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SCIENTIFIC CANADIAN

MECHANICS' MAGAZINE AND PATENT OFFICE RECORD

Vol. 9. JANUARY, 1881. No. 1.

IN presenting a New Volume of THE SCIENTIFIC CANADIAN to our subscribers and the public, we would wish briefly to call the attention of the latter to the main objects of the publication.

THE SCIENTIFIC CANADIAN, which is the only scientific paper published in this country, is intended at once to record the latest achievements in science throughout the world, and to offer a practical assistance to the skilled workmen of the country in their several trades. It will be our endeavour to obtain the best and most recent information upon all subjects of interest to our readers, and with a view to the better carrying out of this object we invite correspondence from all who are interested in the work we propose to ourselves.

We have made changes in the Editorial department of the paper, which may be allowed to speak for themselves.

The present Editor will be happy to place himself in communication with all who may have matter of interest to contribute, or suggestions to offer as to any way in which the Magazine may be made of more service to the class it is intended specially to benefit.

A department of Notes and Queries will also be opened, and information on all subjects within the scope of the work will be answered editorially or otherwise.

The present number will be found to contain detailed descriptions of the rival method of electric lighting, the merits of which are now engaging so large a share of attention in scientific circles. This, with other descriptive and illustrated matter will form an attractive number.

It is much to be desired however that Canadians should take a greater interest in supporting what little scientific literature we have. Our trades, our education, our artistic tastes all reach a far higher standard than ever before, and now that some scientific training is a recognized part of the preparation for the mechanical trades, there should be many who are able to discuss the minor branches of science which come under their observation, and to them we gladly open our columns. We want a Canadian magazine to be the exponent of Canadian thought and Canadian research, and we make an earnest appeal for support from all who are able to help us.

In conclusion, we would wish to thank those who have supported the magazine since its commencement, and while asking for a renewal of their good offices to commit our new volume to the public, with some confidence as to its reception.

A NEW SYSTEM OF APPRENTICESHIP.

A system of apprenticeship in some respects new, says the *Iron Age*, has been adopted by Messrs. Richards & Dole, machinists, of Springfield, Mass. It is intended to combine the thoroughly practical education of the shop with the theoretical education of the school; or, in other words, it is an industrial school in which the most time will be given to practice instead of theory. They propose to require of the apprentice fifty-eight hours a week in the shop and nine hours a week of study. The term of apprenticeship for those beginning to learn a trade who are under twenty years of age, is to be six years, in which time, under this system, it is believed that an apprentice will be qualified to rank with the best journeyman and to earn the same wages. Those who are over twenty years of age are allowed to finish their apprenticeship in five years, and those who have worked in a shop are advanced according to proficiency. The beginner is first put to drawing from sketches, then takes up projection and diagram, and advances regularly according to his ability. It is believed that in this way one year will qualify him as well to work from drawings, as four or five years ordinarily. All applicants are taken from four to twelve weeks on trial, and if not satisfactory are then dismissed. For the first year's labor 5 cents per hour is paid to those under 18, 6 cents to those who are 18, and 7 cents to those who are 20 and upwards; for the next years the rate is advanced to 6, 8, 10, 11 and 12 cents. The firm also pay 2 cents per hour additional into a reserve fund, which is paid to those apprentices who finish their full term of service; for the six years this amounts to $400.

The scheme in this shop grew out of the difficulty experienced in getting thoroughly qualified machinists, and is an attempt to solve again the old problem of how to continue the system of apprenticeship, now largely fallen into disuse. It is stated that this firm have already more applicants than they can accept. The scheme certainly seems worthy of a trial. We have but little sympathy in many cases with the lament over the decrease of the apprentice system. The introduction of machinery and the consequent subdivision of labor have made it unnecessary in many trades. In some trades, however, there cannot be such a subdivision, nor such machinery as will do away with the necessity for a large proportion of skilled, thoroughly educated mechanics, and the machinist's trade is one of these. The scheme we have described above, certainly seems well calculated to produce workmen not only competent for the ordinary routine of shop work, but competent to design and oversee the execution of work.

Fine Arts.

THE STUDY OF THE BEAUTIFUL.

On the 30th ult., Mr. G. A. Storey, A.R.A., delivered a lecture in the theatre of the London Institution, Finsbury Circus, on "The Study of the Beautiful." There was a crowded attendance. The lecturer began by quoting a passage from the *Dialogue of Plato* to show that even Socrates was puzzled when asked to distinguish between what was ugly and what was beautiful, and at a later time Hogarth stated that the subject was too high and delicate for any attempt at a true definition. Yet though the Greek philosopher could not answer the question, the Greek sculptor and even the humble potter had demonstrated that art was really the language of the beautiful. All great art was like nature. In these days we have no longer the Delphic Oracle or the worship of the temples of the gods; but Greek and Roman sculpture still remained and was still admired. Thus, no beautiful art could exist unless founded upon the study of nature, nor could mankind appreciate it unless they knew something of nature's laws. Artists themselves well knew that truth. If an artist found that by putting real art into his pictures they were not likely to attract purchasers, he would be tempted to forget the higher and legitimate walks of his profession, and think only of what would attract the eye and tickle the fancy. In this way might be traced the rise and fall of art in its external aspect. By the study of the beautiful he (Mr. Storey) understood seeking for the beauty and goodness of things as opposed to looking for their faults and badness. For one, however, who could perceive and appreciate the beauty of a fine work of art, thousands could only find fault. For one who could understand the goodness of humanity, thousands could only take note of its weakness, and so betrayed an absence of the capacity to perceive beauty. Now, it was right to expose a fault, and not to be unduly lenient; but it was wicked and unjust wilfully to ignore all beauty and goodness. Which was best for the mind—goodness or badness? The answer was obvious. The poet or artist stored his mind with all the good deeds which he perceived his fellow-men capable of, and made it his study to show them to the world, producing those pictures and poems which were the delight of ages. Still beauty was not all sweetness. Ophelia was beautiful in her sorrow, in her madness, in her death. As in music there were certain discords which conduced to the harmony, so in art there was a certain ugliness which enhanced the beauty of the picture. Men's minds were like bookshelves, on which they can stow away only a certain number of ideas. Should they be occupied with the marvels of nature and true wisdom, mirth, and innocence; or should they be cumbered with the record of man's villainy and the morbid reflections of the pessimist? The one was the light and the other was the shadow, and when both were studied it must be confessed that the light was the better of the two. The question resolved itself into this: In what did the beauty and goodness, and in what did the badness of things consist? That had been so ably treated by Mr. Ruskin that little more could be said on the point, and doubtless his works had contributed, to a great extent, to that desire for beautiful things and for the improvement of things which characterized the present generation. It was surely well for people to have something to think about besides the routine of business and the everyday affairs of life. Though the question of what was beautiful could not be answered in the abstract, any more than the alchemist could discover the philosophers' stone, still it was one which gave a healthy exercise to the mind and led to the solution of difficult and vexed questions. If the alchemist had discovered the means of turning every metal into gold, then he would in reality have discovered only how to make gold itself utterly worthless; and if men were to discover what was scientifically and actually beautiful, then their efforts to do more must cease. So it was better perhaps for mankind to be as they were, seeking to find out some of the beautiful and continuing those studies which were ever opening up field for enquiry and were ever increasing in interest. It was his (Mr. Storey's) object in the present lecture chiefly to consider beauty as shown in the art of painting. They had to consider the drawing, composition, subject, expression, and execution of a picture. A beautiful picture consisted in exactly expressing the form and nature of the thing to be drawn. If it were a leaf or flower the drawing must be light and delicate; if the branch or bough of a tree, firm, free, and strong; if rocks, decided, and perhaps hard; if the human form, firm yet flexible; and if the expression of the face were to be delineated, then delicacy and refinement were necessary. A good draftsman must in short handle his brush according to the nature of the object he was depicting. Hence drawing was not a mechanical but a mental process. Mr. Ruskin said that a careful picture was distinguished by two things—first, moderation; secondly, by never remaining equal in degree at different parts. The lecturer here illustrated his meaning by a Greek and Etruscan vase, both showing how ingeniously man could adapt and mould the great truths of nature to purposes of art. The great doctrine of true art he continued, was that each part of the world was designed to benefit the rest, and it would be well if that could be carried out in real life. With regard to the law of fitness they must be careful to consider whether beauty consisted in fitness only. In nature, fitness certainly grew out of it; but in the works of man there were many articles very ugly but nevertheless useful. There were the chimney-pot hat, the water can, the lamp-post, the ordinary square London house, and even a kitchen jug which he held in his hand, though not offensively ugly, could not be compared with the Greek vase. But if things were called only because they were exactly adapted to their uses, then the jug was as good as the vase. When he called the jug ugly his cook replied, "It may be, sir, but it is very useful." He pointed to another jug, with the remark that it was equally useful but prettier. "It may be prettier," retorted the cook, "but I don't like it so well as the other because I can't get my hand in it to clean it out." People must not, therefore, abuse kitchen jugs: they were good, honest, and meant to be useful. Passing on from outlines to speak of color, the lecturer incidentally alluded to the Japanese, who had a wonderful idea of color, consummate taste, love of nature, keen sense of humour, and great power of delineating human character. Sir David Wilkie, after studying all the great masters on the Continent declared that color, if not the first requisite, was the most essential part of painting. There was something so subtle and intricate about color that one could not speak of it without mentioning his own sensations. Colour affected the emotions almost more than anything else. He could quite understand an artist in the enjoyment of the effects of colour as nature showed them to us, being tempted to make colour the one and only aim of his art; but all great colourists had been men whose senses of proportion had taught them that art was not colour only nor form only, but a combination of the characteristics of nature. Passing on to another branch of the subject, the lecturer observed that false sentiment was never found in true art. A subject might be revolting and terrible, but still was a grand work if true in sentiment; and the most lofty subject might be spoilt by affected attitude and expression. "One touch of nature makes the whole world kin," and he who would depict the thoughts and passions of men must himself be human, so that his sympathies might enter into all the joys and sorrows of his fellow creatures. The real academy of art was in the green fields among the wild flowers; in the woods, in the rivers, in the sea and sky, and in all living things which inhabit them; among the mountains in all their grandeur; and in the populous streets of towns. If students would study earnestly in this academy there was no reason why modern art, or the art of this country, should not be capable of equalling, if not surpassing, that of the ancients. (Applause). He did not say whether it would or did, but the road was open. Nature was as good as ever, mankind had as kindly feelings, were as beautiful, children as sweet, and men as handsome. Why, then, should not modern art be as fine as in the old times? Mr. Storey, in alluding to the admirable manner in which familiar toy and story books were now illustrated, paid a high compliment to Mr. Caldecott, Miss Kate Greenaway, Mr. W. Crane, and to Mr. Stacey Marks, who was the founder of this delightful and important branch of art. It had been said that there was nothing new under the sun, but the illustrations of these artists made one doubt the truth of the assertion. When artists copied from each other instead of from Nature degeneracy took place. Of course lessons must be learned from the art which preceded us; but all great artists like Raphael drew straight from nature, both for their inspiration and details. Certain German imitators of the great master doubtless reminded the beholder of him, but only that he was dead. Pose was the first essential in art. Mr. Frederick Walker used to say that "oneness" or unity was the great quality to aim at. Yet everything that was painted should be put in its right place, right tone and colour. A work of art should put us in a pleasant frome of mind. The contemplation of it should give us peace. But some pictures had the opposite effect, and appeared to be painted with the aim of startling their beholders. Raphael's and Reuben's pictures led the heart and mind along wath them. In the study of the beautiful we had only to open our eyes and seek for the beauty and loveliness which were everywhere visable and which were never before dreamt of. The greater the number of minds occupied in this manner the greater was the chance of the advancement in the perfection of art. In these days when men were perplexed with doubts, and the political atmosphere was darkened, surely it was better to turn to nature, which would teach us to "turn our spears into plough-shares and our swords into pruning hooks." The lecturer concluded amid applause.

MOSAIC DECORATION.

The art of representing various outlines and patterns by means of small fragments of different coloured minerals or artificial substances is one of very ancient date. What is now termed "mosaic work" was known and practised in Assyria and Babylon, as also in Egypt, and attained to high perfection among the Greeks and Romans. This ancient art was much used by the early Christians, and after falling somewhat into disuse in the dark ages was revived in Italy at the end of the sixteenth century. The decoration of the dome of St. Peter's gave a fresh impetus to Roman mosaic workers, and a school was established for instruction in the art, which still survives, and is known as the "Fabrica.

The numerous remains of mosaic work found in the buried cities of Herculaneum and Pompeii and the traces of mosaic or tesselated pavements which have been discovered wherever Roman influence or colonization extended, prove how universal was the employment of this mode of decoration in the first few centuries of our era. Like all the Roman arts, that of working in mosaic seems to have been borrowed from the Greeks; and from the writings of Pliny we have good reasons for believing that this work first became prevalent in Rome about 80 B. C.

Roman mosaic work has been divided into four classes,—namely, the pictorial consisting of fictile and vermiculated work, and the tesselated and sectile work for paving purposes. There is no doubts that the mode of working with small cubes, or *tesseræ*, as the fragments were named by the Romans, was first employed for pavements in the production of the tesselated work. Most of the examples of ancient mosaic work which have been found in England belong to this class, and some of the finest specimens of tesselated pavement have been found at Pompeii and at the Baths of Caracalla. The Roman *tesseræ* were generally small cubes of marble about three-quarters of an inch in each direction. The designs were, ih the earliest work, confined to simple geometrical figures. The next variety is the *opus sectile*, or sliced work, for which thin slices of marble were employed, and which were formed into designs of a more complicated character. The pavement of the pantheon is one of the most splendid examples of this style of work; no ancient specimen has been discovered in any other country except Italy.

Passing on to wall decoration we have next the *opus fictile*, for which artificially made tesseræ were first used. It was the facility afforded by such materials for obtaining an effective and durable wall covering which gave to the mansions of imperial Rome their chief splendor. Indeed the *vitreæ pasetes*, or walls of glass, seem to have been among the most general of the modes of decoration employed by the wealthy Romans. From the descriptions of specimens of this fictile work it would appear that the tesseræ were almost exactly similar to the modern enamel tesseræ termed *smalto* by the Italian worker. The fourth and last class of Roman work was the *opus vermiculatum*, divided into three sub-divisions, dependent upon the sizes of the tesseræ employed. Ths substances used for vermiculated work were in most cases very small and irregular-shaped fragments of rare, coloured marbles, but in the finer sort of work, gems and fictile tesseræ were often introduced. In the coarsest work of this class, termed *opus majus*, and chiefly adapted for pavements and ceilings, the tesseræ were generally very uniform in size and arrangement, and the effect produced was similar to that obtained by the modern mosaicists.

There are few remains of mosaic work in great Britain of post-Roman date until we come to the monuments in Westminster Abbey, which were no doubt executed by Italian artists employed by Henry III. The shrine of Edward the Confessor bears the date of 1270. During some restorations at the abbey, Sir Gilbert Scott found in the soil beneath one of the tombs numerous fragments and chippings of the tesseræ employed in the design, and the evidence that they were actually produced on the spot appears to be incontestable. This mode of working in mosaic, in which each tesseræ is fixed into its appointed place and securely cemented to those around it as the work proceeds, is what we may term the ancient method, in contradistinction to the plan now generally adopted in forming mosaic pictures, in which the entire mode of proceeding is changed.

The modern plan is due, we believe, to the skill and ingenuity of Dr. Salviati, of Venice, whose name is associated with the revival of many beautiful almost lost arts connected with the manufacture of the famous Venetian glass, and the products of the island of Murano. Sir Henry Layard tells us that Dr. Salviata taught his workmen to reverse the cartoon, or the design prepared for the reproduction in mosaics, that is, to trace it from the back; the tesseræ were then placed face downwards on the smooth surface of the paper design, each tessera being temporarily retained in positions by means of common paste. Of course the workman sees only the back of his picture, and this method would scarcely be applicable to very delicate work, but it is all-sufficient for ordinary decorations of an architectural character, and when once the workman has acquired skill and proficiency in this plan of arranging the tesseræ, he can judge of the work as it proceeds, from the appearance of the back, almost as well as he could from its finished surface. When the design is completed the under surface is covered with liquid cement, which runs into all the crevices and securely embeds the tesseræ; the paper design is then removed, bringing to light the perfectly smooth and level surface of the completed picture, now seen for the first time.

Another plan by which the necessity of putting together the tesseræ in the actual spot they are to occupy is prevented, is that which has long been practised in the Fabrica at Rome. The method of working is as follows:—A containing rim or band of thin metal shaped to the actual size of the finished design, and attached to a slab of hard cement, which is to form the back of the panel. Over this is then spread a layer of soft or rather rotten plaster of Paris, which is brought up level with the edge of the metal rim and the finished surfaee of the picture. On this bed of plaster, the design to be worked in mosaics is then carefully traced, and the workman can commence his picture. He cuts out with a small chisel the form of each tessera, and having selected one of the right color, he dips it in cement and secures it in position. In time the whole of the plaster is scooped out and replaced by the mosaic work of the finished design. This plan resembles that followed in making inlays in marble and pietra dura, has many obvious advantages over the earlier method of working the subject *in situ*, as it enables the rough surface of the mosaics to be readily smoothed down and polished, and greatly reduces the cost of the work.—*Cassell's Magazine of Art.*

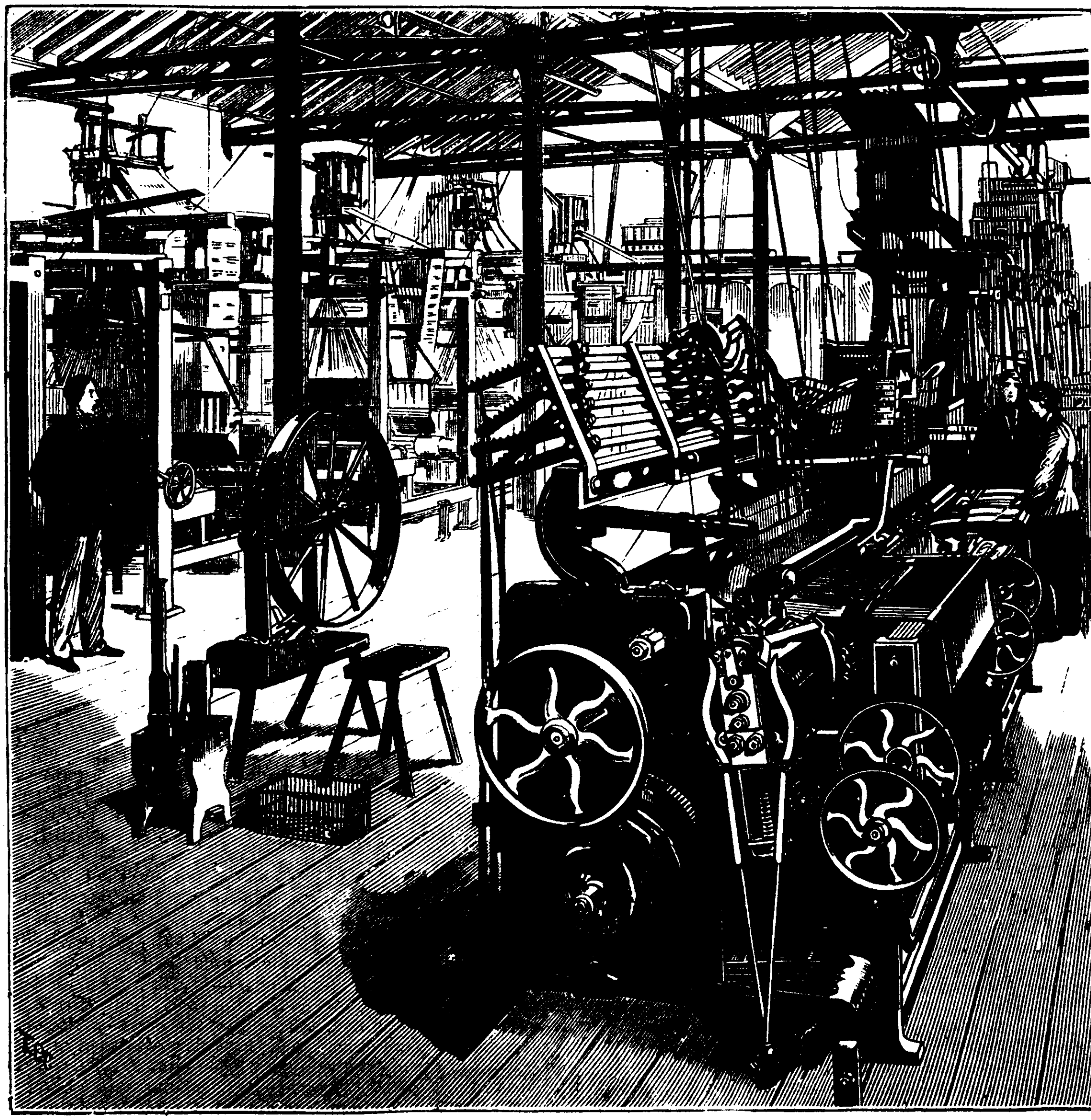
THE LATEST ELECTRIC LAMP.—The Maxim lamp, which is mentioned as accomplishing the results sought for by Mr. Edison, is an incandescent lamp, having a filament or conductor, which is placed in a glass globe from which the air has been exhausted and replaced by the vapor of gasoline. If there is any weak point or thin part in the carbon filament when the current is passed through it, this point er part will become hotter than the rest, and will decompose the gasoline so as to deposit carbon in the form known as coal-gas carbon upon that particular spot. When this spot as been built up to an equal conductivity with the rest of the filament, the current from the machine is increased with the effect of seeking out the next weakest point or thinnest part, and repeating the process just described. In this way the filament becomes glazed with gas carbon. The gasoline is then withdrawn from the globe, and the lamp is ready for use.

TO TEST ENAMELLED IRON-WARE FOR LEAD.—Take ordinary vinegar, which dilute with four times its weight of water, and to which add 5 per cent. of table salt. The solution is poured into the vessel, and left in it for twelve hours at ordinary temperature. After this time the liquid is examined for lead by means of sulphide of ammonium. If the liquid acquires a black or dark-brown colour, the enamel is dangerous; if the colour is only light yellow or light brown the vessels may be used.

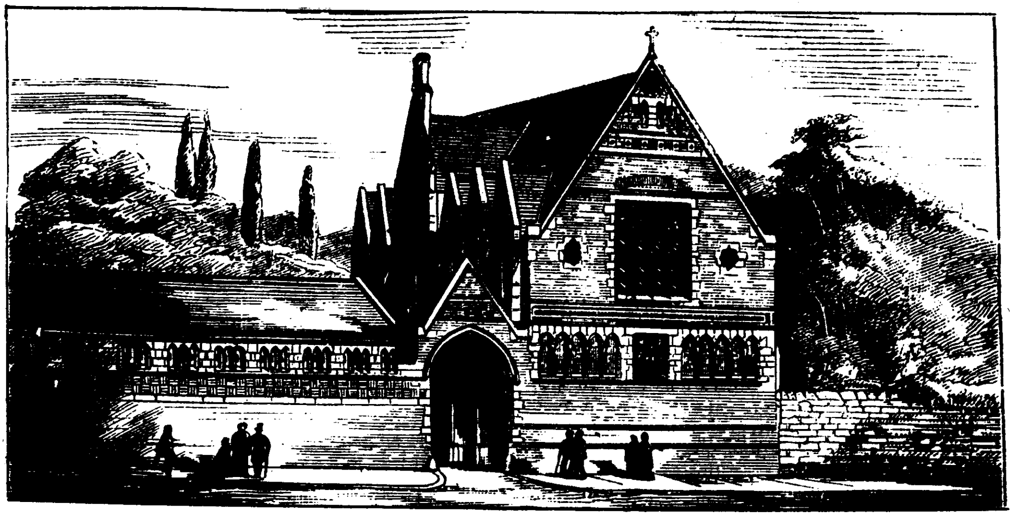
TRANSPARENT GOLD. If a solution of gold in aqua regia is centralized by carbonate of soda, and a solution of oxalic acid is added, the gold is precipitated in a brilliant yellow powder. On examining this precipitate by the microscope the flakes are found to have a triangular or hexagonal form and to be translucent, the color of the transmitted light depending on the thickness of the crystals.—*Les Monde.*

THOUGHT RULES THE WORLD.—It makes no noise, but lives on and reigns when all the bustling and shouting that seemed to stifle it are hushed, and whilst the great works, which it guided the hand of man to do, have either perished or remained to tell of a pomp and vain glory gone forever. Thought is with us in the words of wisdom that "Shall not pass away," and to which we do well to give heed.

