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SCIENTIFIC CANADIAN
MECHANICS' MAGAZINE
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PATENT OFFICE RECORD

Vol. 9. AUGUST, 1881. No. 8.

NOTE AND COMMENT.

IN these columns we have often had occasion to speak of the late Josiah Mason and his death would seem to call for at least a brief editorial mention in this place. In one particular he has a record peculiar to himself among those who have devoted the earnings of a life time to the endowment of public institutions. The majority of these have left their money after death for charitable purposes, but Sir Josiah has spent upwards of $2,000,000 during his own life time in building and endowing immense public institutions. Apart from the satisfaction which must accrue to the man who sees around him the monuments of his own greatness, there is surely a higher philanthropy in the spending of wealth during one's lifetime, than in the common practice of public benefactors, who after making all the use they can out of their money during life, leave the trouble of its disposal to their executors, and gain a reputation of benevolence which has not cost them a penny, nor probably done them much good. Josiah Mason both earned and spent his money well. From nothing he raised himself to affluence, and the money he had gained by the sweat of his brow he devoted to the highest of uses, the elevation of the class from which he had sprung, in the hopes of smoothing the path for those who would follow in his steps, and obtaining for them the advantages which he himself felt the want of.

OPINIONS, many and diverse have been expressed in various quarters about the falling of the plaster ceiling in the Baptist tabernacle in Ottawa. The inquiry was conducted in the usual way. Some "practical men" were examined, and gave opinions which recall those of their brethren who testified concerning the disaster at the Madison Square Garden. Some of them thought that the fall of the plastering was due to the "damp weather" from which we must infer that Dominion plastering is only expected to stay up so long as the clouds are propitious. Others supposed that the settling of the building had "forced off the framework," that is, we suppose, the cross-furring, "from the rafters," an opinion still more extraordinary than the other. We are not at all disposed to believe that Canadian plasterers generally do work which is incapable of resisting a moist atmosphere or the settlement of a wall, and we prefer to adopt the suggestion put forward by the *Building and Engineering Times*, that the ceiling fell down because it was too weak to stay up. What was the nature of the weakness we cannot say. Perhaps the lime was bad, or the mortar was not trowelled sufficiently to make it clinch the laths, or perhaps the hair was omitted, or had been left too long in the lime, and thus corroded and destroyed—such faults are found in the work of dishonest and ignorant masons, or possibly the furring-strips had been put on with small nails, and secured only to alternate rafters, as is sometimes the way of dishonest and ignorant carpenters; but we affirm with confidence that if the ceiling had possessed proper strength it would not have fallen, and that its lack of such strength was due to the ignorance or greed of some person or persons unknown, but whose identity couldbe established by a very simple investigation.

LANDLORDS are a much abused class the world over, and tenants are too prone, it is to be feared, to cast upon their shoulders the burden of their own negligence and that of their household. A favorite cause of complaint is the imperfection of the drainage, for which the landlord is invariably made responsible, occasionally without cause. An illustration of a not uncommon occurrence is to be found in the case of Muspratt *vs* Hussey recently decided in England. The plaintiff, a clergyman, sued the defendant, a builder, for misrepresentation as to the sanitary conditions of a house which he leased. That the drains were in fact in a bad state, was clearly proved. But the jury, by finding a verdict for the defendant, shewed that they at least did not believe that any misrepresentation had been made, and the condition of the drains, which had been used by the plaintiff for over a year was clearly due to the usage they had received at the hands of his servants. The plumber opened the offending drain, wrote down a list of the wonderful things he found there, at the request of the judge, and this was handed to the jury. Putting the point as mildly as possible, it appears that this list contained several solid articles which could not fairly be expected to be carried off by any closet exit pipe. This is by no means an exceptional case, though such cases of course find their way into court comparatively rarely. If people would exercise more care in the use of their drains, a large proportion of the complaints of ineffective drainage would vanish. As it is, it is well that the blame should rest upon the right shoulders and that the tenant should realize that he, as well as the landlord has a duty in the matter, and that he deserves to suffer for his own neglect.

THE long disputed question as to whether fish sleep, has been solved by Prof. E. Hosang of Berlin, from actual observation,in the affirmative. On page 53,we give an engraving from a drawing made by him in the Berlin Aquarium, which shows the fish enjoying that slumber which so many naturalists have hitherto denied to them.

Editor of *Scientific Canadian.*

Sir.—After all the patience and ingenuity applied by men of the highest education and talent to the tides there is still in the subject an uncertainty which should not be concerning the simple law of flowing liquids.

This uncertainty, more apparent in the Gulf of Georgia than, perhaps, elsewhere, brings the following thoughts about the received theory of tne tides.

If the Newtonian theory is correct, modern discovery proves that tidal waves must travel four hundred feet per second; yet they do not deluge the land they rush against. By it we are required to believe the power which raises great oceans to be unable to raise small ponds; as if the Sun and Moon did their work with giant hands, too clumsy to grasp small articles, instead of attraction similar to gravitation. We are also taught to believe the tides to be confined to the vicinity of land, there being none in mid ocean. How the discoverer of the latter missed the real truth is strange; his faith in Sir Isaac must have blinded him. If we substitute for that theory one of a rise and fall of the earth's crust, so small per mile of the earth's quadrand as to be imperceptible except on the brink of the non-attractive sea, we do not require to slur over inconsistencies, and account for many phenomena now imperfectly explained. No impossible speed is required in waves, the absence of tides in enclosed and shallow waters is easily accounted for; as also the great tides on iron producing shores, the increase of wind with rising tides, refluxes of water amongst islands, and some earthquakes and elevation of shores. Many discrepancies in observations on the heavenly bodies and measurements of the earth's surface, now attributed to refraction, bad observing and imperfection of instruments will be found to be the result of change in the earth's contour.

Competent men can easily test the truth of the theory by observations in such places as the Bay of Fundy or Bristol Channel.

This is not mere theorizing but the conclusion of many years study, and observation.

Yours most respectfully,

TOMKINS BREW.

VICTORIA, BRITISH COLUMBIA.

Engineering, Civil & Mechanical.

THE STEPHENSON CENTENARY.

The centenary of Stephenson's birth has been celebrated with fitting honours in every place which could claim the least connection with the great engineer; but all eyes naturally turned to Newcastle to see how the Tynesiders would keep the 100th birthday of the most distinguished of all Northumbrians. To say that Newcastle was *en fête* would convey but a sorry idea of the enthusiasm which pervaded every class, for it is not too much to state that Tyneside witnessed such scenes on the 9th of June as it never witnessed before, and never will again. Merely to enumerate the meetings held, the exhibitions, the banquets, and the decorations would more than fill our space; suffice it to say that one and all vied with each other in doing honour to Stephenson. The little village of Wylam never before had so many men of mark in its streets, and the "cottage" had never such an assembly beneath its roof. The special train conveying the visitors stopped at North Wylam, where the vicar of Ovingham exhibited the registers recording the marriage of Robert Stephenson and Mabel Carr, and the baptism of George Stephenson, their second son. Having planted an oak behind the house, and witnessed the procession of sixteen modern locomotives sent by different railway companies, the mayor's party returned to Newcastle, and the formal proceedings were completed. The life of George Stephenson has been told so often that to readers of these columns it must be as familiar as household words; but the story bears repetition, and is full of encouragement for others to do what Stephenson did—persevere. According to Dr. Smiles, the births of none of the six children of Robert Stephenson are registered in the parish books, but there is a Family Bible, in which a "rechester" of the "Stephensons" has been kept, and that leaves little doubt that George was born on June 9, 1781. Robert was fireman of the old pumping-engine at Wylam Colliery, and had so much of a struggle to feed and clothe his children that nothing was left to pay for schooling; but old Robert in his way was a man of mark in the village, for he told good stories and had an intimate knowledge of the habits of many birds and animals, while his wife Mabel was, by common consent, a "rale canny body,"—high praise from Northumbrians. From his parents, then, we may fairly assume that Geordie inherited a retentive memory and the power of observation; for the rest he was indebted to his own exertions. The surroundings of his early life were not such as to favour any material advance in social position, and as a matter of fact it was not until half his life had been spent that George Stephenson rose above the rank and file, save that he was always a noted man wherever he lived. The house in which he was born was portioned off into four apartments for labourers, and in one of these the family of the Stephensons made their "home." The first "duty" George did was to see that his younger brothers and sisters kept out of the way of the waggons which were dragged by horses along the wooden tramway in front of the cottage door, so that his earliest recollections were in connection with what may be termed "railways." Eight years passed in the dull round of the life of a colliery village, and the family removing to Dewley, George obtained his first appointment as a sort of cowherd at two-pence a day. Steam-engines and pumping-machines in those days were rather crude appliances; but George and his playmate, Thirlwall, found their chief amusement in making clay models of the pumping and winding machinery. Blessed with a good constitution, the lad as he grew found his chief pastime in feats of physical strength, and when he had reached man's estate was possessed of a well developed frame, which had much to do with his after success. Stephenson's ambition grew with his growth; for although when appointed fireman and raised to 12s. a week, he declared he was a made man for life, he never sat down as if his career was settled. From fireman to engineman was but a step, and here he met with his first difficulty; for, continuing his early practice of modelling engines in clay, he was desirous of getting a drawing of some of those made by Boulton and Watt, which were then known by repute even in the colliery villages. But he could not read, and there was no engine of the make in the country, so, at the age of 19, George Stephenson went to school. Once past the rudiments, his progress was rapid, his fellow-students wondering at the facility with which he mastered "figuring"; the secret was perseverance, for George tackled the sums in his spare time, and purposely took the "night shift" that he might have as much as possible. To earn extra money he made and mended shoes, and became an expert clock-cleaner, simply from his determination to succeed. For several years Stephenson plodded steadily on until he reached the turning-point in his career, the doctoring of the Newcomen engine at Killingworth High Pit, which spread his fame far and wide amongst collieries, and led to his being appointed to a position in which he found scope for his talents. A short time before that event Stephenson had been drawn for the militia, and it was probably a "lucky draw" for this country and the world. To find a substitute George not only parted with all his little savings, but borrowed money of a friend, and was thus prevented from emigrating to Australia with his sister and her husband. When he was about thirty-four years of age Stephenson was appointed engine-wright at Killingworth, a position of much trust and responsibility, with corresponding advantages from a pecuniary point of view. Mindful of his short-comings in the matter of education he sent his son Robert to a good school, and derived benefit himself by going over the lessons with the boy on his return home. Robert also spent his spare time in the Literary and Philosophical Institute of Newcastle, and he recounted what he had read to his father. The latter had by this time become intimately acquainted with such steam-engines as were to be found in mines, and had a fair book knowledge of other kinds; when, therefore, Mr. Blackett, encouraged by the success of Mr. Blenkinsop, renewed his experiments, with locomotives, Stephenson studied the question with ever increasing interest, and had abundant opportunities of witnessing the failures of others. Trevithick some ten years previously had invented a locomotive, and Blenkinsop and Blackett, the latter with the assistance of Foster and Hedley, had made engines which served to show that the thing was to be done when the man and the hour arrived. The earlier attempts were practical failures, and the colliery owners gave up experimenting; but meanwhile Stephenson had been thinking, and in 1813 he broached the subject to the lessees of the Killingworth colliery. He had by this time made his mark as a clever engineer and an ingenious man, and Lord Ravensworth, who had a high opinion of him, gave the desired permission to make a locomotive. This engine, like its predecessors, was not altogether a success; it did the work, but it cost as much as horses. However, it did something more, for it gave the engineer experience, and in 1815 Stephenson took out a patent for a locomotive which combined the essential features of success. That date marks the real birth of the locomotive; it became a practical machine, and might be trusted to grow with the experience of its makers. Differences of opinion still continue as to who invented this or that detail of the locomotive, but the great fact remains that Stephenson made it a paying machine, and just as Watt is regarded as the father of the steam-engine so is Stephenson the parent of the railway system. He had seen the failures of Blackett, and had talked with Foster and Hedley, and when they had practically given up the task, his belief in himself and his determined perseverance led Stephenson on until he grasped success. Another quality of the man was his unflinching courage. Years before the locomotive troubled his active brain he had made experiments on coal gas, and had frightened the pitmen by the apparently reckless way in which he held lighted candles near the "blowers." To all remonstrances his answer was that he "hoped to make something useful in preserving mens' lives." The famous experiment with the lamp, the outcome of much thought, was made in the same year as the patent for the locomotive was completed, and before the year had closed, the lamp, too, was a practical success. Helmholtz, in his recent lecture on Faraday, spoke of his wonderful intuitive perception, which enabled him to understand the causes of the effects he witnessed, although he had none of the training which is supposed to assist in the work of research. The same gift was a notable characteristic of Stephenson. Quite ignorant of laws and principles, and possibly unable to give a clear reason for doing anything one way instead of another, it is certain that his practical experience enabled him to comprehend the why and the wherefore and to foretell the results of the experiments. Although Trevithick had, some years before shown that the friction between the wheel and the road was sufficient without cogs and rack, Blenkinsop adopted the latter; but Stephenson thinking for himself, made an experiment which satisfied him how far the rail was an advantage, and to what extent smooth wheels could be used. The rack was the weak part of Blenkinsop's engine, as the geared wheels were of Hedley's, and though ,in his first locomotive, he adopted spur wheels and an endless chain. Stephenson discarded them in his next. The manner in which he laid out the colliery tramways under his charge shows that he had fully grasped the secret of success, for, where inclines were absolutely necessary, he put down stationary engines to haul the waggons, and used his locomotives only on the practically level parts. His ingenuity was extraordinary, and enabled him to surmount the difficulties which the undeveloped state of the mechanical arts placed in his way. The road-bed of the early railways was unequal to the heavy weights of locomotives; and the spring-makers had not then succeeded in making the compound springs which now so easily carry the heavier loads of our modern engines. Stephenson was equal to the occasion, and made the boiler itself act as springs by connecting it with pistons and cylinders to the frames or axles. Although colliery railways had been developed to a considerable extent, it was not until Mr. Pease started the idea of the Stockton and Darlington railroad that Stephenson found another opportunity; but his earnestness, and the proof of what he had done at Killingworth and Hetton, won him the favour of the far-seeing Quaker, and by his influence the locomotive was adopted. As a reward for his safety-lamp, a subscription of £1,000 had been given to Stephenson, which he, seeing the need of getting a number of the best mechanics together for the making of engines, put down as half the capital in a workshop which has since become famous, and he persuaded Mr. Pease to advance the other half. Whether he foresaw what was coming may be doubted; but the wisdom of the step is apparent, for the workshop at Newcastle certainly helped George Stephenson to win the day at Liverpool. The success of the "Rocket" established the reputation of the engineer, and opened the path for the great social revolution of which Stephenson was the pioneer. It may well be doubted whether all his inventions put together required so much perseverance as did the famous battle over the Liverpool and Manchester railway. The ridicule heaped upon the scheme and upon the manner in which it was proposed to carry it out was enough to make the most courageous man turn back; but Stephenson had thought it out, and Chat Moss was a difficulty he had determined to conquer. At this time it is amusing to read the speeches of the legal gentlemen engaged in the great case; they are curiosities of forensic eloquence, and of the license of the Bar. As Stephenson pursued his course, gradually overcoming the difficulties he met, the unreasoning scepticism gave way, and those who had been most madly opposed to the introduction of the iron-horse developed a mania in the contrary direction. Through all, the great engineer passed determinedly, though his feeling must often have been aroused by the abuse of those who dogmatised on subjects they had never studied. When the turn of the tide came, just as he had felt confident of the success of the locomotive, so Stephenson was not led astray by the delusion which seized his countrymen, and his sterling honesty prevented him from lending his name to schemes which other engineers less scrupulous puffed for professional purposes. We, nowadays, cannot realize the difficulties which the early pioneers of railways had to encounter, but we can appreciate the courage of the man who, when satisfied in his own mind as to the possibilities of the locomotive, found that he had almost to force his great revolution upon an unwilling world. At the age of 40, Stephenson, when he presented himself to Mr. Pease, was practically an uneducated man; but he had had experience in laying down railways, and had learnt the art of surveying; he had, as we have shown, an intuitive skill and the faculty of observation, which compensated to a large extent for the absence of school training; and he had invincible courage and a determination to succeed where success seemed at all possible. It might be urged that if such a man could do so much, education could help him to do little more; but Stephenson's opinion on that point is left without any doubt, in the care that he took, and the self-denial he practised, in order that his son Robert might have the best training he could afford to give him. The best memorial of the great engineer, then, apart from the gigantic memorial we see around us, is the Stephenson College in what may be termed his native town, and we are happy to think that the establishment of such an institution will not be the least important outcome of the Stephenson Centenary.

A patent has been taken out on behalf of Herr B. Roeber, of Dresden, for transmitting heat to the contents of steam-boilers. The method consists mainly in the creation of currents of heat in vessels or pipes situated partly within the material to be heated and filled with fluids of special qualities in a fluid or gaseous condition, or in a condition of chemical dissociation and reunion. By means of these pipes the heat of the fire is transmitted to the interior of the boiler or other vessel without direct contact of the fire with the walls of the vessel. The number of the specification is 4516, 1880, and there are 87 figures and 35 claims.

UNION ARCH, CABIN JOHN CREEK.—(See page 230.)

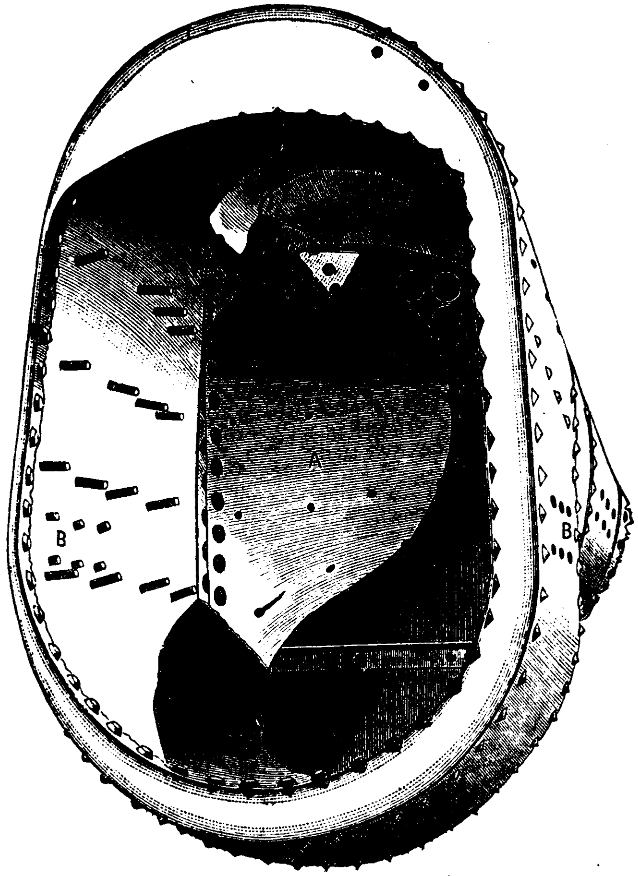


FIG. 1.—Front view, copied from a photograph, showing the collapsed fire-box. A, the left-hand side buckled back upon the tube plate, exposing the interior surface of the outer shell, the screw stay-bolts, and the ends, B, of the leg-bolts.

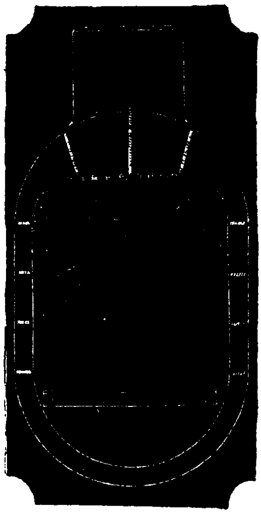


FIG. 3.—Cross section of the body and the patch, showing the screw stay-bolts; the upper one of the left-hand row being the same as D, Fig. 2.

FIG. 4.—Plan of the bottom of the safety valve, the bright portion being indicated by the white arc. "*It did not leak.*"(*f*)

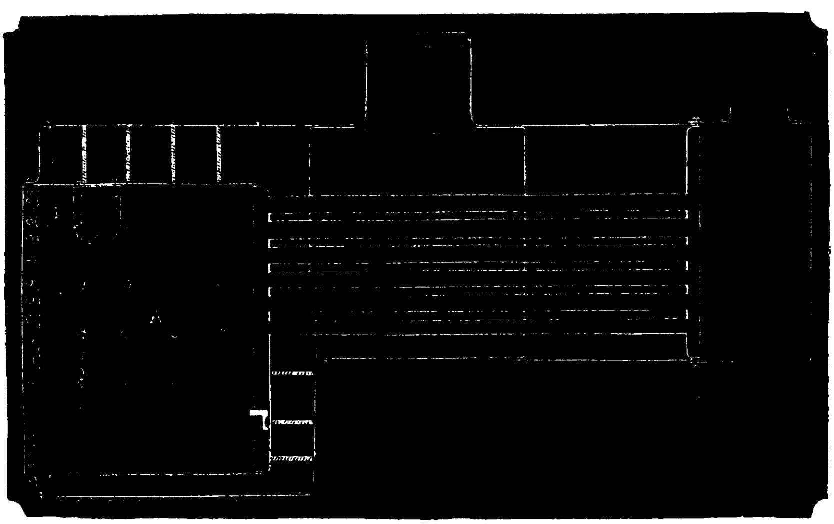


FIG. 2.—Longitudinal section of the boiler, showing lines of fracture of the left-hand wall of the fire-box, the corresponding end of the thin patch, and D, the probable point of initial rupture, indicated by the thin, pouted edges of the hole through which the head of the bolt was drawn, not shown in the cuts.

EXPLOSION OF A PORTABLE BOILER.—(SEE NEXT PAGE.)

UNION ARCH, WASHINGTON AQUEDUCT.

In its latest edition the American Cyclopædia states, under the head of masonry bridges, that there are comparatively few of any great size in the United States, and instances as perhaps the finest example the High Bridge of the Croton Aqueduct, over the Harlem River, with its eight arches of 80 feet span, and five others of 50 feet span. Probably the majority of well-informed Americans would accept the statement as correct, and few, even among engineers, would hear without some surprise, that by far the largest masonry arch in the world is in this country, and that it forms a part of one of the most important engineering achievements that have been accomplished during recent years—namely, the aqueduct by which the City of Washington is supplied with water.

Unfortunately for its own fame, the work was completed during the most exciting period of the civil war, when the security of the national capital against the assaults of the Confederate army was a matter of infinitely greater popular interest than any improvement of its water supply. Possibly, too, the inadvisability of calling the attention of the enemy to a work of such importance to the beleagued city may have had something to do with the singular absence of information with regard to it in the popular prints of the time and in later publications. At any rate one will have to search a long time to find more than a casual mention of the work, where one would expect to find the fullest description of it. The splendid masonry arch shown in the accompanying engraving carries the aqueduct over the Cabin John Creek, with a span of 220 feet. The height of the arch is 101 feet, and the width of the structure 20 feet. The arch forms an arc of a circle, having a radius of 134.2852 feet. When the center scaffolding was removed, the arch (unlike all other works of the kind) did not settle, the keystone having been set in winter, and the centre struck in summer.

Two other remarkable structures are included in or form a part of the Washington Aqueduct. From the distributing reservoir the water is conveyed in two thirty-inch pipes. There were two streams to be crossed, College Branch and Rock Creek. Instead of building bridges and laying the pipes on them, the pipes themselves were in each instance cast in the form of an arch and constitute the bridge. The Rock Creek Bridge has a span of 200 feet, with two forty-eight-inch pipes; the College Branch bridge has a span of 120 feet, with two thirty-inch pipes. The arch over Rock Creek is so strong that it is used for a roadway, continuing Pennsylvania avenue to Georgetown.

