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NOTE AND COMMENT.

WE have heard so little lately of the Channel tunnel, if we except Sir Garnet Wolseley's protest against the scheme and the French criticisms upon it, that the world has almost forgotten the gallant little band of workmen who are steadily cutting their way through the lower chalk on either side the "silver streak" between Dover and Calais. Already, at last advices, one-tenth of the boring has been completed, the French workmen having pierced through 1800 metres, and their fellow workmen on the English side 1,600, the tunnel being in total length, irrespective of the inclines at each extremity, about 29 kilometres. The successful accomplishment of so large a portion of the work goes far to establish the entire practicability of what was so long denounced as a visionary scheme. From Sir John Hawkshaw's careful observations the conclusion was reached that it would be possible to excavate the entire tunnel in the lower bed of homogeneous chalk. This stratum affords several important advantages to the engineers. It is very easily worked, its great depth makes it possible to run the excavation in a gradual curve corresponding with that of the bed of the Channel itself, and last, but not least, it is practically water-tight. The tunnel excavated by Sir John Hawkshaw a few years since near Brighton, was in the upper chalk, and the constant discovery of water springs materially impeded the work, though even this disadvantage was not productive of permanent delay. From this difficulty the present work is entirely free and the tunnel is proceeding more rapidly even than was expected. The present boring is merely to be a drift way, which once finished, the work of enlarging it to a tunnel will be mere child's play. The original calculation contemplated an expenditure of two years upon the piercing of this way, but it seems likely now that the actual work will take considerably less. After this, perhaps four years will be needed before the railway will be fit for use, but long before then the most striking if not the greatest engineering work of modern days will have been practically completed, and imposing as will be the final opening of the line, there will come before that a day which will be far more exciting and far more impressive in its result. A day when the little band of workers, deep down out of hearing of wind and waves, shall hear through the rock the distant echo as it were of their own blows, and pushing on with redoubled exertions shall see the thin barrier fall, and clasp, through the narrow opening, the hands of their fellow workers from the other shore.

THE passing of the Employers Liability Act has produced a marked effect already in England, where the press generally are commenting upon the change in the legal position of master and servant produced by it. The *Building and Engineering Times* gives an account of a case lately heard in the City of London County Court. There a man who was employed as a labourer by the Midland Railway sued the Company for compensation for personal injuries received by him, while in their service, under these circumstances. When acting under the orders of a foreman, in loading a van, he had helped to fix a case upon a crane in such a careless way that the crane canted over and broke his leg. The defendant's evidence contradicted this view of the case; but as the learned Judge found for the plaintiff, with £150 by way of damages, that need not be considered. The important point in the case is that the Employers' Liability Act should be so easily applied for the benefit of workingmen. The sections upon which this action proceeded give a right to compensation whenever injury is caused to a workman by reason of his conforming to the orders of one placed in authority over him. Here, all the plaintiff had to show was that he had acted under the foreman, and that the accident was caused by that foreman's negligence in giving an improper order. By the old law no such action could have been maintained, but now it is well nigh unanswerable. If, however, the employer could show that the plaintiff had by his own careless conduct contributed to the result, that would be a good defence, though in this last case that point does not seem to have been taken. The fact that a workman knowingly loads cases on a crane in a dangerous manner may, however be used as strong evidence against him; but the judgement in this action will no doubt act as a warning to all employers of the risks they run when they allow their foremen to carry on business in a reckless or negligent manner.

MR. GLADSTONE's trumpet has given out no uncertain sound upon the subject of Free Trade at all events. In one of the speeches at Leeds, he compared at length the statistics of trade of the various countries of the world with results that were at least gratifying to our mother country. Speaking of the neutral markets of Asia, Africa and Australia, in which the trade may be supposed to be open to all countries alike, the Premier showed that the exports to those countries from America amounted to but £4,751,000, as against £78,000,000 exported from the United Kingdom—"I do not say it with satisfaction or sympathy," says Mr. Gladstone, "but I say I regret that she has been committing, in the matter of commerce, the errors of which we had set her the example, and the result was that puny competition of America in the neutral markets of the world. What I will say is, that so long as America adheres to Protection your commercial primacy is secure. So long as she is content to fetter her strong arms by Protection she will not be able to compete with us in the markets of the world; and the advocates of Fair Trade may rest satisfied that there is not the least fear of their slumbers being interrupted by American competition, or of our losing commercial primacy." These are strong words and the figures make them stronger yet. In 1879—the fatal year, according to Mr. GLADSTONE, of commercial anarchy—England's trade amounted to £612,000,000, and there was only a falling off of £80,000,000 in a population of thirty-five millions. Comparing this with the returns of the other great countries of the world, we find that France had £313,000,000 of trade, with 36,000,000 of people; Russia had £183,000,000 of trade, with 80,000,000 of people; Holland had £116,000,000 of trade—a good deal of which is transit trade—with about 5,000,000 of people; the United States and France, with a population of 900,000,000 combined, had a trade of £610,000,000; whilst the United Kingdom with a population of 35,000,000, had a trade of the value of £612,000,000.

NEW YORK is awakening to the fact that the lager supplied to her thirsty citizens is not all that it should be. Without meddling at all with temperance matters we may consistently argue that good beer is superior to bad, and prefer the beer made in St. Louis or Cincinatti to that which is supplied to patrons of the popular beverage in New York. And now the murder is out. The revenue officers have unfathomed the mystery. They find there is scarcely any honest beer made in New York. On overhauling the books of the principal brewers, it was discovered that the materials used were glucose, grape-sugar, rice-spirit and corn, but very little malt was employed. This stuff is fortified by some powerful drug which chemistry cannot detect, as it fails in its analysis of vegetable poisons. In Germany, New York lager would be promptly seized by the police and poured into the gutter. This question of adulteration of intoxicating drinks is one over which the fiercest war will have to be waged before the so called temperance question is decided. If non-abstaining societies would set themselves in the first instance to war against the poisons introduced into the liquor trade they would do far more service than by unreasoning opposition to the use of liquor good and bad. The effect of the prohibition of the liquor traffic in several of the States has been to produce a large increase of adulteration. Here, in Canada, much of the liquor sold is absolute poison. Such horrible ingredients as lye even are introduced to give a "bite" to well watered alcohol. Whiskey *per se* may or may not be a desirable beverage, but lye and water is a deadly poison. For ourselves we believe in encouraging the sale of malt liquors, placing a prohibition duty upon alcohol, and making adulteration a felony in law.

Educational.

EVENING SCHOOLS IN NEW ENGLAND.

BY WM. O. CLOUGH, NASHUA, N. H.

Evening schools for the benefit of mill operatives and mechanics' apprentices have come to be an established institution in the greater number of New England manufacturing cities and villages. They meet a demand of the times; they have come to stay, and therefore educators of the young must recognize them as an important factor in the educational system,—a factor that should not be overlooked or neglected. In fact, those who have to deal with them should at once and for all time disabuse their mind of the idea that their existence is for the purpose of dodging the law, where education is made compulsory, and devote themselves to the task of developing methods that shortened the relative position to the evening school that made it practical and complete for the day school. Before proceeding, however, to point out some of the necessities of the evening school, as they appear to our understanding, it will be interesting to many, no doubt, to know why it exists, and something of its personnel as it appears to one who has had experience as a principal.

The evening school has its existence (1) because of a law that requires children under a certain age, who are employed during the day, to exhibit to their employers a certificate that they have attended school twelve weeks in the current year, and (2) because of the necessities of families. The first is the law of the State, and the second is the law of necessity. The law of the State is well understood as compulsory education, and the law of the necessity of the case is found in the fact that in large families—where there is a constant strain upon all members to procure food, fuel, and clothing—sickness sometimes adding its weight to the burden—the children must work, or go ragged and suffer hunger. To the verdict under this law there is no appeal, and the state confronts vexed questions when it sets up its law of compulsory education against it, in that it compels the members of families to suffer for the things whereby they live, or seek relief of the overseers of the poor of the town, city or county. Now, if we believe that the law is not justified in compelling pauperism upon the people and if we take into consideration that other well-known law of nature that people who have an honest pride will suffer terrible sorrow before they will compel themselves to ask alms—then we have readily solved the problem, "why evening schools exist."

The scholars,—we must presume that there is little or no difference in localities—vary in their ages from ten to twenty years. Those who are under fifteen years of age are driven, in most instances, unwillingly, and those who are over fifteen "ask in" because of a commendable desire to obtain an education, or because some stern parent, who knows the advantages to be derived, compels their attendance The first-mentioned are usually well disposed, but, being fatigued by the labor of the day, often sleepy; and having no opportunity of study except such as the hour and a half in the school-room offers, generally make slow progress. They are tired and restless, and therefore the strict discipline of the day school cannot be reasonably enforced. The second class—those who ask the privileges of the school—are very attractive scholars, and it is always a satisfaction to assist them and share the joys of their triumphs. The third class—the drone who has been taken in hand by a "stern parent,"—is the curse of the school. He is the young man whose wants are never satisfied, who demands the greater part of a teacher's time in accomplishing nothing, who performs all the tricks that disturb the school; who must be watched, flogged three times a week, or expelled. Fortunately for those who have to do with evening schools, the number of the latter class is not large.

It will be observed by our statement, that many of the scholars are fatigued by the labors of the day, and have no time for study,—that the methods of teaching must of necessity vary considerably from those of the day school. A memorized lesson is out of the question, and, moreover, a teacher cannot divide his time among all grades of scholars, so as to give thorough drill and explanation to those who rank in classes. What is the method? So far as we are informed, no two schools have the same. What shall be the method? This is an open question that should be considered in educational conventions. We have experimented with but one, and, while it has its disadvantages it has its advantages. In a room of forty scholars and two teachers, we arrange them so that those in the alphabet are given work at the board copying a word or sentence of short words. The reading—the class being called to the floor—is so arranged that no two of the five are speaking at the same time. While one teacher is thus engaged, the time of the other is spent in passing from one desk to another, explaining and assisting individuals in mathematics. This method—the last fifteen minutes of the hour and a half being devoted to writing —serves to arouse the interest of the scholar, inasmuch, as it makes it certain that he is to be personally assisted and fully occupy the time of the teacher. It is open, however, to its objections, and is not put forward with a view of its adoption except by those who in the absence of another method, may think favourably of it.

Another important matter to consider in connection with evening schools is books. With the Readers now in use in the day schools, we find no fault. They cover the ground completely, and the moral lessons they contain are calculated to make a good and lasting impression upon the mind. The first three of the series (Franklin) are well enough for the beginners in the evening school. The fourth and fifth books should, in our judgement, be replaced with an attractively written work upon the history of the country, commencing with a condensed statement of colonial matters, taking up the Revolution of '76, and following on with important happenings to date. The scholar, who now, owing to limit of time, learns nothing of history, would thus be made familiar with something tangible and of special benefit to him in his search for knowledge. A book of this kind must, it seems to us, find favor with boards of education and superintendents.

The Franklin Written Arithmetic in use in the day schools is complete in every particular, and should be satisfactory where thoroughness is possible. For the pupils of an evening school, we should simplify it. We should strip it of drill tables, and condense the first fifty-six pages into twenty-five pages. retaining the slate exercises—which are the best we have ever seen for the development of the reasoning faculties of a scholar—and add others in each of the four rules. We should then take up a practical method of interest and follow on—making a book of about one hundred pages—with United States money, a few practical examples in percentage, and a complete system of single-entry book-keeping, with explanations concerning bank-checks, notes, drafts, etc. This suggestion will undoubtedly strike the average educator and book-maker as exceedingly raw; but were they situated so as to observe the struggle of young men who have had no opportunity to learn these things, and who realize that school-days are ending with them, they would change their minds. The conviction would come to them that there is a class—a large and a worthy class—who want to know some of the simplest and most practical methods of doing business; and when they have mastered it, and the wider fields open to them, they have the germ that will develop to their advantage and protection.

But we are making this article too long, and attempting to canvas too much in condensation. The evening school needs airing, and if we succeed in calling attention to it, so that boards of education and superintendents will recognize its claim, we shall be satisfied. It is not enough to clear the compulsory-education law by giving an evening school ninety minutes an evening, five evenings a week, twelve weeks in a year; in contrast with five hours a day, five days in a week, thirty six weeks in a year, and then declare that duty is done, and the letter and spirit of the law kept. It is right, it is just, that the poor, the laborer, the unfortunate should have as equal a chance as it is possible to give, and we respectfully submit that there is not a New England Manufacturing town or city that cannot do better, and that, too, without burdening that other and self-constituted, unfortunate class known as the tax-payer.

THE HIGHEST LAKE IN THE WORLD.

The lake that has the highest elevation of any in the world is Green Lake, in Colorado. Its surface is 10,252 feet above the level of the sea. Pine forests surround it, and eternal snows deck the neighboring mountain tops. One of these, Gray's Peak, has an altitude of 14,341 feet. The water of Green Lake is as clear as crystal, and large rock masses and petrified forests are distinctly visible at the bottom. The branches of the trees are of dazzling whiteness, as though cut in marble. Salmon and trout swim among them. In places the lake is two hundred feet deep.

Engineering, Civil & Mechanical.

THE RAUB CENTRAL POWER LOCOMOTIVE.

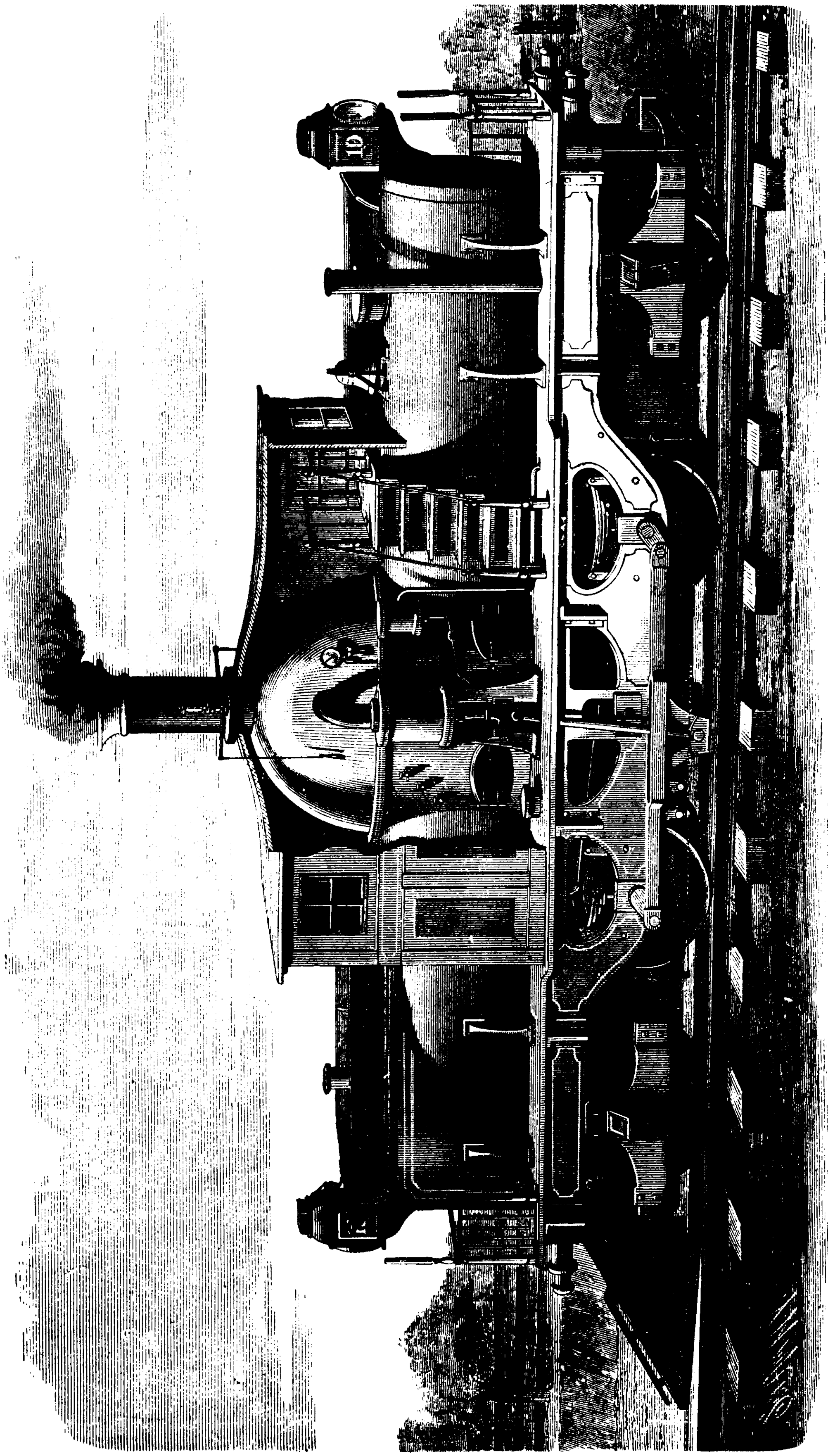
We present illustrations of a new system of constructing railroad locomotives, recently patented by the inventor, Doctor Christian Raub, of New York City. The object of this invention is to construct a perfectly balanced locomotive, in which the center of gravity is coincident with the vertical median line of the engine, and in which the motive power is located at the middle of the engine in a plane extending through the centre of gravity. These two objects being attained, it is hardly possible to overestimate the value of the invention, since the locomotive will then be constructed upon correct principles and according to natural laws. It works from its centre, and has its motive power situated in a plane extending through its center of gravity, and has therefore no dead weight.

It is not within the scope of this article to review the various attempts and experiments undertaken in the course of time in this direction, but it may be stated generally that the problem of locating the center of gravity in a railroad locomotive upon the centre of its base formed by the driving wheels, and to place the motive power at that centre, had not been solved before the invention of Dr. Raub; and probably the reason why these attempts have not been successful is, that the fact was not sufficiently realized that Stephenson's system was at variance with the principles above referred to, and that nothing short of a radical change of the whole system of construction could lead to success; any improvement upon the original design, no matter how great, could not overcome the faults or disadvantages which were inherent in the system as a whole.

Dr. Raub, in order to definitely locate the center of gravity, has constructed his engine in such a manner that each half of the total structure, whether divided longitudinally or laterally, is an exact counterpart or duplicate of the other half, both as regards weight or measure: the consequence of this is that the center of gravity is in the intersection of the longitudinal and transverse center planes of the entire locomotive, and by placing his motive power in the central transverse vertical plane ot the engine he has disposed the parts of his locomotive to the best advantage for economy and efficiency.

The engravings represent the invention so clearly as to require but little explanation. The whole engine rests upon an oblong platform which extends all around the structure, and which is made wider in the middle to support the engineer's cab, which will be as wide as the cabs now in use; at each side of the engine is a boiler extending longitudinally to the end of the locomotive, each boiler having a separate firebox, which is located in the cab. The boilers have ordinary flues, which terminate in a smoke chamber at the extreme ends of the locomotive, but instead of allowing the heat and gases to escape through smokestacks at the ends, as in the present locomotives, they are conducted through return flues of a larger size (as shown in Fig. 3) to an interior collecting smoke chamber, which thus collects the smoke and gases from both boilers, and allows them to escape through one common smokestack which stands above it. This collecting smoke chamber extends upward and downward vertically through the entire locomotive, and serves not only as a brace to the steam dome which surrounds its upper portion, but also gives an additional support and strength to the entire structure. The steam dome stands in the centre of the locomotive, its axis being the exact center of the engine. It is stif-

FIG. 1.



THE RAUB CENTRAL POWER LOCOMOTIVE.

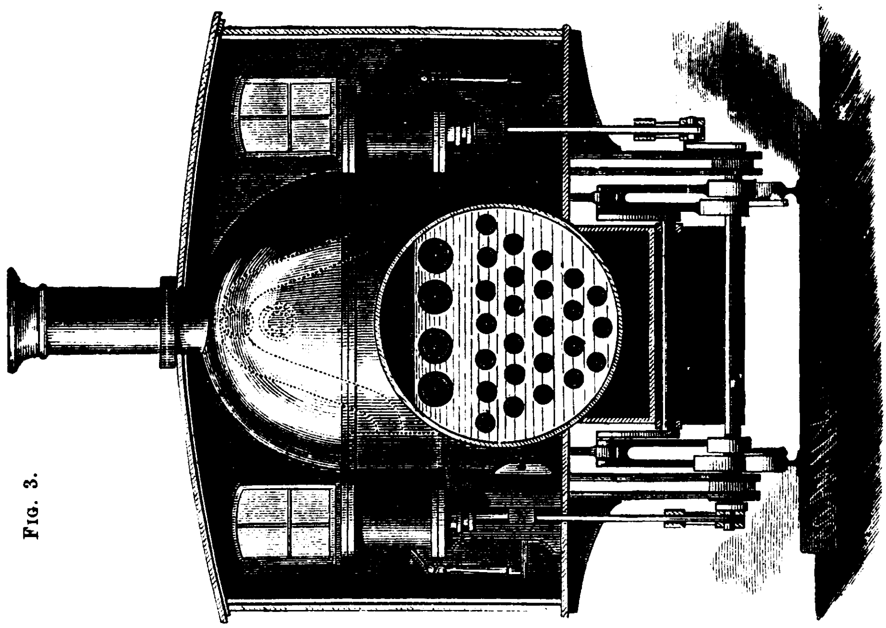


Fig. 3.