WEST FRONT OF THE LECTURE ROOM AND MUSEUM, WITH DYE HOUSE AND WEAVING SHED.



INTERIOR OF THE WEAVING SHED.



ENTRANCE IN THE BEECH GROVE ROAD.

INTERIOR OF THE DYE HOUSE.

Astronomy and Geology.

THE WORK NOW BEFORE ASTRONOMERS.

Prof. Asaph Hall, in an address before the astronomical section of the American Association for the Advancement of Science, which lately held its annual session in Boston, gave an admirable outline of the present status and future prospects of the work before astronomers, which we briefly summarize as follows: An accurate knowledge of the proper motions of the fixed stars, and of the great changes of light and heat among them, can only be attained by long continued and laborious observations made through centuries yet to come. Hence, the observations of to-day should be carefully divided up and made so accurately that the astronomers of the future may rely with confidence upon the results of the labors of their predecessors to detect and measure changes which takes place only during the lapse of ages. Similarly prolonged observations are also needed for the full development of the secular changes in our own solar system. With the exception of Neptune, the *orbits* of the planets are already quite well determined; but in many other respects much yet is to be learned. In the case of Saturn, all the tables are in error; but these errors are supposed to arise from some defect in the theory of that planet. The lunar theory is still an unsolved mystery, and all the lunar ephemerides are effected with empirical terms. The observations of the fixed stars are of the highest importance, since they are the fundamental points on which our knowledge of planetary motions and even the motions of the stars themselves depend. Previous to the present century, but little work had been done on double stars. In this field, although the work is simple, the observations should be made with great care and accuracy. The astronomer, above all other scientists, should have patience in his work, and be content to allow future generations to reap the reward of his toil. The physical theories of the universe, of which modern popular science is so productive, are generally worse than useless, notwithstanding he who rants freely about the nebular hypothesis is often considered one of the advanced astronomers of the day. A good observation of the smallest double star, or of the faintest comet or asteroid, is worth more than all such vague talk. It is only about 40 years since a stellar parallax was first measured, and then the most powerful instruments were employed. Much remains to be done in this direction. Photography, which has rendered good service in descriptive astronomy, does not admit of the accuracy of measurement required for stellar work. The determinations of the motion of stars toward or away from the sun are so discordant that no confidence can be placed in the results so far obtained. It is hoped that some of the large instruments now in course of construction, may throw more light upon this obscure subject. Argelander and his assistants completed their great catalogue of 324,198 stars in 1861. It is a work of great value and should be extended to other parts of the heavens. By taking account of a large number of stars, it may be possible to determine the motion of the solar system in space. Very few American observatories have been established for the purpose of doing purely scientific work, for they are generally built in connection with some college, and are the product of some local enthusiasm, which builds and equips an observatory and then leaves it helpless for support. The Professor remarked, in closing, that the present and prospective means for placing instruments at elevations of 8,000, and even 10,000 ft., will doubtless result in much good. At such altitudes, we may be able to do, with small apparatus, work, that under ordinary conditions requires much more powerful instruments.—*Californian for December.*

SPECTROSCOPIC STUDY OF THE SUN.

The intensity and the frequency of reversal of the magnesium rays, in the green region of the solar spectrum, has long attracted the attention of spectroscopists. It has also been observed that the reversal did not affect all the rays at the same time. Prof. Young has made extensive comparisons with the C ray of hydrogen, which is always reversed in the chromosphere; Lockyer has shown that the reversed rays are the longest, and that among the reversed rays that which is the least intense is also the shortest; Tacchini measures the variations of solar activity by the number and frequency of reversals, supposing that the most intense rays appear first and that the energy of the eruptions varies in proportion to the number of reversals. This inequality of reversal has led to the theory that all terrestrial elements are dissociated in the sun into other unknown elements which have more simple spectra than those which are known. This theory implies the impossibility of deducing the constitution of celestial bodies from the spectral study of terrestrial elements until they have been dissociated and their component elements have been recognized.

Fievez has studied the spectra in various ways. He first examined the influence which the relative intensity of the brilliant magnesium rays exercised on their visibility by projecting them upon the solar spectrum and thus effecting a true reversal. He then repeated his experiments upon the simplification of spectra by varying the intensity of the spark. Finally, guided by Lord Rayleigh's investigations in spectral optics, he studied the influence of a dispersion and of a definition, more or less considerable, upon the number and visibility of the rays, by comparing prismatic and diffraction spectra. His experimental arrangements were the same as those which he adopted in his investigations upon the spectra of hydrogen and nitrogen. They seem to establish conclusively his opinion that a modification in the appearance of the spectrum springs from a physical cause and not from a change in the chemical constitution of the metal or a dissociation, and that the unequal reversal of the magnesium rays is caused by a difference in the intensity of the brilliant rays and not by any special state of the metal.—*Mining and Scientific Press.*

Inventions.

FABER'S TALKING MACHINE.

The *London Times* gives the following description of this celebrated machine, as improved by Joseph Faber son of the inventor: "The principal features of the machine are, to begin with, the bellows, from which the air is being driven with considerable but varying force, by means of a pedal lever. The air passes in a horizontal stream through a small chamber, which represents the human larynx, and in the same right line out through the mouth. The lips and tongue are made of India-rubber, and the lower jaw is movable. Below the laryngeal apparatus, and opening from the chamber in which it is contained, is another smaller chamber, about the size and shape of a lemon, from which a pipe curved upward allows the air when driven through to escape. This supplies the place of the nose instrument, and when a valve is opened, enables the sound of the letters m and n to be produced by striking of the same keys with which the sounds of b and p are obtained. The larynx is, of course, the most complex part of the machine, and to Herr Faber is due the elaboration of this portion of the mechanism. Within a small oblong box, a narrow and exceedingly thin strip of hippotamus bone, strengthened by India-rubber on one side, produces by its vibrations, the speaking tone, which may be called the fundamental sound to be subsequently modified. At the will of the operator the pitch can be raised or lowered, but not during the utterance of a word or sentence, so that in saying "Mariana," or "*Comment vous portez vous?*" (the machine talks French, German, Italian, or English) the key note remains unaltered to the end. In front of the vocal chord and within the laryngeal chambers are stops or diaphragms placed vertically, and rising and falling like the wards of a Chubb's lock, but different in that each stop is a complex machine in itself, having within, moved by a spring, another stop, by means of which an orifice at the base is enlarged or diminished. Herr Fabre has taken another liberty with nature, for, besides placing the nose below the mouth, for the sake of convenience he has placed the teeth in the larynx, or, more strictly speaking, with one of these stops he gets a somewhat lisping "s" or the sound "sh" from the machine. A small windmill-like arrangement gives the rattle of the letter "r" and a thin iron band, notched in the lower rim in front, fitting outside the upper lip' descends to give the "f" or "v" sound. There are fourteen keys by which sounds are controlled. Striking the first the sound of "a" in "father" is produced, the mouth remaining wide open; another key being struck, the lower jaw rises and the sound of "o" in "bowl" is given; a third key moves a lever, which nearly closes the mouth, and the sound "o" in "movement" is emitted. The other vowel sounds and consonants are produced by the use of diaphragms in the larynx with the mouth in the second or third position.

ACID-PROOF CEMENT.—An acid-proof cement may be made by mixing a concentrated solution of silicate of soda with powdered glass to form a paste. This simple mixture is said to be invaluable in the operations of the laboratory, where a luting is required to resist the action of acid fumes.

THE BRUSH ELECTRIC LIGHT.

It is becoming more and more apparent as the months pass by, that the recently awakened enthusiasm respecting the general introduction of the electric light is destined to be realized, and that this time the electric light has come to stay. Since the earlier attempts at utilizing electricity for illumination, some twenty-five or thirty years ago, which resulted in the failure to achieve practically successful results, and in the general impression that it was at best a superb but expensive luxury, which was probably destined to remain such for an indefinite period, we have immensely improved upon the methods of generating electricity. The troublesome, uncertain and expensive chemical battery has been supplanted by steam-driven induction machines which afford an immeasurably superior source of electricity than the former, and are adapted to all the requirements of science and the useful arts. Since the announcement of the earliest machines of this class, they have attracted the attention of scientific men, and have undergone material improvement at the hands of Brush, Wilde, Gramme, Siemens, Edison, Maxim, and Houston and Thomson.

With improvements in the machines for supplying the electric current, we have had corresponding improvements in the methods of utilizing the electricity, and to-day we have two distinct systems of electric illumination—the voltaic arc and the incandescent, contending for public favor. The last named system is the outgrowth of the attempt to practically substitute gas lighting for domestic purposes, and involves the successful solution of the difficult problem of indefinitely subdividing the electric current without serious loss of power. This problem has thus far baffled the skill of inventors.

The other system contemplates the illumination of large areas by powerful lights, and was of late been so far perfected as to have achieved a pronounced success for the lighting of public thoroughfares, harbors, bridges, public buildings, hotels, mills, factories, and the like. In this connection the Brush electric lighting system, by reason of the extent to which it has been introduced, and the favor with which it has been received, has come to be recognized in this country as the representative of the system which it illustrates.

Up to the first of July last, we are informed, there were no less than 3,000 Brush lights in use, and since that time their number has been increased to over 4,000. As an evidence of the superiority of the methods employed for utilizing the current, the advocates of the Brush system point to the fact that the machine about to be described, is capable of maintaining from 10 to 18 electric lamps, each of a nominal power of 2,000 candles, on one circuit, with the consumption of about 14 horse power, a performance which, it is claimed, greatly surpasses anything that has thus far been achieved by any other system in use.

This subject at the present time has acquired special importance from the fact that within the past month a company has received the necessary concessions for the purpose, from the municipal officers, and has been engaged in introducing the Brush system of electric illumination in New York city for lighting the streets. The company in question has already located its first station, and has put down its initial plant at 133 and 135 West 25th street. The territory contracted by the company embraces the area from 14th (Union Square) to 34th streets, and from Third to Eighth avenues; and they have already introduced their system in practice upon Broadway between 14th and 34th streets, within which limits they have erected 22 lamps, each giving, it is said, a light of 2,000 candles. These lamps are mounted upon iron posts of ornamental design, and 25 feet high. Thus far, we are informed, this experiment has given very general satisfaction, and we have every reason to believe that we shall soon witness the extension of the system throughout the city on the large scale contemplated by the movers in this enterprise.

A brief description of the details of this important public work may not be without interest. The power is supplied by a Corliss engine of 100 horse power, built by Messrs. Watts, Campbell and Co. The foundations have been laid for a second engine of the same dimensions, but thus far only one is in place. The boilers used are of the horizontal tubular pattern, and are 16 feet long by 5½ feet in diameter, the upper half of the shell being of iron and the lower half of steel. Each boiler has 92 tubes, of 3 inches diameter. Two circuits will be connected with this station, which, when in full operation, will be supplied by five of the Brush dynamo-electric machines. One of these circuits will be used exclusively for public lighting, and the other will supply the wants of private parties for hotels, stores and the like.

The plant has been devised with the view of accomplishing every possible economy in the generation and consumption of power. An interesting feature in this connection is the setting of the boilers with the Jarvis system, which has achieved a very favorable reputation for effecting a decided saving in the consumption of fuel, and which also permits of the use of inferior or refuse combustible material to an extent not possible under ordinary circumstances. In the case we are considering, it is intended to use as fuel a mixture of about 10 parts of coal dust to 1 of bituminous coal. The element of economy claimed to be introduced by the employment of this invention is important enough to warrant a brief account of its details.

The object of Mr. Jarvis in his system of boiler-setting is to utilize the heat which is ordinarily wasted in a furnace, by compelling it to perform the useful work of heating the air required to effect the more complete combustion of the fuel, and the gases evolved during combustion. To accomplish this, he utilizes the bridge-wall and the back of the furnace, as well as the side walls, for the heating of the air to be discharged into the combustion chamber, for which purpose suitable channels or passages in the side walls are provided as conduits. The entering air, therefore, is delivered to the column of gases arising from the fuel at a high temperature, thereby avoiding the usual loss of heat by the introduction of cold air, bringing the combustible gases into contact at a temperature more closely approximating to the temperature of combustion; and, by the manner in which it is distributed, effecting a more intimate intermixture of the air and combustible gases, and consequently insuring a more perfect combustion and greater heating effect beneath the boiler. That this construction yields excellent results in practice on the score of economy, has been amply demonstrated, and its adoption with the boilers of the Brush company is an evidence that its merits are properly appreciated.

To return now to the electical machinery. Fig. 1 represents the appearance of the Brush dynamo-electric machine employed. It is 68 inches in length, 30 inches in width, 30 inches in height, and weighs 2,500 pounds. It is driven at a speed of from 750 to 800 revolutions per minute. Fig. 2 represents the various forms of lamps used by the Brush company. In this cut No. 1 shows a double lamp, provided with two carbon rods, side by side, so arranged that when one set has been consumed, the other is thrown into the circuit automatically without interruption of the light. These lamps will burn for sixteen hours without requiring attention. No. 2 represents a bundle of carbons ready to be used, showing the manner in which they are packed for shipment. No. 3 shows the single lamp ordinarily used, and which is capable of running without attention for 7 or 8 hours. These lamps are run without clockwork or similar mechanism; being provided with a magnetic regulator, which in turn is called into play by the current, and automatically regulates the distance between the carbons and preserves the uniformity of the lights. The carbons themselves are made with the greatest care, with the view of preserving a perfect homogeneity of texture. No. 4 represents a focussing lamp, intended for use with the stereopticon and for lecture-room purposes. No. 5 shows a form of head-light lamp to be used on locomotives or steamships, with reflectors. No. 6 is a regulating switch or dial attachment, intended for use with the large machines, and is arranged so that any number of lights from one up to the full number may be burned without varying the speed of the machine. No. 7 shows an ornamental lamp adapted for use in hotels, stores and other places where a more showy lamp is needed. It can be made either single or double, as desired.

Tested by the gauge of practice, the Brush electric lighting system has certainly achieved a very remarkable success, and the latest and most ambitious of its public applications to which we have alluded, will be watched with particular interest, since its triumph would insure the wide extension of the plan of lighting by electricity in our cities and towns. That the experiment now being made will be successful we sincerely hope, and have every reason to believe, since it has already proved successful where similarly employed. In Montreal, Que., for example, where it has for some time been in use, one Brush machine works a circuit of 14,600 feet, or nearly 2¾ miles in length, along the wharves for illuminating the harbor.

The details of operating the Brush system of lighting seem to have been worked out to a high state of perfection. Its representatives assert that with the latest machine they have constructed, which is known as the No. 8 Machine, they are enabled with the expenditure of 34 horse-power, to maintain 40 lamps, each giving a light of 2,000 candles, a performance which, it may be safely asserted, has not been hitherto equalled.

Of the general merits of the electric light on the score of safety, brilliancy and purity of color, we need add nothing, since our

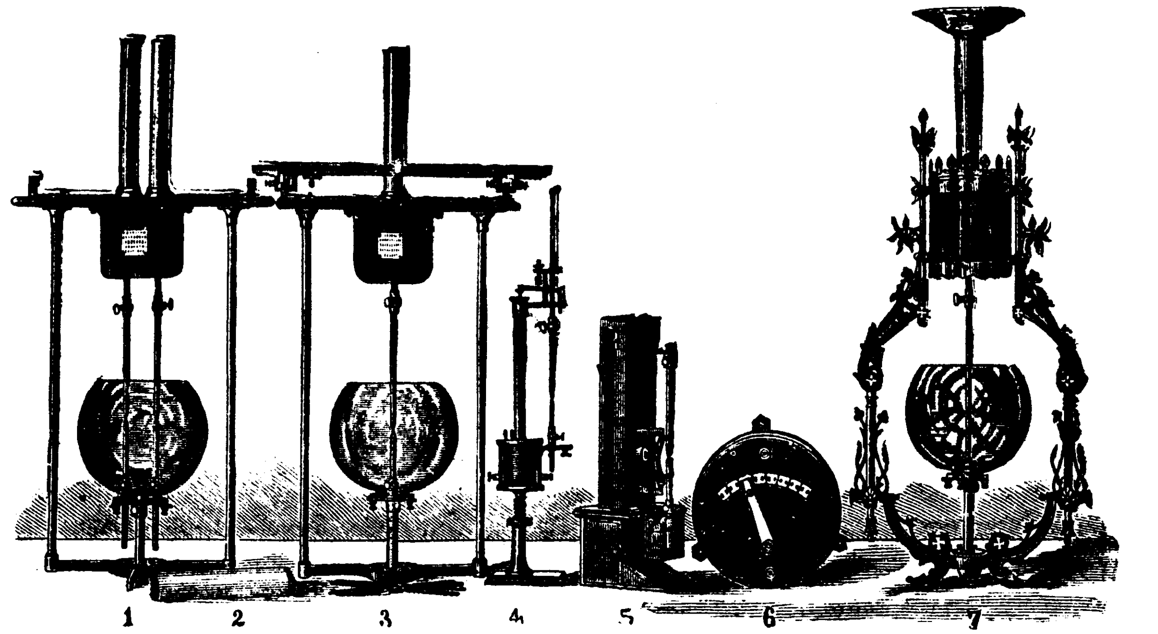


FIG. 2.—THE BRUSH IMPROVED ELECTRIC LAMPS AND FIXTURES.

readers are already sufficiently familiar with the facts. To these desirable qualities we may now add that of cheapness, and have little hesitation in making the assertion that it will speedily come into general use for the illumination of large buildings and areas, and for public streets, parks, &c., for which it is pre-eminently adapted.

In conclusion, we add the names of a few of the establishments in which the Brush electric light has been introduced, most of which will be recognized by our readers as among the most prominent in the country, viz., the North Chicago Rolling Mill Co., the Union Rolling Mill Co., Chicago; Park, Bro. & Co., Black Diamond Steel Works, Pittsburgh, Pa.; Brown, Bonnell & Co.'s Mills, Youngstown, O.; Washburn & Moen M'f'g Co., wire mills, Worcester, Mass.; Niles Tool Works, Hamilton, O.; Otis Iron and Steel Co., Cleveland, O.; Passaic Rolling Mill Co., Paterson, N. J.; Bay State Iron Co., South Boston, Mass.; M. C. Bullock, Diamond Drill Works, Chicago; Riverside Worsted Mills, Providence, R. I.; Amoskeag M'f'g Co., Manchester, N. H.; Willimantic Linen Co., Willimantic, Conn.; Grand Pacific Hotel Chicago; to which might be added the names of some thousands of others, which we have not space to mention.

We regard the experiment now in progress in New York as of the highest importance in its bearings upon the general introduction of public lighting by electricity and we shall watch the progress of the experiment carefully.

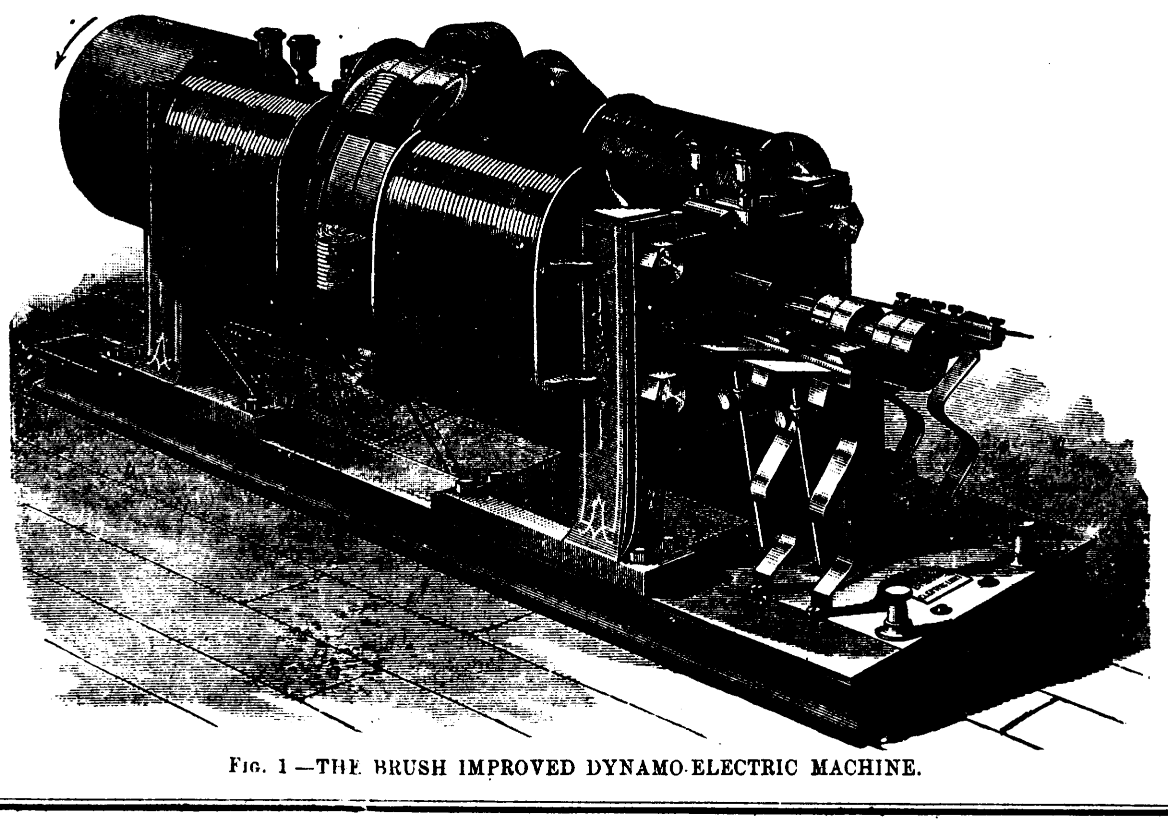
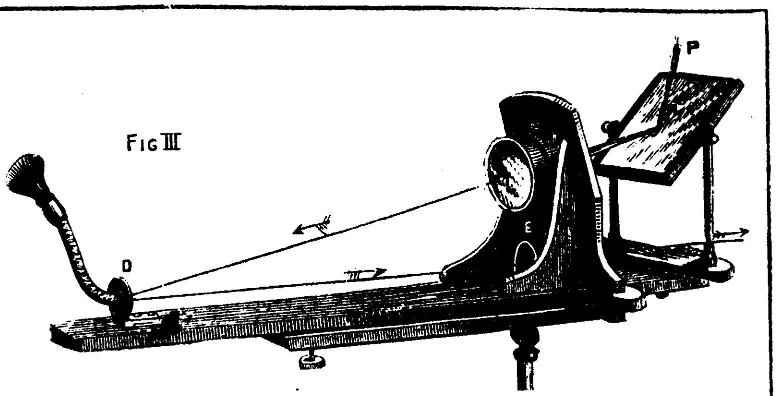


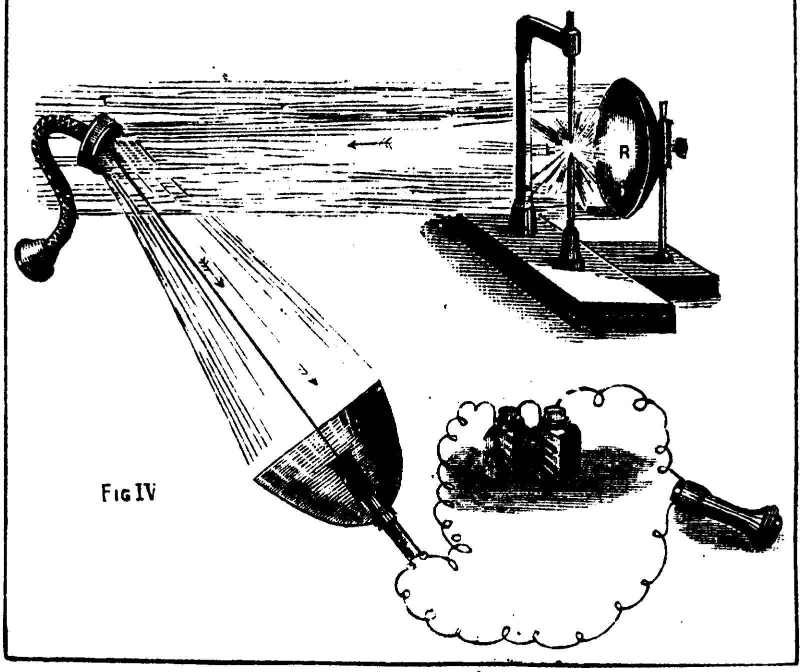
FIG. 1.—THE BRUSH IMPROVED DYNAMO-ELECTRIC MACHINE.

