seemed only to increase the interest of the mining engineers.

After the papers the company adjourned to the open air to witness the practical working of the Marvin drill, as already described.

ELECTRICITY IN TOOTH EXTRACTION.

A small party of medical men and dentists lately met at the Institute of Medical Electricity, 35 Fitzroy Square W. C. London, to witness a demonstration of the new method of extracting teeth without pain. One of our staff was there. We sent the one who had most experience in the shocks and squirms of the dentist's chair, and he was imbued when he left the office with more than his share of skepticism regarding the powers of electricity in drawing teeth. He came back brimming full of enthusiasm about the "vibrator." This is what the electrical arrangement is called. It is a simple arrangement, consisting of a neat walnut case, within which are a couple of bichromate cells and a Ruhmkorff's coil to which is attached a commutator of extreme sensitiveness. The commutator is the secret of the whole affair. It is a thin ribbon of highly tempered metal, secured at each end by an elaborate arrangement of screws. It is capable of vibrating at a tremendous pace—so quickly, indeed, that it is really musical—and the force passing through the coil is regulated until the vibrator is in unison with the key A, which the Philharmonic Society says is equal to 420 vibrations per second.

The operator was Mr Burgoyne Pillin, L.S.D., who stated that he was a visitor himself, not being connected with the institute. He had four patients in waiting. The first was a young professional man, who seated himself in the operating chair to get a bicuspid extracted. He got the handles of the battery in his hands. One of these is connected with the negative pole. The positive is divided into two, so that one of the divisions is connected with the handle and a wire from the other division is screwed into the handle of the tooth forceps. When the patient takes hold of the handles the current is gradually increased in intensity until the patient can bear no more; then, while the forceps are being introduced, the current is turned off for a second, and on again. The rest is the same as without electricity. "Had you no pain?" asked our representative of the patient when the roots of the bicuspid were held up to view. "Not a bit; I only felt the grip." "What did you mean by stretching your body, then?" "Oh, that was when the current was turned on." "You didn't feel the frightful wrench, then?" "No," was the reply. Our representative was still skeptical, it will be seen. All this skepticism went with the next patient, a young and robust-looking lady, who had the left anterior upper molar troubling her. She took the chair, and quickly enough Mr. Pillin had his forceps on the shell. Crack it went, and the usual thing followed—three separate extractions, the last bringing away part of the crown and two twisted roots an inch in length—as bad a case as one could wish to see. It took some time to persuade the patient that her tooth was out. "I felt no pain," she said, after she had an affirmative reply to her question, "Is it out?" The next patient was a young lad who declared that he felt like getting a shave (he had not got his first). His lower bicuspid was also quickly brought to view, and he went out with a smile.

The next turned out to be a bad case. The tooth was fearfully exostosed, and it was only by a prolonged wrench, which was painful to look upon, that Mr. Pillin got it out; but the patient showed not a trace of pain, and he, like the others before him, was quite free from shock. This is one of the characteristics of the process: there is no nervous shock

The four cases were typical, and all the experts present were enthusiastic about the succ ss, and loud in their praises of Mr. Pillin's skill. Now, why is it that electricity prevents pain? was the question that every one was asking. Simple enough, said Dr. Arthur Harries, the physician to the institute. "Electricity travels over the nerve at the rate of 420 vibrations per second; pain travels from the tooth to the brain in one-sixtieth of a second. My theory is that the electricity, being so much quicker and having the greatest force behind it, gets to the brain first, and then keeps the line for itself, crowding out the pain." If Dr. Harries' theory is right, what a future there is for electricity in surgery! Chloroform and all other anæsthetics will have to take a back seat, and we shall banish pain simply by not allowing it to be produced.

There are other points about the vibrator which we should like to speak of, but need only mention that there is less bleeding and that it interferes in no way with the operator. It is really a good thing, thoroughly sound in principle, and without any humbug about it.—*Chemist and Druggist.*

ANOTHER FARADAY WANTED.

Among the scientific problems that await solution was that described at the recent meeting of the National Electric Light Association by Prof. Elihu Thomson, to wit, a direct method of obtaining electricity from fuel. The present method necessitates the interposition of the steam engine, in which even under favorable conditions scarce more than ten per cent of the theoretical energy of the coal is recovered in mechanical power, this suffering diminution again at the wire end of the dynamo. "It almost seems," said Prof. Thomson, "from all that we who are actively engaged in looking up matters in this connection can say, it almost seems to us that we must wait for some new discovery, for another Faraday to come forward and show us principles which are not now known, some relation between electric energy and heat energy whereby we can convert even 35 to 40 per cent—we will be satisfied with that—of the heat energy into electric energy. Look what it means, should such a thing come about. The steam engine would disappear. The steam locomotive would disappear. The steamship would be propelled no longer by the steam boiler and the burning of fuel under a steam boiler. Fuel would be burned, but burned to produce currents. The apparatus to propel the steamship would not be a steam engine with its reciprocating motions and its racking strain, but would have that quiet rotary motion which characterizes the modern electric motor."

Edison has been working on the problem. If only he could solve it! Davy, after years of unrewarded study and observation, put two wires together tipped with carbon, drew them apart and got the flame which now we call the electric arc. We put together a mechanism which has made the generation of such light commercially practicable. Faraday discovered the principle which underlies the generation of current by the dynamo, being the first to move armatures in magnetic fields. We have profited greatly also by that. If only now we could repay these free gifts by the discovery of a principle by which the energy of coal could be directly obtained!—*Scientific American*.

EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

(From Houston's Dictionary.)

Anomalous Magnet.—A magnet possessing more than two free poles.

There is no such thing as a unipolar magnet. All magnets have two poles. Sometimes, however, several magnets are so grouped that there appear to be more than two poles in the same magnet.

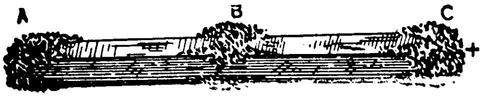


FIG. 18.

Thus, in Fig. 18, the magnet A B C appears to possess three poles, two positive poles at A and C, and a central negative pole at B.

It is clear, however, that the central pole is in reality formed of two juxtaposed negative poles, and that A B C actually consists of two magnets with two poles to each.

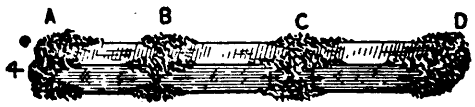


FIG. 19.

The magnet A B C D, Fig. 19, which in like manner appears to possess four separate poles, in reality is formed of three magnets with two poles to each.

Since unlike magnetic poles neutralize each other, it is clear that only similar poles can thus be placed together in order to produce additional magnet poles.

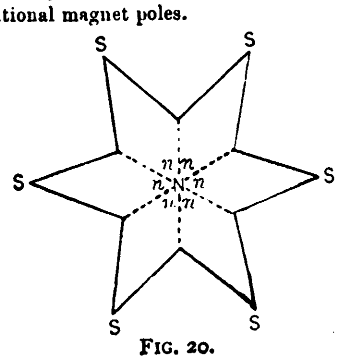


FIG. 20.

The six-pointed star shown in Fig. 20, is an anomalous magnet with apparently seven poles. The formation of the central N pole, as is evident from an inspection of the drawing, is due to the six separate north poles, *n*, *n*, *n*, *n*, *n*, *n*, of the six separate magnets, S*n*, S*n*, etc. Such a magnet would be formed by touching the star at the point N with the S pole of a sufficiently powerful magnet.

These extra poles are sometimes called ***consequent poles***. Their presence may be shown by means of a compass needle, or by rolling the magnet in iron filings, which collect on the poles.

Anti-Induction Conductor.—A conductor so constructed as to avoid injurious inductive effects from neighboring telegraphic or electric light and power circuits.

Such anti-induction conductors generally consist of a conductor and a metallic shield surrounding the conductor, which is supposed to prevent induction taking place in the wire itself.

The anti-induction conductor sometimes consists of a conductor enclosed by some form of metallic shield, which is supposed to prevent the action of electro-static induction.

A. O. C.—A contraction used in medical electricity for *Anodic Opening Contraction.*

Arc, Metallic.—A voltaic arc formed between metallic electrodes.

When the voltaic arc is formed between metallic electrodes instead of carbon electrodes, a flaming arc is obtained, the color of which is characteristic of the burning metal; thus copper forms a brilliant green arc. The metallic arc, as a rule, is much longer than an arc with the same current taken between carbon electrodes.

Arc, Voltaic.—The brilliant arc or bow of light that appears between the carbon electrodes or terminals of a sufficiently powerful source of electricity.

The source of light in the electric arc lamp.