The other notable masonry arches of the world are the Chester arch across the river Dee, at Chester, England, with a span of 200 feet; the famous centre arch of the new London Bridge over the Thames, with a span of 152 feet; Ponty-Prydd, over the Taff, in Wales, 14 feet; the bridge across the Seine, at Neuilly, France, with five spans each of 128 feet; the nine spans of Waterloo Bridge, London, each 120 feet; and the celebrated marble Rialto bridge in Venice, with a span of 98½ feet.

Washington Aqueduct was begun in 1853, and finished in 1863. The engineer in charge of the work was Gen. Montgomery C. Meigs.—*Scientific American*

EXPLOSION OF A PORTABLE BOILER.

The case of explosion illustrated and described in the following article, abstracted from the monthly bulletin of the Hartford Steam Boiler Inspection and Insurance Co., was that of a semi-portable fire-boiler, of the locomotive type, and a variety having an oval cross section of body. It is a style much used for small powers, and usually has, as this one originally had, an engine attached, and brackets or legs for supporting it either on timbers or on ordinary flooring. The letters B B, Fig. 1, on the body, and the six unoccupied holes on the barrel, indicate the location of a set of four legs upon which this one was mounted by means of tap bolts. It was, when complete, known as a 6-horse engine, and had perhaps done duty as a well-borer in western Pennsylvania, although its history prior to its present ownership was not obtained. For some time it had been used without its engine, to supply steam for refining or re-distilling mineral oils for special purposes, the pressure required being about 50 pounds to the square inch.

The principal dimensions and general construction are as follows: Length over all, about 8½ feet, including the smoke arch, which was bolted to the barrel and supported the chimney. The body was 46 inches high by 29 inches wide and 36 inches long, the sides, top and bottom of which were formed of a single plate joined at the bottom. The enclosed fire-box was similarly constructed, varying from the regular form of the shell by having a flattened arch at the top for fire crown. The dimensions of the fire-box, 25 inches wide, allowed a 2-inch water-space on the sides and bottom, while the height was such as to give a steam-space about 8 inches high above the crown of the furnace. A front plate flanged inward at its periphery and riveted to the main body plate, and flanged outward on the borders of the opening which corresponded in size and form to the cross section of the fire-box, and riveted to its principal plate, formed the front wall of the steam and water chamber of the boiler. The tube plate, which was also the rear wall of the fire-box and ash-pit, was a plane plate flanged towards the front, and riveted in the usual manner to the principal fire-plate. There were in this boiler 42 two-inch tubes about 4½ feet long, which were beaded at each end. The body of the boiler shell was completed by a rear plate below the barrel, flanged outward, to fit the interior of the barrel, and inward to fit the interior of the body-plate in accordance with the usual American practice in locomotive boiler construction. The fire-box was completed by bolting a cast-iron plate upon the outward flanged opening in the front plate which served as a door-frame, and to carry the front ends of the grate bars, their rear ends resting on an angle bar which was riveted to the tube plate.

Screw stays, arranged in regular rows on the sides, top and rear below the barrel, at intervals of 6 to 7 inches, passed through the outer and inner plates of the body of the shell and the fire-box, and were headed at both ends to prevent the collapse of the fire-box. No stays were placed in the lower semicircles that formed the "water bottom."

Upon the barrel near the middle of the length of the boiler was fixed a steam dome 11 inches high and 14 inches diameter, made of flanged wrought-iron plates. The description of this boiler is rather more minute than need be, but its simplicity of construction is something notable for this type, although the variety is in common use in some parts of the country. There are but eight principal parts besides the dome and smoke arch, which make a total of eleven plates of wrought iron, namely, two tube plates, two end plates, (body), two body plates, two barrel plates, two dome plates, and one in the smoke arch. Other forms of boilers, such as the cylinder tubular and the plain or simple cylinder, are much simpler, having no contained fire-box, and mostly in New England practice, no steam dome.

The principal fire plate A, Fig. 1, was something less that ¼ of an inch thick, while some parts of the shell were 5-16 of an inch. At the corner of the patch—the point from which the lines of rupture radiate, Fig. 2—a stay bolt passed through the plate and the patch, and both were here much reduced in thickness.

The safety valve bottom presented an appearance indicated in Fig. 4, the light arc representing about the proportion of the seating that had metallic contact. It was found that the steam-gauge pipe had been plugged with solid matter deposited by the boiler water, in which it was very rich.

When the explosion occurred, the proprietor or superintendent was directing a man who was examining or repairing the small still or superheater, located about 20 feet from the boiler, through which the steam was made to pass. It will be observed that the explosion was cause by the collapse of the furnace; the portion of the left-hand side marked A, folded back upon the tube plate, turning on its vertical seam and buckling so that its upper and lower torn edges are turned towards the front as shown in Fig. 1, which is a cut from a photograph. The boiler, impelled by the reaction of the issuing contents, flew away, slightly ascending and veering some 40 degrees to the right of its extended axial line. It is possible to form a pretty clear idea of its course because it struck and carried away several objects that were in its path through the air before reaching the ground near where it finally rested, about 285 feet away.

The men who were nearest the boiler when it exploded, were blown as by an overpowering gust of wind to a considerable distance and stunned, but not killed; they were out of the track of both water and boiler. It is hardly profitable to speculate on the probable pressure at which the stay bolt in the corner D, of the patch, Fig. 2, gave way, or rather pulled through the patch, for it is deemed enough to know that it was quite sufficient to break this obviously weakest spot in the boiler, and that once broken, an extraordinary and over-powering load fell instantly upon its neighbors, and they gave way in detail.

It is likewise *almost* certain that there was sufficient force stored in this boiler to do the work which we see it has done, and which nothing else exterior to it did accomplish. Each unit of the water, however small it may be conceived to be, when heated to a high temperature, which was possibly only under a corresponding pressure (barring the Donny theory, etc.,) had within its own quota of the gross amount of force which was kept confined till the prison was broken, then each minute particle expanded with a suddenness analogous to an explosion, and the whole mass was set in motion towards the broken door of its prison, which now weakened as to its surroundings, grew larger as the crowd pressed against its borders. The opening may not have reached its present size until the boiler was well on its way.—*Manufacturer and Builder.*

AN INTERESTING BOILER EXPERIMENT.

Numerous instances are on record of strong boilers, well made in all respects and handled with good care, having suddenly exploded with terrific violence, just at the instant when the valve was opened to admit steam to the cylinder; or at the moment when cold water was injected into the boiler. The usually received theory of this class of explosions is that by opening the valve or throwing in cold water, the pressure of steam on the surface of the water is suddenly reduced, whereupon the water, charged as it is with the tremendous energy of its heat, leaps from its place, divides, and strikes with the solidity and force of cannon balls against the interior walls of the boiler, tearing everything to pieces with its resistless momentum. Water may in fact be easily heated to such a degree that a pound of the liquid will equal a pound of gunpowder in energy. At sixty pounds pressure to the square inch every cubic foot of boiler water has the energy of a pound of gunpowder. Given the proper conditions for discharging that energy against the boiler, and it will be rent as if it were exploded with a corresponding weight of cannon powder.

In the *Scientific American* of July 3, 1880, we presented an engraving and description of an improved form of boiler, invented by Mr. Daniel T. Lawson, of Wellsville, Ohio, which was designed by him to promote safety in the use of steam by preventing all danger from explosions or injurious strains arising from the causes we have mentioned. In the article describing his invention Mr. Lawson's theory was fully set forth; it differs somewhat from that we have stated as ordinarily held. Mr. L. claims "that when water is superheated it becomes as explosive as gunpowder, exploding by bursting into steam from a reduction of pressure." This explosive formation of steam produces a concussion on every inch in the boiler, much greater, Mr. L. thinks, than the regular steam pressure. "There is abundant reason to believe," he says, "that it is this concussive action which causes the numerous and mysterious boiler explosions, and which cause is wholly independent of the amount of water in the boiler; in fact the greater the amount of water in the boiler the more terrific the explosion."

We are not disposed at this time to question the correctness of Mr. Lawson's theory; but will only suggest that the other mentioned theory better explains the actual result, since steam has a yielding or gaseous action, whereas projected water acts like a solid.

Mr. Lawson has lately tried, at Pittsburg, P., a very interesting and important practical experiment, for the purpose of verifying his theory and demonstrating the advantage of his invention. His first step was to prove that boilers were liable to and did explode in the manner he asserted; and this he has apparently proved by actually getting up an explosion, which took place at the time, and hour he named and in the way he said it would, namely, by simply opening the boiler valve and letting off some steam.

This experiment has been heretofore tried by various engineers, some of them very learned, but Mr. Lawson is the only one, so far as we know, who has succeeded. He has certainly taught us a good lesson in the boiler explosion art, which we think will result in great benefit. A letter in the *Tribune* gives the following particulars:

"The experiments were made in June, at Munhall Farm, on the Monongahela river, nine miles above Pittsburg, Pa., where the United States Government Commissioners made signal failures in their attempt to produce the same result a few years ago. The same foundations, furnaces, water supply, and bomb proofs were used on this occasion. The boiler was made of the very best iron, and showed a tensile strength of 624 pounds to the square inch, according to the United States standard. It was six feet in length by thirty inches in diameter. Before being taken to the ground it was tested by the boiler inspector of this country and pronounced one of the best and most perfect steam boilers he had ever examined.

"The cylinder of an old steamboat engine was connected with the boiler by means of a two-inch pipe, in which was fitted a quick-lifting valve. The steam was permitted by means of this valve to enter the cylinder in the same manner as it enter he cylinder of any ordinary engine, with the exception that its was not cut off suddenly, as in a working engine. Had it been, Mr. Lawson claims the explosion would have been still more certain. When the pressure reached a certain point the furnace was fed with petroleum by means of a small pipe connected with a tank located at a safe distance.

The majority of those who saw the boiler were of the opinion that it would safely stand 500 pounds pressure, and would not give way to less than 600. In order to save time no test was made until a pressure of 325 pounds to the square inch had been obtained. The valve was then lifted quickly, and the steam rushed into the cylinder rapidly, but with no other effect than to produce a shock distinctly noticeable by those in the bomb-proof.

The final test was made at a pressure of 380 pounds, a little over half the capacity of the boiler. At this time the water was eight inches above the fire line, the boiler being at least three-fourths full. No sooner was the cylinder filled by the rushing steam than a slight shock was felt, followed by a terrific report. Vast volumes of steam enveloped everything, but there were no signs of any hot water, it all having burst into the steam when the pressure was removed.

The report had scarcely died away before a shower of condensed steam began falling, accompanied by pieces of iron, bricks, steam pipes and other *débris*. Scarcely a vestige of the furnace or boiler was left. The latter had not merely given way at a single point, but was literally torn into fragments. One of the largest pieces yet found was about a foot and a half long and a foot wide. It had been blown fully half a mile. One of the heads was found nearly half a mile from the bomb-proof. The other one had not been found at last accounts. The most of the pieces picked up were of irregular shape, with very ragged edges, showing the iron to have been of excellent quality.

Mr. Lawson has invented a boiler which he believes to be proof against explosions of this kind. It is constructed with a partition intervening between the flues and the top of the boiler, thus creating a steam compartment over the water, to be supplied with steam from the water through valves in the partition, which valves, to ensure safety, must be smaller in the aggregate than the port or valve through which the cylinder is fed from the steam compartment. By this means the pressure is kept approximately uniform upon the surface of the superheated water, thus preventing the dangerous effect which must follow the sudden reduction of pressure from its surface. Mr. Lawson's next step will be to show that his improved boiler cannot be exploded.

THE BIGELOW BOILER.

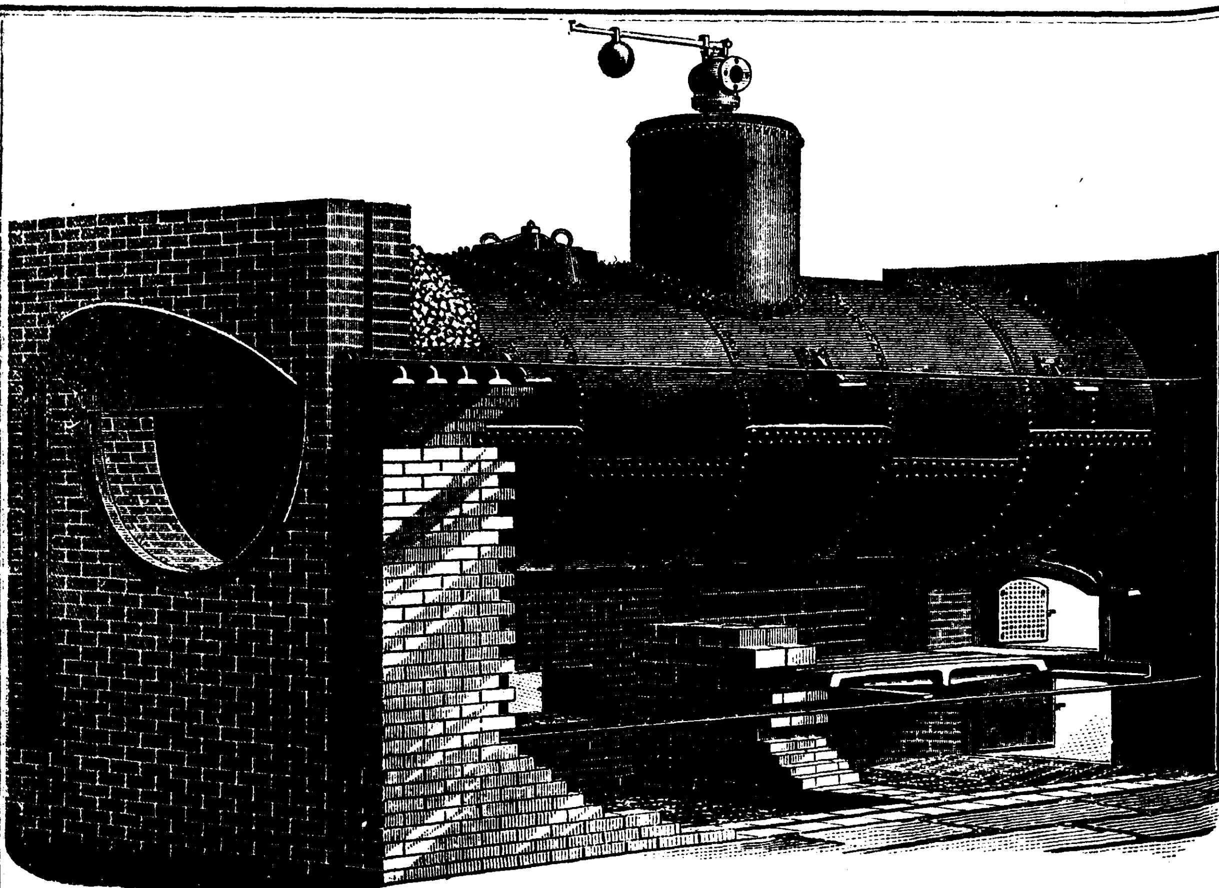
The accompanying illustration repiesents a return tubular boiler, manufactured by H. B. Bigelow & Co., of New Haven, Conn.; and while not distinguished by any special novel features of construction, is an excellent representative of this very serviceable and popular type of boilers. A glance at the excellent engraving annexed, which shows the boiler in place, with a portion of the masonry removed to permit of better inspection, will give our mechanical readers a fair idea of this generator and will render an elaborate description unnecessary.

In general terms, we may explain that in these generators the heated furnace gases pass beneath the boiler, the same as in a plain cylinder boiler, returning through the tubes into a smoke chamber, and thence to the stack. This type of boiler has long been held in the highest esteem, because of its excellent steaming capacity.

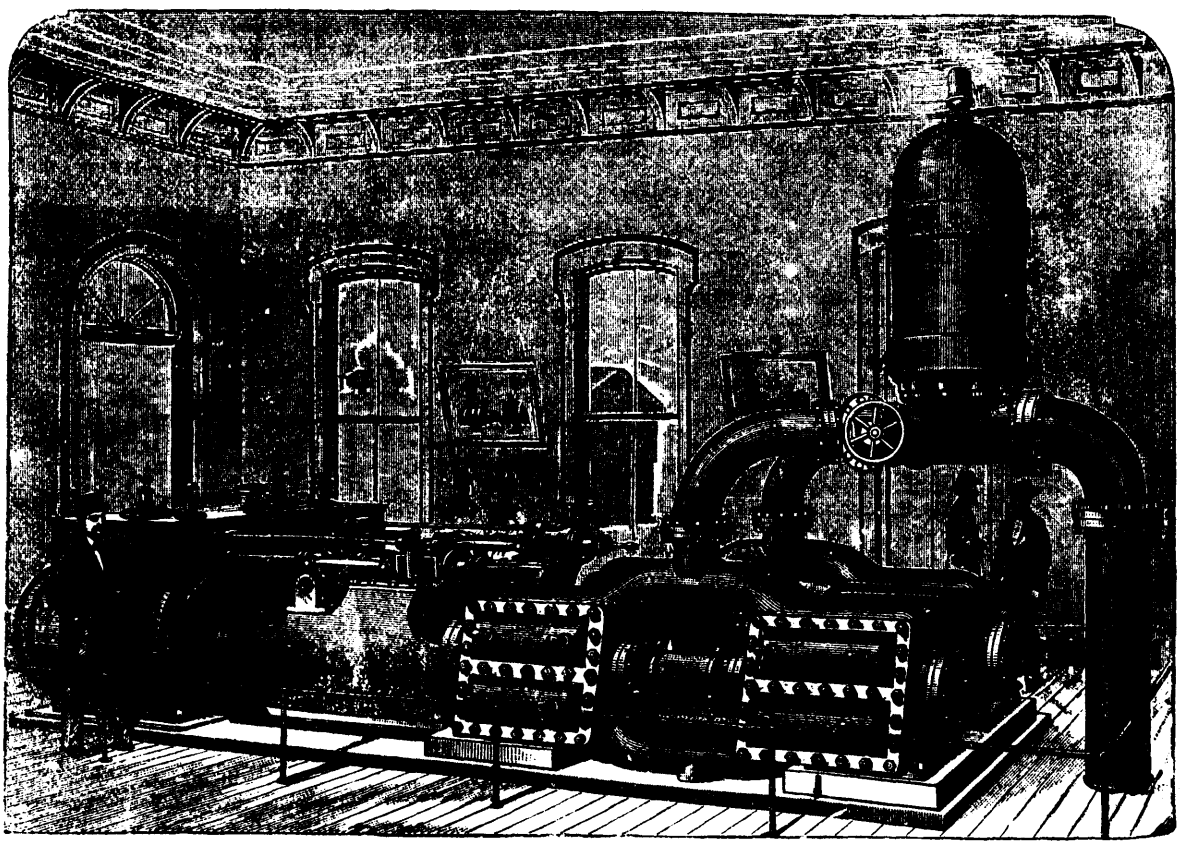
With sizes over 40 horse-power the manufacturers call attention to the fact that they place a man-hole in the front head under the tubes, which has the advantage of enabling a man to pass along the whole length of the boiler and remove any sediment that accumulates on the bottom, as well as giving him the opportunity of examining the tubes and other points inside.

With this boiler the makers furnish the front properly fitted, grate bars, binder bars, back and side doors, anchor bolts, safety valve, try cocks, blow-off cocks steam and glass water gauges. The boilers are made of the best material, and submitted before leaving the factory to a hydrostatic pressure of 150 pounds to the square inch. They are supplied to order of any desired power from 20 horse power.

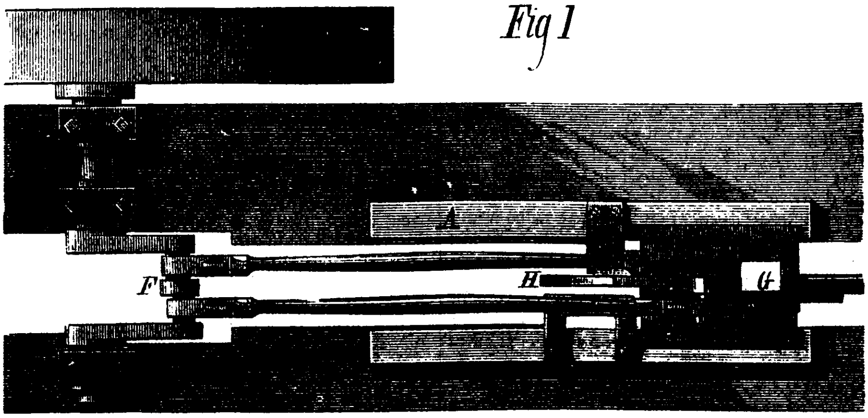
Further details will be furnished on application to the manufacturers, Messrs. H. B. Bigelow & Co., River street, New Haven, Conn.—*Manufacturer and Builder.*

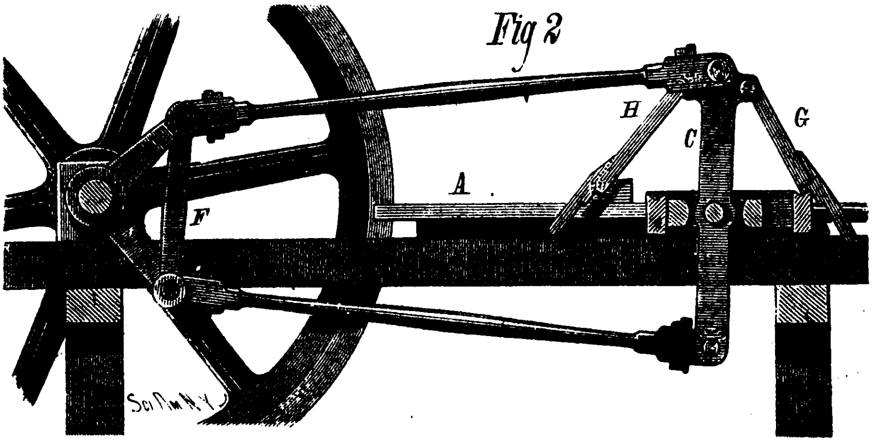


THE BIGELOW RETURN-TUBE BOILER.

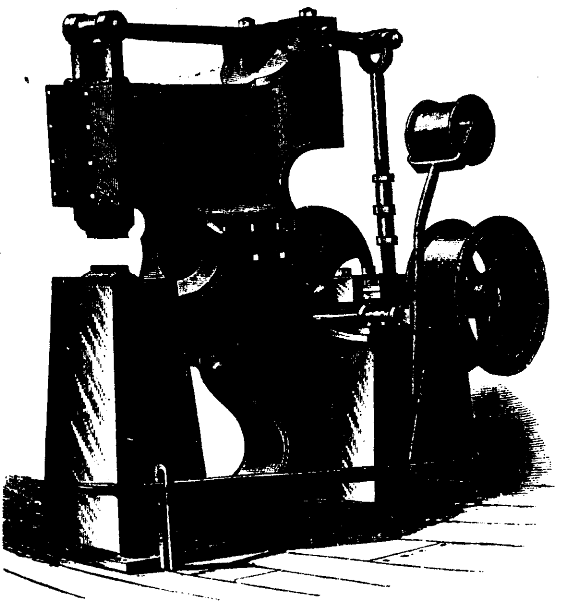


NEW COMPOUND PUMPING ENGINE.





HARRIS' MECHANICAL MOVEMENT.



SQUARE STROKE POWER HAMMER.