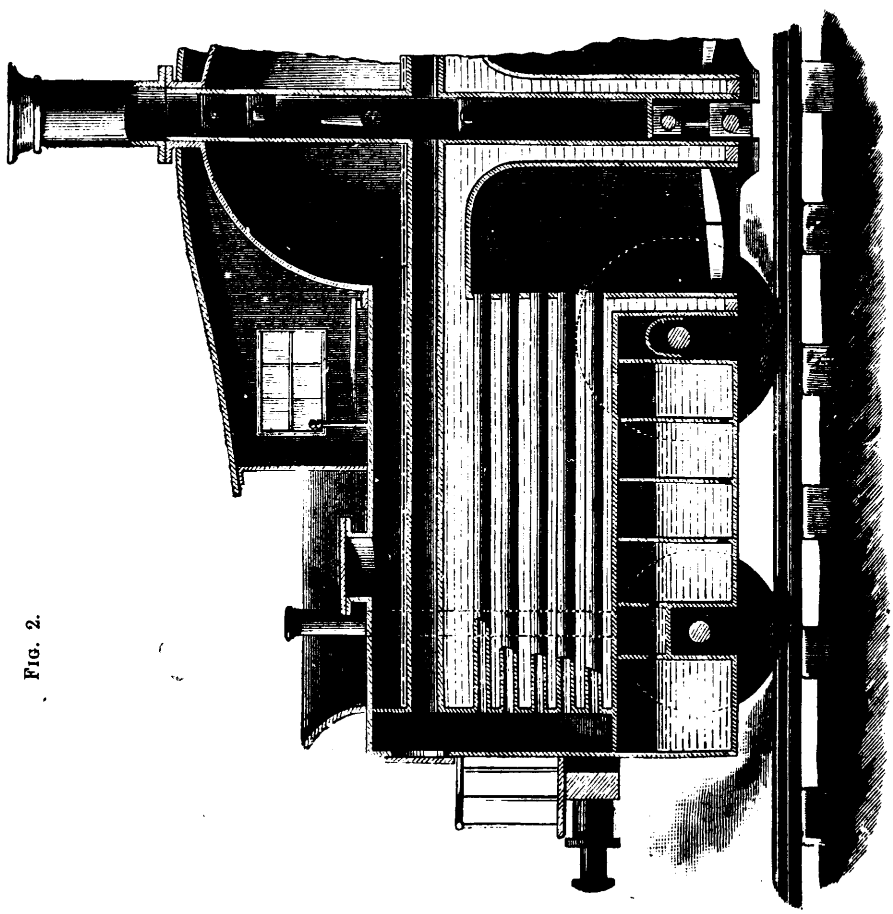


Fig. 2.

THE RAUB CENTRAL POWER LOCOMOTIVE.

fened by the collecting smoke chamber which extends through it. A separate valved connection is made through this interior smoke chamber for the steam as well as for the water in the boilers, so that both steam and water can circulate freely from one boiler to the other, or may be shut off if it is desired to use one boiler only. The steam cylinders are vertical, and placed outside the steam dome, their axis being in the vertical transverse extending through the center of gravity of the locomotive, and preferably placed as high as possible, so as to take the steam by means of pipes which receive their steam supply from a common opening at the highest point in the steam dome, the opening being closed by a throttle valve operated in the usual manner. The steam chests are placed inside the dome as shown in Fig. 3.

The driving-wheels are situated equidistant from the center line, and upon them rests the whole platform, and in the centre-line, and as near the rails as possible, is placed an intermediate driving shaft, to the cranks of which, on opposite sides of the locomotives, extend the connecting rods from the cross-heads of the piston rods above. The cranks of the two drivers on each side of this vertical connecting rod are connected in the usual manner by a horizontal driving rod, which, near its center, extends downward to the crank of the intermediate driving shaft and is connected with it. The driving rod is slotted in its centre to allow the vertical connecting rod free play.

The eccentrics are placed upon the intermediate driving shaft, while the link motions are arranged on an auxiliary shaft vertically above it.

The locomotive may have horizontal cylinders, if they should be preferred. In that case they would be placed lower down in a line with the center of the driving wheels, but in the same central position.

At each end of the locomotive the frame rests upon a truck, but as the whole engine is evenly balanced upon and supported by the driving wheels, the object of the trucks is not so much to support any specific weight, as in other locomotives, as to serve as a guide over curves. Each end truck has one transverse axle with one pair of wheels and a frame which incloses the wheels and is connected by an arc-shaped guide piece, which is transversely guided in a fixed center box at the end of the locomotive.

The water tanks are below the boilers, openings being provided to allow the axles of the wheels to pass through. The fuel is carried in bunks arranged sideways and above the boilers.

A novel and ingenious plan is devised for feeding the boilers. The return flues being situated but a few inches below the water level, it is important that the level should be continually kept up. The inventor has, therefore, arranged a steam pump, which is worked by a lever connection with the main piston, and which injects into the boilers at each stroke of the piston the equivalent of water for the steam used.

These are the main features of this novel engine, which the inventor claims as the first locomotive built upon strictly scientific principles.

The advantages claimed for this new style of locomotive, and to which Dr. Raub has given the appropriate name of central power locomotives, are numerous.

This engine has no dead weight, therefore its whole power can be utilized for drawing freight; and it is claimed that a central power locomotive of a given size will do more work than another locomotive of the same size under the same conditions. The heat is better utilized, as it is led back through the boiler by means of the return flues, and the fuel will be more fully consumed than it is now. The collecting smoke chamber which extends upwards through the steam dome, serves to superheat the steam, consequently dry steam will be obtained, and the steam chests being inside the dome, no loss of steam from condensation, will take place. Should an accident happen to one of the boilers the connection between the two may be interrupted, and the remaining boiler will be sufficient to propel the train to the next station thus preventing blocks on the road and delays to traffic.

It is claimed that a train may be run at a much higher rate of speed with this engine and with much more safety than now, owing to the balanced driving wheels and the peculiar relation of the parts; and there is less danger of breaking the driving rods and less strain upon the track.

A separate tender will not be required, as both water and fuel are carried upon the locomotive itself; and, furthermore, turntables with their necessary attendance will become superfluous, since the locomotive is a perfect double-ender, and runs in either direction with equal efficacy and without any damaging effect to the gearing.

We understand that Dr. Raub is now making arrangements to build several locomotives according to his new system of different patterns and sizes, in order to practically test their merits and superiority and to ascertain the actual percentage of saving in running them.

The doctor has for many years been identified with several large Western roads, and is well known as a prominent and able railroad engineer.—*Scientific American.*

THE HARDENING OF STEEL.

The tempering of steel is a question which is attracting considerable attention at the present time, especially the relation between the metal and the gases which come into contact with it during the process of manufacture. An interesting communication on the subject was recently made to the Physical Society by Professor Chandler Robert of the Royal School of Mines, and his principal result, though of a negative kind, is valuable as narrowing the question at issue. Professor Roberts began by tracing the history of our knowledge concerning the carburization of iron, from the work of Clonet, at the end of the last century to that of Margueritte, in 1856. Margueritte showed that although the conversion of iron into steel could be effected by contact with carbon even in the diamond form, it is, nevertheless, true that carbonic oxide ordinarily plays a considerable part in the process. Graham's paper "On the Occlusion of Gases," read in 1867, gave singular point to this conclusion by showing that carbonic oxide can penetrate to the centre of a mass of iron. This gas is in fact introduced into the iron at a comparatively low temperature, while a high temperature is necessary to enable the metal to appropriate the carbon in order to become steel.

The effect of occluded gases in iron and steel is now being carefully studied by metallurgists in general, and a committee of the Institution of Mechanical Engineers recently raised the question in one of their reports as to whether the hardening and tempering of iron and steel might not be produced by the expulsion of occluded gases during the heating process, and their subsequent exclusion by the sudden cooling and contraction. Professor Roberts has undertaken to answer this question, and by heating rods and spiral wires of steel in *vacuo* by means of the electric current and suddenly quenching them in cool mercury, he demonstrates that steel will harden when there are no gases to absorb. The metal was of course robbed of its occluded gases by means of an air pump connected to the vacuum chamber, and the parts which were quenched in the mercury were found to be glass hard, while those which did not reach the cold fluid were found to be quite soft. Professor Robert therefore concluded that gases do not play any part in the process of hardening and tempering. Historically interesting are the facts mentioned by Professor Roberts that as early as 1781, Bergman clearly stated that fixed air could give up its carbon to iron, and that Reaumur in 1722 actually employed the Toricellian vacuum in experiments on the tempering of steel, the metal being placed red-hot in a highly-rarefied atmosphere, thereby anticipating the methods of to-day by more than 150 years.

An interesting discussion followed the reading of the paper. Professor Hughes who has made numerous experiments on the subject, expressed his opinion that the temper of steel was due to the chemical union of the iron with the carbon. At low temperatures this union takes place only in a slight degree, and hence in soft steel we have the carbon keeping aloof from the iron; but as the temperature is raised the combination is furthered, until in the case of grey or glass hard steel we have really a kind of diamond alloyed with iron. Sudden cooling is necessary to fix the combination, for in slow cooling the carbon separates out again from the iron. This theory is a very promising one, and is supported by a variety of facts; Mr. Stroh, for example, having observed that when an electric spark passes between the two iron contact-pieces and fuses them, the fused part becomes diamond-hard and will scratch a file. Recent researches by Mr. T. W. Hogg have also led him to a similar conclusion, namely, the temper of steel is due to the presence of an unstable compound of iron and carbon. The theory might very well be tested by chemical analysis in order to see whether the proportion of carbon appropriated by the metal increased with the temperature, or if any change took place in the refractive index of the steel.

It was generally agreed by all the speakers at the meeting that the color of the surface of tempered steel depends on the temperature, and is due to the thickness of the film or skin of oxide; the blue film signifying a higher temperature than the yellow, as well as a thicker coating. In this connection Professor Hughes has demonstrated that the electric resistance of the film increases with the temperature. A novel illustration of metallic skins was furnished by Professor Guthrie, who exhibited a steel chain to which he had given a beautiful bluish-black protective coating by simply dipping it in melted nitrate of potash or common nitre. The process was discovered accidentally, and as the bloom improves the appearance of the metal, it will probably be applied to utensils of iron and fancy articles.—*Engineering.*

THE PANAMA CANAL.—WORK DONE.

The president of the American Branch of the (De Lesseps) Panama Canal Company has issued a statement of the condition of the work. Notwithstanding the obstacles encountered in the luxuriant vegetation and the thick forests, there has been opened and recorded transversely to the axis of the canal over 200 kilometers of paths, and also a passage from 20 to 30 meters has been made from one end of the Isthmus to the other, according to the proposed lines of the Canal Commission. For meteorological studies, to which especial attention has been given, four stations have been established—at Colon, Gamboa, La Boca del Rio Grende, and Naos Island. Geological surveys have been made and are now in progress. It has been ascertained that between Colon and Lion Hill the canal will not encounter any rocks. At the present time two steam sounding apparatus are being put up similar to those at Colon. At this station the samples brought up by the spoons have given an exact structure of the soil. It is shown to be a succession of layers of clay, representing the degradations of a greenish pyroxenic rock, which through its gradual degradations and decomposition has produced this formation. At other places the ground, bored to a depth of 25 meters, has revealed nearly every way, instead of successive formations methodically arranged, a chain of derived rocks growing softer and softer. The thickness of the mellow soil is quite remarkable, and, in a word, the soundings have given results beyond expectation on the whole line of the canal.

Work on the canal has been commenced. The company now have 200 cars, 12 locomotives, 2 pontons, 2 steam cranes, 18 flatboats, 2 dredges with change pieces, ribbon saws, rails, etc., a part of which is already at Colon and the remainder is on the way. The storehouses at Colon cover an area of 1,400 meters, and are full. Five barges and two steamboats are plying upon the Chagres River. Another steamboat at Panama is used for hydrographic surveys of the bay.

SUCCESSFUL MOVING OF A LARGE HOTEL.

At a recent meeting of the Engineers' Club, of Philadelphia, the Secretary read a detailed description of the moving of the Hotel Pelham, at Tremont and Boylston streets, Boston, for the purpose of widening Tremont street. This hotel is built of freestone and brick, 96 and 69 feet frontage. The Boylston street wall is supported on eight granite columns 12 feet high, 3 and 4 feet square. There is a basement and seven stories above the sidewalk. Height above tramways on which it was moved, 96 feet. Weight, 5,000 tons, exclusive of furniture, which was not disturbed during removal, as also were not the occupants of the stores on the first floor and some of the rooms, the various pipe connections being kept up with flexible tubes. Careful experiments with models showed that if the lower part of the building was firmly braced, there was no danger of shifting in the parts above. The general arrangements consisted of heavy and substantial stone and brick foundations for iron rails and rollers, and the building was forced to its new position by fifty-six screws, 2 inches diameter, half inch pitch, operated by hand against timbers arranged to uniformly distribute the pressure against the building. Much care and ingenuity were displayed in the details of the arrangements and work. Two months and twenty days were occupied in preparation. The moving itself was begun on August 21, and finished on August 25, but the actual time of moving was but 13 hours and 40 minutes. The greatest speed was two inches in four minutes. The hotel moved about one-eighth of an inch at each quarter turn of the screws. The whole distance moved was 13 feet 10 inches. Four thousand three hundred and fifty one days' labor was required for the work. The whole cost was about $30,000. This is the largest building that has ever been removed, although larger have been raised, which latter is a much simpler and less risky operation. The complete success of this undertaking is shown by the fact that cracks which existed in the walls prior to removal were not changed by the operation. Paper was pasted over them before commencing, that any change might be seen.

Trade Industries.

PETIT PAIN.

The millers of France are in a state bordering on panic, and may now be supposed to have little reason to boast over the farmers whose corn they have so long ground with such ease and certain profits to themselves. The reasons for this desperation which has overtaken them are not be understood properly without an intimate acquaintance with the whole art of grinding, but they may be briefly explained by saying that in this department of national industry, as in several others, the French are behind the age. For some centuries the flour produced by them was justly celebrated throughout Western Europe for its purity and whiteness; and even now visitors to Paris are often agreeably surprised at the color and attractive appearance of the *petit pain* which makes its appearance at the early morning meal. But all the credit for this delicacy is now admitted to be due to the baker, and not to the man who supplies the elementary materials for baking. By a careful study of the question, and a comparison of the French flour with that of other countries, the sad conclusion has been arrived at that Gallic millers are beaten in the race, not only by the Austrians, but also by the Swiss. For the last three years these two nations have boldly disputed the palm with their Western rivals, and have at last succeeded in convincing the cosmopolitan market of their superiority. The export of flour from France is diminishing, and it is no longer possible to doubt that industry has received a serious blow. A French engineer has lately broached this uncomfortable theory in a paper read before a trade assemblage, and has suggested the reason already given for the growing unpopularity of French-ground flour. The consideration is one of some importance, not only for the millers but for the country. Two hundred million francs are supposed now to be invested in the industry, and it would require a hundred thousand to renovate the machinery. On the other hand, it is calculated that 150,000,000*frs.* a year are lost by sticking to the old utensils, which are now superseded in more progressive parts of the world.—*British Confectioner.*

WHEAT HARVEST ABROAD.

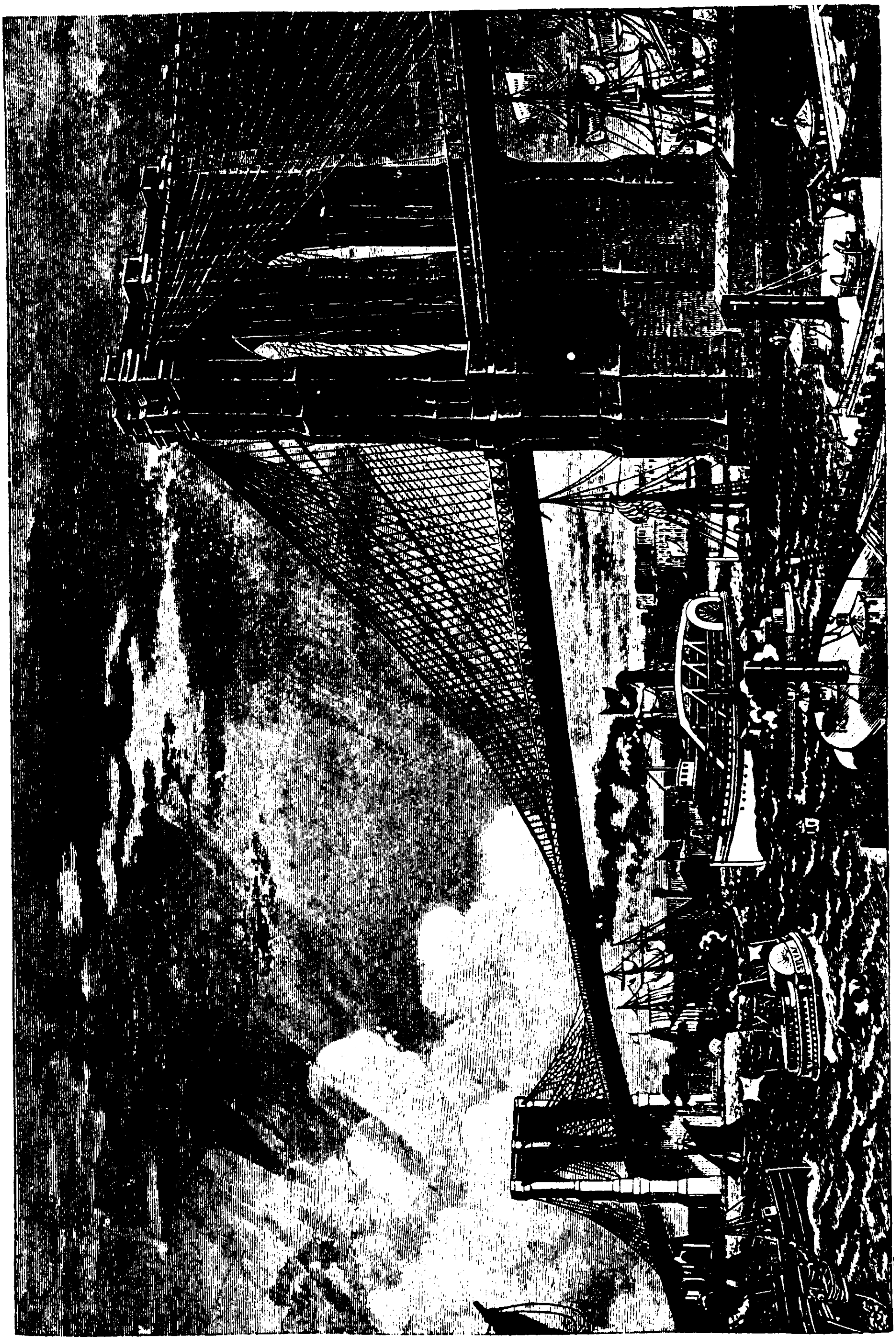
The London correspondent of *Bradstreet's* says, under date of September 8th:

The high percentage of yield accredited the British wheat crop by the Vienna international corn market recently would tend to render the exhibit of very little value, if as wide of the mark throughout as in our case. The fact is they were formed before the three week's rain—at the most critical season of the year. Within the past seven days a considerable amount of grain has been got in, and from all I hear I very much doubt whether our wheat harvest can be placed much above 75 per cent. of an average, while barley may range from 100 to 105 per cent., and oats from 70 to 75. With regard to the French harvest, the information at command would indicate that 85 per cent. is full low; but, nevertheless, it seems certain that these two countries are open to absorb as much foreign wheat as they have in the past twelve months. That in the case of England has been as fol'ows:

	—Twelve months ending August 31st.—		
	1879, cwts.	1880, cwts.	1881, cwts.
Wheat	51,725,435	59,815,691	55,990,769
Wheat flour	9,124,388	10,431,726	12,242,571
Barley	9,994,624	12,382,665	10,624,616
Oats	12,133,645	15,622,912	10,879,916
Indian Corn	38,621,787	31,870,896	37,777,160

This country will probably require not far short of the equivalent of 120,000,000 bushels of wheat during the next twelve months. France, it seems probable, will require about 90,000,000 bushels, and Germany must also be an importer, although that country will for the most part be supplied from Austria. For all practical purposes it is the requirements of France and England which American shippers will be asked to satisfy in the coming twelve months, the rest of Europe apparently being well able to support itself.

In the departments of France the destruction of hurtful and dangerous animals is encouraged by money awards. Last year, in Seine-et-Marne, there were killed as many as 3,598 vipers, paid for at the rate of 25 centimes per viper, the total amount being 899f. 50c. The great bulk of these vipers were killed in the arrondissement of Fontainebleau.



THE BROOKLYN SUSPENSION BRIDGE.

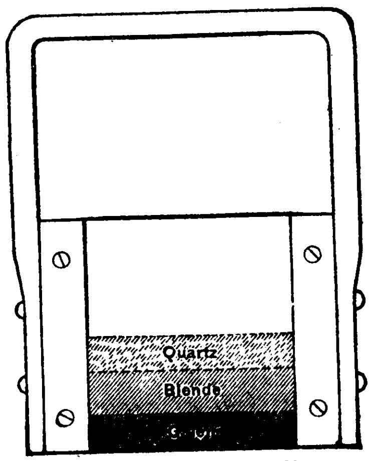
Mining, Metallurgy, Mineralogy.

NOTES ON THE ASSAY SPITZLUTTE.