THE PHOTOPHONE.

The theory of the photophone, which depends for its action on the influence of light in affecting or modifying the electrical conductivity of selenium, was explained at some length in this journal immediately upon the announcement by Prof. Bell of his highly interesting discovery. We are enabled this month to place before our readers several illustrations of the apparatus, which will serve to render the action of the photophone more intelligible.

The curious phenomenon presented by metalloid selenium above referred to, has attracted the attention of investigatoıs for the past ten years, but up to the present announcement of the photophone, no application worthy of mention had been made of it. One of the greatest difficulties encountered in the attempts to utilize selenium, has always been the construction of a practically successful selenium cell, by which its sensitiveness to light of varying intensity could be utilized; and this difficulty is due chiefly to the fact that selenium offers great resistance to the passage of the electrical current. Because of this great resistance, therefore, selenium can only be used in the form of an exceedingly thin sheet or film, for the reason that the working of the telephone, which is part of the apparatus about to be described, would be interfered with by too strong a current. The earlier experiments to meet the conditions of the problem, by fixing a thin film of selenium between two plates of platinum or iron, very near together, and introduced into the galvanic circuit, were not successful, for the reason that the selenium could not be brought into proper contact with the metallic surfaces.





BELL'S PHOTOPHONE USED WITH THE ELECTRIC LIGHT.

After numberless experiments, Messrs. Bell and Taintor found that the substance best suited for the contact surfaces of the selenium cell was brass, although at first it was thought to be unsuited because of the chemical action that was anticipated. This action it was found did take place, but proved unexpectedly to be advantageous. A portion of the copper of the brass unites with the selenium to form a selinide of copper, which forms an excellent surface for the attachment of the selenium, and thus affords the extended surface of contact between the selenium and the metal which was sought. The investigators found it best to give the cell the form of a cylinder, as the light rays could be readily concentrated upon its sensitive surface with the aid of a parabolic mirror. The cylinder is made up of a number of insulated brass discs, of which the odd and even members are connected by metallic wires. This construction is shown in Fig. 1, which is a cross section of the cylinder; M and N indicate the conducting wires, B the battery, and T the telephone. Each of the brass discs (shown cross-lined and numbered in the cut) is insulated from the adjacent discs, so that the electric circuit is not complete. The edges of these discs are brought into electrical contact be means of the selenium, which is indicated in black in the cut. The cylinder, formed of the series of united but electrically insulated brass discs very close together, is heated to the melting point of selenium, and then rolled to and fro upon a sheet of plate glass covered with a film of melted selenium. By this means the selenium is pressed in between the surfaces of the series of discs. After the selenium has hardened, the cylinder is turned off in a lathe. By this method of procedure there is left on the surface of the cyliuder a comparatively large surface which is sensitive to light, while the selenium film is exceedingly thin. The discs are made somewhat thicker at their circumferences, so that here the selenium film is the thinnest. In this manner the

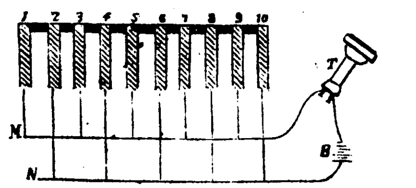


FIG I

BELL'S PHOTOPHONE—SECTION OF SELENIUM CELL.

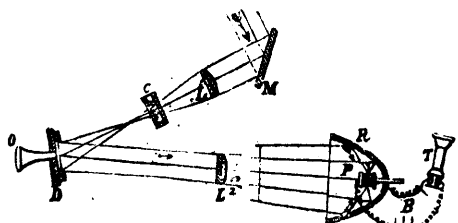


FIG II

BELL'S PHOTOPHONE—SECTIONAL VIEW.

before mentioned investigators have succeeded in devising a selenium cell which in the dark only offers a resistance to the electric current of 300 ohms.

Fig. 2 shows the essential parts of the photophone of Messrs. Bell and Taintor. The light rays are received on a mirror M, from this reflected upon the lens L, from which they are condensed upon the mirror-diaphragm D, after passing through the alum cell *c*, which eliminates the non-luminous heat rays. The mirror D, which is supported by the mouthpiece O, is caused to vibrate by the voice of the speaker behind it, and impress corresponding irregularities upon the light reflected from it. These affected light rays are thrown from the mirror upon the surface of the parabolic mirror P, in the focus of which is fixed the above described selenium cell. The sensitive selenium cell, receiving the light reflected from the diaphragm D, affected irregularly, as to its intensity, by the sound vibrations, responds to these irregularities in corresponding affections of its electrical conductivity. The electrical current meets with less resistance in the selenium, as the light falling on it is more intense, and *vice versa*; and these modifications of luminous intensity produce a strengthening or weakening of the magnet of the telephone T. The strength of the magnet, therefore, varies according to the character of the sound waves impressed upon the diaphragm-mirror D, and by the affection of the magnet as just described, the same sound waves are reproduced in the telephone.

Fig. 3 gives the appearance of the apparatus on a larger scale than in Fig, 2, by comparison with which the corresponding parts will be recognized.

Fig. 4 is the apparatus modified by the employment of the electric light L, in which case a reflector R is employed to throw the rays parallel upon the transmitting diaphragm T.—*Manufacturer and Builder.*

THE ALBION COAL MINES.

BY H. C. HOVEY.

The series of startling disasters by which these famous mines have lately been overwhelmed with loss, and perhaps with utter ruin, serves to recall a memorable visit I made to these same collieries only three months ago. They are worth describing, independently of the painful interest awakened by recent distressing events.

The Albion Mines are located in Pictou County, in the province of Nova Scotia, about 100 miles north of Halifax, and one mile from the village of Stellarton. The entire coal field of the province, so far as explored, occupies an area of about 685 square miles; but the portion lying in Pictou County is a basin by itself, irregular in form, inclosed by much older geological formations, and covers only some 35 square miles. Although thus limited in extent, as compared with other fields, it possesses great value on account of the extraordinary thickness of its beds. According to Hon. Mr. Gilpin, Inspector of Mines for Nova Scotia, to whom I am indebted for much of my information, as well as for personal attentions, the sections of measures in the district of the Albion Mines has a vertical thickness of 2,450 feet, holding 100 feet of coal, lying at an angle of 18 degrees.

The group on the western side of East River exists in several seams of varying thickness and quality. Those most extensively worked are known as the deep seam, which is reached by the "Cage Pit," and the main seam, pierced by the "Foord Pit." The deep seam is nearly 23 feet thick; the main seam actually attains the enormous thickness of 35 feet, although the portion worked does not exceed 22 feet. I was conducted to a spot where the workmen had cut through the entire seam and had taken out a section 35 feet high for exhibition in the Provincial House at Halifax, where I afterward had opportunity to verify the statement by actual measurement. For 22 feet it is clear coal, without a particle of foreign material that I could discover; and the balance has only here and there an intruding stratum of slate or clay.

It should be stated that all the coal thus far found in Nova Scotia is of the bituminous variety; no anthracite having yet been discovered. It has much firmness, however, and though burning freely does not readily slack or crumble. These qualities make it a favorite steam coal on the Atlantic and other steamers. It has also been extensively used for domestic purposes, and it is admirably suitable for cooking. Large quantities were formerly exported to the United States for gas making. Analyses made by the London Gas Company, in 1879, gave 10,300 cubic feet of candle power gas, and 14 cwt. 2 qrs. of good coke per ton of coal. The gas is also represented as remarkably free from sulphur and other deleterious ingredients, when the purifiers were attended to.

The mines were formerly owned by the General Mining Association, of England, which also owned other mines in the Provinces; but a few years ago they sold out to what is known as the Halifax Mining Company, chiefly, however, London capitalists. The Acadia Company, working what is regarded as an extension of the main seam at Westville, is the only American company in the region. Some idea of the importance of this field may be had from the official statement that the area of the Halifax Company alone contains 67,365,000 tons of available coal. The entire coal produce of Nova Scotia for 1879 was reported to be 788.271 tons; of which aggregate the Albion Mines produced 171,534 tons, being a larger quantity than was taken that year from any other single mine in the Dominion. In the year 1862 the yield was about 200,000 tons, and the current year promised to exceed even that showing. The company, under the able management of Superintendent James Hudson, has a line of steamers of their own, and were filling large orders in Montreal and elsewhere. With the improvements recently made, a daily extraction of 500 tons had been reached from the Foord Pit alone, besides what came up from the Cage Pit; and other enterprises were under contract that would operate to increase even this very large yield. Several fine engines had been sent over from England, just prior to my visit, the design of which was to introduce compressed air as a substitute for horse power on the underground railways. To facilitate work further the principal inclines had been re-graded. In fine, everything pertaining to the mine was in as perfect order as human ingenuity could compass; and the terrible disaster that now has wrought such havoc was wholly unexpected.

The upper works of the Cage Pit present nothing of unusual interest; but after descending a shaft 300 feet deep, one is led to the head of a wonderful inclined plane, half a mile long, up and down which cars are drawn by a steel rope. The rope itself is a heavy load to be hauled up many times a day, without taking into consideration the string of cars full of coal. Another curiosity that the foreman took some pride in exhibiting was the system of lighting the portion of the mine near the engine. This was done by utilizing a natural supply of gas flowing from a crevice in the wall. I asked the question, if there was not a degree of danger attending this; but was reassured on being told that the gas was thoroughly headed up in a reservoir, and that those very jets had been burning *seven years*. Yet when tidings came of the explosions in and flames issuing from the neighboring pit, it occurred to me that such a steady stream of gas as I saw must proceed from a hidden and dangerous source. Undoubtedly it was so, though there may have been no immediate connection between those pretty jets and that destructive conflagration.

Before entering the Foord Pit I gave some time to an examination of the works above ground. In doing so I had the company of Mr. Gilpin and Mr. Joseph Hudson (the son of the superintendent). They showed me the old engine "Hercules," the first locomotive run on any railroad in British America. It was still in use; and the man who ran it on its trial trip, so long ago, is still employed by the company. A duplicate engine of the same age, called the "Samson," stood on a side track near by, in good repair and daily use. In proximity to these antiquated affairs was one of the latest and most highly improved English locomotives; the contrast furnishing an instructive object lesson in the progress of modern mechanism.

We found the patriarchal engineer himself at his post of duty in the pump house, running the gigantic steam pump by whose powerful strokes a volume of water is continually discharged as large as a man's body. The buckets, about two feet in diameter, are brought up in three successive lifts of a little more than 300 feet each, making 1,000 feet in all. At the time of my visit the water from the old workings had been nearly exhausted, and the great pump was relied on to raise the water from both the main and deep seams. Who could then foresee the bursting in of a flood in September, from an old and long disused pit, and another on the 12th of October, drowning six men besides several horses? Or that later explosion of fire-damp, making it necessary to pour *into* the mine all the water that could be obtained? This pump was at that time considered equal to all emergencies that might arise.

The ventilating fan, of the Guibal pattern, having, I believe, a diameter of 30 feet and a width of 10, was in a building by itself, and was run by steam acting on a crank turning the fan at the rate of 40 revolutions a minute, with a capacity of 50 or more, and drawing from 65,000 to 70,000 cubic feet of air from the mine. So strong was the suction that ingress to the fan house could be had only through an air-lock. The object was twofold, to withdraw inflammable gases from the pit, and to supply the men working there with fresh air. The Cage Pit is ventilated by a furnace. The atmosphere, as we afterward ascertained, is kept as pure as could be desired by either method under ordinary circumstances.

The actual conveyance of the current thus forced under-ground to the places where it is most needed is by shutting off the old passages not now worked by brattices or thin partitions toward the working faces, and in many cases by air-proof cloth curtains hung in such a manner as to guide the current, even to the extent of splitting it and making the sub-currents travel in opposite directions. But, as recent events have shown, the best precautions cannot prevent the sudden release, at times, of hidden magazines of explosive material stored up in the coal, which by superior force overpower the ventilation, and, as in the Albion disaster, destroy the fan itself, hurling its fragments to a distance and demolishing the building covering it.

The original method of entering the mine was, of course, by the inclined plane, through which the horses are still let in; but the drawing arrangements of the colliery at present are clustered around a pit, and the coal is drawn to the surface in cages. The cage is an open framework of steel bars holding a double deck, two trams being carried on each deck. It is raised by a steel rope fastened to the top bar; and while one cage is lifted another is lowered. The cages are guided by vertical rails to hold them steady in passage.

The loaded cars are run from the cage on to a wide platform, where they are first weighed, then dumped and returned. The steel rope is 6 inches in circumference and 1,200 feet in length. It runs over a drum 22 feet in diameter, revolving at a rate wholly under the control of the engineer. Entering an empty cage with Mr. Hudson, we were let down the vertical shaft, 1,000 feet in 70 seconds, and found ourselves among the swarthy miners. The number employed varies according to circumstances. The published statement in 1879 showed the number at work underground to be 384, of whom 84 were boys; there were 200 surface workers, of whom 37 were boys; a total of 584 employes. The horses used were 38 below and 17 above. The cutters numbered 259, and the average per cutter per annum was 662 tons of coal.

Those whom we conversed with seemed contented, and said that they made a comfortable living, getting from $1.25 to $1.75 per day, besides rent and fuel at greatly reduced rates. They surprised me by their intelligence and some of the very men who have since met a terrible fate spoke most warmly of the pleasure and profit they derived from *Scientific Reading*.

A few feet from the bottom of the shaft is the lamp cabin, where stood Mr. William Dunbar, a man 70 years of age, who for 40 years had been a miner, and during most of that long period had been responsible for the safety lamps. He explained to me the improvements made in the old-fashioned Davy lamps, whereby the gauze is protected by a glass-cylinder from being overheated, and the construction is such that when the air is dangerously charged with gas, the light is infallibly extinguished. As an additional precaution each lamp is locked when given out, so that a careless workman cannot get at the blaze to light his pipe, or for any other purpose. When Mr. Dunbar handed me my lamp he was in fine health, and boasted that mining agreed with him well. It pains me to see it stated that the fine old man is among the victims. He was in his cabin as usual, at the time of the explosion, dealing out lamps to the men, when the flames burst in at his back door. He rushed out the front door and fell on his face. His oil-soaked garments instantly caught fire, and though by his own efforts and by the aid of others he finally extinguished them, it was not until he was so badly burned as to be beyond recovery.

My guide and I traveled around in the mine for what he said was about six miles; finding, of course, considerable sameness of scenery, yet seeing many things novel to one more used to exploring natural caverns than such artificial excavations. My main anxiety was to keep from being run over by the horses which went at full trot through the darkness as fearlessly as if above ground. Their stables were below, but extensive and comfortable; and the horses were seldom taken to the surface, except in case of sickness, till they died. At the time of the explosion 17 horses were found dead in their stalls. Suffice it to say that our trip was without accident.

The only indication of the presence of deleterious gas observed by us was an occasional hissing sound, like the singing of a tea-kettle, caused, as we perceived, by leakage of gas through fissures in the seam, but not in quantity sufficient to make an explosive mixture before being carried off by the current of ventilation. Everything seemed as safe as could be desired. No serious accident has occurred since the great fire of 1861, when the East River had to be turned into the mine to extinguish the flames.

In order to an understanding of the late calamity, some idea should be given of the method of working the field. The entire excavation, judging from the official survey I saw in the possession of Mr. Hudson, must equal 100 miles; and the tramways alone extend for about 20 miles. There is also an underground connection between the Foord Pit and the Cage Pit, as a workman told me who had gone through it. Most of these workings are now abandoned, and closed up by masonry. The system adopted is a form of pillar-working, ribs of solid coal being left between the "bords," or openings at right angles with the main or gate level; and these again are intersected by bords parallel to the main level. The result when spread on a chart looks like an irregular checker-board. The side passages are usually at a steep slope from the main level, and advantage is taken of this to arrange for delivering the coal to the tramways by a system of counter balances, the full cars as they run down carrying the empty ones up to the place where the coal is being cut. The pillars vary from 16 to 18 feet in thickness, and the bords are about 20 feet wide; hence it is evident that, as mining proceeds, only about one-half the coal in the field is removed, the remainder being left as a support for the roof. The custom of "robbing the mine" has not here been introduced; by which is meant taking out the pillars one at a time and letting the roof fall to the floor. The practice is attended with some danger, and also shuts off access to portions of the field lying beyond the passages thus closed.

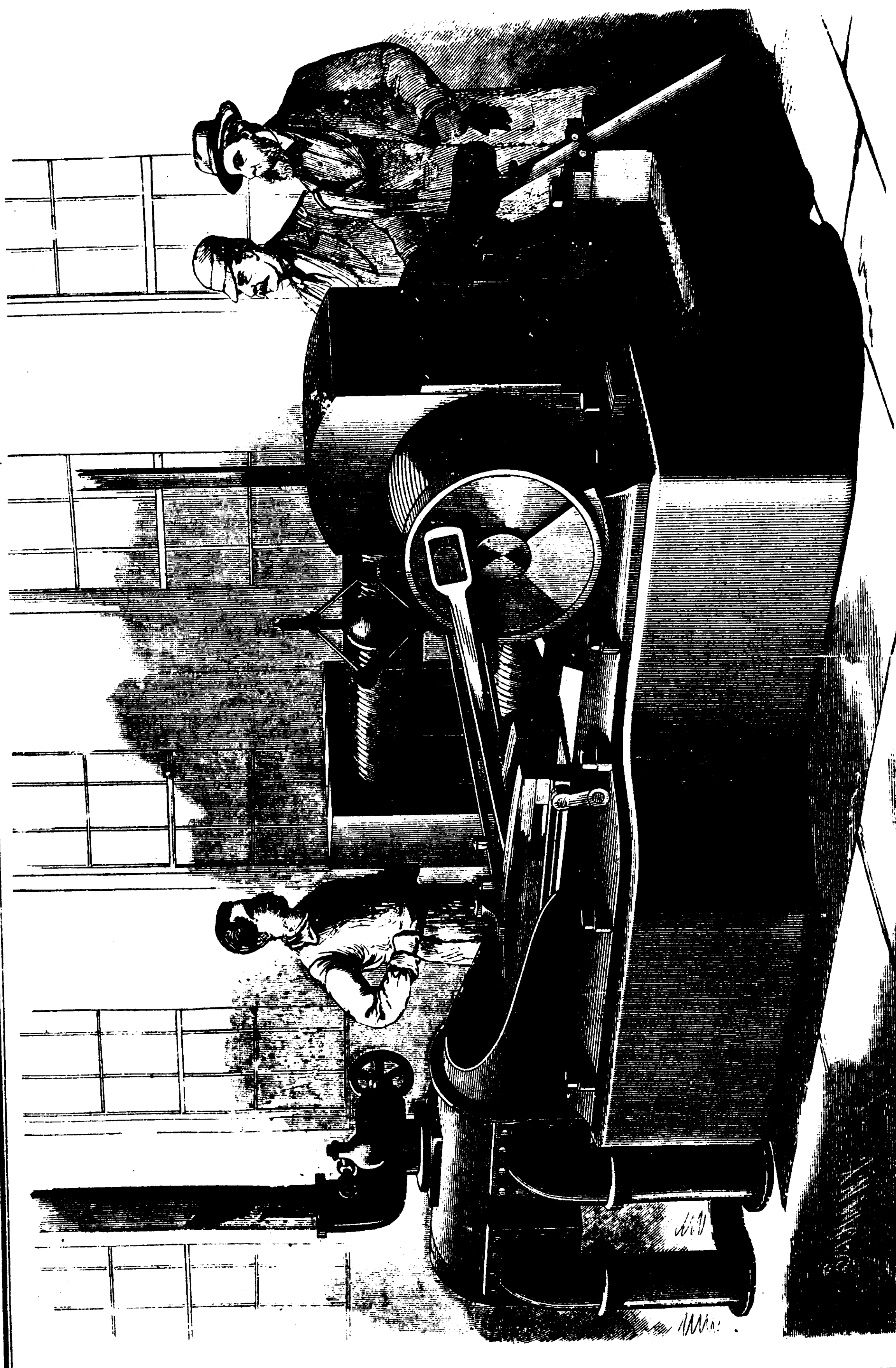
The Foord Pit is divided into the north and the south stope; the one to the north extending for a mile and three-quarters, and the south stope for more than a mile, numerous bords being worked in each. The explosion of November 12 took place in the south portion, at half-past six o'clock A.M., when 150 men had just begun their day's labor. At first it was supposed that this entire number had been destroyed; but those in the north stope escaped uninjured, and the number of the lost as last reported was thought not to exceed 50 men and boys, of whom, however, 33 are married men.

The first to volunteer to explore the mine was Mr. Joseph Hudson, who, together with Mr. Tupper, overman, and Messrs. Poole, Greene, and others from the Acadia and Vale collieries, ventured in for a quarter of a mile, four hours after the explosion. They found the stoppings on the south side blown off, and did something to facilitate ventilation, but peril from accumulating gas was too great to allow of their remaining more than two hours or so, and they came to the surface at noon to await further developments. At the same time the men at work in the north stope came up to dinner and learned the fate of their companions.

The alarm spread until the mines were stopped in all Pictou County, and the people came in crowds about the pit. Attempts to flood the mine during the day were made, and many thought the danger over. But at 10 P.M. an explosion more violent than ever shook the ground, tore off the roof of the fan house, and the descending fragments riddled the roofs of adjacent buildings. The report was heard a long distance. This was followed by another explosion at 2 A.M., and similar outbursts were repeated at intervals till the ruin of the mine seemed inevitable. Volumes of smoke poured forth from the shafts, showing what a conflagration was raging below. Fire engines from Pictou and New Glasgow were brought and set to pumping water into the shafts. Men were set to work to fill the main shaft with spruce boughs, clay sods, hay, etc., to stop the air from the mine; and for the same purpose the shafts of the Cage Pit were closed up, and orifices into old mines in the viscinity. A trench was opened from East River to the fan shaft, through which it was hoped to extinguish the subterranean fires.