It is called the voltaic arc because it was first obtained by the use of the battery invented by Volta. The term arc was given to it from the shape of the luminous *bow* or *arc* formed between the carbons.

FIG. 21.

To form the voltaic arc the carbon electrodes are first placed in contact and then gradually separated. A brilliant arc of flame is formed between them, which consists mainly of volatilized carbon. The electrodes are therefore consumed, first, by actual combination with the oxygen of the air, and, second, by volatilization under the combined influence of the electric current and the intense heat.

As a result of the formation of the arc, a tiny crater is formed in the end of the positive carbon, and appears to mark the point out of which the greater part of the current flows.

The crater is due to the greater vo'atilization of the electrode at this point than elsewhere. It marks the position of greatest temperature of the electrodes, and is the main source of the light of the arc. When, therefore, the voltaic arc is employed for the purposes of illumination with vertically opposed carbons, the positive carbon should be made the upper carbon, so that the focus of greatest intensity of the light may be favorably situated for illumination of the space below the lamp.

The crater in the end of the positive carbon is seen in Fig. 21. On the opposed end of the negative carbon a projection or nipple is formed by the deposit of the electrically volatilized carbon. The rounded masses or globules that appear on the surface of the electrodes are due to deposits of molten foreign matters in the carbon.

The carbon, both of the crater and its opposed nipple, is converted into pure, soft graphite.

Arc, Voltaic—Resistance of.—The resistance offered by the voltaic arc to the passage of the current.

Like all conductors, the ohmic resistance of the arc increases with its length, and decreases with its area of cross-section. An increase of temperature decreases the resistance of the voltaic arc.

The total apparent resistance of the voltaic arc is composed of two parts, viz.:

(1.) The true ohmic resistance.

(2.) The counter electro-motive force, or spurious resistance.

Armature.—A mass of iron or other magnetizable material placed on or near the pole or poles of a magnet.

In the case of a *permanent magnet* the armature, when used as a *keeper*, is of soft iron and is placed directly on the magnet poles. In this case it preserves or keeps the magnetism by closing the *lines of magnetic force* of the magnet through the soft iron of the armature, and is then called a *keeper*. In the case of an electro-magnet, the armature is placed near the poles, and is moved toward them whenever the magnet is energized by the passage of the current. This movement is made against the action of a spring or weights, so that on the loss of magnetism by the magnet, the armature moves in the opposite direction.

When the armature is of soft iron it moves towards the magnet on the completion of the circuit through the coils, no matter in what direction the current flows, and is then called a *non-polarized armature.* When made of *steel,* or of another electro-magnet, it moves towards or from the poles, according to whether its poles are of the same or of different polarity. Such an armature is called a *polarized armature.*

Armature, Dynamo.—The part of a dynamo-electric machine in which the useful currents are generated.

The armature usually consists of a series of coils of insulated wire or conductors, that are wrapped around or grouped on a central core of iron. The movement of these wires or conductors through the magnetic field of the machine produces an electric current by means of the *electro motive forces* so generated. Sometimes the field is rotated; sometimes both armature and field rotate.

The armatures of dynamo-electric machines are of a great variety of forms. They may for convenience be arranged under the following heads, viz.:

Cylindrical or drum armatures, disc armatures, pole or radial armatures, ring armatures, and spherical armatures. For further particulars see above terms. Armatures are also divided into classes according to the character of the magnetic field through which they move—into uni-polar, bi-polar, and multi-polar armatures.

The term armature as applied to a dynamo-electric machine was derived from the fact that the iron core acts to magnetically connect the two poles of the field magnets as an ordinary armature does the poles of a magnet.

Armature, Polarized.—An armature that possesses a polarity independent of that imparted by the magnet pole near which it is placed.

In permanent magnets the armatures are made of soft iron, and therefore, by *induction,* become of a polarity opposite to that of the magnet poles that lie nearest them. They have, therefore, only a motion of attraction towards such poles.

In electro-magnets the armatures may either be made of soft iron, in which case they are attracted only on the passage of the current; or they may be formed of permanent steel magnets, or may be electro-magnets themselves, in which case the passage of the current through the coils of the electro-magnet or electro-magnets may cause either attraction or repulsion according as the adjacent poles are of opposite polarity or are of the same polarity.

Armature Coils, Dynamo.—The coils of wire or conductors on the armature of a dynamo-electric machine.

Armature Core, Dynamo.—The core of iron around or on which the armature coils are wound or disposed.

Armor of Cable.—The protecting sheathing or metallic covering on the outside of a submarine or other electric cable.

Arrester, Lightning.—A device for protecting instruments on any line from disturbance by lightning.

Artificial Magnets.—Any magnet not formed naturally.

All magnets other than magnetic iron ore, or lodestone, or meteoric iron.

SMALL ELECTRIC MOTOR FOR AMATEURS.

BY GEO. M. HOPKINS.

Every piece of electric work done by a student or amateur is of value, not only as an addition to his collection of apparatus, but as a means of acquiring a positive knowledge of electricity and of electrical apparatus. The annexed engraving shows a simple and easily constructed motor, which very fully illustrates the construction and operation of the Gramme motor, and is well adapted to various uses requiring only a small amount of power.

This motor was built by Mr. W. S. Bishop, of New Haven, Conn., after the general plans of the simple electric motor already illustrated and described some months since in these columns, but the construction here shown is more simple and more easily carried out. The perspective view here given is two-thirds the actual size. The detail views (Figs. 2 and 3), showing the armature in process of construction, are full size.

The field magnet is formed of a yoke of Norway iron $\frac{7}{16}$ inch thick, $\frac{1}{2}$ inch wide and $2\frac{1}{4}$ inches long. In the yoke, near its ends and $1\frac{5}{16}$ inches apart, are drilled holes for receiving the quarter inch Norway iron cores of the magnet, which are driven into the yoke.

The polar extremities of the field magnet are curved to form a circular opening $2\frac{1}{16}$ inches in diameter. The winding of the field magnet may be applied to the magnet cores, as shown in the engraving, or the wire may be wound upon spools fitted to the cores. The spools are 1 inch in diameter and $1\frac{1}{8}$ inches

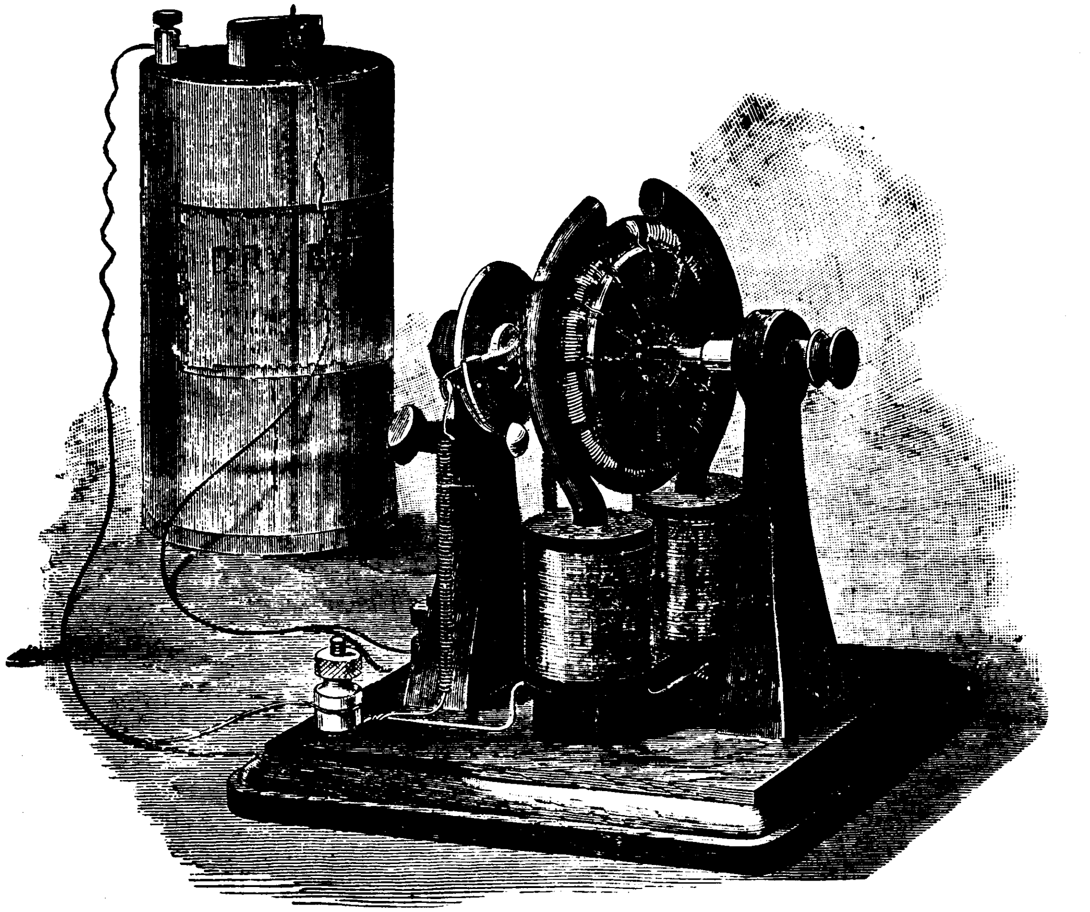


FIG. 1.—PERSPECTIVE VIEW OF A SMALL GRAMME RING MOTOR.

long between the heads. Upon each spool is wound one ounce of double-wound, cotton-covered magnet wire. The yoke of the field magnet is fastened to the wooden base piece of the motor by screws passing upwardly through the base into threaded holes in the yoke.