The illustration on this page is a very good representation of this hammer, although the most valuable features are concealed from view by the housing. There have also been some changes and improvements since the engraving was made. This hammer possesses several points of superiority and is a great favorite with hammer-men wherever used. It strikes a true, square blow at all times. There are no steel springs to break or get out of order. It runs with remarkably light power and at a very high speed when required. The helve is solid steel forging. The elasticity and cushioning are obtained by means of four rubber cushions mounted above and below the fulcrum bearing of the helve, so that the helve is in fact mounted on elastic bearings. The effect of this arrangement on the blow is surprising in its elasticity; the stroke of the ram being almost double what it would be if the helve were fixed on rigid bearings. The whole machine is well proportioned, the anvil being heavy enough to receive the force of the blow so that expensive foundations are avoided. The force of the blow is under complete control of the operator who regulates with his foot by means of the treadle.

Full particulars in regard to the working capacity, etc., will be cheerfully given on application to J. H. Kerrick & Co., Indianapolis, Ind., Minneapolis, Minn.

An enterprising Frenchman has proposed to lease a portion of the Mammoth Cave, Kentucky, for the purpose of cultivating mushrooms. There are many miles of underground passages in the cave, which are never visited, because there are no attractions, and the equable temperature admirably adapts them for the cultivation of fungi.

NEW COMPOUND PUMPING ENGINE.

The attention of town and city authorities is especially desired to the consideration of the peculiarities and merits of the compound pumping engine described below, which embodies in its construction and operation certain new features which are affirmed to be highly advantageous. The requirements of towns and cities of moderate size, which have been studied with much care by the makers of pumping engines, have originated many of the recent improvements in this class of machinery, inasmuch as they demanded the production of an engine which should combine with high duty a very moderate first cost, and economy in operation and maintenance. The last named conditions are imperative, and must be estimated by the relation which they sustain to the desired capacity of the works. These requirements have called out the best efforts of our engine builders, and the fruits of their labors will compare very favorably with the best achievements in other branches of the mechanic arts.

The improvements that have been made in this department of mechanical engineering have long ago displaced the old type of direct-acting pumping engines, in which the steam was used at constant pressure the full length of the stroke, and then exhausted at that pressure into the atmosphere without doing any further duty ; and in place of these have come the compound engines using steam expansively, experience having demonstrated that engines of this type are vastly superior in duty to the old and no more expensive in operation and maintenance.

The compound pumping engine illustrated and described herewith is one of the best representatives of its class and embodies certain specially advantageous features in its construction.

The most desirable plan for moving water is by the direct action of a steam piston upon the plunger of the pump ; and the labors of the makers of pumping machinery have been expended in the task of effecting a combination of the pump with an engine that would yield the highest duty—in other words, with an engine that would work the steam in the most economical manner. In the compound engine herewith illustrated we have a machine eminently adapted to meet this requirement. In this we have the steam doing a portion of its work in one cylinder, operating one plunger of the pump, then exhausting into a large receiver beneath the floor, and expanding into a second cylinder, whose piston operates another pump plunger. To render the equalization of force between the two cylinders as nearly perfect as possible, a notable advantage is derived from placing the receiver between the cylinders, which, by the addition which it makes to the volume of steam effected by influx and efflux, materially assists in maintaining uniformity of pressure. The two steam pistons moving coincidently, the degree of expansion is governed by the relations of the areas of the two steam pistons and their stroke. The relation of these areas is determined by the steam pressure, the grade of expansion determined on, and by the measure of work to be done.

The engraving shown illustrates an engine of the type above described. They are in use at the water works of Milwaukee, Wis. ; Cincinnati and East Liverpool, O ; and Trinidad, Colo., and have been constructed up to the capacity of eight million gallons for twenty-four hours.

As above described, these machines consists substantially of two direct-acting pumping engines. They deliver into one main, but there is no further connection between them. save by the steam and water pipes. They have entirely independent motions, and their pipes and valves are so designed and constructed that either one or the other may be operated independently. The low-pressure is made at least equal in power to the high-pressure engine. An isochronal device is attached to the low-pressure engine, which insures a perfect regulation of the speed. The motion of the two engines being entirely independent of each other, the grade of expansion is varied by an increase or decrease in the speed of the low-pressure piston, which practically effects a change in the comparative volumes of the cylinders. The engine being self-adjusting, the low-pressure piston adapts its motion to the work required of it, thus maintaining the needful pressure in the receiver from which it draws its steam supply. In practice the engines are carefully proportioned for the work required of them, so that no excessive variations in the number of strokes of the engine shall occur.

From the foregoing description it will be perceived that we have in this machine a self adjusting, variable expansion, direct-acting pumping engine, which possesses special advantages on the score of simplicity of arrangement and extended adaptability.

These engines are manufactured by the Cope & Maxwell Manufacturing Co., of Hamilton, Ohio.

Mechanics.

NEW MECHANICAL MOVEMENT.

The engraving shows a new mechanical movement for changing a reciprocating motion into a continuous rotary motion at every point in the revolution of the crank.

Fig. 1 is a plan view, and Fig. 2 is a side elevation, partly in section, showing the relation of the various parts. The device is represented as connecting the crosshead and crank shaft of a reciprocating steam engine, but it is capable of application to any kind of machinery in which reciprocating is converted into rotary motion. The ways, A, support the crosshead, which is attached to the piston rod of the engine and reciprocated in the usual way. The crosshead carries a lever C, having at its ends connecting rods connected with the cranks D E, the latter being connected together by the tie rod F, so that they stand at right angles to each other. Pawls G H, jointed to opposite sides of the upper end of the lever C, are fitted to engage notches in the ends of the auxiliary crosshead B, and are arrranged so that during the stroke one of them may be engaged by an arm attached to one of the ways A, and the other will be engaged by an arm projecting from the other way.

With this device arranged in this way the engine will turn only in one direction, but by attaching a set of pawls G H, to the lower end of the lever, C, the engine may be made to turn in either direction, depending of course upon which set of pawls is allowed to operate.

The auxiliary crosshead is of such length relative to the length of the main crosshead that has an independent long stroke—that is, a longitudinal movement at the ends of the stroke which is independent of the movement of the main crosshead, and the ends of the auxiliary crosshead are provided with the grooves with which the notched end of the pawls G H, alternately engage while the crosshead is traveling the space of its independent movement. By this means the force during the independent movement of the auxiliary crosshead is transferred through the pawls, G H, to a point above the plane of reciprocation, and applied to the cranks of the shaft through the oscillating lever C, and the connecting rods at a point above the line of dead center. It will be understood that during this time the main crosshead remains at rest, and that the motion of the oscillating bar is only upon its pivot.

When the main crosshead and oscillating bar begins to move, the pawls G H, are thrown out of engagement with the notches by coming in contact with the arms or projections, which are secured in proper position for that purpose upon the ways A, as shown in the plan view.

After sufficient motion has been obtained to carry past the dead-center, the auxiliary crosshead is brought to its short stroke by placing blocks between the crossheads or by the employment of a device actuated by a lever which locks the two crossheads together, when they act as a single crosshead.

SOME INTERESTING PARTS OF MACHINES.

BY G. W.

None of all our countless and wonderful practical scientific attainments will be found to involve so great an amount of ingenuity and practical application of theoretical principles as the designing of the working parts of machinery. Our great engineering works, such as the railway and the canal, vast as they are in their actual size, when compared with the contents of the average machine-shop, sink far out of sight below them, as regards ready application of inventive power, or minuteness in the mathematical calculation of details. Every part of a well working machine must be designed in its size and form, not only with a view to the force it has to bear and transmit to other parts, but also with a view to the rate of motion required ; and, what is almost more important still, to the effective working of the whole, with a view to the uniformity of that motion, and the reduction to a minimum of the friction between the parts in contact, by so adapting them to one another that they shall work together with all the nicety and accuracy possible.

Still giving the first place to practical knowledge, it will naturally follow from the above that more really useful theoretical knowledge is to be obtained from books and magazines in this branch of engineering than in any other ; and bearing the same in mind, it is intended in this series of articles, which at present are designed to extend not beyond three or four numbers of this magazine, to gather together some interesting examples in the designing of machines that have been in actual use in various workshops, giving one or more illustrations of each.

Taking the general, if not universal, type of all our factories; it must first be understood that we may divide their works into a series of machines. The required power to move them is obtained from the pressure of steam in a closed boiler, or from the flow of water acting on the paddles of a wheel. This wheel, or in the case of steam power the engine, constitues the first machine; and in many cases the next step is to apply it to turn a heavy fly-wheel, whose use is to render the motion as uniform as possible through its own momentum. The motion so obtained is then carried on, by means of belting and lengths of shafting, through all the different floors of the building; and then applied to the last series of machines, those that do the actual useful work.

To proceed now more into details, it may be noticed that there is placed on the main shafting over each machine, or more accurately speaking, directly useful machine, a rather plain and small wheel; which is connected by means of a belt or strap with another, very similar to it, but forming a part of the machine itself. Thus all the intricate motions of the various parts of the latter are merely a resolution or transference of the first simple uniform circular motion, through the aid of a large number of devices.

The first inconvenience that might appear to a novice to be caused by this arrangement, is that while all would be very well as long as every machine in the factory was at work at the same time; supposing it happened as must often be the case, that several were not required to be in use, would it not then be very undesirable to have such continue in motion, wearing themselves out on nothing; not to mention the loss of power, the increased space required, or the danger of the workmen? This difficulty, however, it is almost needless to mention, has long been got rid of by a very simple device, so common that it must surely be familar to every one that takes any interest in machinery; as it leads to a further part of the subject though, we will take it for our first example.

The upper wheel on the main shaft is made of increased width (sometimes continuous between the points of support) so as to allow of the strap moving sideways along it for a short distance. Below are placed two wheels, side by side, almost touching similar in form to the upper one, but of a width only a very little greater than that of the strap itself. The inner of these wheels is keyed firmly to its axle, which turns with it and drives the whole machine; the outer one turns round loose on its axle, and does not transmit its motion to anything. It will thus be seen that any machine provided with this device may be stopped or set in motion without affecting the others, by simply shifting the driving strap from one to the other.

We now come to what appears to be a second objection; the means of avoiding which are I think not so generally known. What is then to prevent the strap from slipping sideways on the smooth surface of the wheels, moving from one to the other, or falling off altogether; and might not such an occurrence do injury to a workman standing by, or cause great inconvenience through the accidental stopping or starting of the machinery at improper times? appear to be very natural questions. A round band running in a groove on the surface of the wheels is sometimes used to avoid these objections, but it cannot be shifted sideways without difficulty, and were a very strong and thick band required, too deep a groove would have to be made. The method that answers best, and is at the same time found just as safe as any other, is readily explained in the following way.

Any portion of a driving strap coming in contact with a wheel is held tight in whatever position it may happen to be in when the contact commences, and retained in that position during the whole time it is being carried round, and until it leaves the wheel on the opposite side. Thus if the strap happens to be deflected a little to the right on the advancing side, it will be so carried round the wheel, and work its way along it in that direction as long as the deflection lasts. This fact is taken advantage of when the strap is to be shifted; but its more important use is just what we are seeking.

Suppose the wheel become conical in shape, as shewn in the figure. The part of the strap at A would accommodate itself to the slanting surface under it; and the stiffness of the material itself would in consequence throw the lower portion into the curved form shewn, the part at B on the advancing side being nearer to the larger end or base of the cone than that at A. Now the rotation of every point being parallel to the base, the path of B would be along the dotted line; and the strap would continue working its way along the cone till it either became too tightly stitched, and was torn in too, or fell off the larger end. Suppose again though, that a second cone of the same size were placed on the same axle, sloping in the other direction, with the two bases touching each other; what must then follow is that the strap would take up a fixed position immediately over the junction of the two cones. This is what is actually done in practice, the slop of the cones being very slight, and the obviously objectionable ridge given to the wheel is shewn in the figure considerably exaggerated to make it more clear.

To take a further example in the application of this principle it may be observed from the above, that while it is necessary to keep the advancing side of a driving belt in the same plane as the wheel, it is of little consequence whether the retreating side be deflected off to the right or left, or not. The device shewn in the following figure will in consequence be found perfectly practicable so long as the motion is in one direction only, that shewn by the arrows, and a considerable distance be left between the wheels.

The wheels are placed on axles not parallel to one another, so that the motion is, as it were, carried round a corner. They need not be at right angles; but must in any case be so arranged that the part E of the upper one is in the same plane as the lower one and also that the part C of the lower, which has a slight projection to the front owing to the size of the wheel itself, is in the same plane as the upper wheel. It is quite evident that if the motion was reversed the strap would be at once cast off, in spite of any slightly rounded form the faces of the wheels might have received.

Before leaving this portion of our subject, a few words on the strength required in the belt or strap which is to work a wheel, seem needful.

It can be proved mathematically, an investigation into which it is not necessary for us to enter, that the pull in lbs. on the strap, that is on each return of it, when it is moving at the unit rate of speed of one foot per minute, is equal to the number of foot-pounds of force transferred by it in the same time. And further, that the pull decreases directly as the velocity increases. Thus, if we have to convey by a strap, from one wheel to another, a power of 162,000 foot-pounds per minute, and the strap is required to move at the rate of one foot per minute, it would have to be made capable of withstanding a pull of 162,000 lbs. But supposing we increase this impractically slow velocity to one of 600 feet per minute, or 10 feet per second, then the strap will have to withstand a pull of only $\frac{162000}{600}$, or 270 lbs.

Therefore, calling P the pull, V the velocity, and W the work done, we may state the formula:

$$P \times V = W$$

Care being taken in working with it to employ the same set of units throughout.

Thus to take another example, suppose a force of five horse power is to be carried over a strap moving at the rate of 6000 feet per minute:

5 H. P. = 5 x 33,000 = 165,000 foot pounds per minute, therefore $P = \frac{165000}{6000}$ 27½ lbs.

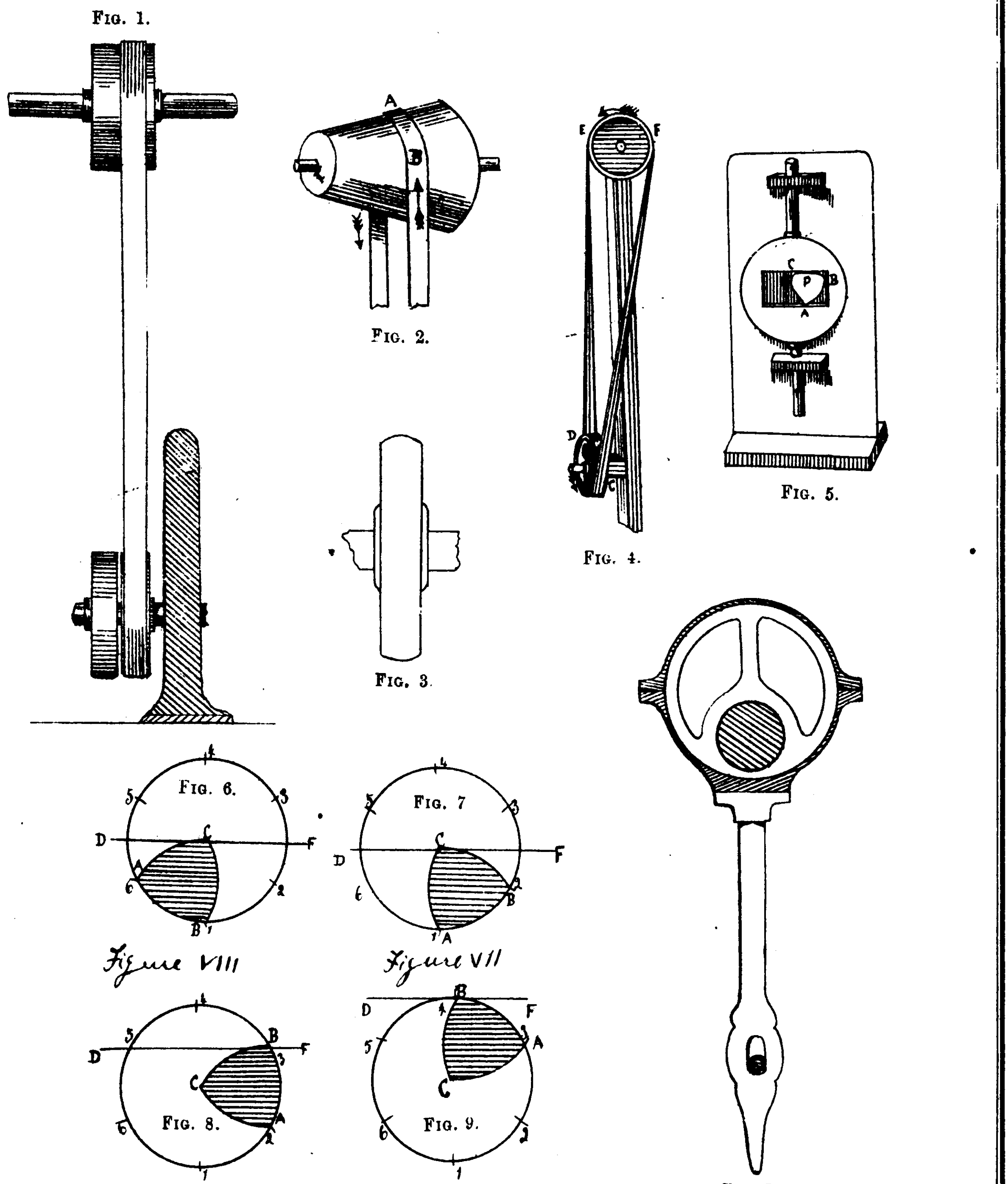
It is interesting to note, that following this principle, through the aid of high velocities the old heavy leather bands have in some workshops been replaced by slender wire ropes; and that in one instance, the power to work a crane, capable of lifting a weight of 25 tons, has been carried over a cotton rope but ⅝ of an inch in diameter, and weighing only 1½ oz. to the foot.

CAMS.

About the simplest form of cam in use is the eccentric circle. An analysis of the motion produced by it, which is not uniform, would not be uninteresting; but as this form is so frequently met with in connection with the slide valves of steam engines, it will be well to omit examining it further, and proceed at once to the more complicated kinds of cams.

The one we shall first consider is merely a modified form of the eccentric circle, giving an intermittent motion, and used sometimes in connection with the slide valves of steam engines in which the expansion system has been adopted.

Bereft of all connecting gear, which, though of course a necessity, we may leave out of sight in considering the motion produced by the machine itself, it takes the form shewn in the accompanying figure. The tie-angular piece P, turning about C as a centre, and working within the rectangular opening, is the altered form of the eccentric circle. P is described by drawing a circular arc about each side of an equilateral triangle, with the opposite angle as centre. Thus C B is part of a circle having A as its centre, and A B and A C the same with C and B as centres.



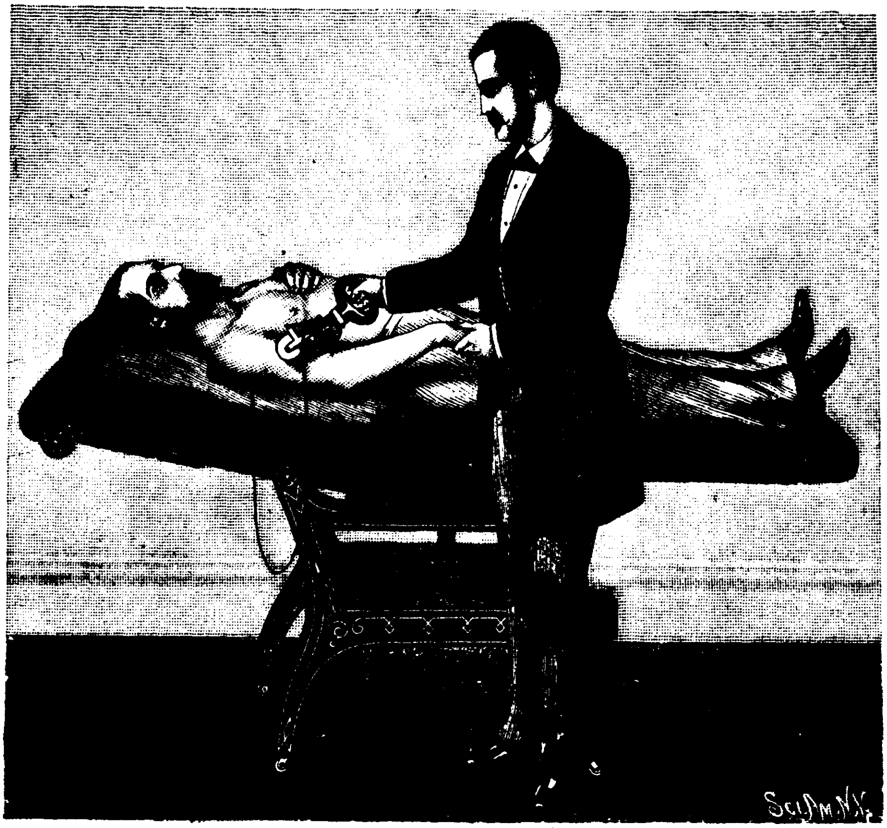
SOME INTERESTING PARTS OF MACHINES.

To consider the motion produced, let us take, instead of the sketch of the machine itself, the four following figures; where the shaded portion represents the cam in four different positions it will pass through during a half revolution. The path of the side A B, opposite to the centre C, is also shewn by a circle divided into six equal parts, in the points 1 2 3 4 5 6, so that, by the principles of geometery, A B must be equal in length to any one of these parts.

Suppose then, that the revolution commences with the cam in the position shewn in the first figure, when B is at 1, and proceeds in the direction of the numbers. During the first sixth of a turn, till B reaches 2, as in the second figure, there will be no motion imparted to the horizontal line D F, which represents the rectangular opening of the complete machine. While B is moving on from 2 to 3, as in the third figure, the arc C B, will drive D F upwards, the motion being the same as that of a simple eccentric circle turning about a point in its circumference, and whose connecting rod is parallel to the direction of the reciprocal movement. After passing 3 the point B itself will become the driver until 4 is reached, as in the fourth figure; and the motion will be the same as from 2 to 3, except that it is decreasing in velocity, while that was increasing. Finally, as B moves from 4 to 5 the motion will again cease; and afterwards be repeated exactly as it was from 2 to 4, excepting that it will be in the reverse direction, till the revolution is completed.

The same motion might be obtained from an eccentric with a loop at the end of the rod, as is also shewn in a figure; but a great objection would be, that a blow would be struck on the pin at the end of each intermission.

Cams are almost endless in their variety; but we will leave the consideration of several more examples of them for our next paper.



PRACTICAL APPLICATION OF ELECTRO-MASSAGE.

ELECTRO-MASSAGE.

A large portion of electrical treatment that hitherto could only be carried out by specialists by using elaborate apparatus, by the proper use of a new mode of treatment, by employing the apparatus shown in the engraving, can be intrusted to the hands of those who are not so skilled.

By means of this simple machine the manipulator transfers the mechanical motion used in rubbing the patient into an electrical current, and the current as it is generated is transmitted through the part while being rubbed, and it fulfils the requirements of a treatment including rubbing, kneading, pounding, flexing, etc., combined with the application of the electric current.

The instrument consists of a metallic roller covered with chamois leather or other suitable material, an electro-magnet, and a permanent magnet set in a strong frame, which hold the instrument together. The roller, besides acting as the driving wheel of the machine, is so arranged that it it also acts as one of the electrodes by which the current is transmitted and is connected by gearing with the electro-magnet so as to cause the poles of the latter to revolve opposite those of the permanent magnet which forms the handle of the instrument. Each revolution of the roller produces twenty-five revolutions of the electro-magnet, which is magnetised and demagnetised at each revolution, and thus induces a current of electricity which is ample for all purposes for which it is intended. The circuit is completed by connecting any required electrode by the binding post at the side of the instrument, the roller acting as the other electrode; both are brought into contact with the surface of the body of the patient, and as the roller is moved about over the surface, the current is established and transmitted through the part over which the roller is made to revolve.