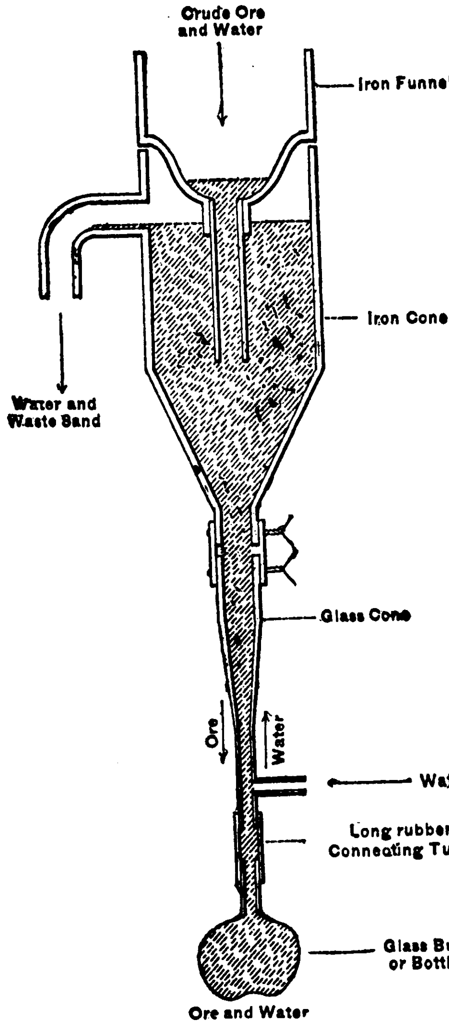
Robt. H. Richards, S. B., Professor of Mining, read recently, before the American Institute of Mining Engineers, a description of an assay spitzlutte from the mining laboratory of the Massachusetts Institute of Technology. Prof. Richards says:

The spitzlutte, as described by Rittinger, is an instrument by which sand is sorted in a continual upward-flowing stream of water. Its usual form is that of a pointed box, placed with the point downward, the box receiving its feed of sand and water on one side, and discharging its tailings on the other. The assorted product or concentration is discharged at the bottom, at the apex of the box, through which it falls against an upward current of water, which current serves to effect the assorting and separation. To make this exposure to the quicksand condition still more effective, an inverted dam is placed across the spitzlutte, which forces the sand in its passage from the feed side to the discharge, to pass down into the more active portion of the upward-flowing current of water.

In the form adopted for small tests in the mining laboratory of the Massachusetts Institute of Technology (see accompanying sketch) the feed is through a central funnel instead of being at the side, and the apex of this funnel, extending down nearly to the apex of the cone, takes the place of the inverted dam in the large spitzlutte. To keep the experiment perfectly under control a bulb or bottle is attached by a rubber connecting-tube to receive the concentrations, and between this bottle and the apex of the spitzlutte is placed a glass tube of conical form, with a side tube for the admission of water. By regulating the admission of water through this tube the concentration may be allowed to go down into the bulb as fast or as slowly as the richness of the ore seems to demand.



JIG WITH GLASS SIDES
([illegible] Natural Size)



SPITZLUTTE
([illegible] Natural Size)

AN ASSAY SPITZLUTTE FOR MINING LABORATORIES.

This spitzlutte may be used on products that have been previously sized to take out the heavy mineral. As an example of this, a test was made upon a sample of ore where the galena, blende, and quartz were much mixed up, but separated perfectly when crushed. The sample of ore was from Newburyport, and assayed 16.50% lead. After sizing through a series of sieves the ore yielded concentrations and tailings to the spitzlutte as follows:

Through.	On.	Concentrations, Lead.	Middlings, Lead.	Tailings, Lead.
12	— 20	47.28%	11.38%	2 48%
20	— 30	47.81%		1.67%
30	— 40	48 61%		2.56%
40	— 50	51 93%		3.54%
50	— 90	50 95%		1.18%
90	—	31.93%		Not worked.

Again this spitzlutte can be used on natural products. By these I mean products that have been crushed simply without being subjected to the usual process of sizing by a series of sieves. In this case its overflow sand must be re-treated by the miner's pan or sichertrog to extract the finer portion of the ore. It makes a very good preliminary to the miner's pan, taking out the largest grains, which interfere with the pan's best action, leaving the finer grains of ore for the pan to finish.

The spitzlutte has been used by us mainly to separate mercury and amalgam from pulp after amalgamating tests. For this purpose it is very efficient. It is also used to gain an approximate idea of how an ore will concentrate, and how fine it should be crushed in order to concentrate it to the best advantage on the large scale.

The little jig (shown in the accompanying sketch) used as a lecture experiment and as a test of larger machines, is 6 inches deep, 4 inches long and 3 inches wide, with plate glass sides, wooden ends, and a sieve bottom of 30 meshes to the inch.

This jig will show very perfect lines of separation between quartz, specific gravity 2.6, blende, specific gravity 4, and galena, specific gravity 7.5. It will show a partial separation between blende, specific gravity 4, and magnetite, specific gravity 5.1.

The separation of red marble, white barite and blue galena is very marked, and makes a good lecture experiment.

In using this jig to test the running of larger machines it simply shows with what ease or difficulty a given set of layers may be obtained.

THE CALIFORNIA ASBESTINE SYSTEM OF SUBIRRIGATION.

The subject of irrigation is one that is ever uppermost in the Golden State where the long, dry seasons would prove an insurmountable obstacle to agriculture and fruit raising, were an artifical method of supplying moisture to the arid soil an impossibility. The original mode of irrigation was to pour the water on the surface of the ground around the trunks of the trees or vines in orchards and vineyards, and flood the surface ditches in the case of field crops. Numerous disadvantages attended this method: the earth would become hard and baked, a disagreeable dampness would be imparted to the night air, roots would seek the surface of the ground where they would obstruct the plough, and evaporation would ultimately waste half the water.

Appreciating the necessity of a more efficient and economical system of distributing the water, thoughtful men began to experiment with underground wood pipe and covered ditches. These were only partly successful, and it was not until 1876 that the fertile brain of Mr. E. U. Hamilton of Los Angeles, evolved the admirable system of subirrigation, which is rapidly superseding every other method, not only in Southern California and the Sierra foothills, but wherever necessity of irrigation is recognized.

The system consists in laying continuous cement pipe in trenches by means of the tile machine described in the last number of this paper, through which water flows by force of gravity from a reservoir above, and is permitted to emerge here and there through openings made in the pipe and saturate the earth beneath the surface, thus irrigating adjacent trees and plants.

The construction and distribution of the pipe will be readily comprehended by examining accompanying engravings.

In figure 1, A is the main pipe supplying water from the reservoir. B—Distributing pipes laid about a foot below the surface of the ground and about a foot from each row of trees (some fruit raisers assert that it is better to lay the pipe midway between the rows, with the openings in the centre of the squares formed by the trees.) C—Earth-guard, a piece of pipe shown in figures 3 and 4. H—Hydrant or gate, shown in figure 2. L—Spur from main. M—Connection between main A and distributing pipes B.

Figure 2 shows the position of the hydrant as set. The plug valve V being closed the water rises in H to level of water in reservoir; when V is raised water flows in direction of arrows passing into V.

Figure 3 shows the position of distributing pipe B, and the earth-guard C, set loosely on B, and extending six inches above the surface of the ground to prevent the earth from falling upon the wooden plug P. Water passes along B, flows up through the hole (O, Fig. 4) in P, and falls down upon B outside of P and inside of C, and is taken into the soil by capillary attraction.

Figure 4 shows the relative positions of B, C, P, and the tree, the dotted line representing the surface of the ground. The plug P is a tapering piece of wood, stone or metal set in the pipe B, having through it a tapering hole for the passage of water.

The cost of laying this pipe in orchards ranges from $15 to $25 per acre, and the saving in water, land, cultivation, labor of irrigation, freedom from noxious weeds, insects and vermin, the increased growth and healthfulness of the trees, the greater yield of the crop and its uniform size, appearance and superior flavor will, in two years, pay more than the expense of the improvement.—*Mining and Scientific Press.*

REPRODUCTION OF MEDALS, ETC.

There are several methods by which medals may be reproproduced, and of these the following are the simplest and afford the most satisfactory results:

THE STEREOTYPE PROCESS.

The medal, thoroughly cleansed, dried, and coated with a thin but uniform film of pure sperm or olive oil, is bound around the edge with a piece of cardboard so as to form a box, the bottom of which is the medal. A small quantity of finest plaster of Paris is then mixed up quickly into a thin cream and applied all over the exposed surface of the medal with a camel's-hair pencil so as to fill all depressions and exclude air bubbles. A thicker cream of plaster is then at once poured in until the box is nearly or quite filled. When the plaster has properly hardened the cardboard is taken off, and the plaster adhering to the rim of the medal trimmed off with a knife; the medal can then be easily detached from the cast. Another cast may then be taken of the reverse side of the medal in a similar manner. These casts, after trimming, are set aside in a warm place until they become quite dry, and are then clamped securely, face upward, in a small shallow iron tray, so that their face is about half the thickness of the medal distant below the top or edge of the tray. The spaces in the tray about the casts are then filled up even with the inferior edge of the casts with plaster, *papier maché*, or clay (dry). The tray thus arranged is put into an oven until the temperature of its contents is uniformly heated to about 250° Fah., when it is removed and immersed wholly below the surface of a potful of ordinary type metal heated just hot enough to make it quite liquid. As soon as air bubbles cease to escape the tray is slowly and steadily raised out of the pot, and the contents allowed to chill and harden in the air (sometimes it is preferable to plunge it in water, so as to facilitate the removal of the "cake" from the tray.) When the plate of type metal is cut out of the tray a correct (reversed) copy of the plaster moulds will be found on its under surface, and when the superfluous metal has been cut away and the pieces trimmed to proper dimensions and thickness they may be soldered together back to back, and the edges cut, turned, or milled, as the case requires to produce a correct imitation of the original medal. Cleansed by dipping momentarily in a strong solution of caustic potash, and, after quickly rinsing in running water, in hydrochloric acid, it may be coated with silver or copper, if desired, by electro deposition

BY ELECTROTYPY.

Melt pure white wax, and stir well into it while cooling about one fifth its weight of finest flake white (plumbic carbonate). Having uniformly coated the faces of the medal with a film of finest graphite or plumbago, arrange it in the box of cardboard as in taking the plaster stereo cast, and pour in the wax preparation previously heated just enough to make it semi-fluid. Having thus obtained a mould in wax of both faces of the medal, harden the wax in a cool place, then coat it perfectly with a film of pure graphite, wrap about the edges a number of turns of clean copper wire, and brush on plumbago so that the film of the latter may have contact with the wax and wire all around. Suspend the wax cast thus prepared by the copper wire in a saturated (or nearly saturated) aqueous solution of *pure* sulphate of copper, jarring it so that all bubbles of air may escape from the deep lines of the cast. Close in front, but not touching the immersed mould (or its connections), suspend by a copper wire a sheet of clean copper. Connect the copper by stout copper wire with the silver (or carbon) pole of a Smee battery of three cells (in series), and the copper wire on the mould, in a similar manner, with the zinc pole of the same battery, and let the deposition of copper on the mould proceed until it becomes thick enough to separate without breaking (about as thick as this paper). Then carefully detach it from the mould, embed the pieces, face downward, in dry plaster, and fill up (after drying) with melted type metal (or fusible metal). Trim to proper size and thickness, solder the pieces together, back to back, and cut or mill the edges to proper form. These *copies* may be coated with a thin film of silver by electro deposit. The surfaces may be given an *aged* appearance by immersing them for a few moments in a dilute solution of sulphide of soda in warm water.

When a copy, as produced by stereotypy, of a medal is taken in metal, the latter coated with plumbago, and immersed in a bath composed of three-quarters of a pound of sulphate of nickel and ammonia per gallon of water, under the conditions described in electrotyping with copper, a hard shell of nickel is obtained, which, when separated and backed with type metal, may be used as a die. It is difficult, however, for an amateur in electro metallurgy to obtain good results in this way. Steel dies cannot be produced in this way. Moulds for stereo or ordinary casting should be heated.

For a fusible silver-white alloy melt type metal and mix it with one-eighth its weight of grain tin, remove from the fire, and stir well before pouring.

MICA.

As in times past, when the search after the "philosopher's stone," resulted in the discovery of many unsought, but nevertheless valuable substances, it frequently happens that the treasure seeker of to-day brings to light some unthought of ore or mineral—not as valuable as the substance sought, but certainly well worth finding—if the discoverer is wise enough to understand this.

The discovery of good merchantable mica in some of our Western gold mining regions is illustrative of this. We have recently received many samples of this peculiar mineral—chiefly from Dakota, Colorado and California—and some of these compare very favorably with the best products of the celebrated Carolina mines. We are glad to note this, for mica is peculiarly well suited for hundreds of useful applications in the arts for which it is not now available on account of its cost.

Mica is a very common mineral in some localities, but the merchantable article is by no means common, and a large body of "mica rock," capable of affording large, clear, and colorless sheets of the mineral, free from flaws and of uniform structure, is worth developing almost anywhere.

Muscovite or oblique mica—the clear variety—is essentially a silicate of aluminum and potassium. When the crystallization is uniform it can be easily separated with a knife blade into very regular flexible and elastic sheets of almost any required thickness. It is not affected by water or strong acids (with the exception of hydrofluoric acid), and may be heated quickly to redness without danger of melting or cracking it. In thin plates or sheets it resembles glass, but it is not brittle, and this, in connection with the other peculiar properties alluded to, makes it available and serviceable as a substitute for glass under conditions which preclude the use of the latter. Mica is never quite colorless, although in good sample the color is barely perceptible in the thin sheets. That having a faint wine or brandy tint commands the best prices.

In the New York market the mineral is usually sold by the pound, in sheets cut to sizes varying from two inches to fifteen inches square, the price varying with the size and number of sheets to the pound, color and quality. When the sheets are properly split, trimmed and cut to size the prices for good clear mica vary from twenty cents to eight dollars per pound.

Of the numberless uses to which this mineral glass has been put it is chiefly in demand for the glazing of stone and furnace or heated doors, and as a substitute for glass in some kinds of lanterns, as it is much lighter and tougher than glass, and is not easily ruptured by jar or concussion. The latter consideration has caused its substitution for glass lights on gunboats and naval vessels.

Mica is peculiarly well suited to the construction of light roofs and walls for galleries, conservatories, greenhouses, or hot-beds, etc., as it can be easily shaped and bent, and secured with tacks after the manner of shingles; is not easily fractured and requires very light supports. We have seen structures of this kind, and they would seem to leave little to desire in this line, except, perhaps, larger sheets of the mineral and a reduction in its cost. The sheets may be tinted or colored by dipping them momentarily in a very dilute alcoholic solution of pale shellac suitably colored with any of the soluble coal tar or aniline dyes, and exposing them for a few minutes to warm air to dry. Very pretty color effect can thus be produced. A simple way of producing a frosted or ground appearance on the sheets of mica is to coat them with a thin milky varnish prepared by mixing together solutions of one ounce of pale shellac in three pints of wine spirit and one ounce of pale resin in a pint of good benzine. A rather thin sirupy solution of water glass, with which has been mixed a trace of zinc sulphate dissolved in water, can be used in a similar manner to effect this object.

A colorless cement for joining sheets of mica is prepared as follows: Clear gelatine is softened by soaking it in a little cold water, and the excess of water is pressed out by gently squeezing it in a cloth. It is then heated over a water bath until it begins to melt, and just enough hot proof spirit (not an excess) stirred in to make it fluid. To each pint of this solution is gradually added, while stirring, one-quarter ounce of gum ammoniac and one and one-third ounces gum mastic previously dissolved in four ounces of rectified spirit. It must be warmed to liquify it for use and kept in stoppered bottles when not required. This cement, when properly prepared, resists cold water.

Flexible mirrors are made from sheet mica, the silver being deposited from a solution of the nitrate by one of the processes in the *Scientific American Supplement* No. 104. Small mirrors of this description are used in some kinds of inlaid work and for various decorative purposes. As their flexibility admits of their application to irregular surfaces they can be used where glass mirrors cannot. With the aid of a little gold leaf, bronze powders, size, and various colored thin transparent varnishes or collodion mica has been worked into hundreds of beautiful articles for decorative purposes, toys, etc.

When mica is heated to redness for some time in a muffle and then allowed to cool rather quickly the laminæ become distorted and the sheets present a silvery white appearance by reflected light the mineral losing much of its flexibility. The dust of this whitened mica is used to some extent by the French as a silver bronze powder. Mixed with a weak solution of gum arabic it makes a good silver ink. The powder is sometimes variously tinted by washes of very dilute colored solutions of gum or varnishes. To prepare the glistening powder the sheets of whitened mica are simply crushed (not ground), boiled in hydrochloric acid, rinsed, dried, and assorted to size of laminæ. The finer filaments have a pearly luster and are made to adhere to semi-softened gelatine and wax to imitate pearl. The silvery powder is used on metals, glass, wood, paper, plaster, tapestry and furniture, it has also been used in calico printing in place of the heavy bronze and glass dust of Lyons fabrics, and for the decoration of china and glassware.

Mica is used by electricians for certain insulating purposes and also to some extent by makers of philosophical and optical instruments. Good mica because of its lightness, is often employed as a substitute for glass in spectacles designed to simply shade the eyes or to protect them from dust, cinders, or flying particles of metal or stone for travellers, millwrights, grinders, polishers, and others whose work necessitates such protection. Vessels of mica are often used in the chemical lecture room, and are particularly serviceable in the experimental illustration of the properties of certain gases—the burning of metals in oxygen, etc.

The powdered or crushed mineral has recently been used, in connection with nitroglycerine, in the preparation of a kind of dynamite called mica blasting powder. It has also been employed as a filling for fireproof safes, as a non-conducting covering for boilers and steam pipes, and, in connection with water glass, as a fireproof varnish or paint. The larger sheets, applied after the manner of shingles, make very good fireproof roofing material.

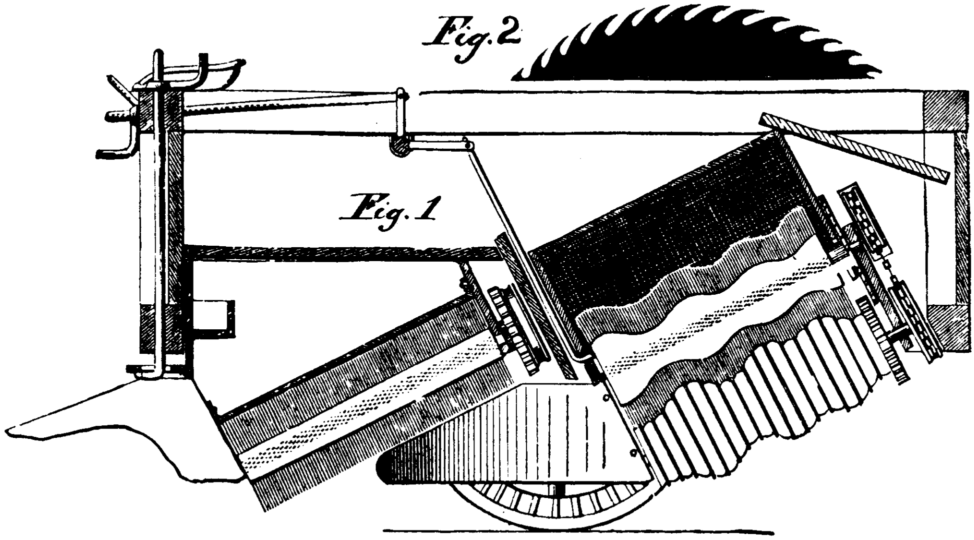
Formerly most of the merchantable mica used in this country was imported, but for the past few years—since 1867—our supply of the mineral has been derived chiefly from mines located in Mitchell, Heywood, Yancey, McDowell, and Macon counties, North Carolina. The product of these mines is at present hardly equal to the demand, which is increasing very rapidly.

The discovery—or rather rediscovery (for some of them show signs of having been worked centuries ago)—of these valuable beds of mica in the Carolina gold fields was, like the Western "finds" above referred to, one of the results of a search after the precious metals.—*Scientific American.*

ARCHEOLOGICAL DISCOVERIES.

The latest excavations made by order of the Athens Archæological Society at Tanagra, the well-known place in Bœotia, whence comes the charming terra-cotta figures, have yielded important results. On the northern side of the town, in front of the principal gate, fifteen tombs were discovered which were completely untouched. They contained some sixty clay figures, most of them perfect, and measuring between ten and thirty-five centimetres in height. They represent satyrs and women standing and sitting, and one is a group of two figures. Besides these many vessels were found, amongst which some twenty lekythoi (paint and oil phials) with antique painted ornaments. Unfortunately most of these were broken. One vase which was found in a stone case shows an artistic inscription which designates it as a work of Teisias. We may also mention that fourteen scraping irons were found, and also that in two of the tombs some fifty small terra-cotta ornaments were discovered, most of which were brightly colored, and some covered with thin gold. The excavations became even more important after April 1. The published report mentions twenty vessels, some broken, ten of which are ornamented with paintings. Two of these are said to be particularly fine. Of the numerous clay figures only eight could be got out in a tolerably perfect condition. Of these two are reported to be the most perfect figures ever found at Tanagra. One represents a winged youth who is about to raise himself into the air; before him is a maiden on her knees, her dress forming an arc above her; the youth holds her by the arms as if he wished to take her along with him in his flight. The other masterpiece is an Aphrodite rising from the sea, diving up out of a shell as it were.