The armature consists of a small Gramme ring mounted upon a wooden disk secured to the armature shaft. The armature core, *c*, is a ring formed of a piece of annealed iron wire, No. 13 B. & S. gauge, having its ends beveled and drilled transversely to receive a pin, as shown in Fig. 2. A core of this kind, although theoretically not as efficient as a laminated core, answers every purpose in this very small motor, and greatly facilitates the construction of the armature. The core has an outside diameter of $1\frac{7}{8}$ inches. The outside diameter of the armature is 2 inches, and the inside diameter $1\frac{1}{2}$ inches. Upon the armature core are placed 12 coils, *b*, of silk-covered, single-wound magnet wire, No. 25 B. & S. gauge, separated by rings *d* of soft iron wire No. 13, the rings forming polar extensions which add to the efficiency of the motor. The armature coils are formed in a lathe on a mandrel, separately, as shown in Fig 3. This mandrel consists of a piece of No. 11 wire having two collars $\frac{3}{8}$ of an inch apart, one of the collars being fixed and the other being removable. To allow for any contingency, it is advisable to make the distance between these collars a little less than that given, say $\frac{1}{32}$ inch less. Each coil contains 4 feet 4 inches of wire wound in five layers.

To facilitate the removal of the coil from the mandrel, the first layer is wound loosely. After winding, and before removing the coil from the mandrel, the wire is cemented with paraffine or wax melted on the coil with a warm iron. After twelve coils have been completed, they are strung upon the armature core, *c*, in alternation with the iron wire rings, *d*, and when the core is filled, its ends are brought together and secured by means of the pin, as shown.

The wooden hub of the armature is now fitted to the ring, but before the ring is secured on the hub, twelve equidistant holes are drilled transversely through the hub, near its center, and in each hole is inserted a piece of No. 12 copper wire one-half an inch long. The ends of the pieces of copper wire are allowed to project one-sixteenth of an inch beyond the sides of the hub. The ring is placed on the hub, and ends of the wire projecting from adjacent coils, *b*, are twisted together, and attached by means of solder to the copper wire pins extending through the hub and forming the commutator bars, the covering being removed from the extremities of the wire. It will thus be seen that to each commutator bar is connected the beginning of one coil and the end of the adjacent coil, so that by means of these connections the winding of the armature becomes continuous.

The posts in which the armature shaft is journaled are perforated near their upper ends with a hole of a size adapted to receive the armature shaft, and these holes are counterbored from the inner surfaces of the posts, and a wire of the same diameter as the shaft is placed in the position of the armature shaft, and Babbitt metal or type metal is poured into the openings around the shaft, forming the journal boxes. A hole is bored in the top of each post before casting the metal, to form an anchorage for the journal box, and after the casting, the anchorage is drilled through to the opening of the journal box to form an oil hole for the armature shaft.

The journal box on the side of the commutator is made to project beyond the inner face of the post, o receive the disk which carries the commutator springs. This projection is made by clamping to the post a piece of wood having in it a hole corresponding with that in the post. After the journal box is cast, the extra piece of wood is removed, leaving a sleeve upon which to place the disk. This disk is an inch and a half in diameter and $\frac{1}{16}$ of an inch thick.

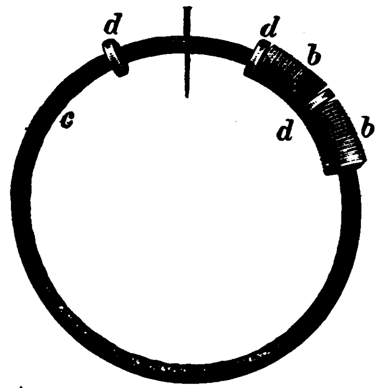


FIG. 2.—ARMATURE OF SMALL MOTOR IN PROCESS OF CONSTRUCTION.

To the inner face of the disk are clamped the commutator springs by means of small blocks, as shown in the perspective view, these blocks being held in place by screws passing through the disk into threaded holes in the blocks. The commutator springs are curved outwardly and their ends are turned backward toward the disk, and their extremities rest upon the commutator bars, as shown in Fig 1.

The commutator disk and the clamping blocks are made of vulcanized fiber, which is strong and at the same time a good insulator. The commutator springs are hard-rolled copper, and their inner ends are adjusted so as to lightly touch diametrically opposite commutator bars. The best adjustment for the commutator springs is found by moving the disk in one direction or the other. It will be found that the maximum effect is secured when the contact surfaces of the commutator springs are nearly in a vertical line.

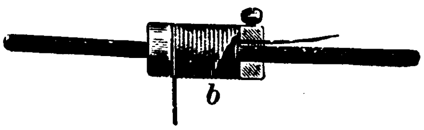


FIG. 3.—APPARATUS FOR WINDING ARMATURE COILS.

The commutator disk is clamped in any desired position by an ordinary wood screw, which passes loosely through the post and is screwed into a wooden thumb nut bearing against the outer surface of the post. The terminals of the field magnet are connected directly with the binding post and also with the outer ends of the commutator springs as shown.

With one cell of dry battery the motor makes about 1,800 revolutions per minute, but it does not develop its maximum power until one or two cells are added in parallel. Any of the dry batteries will run it for short periods, but if it is required to run it continuously for any length of time, one or two cells of Bunsen or Fuller battery should be used.

The motor being shunt wound, is practically self-regulating. Its speed with any amount of battery power does not much exceed 2,000 revolutions per minute.—*Scientific American.*

LIFE AT THE LICK OBSERVATORY.

So many articles have been written on the scientific equipment of the Lick Observatory, and upon the discoveries the instruments are capable of making and are making, that I think, says a writer in the Boston *Journal*, a sort of description of the personal life of the observers on that mountain, and the difficulties encountered, will be of interest. The following description is taken from an address by the director of the observatory, Professor Edward S. Holden, before the Astronomical Society of the Pacific.

To those who visit Mount Hamilton in summer, says Professor Holden, nothing can seem easier or more delightful than to plan and execute investigations with the instruments at hand. A short visit there, however, would at once show the almost insurmountable difficulties that attend an attempt to live at such an elevation. As soon as winter sets in, storms that here in Massachusetts we would call cyclones sweep over the mountain, and drift the snow about the astronomers' dwellings more than ten feet deep. Three or four times during each of the winter months the wind blows at the rate of more than sixty miles an hour. Many of the stronger gusts, which must exceed seventy-five or eighty miles an hour, have never yet been measured, for no instrument can be found that will stand the test. Although the windmill which supplies the observatory with water is carefully furled before each storm and held in position by iron braces, nearly two inches in diameter, once a year it is torn from its mounting and destroyed.

During five days of February, 1890, absolutely no communication with the outside world was possible. The snow fell in enormous quantities, and a fierce blizzard was blowing, which could not be faced. On the sixth day of our imprisonment three men started together for Smith Creek and returned the same night, bringing the mail and thirty pounds of much-needed provisions, after a journey of fourteen miles, which had taken something like eight or nine hours of hard work.

In such a climate we should naturally expect to find whatever was necessary for warmth and comfort indoors. How different, however, is the account Professor Holden gives us.