No one seems to know how the fire originated, though several theories have been suggested. In Mr. Gilpin's report on the Department of Mines for 1879, he gave a warning note to increase the systematic ventilation of the collieries, and not to reason that "because fire-damp is present only in traces a very slight circulation of air is all that is required." He also points out the defects of the kinds of safety-lamps in general use. But the mystery of the calamity at the Albion Mines is that every precaution imaginable seems to have been taken, and all the machinery made after the best patterns, and yet in vain. The deposit of coal is too valuable to be abandoned, being one of the finest in the world, and it is probable that at some time operations will be resumed. But it is certain that this cannot be done for a long time to come.

Meanwhile there are left to the charity of the public, it is said, "33 widows, 110 orphans, and 700 men, representing a population of 2,000 people, thrown out of employment in the face of a Canadian winter." An appeal on their behalf has been sent out by the managers of Nova Scotia mines, clergymen, and others. The case is certainly one that calls for an immediate and generous expression of popular sympathy.—*Scientific American.*



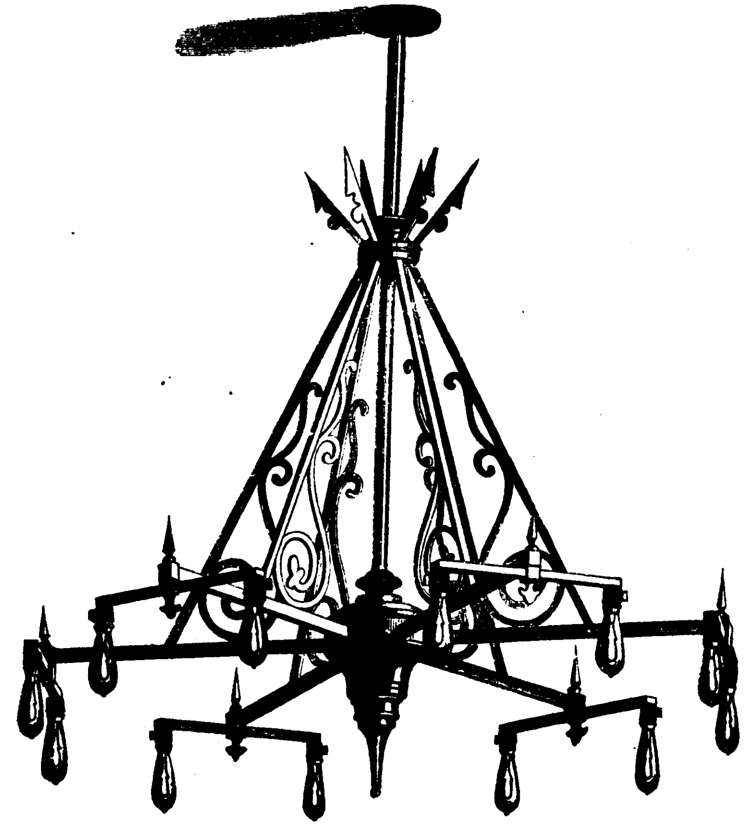
EDISON'S STEAM DYNAMO-ELECTRIC MACHINE.

EDISON'S NEW DYNAMO-ELECTRIC MACHINE.

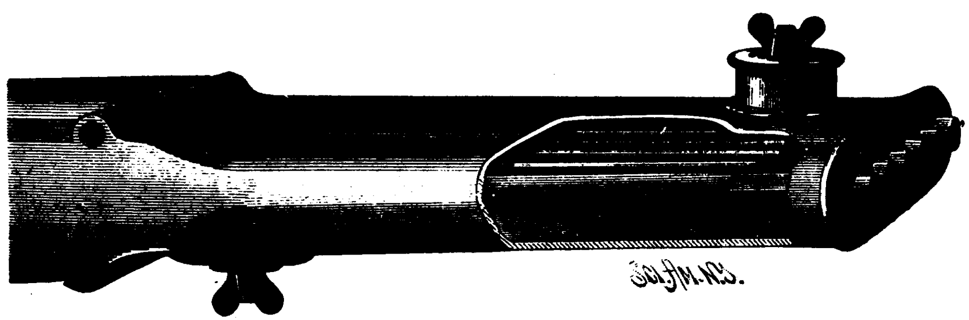
The remarkable activity prevailing at the Menlo Park laboratory and machine shop, and the evidences of the enormous outlay of capital which one sees at these works on every hand, are convincing proofs of the good faith and thorough earnestness of Mr. Edison and his co-laborers and supporters. The great work of perfecting a complete system of electric lighting in all its details is necessarily a very slow operation, however much the work may be urged, as time-tests of the endurance of lamps, perfection of the insulation of the underground conductors, and a hundred other time-consuming operations must, of necessity, be gone through with.

As it is Mr. Edison's determination that his system of electric illumination shall not be presented to the public until it is complete and commercially practicable to the smallest detail, the would-be-users can afford to wait patiently for the perfected thing, rather than be subjected to the trouble and possible disappointments attending the perfecting of the system while it is in public use, as is commonly the case with great inventions.

Besides carrying to a successful issue the grand experiment of illuminating a large out-of-door area with incandescent lamps, Mr. Edison has practically demonstrated that the higbest economy in the conversion of power into electricity can be reached only by the use of very large machines, and by the direct application of the power to the armature without the intervention of belts or other means of transferring power.



Our engraving represents a gigantic dynamo-electric machine approaching completion at Mr. Edison's machine shop, and designed to replace sixteen of the largest machines of this kind previously made. The dynamo and the driving engine are both mounted on a massive cast iron bed, 8½ by 7 feet and 2 feet deep, very heavy and strongly ribbed, the entire machine weighing 8 tons. Near the middle of the bed is mounted the dynamo-electric machine, which, we believe, is the largest ever constructed. Its field magnets, three in number, are 6½ feet long. The armature is 21 inches in diameter and 28 inches long, and weighs 1½ tons. The engine is 100 horse power, of the Porter-Allen type, built especially for this purpose at the Southwark Foundry, Philadelphia. Its stroke is 10 inches. The internal diameter of its cylinder is 9 inches. The crank disk is placed on the end of the armature shaft. Steam pressure, 120 lb. per square inch. The engine cuts off at one-fifth of the stroke and makes 600 revolutions per minute. The working pressure of the dynamo is 140 volts, the resistance of the armature is one two-hundredth of an ohm.



PARKHURST'S MACHINE GUN.

IMPROVEMENT IN MACHINE GUNS.

In machine guns the heating of the barrels has limited the number of charges that could be rapidly fired before they become too hot for use, so that after a period of rapid firing the gun would become dangerous if not allowed to cool. The engraving shows a device for keeping the barrels cool by surrounding them with water under atmospheric pressure, thus preventing the temperature from rising above the boiling point of water. A temperature not exceeding 212° Fah. does not impair the action of the gun.

The barrels are inclosed in a metallic water-tight casing having a vent for the escape of steam. The casing is filled from time to time during firing, as may be required. The mechanism for rapidly loading and firing is omitted in the engraving. This invention was recently patented by Mr. E. G. Daikhurst, of Hartford, Conn.

Home Industries.

THE WINNIPEG BASIN.

It is assumed by many that the Winnipeg Basin, including the Saskatchewan Valley, is to excel any other portion of North America as a wheat-growing region, and that it is to become settled more rapidly, and to have a more rapid growth in population and prosperity than any of the Western States and Territories of the United States. Emigrants are to flock in from Europe and to cross the border from the United States, and in a few years the great wheat country is to be, in the number of its homes and the extent of its farms, a nation in itself. This great farming population is to do for Winnipeg and Saskatchewan what an enterprising and 'adventurous people have done for States like Minnesota and Illinois. Railroads are to be built, rivers are to be improved, cities are to spring up, and in good time this immense territory, producing more wheat than is now grown in all the United States, will, in seeking a market, create a revolution in the grain movements of the world. The rapids in the Saskatchewan will be overcome, Lake Winnipeg will become the Black Sea of North America, floating great grain fleets, which in some way mastering the rapid current in the Nelson River, will reach Hudson's Bay at a point nearer Liverpool than in New York. Hence a great commerce will be directed northward through the very heart of the continent, carrying with it all the great possibilities of commercial traffic.

All this future promise is predicted on the assumption that the Northwest Territory will speedily become the permanent home of contented and prosperous farmers. Kansas, Iowa and Minnesota have been settled in this way, why not Manitoba and Kewatin? Illinois has become a great State within a few years, having as her chief city a trading post that has become the metropolis of the Northwest. Why should not the same thing happen on Lake Winnipeg?

The conditions are different. The Winnipeg Basin is simply a wheat-growing region. There can be no orchards or vineyards there. Peaches, pears, apples, grapes, and all the fruit products of States like Illinois, must be imported. Not even Indian corn can be successfully grown, and the farm products will be limited to wheat, potatoes, turnips, hay, etc. Up to this time the land has been taken, to a great extent, in large tracts, and by men interested in money-making. These may be classed with permanent settlers, of whom there are a surprising number, but they are interested only in wheat growing, just as thousands of men penetrate the Canadian forests, interested in the lumber business. That is to say, these men care less for the country than for their wheat, and carry to their new homes less heart than emigrants settling in Kansas take to theirs. For a few years the growth may be rapid, but this will not continue while good lands remain open in more hospitable climates. The country will have a fair degree of prosperity, but the miracle of the settlement of the Western prairies of the United States will not be repeated.

The work of the last two years in Manitoba and Kewatin has been largely experimental. It has demonstrated that farming in that region is profitable, and the general results are eminently satisfactory to the Canadian or Dominion Government. It is certainly to the advantage of our Northwestern States that prosperous provinces should exist over the border, and there is no disposition, as has been intimated in some quarters, to misrepresent the more Northern districts in our own interest. But it is not fair to say that in the general race they will be left behind those thought to be more fortunately situated, and that they will become a disturbing influence in the American grain trade. —*Bradstreet's Correspondence.*

Domestic Hints.

The Glue Pot.—That indespensable and of all others the most important article in every well-regulated factory and cabinet shop, as well as many other kindred branches of trade. How common is it for the young artisan or apprentice to fall into the error of thinking that glue is king-cure-all, regardless of the application! In the first place, the article used should, by all means, be a good one, of which we presume every practical mechanic is a judge. It should then be dissolved in a proper manner and to the proper consistency or body, according to the work to which the application is to be made. Now comes the point at which there is the great majority of the failures; and the difficulty is not so much with the glue or application as it is in the preparation for the same. In other words, be sure that you are ready by having tried the work together, before you take the glue brush in hand. And if the work is mortise and tenon, you have made a failure that is not easily remedied if you have made the tenon too small either in thickness or width to fill perfectly the space in the mortise. To guard against this error, know what you are doing.

When you are cutting the mortise and tenon let it be either by hand or machinery; and when the glue brush is taken in hand, these general rules should always be observed, no matter what the character of the work. See that the temperature of the room is warm. If in cool weather, use artificial heat to bring the thermometer to 70° or 80°, if you can conveniently do so. But this depends entirely on the nature of the work. As to how much time must of necessity be consumed between the first spread or application and the final set, that time should always be brought down to the shortest period, if the nature of the work is such that it must of necessity take time to get the work together.

The great objection of chilled glue should be avoided by getting the wood to be glued first warmed and having your glue boiling hot. Dissolved glue contains a large percentage of water. The glue joint dries by the wood absorbing the water from the glue, and hence must of necessity expand the fibres of the wood coming in close contact with it, and if dressed off in this expanded condition, that part must dry out, although it takes time to do it, as the moisture cannot escape except through the pores of the wood. And upon the same receiving a high polish in the finishing room, you will see a sunken place 20 ft. off right over the tenons that were dressed off in the wet or uncontracted state. This same rule is applicable to joints in the edges of boards that are glued together. The tongue and groove joint becomes more expanded than the square joint, and hence takes longer to dry, from the simple fact that it takes in more glue.—*Cabinetmaker*.

Siemens on Economy in the Use of Fuel.—Dr. C. W. Siemens thinks it is about time that the economical use of fuel should be practiced in our offices and homes, as well as in large manufacturing establishments. He has devised a grate which gives out a fine heat without noxious gases into a room—a grate which is very cleanly, and which meets fairly the requirements of economy in construction and use. There is no patent on this grate. A iron dead plate is riveted at right angles to a stout copper plate, facing the back of the grate and extending five inches above and below, where the iron plate joins it. The dead plate stops short about an inch from the bottom bar of the grate to make room for a half-inch gas-pipe, which is penetrated with small holes, arranged zigzag on its upper surface. This pipe rests on a lower plate, bent downward towards the back, so as to form a vertical and horizontal channel of about one inch in breadth between the two plates. A trap-door in the lower plate, below the gas-pipe, serves to move the ashes. The vertical portion of the channel con

Bread-Making in Winter.—House-keepers sometimes object to the use of the dry yeast-cakes purchased at groceries, because bread made with them is so slow to rise, especially in winter. I like to use these cakes in hot weather on that very account. The bread sponge never sours on the hottest night. But in winter it is advisable to set a small sponge in the afternoon—about four o'clock—in this way: A scant pint of flour is mixed with a pint and a half of warm water. To this add a cake of yeast previously soaked in a little warm water (taking care not to *scald* the yeast), and beat all well together. By seven o'clock this, if kept covered in a warm place near the stove, will be very light. Now set your bread sponge as usual, using this smaller sponge for your yeast. Cover warm, and in the morning you will be almost sure to find it very light and entirely sweet. Now, if you have a good deal to attend to, you can defer kneading the dough until after breakfast, provided you stir in considerable flour and mix it thoroughly with the spoon.

Paste for Paper.—To ten parts by weight of gum arabic add three parts of sugar in order to prevent the gum from cracking; then add water until the desired consistency is obtained. If a very strong paste is required, add a quantity of flour equal in weight to the gum, without boiling the mixture. The paste improves in strength when it begins to ferment.—*Chron. Industr.*

Brass Coating for Steel.—For small articles, clean and plunge them in a mixture of six gramms each of sulphate of copper and chloride of tin, in a quart of water.

ADULTERATION OF MERCHANDISE.

Mr. Charles Aldrich, of Webster City, Iowa, writes to the *Homestead*, referring to the law prohibiting the manufacture of bogus or adulterated butter, and asks:

Why not apply such a law to all classes of merchandise as well as the single article of butter? Adulteration prevails not only in the preparation of most articles of food and drink, but in drugs, medicines, paints, oil, etc. So it does in many kinds of dry goods. Cloths which are claimed to be all silk or all wool are "adulterated" with large admixtures of cotton or worse of shoddy. Every man who has ever painted a house knows how difficult it is to procure pure paints and oils. Drugs and medicines are the subjects of almost infinite bedevilment! If one needs a dose of quinine he must buy and take enough in bulk for two or three doses in order to obtain the proper effect. Other medicines are subjected to the cheapening or thinning process. At ordinary hotels we often find tea and coffee which are almost wholly innocent of any admixture of those articles! Lately a Chicago chemist analyzed twenty or thirty samples of candies from as many manufactories in and around that city. Of the whole lot only one sample was made from pure cane sugar. Some were made wholly of glucose, while the others contained the same fraudulent stuff in greater or less proportions. There are factories in New York City where articles are made and put on the market at wholesale for adulterating such manufactured articles as ground spices, coffees, etc. The article with which ground pepper is adulterated, looks almost precisely like pepper, and yet it is an inert, tasteless stuff; so of the article used in adulterating ground cinnamon and allspice. These preparations are sold by the ton to proprietors of "spice mills," where such goods are "manufactured" and put up with attractive labels. Corn meal is used to adulterate ground mustard.

I am told that fruit (!) jellies, which are on sale at many groceries in beautiful glass and with attractive lab l·, often are made in some such way as this: Old bones, poor meat, scraps, etc., (possibly horse flesh), are boiled up and the animal jelley thus extracted. This is then colored and flavored, and it is already to be put on the market in neat glass jars, with gorgeous labels representing such delectable fruits as strawberries, plums, raspberries, cherries, etc. It is wonderful how many sorts of delicate jellies may be elaborated from the "protoplasm" of a single superannuated street-car horse! I was on the Hayden United States Geological Survey in 1875, and when we had got out in the Rocky Mountains, 500 miles beyond the "jumping-off place," we found that our beautiful lump sugar scarcely sweetened our very good, but camp-made, coffee. One of our topographers told us how it was adulterated and put up in this form, near his home, in the Wooden Nutmeg State, by the admixture of large portions of barytes—an inert, soluble mineral substance. The sugar looked well, but it wouldn't sweeten. We could not step over to another shop and get more, and so all used it and made the best of it. We had some maple sugar which had also been "glucosed," and our tea was simply trash; but in all other respects our provisions furnished by our good old Uncle Sam were all right.

Much more ought to be written by way of showing the extent of these adulterations of the merchandise we are continually buying. But it seems to me to be generally well enough understood. The pertinent question is this, What is the proper remedy? My own idea was simply this: Let our Legislature enact a law to take effect not until one year after its passage, so as to allow dealers to close out their stock of goods and make the needed preparations to meet the requirements. Let the law be so framed that a dealer who sells pure goods of whatever kind shall have no restrictions of any nature placed upon him; but compel every dealer who sells impure, mixed, or adulterated dry goods, groceries, provisions, drugs, medicines, liquors, etc., to attach to every such parcel a printed statement setting forth precisely the kind and amount of such adulteration or admixture. Let people buy and sell all the adulterated stuff they please—just as they do now—but in such a manner that deception will be impossible. Possibly, however, in regard to some things it would be found convenient to adopt the rule of total prohibition. With such a law the manufacture of such spurious merchandise would soon be greatly reduced. The law should provide proper penalties, nol only for the local dealer, but for the manufacturer, when he can be reached. The manufacturers could be made amenable to our State law by reason of the fact that most articles of merchandise are now sold by travelling agents. Of course it would be impossible in an article like this to set this subject forth in all its bearings, or even to glance at the details proper in a law; but I have stated my general idea on the subject. Questions of health and comfort enter so largely into the subject that it would seem that there should be no hesitation in demanding some such law. At the least it is only an aspiration for common honesty in the manufacture and sale of the ordinary merchandise of the shops and stores.

UTILIZATION OF WASTE HEAT.

We present with this, three illustrations showing various methods of utilizing the waste heat from a kitchen stove or range for the purpose of heating a chamber. In this connection it may be remarked that while the surplus heat of a stove is utilized by the various plans here suggested, it is nevertheless true that it is necessary in many cases to maintain a larger fire in the stove than would otherwise be necessary, in order to afford sufficient heat to the room above. This, in some instances, may be necessary only in the coldest weather. We allude to it only because it might be supposed, from the fact that a larger fire was required, that the employment of a drum was not an economy after all. The heat which a drum throws off in an upper room consists in part of that which would otherwise be wasted, and in another part to that which is afforded by extra fuel burned, but as one large fire is always more economical than two small ones, there is a considerable saving to be obtained by managing in this way.

Fig. 4 shows a somewhat novel method of heating an upper room by means of a drum from a range in the kitchen. For this purpose the smoke pipes B B are combined in one and carried in the pipe A to one of the side flues. This pipe is taken up to the level of the next floor, and provided with a damper at the top, worked by a long handle from the kitchen. The branch pipe C takes the smoke through the drum, which in this case is shown standing at the side of the mantel-piece. If desired, it could as well be placed in front. The usual objection to range heaters is that the air sent to the rooms above is laden with all the odors from the cooking and is in general very foul and unsavory. In this plan, however, it will be observed that there is no escape of air from the kitchen to the rooms above. It is not ventilated at their expense, a separate pipe, D, being in this case provided for the purpose of taking the steam from the cooking to the chimney flue on the other side.

With reference to the arrangement of parts shown in Fig. 4, it must be borne in mind that in starting a fire in the range the damper at E should be open, and should remain open until the flue becomes somewhat warmed. By managing in this way no difficulty with the draft will be encountered, while on the other hand it might be almost impossible to get the stove to draw well at the time a fire was kindled, if the outlet for the smoke was through the drum.

A very simple construction is shown in Fig. 6, where a stove pipe from a room below is led into the bottom of a handsomely ornamented drum, set in the same fashion as an ordinary heating or parlor stove. Here the lower row of openings is closed by an ornamental grating or perforated screen. This is one of the neatest arrangements which we have illustrated. It is liable to this objection, however, that since there is no passage for the smoke from the kitchen stove except through the drum, the upper room will be heated whenever there is a fire below. There is no way of regulating the amount of heat in the upper room. This objection, on the other hand, does not apply to the arrangement employed in Figs. 4 and 6, for, by the use of dampers, no heat need be passed through the drum at all, save at those times when it is desired.

Fig. 5 illustrates a method by which it is possible to tap a chimney flue at any point, and take the smoke and other products of combustion through a drum and then pass them back again. The connection is made above, as for a stove, but below there is a damper placed in the flue which is controlled by a handle on the outside. This plan can often be used where it would be inconvenient or unsightly to run a pipe from one floor to another. In each of the several cases here illustrated it will be noticed that the air warmed is that of the room in which the drum is placed. There is no difficulty in making such outside connections with drums as will supply an abundance of fresh or outdoor air. Instead of jacketing the drum and passing the air inside of the jacket, it is to be let directly into the drum by means of the openings near the bottom, as shown in the accompanying cuts, or preferably by other openings so located as to permit of the best connection between supply pipe and drum. A little ingenuity upon the part of the one who fits up the drum will determine the proper course in each instance.—*Metal Worker*.

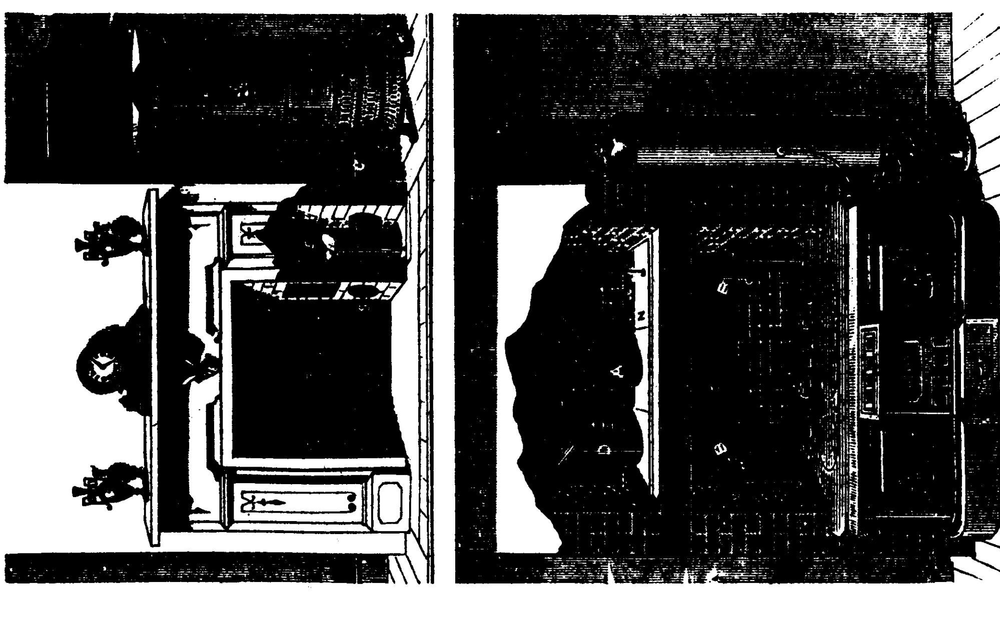


FIG. 4.—Heating Upper Floor with a Range, without Disagreeable Odors from the Kitchen coming into Upper Part of House.