ONE of Mr. Berthon's folding boats has been supplied to the *Inflexible*. It is 31ft. long, 8 ft. 3in. wide, and 3ft. 10in. deep, and is capable of carrying 60 men. This boat was recently put to a severe test in going out to Spithead with a crew of 16, accompanied by Mr. Berthon. Taken in tow by a steam launch that was swept fore and aft by every sea, the boat did not ship a pint of water, although the sea was heavy and broken.



PERFECT COTTON PICKER.

THE PERFECT COTTON PICKER.

Before the late war, pickers were invented, and used to some extent, and during the last fifteen years a large number have been invented, and some of them were used last year. The difficulties heretofore experienced are two: First, picking dead leaves, trash, etc., with the cotton. Second, destroying plants by scratching and tearing the leaves, blooms and unopened bolls. These objections have been partially met by picking at first by hand, in the usual way, and finishing the last picking and the plant at the same time. The cotton is then passed through a cleaning machine which beats out the trash.

This invention avoids both of these objections: First, by brushing the plant clean from all the trash as a preliminary process, at the same time the picking is done. This is accomplished by means of revolving brushes in the front of the machine, which perate on the plant after it has been flattened into a fan-like shape by guides.

These brushes are so constructed that while they take off all the loose trash they do not take the cotton out of the bolls. In the rear of the machine are the picking cylinders, consisting of serrated or toothed disks (separated by loose disks) so constructed that while they pass freely and without injury over the leaves, blooms and unripe bolls, they instantly seize and remove all cotton protruding from the ripe bolls. These cylinders are prevented by the loose disks from any inclination to pull up or injure the plant in any way, so that the picker can be used from the earliest to the latest picking. The revolving brushes, besides their office in preparing the plant for picking, can also be used to remove and destroy all parasite injurious to the plant at any stage of growth. The revolving brushes throw the worms, etc., into a close box above them, which contains an arrangement for generating a gas fatal to animal life. They are then discharged through an opening just in front of the wheels and crushed.

The only part of this invention susceptible of wear are the revolving brushes. These are made of ordinary broom corn and can be renewed by any one of ordinary intelligence in a few hours. The capacity of the picker can only be determined by experiment or actual use. The inventor estimates eight acres a day as a minimum figure, but the machine can be used by night as well as day. One man and a boy are the only attendants required. The picker will suit any description of cotton. Fig. 2 represents the form of the serrated steel disks used.

Mr. D. B. Hazelton, of Charleston, S. C., is the patentee.

Carriage Maker's Work.

GROCER'S WAGON.

(*See illustration.*)

Our engraving represents an express wagon with elevated driver's seat, which is frequently used by grocers and milk dealers in New York. Its advantages over the ordinary express wagon with a low seat are that with the same length of body; namely, 8 feet; it affords some additional and protected room under the seat, and the higher position of the latter is desirable in crowded thoroughfares.

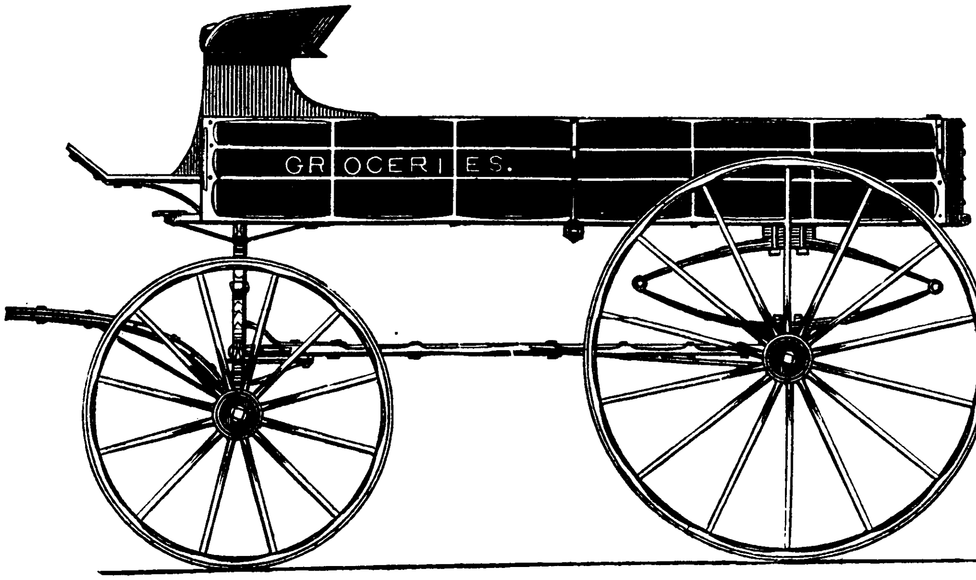
The main dimensions are: Width of body, 44 in.; track, 4 ft. 8 in.; wheels, 3 ft. 3 in., and 4 ft. 3 in.; hubs, 7 in.; spokes, 1⅞ in.; rims, 1⅝ in.; tires, 1⅝ in. x ⅝ in.; axles, 1⅝ in.; springs, front, 6 plates, 1¼ in. wide; back, 5 plates, 1¾ in. wide.

ONE-HORSE BAKERS' WAGON.

(*See illustration.*)

Our illustration shows a style of bakers' wagon used in New York, of which there are two sizes made, namely, a two-horse wagon with a body about 8 ft. 4 in. long, and which is invariably suspended on platform springs. The other is the light one-horse size on two elliptic springs, as shown in our engraving.

The finish of the sides of the style in question is somewhat modernized, and it is intended that the tinted parts should be painted in a prominent and bright color, such as yellow, light blue or lake. We have shown the front quarter paneled up all the way, but some prefer to run the panel only to about 20 in. from the roof-molding, in which case additional short curtains are provided. For painting the running gear, cream color or vermilion are at present mostly in demand. The principal dimensions are as follows: Width of body, 44 in.; track, 4 ft. 8 in.; wheels, 3 ft. 11 in. and 4 ft. 3 in.; hubs, 6¼ to 7 in.; spokes, 1¼ in.; rims, 1¾ in.; tires, 1⅝ x ⅝ in.; axles, 1⅝ in.; springs, front and back, 6 plates, 1¾ in. wide.



GROCER'S WAGON.—SCALE ONE HALF INCH. SEE DESCRIPTION.

ONE HORSE BAKER'S WAGON.

Scientific.

THE ORIGIN OF TELEGRAPHY.

From early times some mode of rapidly conveying information from place to place has been anxiously sought for, and many different schemes have been proposed. At first the human voice was employed, and the message passed on from mouth to mouth. It was, however, soon found that signals might be seen at a distance to which the voice could never reach. Some simple signals were usually agreed upon beforehand, and transmitted by means of motions of the hand or by a bright light.

One of the earliest practical uses of this was in announcing to the inhabitants of Palestine in ancient times the appearance of the new moon, by which their festivals were regulated. After it had been seen and information of the fact conveyed to the Sanhedrim by trustworthy witnesses, the news was telegraphed over all the land by fire signals. A party of men would ascend a hill outside of Jerusalem and kindle there a large fire of wood, pitch and other inflammable materials. As soon as this was seen the neighboring hills copied the example, and thus in a short time the news was conveyed throughout the country. By this plan only a few simple messages could be conveyed. A great advance was made on it many centuries later by the use of semaphores, or arms somewhat like railway signals. An arbitrary code was arranged by which words might be spelled out and messages sent by these. The stations were at a considerable distance apart, and at each were placed two men, one of whom, by means of a telescope, read the signals, while the other transmitted them. The process was, however, very slow and uncertain, as there was no means of calling attention to the fact of a message coming, and a slight fog served at once to interrupt all communication. A telegraph worked in this way was, however, erected between London and Dover, in England, and continued in operation some little time.

Soon after the discovery of the more simple phenomena of frictional electricity, attempts were made to convey communication by means of it. As early as 1727 the electrical excitement was conveyed a distance of several hundred feet by means of a wire suspended by silk threads. An excited glass cylinder was applied to one end, and it was found that particles of paper or other light substances were attracted at the other extremity of the wire. About 25 years later a letter appeared in the *Scots' Magazine*, suggesting a means of communicating with a friend at a distance by means of electricity. A number of wires, one for each letter of the alphabet, were to be taken, and supported by some non-conducting element. The excited barrel, or cylinder, or, as we should now call it, the prime conductor, was to be placed at right angles to these wires, and at the end of each was to be a metal spring, which might be made to touch the conductor. At the other extremity small balls were to be arranged, marked with the letters of the alphabet, and under each, at a trifling distance, small pieces of paper were to be placed. When a word or message was to be sent, the spring marked with the first letter of it was pressed by means of a glass rod against the conductor; the wire then would at once become charged with electricity and attract the fragment of paper at the further end, indicating thereby the letter sent. The next letter would be sent in a similar way, and so the whole message was spelled out. The scheme unfolded in the letter seems to be the first germ of the telegraph, but so many improvements and alterations have been made by different men that there is no one in particular to whom we can point as its inventor.

The first electric telegraph ever actually erected by which intelligible signals could be transmitted, was constructed at Geneva, Switzerland, by Lesage, and was somewhat on the principle of that described in the letter referred to above. Twenty-four wires were employed, and from the further end of each a small pith ball was suspended; as soon as any wire was excited by being brought into contact with the conductor, the balls would immediately diverge. Various other attempts were made to construct telegraphs to act by means of frictional electricity, and several important improvements were made, but none were ever brought into practical operation. About the begining of the present century several facts were discovered in connection with voltaic electricity, and attention was soon turned to that as a mode of transmitting signals. A telegraph was constructed by Somering, at Munich, Bavaria, in 1808, which was worked by a "voltaic pile," and in which the messages were received by the decomposition of water by the current. The wires terminated in gold points, placed side by side in a trough of water, and lettered. When the current was sent along any wire minute bubbles of gas were evolved at the gold point and indicated the letter. The discovery by Oersted, in 1820, that a magnetic needle was deflected from its position by an electric current passing along a wire near it, constituted a red-letter day in the science of telegraphy; and the discoveries of Faraday, a few years subsequently, as to the phenomena of induced currents, greatly aided in bringing the science to the degree of perfection it has now attained. Galvanometers were soon constructed for the purpose of receiving the messages, and a powerful bar magnet was frequently used to induce the current.

The great drawback in the early forms had been the number of wires required, which added very greatly to the cost, and to the difficulty of maintaining the apparatus in working order. These have been gradually reduced in number, till now the great majority of instruments require only a single one, and over that, by the aid of the most recent inventions, several messages may be sent at once, and in opposite directions. At first a "return wire" was always employed to complete the circuit. Steinheil, however, in experimenting with a view of ascertaining whether the metals of a railroad could be used as conductors, made the important discovery that the earth itself would serve the purpose of a return wire. Since then a separate wire is always dispensed with, and a metal plate is buried in the earth near each telegraph station, the return wire being connected to it.

The first experimental application of electric telegraphy was made by Mr. Cooke, on the Liverpool and Manchester Railway, in 1837, and he and Prof. Wheatstone, to whom he was then introduced, afterward elaborated the present system of telegraphy now in general use in Great Britain. Prof. Morse is the inventor of the system which bears his name, and his is the system adopted in the United States and Canada.—*Metal Worker.*

THE ELECTRIC LIGHT IN NEW YORK.

The experiment of lighting the streets in this city by electricity has progressed sufficiently far to allow something of an estimate as to its value and economy. In May last, the Gas Commission awarded a contract to the Brush Electric Light Co., to light the following streets for one year, at the rate of $7,400 per annum: 14th street, from 4th to 5th avenue; 5th avenue, and Broadway from 14th to 34th street, and 34th street from 5th avenue to Broadway. In addition to the lamps necessary on these streets, the company were to furnish two groups of six lamps each, to be placed in Union and Madison Squares respectively. The street lamps were erected and in operation some months previous to the awarding of the contract, it having been done by the company as an experiment, to give the people an opportunity to judge of the suitability of the electric light for street illumination. On account of the labor and experiment necessary, the groups of lamps have been in operation but a short time.

On counting the electric lamps which have been furnished and also the gas lamps extinguished, we find that there are forty-three lamps used in lighting the streets already mentioned, besides the twelve lamps of the two groups, making fifty-five in all. The total number of gas lamps which it has been possible to extinguish is 430. In Union Square all of the gas lamps, thirty-eight in number, have been extinguished, while in Madison Square, which is considerably larger, sixty-four have been extinguished, and twenty-five continued in use. These figures include those lamps on adjoining streets, which the electric lights have rendered needless. It is hardly necessary to state that there were more gas lamps required in the Square than in ordinary street lighting, where there is little or no foliage to interfere with them. In Madison Square each one of the groups of six electric lamps replaced ten and two-thirds gas lamps, while in Union Square the ratio was 1 to 6⅓. In the lighting of the streets forty-three electric lamps have replaced 328 gas lamps or one electric lamp to about 7½ gas lamps.

The city pay the gas company $17.50 per lamp per annum, or $7,525 for the total number of gas lamps replaced by the electric lamps costing $7,400. Thus there is a saving to the city in this respect of $125 per annum. The gas company say that there is not sufficient margin in maintaining the street lamps for $17.50 per annum to make competition desirable, and if the Brush Company are content to light the streets at the present price, there certainly is an element of cost in their favor, or they are satisfied to do the lighting for a less percentage of profit than the gas company. The gas burners in use are of three feet capacity and burn for 4,000 hours during the year. Deducting for cleaning, etc., the company receive about $1 per thousand for the gas used. At the same time they would willingly turn over to the electric light companies the lighting of the streets. It is impossible to say how much the Brush Company will make out of this undertaking, or how much of the total cost will be considered as covered by the advertising thus afforded.

The electric illumination is, in many respects, very satisfactory. while in others there is still much to be desired. The system of lighting by means of the poles or towers is somewhat disappointing, on account of the comparatively small area which is illuminated. In clear weather the groups of lamps are very effective as beacons, but if they were separated and placed at different points over the same area, the illumination would be more satisfactory. The foliage seriously interferes with the efficiency of the lamps, and this objection would be still more noticeable in midsummer.

As to the illuminating power of the electric lamps employed, it should be stated that it is a matter of importance as to how this is measured. In the Brush and other systems in which the lights are fed by continuous current machines, the upper carbon, in the case of the arc light, soon becomes worn away in the form of a hollow, the inner or deepest part of which emits the greatest amount of light. It is evident, therefore, that in determining the illuminating power of arc lights of this nature by horizontal measurements, a portion of the light will be cut off by the sides of the hollow or cup formed. For a similar reason the greatest amount of light would be thrown downward at an angle of about 60°, and angular measurements would give a result three or four times greater than the horizontal.

The illuminating power of the Brush lamps with ⅜ inch carbons is from 300 to 400 candles, horizontal measurement, and from 1,000 to 1,300 candles, angular measurements. There is no reason for the expression "French measurement." It is without any advantage and being unlike the plan customary in expressing photometric results is very misleading. A gas flame of twenty candles would by French measurement, be rated at eighty candles.

The carbons employed in the groups of electric lights in the Square, are said to be of ⅝ inch diameter, and presumably the illuminating power is greater than in the case of the street lamps, but from the effect produced we are inclined to think that the estimate given (36,000 candles), rather high, unless expressed as "French measurement."—*Sanitary Engineer.*

ELECTRIC CLOCK-DIAL MECHANISM.

The construction of a perfect electric clock involves several difficult problems, and it is this which explains in part the existence of a large number of electric clocks varying in efficiency according to the attention paid to the fundamental principles which should control this construction.

Electricity actually plays three very distinct characters in the electrical clock, and the Paris Electrical Exposition presents numerous examples of this:

1. Electricity is made use of as a motive power, to swing a pendulum and replace the springs or weights of an ordinary clock.

2. Electricity is employed for transmission. A central clock sends an electric current every second, half a minute, or minute, to one or more dials placed at a distance, which causes the hands to advance respectively a second, a half minute, or a minute.

3. Electricity is employed to regulate clocks and dials propelled by ordinary weights and springs, and adjusts the hands every hour, every six hours, or every twenty-four hours. It is this system of synchronism which has been adopted by the city of Paris for the public clocks.

We do not wish to discuss here the respective advantages of the two systems of distribution of time in a city by electric transmission or by electric adjustment effected at fixed intervals. The electric distribution of time has some special advantages which are not possessed by the system of electrical adjustment, and the disadvantages disappear in proportion as the apparatus is perfected and simplified. The pneumatic clock established in Paris two years ago has a transmitter operated by compressed air.

The engraving represents a simple electrical dial mechanism which exactly fulfills the requirements, working surely each minute under the action of the current sent by the central distributing clock.

All of the earlier forms of electrical dial apparatus are operated by an oscillating armature, moved by an electro-magnet and retracted by an antagonistic spring, or two electro-magnets acting upon a polarized armature. The movement of the armature is transmitted to the gearing by the levers and pawls, which must be very perfectly adjusted, as they cease to act if there is a little play, wear, or oxidation. In order to give a slight movement to the armature it is necessary to lengthen the lever immoderately.

All of these inconveniences are avoided in the very simple apparatus of M. Thomas, the mechanism of which is represented in the engraving. It is composed of a horizontal electro-magnet, the poles carrying two armatures, between which is placed a polarized armature in the form of an S, fixed upon a vertical axis. The axis carries an endless screw, which operates the minute hand and gearing. The transmitting clock sends into the electro-magnet alternate positive and negative currents at every half minute. The current sent is such that it develops in the poles of the electro-magnet alternate positive and negative polarity, so that the polarized S-shaped armature is first attracted and then repelled, causing a half revolution of the S shaped armature for every electrical impulse. The current should continue from two to three seconds, in order that the polarized armature may be maintained in position. The endless screw carries along the gearing and causes the hands to advance each time.

In conseqence of its inertia the polarized S-shaped armature tends to pass beyond the half revolution, and the speed acquired toward the end of the half revolution is checked by means of a spring against which a pin carried by the vertical spindle strikes at each half revolution.

This simple and ingenious apparatus requires no regulation. The rotation will be produced, whatever may be the distance from the extremities of the polarized armature to the electro-magnet, and this distance may vary from one to two millimeters.

The power of the apparatus is determined by the dimensions of the S-shaped polarized armature of the electro-magnet, and by the size and length of the wire which surrounds them.

By using a high tension current of electricity a large number of these electrical dial movements may be placed upon the same circuit and made to operate dials of two meters in diameter.

At the Exposition of Brussels, in 1880, where the electric dial mechanism of M. Thomas was in operation for the first time, he had in the same circuit a large dial of 1·80 meters in diameter and eighteen other smaller dials of 0·50 meter and 0·40 meter. They worked perfectly, excepting the five or six interruptions proceeding from the stopping of the transmitting clock caused by the moving of the platform on which the clock was placed.—*La Nature.*

IMPROVED KALEIDOSCOPE

The engraving shows a kaleidoscope in which the angles of the reflectors and of the figures produced may be varied at will and held fixed in any desired position without turning the instrument, and to design and arrange the bits of glass or other material whose change in position gives rise to the figures of the kaleidoscope, so that when viewed through the kaleidoscope tube they shall present varying tints, shades, and compounds of color and a greatly increased number of variety of figures. The case of the kaleidoscope may be of any desired shape or size.

The ground glass is set vertically in grooves in one end of the case against the inner face of the end plate, which is provided with a triangular opening. A little in rear of the end plate is a parallel vertical partition provided with a corresponding triangular opening, forming the pocket for the reception of the object wheels. The object wheel is made of two or more circular plates of glass held apart and parallel with each other by a hoop so as to form one or more chambers for containing bits of glass or other material for producing the figures of the kaleidoscope. When in place in the case the object wheel rests on the friction disk or wheel secured on an end of a rod which is extended longitudinally through the case along the bottom, and has a knob on its outer end for convenience in turning. By rotating this rod the object wheel is made to revolve.

The tapering reflectors in which the images are formed are centered by a wooden case, and are drawn together more or less by a roller in the upper part of the case, upon which are wound pieces of cloth attached to the edges of the glass. The cloth and roller not only answer the purpose of varying the angle of the reflectors, but they form the third side of the reflecting tube, excluding light and dust.

Fig. 1 is a perspective view. Fig. 2 is a transverse section. This novel device was lately patented by Mr. V. M. Farr, of Oskaloosa, Ia.

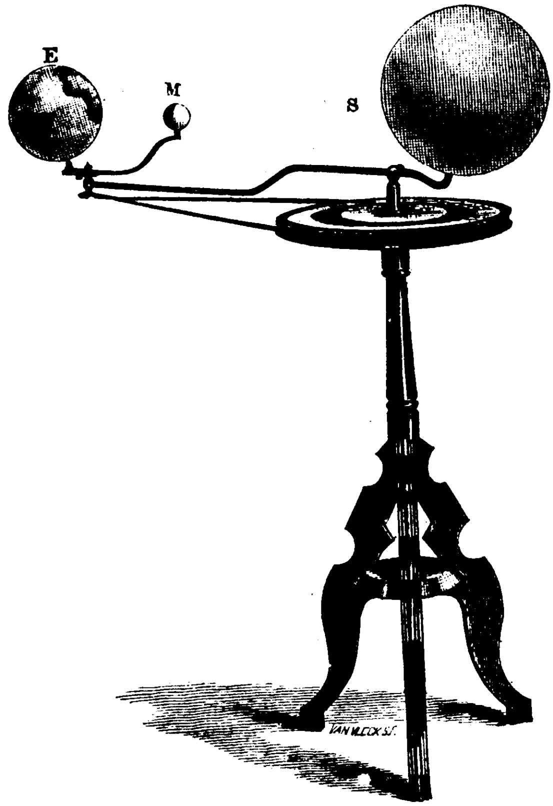


FIG. 1. TELLURION SHOWING MOON IN CONJUNCTION.