There is nothing to be had nearer than San Jose, 26 miles away, and it is necessary to transport everything by stage. Frequently the stage has no room for our parcels, and very frequently has no passengers for the observatory, and stops at the foot of the mountain. In such a case we must send our men over the road 14 or 15 miles to Smith Creek. Very often the road has been impassable to wagons (on account of snow), and all our supplies have been brought in the mail bag on horseback. Whatever was too large or too heavy for the bag was not brought and had to be done without. During the 112 days, from November 15th to March 8th, the stage came to the observatory only thirty-six times. The difficulties in this matter can be met by a kind of "forehandedness," but when we come to the strictly scientific side of our difficulties, they are more serious. For example, a bit of colored glass is wanted to moderate the brightness of Mars, so that the satellites can be seen. Where is it to be found? There is not so much as a square millimeter of such glass west of the Alleghany Mountains. One of the prisms of our spectroscope is stained and yellow. It cannot be replaced nearer than Pittsburg. If it is sent away, we lose its use for a month or more. The negatives of the solar eclipse of December 21st remained at the foot of the mountain from February 16th to March 5th from lack of some way to bring them up.

Fuel seems to be no exception to other articles in regard to the difficulty of getting it up the mountain. It is the present policy not to cut any wood on the reservation, and hence it must be found where best it may, and its delivery hastened as much as possible. During the winter of 1888 and 1889 the only wood available for the observatory and for the various households was from my private stores, which had been ordered in May, but which were not all delivered until the following February. The procrastination of our immediate neighbors has ceased to be annoying. It is majestic—colossal—like a great feature of nature. It must be reckoned with like the inexorable forces of heat, magnetism, and gravitation.

During the severe winter of 1886 and 1887 the Lick trustees were obliged to collect wood along the stage road, and it was delivered in small parcels like express packages. Even so it was impossible to keep the houses warm, and the water froze on the very dining tables. The photographic lens of the great telescope was washed by Mr. Clark in water so cold that it froze where it was not immediately under his hands, and this because no room in the observatory could be heated above the freezing point.

The difficulty, aside from the scanty supply of fuel, rests with the chimneys, which were not properly constructed for the peculiar currents on the mountain top. The wind blows up the deep canons on either side and sweeps almost vertically down the flues. In consequence the flames are driven two or three feet out into the room. In vain every kind of chimney top has been tried. Nothing can remedy the difficulty but to rebuild the chimneys.

When summer comes there is constant communication between the observatory and the outside world, and the troubles of winter disappear. A new difficulty, however, now arises to tax the patience of the astronomers to the utmost—the water supply gives out. Two reservoirs on neighboring peaks are fed from springs by means of the windmill and a steam engine. A third just below the summit acts as a reserve in the summer droughts, and is filled with rain water. The frequent slight earthquakes that occur in California seriously injure the walls, so that a daily inspection has to be made, and the slightest leak stopped at once.

All these difficulties, of course, call for extra work on the part of the astronomers, for their regular routine duty that has been assigned them must be done every day. Each piece of extra work is written on a card and assigned to some person. When the work is accomplished the card is returned. During the last year 2,000 of these cards were made out, including about 3,000 to 4, 00 items, or corresponding to 8,000 hours of extra labor. The secretary's letter-press copying book for the same period contains 51,000 pages of letters, which are equivalent to 500 working days. Also, during the last year 650 checks have been issued.

These figures give some idea of the life at the Lick Observatory. But we must not forget that the instruments are in use whenever it is possible, as the large number of observations in every periodical proves.

SOMETHING ABOUT SAFETY VALVES.

A writer on steam topics, Mr. A. N. Somerscales, says that "so long as a safety valve remains shut, the steam pressure acting on the underneath side of the valve is opposed by the weights of the load resting on the top, which may be either dead weight, a helical spring, or an arrangement of one of these acting through the agency of a lever. Now, either by calculation or by trial, it is possible to proportion the load to the area of the valve so that the valve shall be lifted off its seat when the steam has reached any particular pressure fixed upon as the blowing-off pressure."

WHAT HAPPENS WHEN THE VALVE OPENS.

When the valve opens the slightest amount of lift off the seat allows the steam to escape in all directions through the annular orifice between the edge of the valve and seat. Its velocity is very great—probably 800 feet per second. The steam in the immediate neighborhood of the valve seat escapes first, and its place is necessarily taken by other steam from the boiler which also escapes. A current is thus set up not only through the orifice furnished by the valve, but also through the pipe leading to the same.

Now, a fluid will not commence to flow unless there is less pressure in front than behind. Therefore when the steam is rushing up the pipe leading to the valve seat, we may be certain that there is less pressure at the top of the pipes than at the bottom. In the case of a dead-weight valve, if it has to remain open and permit steam to escape, there must be as much pressure under the valve as balances the load on top. And as we know the pressure under the valve is less than the pressure in the boiler, the sole condition under which the valve can be kept open and allow steam to escape is that there must be some accumulation of pressure in boiler over and above the load on the valve.

If the valve is loaded to 110 pounds per inch, and the difference between the top and bottom of the pipe is four pounds the pressure will be 114 pounds when blowing off.

To trace the action of the valve more closely, we may say that when the steam first begins to blow off, the valve will rise a very small distance off the face—so little, indeed, that the velocity of the steam up the pipe will be small and the reduction of pressure at the under side of the valve inappreciable. The small orifice thus opened being insufficient to relieve the boiler, an accumulation of pressure will result. The extra pressure acting on the valve will increase the lift until the reduction of pressure through the velocity of the steam in pipe is only just sufficient to balance the load on the valve as before.

If the boiler is still making steam faster than it is escaping, a further accumulation will occur and a further adjustment take place. But at any instant the pressure on the under side of the valve will always be 100 pounds above the atmosphere, even when the accumulation of pressure in the boiler is considerable.

Now, to prevent any considerable accumulation of pressure occurring when blowing off, it has always been the practice to make safety valves very much larger than the size of orifice actually required for the escape of all the steam which the boiler can make. If an area of about one-thirtieth of a square inch is actually required for the steam to blow through, safety requires an area of half a square inch in the safety valve.

Such being the practice, it follows that safety valves only need to lift a small fraction of an inch off their seats when blowing off, thus avoiding much accumulation of pressure due to the cause we have been considering.—*Mining and Scientific Press.*

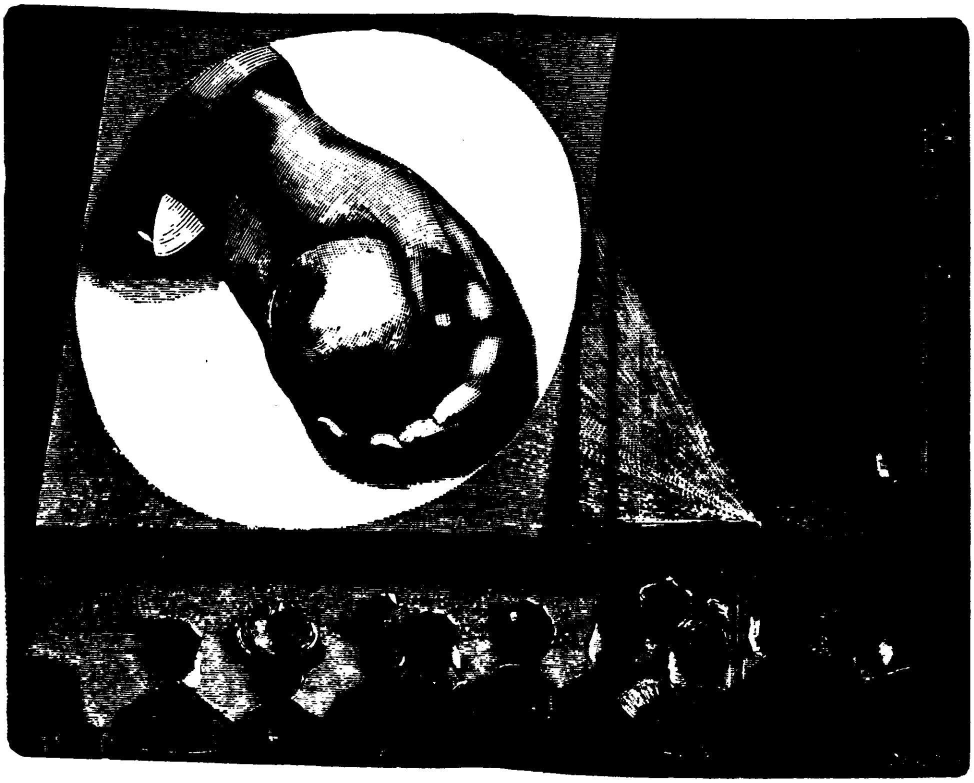


FIG. 1.—THE MEGASCOPE.

OPTICAL PROJECTION OF OPAQUE OBJECTS.

The projection of opaque or solid objects by means of the optical lautern affords a way of showing upon the screen a large variety of objects in their natural colors, and greatly magnified. The form of lantern best adapted to this purpose is the simplest imaginable.