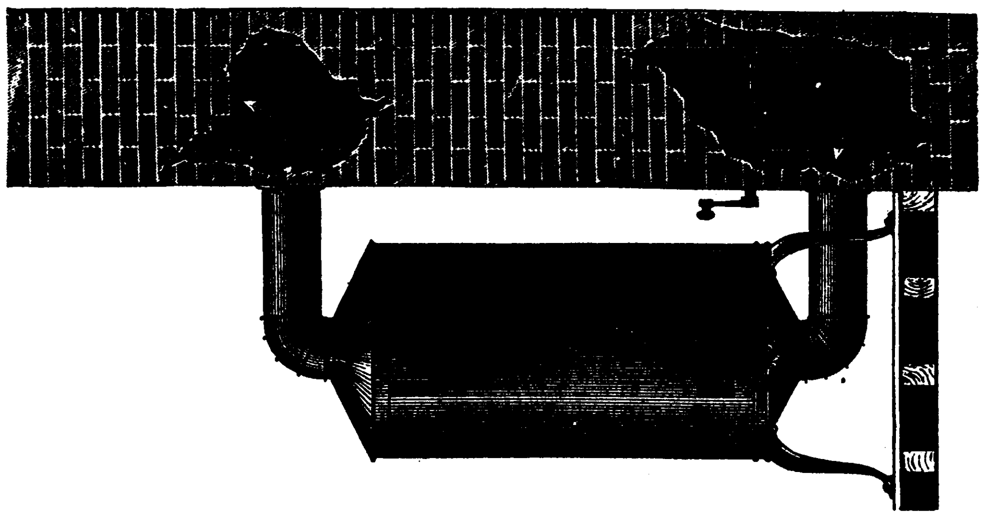


FIG. 5.—Taking Gases from a Chimney Flue to Heat a Drum.

UTILIZATION OF WASTE HEAT.

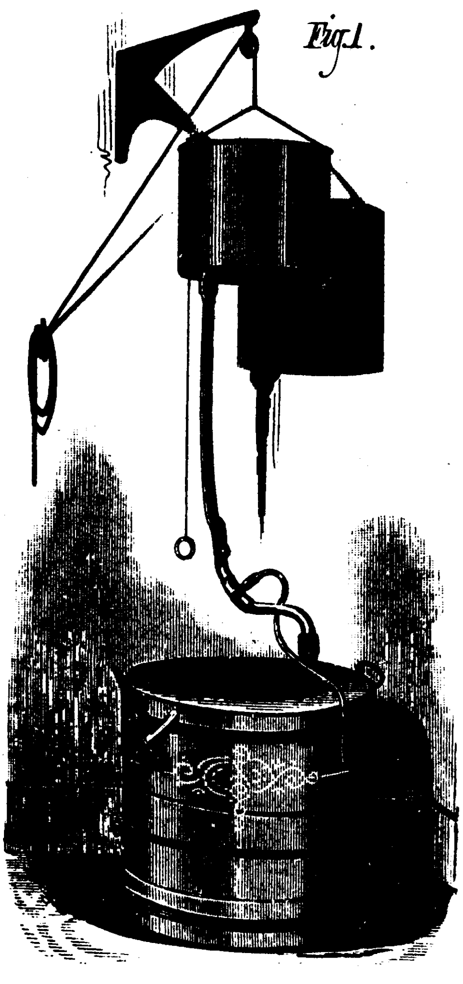
FIG. 6.—Heating on Upper Room by Drum Connected with Pipe of Kitchen Stove.

PORTABLE FOUNTAIN WATER CLOSET.

The article shown in the annexed engraving is one that should form a part of the furniture of every house, and is especially valuable for invalids and the aged. It is also a great convenience for persons in health, particularly in the country, in cold and inclement weather and at night; and as a sanitary provision it will prove beneficial in several ways. It will permit of a prompt obedience to nature's laws, and thus save both health and the cost of medicines and medical attendance. It is perfectly air-tight, and is consequently odorless. It is readily moved from one room to another, and if it becomes necessary to pack it for storage or for transportation, all of the parts may be placed in its lower casing.

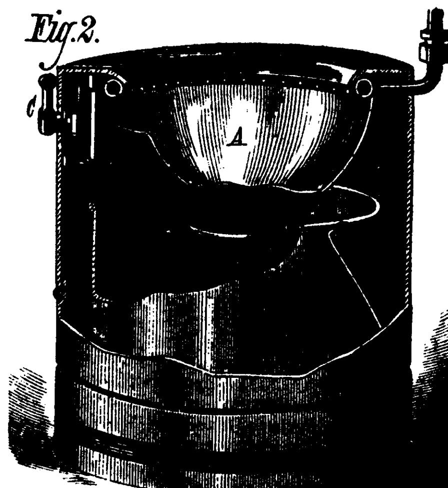
The inventor has arranged the fountain in connection with the lower portion of the casing, so that it may be used as a shower bath, a perforated nozzle being provided for this purpose.

The device is contrived so that it may be concealed in



PORTABLE FOUNTAIN WATER CLOSET.

an ottoman or easy chair. The bowl, A, is furnished with a circular perforated pipe at the top, through which water is admitted from the flexible pipe connected with the fountain. The valve, B, at the lower end of the bowl is operated by the lever, C, which when raised first drops the valve, then swings it to one side. When this lever is depressed it first brings the valve under the bowl and then raises it up against the soft rubber packing at the bottom of the bowl. The joint between the bowl and valve is practically air tight, and the water always left in the bowl seals the joint perfectly. All other joints in the apparatus are sealed with flexible rubber packing rings.



PORTABLE FOUNTAIN WATER CLOSET.

In connection with the fountain an enema jet is provided, which can be used without the slightest inconvenience.

We are informed that a number of these closets have been in use in cottages at watering places and in other summer resorts, giving great satisfaction. They also attracted a great deal of attention at the late Fair of the American Institute, and were awarded a diploma.

This invention was recently patented, and is being manufactured at No. 243 Water street, by the Portable Fountain Water Closet Company, M. J. B. McQuillin manager. The post-office address of the company is Box 2279 New York city.

STEAMBOATS FOR SOUTH AMERICAN RIVERS.

Messrs. Yarrow & Co., Poplar, the well known builders of swift torpedo boats, have been recently building two shallow draught stern-wheel steamers, intended for the conveyance of the mails on the river Magdalena, for the Government of the United States of Colombia. These vessels are put together temporarily in the yard at Poplar, and are then taken to pieces and shipped out to their destination. Each vessel is 130 feet long, has 28 feet breadth of beam, and draws 16 inches of water when without cargo and having the steam up, but 26 inches with 90 tons of cargo aboard. The hull is built of steel varying from three-sixteenths inch to one-fourth inch in thickness. It is divided into eighteen water-tight compartments, so as to localize any damage through being penetrated by rocks or snags. All the forward part of the vessel below water is treble riveted, as an extra precaution. The boiler, which is of the locomotive type, is placed on the main deck forward, and the engines on the main deck aft, and thus easily accessible. To obtain the greatest economy of fuel the engines are made on the compound surface condensing system, and for the sake of lightness all the working parts are of steel. They are probably the first compound engines ever fitted to stern-wheel steamers. The cylinders lie one at each side of the vessel, and work direct with a connecting rod on cranks at each end of the axle of the wheel. They are expected to develop 350 to 400 horse power, and have some peculiar arrangements to adapt them for the service. The vessels have what may be termed spoon bows; the sterns retain their full breadth, and everything is sacrificed to lightness of draught, the cabins and other accessories being entirely neglected. Our illustrations of these vessels will appear in the next number, accompanied, by way of comparison, with illustrated description of the attempts of American mechanics in the same direction. It will remain to be proved whether Messrs. Yarrow's steamer or the one built by James Rees of the Duquesne Engine Works for the Magdalena River Navigation Company will prove the most serviceable for the purpose.

Chemistry, Physics, Technology.

THE SUN'S HEAT.—Prof. C. A. Young, in the November number of the *Popular Science Monthly*, finds himself face to face with these questions: How is the heat of the sun maintained? how long has it lasted already? how long will it continue? are there any signs of increase or of diminution? After affirming, that, in the present state of science, only somewhat vague and unsatisfactory replies are possible, Professor Young holds that, so far as observation goes, we can only say that the outpouring of the solar heat, amazing as it is, appears to have gone on unchanged through all the centuries of human history. The author thinks that there is some truth in each of the two theories which have been proposed to account for the sun's fire. As to the first, the impact of meteoric matter, it is quite certain that solar heat is thus produced; but the question is, whether the supply of meteoric matter is sufficient to account for any great proportion of the whole? After giving Sir William Thomson's calculation of the amount of heat which would be produced by each of the planets falling into the sun from its present orbit, by which it appears that Jupiter would maintain the sun's present expenditure of energy for 32,254 years, and Mercury for six years and 219 days, and that the collapse of all the planets upon the sun would generate sufficient heat to maintain its supply for nearly 46,000 years; and after estimating that matter equal to only about one hundredth part of the mass of the earth, falling annually upon the solar surface, would maintain its radiation indefinitely, Professor Young thinks it improbable, from astronomical reasons that any such quantity of matter would necessitate a vastly greater quantity circulating around the sun, between it and the planet Mercury. But if there were near the sun meteoric matter equaling for example, the mass of the earth, it ought to produce an observable effect on the motions of Mercury, and no such effect has yet been detected. Astronomers, therefore, failing to find a full explanation of the cause of solar energy in this hypothesis, have adopted a second one, which is, that the sun's diameter is slowly contracting, and that the gaseous mass is gradually liquefying and becoming solid. The conclusion is drawn that, if this theory be correct, there must come a time when there will be no solar heat, as there has also been a time when it began. How far forward is the end, how far backward the beginning? Newcomb is authority for the statement that, with its present radiation, the sun will shrink to half its present diameter in about five million years. Reduced to this size, and eight times as dense as now, it will cease to be mainly gaseous, and its temperature will begin to fall. Hence Newcomb assigns as the term during which the sun can supply heat enough to support life on the earth, as we know life, a period of ten million years. The writer somewhat more confidently casts his eye backward, and concludes that the sun can not have been emitting heat at the present rate for more than eighteen million years, if its heat has been generated in the manner described. If the sun has contracted, from a diameter even many times larger than that of Neptune's orbit to its present dimensions, as is probably true in the main, "we are inexorably shut up to the conclusions that the total life of the solar system, from its birth to its death, is included in some such space of time as thirty millions of years: no reasonable allowances for the fall of meteoric matter," etc., "could raise it to sixty millions." The possibility of collision with wandering stars, and the suggestion of ways as yet unconceived of for restoring wasted energy, are followed by the statement that "the present order of things appears to be limited in either direction by terminal catastrophes which are vailed in clouds as yet impenetrable."

AN ARTIFICAL EYE SENSITIVE TO LIGHT.—In the course of a discussion on a paper recently read before an English scientific body by Prof. Bell, Dr. C. W. Siemens was called upon to describe and explain one of his recent inventions, which he terms a "selenium eye." The substance of his remarks is given as follows: The researches made by Dr. Werner Siemens on the cause of the extraordinary variations in the resistance of selenium to the passage of an electric current caused by light, led to the conclusion that the resistance of selenium, and probably, indeed, of all substances, varied inversely to the amount of heat which they contained; and the reason why selenium showed such extraordinary changes under the influence of light was, that under its influence it changed from one aggregate condition to another —from an amorphous to a crystalline condition; and that at the moment when this change took place a great deal of heat was absorbed, and, therefore, the specific heat of the selenium was very much increased. Dr. Siemens has constructed a little instrument to show the effect of these changes. It has the form of an eye, and on opening the lids a lens is presented to the light; through that lens the light falling upon it is concentrated upon a spot in the interior of the ball. At that spot a selenium grating is placed, consisting of five wires laid in zig-zag fashion; one wire is connected to the positive, and the other to the negative pole of a battery, with a galvanometer in the circuit. These wires, lying close together, but not touching, are laid on a plate of mica; a drop of selenium is placed upon them, and this small quantity suffices to produce the desired results. The principal object Dr. Siemens had in devising it was to construct a selenium photometer; but a difficulty arose in using it for that purpose, because selenium got fatigued under the influence of light. The "eye" after being exposed for any considerable period to an intense light becomes insensitive, and the lids have to be closed; it has to go to sleep for some time before it regains its sensitiveness, and the analogy to the human eye goes even further than that. If the eye is used after having been kept in the dark for a length of time it detects the slightest gleam of light, and marks it on the galvanometer, whereas after it has been once used in intenser lights, a small gleam is utterly lost upon it, until it has again had ample rest. Dr. Siemens showed some experiments with variously colored sheets of card-board prepared for the purpose, and the reflected light was found to cause a deflection of the galvanometer in each case, the slightest effect being produced with light reflected from a black piece of paper, and successively increasing with green, red and white, the greatest of all being producing by exposing it to the direct light of an argand burner.

SINGULAR DISCOVERY IN CONNECTION WITH PHOSPHORESCENCE.—The property possessed by certain metallic sulphides and other phosphorescent bodies of absorbing light when exposed to its influence, and giving out the same when brought into a darkened room, have long been known to scientists, but it is only quite lately that efforts have been made to utilize such properties. Of these, the most striking consisted in spreading a sulphide of this nature upon a flat tablet and exposing it to strong light for a few seconds under an ordinary photographic negative. Upon removing the tablet thus impressed into a dark room, the picture on it will be found to be glowing in quite a mysterious and wonderful manner, and it will continue for some minutes to radiate the light which it absorbed. It has occurred to an ingenious physicist, A. L. Henderson, to mix one of the most sensitive of these phosphorescent metallic sulphides with the bromide of silver, now so generally employed in the preparation of photographic dry plates, and, after emulsifying this mixture with gelatine, spreading it upon the surface of glass plates, and treating the same as ordinary ones except in so far as regards the exposure, which must be momentary. He appears to have reasoned in this way: With even the briefest exposure capable of being given, a certain modicum of change will be produced on the sensitive bromide of silver, although manifestly such as will be incapable of yielding a properly developed image. But the light also falls upon the atmos of the phosphorescent powder incorporated in the films: and as these in turn radiate such light, it follows that they will complete the imperfect exposure set up in the bromide by the direct action of the light. This reasoning has been found correct, and the result at present stands that plates have been prepared having such exceeding sensitiveness as to be well impressed by what Mr. Henderson designates "the flash of a match." Phosphorescent sulphides may easily be prepared by heating the carbonate of lime, of barytes, of strontia, or other carbonate found most suitable, in a covered crucible with half of its weight of sulphur. After an hour's exposure to heat the preparation is complete and phosphori are obtained which, upon being briefly exposed to light and then withdrawn into a dark room, will be seen to glow brightly, the color of the light emitted depending upon the nature of the carbonate originally selected. This application of a well recognized fact in phosphorescence is so novel, and calculated to be of so much use, that we have no doubt its progress toward development will be rapid.

PLUMBERS AND GASOLINE.

Unusual interest has been created by the burning of a crowded tenement house, in Madison street, Jan. 4th, by which ten lives were lost, through a gasoline machine, used to thaw frozen water pipes. Two women and eight children were burned to death, the building was destroyed, and several other persons barely escaped injury. William J. Patton, the boss plumber for whom Harrington, who started the fire, was working, was arrested at 79 Baxter street and committed to the tombs in default of $10,000 bail. Sureties were furnished in the evening and Patton set free. Patton's statement under oath was that he is a plumber and keeps a shop at 220 Canal street. He was engaged as the agent by Mrs. Eagan, the landlady, to thaw out the pipes in the house 35 Madison street and repair them. Having much work on hand, he sent for Timothy J. Harrington, and engaged him to do the work at 35 Madison street. He began work there in the morning at 1.30 o'clock and again went to work at 7 a.m. Patton says that he heard of the accident at 10 o'clock. He never used gasoline until this winter, but last month he used it with success and at 70 or 77 Maiden lane bought it twice or three times. He knew gasoline was explosive if fire got near it and that it required careful handling.

The following sworn statement was made to the Fire Marshall by Harrington: The witness testified that he was a plumber by trade. Patton hired him to work by the day, and he did a few little jobs for him on Monday. Patton had another man working at the Madison street house on Monday, but for some reason the man had abandoned the job, and Patton sent Harrington down to take charge of it. This was on Monday afternoon, and a plumber named Lenihan went with him. Before going Harrington asked Patton if he had a thawing machine. He replied that he had, and asked Harrington if he had ever used gasoline. The latter replied that he had never used it, nor had he seen it used. Patton said it was first-rate for thawing out pipes. Lenihan and Harrington then went to the place and began thawing out a water-closet on the first floor with hot water. Much other thawing was to be done, and Harrington wished Lenihan to get him some paper to burn under the pipes, but Lenihan urged him to use the gasoline instead. They went back to the shop and got the machine and a two-gallon can of the gasoline. Harrington objected to take so much gasoline, as he was afraid of it. He wished merely to take a bottle of it; but as Lenihan said the machine had to be filled every fifteen minutes, they took the can. They did not use any gasoline that afternoon, but Lenihan filled the machine and showed the witness how to use it. It made a great flame, and Harrington said it was dangerous, and he didn't wish to use it.

Lenihan was to go to the house in Madison street the next morning, but he did not reach the shop early enough, and Patton sent the lad McGloin with Harrington. Harrington lighted a candle and cautioned McGloin. He told him to be very careful and not have a light near it, as it might blow up the house. Harrington improvised a small tin funnel, and McGloin poured the gasoline into the machine. When they returned from the cellar to fill the machine again, the funnel could not be found, and Harrington told McGloin to hold the machine while he poured the gasoline into it from the can. At this time the lighted candle was on the floor about six feet away from them. A little of the gasoline spilled on the floor, and Harrington set down the can on the floor and told McGloin to look out for it, while he took the machine to screw the cap on. In a moment the flames shot up beside him, and McGloin ran out with his coat on fire. Harrington then ran to the window and opened it. The blinds were fastened, and he could not get them open. The can was all on fire. He seized the burning can and ran to the door to throw it into the yard. The outer door was closed, and he could not open it. He was then all on fire, and dropped the can and ran for his life. He ran out through the liquor store and down James street, where he met a policeman and told him of the fire. His clothes were still burning, and some person took hold of him and extinguished the flames.

As our readers may not be familiar with the appliance which was the indirect cause of the disaster, we illustrate it herewith. The machine is usually used by painters in removing graining from outer doors of buildings, and is called a "Patent Paint Burner." The handle unscrews at A, and the main portion is filled with gasoline. The bent tube B is hollow and contains several fine wires with a pin-hole at the end to permit the gasoline escaping. A funnel pierced with holes to admit air is placed over this, and on light being applied a large flame is produced. This machine requires filling about every twenty minutes.

Devices to accomplish the same purpose are made to burn alcohol, but as this costs $2.50 per gallon, while gasoline costs but fifteen cents, it is evident why the latter dangerous fluid is used. After this experiment we must condemn every sort of a device to burn gasoline inside a house, whether for thawing pipes or for heating irons or melting solder. The makers of such devices had better adapt them to burn alcohol, and the use of naphtha or gasoline inside a house should be prohibited.

Since the above was written, an explosion of naphtha which some plumbers were using to clear out a clogged gaspipe, damaged a drug store in Boston $3,000.

Last June there was a fire in this city, arising from a similar cause, by which three persons were severely burned and the lives of two others endangered; and within a week since January 1, there have been ten fires ascribed to the use of gasoline by plumbers.—*Sanitary Engineer.*

THE HOLLY PUMPING ENGINE AT BUFFALO, N.Y.

We present herewith an illustration of the Holly pumping engine employed at the Buffalo (N.Y.) waterworks. As will be perceived, the engine is provided with four cylinders and four pumps. These cylinders and their pumps are arranged in pairs opposite to each other, upon supports of unusual strength, and the two cylinders of each pair are connected with each other. The connection of the pumps with the steam cylinders, and of the steam piston rods with the pumps, is such that any of the engines or pumps may readily be thrown out of action. The steam pistons are packed by means of cast-iron rings and springs, which can be adjusted without the necessity of opening the cylinder.

The valve mechanism of the steam cylinders is the ordinary slide valve, actuated by an eccentric. The engines are provided with a cut-off mechanism of peculiar character, by which the period of steam introduction may be completely varied from the instant of introduction to full stroke. The governor is likewise of special construction. The dimensions of this engine are as follows: Extreme length, 43 feet; height, 26½ feet; breadth, 17 feet; the diameter of the steam cylinders is 25 inches, with 33 inches stroke; the pump cylinders are 15½ inches diameter, with 33 inches stroke.

The engine in question developed at a trial test a duty of 141 .55 horse power, but develops in ordinary use an average of 119 .85 horse power.

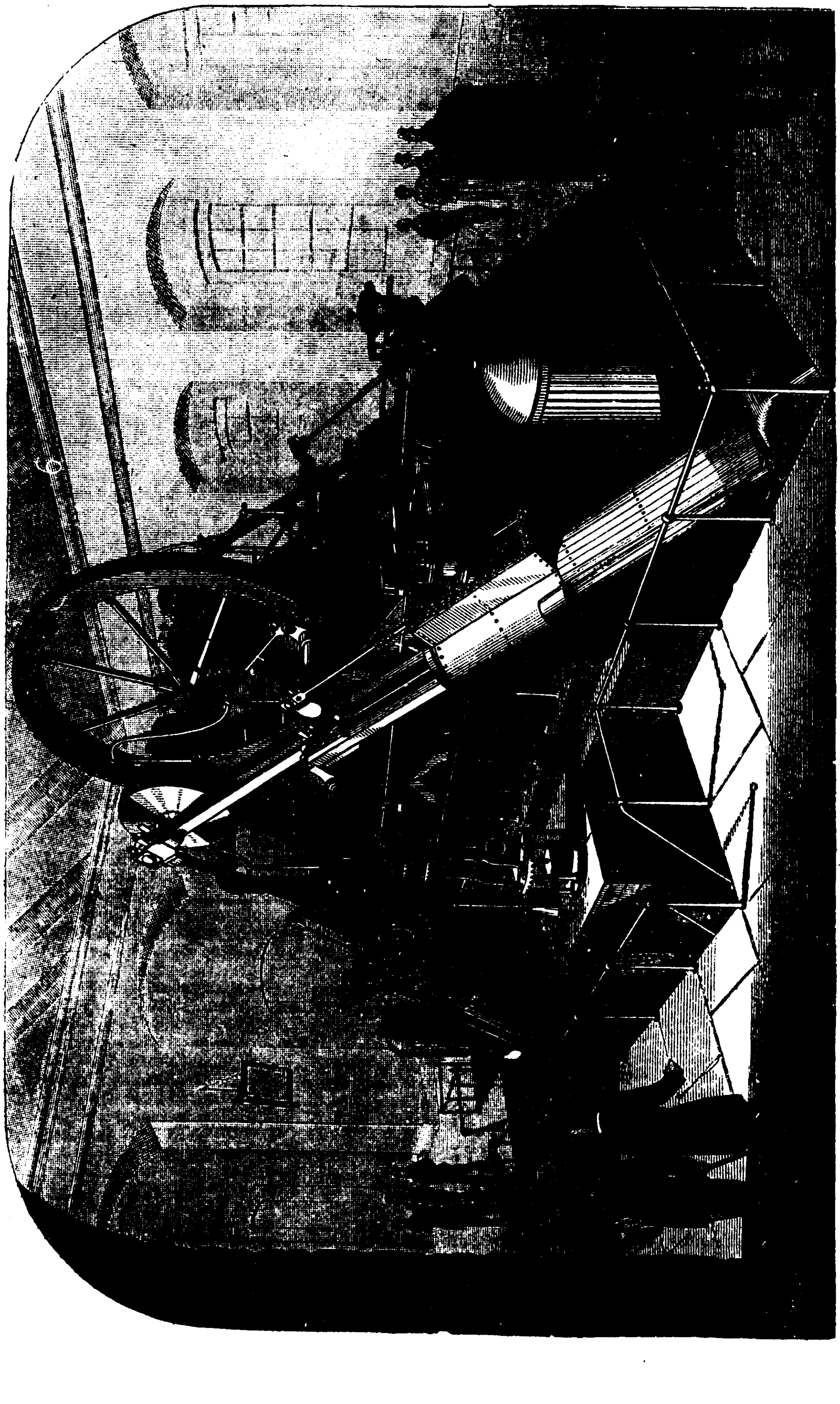
This engine was built by the Holly Pump Works, at Lockport, N.Y.—*Manufacturer and Builder.*

Population of the Earth.—The latest and most trustworthy statistics of the population of the earth has just been given to the public by Herren Behm and Wagner, the distinguished German geographers. The world is being peopled at the encouraging rate of nearly a million a month. The total population of the globe is now 1,455,923,000, or 17,778,000 greater than it was nineteen months ago. Considerably more than half of the people of the earth are gathered in Asia. That country is reported to have a population of 834,707,000; Europe, 315,929,000; Africa, 205,679,000; America, 95,495,500; Australia and Polynesia, 4,031,500, and the Polar regions—that is, Greenland and Iceland—82,000. Of the principal countries of Europe, Germany is credited with 43,900,000 inhabitants; Austria and Hungary, 38,000,000; France, 37,000,000; Great Britain, 34,500,000, and the entire Russian dominions about 88,000,000, of which nearly 66,000,000 are in Russia proper. European Turkey has 8,866,000 people, and Asiatic Turkey 16,320,000. Of Asia's population, China, with all its dependencies, is reported to have 434,626,000; Japan, 34,338,000; and British India 240,298,000. The United States contains more than half of the American population. British North America has 3,839,000, Mexico 6,485,000, and Brazil, the most populous of the South American countries, 11,100,000.