This machine includes in itself an electric generator, a rubber, kneader, a manipulator, and a set of electrodes, all in one. Any person of ordinary intelligence can be taught to use it under the direction of the attending physician. It is portable, being quite capable of being carried in an overcoat pocket.

The inventor finds in practice that it has far exceeded his expections, inasmuch as by its use he gets greater tonic effects than from the employment of both faradism and massage separately. It fulfils most of the requirements of the induction current in general practice and every-day cases. As the current is generated by motion, no acids or liquids of any kind are necessary. The instrument is at all times ready for use, a matter that will be appreciated by all who use electricity.

This treatment has been used with great success in cases of nervous exhaustion, debility, neuralgia, rheumatism, paralysis, etc., and we are informed that it is recommended by the medical profession generally.

This invention has recently been patented by Dr. John Butler, of New York city. Communications in regard to the instrument may be addressed to the New York Dynamo-electric Manufacturing Company, 907 Broadway, New York city.

Scientific.

THE FAURE BATTERY—STORED-UP ELECTRICITY.

(FOR ILLUSTRATION SEE PAGE 241.)

The current number of *Le Journal Universal d'Electricité* contains, says *Engineering*, a very ably written article by M. Frank Géraldy upon the Faure secondary battery, to which we recently referred. From this article we find the space to make the following extracts: "The posters bearing the words "Power and Light" in enormous letters, are still visible on the walls; the noisy articles that have appeared in certain journals are not yet forgotten; however, the bills are beginning to disappear, the effect of the articles to decrease, excitement is on the wane, and the scientific press can at last be heard. It has, indeed, been difficult to discuss this matter sooner, for it was essentially necessary to have data and information as exact as possible, and these have not been obtained without trouble."

The author then refers briefly to the secondary battery of M. Reynier, and proceeds to describe the Planté battery, which he states to be almost identical with that of M. Faure M. Planté having, except in one point, long ago anticipated what M. Faure has recently brought forward, and which has been received with so much popular excitement. He then continues: "We will now proceed to the Faure secondary battery. It is protected by two patents dated October 20, 1880, and February 9, 1881, respectively. In these patents M. Faure describes principally those batteries composed of lead plates laid on frames covered with red lead, and protected by leather, attached by means of lead rivets, an arrangement similar to the rectangular batteries of M. Planté. The actual batteries are not so made, being constructed as follows: Two sheets of lead are taken 7·87 inches wide; one of these plates is 23·62 in. long, and 0 04 in. thick; the other is 15·75 inches long and 0·02 inch thick. Each plate is covered on both faces with a layer of red lead reduced to a paste by water, 1·76 lb. being spread over the larger plate, and 1·54 lb. over the smaller. On each face thus prepared a sheet of parchment paper is placed, and the whole is introduced into a sheath of thin leather. One plate is then put on top of the other and rolled up, strips of rubber being interposed obliquely, as shown in the sketch. The roll is then placed in a cylindrical lead cell, the outside of which is strengthened with copper bands, and the inside covered with red lead and leather, so as to increase the useful surface of the battery. The latter then presents the appearance shown in the sketch, and one of the projecting stems from the lead plates is bent over and soldered to the inclosing cylinder, which is ready for use when it has been filled with water with about 10 per cent. of sulphuric acid. The apparatus when charged weighs about 20 lb. It will be seen that this differs from the Planté secondary battery only in the employment of red lead. The material chiefly employed is the same, the mode of construction is precisely similar, the leather takes the part of the cloth previously used by M. Planté; it has no merit in itself; on the contrary, it is a cause of resistance, and is liable to deterioration, being useful only to keep the red lead in place. It is, in fact, this red lead which constitutes the new feature, and gives the special advantage to the apparatus.

Sir WILLIAM THOMPSON has the following letter in this week's *Nature*:—I am continuing my experiments on the Faure accumulator with every-day increasing interest. I find M. Reynier's statement, that a Faure accumulator weighing 75 kilogrammes (165lb.) can store and give out again energy to the extent of an hour's work of one-horse power (2,000,000 foot-pounds) amply confirmed. I have not yet succeeded in making the complete measurements necessary to say exactly what proportion of the energy used in the charging is lost in the process of charging and discharging. If the processes are pushed on too fast, there is necessarily a great loss of energy, just as there is in driving a small steam engine so fast that energy is wasted by "wire-drawing" of the steam through the steam pipes and ports. If the processes are carried on too slowly there is inevitably some loss through local action, the spongy lead becoming oxydized, and the peroxide losing some of its oxygen viciously, that is to say, without doing the proper proportion of electric work in the circuit. I have seen enough, however, to make me feel very confident that in any mode of working the accumulator not uselessly slow, the loss from local action will be very small. I think it most probable that at rates of working which would be perfectly convenient for the ordinary use of fixed accumulators in connexion with electric lighting and electric transmission of power for driving machinery, large and small the loss of energy in charging the accumulator and taking out the charge again for use will be less than 10 per cent. of the whole that is spent in charging the accumulator: but to realize such dynamical economy as this, prime cost in lead must not be stinted. I have quite ascertained that accumulators amounting in weight to three-quarters of a ton will suffice to work for six hours from one charge, doing work during the six hours at the uniform rate of one-horse-power, and with very high economy. I think it probable that the economy will be so high that as much as 90 per cent. of the energy spent in the charge will be given out in the circuit external to the accumulator. When, as in the proposed application to driving tramcars, economy of weight is very important, much less perfect economy of energy must be looked for. Thus, though an eighth of a ton of accumulators would work very economically for six hours at one sixth of a horse-power, it would work much less economically for one hour at one horse-power, but not so economically as to be practically fatal to the proposed use. It seems indeed very probable that a tramcar arranged to take in, say 7½ cwt. of freshly charged accumulators, on leaving head-quarters for an hour's run, may be driven more economically by the electric energy operating through a dynamo-electric machine than by horses. The question of economy between accumulators caaried in the tramcar as in M. Faure's proposal, and electricity transmitted by an insulated conductor, as in the electric railway at present being tried at Berlin by the Messrs. Siemens, is one that can only be practically settled by experience. In circumstances in which the insulated conductor can be laid, Messrs. Siemens' plan will undoubtedly be the most economical, as it will save the carriage of the weight of the accumulators. But there are many cases in which the insulated conductor is impracticable, and in which M. Faure's plan may prove useful. Whether it be the electric railway or the lead-driven tramcar, there is one feature of peculiar scientific interest belonging to electro-dynamic propulsion of road carriages. Whatever work is done by gravity on the carriage going down hill, will be laid up in store ready to assist afterwards in drawing the carriage up the hill, provided electric accumulators be used, whether at a fixed driving station or in the carriage itself.

THE STORAGE OF ELECTRICITY.

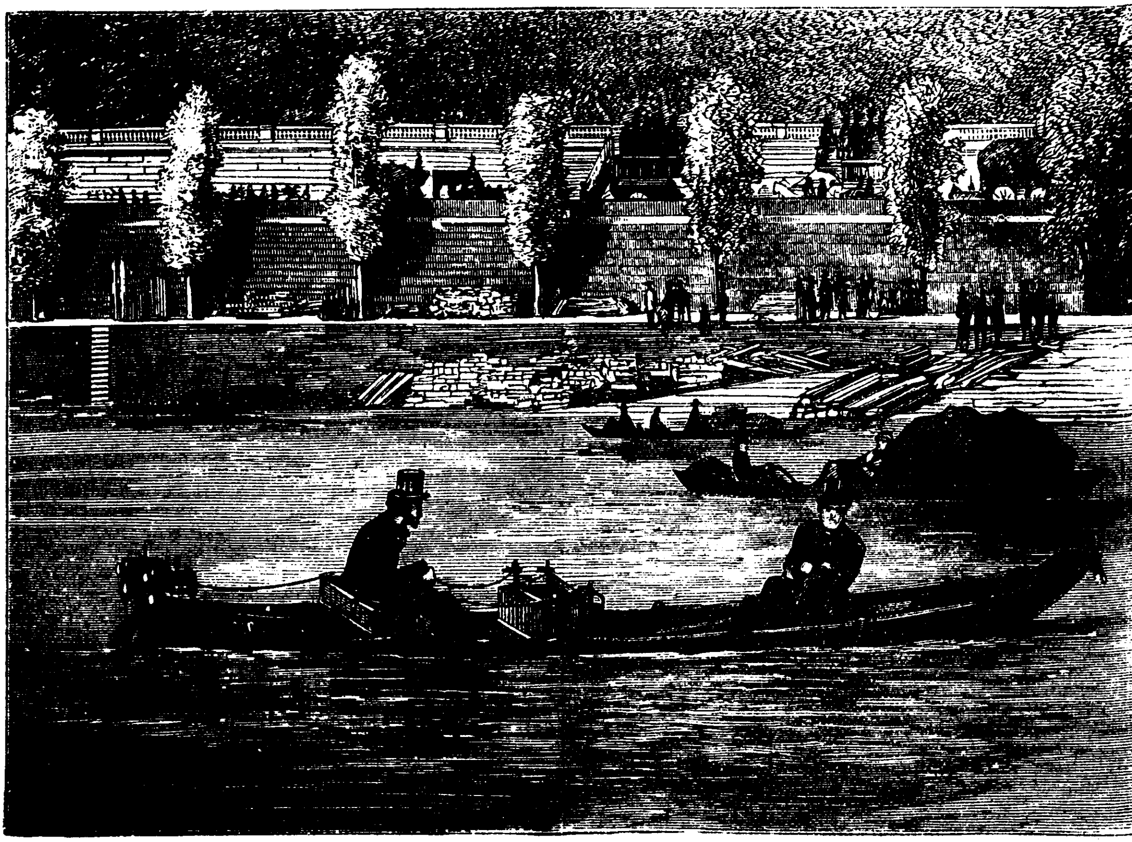
The storage of electricity is a subject which naturally attracts great attention at the present time, which may without much exaggeration be described as the era of electric inventions, and thanks to the letters of Sir W. Thompson, the public has been led to believe that a great and wonderful discovery has been made, which is to give us light, power, and heat for next to nothing. The statement that a million foot-pounds of energy had been stored in a box and conveyed from Paris to Glasgow seems to have astonished the newspapers, especially the apparent magnitude of a "million foot-pounds." Those acquainted with the rudimentary data of mechanical science know that large as a "million foot-pounds" looks upon paper, it really represents very little in the shape of power—just about as much for instance as an Otto gas-engine would give out at the cost of one halfpenny! The really important point is that MM. Reynier and Faure, experimenting on the lines laid down by M. Planté, have invented a secondary battery which enables us to store electricity in a fairly economical manner; what the practical value of that discovery amounts to remains to be seen. The discovery of the secondary battery, the effects of which are technically known as "polarisation of the electrodes," seems like other great inventions, to have been made gradually. Soon after Volta's pile made its appearance at the very beginning of the century, M. Gautherot, a French savant, observed that wires of certain metals after being used as electrodes for the decomposition of water, acquired the power of yielding a current for a short time after being detached from the pile; but Ritter, of Jena, was the first to devise what is termed a secondary battery. He made many experiments with many metals, including lead; but, as is often the case, he failed altogether with the very metal which is now known to yield the best results. Volta and Marianani, and after them Becquerel, gave the true explanation of the phenomenon by showing that the action arose from the accumulation or deposit of oxygen and hydrogen on the electrodes, the surface of which thus became changed chemically, and were consequently capable of acting towards one another as two metallic plates in an ordinary form of battery. In 1843, Mr. Justice Grove invented what is known as his gas-battery, in which two platinum plates are placed in bell-jars containing respectively, oxygen and hydrogen, the whole being partially immersed in a vessel containing dilute sulphuric acid. The platinum plates partly immersed in dilute acid, and partly in the respective gases will yield a current if connected by a wire, and will continue to do so, so long as the gases exist in such proportions as to form water by combining. Further, if the terminals of the gas battery are connected to an ordinary galvanic cell capable of decomposing the dilute sulphuric acid, or practically of liberating hydrogen and oxygen, the reservoirs of the gas battery become replenished. It is not unlikely that, before long, a useful secondary battery, working on the principle of the Grove gas-battery will be invented; but the latter is practically of little use as a reservoir of electricity and just at present more encouraging results in the direction of storing electricity have been obtained with modifications of the devices which Ritter was the first to employ. About 20 years ago, M. Gaston Planté took up the study of the subject where Ritter had left it, and after experimenting with a number of metals, he found that electrodes of lead immersed in dilute sulphuric acid gave the best results. He, in fact, invented the first real accumulator of electricity—a cell which, charged by a weak source, would yield a powerful current for a short time. The Planté cell consists of two sheets of lead, cut so as to leave a long tongue projecting at right angles at the end of each; these are separated by two sheets of canvas, and are rolled up loosely, so as to fit into a battery-jar containing dilute sulphuric acid. The canvas is merely to keep the two sheets of lead from touching; bands of rubber and other materials have also been used, felt, for instance, being employed in the Faure battery. The lead plates being connected with an ordinary battery, oxygen and hydrogen are liberated, the former attacking the surface of its plate and forming peroxide of lead, while the hydrogen is probably to a large extent occluded by the other plate, the surface of which assumes a peculiar spongy texture. When the plates are brought to this state the secondary battery is in its best condition to receive a charge, and in the shape of chemical work done will store up a considerable amount of energy which it will give up again in the form of electric current, less a certain percentage. The current furnished by the secondary battery is, as a rule, far more intense than that employed to charge the accumulator; for instance, a battery of half a dozen Planté cells, about 6in. high, can be charged by a couple of Bunsens, and when, so to speak, saturated, will yield a current capable of melting a knitting-needle, or of producing a brilliant electric arc for a time counted by seconds rather than by minutes. A reference to the indices of our back volumes will show that other forms of secondary battery have been devised, but practically, M. Planté is the most successful, with the exception (perhaps) of its most recent modification by MM. Reynier and Faure. Instead of charging and recharging, including reversing the action, in order to get the lead plates into the proper condition, for receiving the charge, M. Camille Faure coated the plates at once with a film of minium or red-lead, the ordinary composition of which is represented by the formula, 2 PbO,PbO_2, whereas the peroxide formed by the charging and recharging of the Planté battery is PbO_2. The plates separated by strips of felt or rubber are rolled up just as are those employed in the Planté batteries, and according to the accounts published in Paris, the results are surprising. There seems to be no doubt that the use of the red-lead or minium is a decided advantage,—to what extent is not at present known, and that therefore the Faure modification of the Planté accumulator is more likely to be useful than its predecessor. It must be clearly remembered that the Faure battery creates nothing; it is a receptacle for electric energy, which it stores in the shape of chemical work, and gives out again in the shape of electric current, with more or less of loss—how much remains to be seen.

Referring now to the famous letter that appeared in the *Times*, and taking the statements there given by an enthusiast—a box containing four of the new batteries each about 5in. in diameter by 10in. high, weighing some 75lb., and holding nearly one million foot-pounds of "power," conveyed to Glasgow in 72 hours—we may well ask what is the feat that has caused so much ink and paper to be wasted? The new battery enables us to "store electricity" in such a form that we can use it just when we want it; it enables us, therefore, to use electricity where before the invention of the accumulator we could not conveniently or comfortably employ its agency; but as a source of power, from an economical point of view, the secondary battery is practically nowhere. To utilize it as power we must have a dynamo-machine, and that costs rather more than a gas-engine, while at the same time rather more than a million foot-pounds could be put into a box having a capacity of a cubic foot, in the shape of the common, well-understood, and cheap coal-gas. It is pointed out that the wonderful box contained no more energy than exists in an ounce and a half of coal; but then, unfortunately, we have never been able to utilize more than about one-tenth of the energy of the coal, whereas, from the experiments of Sir W. Thomson it seems probable that we may fairly count upon recovering some 90 per cent of the energy put into a Faure's battery, and it obviously has many applications where lumps of coal would be simply useless. But the Faure battery weighs 80 times as much as its actual mechanical equivalent in coal, or 800 times as much as the theoretical equivalent. Suppose, then, we find some means of utilizing the energy of coal in a more economical manner, so as to approach the theoretical value; where then is the wonderful battery which, according to financial speculators and newspaper scribblers, is to revolutionize the industrial world? As the matter stands, to obtain the energy practically available in one ton of coals, we must have 80 tons of lead plates and battery jars, and shall then have to determine whether it is more convenient to use an electric current, or employ the more familiar appliances of steam or gas-engines. The Faure accumulator is more useful than, say, a Daniell's battery, because it enables us to employ the current generated by the latter under more serviceable conditions—under conditions in which the Daniell's battery would be useless: in fact, it presents energy to us under another form than that in which it exists in coal. It may be urged that Faure batteries can be charged by means of currents derived from machines worked by water or wind-power; but if so, it will be necessary to store the batteries near the source of power, and the cost of their carriage to and fro will be heavy; the alternative is to keep the battery where it is to be used and conduct the current to it. With the exception of wind and water-power, the cheapest source of energy is coal; but if anyone can so decompose coal as to employ its energy directly in the form of a battery, then we may regard steam-engines and their boilers as old-fashioned and costly incumbrances. Sir W. Thomson has experimented with the "wonderful box," and has found that one weighing 165lb. will store and give out 2,000,000 foot-pounds, or one horse-power during an hour, and if the conditions of work are adapted to insure economy it will do that with a loss of only 10 per cent. of the energy imparted to it. Accumulators weighing three-quarters of a ton (15 cwt.) will work for six hours on one charge at the uniform rate of one horse-power, giving a high economy, probably fully 90 per cent. of the energy put into them; but if applied to driving tramcars, where it is necessary to reduce the weight, Sir W. Thomson thinks that accumulators weighing 7½ cwt., and working through a dynamo machine, would drive a tramcar more economically than horses, so far as power is concerned; but that is a question that cannot easily be settled, for on the one side we have the cost of horses, their keep, care, and stabling, and on the other the cost and care of dynamo-machines and Faure accumulators. We are inclined to think that at present rates horses are cheaper and simpler, and that if ever tramcars are propelled by electricity it will be by currents received direct from a dynamo-machine, not by secondary batteries which will add materially to the non-paying load. The Faure battery has a field before it which it can occupy. It may be utilised for electric lighting for short periods; it will furnish a supply of electricity where it would be impracticable to convey dynamo-machines and inconvenient to take batteries—it may even be found of use as a precautionary reservoir in electric-lighting circuits to supply current when the motor is temporarily disabled, -but as a substitute for mechanical power, we may safely say its day has not arrived. As a step towards a satisfactory method of storing electricity it will receive a full share of attention; but so far as is know at present it can really do little more, from a commercial point of view, than the Planté battery.—*English Mechanic.*

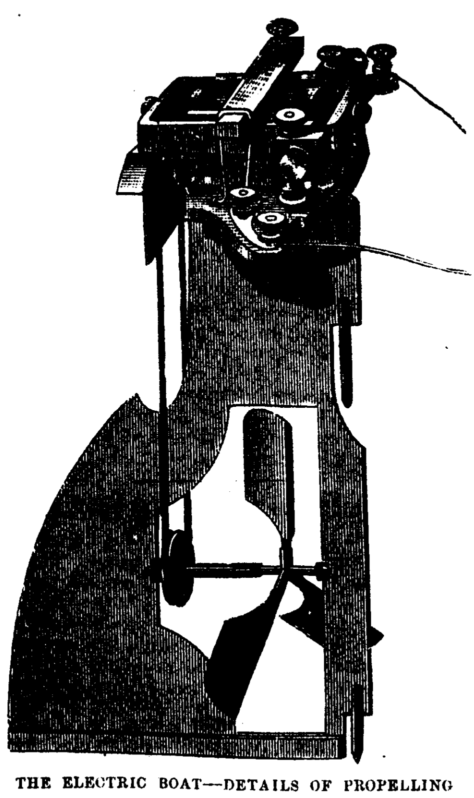
APPLICATIONS OF ELECTRIC POWER.

Mr. G. Trouvè has just constructed an electric motor specially adapted to be used in a row boat or canoe. He made his first experiment on the 26th of May, in Paris, on the Seine, in the presence of MM. Berger, Commissioner-General of the Exposition Universelle d'Électricité, Antoine Breguet, editor of the *Revue Scientifique*, and numerous other spectators, who were greatly astonished to see the boat moving against the current without oars or the smoke generally inseparable from the steam engine.

This electric motor is furnished with a Siemens armature connected by an endless chain with a screw having three paddles, and placed in the middle of an iron rudder. The motor is placed on the upper part of the rudder, so that both the motor and propeller follow the movements of the rudder.



THE ELECTRIC BOAT.



THE ELECTRIC BOAT—DETAILS OF PROPELLING MACHINERY.

This motor, with all its accessories, only weighed five kilogrammes, and was placed in the rear of a little barge about five meters fifty centimeters long, by one meter two centimeters in breadth, and weighing eighty kilogrammes.

In the middle of the boat were placed two secondary batteries weighing twenty-four kilogrammes. M. Trouvé prefers two batteries, as they are more easily managed and have the advantage that they can be used either together or separately; also that in the evening one can be used for propelling and the other for lighting the boat.

The secondary piles are connected with the motor by two cords that serve both to cover the conducting wire and to work the rudder, and are furnished with handles that can be used to regulate the electric current.

This electric motor is complete in itself, and can be placed on a small boat. It is arranged in such a way that it does not interfere with the action of the boat or the use of the oars.

Besides her experimental trip, this electric boat has at six different times easily navigated the Seine for a distance of 200 meters. It was found that the boat, containing three persons, stemmed the current at the rate of one meter a second, and descended with a speed of two meters five centimeters. The current of the Seine at this place runs about twenty centimeters a second.

These trials are very interesting from an experimental point of view, and will, we hope, be an incentive to more important works.

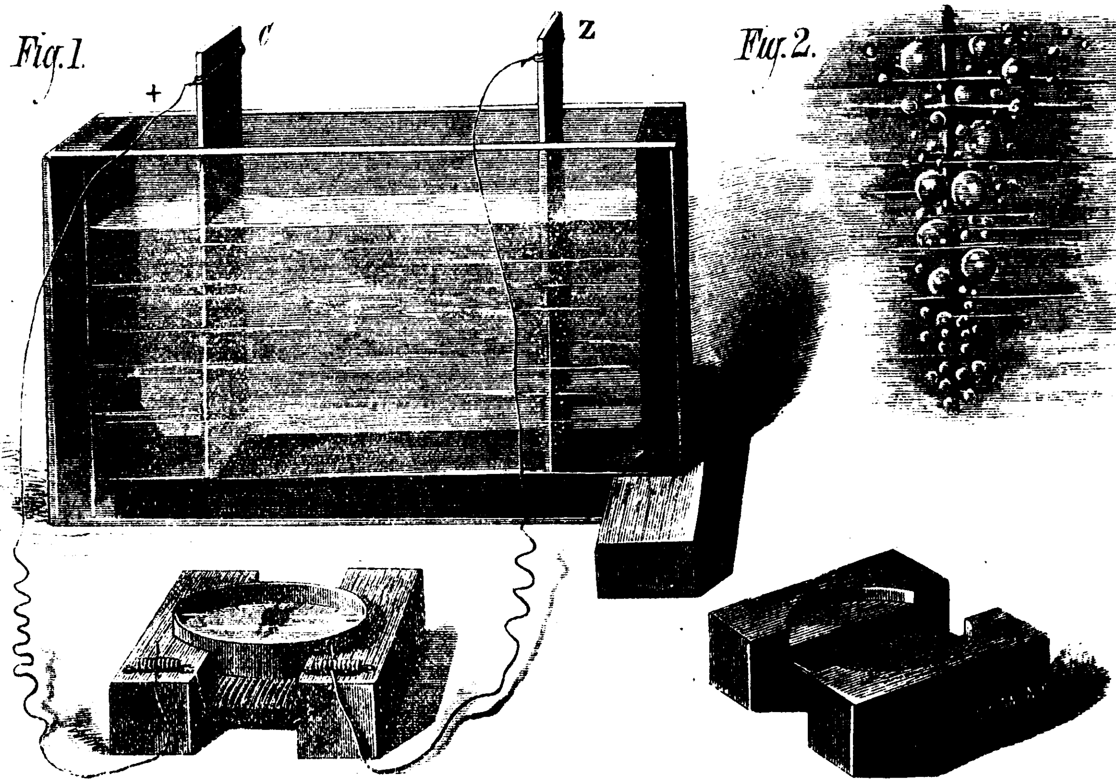
These experiments recall those made by Jacobi in 1829 to navigate the Neva by electricity. We reproduce from the *Merveilles de la Science* the account of this interesting attempt which well deserves to be called the origin of electric navigation.