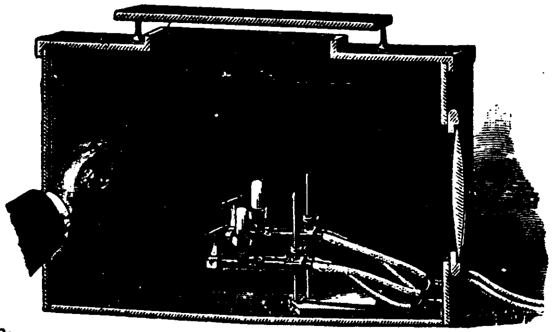


FIG. 2.—MEGASCOPE BOX, SHOWING POSITION OF BURNERS.

The works on optical projection briefly describe different forms of apparatus for this purpose. Prof. A. E. Dolbear in his book describes a megascope, consisting of a plain box, with a large lens in front and an oxyhydrogen light within. Mr. Lewis Wright, in his new work on "Optical Projection," shows two or three forms of megascope; but notwithstanding all this the idea is current that opaque projection is difficult, and several persons known to the writer are so thoroughly convinced of the magnitude of the undertaking that they do not make the attempt to project in this way.

In describing a few ways of oblique projection two or three points are noticed in the beginning. First, all the light attainable is required; second, all kinds of work cannot be done with one and the same instrument; and third, to secure the best effects, suitable shadows are as necessary as strong lights. It is useless to attempt projection on a large scale with a source of illumination inferior to the calcium light. For large objects and a large screen, two large burners are essential, and the use of three insures a much better effect.

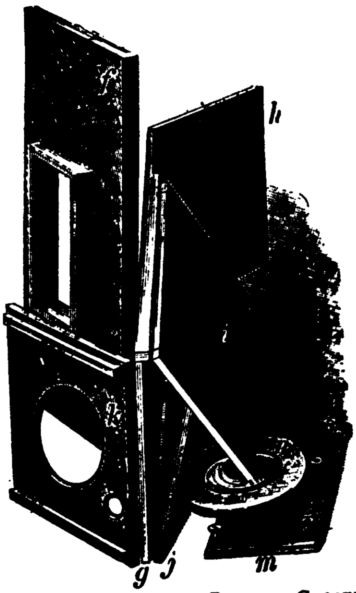


FIG 3.—FOLDING BOX PARTLY CLOSED.

The length of the box inclosing the object and the burners is determined by the focal length of the object glass. In the instrument illustrated, the lens has a focal length of 24

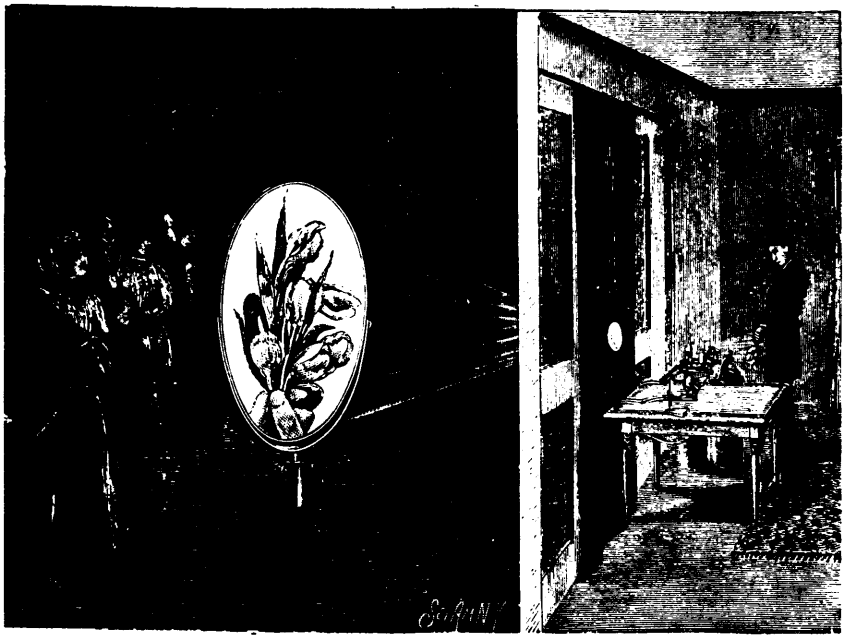


FIG. 2.—MEGASCOPE WITHOUT BOX.

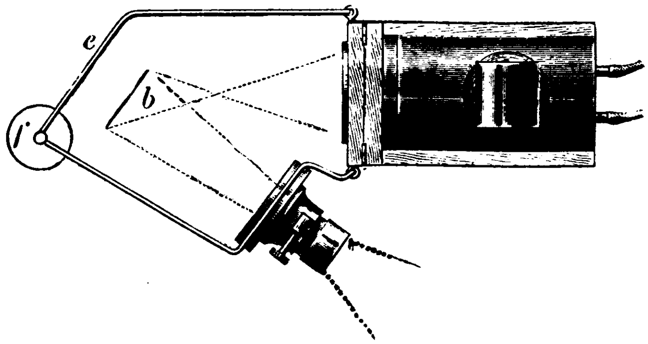


FIG. 5.—MEGASCOPE ATTACHMENT TO LANTERN.

inches. The box is made 24 inches longer, *i. e.*, 28 inches, to allow of moving the object, for the purpose of focusing the image on the screen.

When two oxyhydrogen burners are used, they are arranged at one side of the megascope box, at slightly different elevations, and a short distance apart to secure soft shadows. When three burners are used, the third is placed at the opposite side of the box. It increases the volume of light and modifies the shadows. If the apertures of the burners are the same, they may all be supplied with gas from a single pair of cylinders, by using branch pipes. The burners should be pushed as near the object as possible, without bringing them into the field of the objective.

In the present case the objective consists of a 6 inch double convex lens, but a 7 or 8 inch would be better. The lens is mounted in a soft wood ring, and suspended over a circular aperture in the front of the box.

For the sake of convenience, the box is made to fold, so as to occupy a space of 18 by 28 inches, by 3 inches thick, when not in use. Fig. 3 shows the construction clearly. The top, *f*, is like an ordinary box cover, with the exception of the central draught hole surrounded by a collar.

To the bottom, *g*, are hinged the end *h*, sides, *i j*, and the front, *k*. The cap, *m*, is supported over the opening in the center of the cover, *f*, by the wood screws inserted in the corners. The lens, *n*, is arranged to hang over the large opening in the end piece, *k*. In this end piece there is a smaller opening for the insertion of the gas tubes. The side piece *i* is discontinued near the back end of the box, to provide an opening for the insertion and removal of objects. This opening is covered with a black curtain, which falls over the arm, and prevents the escape of light. Upon the inner surface of the back end of the box is secured a piece of white cardboard for a background.

The sectional view, Fig. 2, best shows internal arrangement.

The object must be inserted in position and moved forward or backward until it is focused. If difficulty is experienced in holding the objects properly for exhibition, they may be placed on a moveable support.

Fruit of all kinds projects well, either whole or divided. A bunch of California grapes forms a fine object. A boquet of flowers is beautiful. Shells, especially polished ones, are very pleasing objects. Peacock and other feathers show well. Pottery and bronzes, plaster casts, toys of various kinds, particularly of the Japanese variety, carvings, embroidery, paintings, engravings, photos, the pages of a book, are all of interest. Whole machines of a suitable size, and parts of machinery, or apparatus of almost any kind may be shown to advantage in this way.

Another way of accomplishing the same result without the use of a box is illustrated in Fig. 4. In this case one room serves as a megascope box and another as the room in which to place the screen. The same general arrangement as that already described is observed. In this case the lens is secured over the space between two sliding doors, and all escape of light is prevented, excep ing of course that which passes through the lens. The screen is made of translucent tracing paper. The lens may be such as is used for the examination of paintings or photographs, but the kind known as cosmorama lenses, sold by the principal opticians, are preferable, on account of being about the right focus. They are not expensive, and may be obtained of a diameter of six or seven inches. Two or three calcium lights are used. The objects may be held in front of a white or tinted background, or the background may be omitted. It is absolutely necessary that no stray light should escape into the room in which the image is thrown. Of course an opaque white screen may be used in this arrangement if desirable.