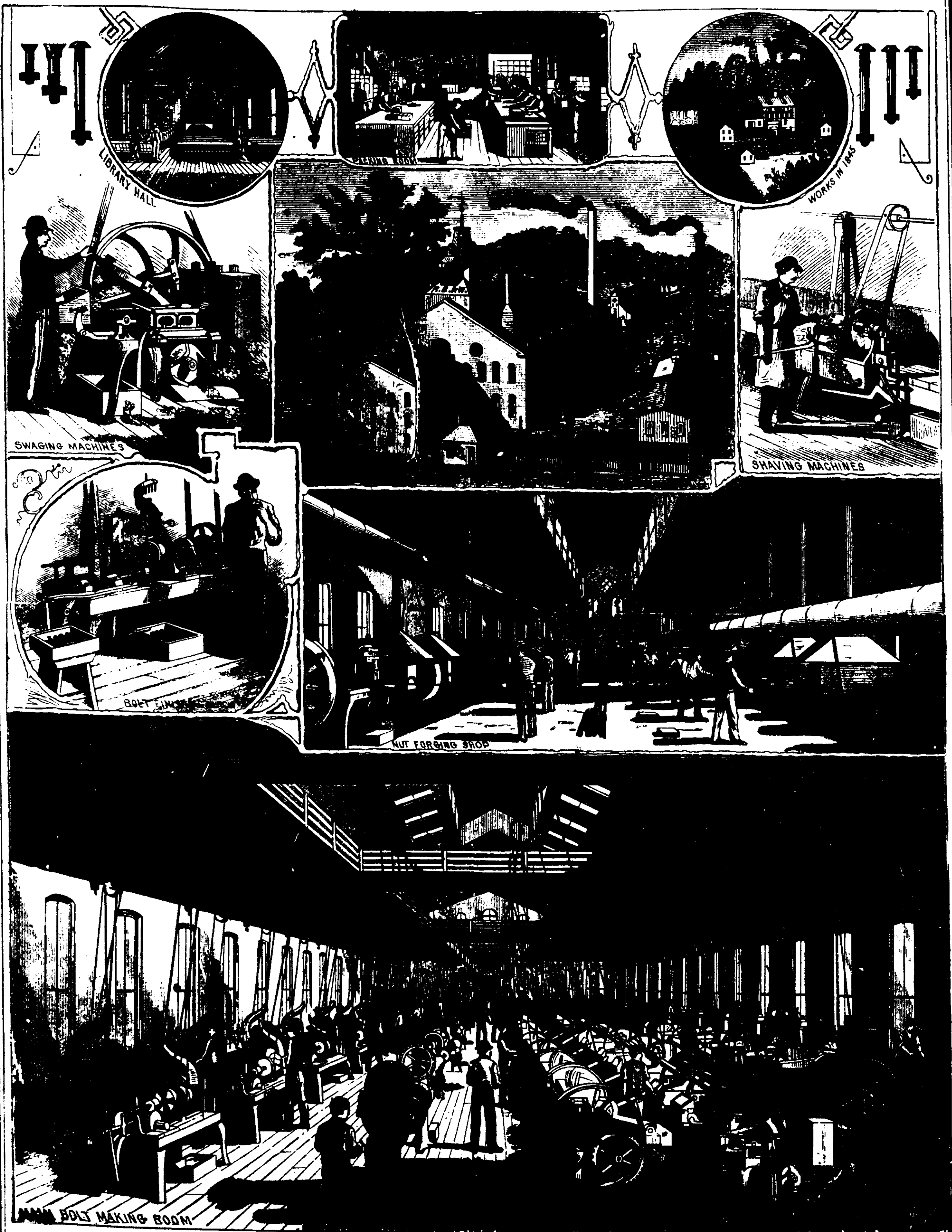
The *Lancet* announces that "the Aromatic and deodorising water closet" has been patented and put on the market in England. "Aromatic" is pretty good, but not hard to beat. One of our subscribers is now perfecting a "Koproeuodmotikion," with balm of a thousand flowers attachment, which will entirely destroy the sale of the Aromatic Closet in this country.

The Psophokeodaleundron is also proposed as a substitute for the ordinary closet trap, and will undoubtedly be a success if Eau de Cologne can be obtained at a sufficiently low price.

An improvement in the manufacture of emery-wheels consists in bedding within the wheel one or more discs of woven wire, which extend from the centre hole nearly to the periphery.



THE HOLLY PUMPING ENGINE AT BUFFALO, N. Y.



THE MANUFACTURE OF BOLTS AND NUTS—RUSSELL, BURDSALL & WARD PORT CHESTER, N. Y.

MESSRS. RUSSELL & BURDSALL'S BOLT AND NUT FACTORY, PORT CHESTER, N. Y.

Owing to press of matter the description of these interesting works will of necessity be postponed to our next issue.

—The magnificent observatory in the neighbourhood of Nice, which is being erected at the expense of M. Bischoffsheim, it rapidly approaching completion—indeed, one of the buildings is finished, and M. Thollon is already at work with the spectroscope. The great equatorial is to be one of the largest in the world—perhaps the largest—as it will have an object-glass 3 ft. in diameter and a focal length of upwards of 50 ft. The construction of this monster telescope has been entrusted to MM. Paul and Prosper Henry, of Paris, and the total cost of the observatory will be more than £80,000.

Engineering, Civil & Mechanical.

THE EXPANSION OF STEAM.

BY PROFESSOR R. H. THURSTON.

A correspondent writes me asking the following question, and requesting me to reply by sending an article to the SCIENTIFIC AMERICAN, " which," as he says for himfelf and shopmates, "we all read, and where we shall all be sure to see it : " " What *is* really, the proper point of cut off in steam engines to give maximum economy in dollars and cents ? " . . . .

" Some people say one thing and some another. In your His- of the Steam Engine, page 475, you say about one half the square root of toe steam pressure is about right ' in general ;' and a writer in the *Journal of the Franklin Insttute*, for June, who ought to understand the matter, says that the steam pressure divided by the back pressure gives the number of times to expand to secure maximum efficiency.

" Now, your rule would give, for a Corliss engire with 90 pounds of steam, a cut-off at one fifth, while the last would make it one-seventh. Then again, for an old fashioned engine with condenser, cueting off steam at 22 pounds, your rule makes it about one-third, and the says one-fifteenth or eveu one-twentieth, which I know py experience cannot be right."

Ans. The point of cnt-off giving maximum economy in steam engiues is never precisely the same in any two engines. It will vary with every chadge of type, with every change of pressure of steam, with every difference in piston speed, and even in two ebgines built from the same drawings and made from the same patterns, the degree of expansion being the same, the two machines will demand differing quantities of steam.

Could all the conditions affecting the expenditure of heat in the production of power be made absolutely invariable, the point of cut-off for maximum efficiency could be determined for those condetions—not by calculation, but by experiment ; and it would remain the same just as loug as those conditions could be maintained. But this never occurs in practice.

Steam enters the cylinder sometimes barely dry, sometimes superheated, sometimes damp with watery vapor, and often mingled with water to the extent of ten or twenty per cent. ; it even sometimes carries with it more than its own weight of water. It sometimes comes in contact with hot and nearly dry metallic surfaces, which aid in keeping it in a state of maximum efficien cy ; but it oftener, in fact usually, meets an interior filled with damp chilling vapors and surrounded by walls cool enough to condense a considerable part of the steam supplied up to the point of cut-off. During expansion the steam never follows precisely the law of expanding permanent gases—with which the pressure diminishes precisely in the proportion in which volume increases—but, by condensation at first and by re-evaporation later in the stroke, the expansion line falls below at first and then rises above the curve expressing Marriotte's and Boyle's law, although frequent-y approaching that curve pretty closely. If the engine speed increases the steam is usually less affected by causes producing loss ; if the speed decreases a loss of economy generally ensues. Large engines are less subjeet to such losses than small ones, and every reduction in the amount of engine friction permits a closer approximation to theoretical conditions.

It is easy to determine the proper point of cut-off for any defined set of conditions provided they are such as can be mathematically expressed, and the larger the engine, the hotter the steam used, the higher the piston speed, the less the friction, and the more perfect the system of lagging and steam jacketing, the more nearly will the actual correspond with the estimated value; but the theoretical rate of expansion is rarely very nearly attained in our very best practice, and experience shows that we must usually content ourselves with a vastly small degree of economy by expansion than would be mathematically predicted.

Instead of cutting off at one-twentieth when using steam at 45 pounds pressure in a single cylinder condencing engine, we find that a cut-off at most one-fourth gives, in practice with ordinarily good engines of moderate size, the best results.

In handling non-condensing engines of two or three hundred horse power, with steam at 60 to 90 pounds and a speed of piston of about 500 feet per minute, and using the standard forms of " drop-cut-off " familiar to American engineers, we can barely gain by expanding more than five times.

As pressures increase the benefit of condensation decreases, and it happens that this rule applies pretty closely both to the old-fashioned condensing steam engine with low steam, and to the modern American type of high pressure " automatic " cut-off engine.

Sometimes an engine is found to give maximum economy when expanding fifty per cent. more, that is, $E=\frac{3}{4}$ P.

No *theoretical* determination of the proper point of cut-off has ever been made that is of any service to the engineer. In " compound " engines of large size and high speed expansion can be carried much farther than in the older forms with single cylinder ; but even they depart very greatly from the conditions as in calculation.

It thus happens that the benefit of expansive working has a limit which is very soon reached, and that the most radical practice, in which condensing engines are driven by steam of 450 pressure, instead of expanding a hundred times, as would be indicated as proper by the purely mathematical analysis referred to by my correspondent, is limited to an efficient expansion of about twenty times, and probably gives best results with still less expansion. The fact is that no device yet invented has ever given even a rough approximation to the efficiency indicated on purely theoretical grounds.

We are gradually learnidg more and more about the behavior of steam in the engine, and are in our every-day practice, as illustrated by the best builders, keeping very close to what is, all things considered, the line of true economy.

Single cylinders are still doing, at their best, about the same work as the best compound engines, and are rarely made to expand, when condensing, nearly to the back pressure, and the best non-condensing engines hold the expansion line at its termination well above the atmospheric line. To double the rate of expansion in these engines would increase the weight and frictional resistance per horse power developed to so great an extent that this consideration alone forbids maximum expansion.

Steam jacketing and moderate superheating the steam are always sources of economy. A good single cvlinder engine, with thorough steam jacketing, has been known to give an economy that is generally considered excellent at as low a rate of piston speed as 100 feet per minute, the coal consumed being but $1\frac{1}{4}$ pounds per horse power per hour.

Increased steam pressure benefits usually, but has its limits. I have known an engine of reputation, working with 250 to 300 pounds of steam, to require over $2\frac{1}{2}$ pounds of good coal per hour per horse power, and its steam jacket proved quite unequal to the task of checking internal condensatron. I have no doubt that a " longer cut-off "—the steam was expanded only one-half as much as unchecked calculation would dictate—would have been better, and *perhaps*, a less piston speed would have made the steam jacket more effective.

All these matters must be finally settled by experience.

THE RICHMANN AIR COMPRESSOR.

The engraving on this page represents one of the latest improved mining appliances invented in California, and one that in many respects is a very great improvement in its class. This air compressor was invented and perfected by Henry Richmann, of this city, and is manufactured by the Richmann Rock Drill and Compressor Company, at their works, 27, Stevenson street.

The bed plate and standards or pillars are made hollow, and on the upper plate is formed a tube connecting the upper end of these standards, and the whole space thus connected serves as a reservoir for the air compressed by the air piston.

The steam cylinder is placed on the bed plate and has two piston rods connecting with a cross slide above. The air compression cylinder on the upper plate also has double piston rods, which are connected below to a cross slide. Guide rods keep the motion of the slotted cross head in line, sliding clamps fitting around these guides form the cross head, and preventing lateral motion by their peculiar construction.

Combined with these cross heads is a peculiar three armed or compound crank by means of which the inventor is enabled to utilize the power of the engine in a most economical manner for compressing the air.

Ordinarily the crank of the engine operates a shaft on which there is another crank for communicating motion to the piston of the air cylinder. This necessitates the air compressing cylinder being some distance from the engine cylinder and very much out of a direct line, and the air compressing appliance is correspondingly enlarged. There is also considerable torsional strain upon the shaft depending on its length. It was desired to make this compressor as compact and snug as possible and to bring the air cylinder in line with the steam cylinder as near as might be, at the same time providing a peculiar connection of the two pistons, whereby the greatest power of the engine is exerted as the air reaches its highest compression. This peculiar compound crank and connecting slides were therefore employed.

Neither of the three arms of the compound crank are in line with one another, nor is either one at right angles to any other; but they are so arranged with relation to each other and the crank-pins that the greatest power of the engine is exerted at its most effective point, with relation to the air compressing piston; that is to say, at the moment when the air in the compressing cylinder has been half compressed by its piston being moved half way up, then the crank of the engine-cylinder is nearly at right angles to the line of travel of the piston of the engine-cylinder, and at its most effective point for exerting the pressure necessary to compress the already partly-compressed air in the compression cylinder. The same is the case on the down stroke.

The air piston commences its return stroke before the engine piston has reached the end of its stroke, and the peculiar connection of the two cranks and their uniting arms with the sliding boxes on the cross slides is such that as the engine begins to reach the highest or lowest point of its stroke it is forcing the sliding box of the air piston cross slide transversely to one side of its slotted cross head, and this box becomes nearly stationary at the time when the engine crank is passing the dead point. After passing that point the power of the engine crank increases until it reaches a position at right angles with the line of travel of the piston, and is exerted as a direct thrust upon the sliding box, through its connecting arm.

By the peculiar formation of the cranks and bringing the two cylinders nearly in line, two complete cranks do not have to be formed, but the central arm which unites the two crank pins, serves to transmit the power of the engine to the piston of the air compressor. This arm revolves bodily around the axis of the shaft, as both its ends are connected with the crank pins, and its action is, therefore, that of a pitman or connecting rod, its peculiar movement being made possible by the action of the two transversely moving boxes, and their vertically moving slides.

This mechanism makes it possible to compress air to 140 lbs. with 70 lbs. of steam, as we saw down at the works this week, the compressor having steam and air cylinders of the same capacity.

By having the double piston rods, whether the valves are in the cylinder head or in the piston, said valves may be of large diameter, as they may come between the piston rods. With a large area for the valves their action is rapid and free. With the piston rod in the centre, not half the area can be utilized for valves and seats; but with double rods, over half the area can be utilized.

An air compressor to run two three-inch rock drills is about 4x4 by 7 ft. high, and weighs about 2,500 lbs. The compressed air is stored in the frame and base, as previously stated, the frame being the air receiver. The compressor is strongly and well made, and after having been tested about a year, has been introduced into several mines on this coast.—*Mining and Scientific Press.*

LIFTING TACKLE.

Every engineer, builder, and millwright knows the great importance that is attached to lifting heavy weights and fixing materials and machinery. It is no use for work to be properly finished if accidents happen in fixing. The young and inexperienced erector is frequently at a loss to know how and where to attach his ropes and other appliances to secure the best results, and, worst of all, no effort is made to teach him—he must rely on his own observations. So well known is this ignorance with respect to lifting and hoisting in mechanical trades, that it is often stated, and often acted upon, that an old sailor makes the best erector. He is as nimble as a monkey on a pole or scaffold. We know very well that in our younger days, we experienced considerable difficulty in obtaining information respecting knots, loops, and other rope fastenings.

No doubt all who have to do with the moving of machinery and other heavy masses, will find the rope knots and fastenings shown in the adjoined engraving very useful. The information is not only very useful when away from home in foreign countries, or away from the workshop—the man who understands the use of rope tackle is a king among his fellows.

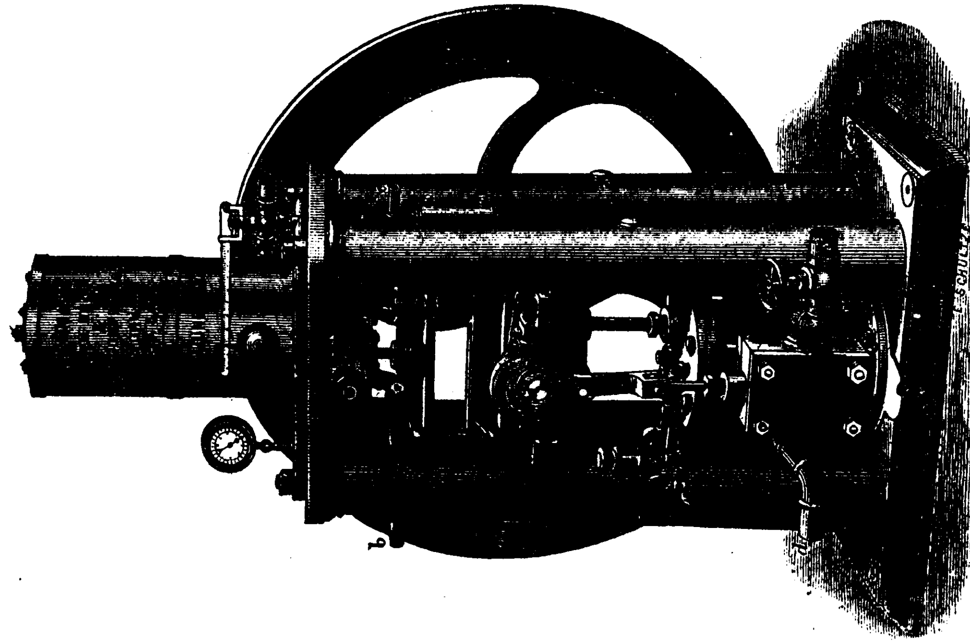
We have often thought that in these days of steam cranes and hydraulic jacks, men are not so ready in resources as they were many years ago; they trust too much to machinery and too little to themselves; they seem afraid to exert their real strength at the end of a rope. If we can only induce a few of our readers to study the art of lifting weights and encourage confidence in manual strength, we shall not consider our efforts to have been in vain.

The various kinds of knots and loops shown in the engravings are as follows: Fig. 1, half hitch; Fig. 2, timber hitch; Fig. 3, half hitch and timber hitch; Fig. 4, clove hitch; Fig. 5, hammock hitch; Fig. 6, cask hitch; Fig 7, bale hitch; Fig. 8, tub or end sling.—*Manufacturer and Builder.*

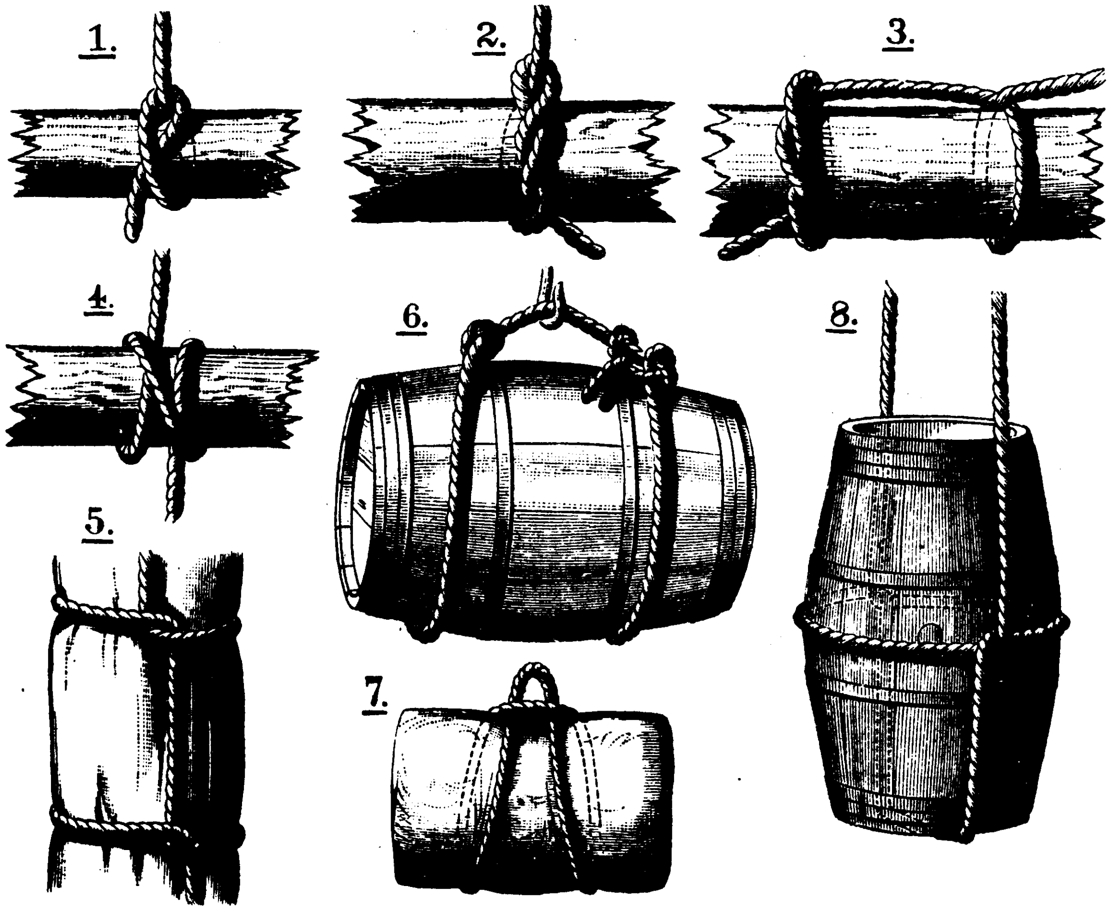
PUBLIC INTEREST IN EDUCATION.