The voltaic apparatus that furnished the electricity to Jacobi's motor was composed of two Grove batteries, each containing sixty-four pairs of cells, the whole covering thirty-two square feet. This furnished so powerful a current that a piece of platinum wire, 2 m. long and as thick as a piano string, was immediately heated to red heat on being exposed to the electric current.

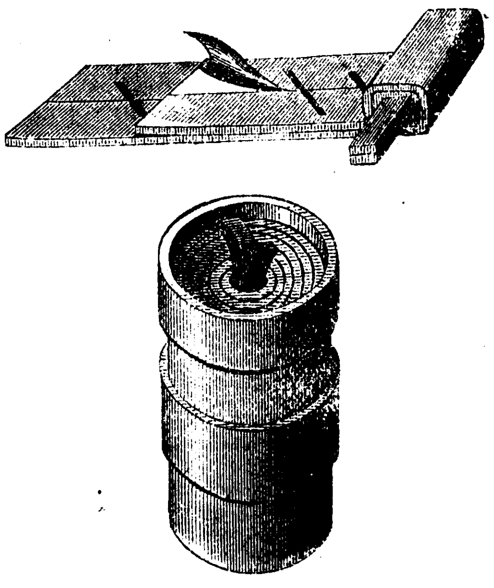
There was so much nitrous gas liberated by the pile that the operators were seriously inccmmoded, and were several times obliged to interrupt their experiment.

The spectators, who stood on the banks of the Neva, were also forced to retire on account of the suffocating odor of the liberated gas that the wind blew on to the shore.

The barge, which was made with paddle-wheels, and was large enough to hold twelve persons, succeeded, however, in sailing several hours on the river against both wind and tide. *La Nature.*



EXPERIMENTAL BATTERY AND GALVANOMETER.



THE FAURE BATTERY.—(SEE PAGE 238.)

DYNAMIC ELECTRICITY

BY GEO. M. HOPKINS.

GENERATION OF THE ELECTRIC CURRENT.

When two dissimilar metals, such as pure copper and pure zinc, are placed in contact in acidulated water, evidences of activity immediately appear in the form of a cloud of microsopic bubbles constantly rising to the surface of the water. If the metals are individually capable of resisting the action of the acid solution, it will be noticed that on separating the metals the action ceases, but it will commence again as soon as the metals are brought into contact. The same action is noticed if the two metals are connected by a wire, which may be either wholly within or partly out of the acidulated water.

The bubbles which are noticed in this experiment are hydrogen, which results from the decomposition of the water and escapes from the copper, while the oxygen resulting from the analysis unites with the zinc, forming zinc oxide.

The copper is scarcely attacked while the zinc slowly wastes away. If the wire connecting the zinc and copper be cut and the two ends placed on the tongue, a slight but peculiar biting sensation is experienced, which will not be felt when the wires are disconnected from the metals.

A piece of paper moistened with a solution of iodide of potassium and starch placed between the ends of the wires exhibits a brown spot, showing that between the ends of the wires there is a species of energy capable of effecting chemical decomposition. If a wire joining the copper and zinc is placed parallel with and near a delicately suspended magnetic needle, it will be found that it is endowed with properties capable of affecting the needle in the same manner as a magnet. This form of energy is dynamic or current electricity, generated in this case by chemical action and confined to, and following a continuous conductor, of which the two metallic elements and the acid solution form a part, the whole comprising a complete electric circuit.

For the purpose of studying the generation and behavior of dynamic electricity the elements referred to may be formed into an electric generator or battery, and the magnetic needle and conducting wire may be combined to form an electrical indicator or galvanometer.

The engraving shows convenient apparatus for making the primary experiments in dynamic electricity. The glass tank or cell is built with special reference to projecting the visible manifestations of the phenomena exhibited in the cell, upon a screen, by means of the lantern, to enable a number of persons to observe simultaneously.

The cell consists of two plates of transparent glass 4 by 6 inches, separated by a half inch square strip of soft rubber, which is cemented to both glasses by means of a cement composed of equal parts of pitch and gutta percha. The cell is nearly filled with the exciting liquid, consisting of dilute sulphuric acid (acid 1 part, water 15 parts), in which are placed two plates, the positive plate consisting of a strip of zinc about one-sixteenth of an inch thick, the negative plate being a strip of copper.

As commercial zinc is so impure as to be violently attacked by the exciting liquid, it is well to dip the zinc strip into the solution, and then apply to it a drop or so of mercury, which amalgamates the surface of the zinc and prevents local action.

When these two plates are brought into contact with each other in the exciting liquid, hydrogen gas is given off copiously at the copper or negative plate, while the action at the zinc or positive plate is almost unnoticeable. If the plates are connected together by a conductor outside of the solution, the same phenomenon is observed.

The plane flat surfaces of the cell offer facilities for the examination of the plates by means of the microscope, and if so examined it will be found that so long as there is no metallic connection between the electrodes they will remain unaltered, and no action is discoverable; but when the circuit is completed, the first visible indication of action is the sudden whitening of the copper plate as if it were frost-covered; the next indication of action is the formation over the entire surface of the plate of myriads of minute silvery bubbles, which grow until they become detached, when they rise to the surface and escape into the air. These bubbles may be discharged into the mouth of a small test tube, and when a sufficient quantity of gas has accumulated it may be ignited, showing that it is hydrogen.

The appearance of the negative plate when the cell is in action is shown in Fig. 2 greatly magnified. The gas bubbles formed on the surface of the copper are at first very minute, but they rapidly increase in size and begin to merge one into another, taking an upward course. When a large bubble has absorbed a large number of the smaller bubbles and becomes sufficiently buoyant to overcome its adhesion to the plate it rises to the surface and is dissipated.

The accumulation of hydrogen on the negative plate seriously affects the strength of the current. To ascertain to what extent and at what time this happens, a

SIMPLE GALVANOMETER

like that shown in Fig. 1 will be required. This instrument consists of a common pocket compass, a wooden frame or spool, and about 20 feet of No. 32 silk covered copper wire. The wood spool (Fig. 3) has a recess cut in the top at either end to receive the compass, which is placed a short distance from the flat body of the spool, and the wire is wound evenly around the body b ck and forth until the spool is full. Then the terminals of the wire are connected with two spiral springs fastened to the ends of the spool and forming "binding posts" for receiving the wires from the battery.

In regard to the adjustment of the compass, it should be arranged with the line marked N S parallel with the wires of the coil, and the instrument should be turned until the N S line is exactly under the needle, then a weak current should be sent through the coil and the deflection noted. The current should then be sent in the opposite direction, when the needle will be deflected in the opposite direction. If the amount of deflection is the same in both cases the galvanometer is in condition for use; but if the deflections differ in degree, the compass must be turned in its socket until the proper adjustment is secured. The only precaution necessary in the construction of this instrument is to select a compass whose needle is delicately poised and vibrates freely.

By connecting the galvanometer with the cell as indicated in the engraving it will be noticed that after a limited time the galvanometer needle begins to fall back toward 0°, a point which it ultimately reaches if the circuit is kept closed; a the shorter the circuit the sooner the cessation of the current. This

ENFEEBLEMENT OF THE CURRENT

is principally due to three causes, one of which has already been noticed, that is, the accumulation of hydrogen on the negative plate. The film of hydrogen not only prevents contact between the exciting solution and the plate, but it actually renders the surface to a certain degree positive and consequently in nature, although not in degree, like the positive plate. Another cause of enfeeblement of the current is the reduction on the copper by the hydrogen of a portion of the sulphate of zinc accumulating in the liquid. This increases the similarity of the two plates, and consequently assists in diminishing the current. The reduction of the strength of the exciting liquid of the cell and the oxidation of the zinc contribute still further toward the diminution of the current. All this results in making the two plates similar in their action, and in a consequent weakening of the current; but this chemical action cannot be avoided, as to secure any action in a galvanic cell the exciting fluid must be capable of decomposition. The oxidation of the zinc, the accumulation of the hydrogen on the positive plate, and the weakening of the exciting solution are the three great causes of inconstancy in batteries. The first may be remedied in a great measure by amalgamation; the remedy for the last is obviously the strengthening of the solution; and the second, the accumulation of hydrogen on the positive plate or the polarization of the plate, can only be remedied by removing the plate from the exciting solution for an instant, or by brushing it while in the solution, or by violently agitating the exciting solution. The galvanometer needle faithfully indicates the result of either treatment. The polarization of the electrode may be strikingly exhibited by allowing the copper plate to become polarized and then replacing the zinc with a clean copper strip like the one already polarized. The galvanometer needle will be deflected in the opposite direction, showing that the polarized copper plate acts in the same manner as the zinc; that is, it is positive to the clean copper plate. Now by removing the polarized copper plate and wiping and replacing it, the deflection of the needle will be much less, and it will not fall back to 0°, until the very slight coating of zinc which has been deposited on the copper is removed from the polarized plate by means of emery paper or otherwise. Precisely the same effect is noticed when a newly amalgamated zinc plate is opposed to an oxidized zinc plate. The oxidized plate in this case will act as the negative.

This method of showing the effect of the polarization of the plate is much more conclusive and convincing than to employ a secondary battery, or to treat the element under examination as such by connecting it with another battery, as the phenomenon attributed to the polarized plate manifests itself in an unmistakable manner while the plate remains in position and under the conditions of actual use.

Although the zinc is called the positive plate of the battery, and the copper the negative plate, the positive electricity proceeds from the copper through the external portions of the circuit toward the positive or zinc plate, and the negative electricity proceeds from the positive or zinc plate toward the negative or copper plate.

This is extremely confusing to the student of electricity, but still there is reason for putting it in this way. The zinc plate in all batteries is the active element, and the platinum, copper, or carbon plate is the passive element. In the exciting fluid of the battery the current passes from the zinc or positive plate to the platinum, copper, or carbon, negative or receiving plate, thence outward by the conductor attached to the negative plate. This conductor, as it conveys away the positive electricity, has been called the positive electrode or conductor; and as negative electricity appears on the conductor connected with the positive or zinc plate, this conductor has been called the negative electrode or conductor. All that need be remembered is that on a conductor outside of the exciting solution, the positive electricity proceeds from the passive plate of the battery, and the negative electricity proceeds from the active plate of the battery, and the flow of the electric current outside of the exciting fluid is from the passive to the active plate.

Terms such as "electric current," "electric fluid," "flow of the current," are based on the assumption that the action of dynamic electricity is analogous to that of fluids; but as nothing is known of the form of electricity, these expressions are to be considered as purely conventional.

Chemistry, Physics, Technology.

PRODUCTION OF SOUND BY RADIANT HEAT.

Since the recent publications relating to the remarkable experiments of Messrs. Bell and Taintor, which led to the construction of the photophone, by which it was demonstrated that sound could be transmitted by a beam of light, these gentlemen have continued their researches in the investigation of photophonic phenomena, and have greatly extended our knowledge.

At the time of publishing his account of the photophone, Prof. Bell announced the fact that thin disks of very many different substances emitted sounds when exposed to the action of a rapidly interrupted beam of sunlight. This led to the suspicion that sonorousness under such circumstances was a general property of all matter. The correctness of this generalization was subsequently fully verified. In the first experiments which led to this conclusion, the substances tested were placed in a test tube, the mouth of which was connected with a rubber tube, the further end of which was held to the ear, and the intermitted beam of light then focussed upon the substance in the tube. With this device excellent sonorous effects were obtained from crystals of bichromate of potassa, crystals of sulphate of copper, and from tobacco smoke. These experiments, which were made by Prof. Bell in Paris, were afterwards repeated and greatly extended in Washington by Mr. Taintor, with the modified apparatus shown in Fig. 1. In this, the materials experimented on were enclosed in a conical cavity of brass, closed by a flat plate of glass. A brass tube leading into the cavity served for connection with the hearing tube. With this apparatus Mr. Tainter examined the sonorous properties of a vast number of substances, and found that cotton wool, worsted, silk, and fibrous materials generally, produced much louder sounds than hard, rigid bodies like crystals, or diaphragms such as had hitherto been used. Furthermore, it was found that the darkest shades of silk and worsted produced the best effects. This observation suggested the trial of lampblack. A piece of smoked glass held in the intermittent beam of sunlight, with the lampblack surface towards the sun, produced a sound loud enough to be heard with attention in any part of the room.

These experiments were repeated and verified by Mr. Bell on his return from Paris. By smoking the interior of the conical cavity of Fig. 1, and exposing it to the intermittent beam, with the glass lip in position, he found the sound produced to be so loud as to be actually painful to an ear placed closely against the hearing tube. The sounds became much louder, however, when some smoked wire gauze was placed in the receiver. These extraordinary results suggested the possibility that the substances which showed marked sonorous properties under the influence of intermittent sunlight, might be capable of reproducing the sounds of articulate speech under the action of an undulatory beam used with the photophone. The experiments made to verify this suggestion succeeded with lampblack.

Fig. 2 illustrates the mode in which the experiment was conducted. A represents the diaphragm of the transmitter, and B the lampblack receiver with hearing tube. Words and sentences spoken into the transmitter in a low tone of voice, were found to be audibly reproduced by the lampblack receiver at a distance between the speaker and hearer of 130 feet. It has not yet been determined at what distance audible effects could be transmitted with this arrangement of apparatus, as much difficulty was experienced in the above experiment in keeping the light steadily directed on the receiver. The experiment proved, however, beyond question that lampblack could be successfully employed in the articulating photophone in place of the electrical receiver hitherto employed.

Fig. 3 shows an ingenious device employed by these experimenters for interrupting a beam of sunlight for producing distant effects without the use of lenses. Two similar perforated disks are employed, one of which is rapidly rotated, while the other remains stationary. A parabolic reflector is used as a receiver, in the focus of which is placed a glass vessel A containing lampblack or other sensitive substance; and to this is connected the hearing tube. The beam of light is interrupted by its passage through the two slotted disks shown at B.

The general conclusions arrived at from a great number of experiments with solid substances, are that the loudest sounds are produced from substances in a loose, porous, spongy condition, and from those that have the darkest or most absorbent colors. The materials giving the best effects are cotton wool, worsted, fibrous materials generally, cork, sponge, platinum, and other metals in a spongy condition and lampblack.

Prof. Bell explains the loud, sonorous effects produced from such substances as follows: Taking the case of lampblack as an example, a substance which becomes heated by rays of all refrangibility, he considers a mass of this substance as a sort of sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass, the particles of lampblack are heated, and consequently expand, causing a contraction of the air spaces among them. Under such circumstances a pulse of air should be expelled, as water is expelled by sudden pressure upon a sponge. The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lampblack. When the light is cut off the converse process takes place—the lampblack particles cool and contract, thus enlarging the air spaces among them, and the enclosed air also becomes cool. Under these circumstances a partial vacuum should be formed among the particles, and the outside air would then be absorbed as water is by a sponge when the pressure of the hand is removed. He imagines that in some such manner as this a wave of condensation is started in the atmosphere each time a beam of sunlight falls upon lampblack, and a wave of rarefaction is originated when the light is cut off. We can thus understand, he concludes, how it is that a substance like lampblack produces intense sonorous vibrations in the surrounding air, while, at the same time, it communicates a very feeble vibration to the diaphragm or solid bed upon which it rests.

This curious fact was independently observed in England by Mr. Preece, and it led him to question whether, in Messrs. Bell's and Taintor's experiments with thin diaphragms, the sound heard was due to the vibration of the disk or (as Prof. Hughes had suggested) to the expansion and contraction of the air in contact with the disk confined in the cavity behind the diaphragm. In his paper read before the Royal Society on the 10th of March, Mr. Preece describes experiments from which he claims to have proved that the effects are wholly due to the vibrations of the confined air, and that the disks do not vibrate at all.

Prof. Bell dissents from this conclusion, and has apparently demonstrated that a real vibration of the diaphragm takes place in the case of thin disks, independently of any expansion and contraction of the air confined in the cavity behind the diaphragm.

Continuing their investigations, Messrs. Bell and Taintor experimented likewise with liquids and gases. The results obtained, however, were not very decided. In the case of liquids, the best results were obtained with sulphuric ether, ammonia, ammonia-sulphate of copper, writing ink, sulphate of indigo, and chloride of copper; and in the case of gases (which gave better results than liquids), the following vapors and gases were found to be highly sonorous in the intermittent beam: Water vapor, coal gas, sulphuric ether, alcohol, ammonia, amylene, ethyl bromide, diethylamine, mercury, iodine and peroxide of nitrogen. The loudest sounds were obtained from iodine and peroxide of nitrogen. These experiments show that sounds are produced by the direct action of intermittent sunlight from substances in every physical condition (solid, liquid and gaseous), and the probability is therefore very greatly increased that sonorousness under such circumstances will be found to be a universal property of matter.

Referring to the photophone, Prof. Bell describes some highly interesting experiments with various substances as substitutes for selenium in electrical receivers. Fig. 4 represents a form of spiral cell of tellurium which gave sonorous effects when connected in circuit with a galvanic battery and telephone and exposed to the action of an intermittent beam of sunlight. The very great molecular disturbance produced in lampblack by the action of intermittent sunlight, suggested the thought that it should produce a corresponding disturbance in an electric current passed through it, in which case lampblack could be employed in place of selenium in an electrical receiver. This turned out to be the case, and the importance of the discovery is very great, especially when we consider the expense of such rare substances as selenium and tellurium.

The form of lampblack cell which was found most effective is shown in Fig. 5. Silver is deposited upon a plate of glass, and a zigzag line is then scratched through the film as shown, dividing the surface into two portions insulated from one another and having the form of two combs with interlocking teeth. Each is attached to a screw-cap, so that the cell can be placed in an electrical circuit when required. The surface is then smoked until a good film of lampblack is obtained, filling the interstices between the teeth of the silver combs. When

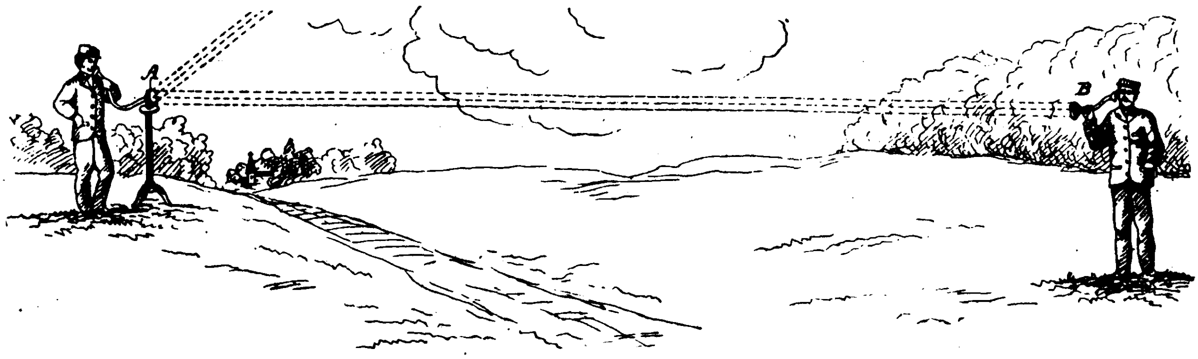


FIG. 2.

the lampblack cell is connected with a telephone and galvanic battery, and exposed to the influence of an intermittent beam of of sunlight, a loud musical tone is produced by the telephone. This result seems to to be due rather to the physical condition than to the nature of the conducting material employed, as metals in a spongy condition produce similar effects. For instance, when an electric current is passed through spongy platinum while it is exposed to intermittent sunlight, a distinct musical tone is produced by a telephone in the same circuit. In all such cases the effect is increased by the use of an induction coil, and the sensitive cells can be employed for the reproduction of musical sounds. It was also found that louds sounds are

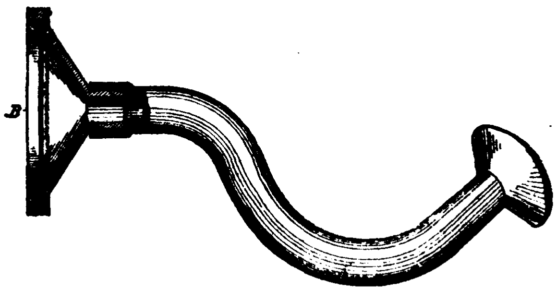


FIG. 1.

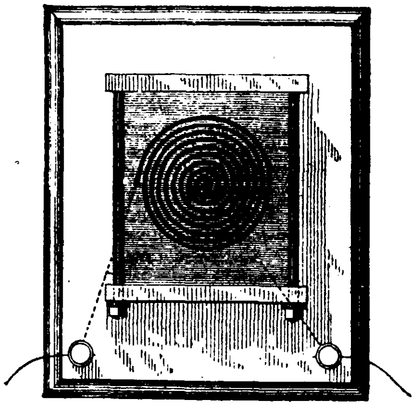


FIG. 4.

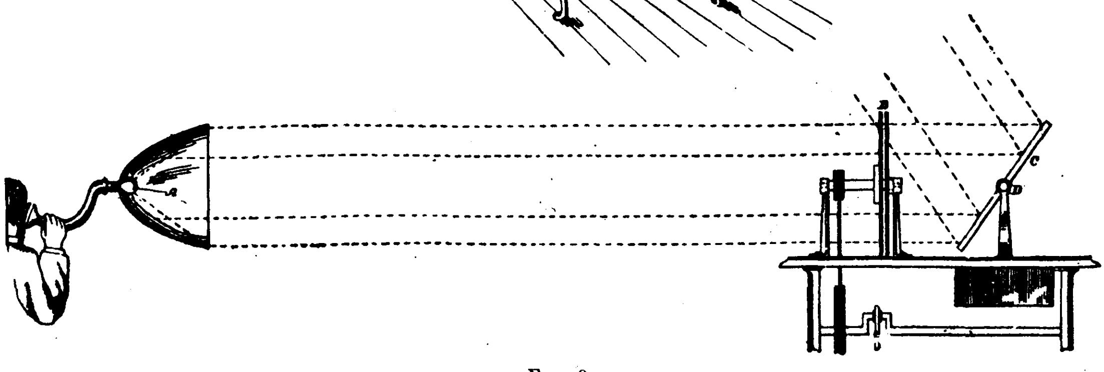


FIG. 3.