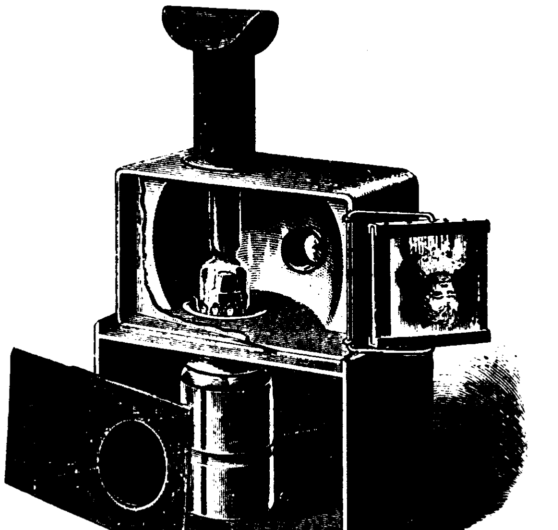


FIG. 6.—WONDER CAMERA.

For the projection of fine objects, such as gems and their settings, a watch movement, or a fine piece of machinery or apparatus, the arrangement shown in Fig. 5 is effective. A plain view of the apparatus is here shown. The objective of the lantern is removed and supported at an angle with the optical axis as indi ated. The lime is pushed forward so as to cause the divergent cone of light to cover the object, *d*, as shown. The light reflected from the object, *d*, passes through the objective to the screen.

The wire frame, *e*, secured to the front of the lantern and held by the standard, *f*, is designed to support a thick black cloth for shutting in all light exc pting that passing through the objective. Apparatus similar to this in principle is sold by some of the dealers in lanterns.

The wonder camera shown in Fig. 6, on this page, is an instrument having a marvelous amount of power considering the source of light, which is simply a single Argand kerosene burner. This toy is furnished by Ives, Blakeslee & Williams Company, of New York.

The lamp flame is in one focus of the ellipsoidal reflector and the picture or object to be shown is placed at the other focus, on the swinging adjustable holder. Opposite the holder in a perforation in the reflector is placed the objective by which the image is projected on a screen three or four feet distant. The small plan view shows the shape of the mirror

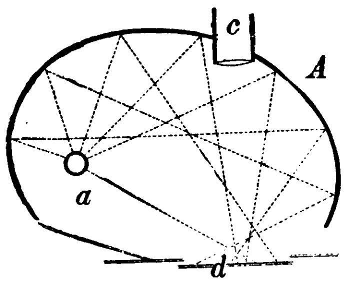


FIG 7.—PLAN OF WONDER CAMERA.

and the course of the light. The linings of the box around the lamp and focus of the reflector are removed in the picture to show the interior. These linings are made of asbestos, to withstand the heat. This instrument will project coins, shells, flowers, pictures, etc., very satisfactorily.—By GEO. M. HOPKINS, in the *Scientific American*.

SUPPOSE —— ?

Suppose you manage it so that the merchants who have accomplished something out of the common should write to *Printer's Ink* and try to tell just how they did it?

Suppose the lawyers should take the matter up, and the eminent ones of this great profession should make the attempt at telling just how they managed to get thousand dollar fees where so many others barely got hundreds?

Suppose the doctors of medicine, jealous of the public attention turned toward the merchants and lawyers should seek out those who win incomes of ten, twenty or more thousands a year, and should induce them to tell through *Printer's Ink* exactly how they did it?

Suppose the doctors of divinity who are happy in the possession of six, ten or twenty thousand dollars a year could be induced to tell through *Printer's Ink* just what it is in them that wins such reward over the others who must be content with as many hundreds as they get thousands?

Suppose you get editors by the ears, and start them off, first of all, at the telling, through *Printer's Ink*, "the only true way to build up a great newspaper," wouldn't there be heaps of fun?

Suppose I suggest that for the past six months business writers have been attempting to place bounds upon that which is boundless?

Suppose we laugh at and with each other, and begin now to learn the first part of the lesson of business life and business needs, to the end that we may discover something of what's wanted in business writing?

Suppose we remember that the English armies are credited with winning battles because they stood like rocks, and never knew they were beaten?

Suppose we look at the other side, and remember that our histories declare that the French armies under Napoleon overran Europe because of the impetuous dash of their battalions.

Suppose we ask those who employ the business writer to remember that the impetuous dash and the indomitable courage that won under the first Napoleon utterly failed when controlled by the last Napoleon? Maybe they will discover that it makes all the difference in the world *who* directs forces as to whether success or failure comes.

Suppose we remember, and take courage, that the sneer of the Austrian general, because his opponent failed to conform to "the rules of war" as he understood them, was soon turned to dismay as he found himself routed by the French innovator?

Will it do any harm if we remember that great stores had been built and great business had been established long before the art of the modern writer was known?

Will it do any harm if the merchant is reminded that he once lighted his store with candles or oil, but that now he must have the greatest power of the electric light?

Will it do any harm to recall to many of them that the time was when half a dozen clerks served instead of the hundreds needed now, and that it was not uncommon for one of them to deliver a bundle "on the way home to dinner?"

Will it be wrong if we assume that the best writers on business are those who are evolved from it and its necessities?

Will it not be pretty near the solemn truth to declare that the spirit that goes out from the firm means almost everything to begin with; that the men who absorb that spirit and control the great departments are of the greatest importance; that the manager who selects the department heads and the clerks to assist them, and so manages to keep them all up to the full requirements of the store spirit with the least friction and the most enthusiasm, is also a man of great importance?

Is it not even so with the writer who catches up the threads of the great, throbbing store life and sends it out a fair fabric of thought, in pleasant measure, to do its work among the thousands who read and think day after day about the store and its ways?

Combine all these in perfect harmony, all working to a common end, and you have a power that will build up any business on earth.

For any one man to think he does it all is absurd!

For a writer to assume that he knows more about a business than the man who created it or the men who direct it, is absurd.

For a writer to formulate a plan for the writing of *all* business announcements is the height of absurdity.

For a writer to assume that he can teach a run round method that will be effective anywhere is another absurdity.

Why is it that one merchant advertises and sells only one hundred and fifty thousand dollars a year, while another merchant, a couple of blocks away, advertises and sells a million?

The merchant who possesses that subtle quantity of brain that enables him to grasp possibilities that are merely shadowed a long ways ahead, wins for himself the first place among merchants, while his neighbor, having the same products of the world to choose from, falls far short of achieving eminence, because he lacks the one important quality so necessary to achieve pronounced success as a merchant.

The lawyer, with that fertility of resource that enables him to make the best and the most of every possible and seemingly impossible point for his client's advantage, gets the thousands where his less acute and brilliant brother gets only hundreds.

The physician who can reason closest as to cause of physical disturbance and knows best how to remove it, stands away and beyond his fellows who have less acute reasoning powers and less knowledge of remedial agencies.

The clergyman who looks the nicest, talks the pleasantest and has the magic power to lift you in his arms and carry you away and beyond the turmoil and struggle of every-day life up into the confident calm of hope and faith, gets the thousands where others get only hundreds.

The editor, the rare one who prints all the news because it is news, who resists the blandishments of sycophants or the money of advertisers alike, and who ploughs his way through cant, hypocrisy, shams and political debauchery wins, at last the thousands where the "real good fellow" gets the hundreds.

The business writer who will win the highest place in this newest of the professions is sure to be that one born with the instinct of the merchant who develops in himself the alert acuteness of the lawyer, who has the power of analysis ascribed to the physician and the warm, glowing electric force of the clergyman.

The writer on business who will add to these the quality of dignified modesty, coupled with unusual versatility of expression, will of a surety be lifted up into the highest places and be given, with alacrity, the thousands where others get the hundreds.

These gifts cannot be educated *into* a man, they cannot be bound by fetters, neither can they be called into any man's service at will. They can only have perfect life and expression when all that is in the man is called into best effort, because his business instinct, his truth, his respect and confidence in the house, and his love for the achievement of purposes of themselves right and good, opens the flood-gates of his thought, and he tells his story with simplicity and truth.

Finally, when the man is found who possesses these gifts, you will have found a treasure that any tired, worried, care-laden merchant may call to his side, sure that he has, at last, found a part of the elixir of life, and that his years will be lengthened and gladdened because of the gracious ability that sits by his elbow ready and able to send the store purpose abroad in the land to gain that confidence which alone wins success.—GEORGE R. KENNEDY, *in Printer's Ink.*

HOW TO UNITE THE ENDS OF LEAD PIPE.

What may be found a convenient method of uniting the ends of pipe, the *American Engineer* thus explains: Whatever the size the pipe may be, procure a block of hard wood, say four or five inches long, and four inches in diameter, bore a hole straight through the center, so nearly the size of the pipe that the block can be driven on the end of the pipe with a light hammer. If one has a set of auger bits, it will not be difficult to select a bit of the proper size to make a water-tight fit. Let the block be driven clear on the pipe, so that the end of the pipe will be flush or even with the end of the block. Now place the two ends of the pipe together and drive the block off one pipe on the other, until the joint will be at the middle of the block. If the hole in the block is made of the proper size, the block will fit so closely that the joint will be water-tight; and if the ends of the pipe are dressed off true and square the joint will be so strong that it will sustain the pressure of a head or column of water one hundred feet high. Iron pipe may be united in the same manner. Should the joint leak a trifle, let shingle nails be driven into the wood around the pipe so as to press the timber firmly all around the pipe.