One great weakness in the educational system of America, particularly of New England, is the almost total lack of general intelligent interest in the work of the schools. In Germany, which confessedly leads the world in the effectiveness of her common-school system the business men, professional and official men, all acquaint themselves with all the details of the educational system. To be ignorant of the school system of the city in which one lives is to be behind the age. Here it is quite the reverse. A man must know of political movements, of business tendencies and ventures, of railroad projects, of the fastest trotting-time, of the best oarsmen and batsmen, of the latest casualty and murder; but it is never for a moment to be supposed that he knows ought of the educational tendencies. The daily papers have editorials upon every shade of politics; of every new railroad, insurance, or financial scheme; of every trifling event in England, Ireland, or Turkey; of every unimportant denominational and religious movement; but rarely does the average daily hint editorially at the great school interests, and its local reference is usually confined to the announcement that some faithful teacher has chastised a rebellious boy. No other department of public life has such just cause to interest the public as the schools. About one-third of the public money raised by taxation, for the current expenses of the cities and towns, is applied to the schools; nearly every household is, for a period ranging from ten to thirty years, interlinked in its daily association with the school; every man and woman in the community received the foundation of his capital intellectual culture in the public schools; the very root idea of the permanency of the American government is in the public school. Why, then, should not our business men, our professional men,—our homes know what is going on in the educational world,—give some time and thought to the drift of things in the public schools? The teachers' journals discuss all these questions, but their articles are written and read almost wholly by teachers, and however valuable the work, it does not tend to arouse the public thought as it should be aroused upon this question. But there is, of late, a manifest awakening, and we think the time is at hand when the average business man will feel called upon to read of these subjects understandingly, giving to the most vital phase of our life his best thought.—*Boston Traveller.*

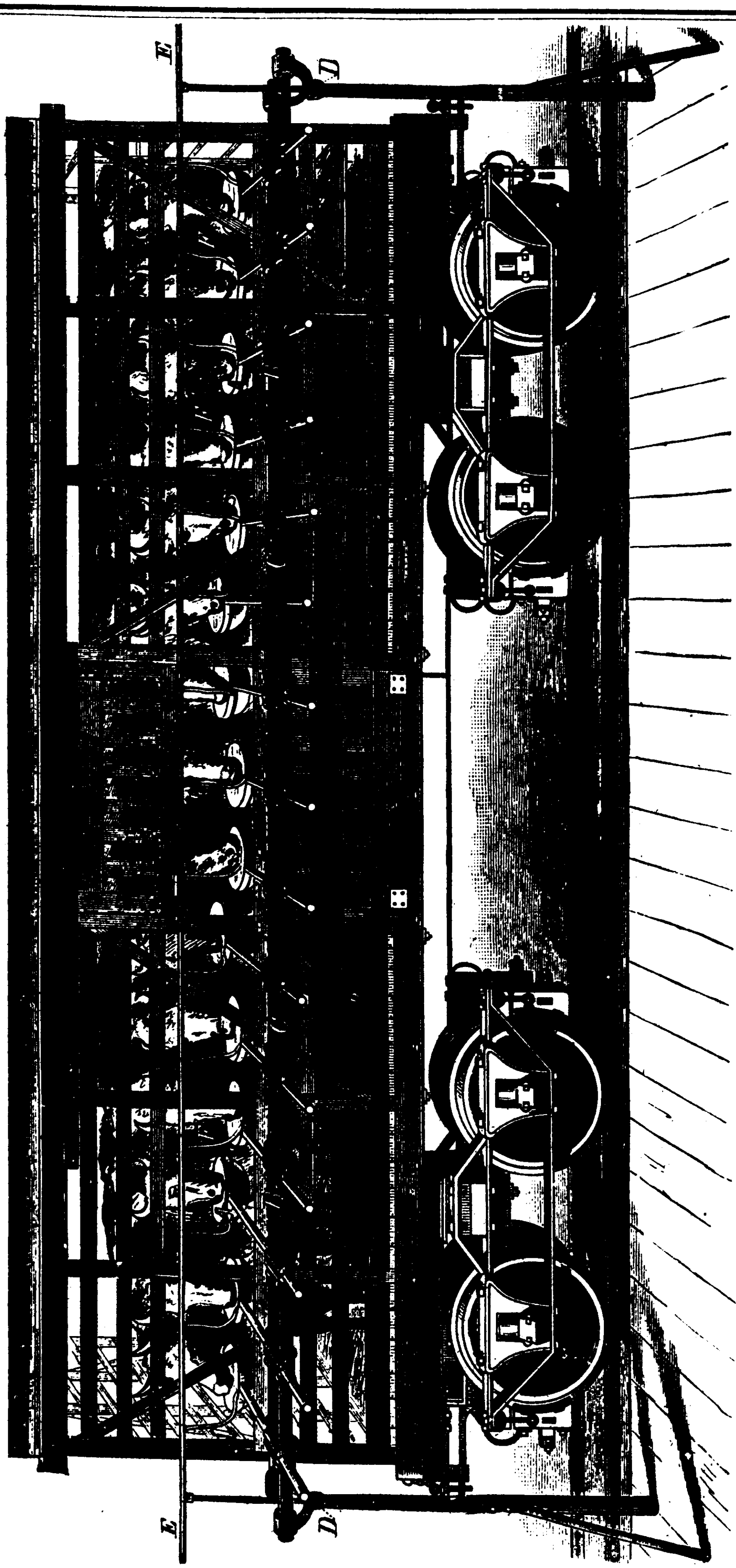
VOLCANIC THUNDER-STORMS.—A paper on volcanic thunder-storms, by M. Faye, was read before the French Academy of Sciences, on November 2nd. It is stated that in paroxysmal eruptions the enormous amount of steam ejected causes volcanic thunder-storms, which are very different from ordinary thunder-storms. The volcanic storm has no gyratory movement; it is confined to the column of ascending clouds, and no flashes occur without the presence of ashes. Altogether, the phenomena resemble very closely to those of the Armstrong electric machine; As observers have failed to mention any hail attending these thunder-storms, it is probably because no hail is formed. Its absence is due, M. Faye thinks, to the lack of gyratory motion already noticed.



RICHMANN'S IMPROVED AIR COMPRESSOR.



ROPE LIFTING TACKLE.



LIVE STOCK FEEDING AND WATERING APPARATUS FOR RAILWAY CARS.

IMPROVEMENT IN FEEDING AND WATERING LIVE STOCK ON CARS.

The cruel and barbarous treatment to which animals in transit from the West to the Eastern markets are frequently subjected is an old and long-standing abuse. It has been clearly stated and denounced for years as shameful, inhuman, and uneconomical, but up to the present time there has been no substantial improvement in the means and methods provided over those of twenty years ago, when the business was begun.

So important has this question become that the American Humane Association has offered a premium of $5,000 for the best device for, and most practicable improvement in cattle cars.

For the best information at hand the estimated loss on cattle in transit equals 6 per cent., and about 9 per cent. on sheep and swine, the greater portion of which loss is chargeable to improper treatment *en route*. The saving of one half of this percentage would amount to an enormous profit to the cattle interest, and would mean as well better and cheaper meat both in this country and in Europe. Of the cattle that live, many, by reason of starvation and cruelties inflicted while in transit, and after, lose nearly a hundred pounds weight from the sweetest and best part of the meat, and come out of the cars full of fever, or with bruises, sores, and ulcers, and these, together with smaller animals, to which the loss and suffering are proportionately great, are all sold in our market for food.

If there were no other side to this question than that which pertains to the "profit and loss account" of the business ledger, we might be content to leave the subject here, letting those whose economical interests are involved discover the remedy. Such, however, is not the case, for it has become well settled through our Boards of Health at the commercial centres, societies of social science, and veterinary experts, that a large portion of the meats offered for sale in our markets is diseased and unfit for consumption, which condition is very largely attributable to the improper and unnatural treatment of live stock during the time of shipment from the West to the East. We can, therefore, only hope for healthy meats for consumption, as a general rule, when live stock are cared for in transit as they should be.

From these facts it appears that cruelty to animals in transportation avenges itself upon the consumer, and that we shall never be secure against disease from eating poisonous meats until animals are properly fed and watered and thus brought in good health to the shambles. This can readily be done without materially adding to the expense of transportation, and with increased profit to all concerned, by adopting the cheap, effectual, practical method showing in the engraving, which are devices recently perfected by Mr. A. D. Tingley, of this city, and are now owned by the Union Live Stock Feeding Company, of 27 Union Square, and are indorsed by the "Farmers' Club" and Mr. Henry Bergh, of this city. The Feeding Company are negotiating with the trunk railroad lines of this country for the early erection and operation of these feeding stations.

There is, therefore, an urgent need for the introduction of some plan by which the needless suffering of these dumb creatures in transit may be lessened. It has been fully demonstrated by actual tests that, by feeding and watering live stock regularly every twelve hours between St. Louis or Chicago and New York, 50 pounds and upward in shrinkage was saved to each head of cattle, and the condition of the meat materially improved. The following is a moderate estimate of saving to the shipper with eight feeding and watering stations between St. Louis and New York:—

Allowing 16 cattle to each car. and a saving in shrinkage of 50 lb. per head, or 800 lb. per car, worth 8 cents per lb., we have a total saving to the shipper on each car load	$64.00
Deduct cost of feeding and watering at 20 cents per head at each station	$25.60
Net saving to the shipper on each car load.	$38.40

By official reports there were received and shipped at the two cities of St. Louis and Chicago alone, during the year 1879, 14,024,172 head of live stock, and the adoption and use of these devices would save millions of dollars annually to this industry, and at the small charge of five cents per head for the devices which effect this large saving, would bring the Union Live Stock Company an annual net income of over $700,000, besides the great beneficial results to beef consumers. It is a simple device for feeding and watering, entirely separate from the cars, and is erected about twelve hours' run apart, at suitable stopping places along the track on both sides of the car. Its construction and use will appear from the following description, reference being had to letters in the engraving.

A, represents a series of feed boxes, with handles which slide back and forth in socket, B, and allow the feed boxes to b. pushed in and out of the car as desired. The sockets or supporters, B, of the feed boxes (through which the handles slide) slide sideways on the rods, C, giving a lateral movement to the feed boxes to avoid posts and braces when the boxes are pushed into the car. D is a joint or hinge in the upright posts, which gives a slight rocking motion to the horizontal part of the framework, allowing the feed box to be slightly raised or lowered. E is the main water pipe, and F represents small leaders from the main water pipe to each separate feed box. It is designed to build a row of these on both sides of the track, and thus get at the heads of the stock, wherever they are. The only alteration required to be made in the stock cars now in use is to loosen one board on each side of the car, head high, and support it on hinges and hooks, so that it may, by lowering, provide an opening for the feed boxes.

This arrangement not only provides in a simple and inexpensive manner for the comfort of the stock, but permits of their transportation with greater dispatch, since it avoids the labour and delay of unloading.

Scientific Items.

AIR-LOCOMOTIVE.—English papers give an account of an air-locomotive designed by Major Beaumont, of the Royal Engineers. From an account of an experiment made at Woolwich, some points may be gathered useful in subterranean communication in cities. The engine, having received a charge of 100 cubic feet of air, with a pressure of 1,000 pounds to the square inch, left the Royal Arsenal station, on October 6th, at 12.22 p.m., for a run to Dartford and back, about 16 miles. In order to increase the energy of the air, it was heated, on being admitted to the cylinder, by a very small quantity of steam. The indications on the pressure-gauge, as different stations were passed, were 940 pounds at 12.27 p.m.; 860 pounds at 12.33; and 760 pounds; 540 pounds pressure being the store of energy on arriving at Dartford at 12.50. Waste having been occasioned by shunting, the return journey began with a pressure of 510 pounds at 1.35 p.m., and Plumstead station was again reached at 2.10. This locomotive, not so large as one of our common street-cars, weighs about 10 tons. and draws a load of 16 tons up a moderate incline. It can be charged with air in fifteen minutes, does not send out any rush of steam or noxious gases, and makes only a trifling noise. Its sanitary advantages for underground work are obvious, and it can also be used for surface roads. Major Beaumont calculates that one on this principle, but weighing about 50 tons, would be the most powerful of traction motors.

THE PHOTOPHONE.—The opinion is gaining ground, especially among French *savants*, that the musical sounds produced by Professor Bell in disks of various substances, such as mica, India rubber, metal, and wood, by holding them in the path of a rapidly interrupted beam of light, are really due to heat and not to light. Radiophonic notes, such is the new term, have been obtained by M. Mercadier from ordinary gas lamps without employing lenses to concentrate the interrupted beam, by simply bringing the receiving disk near the source. Even a plate of copper heated to a bright red heat produced very distinct musical tones, which gradually died away as the plate cooled to a dull red followed by obscurity. The fact that when the receiving disks were coated with silver on the side next the light the effects were feeble, and that when coated with absorbent lampblack they were strong, would seem to tell against Professor Bell's conclusion that the sounds were due to light. It is a curious fact that when the radiometer was first brought out by Dr. Crookes he intimated his belief that its rotation was due to the impact of light waves; but heat is now known to be the cause of the motion.

—A CURIOUS device, whereby pictures of various kinds are burnt out on a piece of ordinary-looking rose-coloured paper, has been brought out by a Berlin merchant, Herr Bergel. You apply a glowing match at two finely perforated points, and the sparks communicated then begin gradually to move over the paper, working out the picture. Neither leaves its proper path, nor injures the paper beyond, and when the end of the path is reached the spark goes out. A negative and positive are thus obtained, after the manner of silhouettes. The contrivance proves highly entertaining, and may be employed for educational purposes.

THE "DESTROYER."

The accompanying illustration represents a foreshortened view of the submarine gun of Captain Ericsson's torpedo vessel *Destroyer*. This novel piece of ordnance is thirty feet long, sixteen inches calibre, and, owing to its great length, is made in three sections, which are bolted together, the breech section being reinforced by a series of steel hoops. It will be seen that the breech is represented closed, the mechanism for handling the breech-plug and for operating a sea-valve at the muzzle of the gun being shown in perspective. The forward end of the projectile torpedo is represented in the place it occupies previous to being inserted in the gun. The projectile torpedo is twenty-five feet six inches long, sixteen inches in diameter, its weight being 1,500 pounds, including 250 pounds of explosive matter. The initial velocity is fully 160 miles an hour, while the recent trial shows that it traverses the first 310 feet in three seconds.

The *Destroyer* is intended to supersede the English steam-rams. It attacks bows on, and being protected by inclined transverse armor, it defies the opponent's fire. The explosive charge of the projectile torpedo being sufficient to shatter the hull of any vessel, it is supposed that this formidable weapon is capable of destroying armored vessels of all classes. In addition to the enormous velocity of the projectile, the *Destroyer* is capable of overtaking iron-clad ships.

HUMAN TREES OF INDIA.

BY DANIEL C. BEARD.

All those who feel a sufficient interest in the subject to study or notice the facts must at times be struck with amazement at the wonderful resemblance of certain insects and other animals to vegetable and inanimate objects. So exact is this resemblance in some instances as to deceive the most experienced. Wallace, the great naturalist, was very anxious to secure a specimen of a certain brilliant butterfly, but was unable for some time to capture one on account of the creature's sudden unaccountable and mysterious disappearance. He finally discovered that the outside of this insect's wings was an exact representation of a leaf. When the butterfly alighted upon a shrub and closed its wings it completely deceived even this experienced scientist. Some species of lobster found at Bermuda so closely resemble submarine stones, even to the coating of sea weeds, that I have passed by an aquarium containing them supposing the tank to be uninhabited. The common katydid, whose constantly repeated notes, late in summer, warn us of the approaching frosts, has a representative in South America, whose wings not only resemble a green leaf, but, to add to the deception, the tips of the wings are ragged and discolored, having the exact appearance of a leaf that has been disfigured from the attacks of caterpillars. I once had one in my studio, and it was with great difficulty that I could convince visitors that it was not an artificial insect with wings made of real leaves. In the snow-covered regions of the North the foxes, hares, bears, and birds, with very few exceptions, assume the prevailing white color of the surrounding objects. Man has not been blind to these hints. There are various tribes of savages who successfully imitate stumps and stones by remaining immovable in crouched positions so as to baffle their pursuers.

This mimicry is carried to a wonderful degree of perfection in India. That strange country, as Dr. Latham says, "of a teeming, ingenious, and industrious but rarely independent population. It is a country of an ancient literature and ancient architecture," and he might have added, of a modern degradation. A country where such a society as that of the murderous Thugs is possible; a country where robbers are educated from childhood for the profession in which they take great pride, openly boasting of their skill. One of our most skillful and adroit bank robbers would be considered by these India experts but a bungling amateur.

The scientific manner in which these robbers prepare for their raids shows a thorough knowledge of the dangers of their calling, and the best guards against the same, choosing darkness for their forays. When their dusky bodies are least observable they remove their clothes, anoint themselves with oil, and with a single weapon, a keen-edged knife suspended from their neck, creep and steal like shadows noiselessly through the darkness. If detected, their greasy and slippery bodies assist them in eluding capture, while their razor-bladed knife dexterously severs the wrist of any detaining hand. But the most ingenious device to escape capture is that shown by the Bheel robbers in the accompanying illustration. It often happens that a band of these robbers are pursued by mounted Englishmen, and unable to reach the jungle, find themselves about to be overtaken upon one of those open plains which have been cleared by fire, the only shelter in sight being the blackened trunks of leafless branches of small trees that perished in the flames. For men so skilled in posturing this is shelter enough. Quickly divesting themselves of their scanty clothing, they scatter it with their plunder in small piles over the plain, covering them with their round shields so that they have the appearance of lumps of earth and attract no attention. This accomplished, they snatch up a few sticks, throw their body into a contorted position, and stand or crouch immovable until their unsuspicious enemies have galloped by.

When all is safe they quickly pick up their spoils and proceed upon their way.

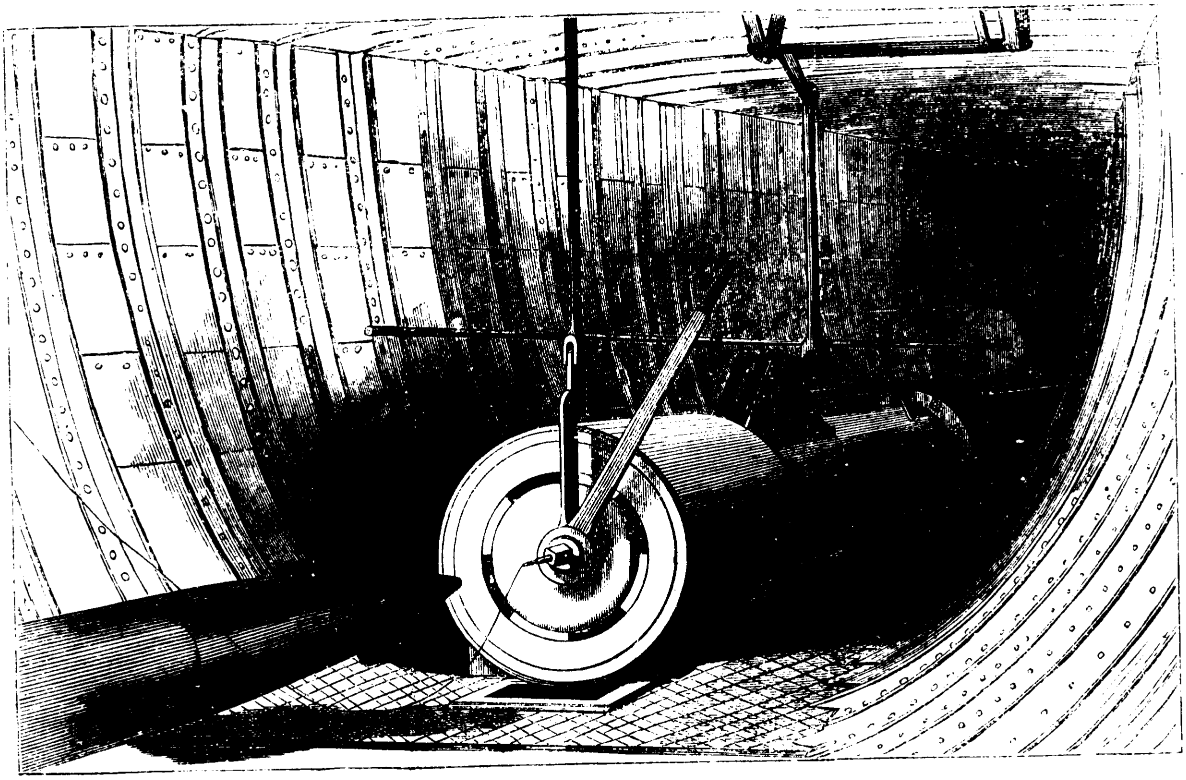
The Rev. J. D. Wood gives an interesting account of these marvelous mimics. I quote the following:

"Before the English had become used to these manoeuvres, a very ludicrous incident occurred. An officer, with a party of horse, was chasing a small body of Bheel robbers, and was fast overtaking them. Suddenly the robbers ran behind a rock or some such obstacle, which hid them for a moment, and when the soldiers came up the men had mysteriously disappeared. After an unavailing search, the officer ordered his men to dismount beside a clump of scorched and withered trees; and the day being very hot, he took off his helmet and hung it on a branch by which he was standing. The branch in question turned out to be the leg of a Bheel, who burst into a scream of laughter, and flung the astonished officer to the ground. The clump of scorched trees suddenly became metamorphosed into men, and the whole party dispersed in different directions before the Englishmen could recover from their surprise, carrying with them the officer's helmet by way of trophy."

Notes and Clippings.

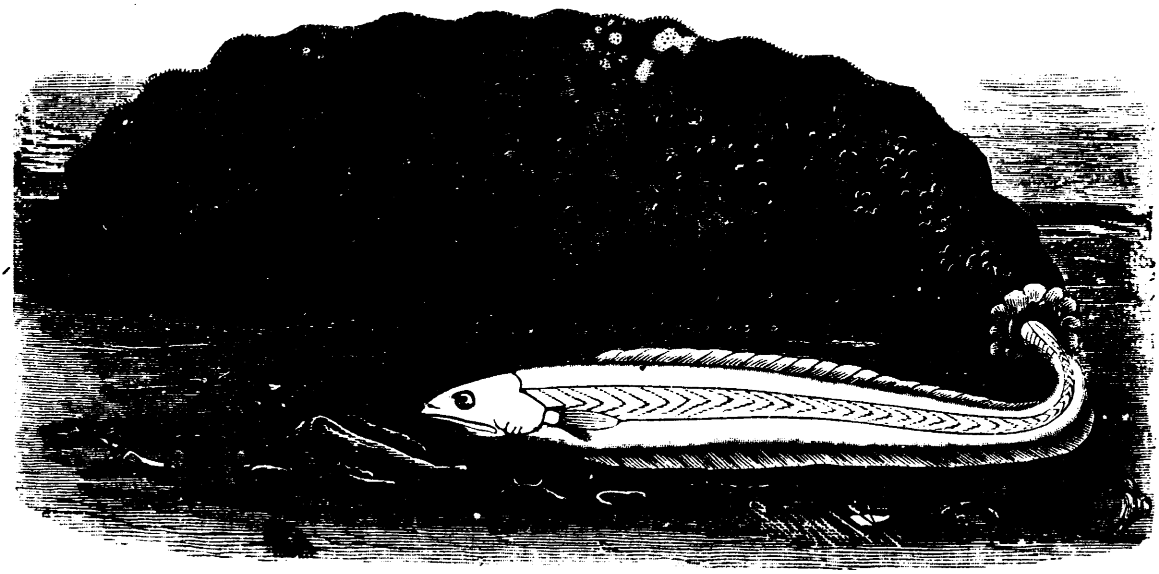
ELECTRIC LIGHT IMPROVEMENT.—One of the great drawbacks to the economical use of the electric light is the waste of light attending the use of ground glass, no proper substitute for which has been suggested until now. A Frenchman, M. Clemandot, has been trying recently to use fine spun glass, or "glass wool," for diffusing the light of the electric arc, his object being to decrease the waste usually attending the employment of ground glass. He builds up his globe, which is conical in shape, with a number of tubes placed side by side, and well closed at the top and bottom, to exclude the dust. These tubes are filled with glass spun by a peculiar process, so as to yield fibers very much finer thay the finest cocoon silk. It is stated that he succeeded in reducing the absorbption of light from 30 per cent., with ordinary globes to 15 per cent., by the use of his improved apparatus.