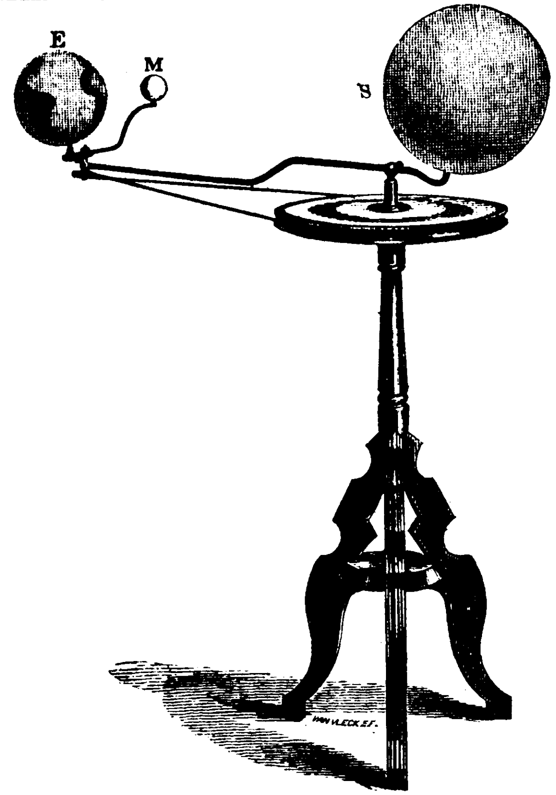
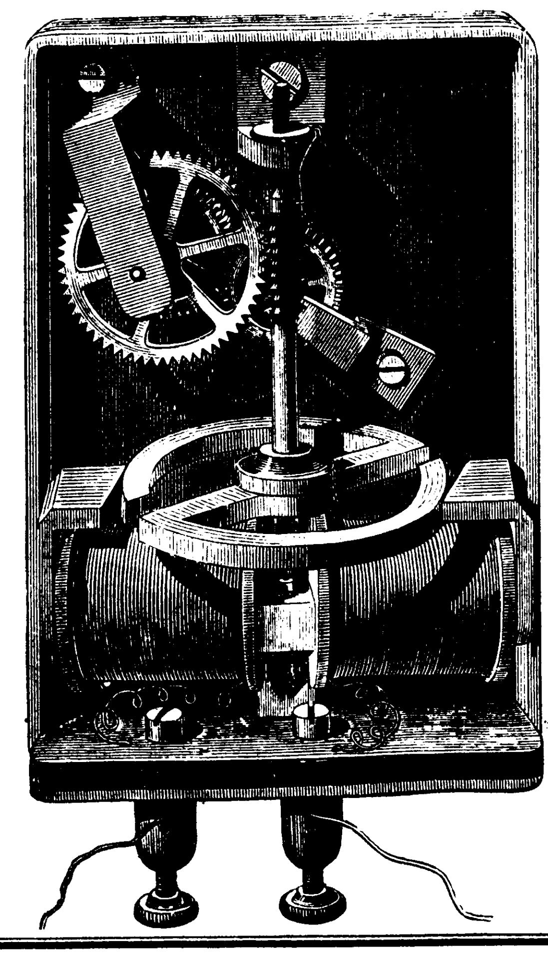


FIG. 2. TELLURION SHOWING MOON IN QUADRATURE.



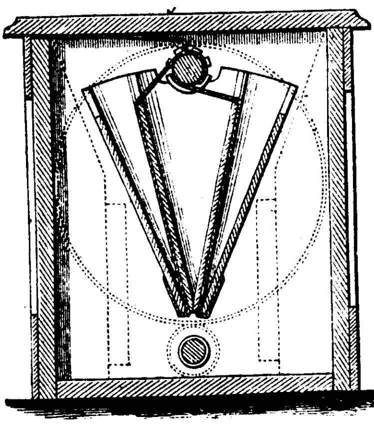
THE MATLICK TELLURION.

Many valuable instruments have been invented to aid in illustrating the great truths of astronomy, but until the present there has not been a tellurion constructed which represented planetary motion as it really exists in the grand workings of the universe. In the construction of this tellurion the known laws of philosophy are recognized and carried out, so that the third or lunar motion of the earth is shown. Other instruments represent the moon as simply revolving around the earth, but it must be remembered that the attraction is mutual; that both bodies describe orbits about their common centre of gravity, and that, while the moon obeys the attraction of the earth the latter equally follows that of the former, by which it is at every instant drawn from the path it would pursue if that influence did not exist; thus, then, we may understand the third or lunar motion of the earth, which is most accurately represented by his tellurion.

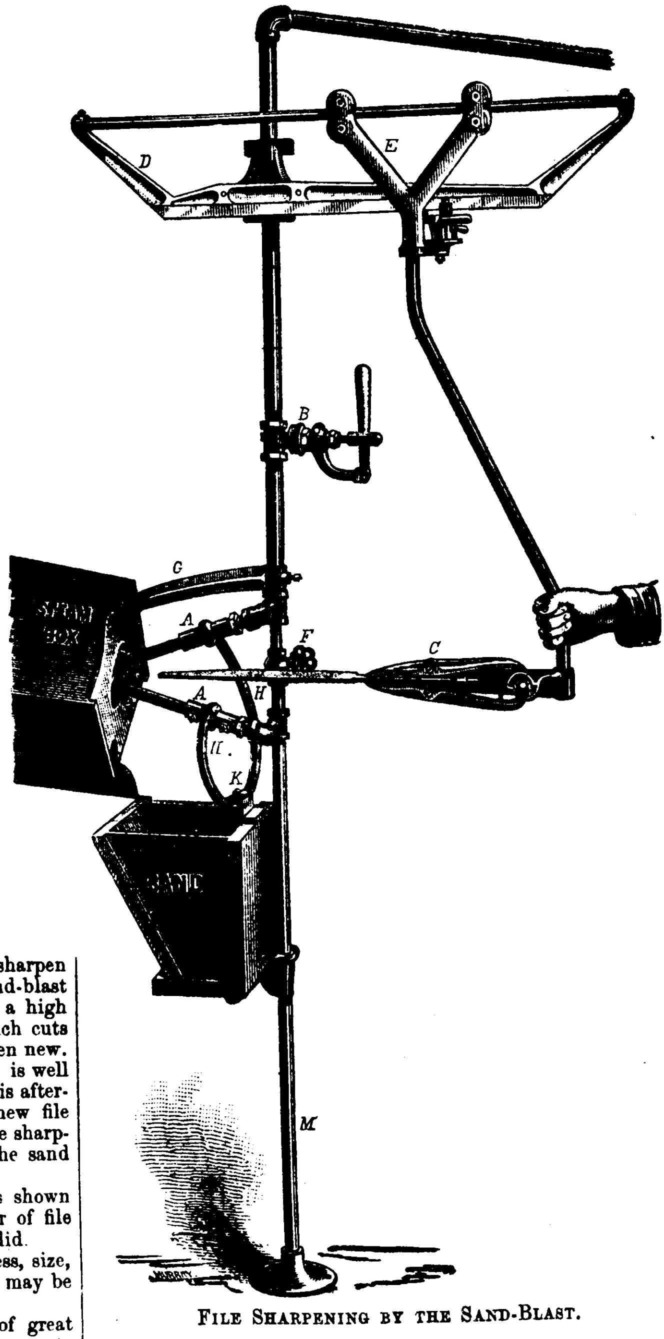
This instrument represents in the most simple manner the intricate and complex movements of the earth and moon around the sun, showing the relative positions to each other any day in the year, so that the cause of day and night, the change of season, the tides, the phases of the moon, eclipses, etc., may be readily comprehended, making it a necessary apparatus for public schools and a valuable instrument for higher classes in colleges, where the more intricate problems are to be studied.

The phenomena of the tides are explained on a different hypothesis from that generally given in our text books—a comprehension of the lunar motion of the earth being necessary to explain this subject.

In the engravings the relative sizes of the earth, sun and moon are as nearly represented as practicable, the earth and moon being in exact proportion; but owing to the enormous size of the sun, it is impracticable to make it of proper proportion, yet the size and distances are so represented that all the phenomena presented by the motions of the bodies can be easily understood. The construction of the tellurion is so well shown in the engraving that a detailed description would be superfluous. Although, heretofore, for the want of proper apparatus, these subjects have been imperfectly understood, excepting by the learned few, it is hoped that in the immediate future they will be properly explained in every school room. Messrs. A. C. Shaw & Co., of San Francisco, Cal., are the proprietors.—*Am. Inventor.*



New Kaleidcscope.—(See page 367.)



File Sharpening by the Sand-Blast.

FILE SHARPENING BY THE SAND-BLAST.

Among the various methods that have been tried to sharpen files, none can be said to be really successful but the sand-blast process. This consists in forcing a jet of fine sand at a high velocity against the backs of the teeth of the files, which cuts away the worn edges and leaves the file sharper than when new.

In explanation of this fact, it may be stated that it is well known that any fine edge is dulled to some extent if it is afterward heated to harden it. Furthermore, there is in new file teeth a burr that is more or less rounded, according to the sharpness of the file cutter's chisel, and this rounded burr the sand reduces to a plane, leaving a sharp cutting edge.

From some experiments that have been made, it was shown that a sand-blast file removed with the same number of file strokes (1,200) twice the amount of iron that a new file did.

It takes from two to five minutes (according to hardness, size, etc.) to sharpen a file by the sand-blast, and each file may be sharpened a number of times.

This process possesses several advantages that are of great importance. Thus the softening and rehardening necessary to recut files damages the steel. In grinding out the old teeth the file is thinned and care is not taken to make the curve of even sweep. Indeed a recut file can be told because the tang shows its undue thickness. Whereas, in a sand-blast sharpened file no warpage and no reduction of thickness occurs. Hence the file retains its original and correct shape.

There is no need to lose time by using files that do not cut freely because we dislike to throw them aside as long as there is any cut to them. This process is as applicable to the finest of cut files and is already in use by some of the largest firms in the country, while from its simplicity and efficiency it must eventually be found in every workshop wherein files are used to any extent. Our engraving shows all the plant necessary, consisting of steam piping to conduct the steam through the nozzles *A A*, which connect by rubber hose *H H* to sand pipe *K*, so that the steam jets passing through *A A* carry with them the mixture of quartz, sand and water in the sand box. By means of the overhead guide frame at *D E* the file clamp *C* is caused to travel when moved by hand in a straight line between the nozzles *A A* in the steam box, from which the expended sand and water flow down back to the sand box. Thus both sides of the file are sharpened simultaneously and from the fixed angles of the nozzles and true horizontal motion of the file the angles of all the teeth are equal and uniform.

To distribute the sharpening effects of the sand equally across the width of the file, the carriage has lateral or side motion, as well as endwise, and on the apparatus represented adjustable rollers regulate this side movement. Having the two motions, any part of the file can be presented to the blast. We regard this as a prominent advance in labor-saving devices, not only from its intrinsic value but also because of its simplicity. The machine is made by the Sand-Blast File Sharpening Company, of Wilmington, Del., to whom our readers are referred for more complete information.

HYDRODYNAMIC ANALOGIES TO ELECTRICITY AND MAGNETISM.

From a scientific and purely theoretical point of view, there is no object in the whole of the Electrical Exhibition at Paris of greater interest than the remarkable collection of apparatus exhibited by Dr. C. A. Bjerknes, of Christiania, and intended to show the fundamental phenomena of electricity and magnetism by the analogous ones of hydrodynamics. I will try to give a clear account of these experiments and the apparatus employed; but no description can convey any idea of the wonderful beauty of the actual experiments, whilst the mechanism itself is also of most exquisite construction. Every result which is thus shown by experiment had been previously predicted by Prof. Bjerknes as the result of his mathematical investigations. It has long been known that if a tuning-fork be struck and held near to a light object, like a balloon, it attracts it. This is an old experiment, and the theory of it has been worked out more than once. Among others, Sir William Thomson gave the theory in the *Philosophical Magazine* in 1867. In general words, the explanation is that the air in the neighborhood of the tuning-fork is rarefied by the agitation which it experiences. Consequently, the pressure of the air is greater as the distance from the tuning-fork increases. Thus the pressure on the far side of the balloon is greater than on the near side, and the balloon is attracted.

Dr. Bjerknes has followed out the theory of this action until he has succeeded in illustrating most of the fundamental phenomena of electricity and magnetism. He causes vibrations to take place in a trough of water about six inches deep. He uses a pair of cylinders fitted with pistons which are moved in and out by a gearing which regulates the length of stroke and also gives great rapidity. These cylinders simply act alternately as air-compressers and expanders, and they can be arranged so that both compress and both expand the air simultaneously, or in such a way that the one expands while the other compresses the air and *vice versa*. These cylinders are connected by thin india-rubber tubing and fine metal pipes to the various instruments. A very simple experiment consists in communicating pulsations to a pair of tambours, and observing their mutual actions. They consist each of a ring of metal faced at both sides with india-rubber and connected by a tube with the air-cylinders. One of them is held in the hand; the other is mounted in the water in a manner which leaves it free to move. It is then found that if the pulsations are of the same kind, *i. e.*, if both expand and both contract simultaneously, there is attraction. But if one expands while the other contracts, and *vice versa*, there is repulsion. In fact, the phenomenon is the opposite of magnetical and electrical phenomena, for here like poles attract and unlike poles repel.

Instead of having the pulsation of a drum, we may use the oscillation of a sphere; and Dr. Bjerknes has mounted a beautiful piece of apparatus by which the compressions and expansions of air are used to cause a sphere to oscillate in the water. But in this case it must be noticed that opposite sides of the sphere are in opposite phases. In fact, the sphere might be expected to act like a magnet; and so it does. If two oscillating spheres be brought near each other, then, if they are both moving to and from each other at the same time, there is attraction; but if one of them be turned round, so that both spheres move in the same direction in their oscillations, then there is repulsion. If one of these spheres be mounted so as to be free to move about a vertical axis, it is found that when a second oscillating sphere is brought near to it, the one which is free turns round its axis and sets itself so that both spheres in their oscillations are approaching each other or receding simultaneously. Two oscillating spheres, mounted at the extremities of an arm, with freedom to move, behave with respect to another oscillating sphere exactly like a magnet in the neighborhood of another magnetic pole. I believe that these directive effects are perfectly new, both theoretically and experimentally. The professor mounts his rod with a sphere at each end in two ways: (1) so that the oscillations are along the arm, and (2) so that they are perpendicular. In all cases they behave as if each sphere was a little magnet with its axis lying along the direction of oscillation

Dr. Bjerknes looks upon the water in his trough as being the analogue of Faraday's medium; and he looks upon these attractions and repulsions as being due, not to the action of one body on the other, but to the mutual action of one body and the water in contact with it. Viewed in this light, his first experiment is equivalent to saying that if a vibrating or oscillating body have its motions in the same direction as the water, the body moves away from the centre of disturbance, but if in the opposite direction, towards it. This idea gives us the analogy of dia- and para-magnetism. If, in the neighborhood of a vibrating drum, we have a cork ball, retained under the water by a thread, the oscillations of the cork are greater than those of the water in contact with it, owing to its small mass, and are consequently *relatively* in the same direction. Accordingly, we have repulsion, corresponding to dimagnetism. If, on the other hand, we hang in the water a ball which is heavier than water, its oscillations are not so great as that of the water in its vicinity, owing to its mass, and consequently the oscillations of the ball relatively to the water are in the opposite direction to those of the water itself, and there is attraction, corresponding to paramagnetism. A rod of cork and another of metal are suspended horizontally by threads in the trough. A vibrating drum is brought near to them; the cork rod sets itself equatorially, and the metal rod axially.

If a pellet of iron be floated by a cork on water and two similar poles (*e. g.* both north) be brought to its vicinity, one above and the other below the pellet, the latter cannot remain exactly in the centre, but will be repelled to a certain distance, beyond which, however, there is the usual attraction. The reason is that when the pellet is nearly in the line joining the two poles, the north pole of the pellet (according to our supposition) is further from this line than the south one. The angle of action is less; so that, although the north pole is further away, the horizontal component of the north pole repulsion may be greater than that of the south pole attraction. Dr. Bjerknes reproduces this experiment by causing two drums to pulsate in concord, the one above the other. A pellet fixed to a wire, which is attached by threads to two pieces of cork, is brought between the drums, and it is found impossible to cause it to remain in the centre.

Dr. Bjerknes conceived further the beautiful idea of tracing out the conditions of the vibrations of the water when acted on by pulsation drums. For this purpose he mounted a sphere or cylinder on a thin spring and fixed a fine paint-brush to the top of it. This is put into the water. The vibrations are in most cases so small that they could not be detected, but by regulating the pulsations so as to be isochronous with the vibrations of the spring, a powerful vibration can be set up. When this is done, a glass plate mounted on four springs is lowered so as to touch the paint-brush, and the direction of a hydrodynamic line of force is depicted. Thus the whole field is explored and different diagrams are obtained according to the nature of the pulsations. Using two drums pulsating concordantly, we get a figure exactly like that produced by iron filings in a field of two similar magnetic poles. If the pulsations are discordant, it is like the figure with two dissimilar poles. Three pulsating drums give a figure identical with that produced by three magnetic poles. The professor had previously calculated that the effects ought to be identical, and I think the same might have been gathered from the formulæ in Sir William Thomson's "Mathematical Theory of Magnetism," but this only enhances the beauty of the experimental confirmation.

Physicists have been in the habit of looking upon magnetism as some kind of molecular rotation. According to the present view, it is a rectilinear motion. Physicists have been accustomed to look upon the conception of an isolated magnetic pole as an impossibility, but here, while the oscillating sphere represents a magnetic molecule with north and south poles, the pulsating drum represents an isolated pole. These are new conceptions to the physicist; let us see whither they lead us. The professor shows that if rectilinear oscillation constitutes magnetism, a circular oscillation must signify an electric current. According to this view, what would be the action of a ring through which a current is passing? If the ring were horizontal, the inner part of the ring would all rise together and all fall together; they would vibrate and produce the same effect as the rectilinear vibrations of a magnet. This is the analogue of the Amperian currents.

To illustrate the condition of the magnetic field in the neighborhood of electric currents, Dr. Bjerknes mounted two wooden cylinders on vertical axes, connecting them by link-work, which enabled him to vibrate them in the same or opposite ways. To produce enough friction, he was forced to employ syrup in place of water. The figures which are produced on the glass plate are in every case the same as those which are produced by iron filings in the neighborhood of electric currents, including the case of currents going in parallel and in opposite directions.

The theory is carried out a step further to explain the attraction and subsequent repulsion after contact of an electrified and a neutral substance and the passage of a spark. But it is extremely speculative, and is not, as yet, experimentally illustrated, and I think that at present it is better to pass it by.—*George Forbes, in Nature.*

Miscellaneous.

THE NEW SCYLLA AND CHARYBDIS.

BY H. C. HOVEY.

Two pits of extraordinary magnitude have lately been discovered in Mammoth Cave, in such perilous proximity that risk is run of falling into the one while avoiding the other. Hence they have been aptly named "Scylla and Charybdis," in memory of the verse:

"Incidis in Scyllam cupiens vitare Charybdim."

Before giving an account of these particular pits it may be well to explain the formation of such cavities in general. The accompanying diagram (Fig. 1) shows a vertical section of an excavation made by the action of water on limestone—a process requiring an indefinitely long time, and proceeding at a varying rate corresponding to the abundance of the rainfall on the surface. The water, becoming acidulated as it sinks down through the soil, attacks the limestone along its lines of weakness. It thus holds in solution a portion of the rocky strata, in the form of carbonate of lime, and carries it away as it seeks the drainage level, A B. The result at first may be nothing more than an obscure fissure, leading from the sink-holes, S and S_1, to the outlets, A and E, which, at a later period, become mouths of the completed cavern. As the crevice grows, the chemical action, in which it began is aided mechanically by the quantities of sand and gravel swept in through the sinks, and that, being whirled about by the water, operate as a powerful cutting engine. The enlargements thus made are irregular in shape and frequently of great size.

Should the opening through the sink-hole be free from rubbish, the explorer will often find it the orifice of what he appropriately calls a pit. Should he gain admittance, however, by the drainage outlet, A, and follow the subterranean channel toward B, he will presently enter the chambers, C and D, and looking aloft to the vaulted roof, he will, with equal fitness, call them domes. But let him enter at E, the outlet of a former drainage, and come to a chasm capable perhaps of being bridged (as at F,) he will say, as he alternately looks up and down, that a pit is below and a dome above. It may not occur to the explorer till long afterward that the pit, the dome, and the chasm are identical.

To this explanation it should be added, that, if the water has to make its way through a stratum of sandstone before reaching the cavernous limestone, the sink-holes and pits may not coincide; the former simply leading to crevices of no great depth, and the latter being connected with them by winding passages burrowed out between the two formations.