STONE WALLING.

Of whatever quality the stone may be of which a wall is to be built, it should consist as much of stone and as little of mortar as possible. If it be inferior in durability and power of resisting the action of the atmosphere, &c., to the mortar, besides the certain fact that the mortar will yield until it has set hard, and so far act injuriously, no ulterior good is gained; and if the stone be the more durable material the more of it that enters into the wall the better. Indeed, in rough walling, if the stones be pressed together until the more prominent angles on their faces come into actual contact, the interstices being occupied by mortar, it will be better than if a thick yielding mass were allowed to remain between them. Absolute contact, however, should not be permitted any more than in brick work, lest the shrinking of the mortar in drying leave the stones to such unequal bearing as the prominent parts alone would afford. Stone being generally of a less absorbent nature than brick, it is not a matter of so much importance that it be wetted before setting. Nevertheless, adhesion on the part of the mortar is more certain and more complete if the stones be worked in in at least a damp state. Bond is of not less importance in stone walling than in bricklaying. Instead of carefully making the joints recur one over the other in alternate courses, as with bricks and gauged stones, the joints should as carefully be made to lock, so as to give the strength of two or three courses or layers between a joint in one course and one that may occur vertically over it in another. In bonding through a wall or transversely, it is much better that many stones should reach two-thirds across, alternately from the opposite side, than that there should be a few thorough stones, or stones extending the whole thickness of the wall. Indeed, one of the many faults of stonemasons is that of making a wall consist of two scales or thin sides with thorough stones now and then laid across to bind them together, the core being made of mortar and small rubble merely. This is a mode of structure that should be carefully guarded against. There is no better test of a workman's tact and judgment in rubble walling than the building of a dry wall, or a wall without mortar, affords. Walls are frequently built with mortar that without it would have fallen down under their own weight in a height of 6 feet, in consequence of their defective construction, thus rendering it evident that they are only held together by the tenacity of the mortar, which is very seldom an equivalent for a proper bond of stone. Masons are very apt to set thin broad stones on their narrow edges to show a good face, by which the wall is injured in two ways. It tends to the formation of a mere case on the surface of a wall, and it for the most part exposes the bed of the stone to the atmosphere, as a stone is more likely to be broad in the direction of its bed than across it.

THE BOYNTON UNICYCLE RAILROAD.

During several weeks last summer there were in regular and continuous operation, in railway passenger service, the locomotive and cars shown in the lower view herewith presented, the service being between Gravesend and Coney Island, on an abandoned section of an old standard gauge track of the Sea Beach and Brighton Railroad. The locomotive weighs nine tons, and has two 10 by 12 inch cylinders, the piston rods of both being connected with cranks on each side the single six-foot driving wheel, and the front of the locomotive being also supported by two 38-inch pony wheels, one behind the other. These wheels have double flanges, to contact with either side of the track rail, as also have similiarly arranged pairs of 38-inch wheels arranged under and housed in the floors near each end of the cars.

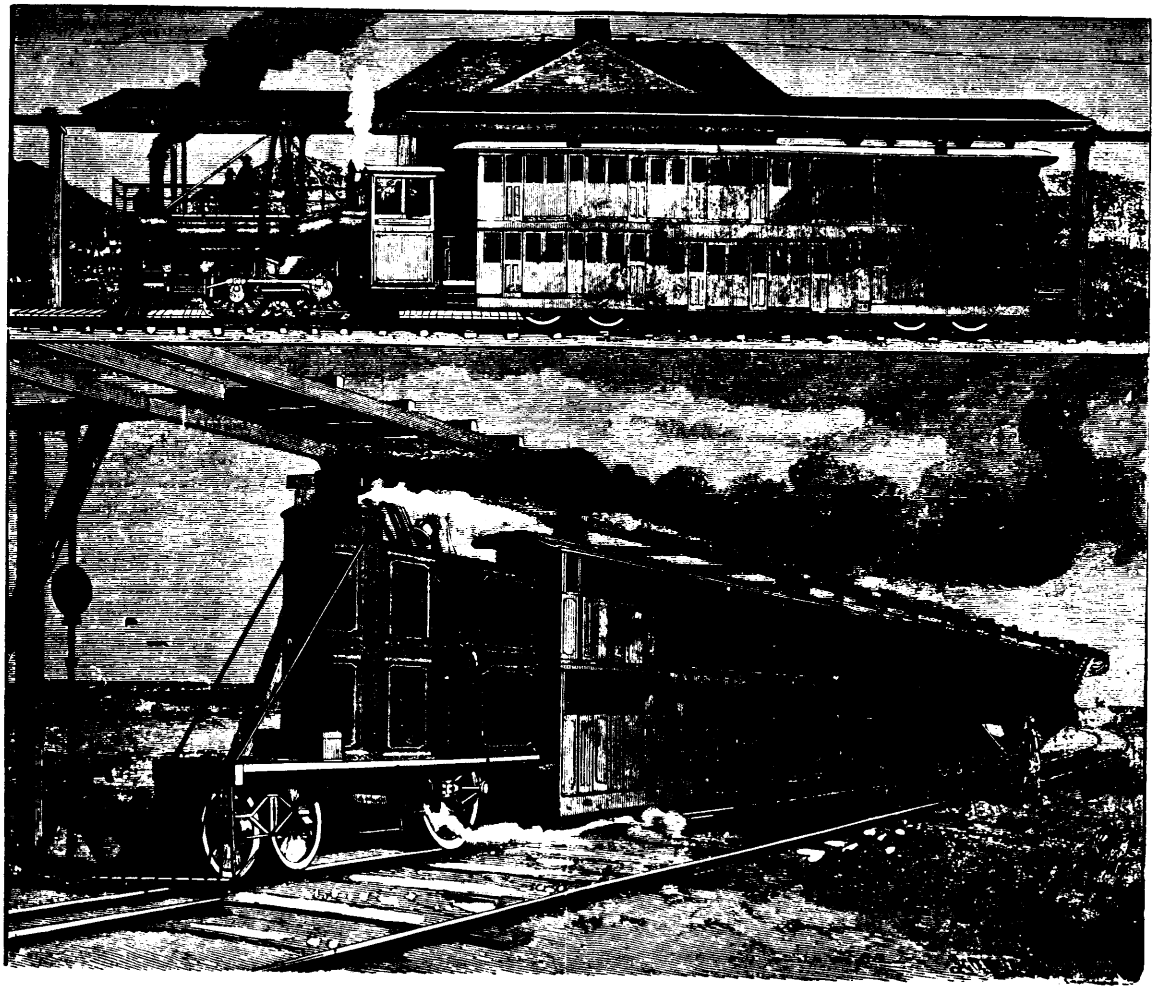
In the upper view is shown an improved locomotive especially designed for this method of traction, and built for use on a street railway of a Western city. It weighs sixteen tons and has a pair of five-foot drivers. The crank is only seven inches in length, and the engine is designed to readily make 600 revolutions a minute, and maintain a speed of 100 miles an hour with a full train of passenger cars. The first Boynton locomotive, described in the *Scientific American* in September, 1889, had an eight-foot driving wheel and weighed 23 tons. It proved too heavy for use on the old Coney Island road, although it was undoubtedly capable of making very high speed and easily drawing a heavy train of single-wheel cars on a properly arranged track.

In a true line with, and fifteen feet directly above, the face of the track rail is the lower face of a guide rail, supported from posts arranged along the side of the track, and on the sides of this guide rail run pairs of rubber-faced trolley wheels attached to the top of the locomotive and the cars. The guide rail is a simple stringer of yellow pine, 4½ by 8 inches in section, and the standards on which the trolley wheels are journaled are placed far enough apart to allow a space of six inches between the contiguous faces of each pair of wheels, thus affording 1¾ inches for lateral play, or sidewise movement toward or from the guard rail, it being designed that the guide rail shall be arranged in the exact line of the true center of gravity of the cars and locomotive. The standards are bolted to six-inch wide strap iron attached to and extending across the top of the car.

The switching arrangement is remarkably simple. In addition to an ordinary track switch, in which, however, the switch bar is made to throw only one rail, a connection is made by means of a vertical rod and upper switch bar with a shifting section of the guide rail, whereby, on the moving of the track-rail and the setting of the signal, the guide rail will be simultaneously moved, the adjustment being effected and both being locked in position according to the methods usual in ordinary railway practice.