LUMINOUS PAINT.—According to the London *Building News*, luminous paint is getting into quite extensive use in England. Mention is made of offices coated with the paint which give great satisfaction to the occupants. The effect is that of a subdued light, every object in the room being clearly visible, so that in a room so treated one could enter without a light, and find any desired article. The luminous paint is excited by the ordinary daylight, and its effect is said to continue for about thirteen hours, so that it is well adapted for painting bedroom ceilings, passages that are dark at night, and other places where lamps are objectionable or considered necessary. For staircases and passages a mere band of the paint will serve as a guide, and costs but a trifle. For out-door purposes the oil paint is used, but for ceilings and walls the luminous paint mixed with water and special size, can be used the same as ordinary whitewash, and presents a similar appearance in the daylight. But the recent discovery that it can be applied as ordinary whitewash considerably expands the field of its usefulness. Sheets of glass coated with the paint are in use in some of the vessels of the navy, at the Waltham Powder Factory, at Young's paraffine works, and in the spirit vaults of several London docks; and now that, by increased production and the use of water as the medium, its cost is reduced by one half, it will probably be extensively used for painting walls and ceilings. The ordinary form of oil paint has already been applied in many ways, to statues and busts, to toys, to clock faces, to name plates and numbers on house doors, and to notice boards, such as "mind the step," "to let," etc. The paint emits light without combustion, and therefore does not vitiate the atmosphere. Several experimental carriages are now running on different railways, the paint being used instead of lamps, which are necessary all day on account of the line passing through occasional tunnels.



THE GUN OF ERICSSON'S TORPEDO-BOAT THE "DESTROYER."—DRAWN BY CHARLES GRAHAM.

HUMAN TREES OF INDIA.—BHEEL ROBBERS IN HIDING.



PARASITE FISH.

SWORDBILL HUMMING BIRD.—Docimaster Ensiferus.

(*See next page.*)

Natural History.

THE SWORD BILL HUMMING-BIRD.

This humming-bird derives its name from the singular shape and size of its beak, which is very nearly as long as the rest of the body.

This curious species is rather large, as it measures eight inches in length. It inhabits Santa Fé de Bogota, the Caraccas, and Quito, and is generally found at considerable elevations, having been often seen at a height of twelve thousand feet above the level of the sea. The inordinately long bill is given to this bird in order to enable it to obtain its food from the very long pendent corollas of the brugmansiæ, and, while probing the flowers with its beak, it suspends itself in the air with a tremulous movement of the wings. Its movements are singularly elegant, and while engaged in feeding it performs the most graceful manœuvres as it probes the pendent blossoms, searching to their inmost depths. The nest of this species is hung to the end of a twig, to which it is woven with marvelous skill, and its whole construction is very beautiful.

The adult male bird is colored as follows: the head and the upper part of the body are green, glossed with gold in some parts and with bronze in others, the tints changing according to the light. The wings are dark black-brown with a purple gloss, and the tail is dark black, bronzed on the upper surface. Behind each eye is a small but conspicuous white spot slightly elongated, and there is a broad crescent shaped mark of light green on each side of the neck. The under parts are of a bronze green, and the under tail coverts are flecked with a little white. The female is much the same color as the male upon the upper parts of the body, except that there is a little white upon the lower part of the back and a narrow white line behind the eye. The throat is brown, each feather being edged with gray, and there is a very faint indication of emerald green on part of the throat. The young male is much like the female but is more coppery in his hues. The throat is white, speckled with brown, because each feather is white with a brown tip. At each side of the throat there is a large patch of green, intermingled with white.—*Wood's Natural History.*

A STRANGE PARASITIC FISH.

BY C. F. HOLDER.

Among the marine parasites we find several fishes whose peculiar methods in the struggle for existence are worthy of being recorded; one is the fierasfer, found by the writer in the Bêche de Mer, and the other the attendant of the physalia. Between Bird, Long, and Garden Keys, of the Tortugas group, a large shallow reef sweeps away to the south, fringed on the outside with breakers, and a submerged wall of dead coral and other *débris* washed up from time to time. The clear water within is rarely over four feet deep, some portions being pure white sandy bottom, while other parts are overgrown with large tracts of coral, astreas, meandrina, etc. Here is the collector's paradise. Among the huge heads of meandrina, numerous rare and beautiful fishes move lazily about. The branch coral swarms with radiates and crustaceans, while the sandy bottom and clear water are peopled severally with hordes of creatures adapted for their various surroundings. In drifting over these submarine gardens, new features appear at every step, and with a small coral hook and a pair of grains, enough specimens can be collected in a day to stock a large museum. The most common objects on the bottom are the large black echinus and the bêche de mer. The latter here attain their largest size, and their worm-like forms are seen stretched out in various positions. While drifting over this reef we came upon an extremely large specimen; jumping over we lifted it from the bottom, and were about to throw it into the boat when our attention was attracted by the end of a fish protruding from the mouth of the holothurian. Holding it over a glass jar in the boat, we saw a long, silvery, eel-like fish gradually squirm out of his mouth. It dropped into the water, and after several attempts to swim, sank to the bottom and shortly died. It was about eight inches long, tapering down to the tail, and in color clearly resembling the fishes from the mammoth cave. A delicate dorsal fin extended the entire length of its back, and its whole appearance was eel-like. Suspecting that the fish was a phenomenal parasitic occurrence, we collected other holothurians, and in many of them, after cutting open the thick skin, found the same fish, and in every case it died when exposed to the open water, showing conclusively that it could not live out of the stomach of its protector. Careful examination of the reef, covering a period of eight or nine years, failed to show one of these fishes in any other condition than the above, and its habits, methods of increase, all are as much an enigma as have been some of the habits of our common eel. The fish, doubtless, takes its position in the holothurian when young, and either feeds upon the entrails of the animal or upon the food it takes in; either conditions are possible, as the holothurian, if deprived of a part of its internal machinery every day, could easily reproduce it, and would probably offer no objection, as we have frequently seen them disgorge their entire system, and reproduce a new set.

The holothurian in which this fish is found has for its specific name *Floridana*, and is a large dark brown sea cucumber, with the feet scattered irregularly over the body, and with smaller tentacles than in *Pentacta* of our northern coast. The alimentary canal is often found filled with pieces of shell, corals, etc. It is about three times as long as the body, with longitudinal small folds, and held in place by a large, broad mesentery, which accompanies the intestine throughout the greater part of its length, terminating suddenly in a cæcum much larger than that of the above-mentioned species. In this canal lies snugly ensconced the fierasfer, now feeding on the pieces of coral or mollusca taken in by its host, or in default of this, tearing and lacerating the sides of its self-constituted prison. Its entrance into the alimentary canal of the cucumber may be attended with some danger, as the pharynx of the *Floridana* is calcareous, while in *Pentacta* it is muscular. Another species is found inhabiting the star fish (*Culcita*).

Concerning the methods of reproduction of these animals nothing is known, and the fact that those observed by the writer died upon escaping from the holothurian makes the question still more enigmatical. They undoubtedly seek the protection of the holothurian instinctively when young, and a curious example of quasi-reasoning power in low organisms is evidently shown. The Rev. J. H. Murphy, in his work entitled "Habit and Intelligence," seems to regard instinct as the sum of inherited habits, remarking that "reason differs from instinct only in being conscious. Instinct is unconscious reason, and reason is conscious instinct."

Health and Home.

BREAD-MAKING IN SPAIN.—The bread in the South of Spain is delicious; it is as white as snow, close as cake, and yet very light; the flour is most admirable, for the wheat is good and pure, and the bread well kneaded. The way they make this bread is as follows: From large, long panniers filled with wheat, they take out a handful at a time, sorting it most carefully and expeditiously, and throwing every defective grain into another basket. This done, the wheat is ground between two circular stones, as it was ground in Egypt 2,000 years ago, the requisite rotary motion being given by a blindfold mule, which passes round and round with untiring patience, a bell being attached to his neck which, as long as he is in movement, tinkles on; and when it stops he is urged to his duty by the shout of "*arra mula*" from some one within hearing. When ground, the wheat is sifted through three sieves, the last of these being so fine that only the pure flour can pass through it; this is of a pale apricot colour. The bread is made in the evening. It is mixed with sufficient water, with a little salt in it, to make it into dough; a very small quantity of leaven or yeast in one batch of household bread, as in Spain, would last a week for the six or eight donkey loads of bread they send every day from their oven. The dough made, it is put into sacks and carried on the donkeys' backs to the oven in the centre of the village, to bake it immediately after kneading. On arriving there the dough is divided into portions weighing three pounds each. Two long, narrow wooden tables on trestles are then placed down the room, and a curious sight may be seen. About twenty men, bakers, come in and range themselves on one side of the table. A lump of dough is handed to the nearest, which he begins kneading and knocking about with all his might for about three or four minutes, and then passes it on to his neighbour, who does the same, and so on successively until all have kneaded it, when it becomes as soft as new putty and ready for the oven. Of course, as soon as the first baker has handed the first lump over to his neighbour, another lump is handed to him, and so on until the whole quantity of dough is kneaded by them all. The bakers' wives and daughters shape the loaves for the oven, and some of them are very small. They are baked immediately.—*St. Louis Miller.*

HYSTERIA.—Many people are distinctly hysterical, but never have a fit of hysterics. We often meet with young women who, from their hysterical tendencies, are a source of constant anxiety to their friends, but who, nevertheless, have never any definite outbreak. It occurs almost exclusively in the female sex, but still we meet with it every now and then both in men and boys. Thus the case is recorded of a young doctor who was distinctly hysterical. He was exceedingly attentive to his own sensations, and fancied that he laboured under a number of diseases that had no existence but in his own imagination; he showed great uneasiness and infirmity of purpose; was what is called "very nervous," and had occasional outbursts of choking tears and laughter, exactly resembling those so frequently met with in the other sex. In women hysteria generally makes its appearance about the age of sixteen, or from that to twenty. When once established it may last for years—in fact, for a life-time. When it occurs in men, it generally begins later—about the age of forty. In them it is usually the result of over-work or excessive worry and anxiety, and that is about the age at which these begin to tell. There is often considerable deterioration of health, an impaired nutrition, and a feeble circulation, with exhausted brain. Hysteria occurs in all conditions of life, but it is more frequently met with in the unmarried than in the married, although it is by no means confined to the former. Its more frequent occurence in single women is probably the result of their social surroundings. A woman, if not married, has, as a rule, very little to do—at all events, in the middle classes of society. She has no housekeeping to attend to, no children to look after, nothing, in fact, to occupy her mind and rouse her out of herself, and this condition is pre-eminently favourable to the development of hysteria. On the other hand, a wife with a family has a good deal to occupy her attention, in fact, she is more likely to be over-worked than not; she has to think of other people besides herself, and an attack of hysteria finds no place in the routine of her daily duties. An active employment and hysteria seem almost to be antagonistic.—*Family Physician.*

The Sterling Dishwasher and Drying Machine.—This machine can be taken to the table where the dishes stand ready for washing, and after being charged with them, can be easily carried and placed in the hot suds bath—operated, rinsed, and taken out—placed on the stove, or over a furnace, or in warm weather in the sun to dry.

The machine will hold 21 plates, and a large quantity of silver at the same time. It will ordinarily contain at one time all the dishes used by an averaged sized family, Machines can be made of any desirable size. In hotels where four hundred plates are used at a meal, a machine can be used which will wash fifty plates at once, that is just the time washing one by hand would occupy. In such a place two men or women could do the work of at least a dozen girls. A succession of several machines could be used in connection, with the same water, and rapidly accomplish the work.

There is nothing intritate or delicate in the construction of the machine, which will render it liable to get out of order, and after a person has used it a few times it can be filled rapidly. Any child can easily learn how to use it.

The dishes are placed in the machine and held firmly in their places by simple attachments, so that they are not allowed to knock or jar against each other. In this position they are washed and dried, and there is no opportunity for them to be thrown about as is often the case in hand labor. Every housekeeper is annoyed by the nicking of her plates and dishes, destroying the neat appearance of her table, while at the same time the dishes are not sufficiently broken to be thrown aside.

The machine enters a field never before reached by machinery. "A good many efforts have been made," says the Solicitor of Patents in Washington, of twenty-five years experience, "to get up such a machine, and some have been patented. It seems they have all been failures, but they did not have that simplicity, combined with real effective working, possessed by Mrs. Sterling's machine."

The Nails.—That the possession of a beautiful hand is a great joy to a woman is undoubted; but what hand would be lovely if each finger terminated in a flat, unsightly, colourless nail? In Paris, where "manicures" are plenty, and their fees reasonable, one seldom sees such a sight on the hands of a lady; but here, where the business of a manicure is not properly appreciated, their customers few, and, of necessity, their prices high, an unsightly nail is frequently seen on hands that, like the lilies of the field, "toil not, neither do they spin." Lately, however, a fashion has arisen for rubbing and polishing the nails, and now quite often a gentleman, in shaking hands with a lady, will notice that this fair friend offers her hand palm outward, so that he may have an opportunity to notice and admire the bright polish and rosy tinge of her well shaped nails. How is this done? Why, by patience, perseverance, chamois-skin, and a little paste composed of rotten-stone and rouge. A small quantity of the mixture is put on the rubber—a tiny brush covered with chamois—and constant friction does the work. The oil and rotten-stone smooth and polish the nail in the same way that the workman does ivory, and the rouge imparts a pinkish glow. So much of this rubbing is done, and such ardour displayed, that a well known editor fears some of the ladies will have an unhappy fate—by constant rubbing the nail will break. An old story tells of an Irish-woman who scrubbed her kitchen-floor so much, in an over-laudable desire to be clean, that she fell through to the cellar, and this is what is feared will happen to some of the fair rubbers. After a severe course of constant friction, the centre of the nail will give way; but this will not happen if the method be practised for only a few moments each day; then the result will be attractive and beautiful.—*Phrenological Journal* (New York).

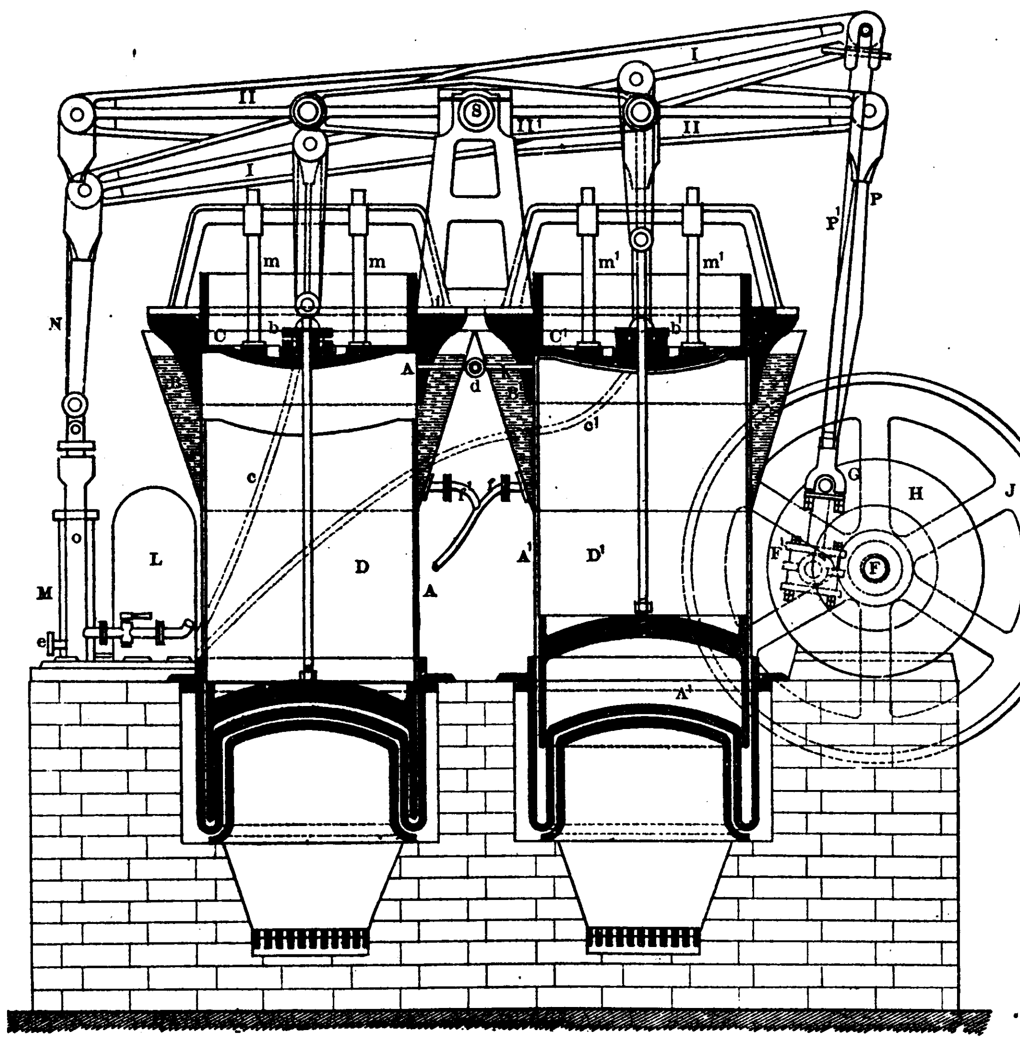
Mechanics.

Mechanics as a Science.—Although no department of science—no portion of the advancement of civilization that take us further from barbarism—is so marked in its triumphs and so certain in its beneficial results as that devoted to mechanics, it is a fact that it does not meet its proper approval or proper reward. It is really true that the mechanic is to-day paid much less for his labor, and very much less for his ideas and practical form, than others who merely reproduce and adapt the facts and settled opinions of their predecessors. The physician, the lawyer and the theologian charge and receive for their presentation of long ago acknowledged axioms, and even of new theories, handsome returns for their trouble. They are acknowledged necessities, while the mechanic is a sort of hanger-on to our civilization—a camp follower, with no recognized rank, and merely allowed place that he may prove his fitness. Certain perquisites follow the lawyer, the doctor of medicine and the theological instructor, all of which are lacking in the case of the mechanical engineer. It is unnecessary to refer to the chances of the lawyer for rich legal fees; to mention the opportunities of the physician with his rich and hypochondriac patients; and the recognition of the religious instructor, with his faculty of dealing with the doubtful, the troubled and the despairing. From these prolific sources these professors draw their incomes, and generally without question as to their individual fitness.

But the mechanical engineer, the adapter of theoretic science to practical utility, has no such resources, and even his legitimate income is limited and its amount frequently disputed. Yet he deals with facts and realities, and not with problematical hypothesis and impractical theories. When he gives an opinion or reports a diagnosis, his statements are based on unvarying laws, which are well understood by those of his profession who are competent. On his opinion vast enterprises, involving the labor of hundreds of men for years, and the expenditure of thousands of dollars, are readily undertaken by capitalists, and it is rare that they or the poorer stockholders find themselves wrong in depending on his acumen and scientific knowledge. In short, the professional opinions of the mechanical engineer are worth all that is paid for them, seldom misleading, rarely extravagant, generally reliable. Can as much be said with truth of the professional advice of others?

Men possessing these qualifications, and on whose opinions such vast enterprises rest, ought to be well paid. It costs much in time, labor and money for a lover of mechanics to become an expert—one whose opinion and direction may be accepted as absolutely reliable, and after the groundwork of theory has been prepared there is a long novitiate of practical service before the mechanical engineer can assume the position of director. It may be said, with entire truth, that in no profession are the exactions preparatory to profit so many and the time of apprenticeship so long.

The opinions of the lawyer are subject to reaision and reversal by a higher authority; those of the theologian are contracted and disputed by a hundred sects; those of the physician have other schools to deny their conclusions, and at best are but individual ideas, liable to be set at naught by another practitioner. But the opinions of the mechanical expert are based on known and proved facts, and are similar to those of every other competent expert. On such opinions the success or failure of vast industrial enterprises may be predicted, and on them are safely risked millions of money in untried experiments.



THE VAN RENNES HOT AIR ENGINE.

ANOTHER HOT AIR MOTOR—THE VAN RENNES ENGINE.

The accompanying diagram shows a section of a hot-air engine, built by Mr. Van Rennes, of Utrecht, Holland. In some of its features it is similar to Capt. Ericsson's well-known pumping engine, which we illustrated in our issue of June 12. It might even be supposed that Mr. Van Rennes' invention was largely inspired by inspection of the drawings and description of the pumping engine published some time since in European journals. It is true that this engine is double, but the hollow displacement plunger and its characteristic method of operation, the water jacket at the upper portion of the cylinder, together with the piston working in the same, are similar to those of the pumping engine. It is true that the method of driving or connecting the cylinders is different, but the difference is merely in the arrangement of the link work and walking beams. A compressed air chamber is employed, but this by no means adds to the convenience of the engine. Owing to this, apparently, it has been necessary to make the engine double.

The following is a description of the method of operation. A and A^1 are two cylinders, the lower part of which, the fire-box, is placed over a fire-place. While the fire-box is made of cast iron, the upper portion is constructed of boiler iron. The pistons C C^1 are open above, and are provided with a leather or other packing. They are guided by m m^1, and each of them has a stuffing box, through which the rods of movable plungers D D^1 pass. The lower portion of these plungers has the shape of a bell. The upper part of the cylinder is surrounded by a water jacket, B B^1. The plungers D D^1 are connected with the walking beam I, while the two pistons C and C^1 are attached to the walking beams II and II^1, the former of which is longer than the latter. By means of the connecting rod P and crank, its right arm turns the fly-wheel J, while the other arm of II drives the air pump M. The walking beam I is just as long as II, and by means of the connecting rod P^1 and crank G, gives the fly-wheel a rotary motion, while a pump is attached to the other arm. When the air in the fire-boxes is heated, the plunger D commences to ascend, driving the air above it into the space between it and the fire-box, where it expands considerably and causes the piston C to move upward. By means of the walking beams, the piston C^1 and plunger D^1 are forced into their lowest position and commence to reascend.

The upper portions of the cylinder are jacketed, as in Capt. Ericsson's engine, in order to absorb any waste heat which remains after making the stroke.

At b b^1 the cylinders have valves opening outward. They are in communication by pipes c c^1 with a chamber L containing compressed air. As soon as the air pressure is less in the cylinder A A^1 than in the chamber L, air will pass from the latter to the former. The pipes c c^1 have valves which are used in the following manner in order to start the engine: One of them is opened, so that communication between one cylinder and the chamber L is established. As soon as the fly-wheel has made half a revolution the valve on the second pipe is opened, and then the engine will be in operation. The running of the engine is regulated in the following way: The two cylinders are connected by a pipe, K, and both may be placed in communication with one another or be cut off from one another by means of a valve a. When the latter is closed the engine is developing its full power, but, if opened, it will gradually come to a stop, so that the position of the valve can command any speed desired.