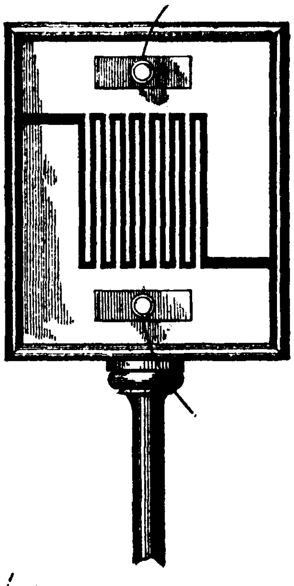


Fig. 5.

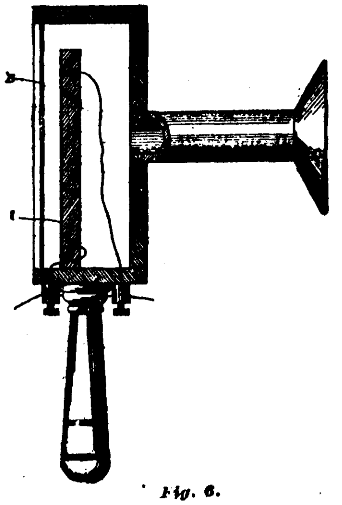


Fig. 6.

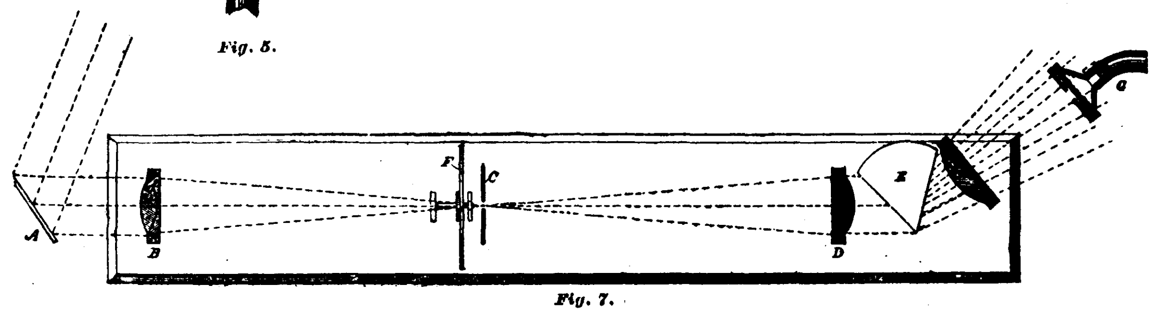


Fig. 7.

produced from lampblack by passing through it an intermittent electrical current, and that it can be used as a telephonic receiver for the reproduction of articulate speech by electrical means.

A convenient mode of arranging a lamplack cell for experimental purposes is shown in Fig. 6. When an intermittent current is passed through the lampblack A, or when an intermittent beam of sunlight falls upon it through the glass plate B, a loud musical tone can be heard by applying the ear to the hearing-tube C.

In describing the results of these and other experiments, Messrs. Bell and Taintor use the word "light" in its usual rather

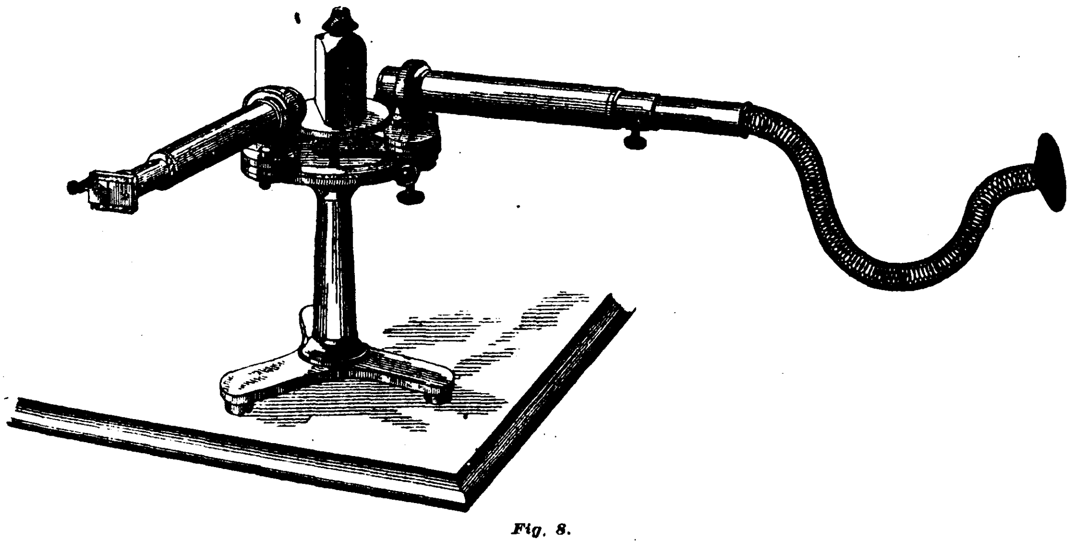


Fig. 8.

than its strict scientific sense, and have not attempted to discriminate between the effects produced by thermal, luminous and actinic rays, all of which are contained in ordinary sunlight. They call attention to this fact because their adoption of the word "photophone" has been construed to imply that they believed the audible effects discovered by them to be entirely due to the action of luminous rays. They disclaim such restricted interpretation, and explain their meaning by quoting a paragraph from their previous paper on the photophone, in which they say: "Although effects are produced, as above shown, by forms of radiant energy which are invisible, we have named the apparatus for the production and reproduction of sound in this way, the 'photophone,' because an ordinary beam of light contains the rays which are operative." To avoid future misunderstandings on this point, they have now decided to adopt the term "radiophone," a term signifying an apparatus for the production of sound by any form of radiant energy, and limit the words "thermophone," "photophone" and "actinophone" to apparatus for the production of sound by thermal, luminous and actinic rays respectively.

To determine the effects produced by the different forms of radiant energy, Messrs. Bell and Taintor devised the form of apparatus shown in Fig. 7. A beam of sunlight reflected from a heliostat A, is refracted through an achromatic lens B, so as to form an image of the sun on the slit C, then passes through a second lens D, and through the bisulphide of carbon prism E, forming a spectrum of great intensity upon a screen behind the prism. When this is properly focussed, the disk interrupter F is turned with sufficient rapidity to give 500 or 600 interruptions per second, and the spectrum is explored with the receiver G. With this arrangement and a lampblack receiver, sounds were heard in every part of the visible spectrum (except in the extreme half of the violet), and also in the ultra-red. The sounds increased in intensity as the receiver was removed from the violet towards the red, and reached a maximum far out in the ultra-red. By varying the substance in the receiver different results were obtained, which it would unduly extend this article to reproduce. We will simply note the conclusion that was drawn from the experiments, as follows: The nature of the rays that produced sonorous effects in different subtances depends upon the nature of the substances that are exposed to the beam, and the sounds are in every case due to those rays of the spectrum that are absorbed by the body.

These experiments suggested the idea of constructing an apparatus for spectrum analysis, to which they give the name of "spectrophone," which is shown in Fig. 8. The eye-piece of a common spectroscope is removed, and sensitive substances are placed in the local point of the instrument behind an opaque diaphragm containing a slit. These communicate with the ear by means of a hearing-tube. For the purpose of examining the absorption spectra of bodies in those portions of the spectrum that are invisible, this instrument will doubtless prove a valuable accessory to the spectroscope. When a rapidly interrupted beam of light is passed through any subtance whose absorption spectrum is to be examined, bands of sound and silence are observed on exploring the spectrum, the silent positions corresponding to the absorptions bands. The ear cannot of course compete with the eye in accuracy in examining the visible portions of the spectrum; but for the detection of absorption bands in the invisible parts of the spectrum beyond the red, it promises to be an invaluable adjunct to the spectroscope.

For the engravings illustrating this article, we acknowledge our obligations to the *Journal of the Franklin Institute.*

HIGH EXPLOSIVES.

DYNAMITE OR GIANT POWDER.

No better illustration can be given of this material than by repeating Alfred Nobel's, the inventor's, own descriptive words, which are as follows:

"My invention relates to a new and useful combination or mixture of nitro-glycerine with some absorbent substance, whereby the condition of the nitro-glycerine is so modified as to render the resulting explosive compound more practically useful and effective as an explosive, and far more safe and convenient for handling, storage and transportation than nitro-glycerine in its ordinary condition as a liquid. The invention consists in combining or mixing with nitro-glycerine some porous or absorbent substance, which, being free from any quality which will cause it to decompose, destroy or injure the nitro-glycerine, forms, in combination with it, an explosive compound possessing certain marked properties of great practical utility, which not only increases its efficiency, but also obviates many of the serious practical objections to the employment of nitro-glycerine as an explosive. Some of the peculiar properties of this mixture will be briefly stated: Nitro-glycerine being a liquid, it is usually necessary in exploding it as an explosive for blasting purposes, to place it in cases or cartridges formed of paper, metal, or other substance, which must, of course, be of somewhat smaller diameter than the bore holes, as, if not so enclosed, the nitro-glycerine would permeate the seams of the rock, and prove highly dangerous to the miner, on account of its liability to explode in subsequent drillings; but by means of my invention, the nitro-glycerine, being held in combination with the porous or absorbent substance with which it is mixed, and then assuming the altered form of a powder or paste remains in the bore hole in which it is placed, without leaking through the seams of the rock. Another advantage over liquid nitro-glycerine is, that this mixture can be made to fill the bore hole more closely than a cartridge case will, owing to the irregularities of the shape of the hole, which greatly increases its efficiency. The liability of fluid nitro-glycerine to accidental explosion from agitation or concussion renders its handling and transportation very dangerous. This danger is, however, almost entirely obviated by the use of the compound, because, when mixed with a suitable absorbent the nitro-glycerine is far less sensitive to shocks than when in a liquid condition, so it may be handled in mass either loose or in packages with impunity. This invention then, consists in mixing liquid nitro-glycerine with some solid substance, which will absorb and retain a sufficient amount of nitro-glycerine to form an efficient explosive. The substance which is believed to be the best adapted for this purpose is a kind of silicious earth found in various parts of the globe, and known by the various names of silicious marl, tripoli, rotten stone, kieselguhr. The peculiar variety of this material best suited for this for this use is homogeneous, has a low specific gravity and great absorbent capacity, and is generally composed of the remains of infusoria. So great is the absorbent capacity of this infusorial earth, that, when in a pulverized condition, it will take up three times its own weight of liquid nitro-glycerine, and still retain the form of a powder. Other porous substances, even though they have less absorbent capacity may be used, but in this case the explosive strength of the powder will be diminished, owing to the smaller proportion of nitro-glycerine contained therein. Chalk, for example, will absorb about 15% of nitro-glycerine and retain its powdered condition; and porous charcoal, although of greater absorbent capacity, has less elasticity of particles, so that nitro-glycerine is apt to squeeze out of it. Any of the various vegetables or mineral substances susceptible of pulverization or comminution, and which will retain nitro-glycerine by absorption, may be substituted for infusorial earth. The relative proportion of the ingredients used in making this non-explosive compound will vary according to the absorbent capacity of the substance mixed with the nitro-glycerine, it being preferable in all cases—and this is the only limit—to use so much only of the liquid nitro-glycerine as the absorbent substance will retain without liability to subsequent separation by compression or leakage. Where the absorbent used in a powdered condition is infusorial earth, a thin paste or semi-fluid condition of the mixture is to be avoided."

"The method of manufacturing this explosive compound with infusorial earth is as follows:

"The earth being thoroughly dried and pulverized, is placed in any suitable vessel, and the nitro-glycerine is then gradually introduced, and thoroughly mixed with the powdered earth, which is effected either by stirring with the naked hand or by means of any suitable wooden instrument, worked either by machinery or by hand. Where infusorial earth is used, the proportions may be conveniently varied, from 60 parts by weight of liquid nitro-glycerine and 40 parts by weight of infusorial earth, to 78 parts by weight of nitro-glycerine and 22 parts by weight of infusorial earth; the former proportions forming, at ordinary temperatures, a dry, pulverulent mass, and the latter a pasty mixture. Let it be here observed, that the explosive force of the mixture is increased when a larger proportion of nitroglycerine is employed, and that, when the mixture is to be used in a cold climate, a larger quantity of nitro-glycerine may be safely employed than when it is to be exposed to a warmer atmosphere.

"For ordinary practical purposes a mixture of 75 parts by weight of nitro-glycerine, and 25 parts by weight of infusorial earth, gives a powder sufficiently dry at ordinary temperatures, and which is susceptible of compression to a specific gravity early equal to that of pure nitro-glycerine. When the ingredients have been intimately mixed, and thoroughly incorporated by stirring and kneading, the powder is then ready for use, and may be packed in bulk in boxes, or compressed into cartridge cases made of paper, of such convenient sizes as may be most in demand for blasting purposes.

"In using this improved explosive compound for blasting, it may be inserted into cartridge cases, as above stated, or without any inclosure or wrapping as may be preferred. For the best effect it should be pressed firmly down so as to fill the bottom of the bore hole, always using a wooden rod for the charging of the hole. (Every miner is aware of the importance of having his charge of powder firmly set in the bottom of the hole.) It is easily and efficiently exploded by means of an ordinary fuse inserted in the open end of a percussion cap, the metallic edges of the cap being compressed or crimped tightly and firmly around the fuse, in close contact with the fulminate in the percussion cap. The capped end of the fuse is then inserted into the explosive powder, which is pressed closely around it in the bore hole, and a tamping of sand or other suitable material may be placed above the charge of powder and pressed down upon it. The fuse thus applied is fired in the ordinary manner; and when the fire reaches the percussion cap, it explodes, which effects the immediate explosion of the charge of explosive compound."

Nobel's invention consists, therefore: "In the combination of nitro-glycerine with infusorial earth or other equivalent absorbent substances."

Kieselguhr or guhr is found in Hanover, Germany. It is a soluble variety of silicious earth, is a white, mealy substance, composed of the silicious armors of a species of shells (*Diatomeen*) that form a multitude of small cells which possess considerable hardness and, looked at through a microscope, show their perfect state of preservation. This guhr possesses, as has been shown above, an immense absorbing capacity, and owing to the peculiar form of these infinitesimal small shells, every small particle of nitro-glycerine is, so to say, surrounded by it, and lies (is stored away) in a small cavity of this porous material in such a manner that these particles of guhr prevent the propogation of the vibration caused by a comparatively strong concussion. It can be said that each particle of nitro-glycerine is packed away separately in each particle of guhr in which it is retained by capillary attraction, and consequently the great objection against the liquid is in this way obviated.

At first the new blasting agent made but slow progress, owing in a great measure to the strong prejudice existing against its chief ingredient. But gradually it has grown into favor and numerous dynamite factories have sprung up all over Europe and America, and not less than a dozen were under the inventor's control, and what is more are on a paying basis.

It was not long after its introduction to the practical and scientific world, that it was universally adopted in both hemispheres, as it became an absolute necessity to the engineer and miner. During the last two decades, which are so eminently marked for the great advancement in railroad building, this material has been an immense aid in cutting the path for the great reformer of our modern age—the iron horse. And certainly the greatest credit is due to the inventor who has furnished us the means of accomplished results, which might have been delayed for years had it not been for the excellent material which he has put into our hands.

The great success of dynamite has given rise to numerous other nitro-glycerine compounds, of which the most known are the Lithofacteur, Dualine, Hercules, Vulcan, Warren, Excelsior powders, which have entered into successful competition with Nobel's dynamite. The remark will be made here, that the object of these articles is not to say which is the best nitro-glycerine compound, but to impart to the reader the knowledge of what they are, as the miners on this coast are two intelligent a class of men to be told which is and which is not the best of these powders. Let everyone use his own judgment on that subject. It is self-evident that that compound which holds absorbed the greatest amount of nitro-glycerine in a pure and neutralized condition, will make the strongest, and consequently, the best powder. In some cases, where the absorbents used do not possess the great absorbing capacity of kiesel-guhr, the admixture of meal powder is resorted to, to add to the strength of the compound, besides acting also as a vehicle to carry the nitro-glycerine.

The strength of dynamite, No. 1, is set down for equal weights to be as one to five, as compared with black powder, although in practice, some authorities set it lower, and some higher.

Dynamite forms a fine grain, somewhat pasty and fatty substance of gray brown color, which has, under the ordinary pressure employed to form it into cartridges, a specific gravity equal to liquid nitro-glycerine.

Against fluids and solutions it comparts itself in the same manner as nitro-glycerine, only it must not be permeated by water, because it separates the oil from the guhr. Against heat it bears the same relation as nitro-glycerine. Dynamite burns in an open flame or on live coal with a quiet development of gases, but it must not be confined, and only when wrapped up in paper or other light substances, like wood; but in that case even there is danger of its being heated to the exploding temperature. Especially in storing large quantities, like in magazines, it can happen that during a fire an explosion can take place, as the mass may become heated to 380° before the same is burnt up. Such an accident happened in the dynamite factory at Hamburg on the 12th July, 1866.

Against moderate strokes and concussion, such as may happen during transport, like the running together of the heavy box cars or railroad trains, jolting of freight wagons, dropping of case, the material is insensible, and although an instance is on record where during a collision a box car containing dynamite was all broken up, the boxes smashed and the powder spilt without explosion, it must be recommended to always handle this material with due precaution.

Some experiments as to its safety in regard to percussion are of interest:

A strong wooden keg containing 10 lbs. of dynamite put up in cartridges, was thrown from a height of 100 ft. against a rock, and the keg and contents remained intact.

To a flat stone weighing 200 lbs., a cartridge of dynamite was tied and then the stone dropped from a height of 20 ft. The cartridge was all smashed to pieces, but it did not explode. In spite of these reassuring results, which show the insensibility of the material against heavy percussion, we have on record some very distressing accidents, which have for causes the reckless handling of the same; and therefore let it be again repeated that although dynamite is a very safe substance when handled with ordinary care, it must not be forgotten that it is the highest explosive known, and that it ought to be treated accordingly

In its frozen condition it is hard to explode, but even then it is to be recommended not to employ any pointed instrument for breaking it up, and in thawing it out to follow the ordinary rules which are known to every miner. It is very hard to explode frozen dynamite, consequently accidental explosions with the frozen stuff ought certainly be easily avoided.

It is hardly to be presumed that we will reach such a point in the manufacture or handling of explosive substances, be it dynamite, be it gun cotton, or be it gun powder, where claim can be laid to an absolute safety, as some accidental combination of circumstances will lead to explosions, and it is therefore the question, that under ordinary circumstances these accidental combinations should be avoided, which can be done by the exercise of care, prudence and precaution, and also by a perfect knowledge of the properties of the material, by the parties who handle it.

Dynamite has been in use in this country some 13 years; it has been shipped and transported over thousands of miles, been distributed in thousands of parcels in different parts of our Territories, under different atmospheric and climatic conditions, and, so far, spontaneous explosions of magazines are not on record as yet. Numerous distressing accidents have occurred, but from different causes, and consequently we presume the theory of scientific men, that dynamite does not explode spontaneously, to be correct, as the particles of nitro-glycerine are finely distributed through the kieselguhr, and if, during a storage of long duration, the nitro-glycerine decomposes the decomposition takes place slowly and gradually and does not lead to disasters.

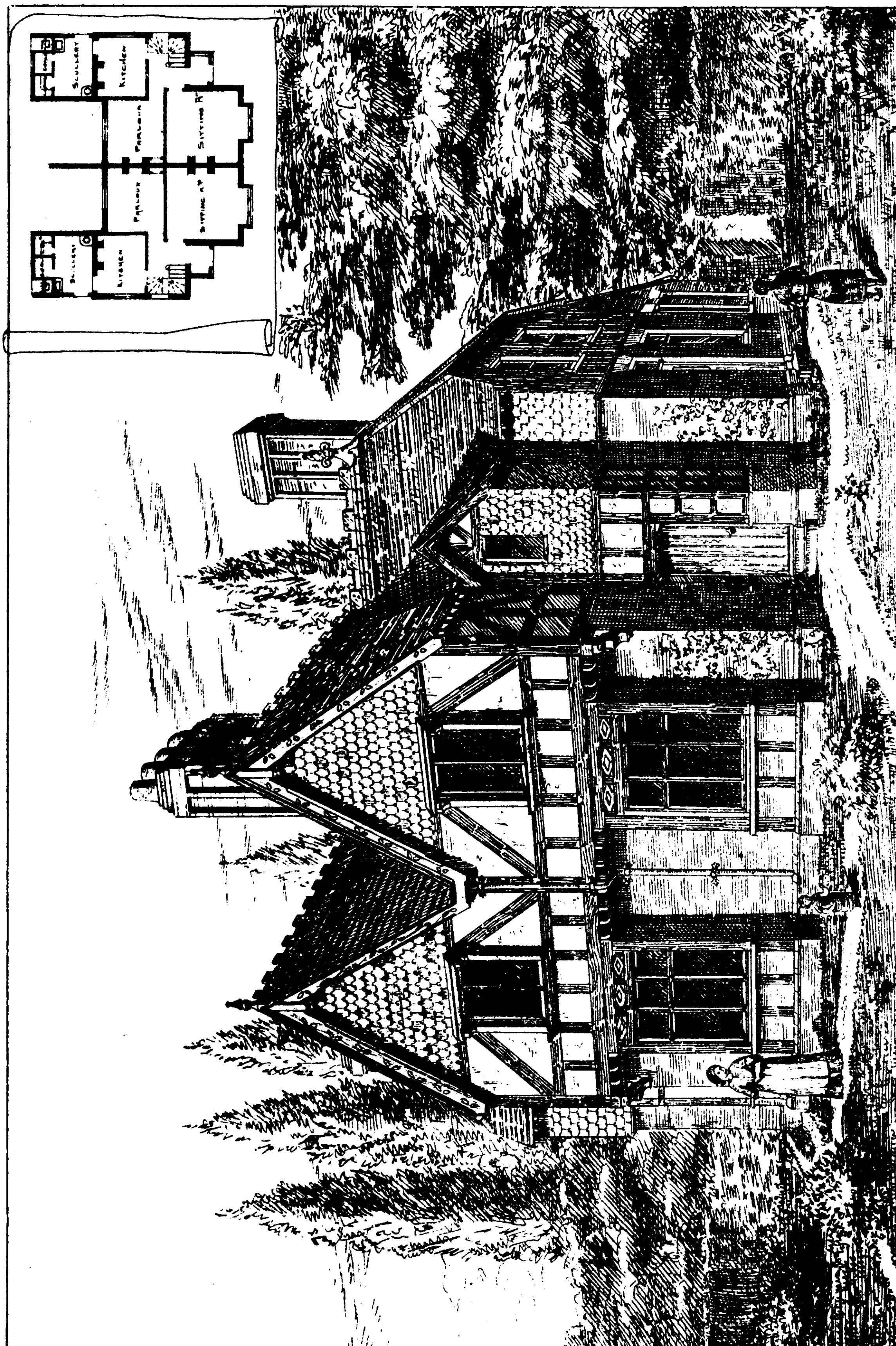
I adopt the theory of scientific men that dynamite does not explode spontaneously, not because scientific men say so, but because practice has proven it up to this date, and it is to be hoped that future experience will bear out this theory.

As yet, I cannot consider the different dynamites as the perfect ideals of modern blasting agents, as they possess some disadvantages, which, no doubt, science will overcome in time.