The cars, as will be seen, are each two stories in height, each story being divided lengthwise into nine separate compartments, each of which will comfortably seat four passengers, thus providing seats for seventy-two passengers in each car. Each compartment has its own sliding door, and all the doors on the same floor of the car are connected by rods at the top and bottom with a lever in convenient reach of the brakeman, by whom the doors are all opened and closed simultaneously. The compartments are each four feet wide and five feet long, the seats facing each other. Only one rail of the old single track was used, as only one guide rail had been erected, except at the ends of the route, for switching purposes, but the width of the cars and motor was such that it only required the erection of another guide rail, for the utilizing of the other track rail, to form a regular double-track road of the Boynton pattern.

The section of road on which this system has been operated is only 1¾ miles long, in which distance the curves are considerable, but, although they are mostly in one direction, the indications of wear upon the traction wheels, and upon the guide rail and trolley wheels, were hardly perceptible. During a portion of the season, when the summer travel to Coney Island was at its height, trains were run on regular schedule time, fifty three-car trains daily each way, carrying from one to three hundred passengers per trip. The regular time taken



THE BOYNTON UNICYCLE AND SINGLE-RAIL TRACK RAILROAD FOR HIGH SPEED TRAFFIC.

for the run was three minutes, but special trips were made in two and three-quarter minutes each, including starting and stopping. The daily consumption of coal in performing this service was but half a ton. The great economy of this method of traction is also evidenced by the smoothness with which the cars run, and the entire absence of side motion and vibration, there being no striking and grinding of the wheel flanges upon the rails, as is common on double-track roads. From a seat in the top part of the tender, where one could observe how the trolley wheels followed the guide rail, it was noticed that frequently, for considerable distances, these wheels did not touch the guide rail at all on either side, and when they did approach and bear upon the guide rail it was with a gently swaying movement, indicating no expenditure of power at this point, and apparently having no effect upon the motion of the car. This was, of course, to be expected, in this system of locomotion, when a high speed is attained, and it is upon this point that the claim is made by the advocates of such systems, that in this way only is it possible to obtain greatly increased speeds on railways with the present styles of motors.—*Scientific American.*

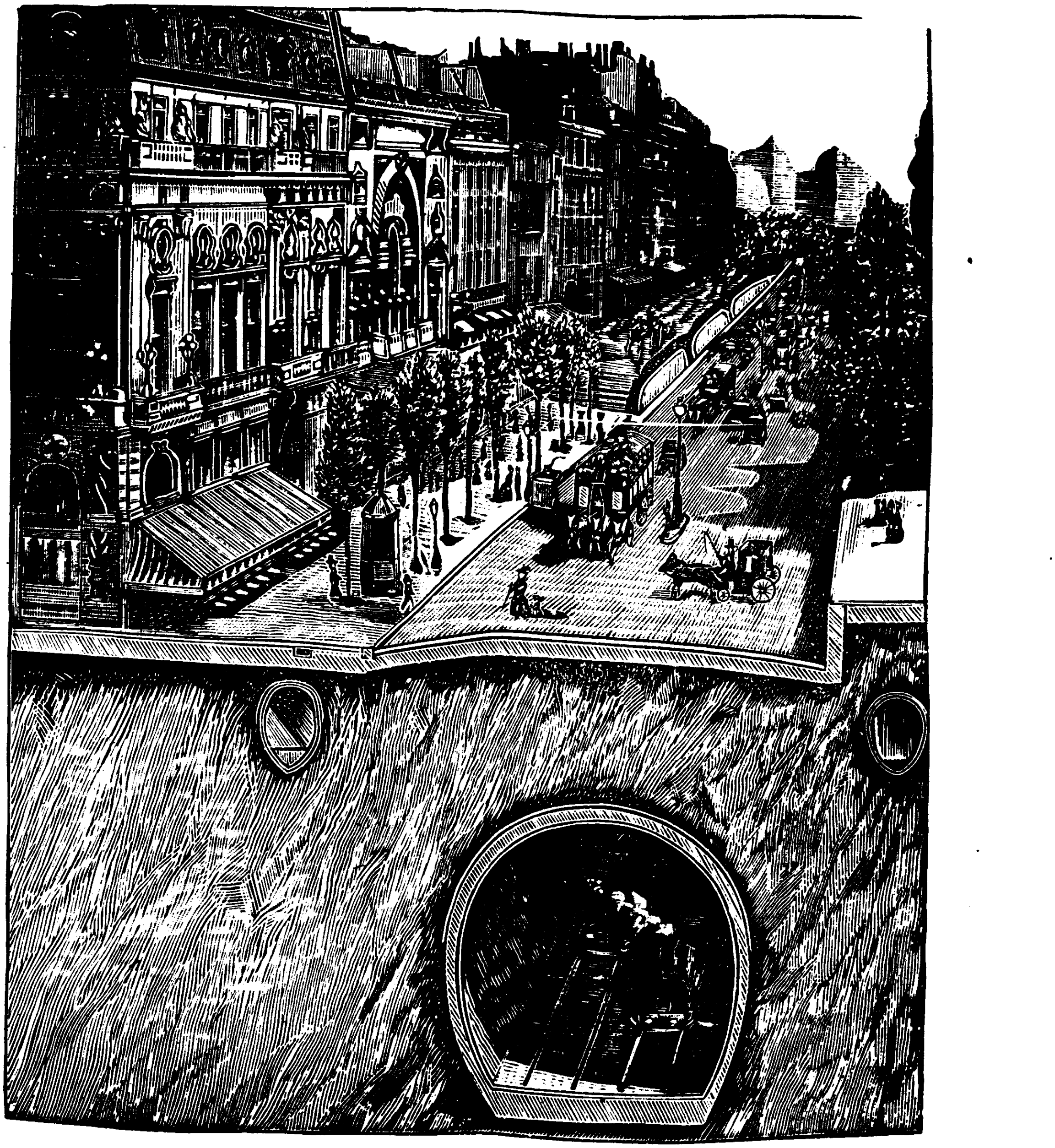
Glass may be cut with a strong pair of scissors if it is held under water.

THE UNDERGROUND SYSTEM OF RAPID TRANSIT FOR CITIES.

The enormous concentration of human energy in the great cities appears to be the characteristic of the present era. The census returns of each successive decade exhibit the prodigious growth of population in the cities, and little or none in the agricultural districts. This expansion of population means corresponding expansion of area for its accommodation, and this, in turn, demands provision of the most approved description for rapid transit. This is the crying demand in all our great cities, and the growth of the cities appears to be directly in proportion to the realization of this requirement. The city that to-day exhibits a lack of appreciation of this essential is the city which, it may safely be predicted, is standing still, while its more enterprising neighbors, though possessed of fewer natural advantages, are forging ahead in the business and commercial rivalry.

The returns of the eleventh census of the United States exhibit no more remarkable example of the truth of the foregoing remarks than the enormous strides made by some of our Western cities, which, if continued in the same proportion in the ensuing decade, will place them far in the lead of many of the older-settled and ultra-conservative cities of the Eastern seaboard.

The question of the desirability of elevated as compared with



PROPOSED UNDERGROUND RAILWAY IN PARIS—PLAN OF M. EIFFEL.

underground railways for the solution of the rapid transit problem in cities, is one of the live questions of the day. New York and Brooklyn have tried the first, and London the second alternative. The experience of the former has not been satisfactory, and we feel safe in the assertion, that, were the sentiments of the people of those cities expressed to-day, they would be practically unanimous in determining that the underground system should be adopted, in place of the elevated.

This, we believe, must be the ultimate solution of the problem, and this is what we must look forward to, in all our large cities. The elevated roads of New York and Brooklyn must finally make way for the underground railway, as it has in London. The Parisians have been for years discussing the same question, and it has practically been decided to adopt one of the many plans that have been proposed for underground transit. The picture we show in this connection is a cross-section of an underground railway tunnel, on the plans of M. Eiffel, now being considered by the Municipal Council of Paris, and which it is now believed will receive the approbation of the authorities. In ten or twenty years, we feel satisfied the concensus of opinion in this city will be unanimous in favor of underground lines within the city limits, and elevated roads will be a nuisance of the past.—*Manufacturer and Builder.*

To cure a felon, says a correspondent, mix equal parts of strong ammonia and water, and hold your finger in it for fifteen minutes. After that withdraw it and tie a piece of cloth completely saturated with the mixture around the felon and keep it there till dry.