The thickness of what is geologically known as "the Saint Louis limestone," as it exists in Edmondson country, Ky., is between 600 and 700 feet, and it dips to the west at the rate of about ten feet to the mile. The exposed ledges everywhere show the results of erosion by acidulated water, and it is said that nearly every acre has its sink-hole, large or small. According to Prof. Shaler, there are about 500 open caverns in that single county. Many of these are capable of being entered directly from sink-holes; but it is a remarkable fact that, of all the hundred of these depressions scattered over the area undermined by Mammoth Cave, not one is known to open directly into it! This I attribute to the overlying stratum of Chester sandstone, which resists the action of ordinary acids, although admitting the acidulated water through its seams and crevices, to do its work on the limestone below. In illustration of this, it is regarded as quite certain that the large sink hole between the entrance to Mammoth Cave and White's Cave is drained through what has long been known as "Little Bat Avenue," in the former. Near the end of this avenue there is a small aperture into which, in 1812, a saltpeter miner dropped his lamp, and in his futile efforts to recover it found that it had gone down into a very deep pit. The incident was noted chiefly because the missing lamp could not be replaced short of Lexington. Messrs. Smith and Buford discovered "Mammoth Dome" in 1843, supposed to be the largest of all known domes. During their explorations they came across, greatly to their surprise, the miner's lamp that had been lost thirty-one years before, and that had been cemented to the floor by stalagmitic drippings!

Among the noted pits and domes in this extensive cavern may be mentioned "Napoleon's Dome," comparatively small, but remarkably symmetrical; "Lucy's Dome," estimated to be 300 feet high, though no means of taking an exact measurement have yet been found; and the "Maelstrom," the pit down whose frightful depths Prentice (son of the poet of that name) descended by a rope held by the guides. The rope was afterward measured and found to be 135 feet long. Most wonderful of all, however, is the cluster of pits and domes represented in the diagram, Fig. 2. In order to see them the visitor leaves the main cave at a point about three-quarters of a mile within, and passes around the huge block known as the "Giant's Coffin," and follows a winding way leading underneath the main cave.

The "Wooden Bowl" is a small room containing quantities of quartzose gravel, betraying the means by which these excavations were made. Next is the "Side-Saddle Pit," 65 feet deep, as measured by my guide, a colored man, William Garvin, who took along with him a ball of twine for such purposes. The opening is about 25 feet across. Over it, or nearly so, is "Minerva's Dome," 35 feet high. Descending a stairway, a short distance beyond, we enter the "Labyrinth," leading to "Gorin's Dome," formerly estimated to be 500 feet high. But the fact that recent barometrical observations fix the extreme vertical depth cut through the mass of limestone to reach the drainage level in Mammoth Cave at 328 feet, effectually disposes of all such exaggerated estimates. The aperture through which "Gorin's Dome" is seen by the visitor is a sort of window 90 feet above the floor of the dome. The latter can be gained by a side passage. In the floor is a small pit 15 feet deep, leading to a body of water 12 feet deep, making the depth from the window to the lowest point 117 feet. The height of the vault overhead seems to me to be about 100 feet; which gives 217 feet for the extreme altitude of this dome.

There are three or four small domes and pits beyond, indicated in the diagram merely because they belong to the group. One of these has been lately named in honor of Prof. F. W. Putnam, and the other for the writer of this communication.

Returning up the stairway leading out of the "Labyrinth," we next approach a famous chasm, know as the "Bottomless Pit," above which expands "Shelby's Dome." This was long considered an impassable barrier to further progress in the cave, but it is now crossed by a substantial bridge built to the further side from a tongue of rock that juts out into the pit for about 27 feet, seeming to devide the horse-shoe-like chasm into two pits. One of these pits is by exact measurement 95 feet deep, and the other 105 feet deep, although the guides have been accustomed to give much larger figures. "Shelby's Dome" may be about 60 feet high, the space between the pit and dome being 15 feet, thus making the greatest distance from top to bottom about 180 feet.

Most of the localities thus far mentioned have long been open to visitors; but it has been necessary to show their place in the cave, and their relations to each other, in order to an understanding of "Scylla" and "Charybdis," which were found only last winter by the guide, William Garvin, accompanied by Mr. C. T. Hill, and are not yet open to any except the most resolute cave hunters. Indeed I was told by the guide that I was the first visitor who had been permitted to explore this perilous place, though I learned that several have visited it since. The approach is by a low, creeping passage, opening from the arched way, and leading to what has been known—only to be shunned—for many years, namely, the "Covered Pit," a treacherous chasm, imperfectly covered by loose slabs of limestone, between which the black depths seem to be lying in wait for the explorer. After crawling on our hands and knees for some distance, we stopped, and William told me to listen to the slow dripping of water, and throwing a pebble through a low opening on the right, I could hear it bounding from side to side, and after long intervals falling into a body of water at a prodigious distance below. The guide was delighted at my expressions of horror, and repeated the experiment several times. He then challenged me to creep up to the edge and look down. In doing so we lay on the rocky bridge, with the old "Covered Pit" on our right, and the cavity since named "Scylla" on our left. The latter is really a pit within a pit, as we found on throwing lighted rolls of oiled paper down its mouth. The upper pit seemed to be about 90 feet deep, and at its bottom we could just discern the orifice of the lower one. I was anxious to find a point from which we could examine this inner pit to better advantage. Creeping back from off the bridge, and then onward around a rocky pillar, for perhaps forty yards, we came upon the further edge of Scylla, and also found another horrible pit on the left, which, in pursuance of a suggestion from Mr. Klett, the manager of the cave, we named "Charybdis." The dividing ridge at this point was only about six feet wide, between the two chasms, and the classical names chosen seemed to us quite appropriate. Willing to run some risk in pursuit of my object, I clambered a short distance down into "Scylla," to a ledge overhanging its very deepest portion, and cleft by a serpentine crevice about five inches wide. Dropping pebbles through this crack, we could easily time them as they fell, unobstructed to the bottom of the lowest pit. By repeated trials we determined the time to be exactly five seconds by the watch. This, by a well known formula for calculating accelerated motion, would give 402 feet as the

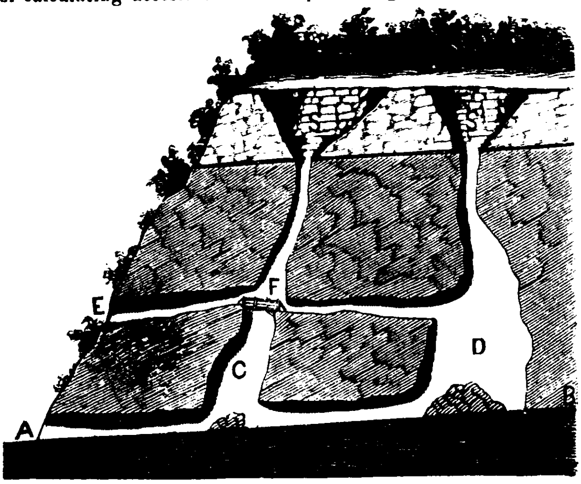


FIG. 1. VERTICAL SECTION.

depth *in vacuo*. Making due allowance for the resistance of the atmosphere, and also for the time necessary for the return of the sound, the space passed by the falling pebble was not less than 200 feet, nor more than 250. William, not satisfied with what he may have regarded as scientific guess-work, produced his ball of cord, fastened a lamp to the end of it, and let it down into the darkness. The glimmering light served to show the irregular walls of the abyss, as it descended, until at length it caught on a projecting rock. In his efforts to shake it loose, the guide was so unfortunate as to burn the cord off. The lamp, however, remained where it had lodged, shining on as if determined to do its duty to the last! The part of the cord that was drawn up measured 135 feet, leaving us, after all, to conjecture the remaining depth, our conclusion being that the previous calculation had been near the truth. Probably the limestone is pierced to the drainage level—a distance, according to the barometer, as inspected in the "Arched Way," of about 220 feet.

Glad to forsake the thin crust on which we stood, overhanging such depths, we climbed out of the jaws of "Scylla," and made experiments on the depth of "Charybdis." Here again the fragments of stone cast down were five seconds in reaching the pool below. Along the perilous rim William led the way to still another chasm, which he identified as the "Bottomless Pit." Regaining with some difficulty the bridge over it, we proceeded for a short distance on the path that leads to "River Hall," and then turned back by a passage leading under the rocks to an opening in the wall of the Bottomless Pit," about forty feet below the bridge. Here we saw the famous pit in a new light, and also obtained the only good view to be had of "Shelby's Dome" overhead. While we were standing there I noticed a volume of smoke issuing from a window beyond us. On investigating this phenomenon more closely, we found ourselves looking again into "Charybdis," though not at its deepest part. The smoke came from blue lights we had ignited just before leaving it. On mentioning this fact to Mr. Klett, I was informed by him that he had, on a former occasion, been burning lights in the new pits, and workmen on the bridge had seen them.

Thus, as we have shown, there are, within an area whose diameter does not exceed 600 yards, and may be considerably less than that, six of the largest naturally-formed pits in the known world, besides several others of smaller dimensions; and the entire group is joined together by connecting passages.

On inquiring if there was any sink hole in the vicinity to correspond with such a cluster of chasms, I was directed to a piece of unbroken forest, less than half a mile from the Mammoth Cave Hotel, where all the requirements of the case seem to be met. This vast depression embraces many acres, and is so deep that, when standing on its edge, one can overlook the tops of the trees growing in the central portion. But it remains to be proved by further explorations whether there are any hidden channels communicating, directly or otherwise, with the remarkable group of domes and pits I have attempted to describe in this article.—*Scientific American*.

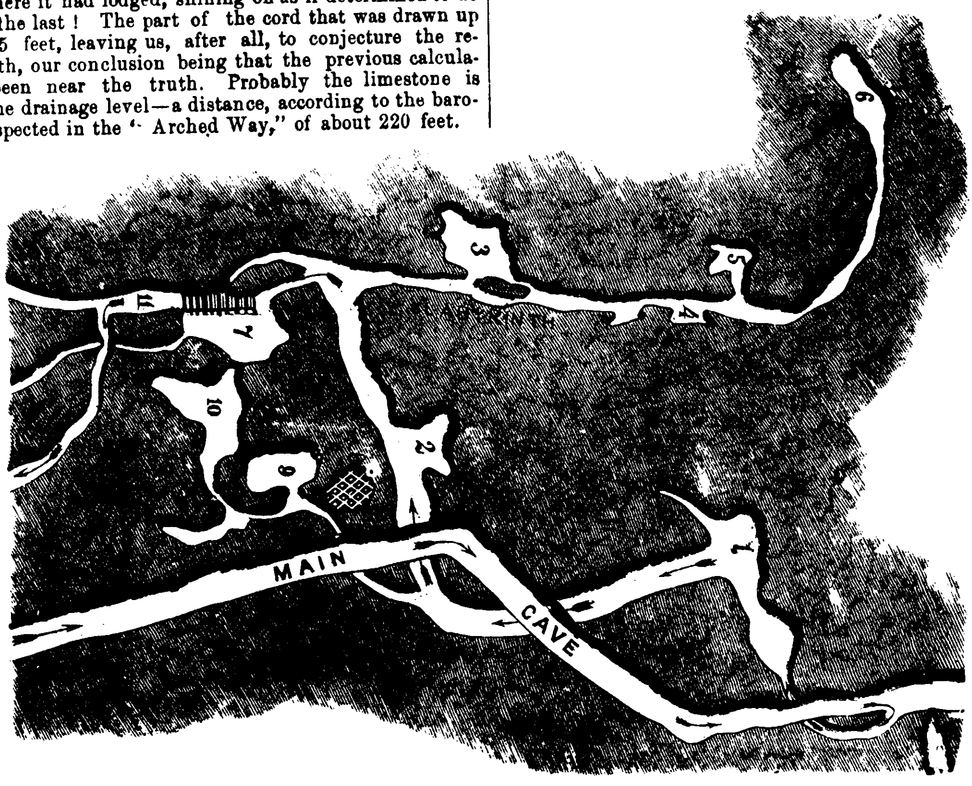
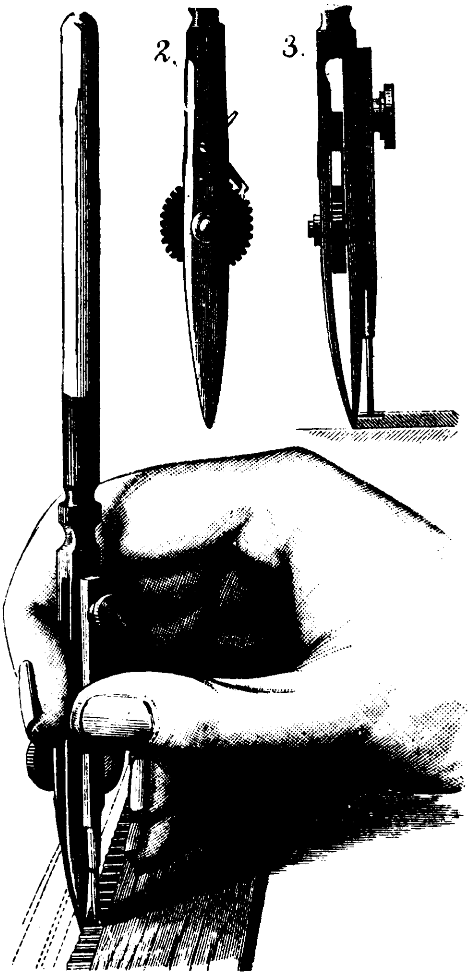


FIG. 2.—PLAN OF A PART OF MAMMOTH CAVE.

1. Wooden Bowl.—2. Side-Saddle Pit.—3. Gorin's Dome.—4. Putnam's Cabinet.—5. Hovey's Cabinet.—6. Ariadne's Grotto. 7. Bottomless Pit.—8. Covered Pit.—9. Scylla.—10. Charybdis.—11. Revellers' Hall.



NEW DRAWING PEN.

IMPROVED DRAWING PEN.

The shading lines of a drawing must gradually increase in width toward the darker part of the drawing, and this is accomplished by increasing the distance between the points of the drawing pen a trifle after a line is drawn and before drawing the next line. The adjustment of the pen is not accurate, as the operator has no gauge to guide him, and relies entirely upon his judgment, and errors can hardly be avoided, except by using a drawing pen provided with some suitable gauge for adjustment, such, for instance as shown in the annexed cut.

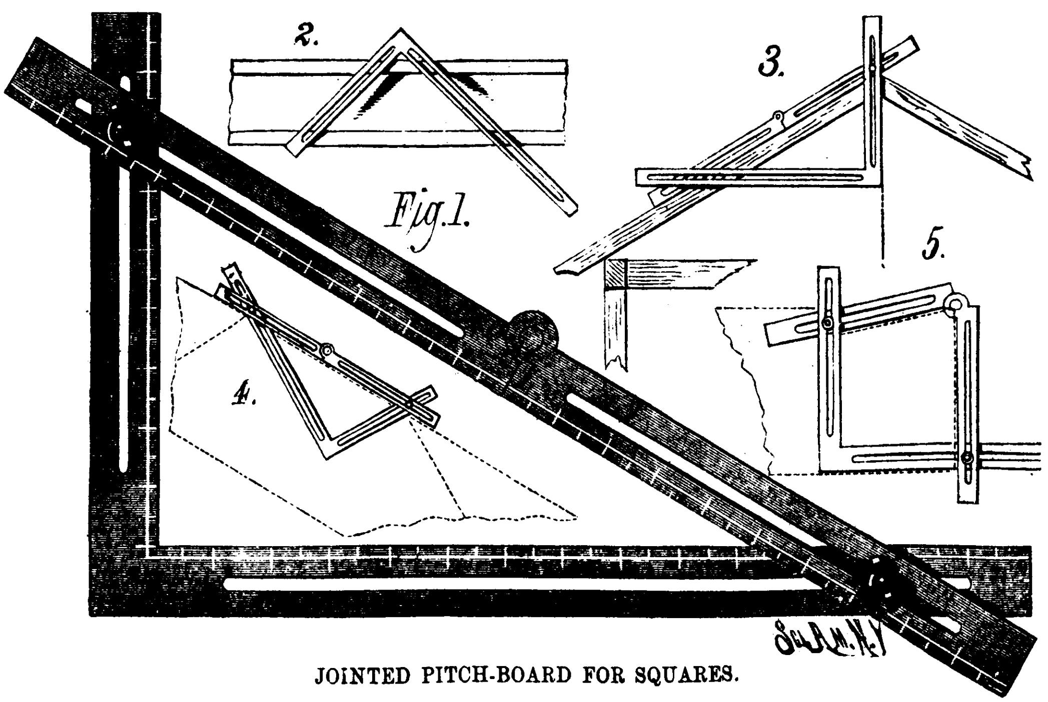
The adjustment wheel is cogged, and its circumference is divided into a number of equal parts, which are numbered. An angular pawl is pivoted between the blades of the pen in such a manner that one end rests on the cogged adjusting wheel and the other end projects from between the blades, so that it can be depressed by the finger, raising the other end of the pawl from the surface of the wheel, which can be turned the distance of one or more subdivisions, as the desired increase in width of the line may require, upon which the pawl is released and locks the adjusting wheel.

Fig. 1 is a perspective view showing the method of making dotted lines. Figs. 2 and 3 are respectively front and side elevations.

If dotted or broken lines are desired a rule is used as having undulations in its upper surface along the edge, and a pin or stylus is attached to that side of the pen toward the edge of the rule, the point of this pin resting on the undulated part of the rule. If the pen is drawn along the rule it will be raised and lowered alternately, and there will be corresponding breaks or interruptions in the line. The size of the blanks in the dotted line is governed by the size of the undulations of the rule. The pen has been patented by Wissmann & Wallegg, of Vienna, Austria.—*Wiener Technologische Blätter*.

JOINTED PITCH-BOARD FOR SQUARES.

The engraving shows a carpenter's square provided with a middle-jointed rule slotted in both sections, and connected by clamp bolts and wing nuts with the slotted arms of the square. The form of the instrument is clearly shown in Fig. 1. The square as well as the jointed rule are made of steel and have suitable scales engraved on them.



JOINTED PITCH-BOARD FOR SQUARES.

This instrument can be used for laying out miter boxes in the usual way, as shown in Fig. 2. It may be used for finding the length and bevel of rafters, as shown in Fig. 3, and it is found very convenient when used as a pitch-board in laying out stairs, as shown in Fig. 4. It can be used for laying out dove-tails on timber, as shown in Fig. 5; and it may have a straight-edge attached to it, so that it may be used as an extended square, and it will be found very convenient in solving many other problems in carpentry and joinery. The arms of the rule can be set respectively parallel with the blade and tongue of the square; then be used to size or box timber. The arms of the rule can be adjusted to the blade of the square and used as a double bevel. The pitch-board can be used to find the diagonal of a square: can be used to solve problems in proportion, such as finding the length of stair-string from the pitch-board; can be used to find the lengths and bevels of hip and jack rafters; can be used to find the sides and angles of hoppers and splayed work. It is the only instrument known to us that solves the right-angled triangle without calculation or drawing, that is, approximately. This useful invention was recently patented by Mr. Frederick N. Marvick, of Palatka, Fla.

Architecture, etc.

MODERN STREET ARCHITECTURE.

The *Real Estate Chronicle*, in discussing the more striking features of New York street architecture, as manifested in some of the buildings recently erected, says:

The general progress made in this country, within the last four or five years, regarding the general appreciation of combining beauty and taste with more usefulness, also manifests itself in our latest street architecture. Where monotony prevailed, and even was contemplated as "aristocratic" not very long ago, in building whole streets with an almost infinite repetition of one and the same house front, at present the utmost variety is aimed at, which taxes the architect's inventive faculties, his productiveness and imagination to an unusual extent, and thus inevitably leads to a richer organization and ornamentation of our present street fronts. With the almost uniform width of our building lots, and the mostly conventional interior arrangements of our private dwellings, as well as our flats and apartment houses, which require a certain given number and grouping of door and window openings, the principal distinguishing features must necessarily lie in the different styles of their exterior decoration and ornamentation, not taking into consideration, of course, the large number of public buildings and palatial residences of our rich that are constantly added to New York s list of remarkable works of architecture. Under such conditions it is quite natural that architects try to surpass each other in originality and novelty of design and construction; and not less natural is it that, besides many first-class productions which favorably compare with the masterpieces of architecture in other leading cities of the world, on our walks through the newly built-up portions of this city we also behold quite a number of buildings where the architects aim at outdoing what was done before, and endeavor to overdo it at the cost of fundamental principles of art and good taste. Sometimes to the thoughtful critic the question may arise: "What are the future aspects of architectural progress in this city? Is there not a danger that such craving for originality must destroy every organic and healthful development of architecture in its bud, particularly since there is missing in this new country the direct influence of those old traditions of art which are embodied in the numerous monuments of the Old World, dating as far back as one and even two scores of centuries and more?"

It is just this latter point which leads us to believe that this country is the one destined to bring forth ere long an independent and leading a new style of architecture. Architecture in Europe is so intimately connected with the past, its present vocabulary of forms is so closely based upon that of the past, that any new departure from traditions and old-established rules can take place only by degrees and very slowly.

American architecture is just entering into the prime of its life, fresh and bright, free, unprejudiced and unencumbered by old schools. Of course, she cannot dispense with their fundamental teachings, but their scenes being so far remote, their influence reaches our architects in a greatly condensed form, which enables them to enjoy those teachings in an objective way, without obstructing a free development of their subjective tendencies, their individuality. This individuality, however, cannot help being governed more or less by the general taste of the public, by the general requirements for any distinct class of buildings, by the building materials available, and by other numerous influences which in their totality contribute toward imprinting upon the architectural works of a period certain uniform features. And this is just what constitutes a style in architecture.