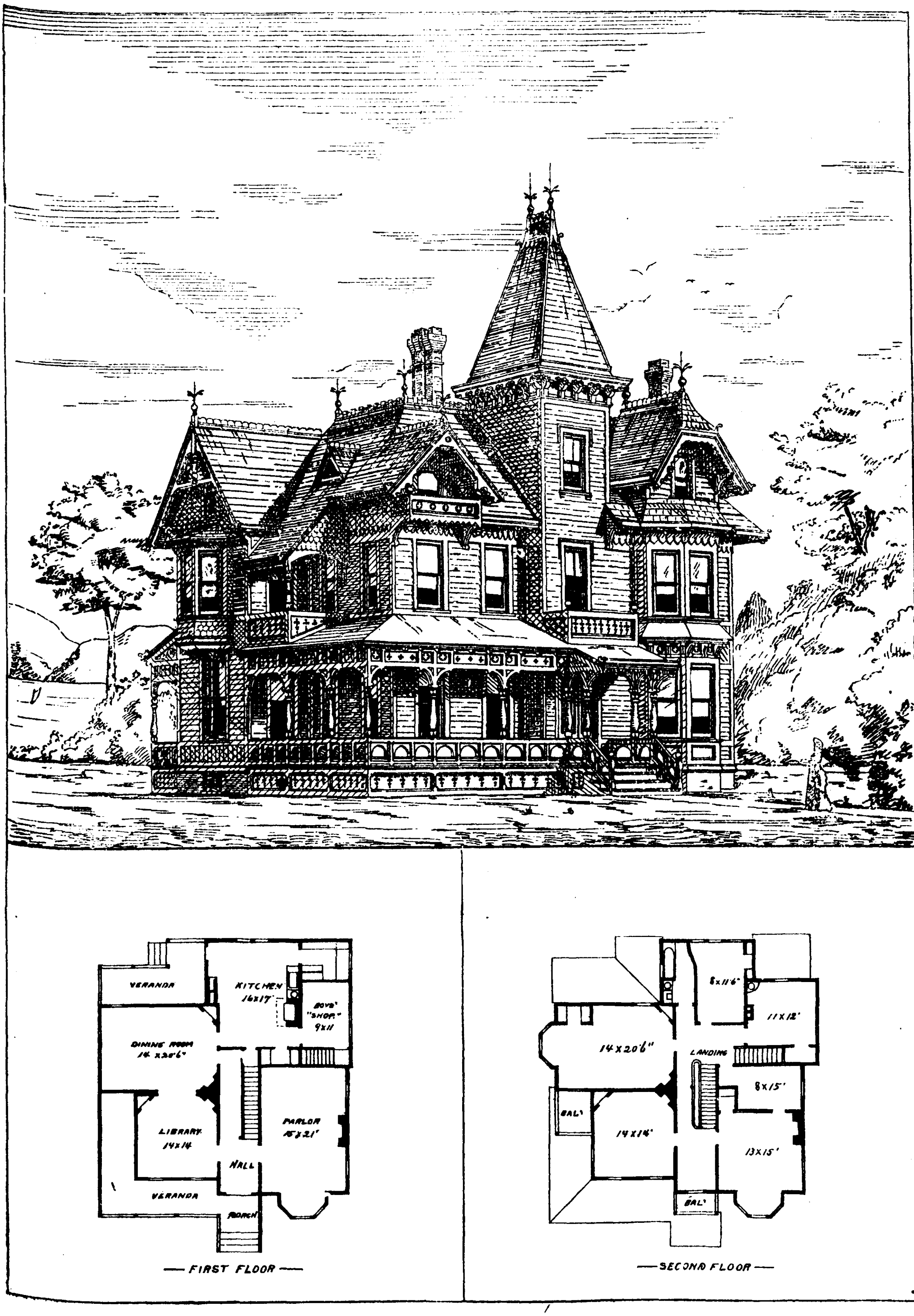
1. The easy separation of the nitro-glycerine from the absorbents through water, which necessitates that it has to be put in water-tight cartridges when used under water for any length of time.

2. It gets hard at a comparatively high temperature; it freezes.

3. A more complete neutralization of its fumes, so as to make them less obnoxious.



MIDDLECLASS COTTAGES, HARROW STATION.



DESIGN FOR SUBURBAN RESIDENCE, COSTING $4,750.

Architecture, etc.

SUBURBAN RESIDENCE.

The house design presented on the opposite page will occupy one of those charming sites for which Nyack is noted, commanding a favorable view of the Hudson and surrounded by all the natural attractions of that delightful locality. The internal arrangements were planned to suit the particular requirements of the owner, and certainly show a most desirable disposition of the accommodations. The aspect is east, and hence, it will be noticed, the library and dining-room have a sunny and cheerful exposure. The front bay window not only affords a more extensive prospect to the parlor and room above, but adds to the spaciousness of those rooms. The sonth oriel occupies a decidedly appropriate position and occasions no obstruction to the carriage drive to the rear of the 60 foot lot on which the house is located. In connection with the kitchen, a spacious store room is fitted up with pastry board, dresser, bins, etc., and a kitchen pantry is also furnished under the servants' stairs. Stationary wash trays are located so as to interfere as little as possible with the culinary work. Long windows communicate the dining room with the front and rear porticos. The cellar stairs are underneath the principal flight, and above the latter are the stairs to attic, where a servant's room and clothes room are finished off. The cellar extends under the entire building, excepting beneath the store room. The house is heated throughout by Graff and Co's No. 5 hot blast furnace, and is finished replete with all the modern conveniences of a first-class dwelling, the plumbing arrangements being according to the most improved method. In construction, the work is thorough and first-class throughout. The frame is sheathed with boards and felt beneath the clapboards, and the slopes of the roofs are covered with slates. The first and second floors are laid with narrow mill-worked white pine flooring, and the attic with flooring of medium width. The architraves and base boards, as well as the inside details in general, are of unique and original design, producing a beautiful effect at a comparatively small expenditure of material and labor.

The structure is conspicuously exposed from each direction and the design has been treated accordingly, presenting an interesting outline from every point of observation. Although in a hastily-prepared perspective sketch much of the expression is lost with the absence of well-defined, characteristic details, yet it will be readily seen that by a tasteful introduction of colors and contrasts this house can be made extremely attractive.

As to the cost of the building, so much depends on circumstances and conditions that it is hardly fair to attempt an approximation. Under favorable circumstances and judicious management the total cost, including heating, plumbing and mantels, should not exceed $4,750. Mr. Horace Greeley Knapp, of 60 Broadway, New York city, is the architect.

Joel's Electric Lamp.—A method of applying electric lighting to indoor purposes has been effected by Mr. H. B. Joel, who has worked upon the incandescent principle. The light is produced by the heating to incandescence of the end of a thin carbon rod which forms one electrode, and which is continuously fed through special and simple contact jaws against a fixed cylinder of copper forming the other electrode. The light emanates from the short length of carbon between the clamping jaws and the copper cylinder, but chiefly at that part near the metal where the rod becomes pointed by the action of the current, and where it is, therefore, more intensely heated. In addition to the light produced by the incandescence of the carbon there is also the glow or flame which proceeds from the surface of the carbon to the copper electrode, similar to an ore light. The Joel light thus takes an intermediate position between the purely indescent system of Edison and the arc lamp of Serrin and others. The lamp in which the electrodes and the mechanism are inclosed is externally precisely similar to some gas-lamps, being fitted with gaselier suspensions and terminating in a ground or opalescent glass globe. A switch or tap is placed in erch room, and the light is turned on and off at will. There are automatic safety arrrangements, so that before the lamp can be opened wheh buruing the electric current is shut off, and this also occurs when the caabon has been consumed, all liabilities of accidents being thus avoided. The whole system, in fact, as far as the arrangements of the lamp and its accessories are concerned, has been approximated as much as possible to that of gas lighting.

Cabinet Making.

HINTS ON DECORATION.

The knowledge and appreciation of true art, viz., perfect form, exquisite symmetry, and harmonious color, is not confined to one small section of the community alone. The word "artistic" brings us to the consideration of what really constitutes true art in decoration. It should be borne in mind that from the bringing together beautiful things, however lovely they individually are, will never be evolved in agreeable whole unless they are suited one to another and suitable for the purpose to which they are put. A house built in the Gothic style must be decorated in a suitable manner; but not in this alone must fitness be regarded. Rooms should be decorated and furnished so as to insure the greatest possible amount of comfort, repose and pleasure, compatible with the uses for which they are designed; a dining room should be arranged so that it may appear to advantage in artificial light, and present a warm solid appearance; while a drawing room may be more lightly and elegantly furnished. Then, again, harmony is another distinctive feature in decorative art. If a good scheme of coloring is faithfully carried out, a satisfactory and pleasing effect will be the unfailing result. A third point of no less importance is the due recognition of true proportion. All decoration is worthless if it is not perfectly adapted to the space it is intended to embellish; the design also must be on a scale proportionate to the size of the panel it occupies.

The several portions of entrance hall and rooms, the floors, walls, ceilings, etc., first call for attention; we will afterwards consider the house as a whole, and suggest a scheme or two that may be of assistance to our readers. The hall flooring may be laid in plain marbles, or patterned in mosaic work; this style is more uncommon, but, unless evenly and well laid, is no improvement on the tiles that are so fashionable at present. Either pavement is desirable on account of the ease with which perfect cleanliness may be maintained. The designs on tiles suitable for halls are so numerous that choice of the prettiest is rendered a difficult undertaking, the one great objection to their use being the noise occasioned by every passing footstep. Plain oak or parqueterie is charming for a hall, presenting, as it does, with one or two oriental rugs laid down, a rich, warm appearance. The polishing process keeps it as clean and free from dust as the tile pavement, and it possesses this advantage over the other, that it gives back but a subdued echo, whereas the tiles ring out each successive footfall clearly and sharply. All floors in a house may be laid either with oak or parqueterie, or the borders only may be of ornamental wood, the centre covered with a carpet.

For wall decoration we have various methods and materials offered us. Woven or painted tapestry, silk, satin, cretonne, are among the textile fabrics suitable for hangings. They afford the depth and richness necessary to suit the prevailing taste. Walls either flatted or done in distemper are preferred by many to other modes of ornamentation. They can be more easily cleansed, and will not hold the dust, as do the above-named fiabrics; they can be made to look warm, cool, rich, sombre, light, dim, or glowing, according to the colors the artist pleases to lay upon them, and may thus be brought to form fitting backgrounds to the furniture of any known period, and to enhance by good contrasts the colors of chair coverings and carpets. Paperhangings, though some would relegate them to the bedroom floors, are cool and bright-looking, and, when artistically designed and harmoniously colored, are worthly of decorating some of our choicest rooms. Entrance halls may be painted, tiled, hung with embossed leather or Lincrusta Walton. The mention of walls brings us to the consideration of dadoes. And first as to height. A dado cannot in any case be allowed to be of such a height that the wall is thereby divided into two equal parts. The usual plan is to raise it somewhat higher than the chair-back; but it may be carried up as high as the top of the door with advantage; this gives an odd yet picturesque appearance, eminently suited to old country houses, where there is plenty of light.

In houses, closely surrounded, the light obtainable is so small in quantity that it is oftentimes requisite that the walls should be as light in tone as possible, in order that they may reflect all the natural light and diffuse it around. This is especially needful in houses where the back windows are of necessity filled in with stained glass, that the outlook, which is often none of the pleasantest, may be hidden. When a rich old oaken dado cannot be rivalled for beauty, durability, and fitness, yet the many other methods of forming dadoes are good and effective in their several degrees. Matting forms a useful lower covering for a wall; it is held in place by a wooden molding, both at top and bottom. Dark paint, a geometrical-patterned paper, leather, tapestry, are all suitable for various classes of decoration. In color they should be darker than the rest of the wall, as they occupy the lower portion. The wainscoting is generally seen to be deepest in tone; then follows the dado, which may be rather lighter, the wall filling still lighter, and then the frieze.

The plan gives the appearance of solidity and strength to the room, the several gradations leading up pleasantly to the ceiling above. It is a plan, however, that is by no means invariably followed, and one that may well be departed from under a clever artist's directions; it is not for instance, always desirable to have a light-colored ceiling. A surbase, or rail of molded wood, divides the dado from the wall above; this is sometimes made wide enough to hold valuable pieces of old china. Or, if a paper dado is used, a border of paper may take the place of the wooden molding. Again, if paint alone is used, a pattern is often stencilled above the painted dado border on the upper wall; this effectually does away with the abruptness that may be too pronounced if the dado is dark and the wall space light in color. When there are many pictures to adorn a room, a painted wall is the background best adapted to set them off to advantage; but, if paper is employed, it should be chosen of some tertiary tint, powdered with geometrically arranged conventional flowers and leaves. If tertiary tints are not approved, a design into which are introduced in minute portions the primary colors, will produce a warm, rich effect, and will yet be free from even a suggestion of vulgarity, provided only that the colors are well balanced.

THE LAW OF CURVES.

"Curves," says an English author, "played a large part in ornament, and often they were drawn in an unscientific manner. A universal law was that all curves, whether springing from other curves or from straight lines, should be struck at a tangent to the lines from which they diverged; and when curves conformed to this rule the effect was agreeable and natural, and when it was departed from the effect was weak and crippled, because the lines would appear to cut through one another, whether continued to that point or not. Further, in two designs of leaves springing from common bases, that in which the stems ended parallel to each other would look better than that in which they approached one another, for in the latter the mental effect would be to continue the lines so as to intercept each other. The effect of these qualities of rhythm, repetition, geometrical symmetry, alternation, equal distribution of spaces and proper relation of curve to curve, made up what might be termed abstract ornament.

"Ornament should not attempt to directly imitate nature; but a large class of genuine ornament was based upon the adaptation of natural forms. There was a beautiful class of ornament not derived from these forms, and which might be distinguished as "abstract" ornament. In the decorative work of all savage nations a great proportion of the ornament was produced by filling up the space treated with simple lines having little meaning or purpose in themselves. This abstract ornament might be traced in a higher form in Egyptian art, and reached its greatest development of perplexity and mystery in Saracenic art, in which a puzzling and complicated effect was produced by the shifting and re-arrangement of a few lines. The familiar Greek key pattern was in like manner a collocation of squares, with one side cut away, interwoven with one another. One of the most intricate Saracenic patterns was a series of concentric hexagons, slightly tilted. Ornament could be produced not only by drawing on a surface, but by varying that surface so as to produce an alternation of light and shade. Ornament derived from nature, while it must not imitate, might have various degrees of approach to nature, governed in their nearness of likeness to a considerable extent by the nature of the material and medium worked in. Thus in crewel work, exact symmetry should be avoided, and the imitation of nature might be comparatively near, but ornament to be placed on a building should be architecturalized. A leading reason against the attempt to precisely copy nature was that in most media it could not be done successfully; the direct effort to reproduce a flower in carving only called attention to the absence of the delicacy, the finish, the fragility of the natural form. Again, such minutely copied work violated the necessity for fitness for its space and purpose. The principle governing growth in nature must be observed in ornament—*e. g.*, as in actual life, all curves must spring in the same direction, whether flowing from right or left of a central stem, and it was an obvious mistake to repeat the trailing festoons, so appropriate in Renaissance decoration for a wall surface, upon a ceiling. The grotesque did not suggest a misuse or degradation of the subject, and might be more boldly employed. The use of grotesque animals upon jugs or other domestic vessels is almost universal throughout the world. The imitation of artificial objects was invariably bad, because it brought back the mind to every-day matter, and it was generally a proof that it was introduced to save trouble and thought. Artificial objects were very frequently used in Roman and Renaissance work, and also in a great deal of the work by Grinling Gibbons, which was often very faulty in conception, although admirably executed."—*Metal Worker.*

INLAYING.—Every one has noticed that in ordinary inlaying there is a very ugly glue joint, equal in its width to that of the saw used, which runs round the whole of the inlaid pattern. This, of course, looks bad, and further, it involves the use of a very fine saw to reduce the width as much as possible. This, again, involves the use of comparatively thin wood. To avoid this, tilt up the saw-table a little on one side—say to the right; with it in this position cut out the right side of a letter—say a capital I; obviously the uppermost of the two pieces of wood on which we are operating would have its I slightly broader than the bottom one. Then finish the letter, being always careful to make the cut "sun about," as the phrase is—*i. e.*, in the same direction as the hands of a clock move. We now have an I cut out of the top piece slightly broader and longer than that cut out of the lower one; if we have proportioned the amount of "tilt" of the table, with due regard to the thickness of the saw and of the wood used, the upper I will just fit neatly and tightly into the space left in the lower piece. Apply plenty of glue and gently tap the letter or monogram into its place, and we have a glue joint which will be barely visible. The amount of slope required in the table is very slight, and one soon finds out the happy medium.

THE FINEST FLOORS are said to be seen in Russia. For those of the highest grade tropical woods are exclusively employed. Fir and pine are never used, as in consequence of their sticky character they attract and retain dust and dirt, and thereby soon become blackened. Pitch pine, too, is liable to shrink, even after being well seasoned. The mosaic wood floors in Russia are of extraordinary beauty. One, in the Summer Palace is of small squares of ebony inlaid with mother of pearl. A considerable trade is done in Dantzic and Riga by exporting small blocks of oak for parquet floors. There is an active demand for these in France and Germany, but none in England.

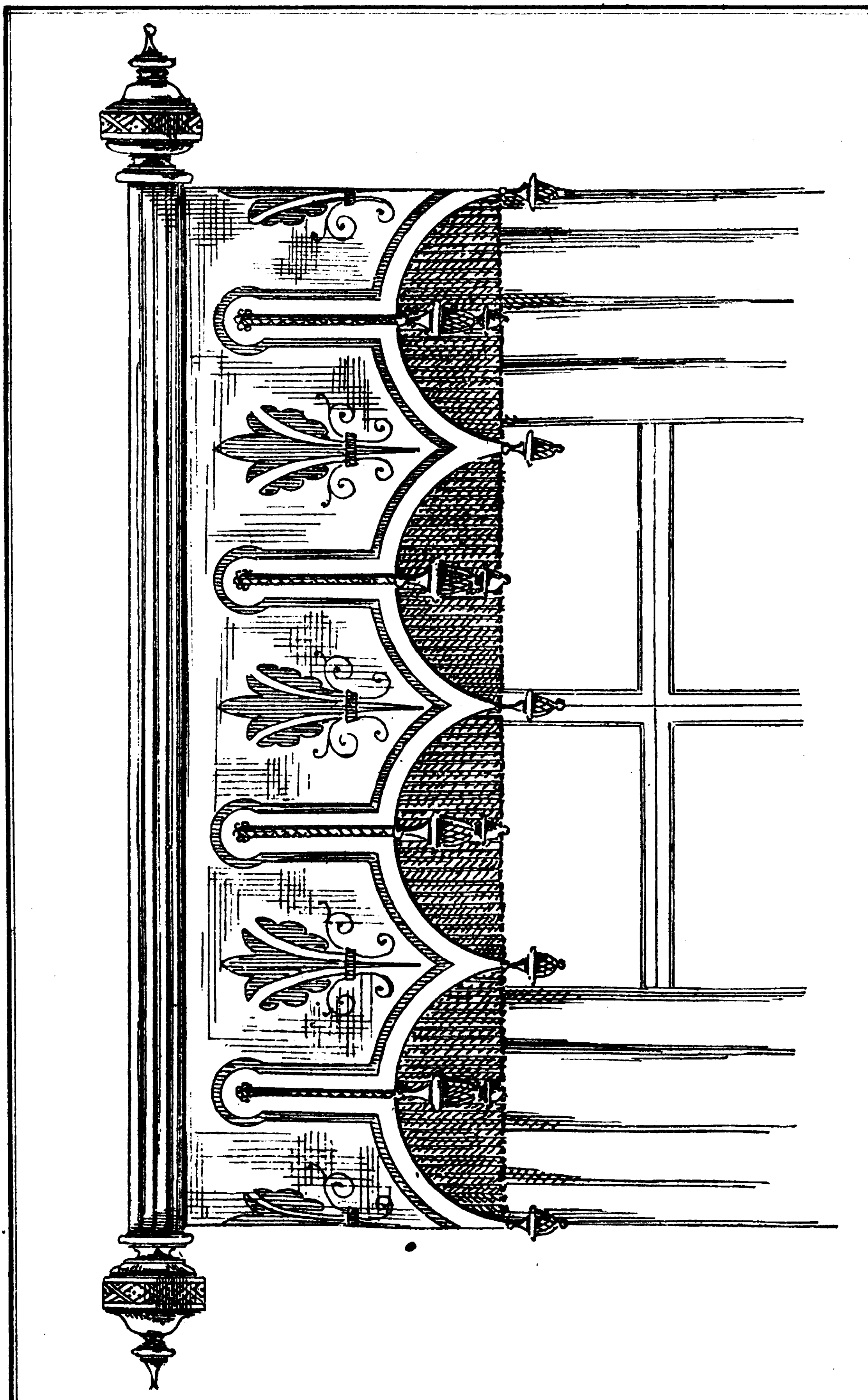
CARBON tracing paper is prepared by rubbing into a suitable tissue a mixture of 6 parts of lard, 1 part of beeswax, and sufficient fine lamp-black to give it a good color. The mixture should be warm and should not be applied to excess.

THE JAPANESE FAN AS AN AUDIPHONE.

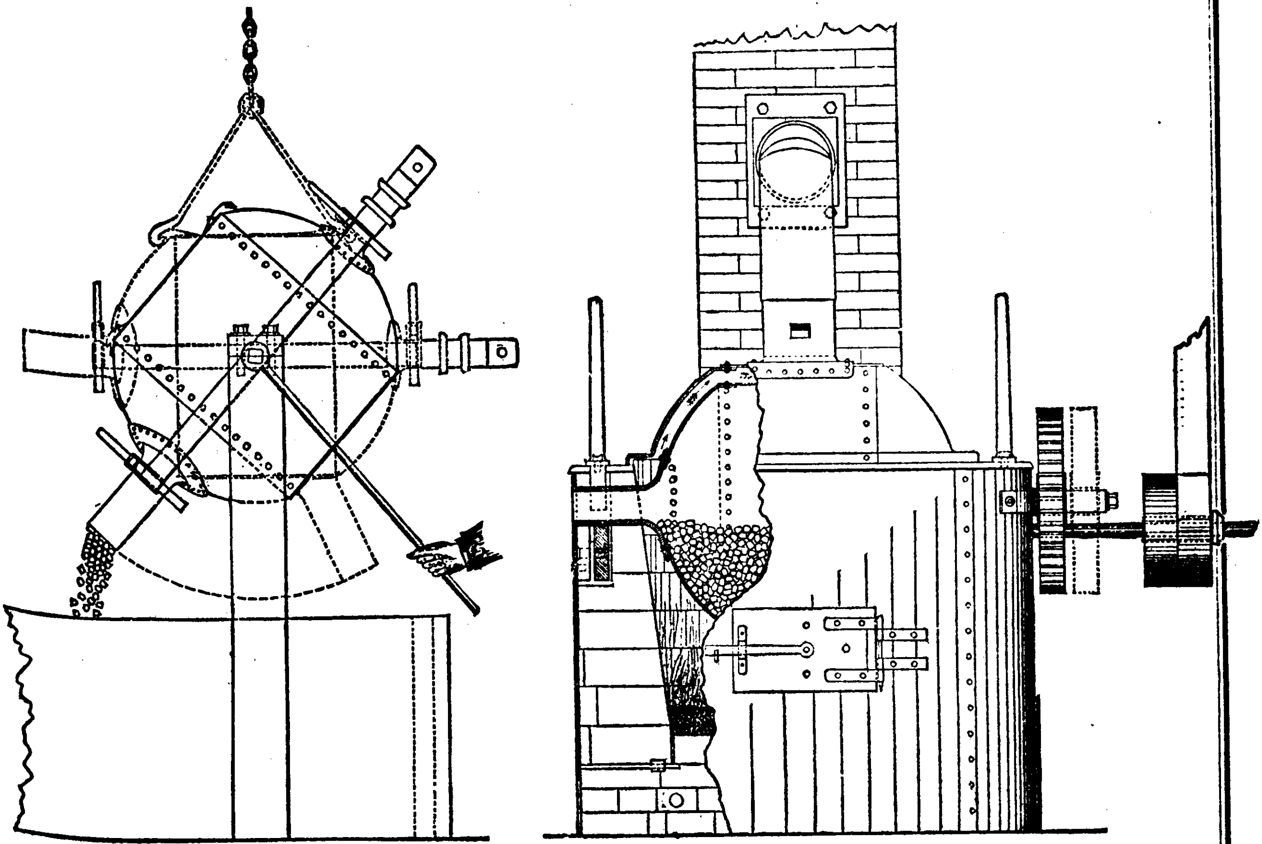
At a late meeting of the New York County Medical Society, Dr. Samuel Sexton read a paper on the use of the lacquered Japanese fan as an aid to hearing. The fan is constructed on the same principle as the audiphone, being composed of lacquered material that receives any ornamentation that may be desired. Its cost is from 25 cents to $1, whereas, when first presented to the public, the audiphone was a high-priced article, ranging from $5 to $25. By using the model of the human skull Dr. Sexton showed how the sounds of the human voice were transmitted to the auditory nerve, and illustrated how the instrument assisted the defective sense of hearing. He had brought a couple of deaf-mute subjects, by means of whom he gave some illustrations of the advantage of the instrument, which proved very satisfactory to the audience. The best distance for conversation was about three feet. When the distance was less the voice was too loud, and when greater it was indistinctly heard.

M. Planté is about to establish a factory for the manufacture of his secondary batteries. He contends that his form is in reality better than M. Faure's modification, as the latter cannot be charged except by a battery, whereas the simple lead-plates can be worked by a magneto-electric machine.

FOR the cattle-car prize at Chicago 480 models and 243 plans were presented, 51 models and 81 plans coming from Illinois. There were eight ladies among the competitors. There have been 116 patents issued on cattle cars by our Patent office.



WINDOW DECORATION, FROM AN ENGLISH DESIGN.



THE GILL ANNEALING FURNACE.

SLEEPING FISH.—(SEE EDITORIAL.)

Mining, Metallurgy, Mineralogy

AN ANNEALING FURNACE FOR SMALL ARTICLES.

In the report of the Chief of Ordnance for the year 1880, Lieut. Col. Whittemore describes an annealing furnace used at Frankford Arsenal for annealing copper and brass shells, cannon-primer tubes, &c. As the furnace is well designed, and, as will be seen, has proved very successful for its special object, it will no doubt prove of value in many branches of manufacture, where similar operations must be daily repeated with a large quantity of small articles. Lieut. Col. Whittemore has reported as follows: It consists of the furnace proper, constructed of boiler iron, lined with fire-bricks, and arranged with flue and cold blast for draft and heat; of an annealing retort, cylindrical in shape, with closed ends of hemispherical form. From these ends project trunnions, which revolve on friction rolls attached to the furnace. The left trunnion, looking toward the furnace, is hollow, and subserves several useful purposes. It is a peep hole for observing the degree of heat to which the charge is being raised, an outlet for the smoke into which the oil on the shells is converted, a means of obtaining samples for test, and of emptying the charge when sufficiently annealed. The annealing accomplished in this tight-jointed receptacle possesses several advantages over the old plan. In the latter the cylindrical vessel used was pierced with holes and revolved with its charge over a charcoal fire. The surface of the shells became considerably oxidized from exposure to the atmosphere and took up some dirt, as ashes from exterior surroundings during the process. By the new plan the charge is protected from the direct action of the fire, and the gases and smoke generated and expanded inside the retort flow out through the hollow trunnion. By the old method charcoal was necessary as a fuel, to guard against the sulphur and other gases which would be generated from burning anthracite coal. Anthracite coal is used with the new retort, and the shells are annealed with less oxidation of their surfaces, and consequently require less pickling and cause less wear upon machinery and tools in the continued process of drawing. Ten thousand shells or thirty thousand cannon-primer tubes is a full charge for the retort. From 180,000 to 200,000 shells can be annealed in one day of 10 hours, at an expense of about $5.25. An equal number by the old method would take three days and 6 hours, at an expense of about $18.75. New process—amount of anthracite coal consumed in annealing 180,000 shells = 600 pounds, as a cost of $1.50. Old process—15 barrels of charcoal at 35 cents = $5.25 A crane takes the retort from the furnace and deposits it upon a cradle, from which it is readily emptied. The retort with full charge, weighs about 600 pounds. The furnace has a hinged wrought-iron cover, which is lowered over the retort during the operation of annealing, and raised when the retort is removed, and a hinged flue, which fits into an opening in the cover connecting it with the draft. The accompanying drawing shows the general construction and operation of the furnace, which was designed by Mr. Jabez H. Gill, master machinist at Frankford Arsenal.

A RAILWAY TUNNEL THROUGH A VOLCANO.

The rocks which constitute the southern island of New Zealand are for the greatest part of the archaic type, consisting principally of gneiss, granite, mica-schist, phyllite, quartzite, and felsitic rocks. They are partly covered by palæozoic strata, which are folded up into innumerable troughs and saddle-backs throughout the province of Canterbury, and which partly belong to the carboniferous period, so that there are prospects for a future discovery of coal beds. By far the greatest interest, however, is offered by the extensive volcanic phenomena of the island, and among them, the extinct volcanoes upon the Banks peninsula, east of the town of Christchurch, are prominent. This peninsula, now only connected by bands of low and recent deposits with the mainland, was once a complete island, only formed by volcanoes, which rose up from the bottom of the sea. The special construction of such an extinct volcano has been made visible by a tunnel of 2,620 meters' length upon the railway between Christchurch and Littleton, which has pierced through the walls of a volcanic cone and thus has laid bare its structure of successive streams of lava and beds of scoriæ, ashes, and tufæ, which are again intersected by dikes of younger volcanic rocks. This is perhaps the first volcano through which a railway has been constructed.

Another peculiarity of New Zealand is the extremely frequent occurrence of bones of those large wingless birds, which by the aborigines were called "moa" and which belong to the family of the Dinornithidæ, of whom the largest representative, *Dinornis maximus*, has reached the considerable height of ten and a half feet; the largest deposits of these bones were found in the Point cavern and the marshes of Grenmark. There is now no doubt that these gigantic birds were contemporaneous with man, and that an early human race were moa hunters in these islands, who lived upon the flesh of these birds at a time when the glaciers extended still very much below their present boundaries, for bones, tools, and other remnants of these early moa hunters are frequently met intermingled with bones of the now extinct Dinornithidæ.

EGYPTIAN ANTIQUITIES.

Brugsch Pasha, the German Egyptologist, has communicated to the *Institut Egyptien* a memorandum which will have a double interest to all who care for Ancient Egypt. The following is an abridged translation:—

"Fifteen days before his death Mariette Pasha, the President of the Institute, summoned me to his bed-side, and begged me to render to him and to science a service of which he could not calculate the importance. Last year, after he had left for France, he had heard that his Arab labourers had opened one of the Sakkara pyramids. They had opened the north door and cleared the passage which led to the funeral chamber in the interior. Along the whole passage, 36 metres in length, the walls were covered with hieroglyphics, which constantly reproduced the names 'Merira' and 'Pepi' encircled by the Royal elliptic. Mariette, to whom were sent impressions of these hieroglyphics, believed they only applied to some high functionary of State, as neither of the names was preceded with the usual Royal titles of the Pharaohs. At the same time Mariette informed me that the Arabs had found the entrance of another pyramid near the first, with the passage and funeral chamber similarly adorned with numerous inscriptions. 'Go to-morrow,' he said, 'and study and report on these two pyramids.' I went next day early, and late in the evening presented the following report; his eyes glistened with joy as I read it:—

'The two funeral monuments are not mere *mastaba* (ordinary rock tombs), but true pyramids. They enclose, the one, the tomb of King Pepi with his official title, "Merira;" the other, the tomb of King Horemsaf, the son of Pepi, of the sixth dynasty, according to Manetho. The granite sarcophagi which once held the mummies of these two kings have been found in their original places. The hieroglyphics with which they are covered prove that the names of "Pepi" and "Horemsaf" belong to kings, and not to mere court functionaries. The mummy of the son of King Pepi, well preserved, though robbed of its ornaments and its linen, has been found in the pyramid. The two pyramids are the earliest examples of royal tombs of the period of the old Empire adorned with hieroglyphics, which not only give the names of the kings who are buried there, but which also set forth for the first time a long series of religious texts, like the "Book of the Dead" of subsequent epochs. They also mention the star "Sothis" (Sirius), the planet Venus, and thus prove a certain astronomical knowledge as long ago as the sixth dynasty. The passages and the funereal chambers, with the sarcophagi, the mummies, and the objects originally placed there, have been either very roughly handled or taken away altogether. The *stela* of Una in the Boulac Museum gives a confirmation of the contents of these two pyramids. Una was an official of King Pepi and his son, and executed many important works for them, of which he boasts on his *stela*. The numerous inscriptions cut in the stone and painted green are of the highest importance. They give an exact idea of the theological notions which obtained at this remote period, and at the same time throw new light on the dictionary, grammar and syntax, and generally on the language and writing of the most ancient known date of Pharaonic Egypt.'"

The following private letter which Brugsch Pasha received from Cairo will be read with interest in connection with this subject:—

"A good deal of interest has been excited by the rumours that two new pyramids have been discovered. As a pyramid is not of a nature to require discovery, and as in any case it was absurd to call any pyramid new, the French newspapers made fun of the rumour, the more so for a reason which does not appear on the surface. A discovery has, indeed, been made, and by a German, a near relative of the eminent historian Dr. Brugsch. He has been for some time engaged in researches at Sakkara, and recently dug out the two ruined pyramids marked, if I do not mistake, 1 and 2 on Howard Vyse's plan. Finding they had not been disturbed before, he prudently covered them up again, as he was summoned to Cairo, owing to the approach of M. Mariette's death. He has, however, now resumed his diggings, which abundantly confirm his first hasty observations. The two pyramids are of the time of the sixth dynasty—the last dynasty, that is, of the ancient Egyptian monarchy. One is the *Men Nefer* (the Good Place) of King Pepi; the other the *Cha Nefer* (Fair Arising) of his son and successor, King Rameren. Both are full of inscriptions of a funeral character, thus differing from the tombs of private individuals of the same period. These inscriptions are likely to prove of transcendent interest to the scientific student, as no other religious writings of the period is known to exist, with the exception of a few brief epitaphs like that of Mycerinus, in the British Museum. It is curious to reflect that during the many years over which M. Mariette continued his researches he never had the good fortune to find the body of a King of the pyramid-builders, and that one, if not two, such mummies should be discovered within a few weeks of his death. The only other body of the kind is that of Mycerinus alluded to aboveas perhaps the most precious Egyptian relic in England."

PRE-HISTORIC MINERS.—The Arizona *Miner* of recent date, says that the miners in the Silver Belt mine have made a remarkable discovery, showing that the mine was worked ages ago. The 10 ft. bonanza recently uncovered, continuing to widen at every stroke of the pick, left an overhanging wall on one side that appeared more like loam than the ordinary wall or vein matter of a quartz ledge, and so soft that it caved in such a way as to obstruct the work. They then went up above the cave and decided to run down on the ledge in a new place, so as to get under the cave, in order to have solid ground to work on; and in cleaning away a place to start in, they found lying on the ore, on top of the ledge, in the soft loam 3 ft. from the surface, five stone hammers, such as are found in the ancient ruins and abandoned mines of the Aztecs all over the country, showing clearly that the Silver Belt has been worked in pre-historic times. This is, the only indication that has been found that the Belt was ever disturbed before the present owners uncovered it.

Miscellaneous.

WARNERKE'S DISCOVERY IN PHOTOGRAPHY.

At the last meeting of the Photographic Society of Great Britain, Mr. L. Warnerke described the discovery he has recently patented. The discovery he said consisted in the fact that a gelatine plate submitted to pyrogallic acid became insoluble in those parts acted upon by light, exactly in the same way as gelatina was acted upon by chromic salts, the insolubility being in proportion to the amount of light and the thickness of the gelatine. This property he proposed to utilize in various ways. The drawback in the ordinary gelatine process was that unless the exposure was very accurately timed there was considerable danger of over-exposure, and, as intensification was very difficult, pictures by the gelatine process were often inferior to those by collodion. By the new process he was, however, able not only to intensify, but also to overcome the drawbacks arising from over-exposure. The latter he effected by using the emulsion on paper. He had found that no matter how much the paper was over-exposed the picture—provided the developer was restrained, sufficiently—was not injured, while in the case of the emulsion on glass, there was not only halation of the image, but a reversal also. The transfer of the image from paper on to the glass was a very easy matter. The paper was immersed in water and placed in contact with a glass plate. The superfluous moisture was removed by a squeegee, and the paper could then be stripped off, leaving the tissue on the glass. Hot water was then applied, which dissolved all the gelatine not acted on on by light, together with the free bromide or soluble salts, and the image was left upon the glass in relief. Intensification he effected by mixing with the emulsion a coloring non-actinic matter, which was not effected by silver. Aniline colors he had found answered the purpose, and in that way special emulsion for special purposes could be prepared. That method of preparation he thoug t would be especially suitable for magic lanterns slides. He claimed for his discovery that by it relief could be obtained far more easily than by the ordinary bichromatised gelatine, and therefore it was especially suitable for the Woodburytype process. By mixing emery powder with the emulsion it was rendered fit for engraving purposes, and by a combination with vitrified colors the image could be burnt in and so was adapted for enamels. In the ordinary methods for producing enamels from carbonized gelatine the latter, from the difficulty of burning it without the formation of bubbles, was a great source of trouble. By using a suitable emulsion, however, so little gelatine might be employed that this drawback was overcome. The process could also be adapted for cullotype printing. In the course of his remarks, Mr. Warnerke demonstrated the removal of a gelatine picture produced by this method from paper on to glass, and showed that the mere immersion and washing in hot water fixed the picture by the dissolving of the gelatine unacted upon by light, which thus carried away the free bromide of silver. In conclusion, he stated that the sensitive paper could be used in the camera in lengths wound on rollers, ond exhibited a camera which he had made for the purpose.—*Industrial News.*

VARNISH FOR GELATINE NEGATIVES.

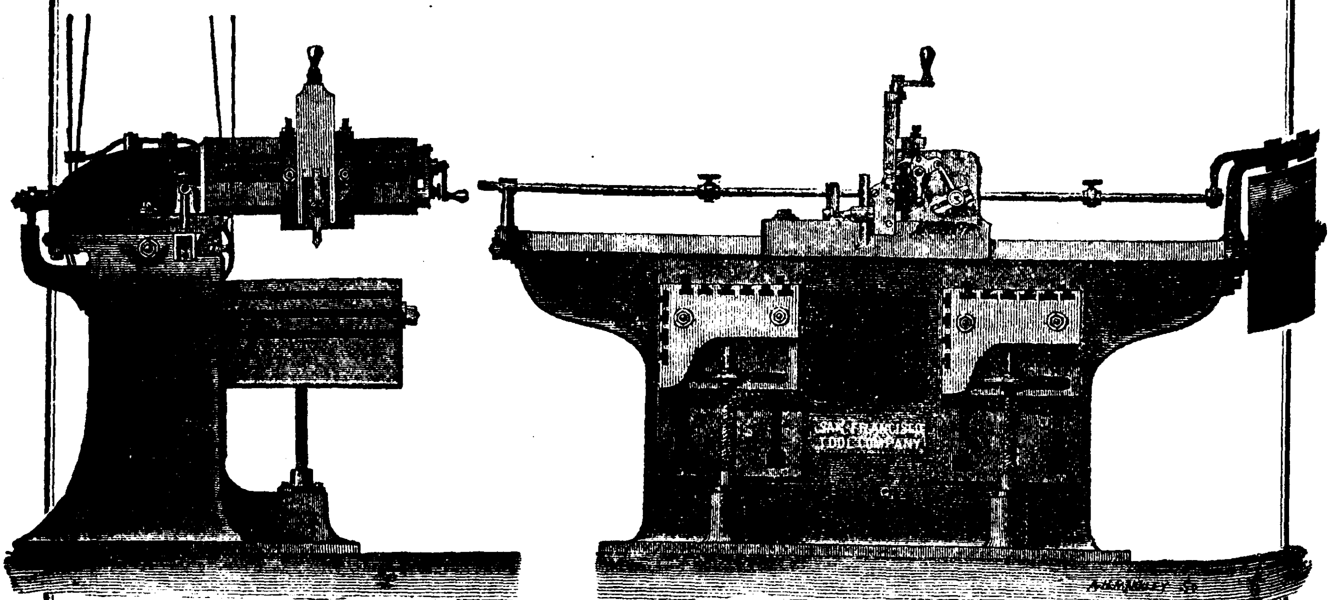
Collodion, by itself—even the ordinary porous collodion employed in negative work—answers admirably, says the *British Journal of Photography*. As a protection against damp its effect is simply marvelous; for should the moisture penetrate it and reach the gelatine film, it possesses sufficient elasticity to withstand the strain put upon it. It exhibits little tendency to absorb silver from the damp printing paper, and in the event of actual moisture being accidently present when in contact with the paper there is no fear of adhesion. For portraiture the film will bear working on with the pencil in retouching, though from its hardness and smooth surface it is usually desirable to use a "medium" to give a "tooth" which will take the pencil.

In preparing a special collodion for the purpose we should select a good, tough—not necessary "horny"—sample of pyroxyline, and use it of the strength of not more than four grains to the ounce, with two or three drops of castor oil. The best protective medium we have used consisted of a collodion made from celloidine, which gives a remarkably clear and structureless film and may be used stronger than ordinary pyroxyline. Five grains of celloidine and two drops of castor oil to each ounce of solvents will answer well. There is a slight advantage in employing a small excess of ether over alcohol in dissolving—say nine parts of ether to seven of alcohol—both being as free from water as possible, and the negative very thoroughly dried before application.

IMPROVED CAR TRUCK.

The annexed engraving represents an improved car truck recently invented by Mr. F. Beaumont, jr., of San Antonio, Texas, which admits of greatly reducing the gauge of the road without diminishing the width of the car. It is easy to show that an immense saving can be made by using the narrow gauge instead of the broad gauge system of railroad building. With the narrow gauge all the heavier work of grading, embanking, tunneling, etc., costs far less, and an important proportion of land damages is avoided. Half the expense of rails is saved and shorter curves are practicable, which makes the constructive engineering both easier and cheaper. Roads of the ordinary narrow gauge of three feet cost about five-eights as much as the broad gauge roads. And an equal degree of speed is also attainable with greater safety, as from the shortness of the axles the wheels slip less on the outer sides of curves, thereby diminishing the torsional strain on axles, which, as is well known, destroys the fiber of the iron, making the car axles useless after a time, and is freqently the cause of railway accidents.

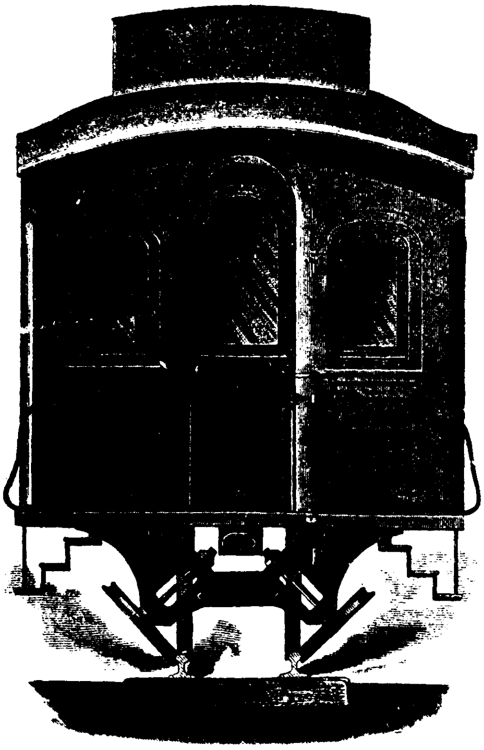
A much larger saving in the cost of construction can be attained by the use of the improvements illustrated, without proportionately diminishing the size of the cars, as shown in the engraving, representing an end view of a car seven feet in width (usual width of narrow gauge cars) on a track of only eighteen inch gauge. The engraving so well explains the nature of the invention that but little need be said further, than that the improvement consists of the lateral wheels placed upon axles, inclined upward and inward at an angle of about forty-five degrees to the axles of the ordinary transporting wheels. These inclined axles have their bearings in the bolsters, one of which is placed at each end of the car truck. The inclined wheels run on the outside of their respective rails, their flanges projecting under the rail head, tending to keep the car in equilibrium, and permitting a much larger part of it than usual to overhang the rails in perfect security, thus enabling the gauge of the track,



PLANING AND SHAPING MACHINE

and consequently the road bed to be greatly diminished in width, as shown in the engraving. When the car is seven feet the gauge is eighteen inches, and the tie is three feet long.

The inventor is fully aware of the necessity of some important modifications in switches, turn-outs, etc., and has also invented a system of these, especially adapted to his method of narrow gauge, which makes it entirely practical.



BEAUMONT'S CAR TRUCK.

The improvement is well calculated to cheapen the construction of railroads, so that they may be built in many instances where now it is impossible to build the present narrow gauge for lack of sufficient capital.

The invention has lately been patented by F. Beaumont, jr., and John A. Fraser, assignee, of San Antonio, Texas, who may be addressed for further information.—*Scientific American.*

A NOVEL PLANING MACHINE

We illustrate above a novel planing machine, made by the San Francisco Tool Co., a machine so thoroughly a departure from common practice that it seems somewhat "revolutionary." Novelty is, however, no object in the design of this or any other machine tool of the company. There is a purpose in the arrangement throughout, which we will proceed to explain :

To meet the requirements of a small shop or where repair work is done, there is generally a shaping machine and one or more planing machines of the ordinary kind, and even with these there are often pieces to be planed that cannot be operated upon because of shape or dimensions.

The machine here shown is to meet such cases. It will perform nearly all kinds of planing on large or small pieces, and does not cost more or occupy more room than an ordinary shaping machine of similar capacity. The drawing is in true elevation, and shows clearly the method of construction.

The tools traverse parallel with the main frame, and adjust transversely 20 inches, or will plane over 24 inches wide, if required. The length of the stroke on the machine shown is from two inches to four feet.

There are two tables on which work can be fastened independently, or by placing a filling-in piece between a continuous table four ft. long is formed. For large pieces the two tables can be readily removed, and as the tools "overhang," almost any kind of a piece can be placed beneath and planed off.

The tools are driven by a strong steel screw, on which there are three separate nuts, making an aggregate length of 12 inches. One of these nuts adjusts so as to prevent back lash ; and all are made from solid brass—not filled with type metal, as is common with the old screw-planing machines. There are no gear-wheels employed. The driving pulleys are placed directly on the end of the screw, so that the machine is noiseless—a feature that can be claimed for no other now in use.

In large works, where a "set" of planing and shaping machines are employed, there is less advantage from one having such a wide range of adaptation, but for present circumstances on this coast, and especially for repair work, at mines or in large factories, such a machine tool cannot fail to meet the expectations of the company who have so boldly left the beaten track in deference to local requirements.

The company have a four ft. machine ready for their own use, and are able to supply them of that or greater length.