The general taste of the public corresponds to the prevalent characteristic features and inclinations of the individuals. We Americans are an assiduous, active people, and particularly in a city like New York, where the large business interests of the country are concentrated, the prevailing characteristic features of its inhabitants must necessarily be a certain dashing boldness of action that is free from pettiness in every respect. Now, is not the most striking feature of our modern architecture in this city just boldness of conception? Are not our architects endeavoring to treat even a naturally monotonous object, like stores of six or seven stories high and a whole block in length, in such a way as to divide and subdivide those tediously extended fronts in pleasing groups and large masses, quite in contrast to what was done hitherto, when one certain pattern of window and its surrounding architecture was repeated without end, upward and sideways, as often as the dimensions of the front required?

As to the influence of building material upon the style of architecture, the recent so extensive introduction of brick into the street fronts of even very costly buildings, must tend to promote that aiming at boldness and to prevent our architects, in their striving at originality, from getting lost in in petty details of ornamentation, the nature of that material confining the use of ornaments to such places as are in themselves prominently distinguished from the masses, as for instance, friezes, cornices, moldings, belt-courses, window and door trimmings.

PUTTING UP GALVANIZED IRON CORNICES.

At this particular season of the year many of the workman engaged in the cornice industry are actively employed in putting up work which has been manufactured in the shop during the past few months. Through September and into October, usually, work of this kind is very pressing, and there is generally a hurry to finish up jobs before the weather is such as to cause cold fingers and cold toes. The difference in construction of galvanized ironwork between the different shops engaged in making it is quite important. Those who are accustomed to the construction employed in the West, would be very much at a loss in putting up work manufactured in the East, and those who know how to proceed with work made in the Eastern cities, would be considerably embarrassed in handling work manufactured in some of the interior towns of the country. Probably the galvanized iron cornice business is not peculiar in matters of this kind. Variations in manipulation and construction, as between sections and different factories, prevail in other lines of trade as well. There is always a right and wrong way in construction, and where several plans offer, one is generally better than the others, and it is to be preferred under ordinary circumstances. We propose at this time to call attention to some features of construction which, although not new to many of our readers, particularly those situated in the central parts of the country, may be new to others. If we present any new ideas worthy of adoption, or if we provoke discussion, sufficient will have been accomplished to justify the space we shall devote to this subject. In an article published not long since, attention was directed to the manner of making joints in galvanized ironwork. The method of forming a gauge for setting, and of forming joints inside of the wall where the various horizontal members meet, was particularly described, and what was there said may be considered as introductory to what follows.

Fig. 1 of illustration shows a cornice constructed upon wood lookouts, and put up in a manner which experience has shown to be quite satisfactory. The brickwork is leveled off on a line with the bottom of the foot molding, and this member is then set by means of lookouts, clearly shown in the engraving, and a strip of board nailed upon the top of them. The foot molding is formed with a dip or gauge joint as described in the last article, which greatly facilitates the work of putting up. The object of the board on the top of the lookouts is to provide a solid base for the feet of the brackets. After the foot molding has been put in place the brickwork is carried up to the top of it, and then the brackets are placed in position, being fastened temporarily by any means most convenient. The frieze pieces or panels are next placed in position, being fastened to the brackets by a process technically termed "hooking." Edges are bent inward upon the sides of the brackets, and edges are turned outward on the ends of the panels. After a panel has been slipped in place, the edge of the latter is turned over the edge in the side of the bracket, thus hooking the two parts together. Along the bottom of the panel an edge is turned inward, which, meeting the edge turned upward on the top of the foot molding, serves as a gauge in lining the panel, and a means of fastening it to the course below. The two flanges should be riveted together, and the edge, which is turned up on the foot molding, bent over so as to form a water-tight joint. After the panels have thus been placed, the brickwork may be carried even with their top. Should the panels be very high, straps should be riveted to them at intervals and drawn into the brickwork, thus securely fastening them in position. When the brickwork has been carried to the top of the panels, the dentil course, into which the dentils had been fastened before the work was carried to the top of the building, is put in position. The lower edge of the dentil course fits back against the edge on the top of the panels, as shown in the engraving, thus forming a gauge by which it may be readily placed, and also forming a means of joining the two sections together from the back, which is to be done as described in connection with the foot molding. After the dentil course has been placed in position, the brickwork may then be carried to the top of it, after which the woodwork for sustaining the modillion course is to be put in position, and the same operation described for the preceding section repeated. In practice it seems to be better to fasten the modillions against the modillion course on the ground, leaving the planceer loose to lay flat upon the modillions and the brackets, and to be fastened in position after all are up, rather than to put it upon the moldings on the ground. Slight irregularities will occur in work of this kind, and some means of compensating for them, and of obtaining a straight line in the final members, should be provided, and, accordingly, by placing the planceer on the modillions after they are in position, it may be shifted one way or the other, as may be necessary to provide a straight line along its outer edge, against which to hook the crown molding. The planceer may be joined to the modillions by cutting through in the center of them, and turning down edges and bending them around so as to clinch with the edge in the top of the modillion. Instead of cutting out the entire size of the modillion and joining in this way, only a portion of the iron should be cut away, so as to leave as much strength in the planceer as possible. The same course is to be pursued in the tops of the brackets.

When the work has reached this stage the principal lookouts may be put in position, and straps, which have previously been riveted at proper intervals to the planceer, are to be carried up alongside the lookout and fastened to them by nailing, as shown in the engraving. This means of fastening the planceer is much better than nailing through it directly into the lookouts. The last operation in putting up the cornice is to hook on the crown molding and fasten it in place by means of straps just described.

This process of putting up galvanized ironwork is different in some particulars from that generally employed by cornice makers, but, on the other hand, it has the sanction of some of the most experienced mechanics in the country, and long practice has shown it to possess actual merit. No manufacturer of galvanized ironwork who has a pride in the quality of his product, will allow a cornice to be put up from the outside; that is, simply nailing it on the face of the building. A great deal of work has been done in this way, and has brought reproach upon sheet-metal cornices, besides producing buildings which have an appearance that is anything but satisfactory to their owners, or a recommendation to the builders in charge. It frequently happens that work is fastened to the outside after the walls are up, because the cornice was not ordered in time or not shipped promptly. Excuses of this kind are frequently offered, but are insufficient when the quality of the work is taken into consideration.

Fig. 2 of the illustrations shows an approved method of constructing a cornice by means of wrought-iron lookouts. Wooden lookouts inside of an iron shell, which, by fire in an adjacent building may be ignited, cannot be considered fire-proof. An iron cornice will fend off a fire for a considerable length of time, but if the lookouts within it are ignited the sheet iron is an effectual barrier against the water which otherwise might put out the fire, and, therefore in many instances an iron cornice becomes a veritable fire trap. Fire-proof construction demands the absence of wood-work inside of the cornice. In some cities galvanized ironwork is prohibited unless erected upon iron supports. The construction of the cornice upon iron lookouts is a matter that concerns the builder perhaps less than that in which wood is employed, because wrought-iron work is in most cases under better superintendence than ordinary sheet-iron, and therefore work of this kind needs less attention from him than that we have been just describing. It is well, however, in this connection to call attention to some general features, so that the builder may know what is really good in work of this kind. One mistake which seems to be very generally made by makers of fire-proof cornices, is in the weight and dimensions of the wrought-iron supports used within the cornice. It is hardly necessary to use a 2 x 2 T or a 2 x 2 angle iron, as we have frequently seen employed in work of this kind, for sustaining sheet iron which, at most, weighs only about a pound to the superficial foot. It is very generally the practice in the cities to construct the cornice upon the ground in sections, and hoist the same to the roof and place it in position, and then allow the brickwork to be carried up afterwards. While this plan has merits, it is not in all cases satisfactory. Some styles of cornice make it almost necessary to construct them in this manner. In other cases the cornice can be divided into sections horizontally, and a part at a time placed upon the building. Experience seems to indicate that this plan is calculated to afford the best results. The engraving shows very light lookouts employed, to which the cornice is fastened by bolts. The construction is such that the lower portion of the cornice may be in position, and the wall carried up level with the top of the brackets, before the other part is placed. If an outside scaffold can be provided, which in many cases (especially where pressed-brick fronts are used) is a matter of no expense or trouble, it is a simple matter to construct the cornice in sections and put it in position as the brickwork is carried up, thus making it a part of the building and getting the joints straight and perfect from one end to the other. The dotted lines in the upper part of the engraving show a means for providing the fall necessary in the gutter. The brace running from the principle tie to the point of the crown molding is punched with a number of holes, or else the several braces are calculated beforehand and punched accordingly, while the upper tie, which is placed edgewise, is bent according to requirements of the case, higher or lower, as it may be nearer one end or the other of the gutter. There are various ways of constructing the gutter on the top of lookouts of this kind. A very common way is to line the gutter with heavy sheet iron, fastening the iron to the lookouts either by cleating or with wires, and then laying a tin or copper gutter above this. In some cases we have seen wood gutter lining introduced, even though iron lookouts were employed. This we do not recommend. So much depends upon the general construction of the building, that at best only suggestions in matters of this kind can be offered. Construction of the cornice must be varied from time to time to suit requirements, and the intelligent manufacturer and superintendent will know how to adapt the work to circumstances.—*Metal Worker.*

FIRE RISKS AND TALL BUILDINGS.

We have frequently called attention to the fact that modern architecture was the greatest peril with which our large cities is threatened. During the past year, thousands of new buildings are being erected in this city, and of these a large number are tall buildings, seven, eight, and nine stories high, insecurely built from the foundation to the mansard roof, having granite foundations to support cast iron columns, which in turn support iron girders, upon which the floors are laid. Such a building is dangerous for a fireman to enter when a fire is raging within, as the granite foundation is liable to melt away with intense heat, and the iron columns and girders to twist and break, precipitating the floors above, and all their contents, into the basement. Put on top of such a building a mansard roof made of pine, and introduce an elevator shaft to carry the flames almost instantly from one floor to another, and you have a modern death trap that could scarcely be improved upon as a fire hazard, threatening the surrounding buildings and the lives of whoever may venture near it. In the lower part of the city there is one building whose roof is 185 feet above the sidewalk—away out of the city limits—and near by are many others nearly as tall. A fire in that roof would be wholly inaccessible to the firemen, while a high wind would scatter the blazing brands upon the roofs of lower buildings for many blocks.—*Fireman's Journal.*

THE international commission for regulating the observations of the coming Transit of Venus has completed its work, and the instructions will shortly be sent to all observatories and distributed amongst professional and semi-professional astronomers.

PUTTING UP GALVANIZED IRON CORNICES.

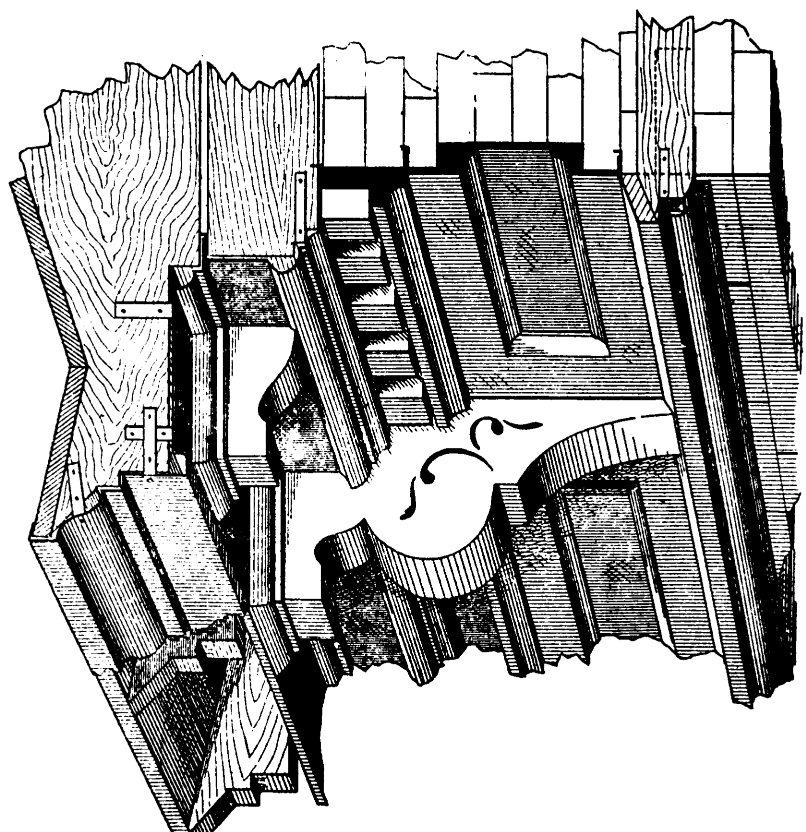


FIG. 1.—APPROVED CONSTRUCTION, USING WOOD LOOKOUTS.

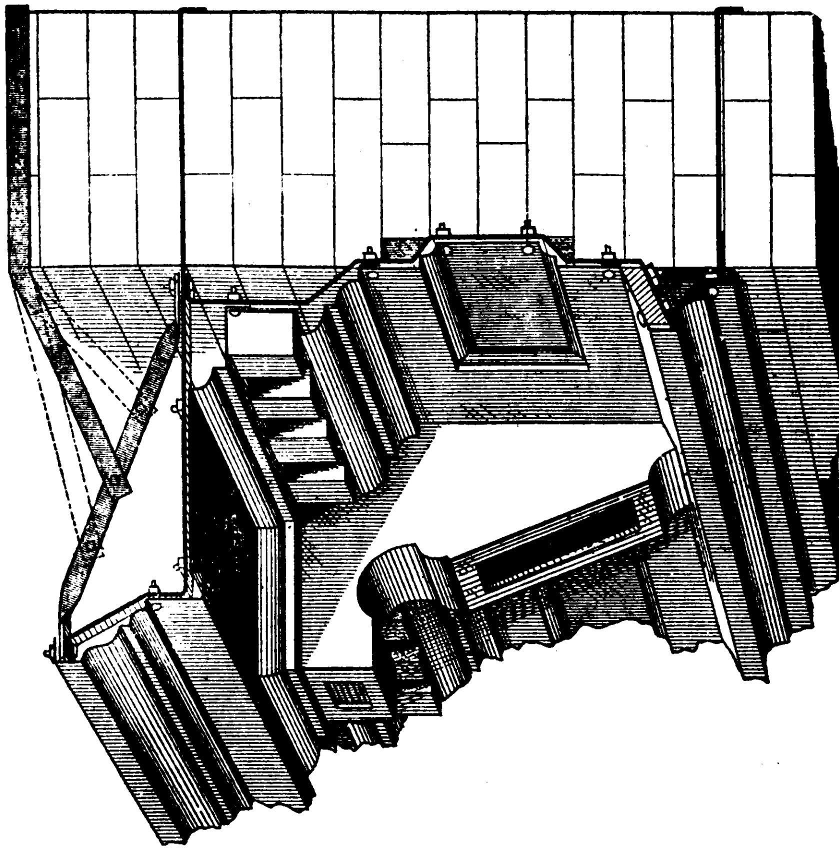
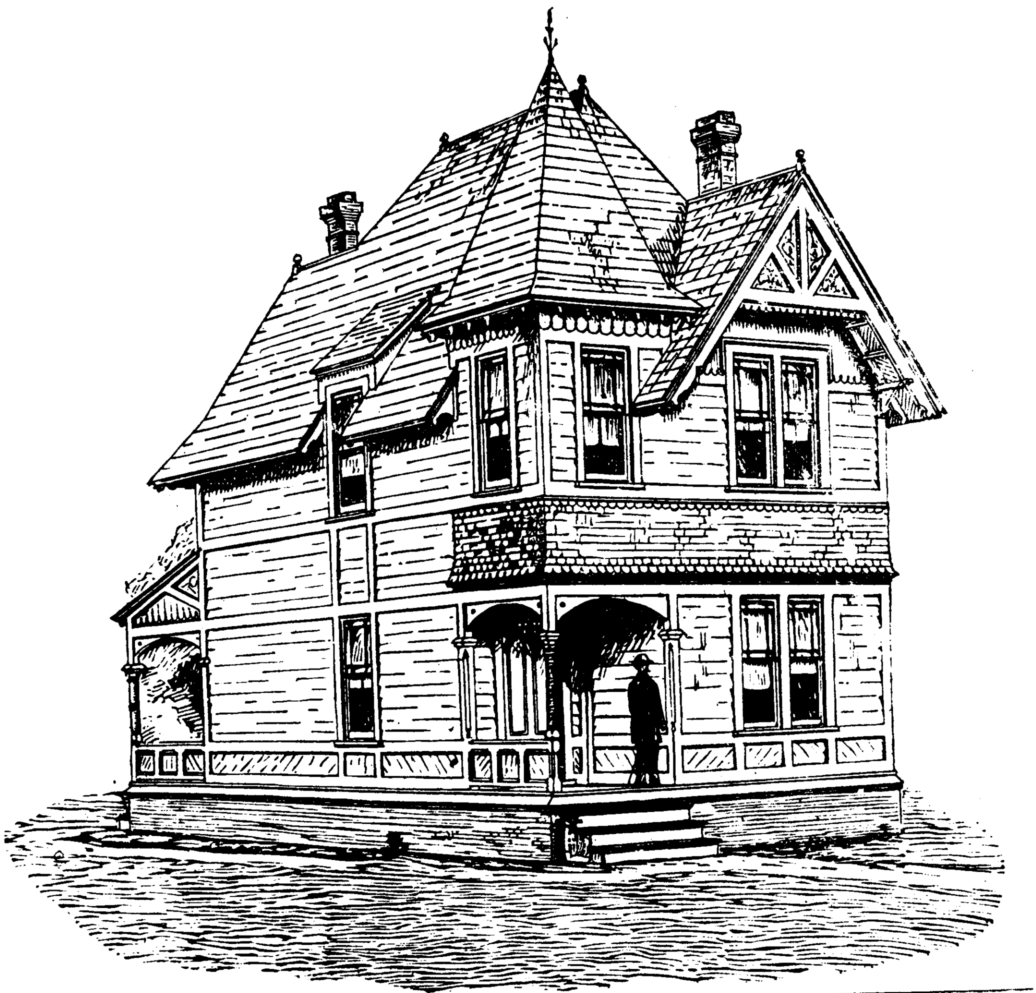
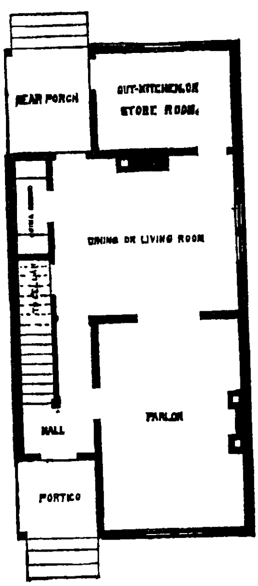


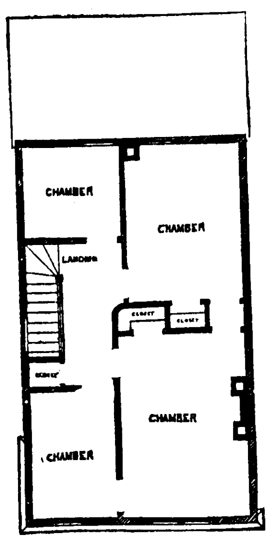
FIG. 2.—CONSTRUCTION WITH IRON LOOKOUTS.



DESIGN FOR COTTAGE, COSTING $1,000 TO $1,500.



Plan of First Floor.



Plan of Second Floor.

Architecture, etc.

A MODEL CHEAP COTTAGE.

We copy from the *Manufacturer and Builder* for our architectural department this month another of those artistic and admirably arranged cottage designs for which at present there exists an unusually widespread demand. Houses of this character find a readier sale or rental than dwellings of any other class, as they afford the most extensive conveniences and the greatest beauty attainable at so low a cost. We believe it will be generally acknowledged that in this direction the *Manufacturer and Builder* has catered more liberally and effectively to the demands of the day than any other publication, aiming to convert the rent-payer into the property-owner, and giving its patrons the advantages of the best professional talent.

The cottage represented on the opposite page is one of a series of twelve now in course of erection in one of the suburbs of New York, costing from $1,000 to $1,500. Under the most skillful management, this cottage can be built for from $1,000 to $1,200. It is built in a thorough and substantial manner throughout, the frame being double sheathed and covered with clap-boards, and the roof slated with best roofing slates. A cellar may extend under the entire main building, or the front portion only. In the construction, much ingenuity has been exercised to produce the best effects from the least expenditure of materials and labor. Throughout every department of the work the most assiduous thought has been bestowed to make every dollar expended tell.

The internal arrangement is well explained by the accompanying floor plans. It will be noticed that the house contains seven-rooms, all of fair size and of convenient access and pleasant communication. By a very slight modification, the arrangement can be adapted to double construction, reversing the arrangement of one building. This would not only reduce the cost of the two buildings, but would afford more available space to the plot.

The architect of this design is Horace G. Knapp, of 61 Broadway, New York.

THE EXPENDITURE OF ENERGY IN INCANDESCENT ELECTRIC LIGHTING.

At the York meeting of the British Association, Sir W. Thomson and Mr. Bottomley gave the results of some experiments carried out by them in order to determine the illuminating power of incandescent vacuum electric lamps with various strengths of current. Every lamp was tried with higher and higher potentials until the carbon broke. The electricity was obtained from a number of Faure's cells, of which 26 were first put in circuit, developing 0·093 horse power, and others were added until the lamp was destroyed. Three lamps only were tried, the first of which broke down after fourteen experiments; the second lasted through fifteen tests; and the third broke before the third reading could be completed.

With 26 cells the first lamp gave the illuminating power of 11.6 candles; 4 more cells then brought it up to 25 candles; with 32 cells it showed 42 candle power; and successive additions of cells forced the light up through a very irregular scale until, when giving the maximum of 114 candle power, the carbon gave way. The next lamp was first tried with 40 cells, affording 0·27 horse power, and giving the light of 49 candles; and the lamp broke when connected with 70 cells, when the light would have been over 200 candles. The irregularity of all the records is very striking, the power of the batteries and the light given by the lamps being very uncertain and by no means increasing in any common ratio. For example, the first lamp gave the light of 84 candles, with the expenditure of 0·247 horse power, from 40 cells. The next lamp, with the same number of cells, gave only 49 candle power in one instance and 35 candles in another, although the energy of 0·27 horse power was recorded, or nearly the same as before. Again, the second lamp gave 186 candle power with 56 cells, while the addition of 6 more cells, instead of increasing the light, brought it down to 180 candles. Much of this variation is said to be caused by the blackening of the interior surface of the globes by the deposition of volatilized carbon, when high powers were applied. The photometric method employed by the authors consisted of directly comparing the depth of shadows thrown by a pencil on a piece of white paper, and the candle employed was the usual standard sperm article, assumed to burn at the normal rate, but not weighed, as the object of the experiments was simply comparative.—*Journal of Gas Lighting.*

Cabinet Making.

THE MANUFACTURE OF FURNITURE IN GERMANY.

The development of the manufacture of furniture during the last decade formed the subject of a lecture delivered by Herr Carl Behr, the manager of the furniture manufactory of Herr A. Bembé, at Mainz. Being of general interest, we reproduce an abstract of the lecture which recently appeared in the *Builder.*

Furniture represents those products of art industry which interest us in, perhaps, a far greater degree than other objects which we use, because they immediately surround us, and appeal directly to our sense of domestic comfort. For this reason it has been ever the endeavor to produce furniture of tasteful design; but it has been reserved to modern times to make real progress.

About ten or fifteen years ago, the furniture industry of Germany was at a very low ebb, and it was accompanied at the same time by an aberration and absence of taste which were most surprising. Furniture was made in Germany either in simple or heavy forms, or else in absurd imitation of French models. The French then, as now, were in the habit of resuscitating the various styles of the past, according as the taste of buyers happened to change. It was a great defect in the manufacture of furniture in Germany that most makers worked without models or drawings, and that with the introduction of new wood-working machinery the traditionally delivered forms were gradually transformed without any regard being paid to the beauty of the whole composition. One of the most flagrant aberrations of taste at that time prevalent in Germany, greatly encouraged, it must be owned, by a large demand for the article, was the manufacture of so-called old oak furniture. The way in which that class of furniture was produced was most barbarous, machine-made naturalistic ornaments, such as fruits, objects of the chase and still-life, etc., being stuck on to the smooth surfaces of the wood, without any regard whatever to the harmony of the whole composition.

Many technical journals of the better class, such as the *Oesterreichisches Museum* (Vienna) and the *Gewerbehalle* (Stuttgart), fought hard against that practice, and exhorted makers to return to a legitimate production of such work, urging that this might best be achieved by an adherence to the forms of the German Renaissance, as being most in accordance with the taste of the people. But it was reserved to the time of national re-awakening, the years of the war of 1870-71, to give an impulse to the endeavors of regaining the lost prestige in art-industry by the adoption of those long neglected forms.

An improvement was noticed as early as the Vienna Exhibition of 1873. But of especial influence in the development of the manufacture of furniture in Germany was the exhibition of the Bayerische Kunstgewerbe-Verein of Munich in 1876, a society which has done inestimable services in raising German art-industry. That exhibition pointed the road to be taken, and enabled a more uniform system to be pursued. From that period dates a steady and speedy development of this industry which was demonstrated at a series of important exhibitions, such as those of Hanover, Berlin, Leipzig, Offenbach, as well as smaller local shows. The foundation of new art-unions and the increased activity of already existing ones contributed considerably to this development.

The author next considers the work of French makers of furniture as shown at the last Paris Exhibition and compares the French and German modes of manufacture.

The furniture of Paris manufactures—the makers of other French towns being far behind them—is distinguished by a perfect execution of the separate parts, a harmonious effect of color and ornament being likewise aimed at. Most of the furniture, however, is of such an expensive nature as would prevent its sale in Germany; prices ranging from 20,000 f. to 25,000 f. for some articles being not all rare. The workmen are consequently very highly waged; it is a fact that clever men are paid at Fourdincis', in Paris, as much as 5 f. per hour. But it is a remarkable fact that German workman execute the best work in Paris establishments, though they have no opportunity on their return home to make use of their acquired skill.

In the design and composition of French furniture, however, there is a striking absence of the noble forms of the Renaissance, the place of which is taken by the pompous shapes of the styles of Louis XIV., Louis XV., and Louis XVI.; here and there, also, the more sober one of Henry II. in the development of which the French have achieved extraordinary things.

If we compare the work of French furniture makers of the present day with that of the same class from the end of the sixth decade of this century it will appear at once that there has been an undeniable standing still. If we compare with this the great strides made by Germany, the time will not seem very far distant when the German furniture industry will be able to compete with that of France without misgiving. This highly favorable state of things has been effected principally by the foundation of societies and the holding of art and industrial exhibitions; yet its fuller development has to some extent been hindered by an absence of artistic feeling on the part of the general public, which can only be created gradually by a more universal training in the elements of art. This artistic understanding is being by degrees instilled into the public mind of Germany by the exhibitions already mentioned, but it might be still further stimulated, the author thinks, by very elementary means, such as rational systematic instruction in drawing in all schools for example. The practice of having work which might well be done at home, executed by foreign hands, and of submitting it to public competition, according to the author, also affects injuriously the growth of the art industries in Germany.

The author endeavors finally to demonstrate that the utilization of German Renaissance forms in the manufacture of furniture of the present day is highly advisable for various reasons. The Italian Renaissance is intended for another climate, other conditions and other manners, and is especially not to be recommended for Germany from pecuniary considerations; for by dispensing with rich carvings, etc.. part of the original characteristics of the style is lost. The art workman must study all styles which have been artistically developed, in order to be able to appreciate their excellencies, and to keep from falling into the mistake of one-sidedness. To do this successfully requires study and application: study alone will make it possible for him to adapt and utilize the styles of former times for the artistic requirements and to the changed wants of our age. Study classic models, but impress your own ideas on your work: such is the advice of the author to the art workman. This alone will guard him against monotony and repetition.

GILDING ON GLASS.

Gilding on glass is not usually practised by the carver and gilder, yet it may not be out of place to describe the process.

We have described oil gilding, and it is not unlike it in its *modus operandi*, but of course the conditions are different. In place of the oil gold size you must mix two ounces of water with the same quantity of spirits of wine, and a small quantity of isinglass or gelatine. Dissolve the isinglass with the water, which should be boiling, and when nearly cold add the spirits of wine and strain through clean silk.

The method of procedure is to obtain a sheet of paper of medium thickness, the size of the sheet of glass on which you propose to gild, and with Brunswick black, write or draw with a camel's hair pencil what you wish to gild on the glass. This paper should be attached to the glass with gum or wafers at the corners, with the design outside. If it is writing it will be seen through the glass from right to left, and the letters of course reversed. After the glass has been thoroughly cleaned, with a camel's hair pencil write or copy the letters with the mordant as above prepared, care being taken not to take up too much in the pencil at once. If it is a long strip of grass, which it often is, the best position for work is to raise it on one end, on a sloping board, so that you could begin at the top and work down, the letters being one over the other. Apply the gold with a tip as usual, and if the writing is not large it would be better to lay on the gold throughout the whole line without reference to the shape of the letters. When the letters are put in begin gilding on the top, aad let each leaf of gold just overlap the one laid above. If this particular is not attended to every seam in the gold will show; if large letters are required the gold can be cut to the shape necessary.

When all the gold has been laid it should be left to dry, or placed before a fire, when as it dries it will assume a burnished appearance. It should be then carefully rubbed over with the fine cotton wool (to be obtained of chemists) to remove the loose pieces not adhering to the glass. At this stage the work will look faulty, and another coat of gold must be given to make it appear solid. To this end, lay on a thin coat of isinglass size with a soft camel's hair brush, and be careful not to go over the same place twice, or the gold will be removed. In order to enhance the burnish of the gold, the size is sometimes laid on hot, but the workmen would prefer for the size to dry, and pour on hot water. The last method sometimes cracks the glass, but the hotter the water the brighter the burnish. The second coat of gold is laid on with the same size as the first, and in the same manner. After it is dry the superfluous gold must be removed and a coat of hot size laid on carefully. The gilding will now be brilliant, but not so effective as wished; another coat or two will improve its appearance. The work should now be left for a few days to harden.

At the present stage of the work there is little or no shape to the letters, as the gold has rough edges and letters badly formed. The gold must be written on with Japan black; this will make the letters smooth and shapely. In order to have an outline to work from, take the copy from the back, rub it over with whitening, and lay it face downwards on the gold, and with a stile or pointed piece of wood go over the outline of the letters, and, on removal, it will be found a good outline to work by on the gold. After the lettering has been neatly done and dry, all the gold not covered must be washed off with warm water. If any of the edges should happen to be rough, they can be trimmed, and the tops and bottoms of the letters can be cut up with a straight-edge and chisel. The shading can now be put in. The operations described above should have full time to dry, and not follow one another too closely; the risk of the gold coming off is lessened thereby. When the gold has been on the glass for a few months, it is with difficulty that the leaf is washed off the glass at all.—*American Cabinet Maker.*

CONVENTIONALITY IN DESIGNING.

An instructive commentary on our recent criticism of the conventional work of the art schools, as contrasted with the genuinely artistic work of our tool makers and machinists, is furnished by the recent competition in wall paper designs instigated by Messrs. Fuller & Warren.

Speaking of the disappointment occasioned by the designs sent from France the critic of a morning paper says:

"Without being able to lay our hands at once upon the original sources of these designs—without even wishing to say that they are copies—we yet know that there is nothing in them that is not familiar; they are mere variations, and not at all clever ones, on the fashionable stock-in-trade of the day. Some of them are suggestive of the tapestries of French manufacture. One of them has a "filling" that is inspired by Persia; there are two very good borders, skillful treatment of old models, but of the most of them Japan is the fruitful mother—Japan treated rather cavalierly, after the French fashion. But whatever it may be—tapestry, Persia, or Japan—it is all copying, skillfully, accomplished, and thorough workmanship, but all inspired by books and all drawn from the brains of other men."

In a later paper, speaking of the absence of originality displayed in nearly if not quite all of the designs submitted, the critic is constrained to say that "it is beginning to be felt that the production of good designs by any of the now long-tried methods of art schools, schools of designs, South Kensington schools, and the like, is less and less to be depended on. There has been for some time in England much groaning and complaint over the failure of the costly governmental methods employed to stimulate the faculty of design in the British subject, and whether the peoples of the continent are as well alive to their own failure or not, it is nevertheless true, that not only the Germans, the Austrians, and the Italians, but even the French, are reduced to the imitation of the work of the past in every department of manufacture calling for design. It is true they have carried this imitation, not only in the design, but in the manufacture itself, to the very highest point of perfection, so that the brocades and stuffs of all kinds, the metal works, the ceramics, the tapestries, carving in wood and stone, the glass, etc., that are produced to-day are, in all cases where price is of no importance, as well made as they ever were at any time, and even when a cheaper market is looked for these things are often a very high degree of excellence. But original design has by no means kept pace with manufacture, and though there are few striking exceptions to the statement, it may be safely said that in design to-day we are dependent on the work of those who have gone before. The design of to-day consists in the clever copying or combining of what has been produced by other people in other times."

Herr K. Kraut has communicated to the Berlin Chemical Society the results of a series of investigations which have led him to conclude that nitric acid coming into contact with cotton, sawdust, straw, hay, and similar substances, is very liable to cause combustion.

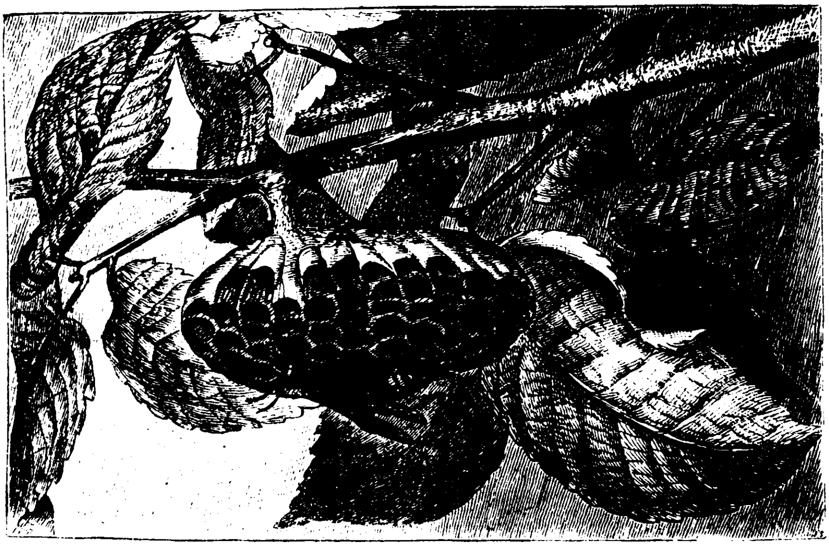


FIG. 3.—WOOD WASP AND NEST, SHOWING ARRANGEMENT OF THE LOWER COMBS.

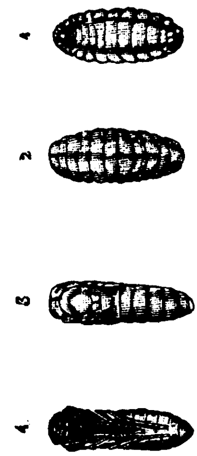
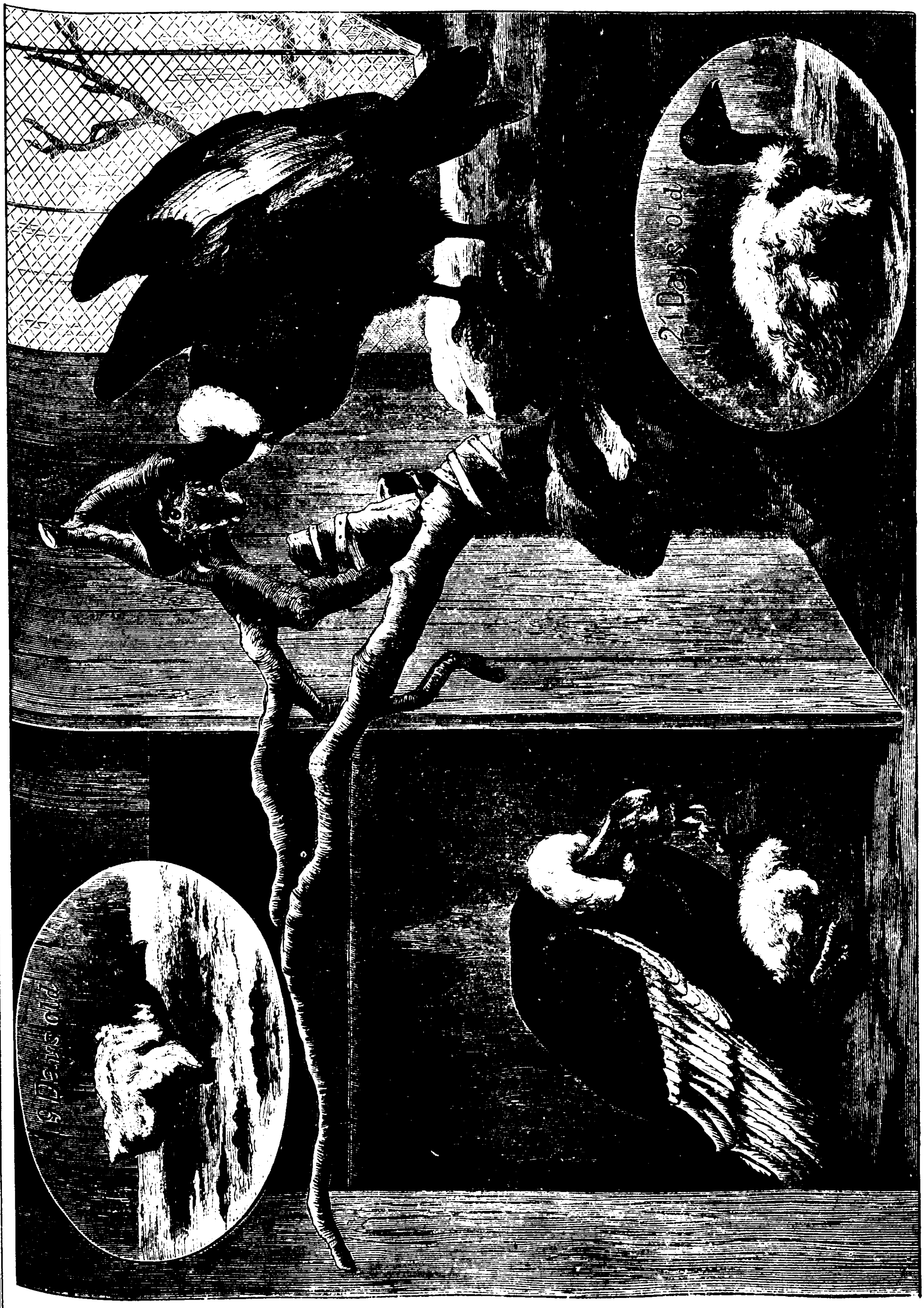


Fig. 1.—Eggs of the Common Wasp: Larva—1, beneath; 2, above. Nympha—3, above; 4, beneath.

FIG. 2.—WASPS' NEST WITH THE MOTHER WASP.



THE CONDORS AND THEIR YOUNG IN THE DRESDEN ZOOLOGICAL GARDEN.

Natural History.

THE CONDOR.

The condor is a native of the mountain chain of the Andes, and is one of the largest of the birds of prey. The average expanse of the condors's wings is from eight to nine feet, and the length of the body from the point of the beak to the extremity of the tail three feet and five or six inches.

The color of the condor is a grayish black; the wings are marked with white, and there is a collar of downy white feathers about the neck. The crest of the male is quite large. The internal structure of the condor presents some curious features; the "gizzard" is provided with longitudinal rows of horny spikes, which are supposed to assist the bird in the rapid digestion of its food.

These birds often attack cows, bulls and deer, and as their assaults are chiefly directed upon the eyes, they blind their victims, and they soon fall by the blows which are inflicted upon them by the beaks of the birds.

The condor is very strong, and even when wounded a powerful man is no match for one of these creatures.

The Indians have a great dislike to these birds, and if they capture one of them alive they torture it very cruelly. Their mode of capture is as follows: They kill an animal and expose the body in the open air. The condors soon assemble in large numbers and feast upon the flesh. As soon as they are gorged to the full the Indians dash in among them and capture them with their lassos. When they feel the noose around their necks they endeavor to reject the meal which they have swallowed, but are made captives before they are able to rid themselves of the food.

The flight of these birds is grand and beautiful; they seem to fly by moving the head and neck rather than the wings.

Although there have been condors in the Zoological Gardens at Dresden since 1874, it is only recently that anything has been found out in regard to the length of the brooding season, their habits at the time, their manner of feeding their young, etc.

Very little has been known of the habits of these birds until lately, as they live at a height of from 10,000 to 15,000 feet, and only come down to the lower points in search of prey. The Indians assert that the eggs are laid upon the bare rock, the bird making no nest whatever.

The condors in Dresden commenced laying in April, 1877, and, after that, laid from two to three eggs yearly in April or May, but unfortunately they crush their eggs immediately, or after playing with them several days. Last year a nest of dried branches, feathers, and wool was made in the top of the cage, about two meters from the ground, and it was thought that the birds would avail themselves of it. Loose material for nest-building was also put in the cage, but the female laid her eggs in the sand as before, and both the eggs were soon destroyed. The same thing happened this year in the middle of April. Shortly after the birds were removed into the large summer quarters of the birds of prey, and the female laid an egg on the 9th of May, in a dark corner of the cage. The next day the male commenced to brood. All the materials for a nest that the keeper laid under and about the egg were rejected and scratched away, and the brooding went on upon the gravel bottom of the cage. The male devoted himself to the brooding the greater part of the time, the indolent female only setting upon the egg about a third of the time.

On the seventh of July, after nearly eight weeks, the keeper announced that he had discovered life in the egg. The next day the bird had almost escaped from the shell, only the head and neck remaining in, and on the following day the bird was entirely freed. Since then the old birds have been very busily employed in giving the little one the necessary warmth, and have manifested equal anxiety in feeding it with horse flesh and small pieces of cat and dog flesh. The little fellow, with its grayish feathers, looks something like a little owl. Its head and neck are quite black. If any one approaches, it commences already to utter angry cries, and the old birds are so ugly that the keeper can only enter the cage armed. The brooding continued for eight weeks less one day. Cassel says, in his "Natural History," that a condor's egg was hatched in six weeks and two days by a hen. This may be on account of the nest which the hen had.

The young bird, on the first day, measured ten centimeters in length, and on the twentieth day twenty-eight centimeters. The condors are fond of bathing, and often sit upon their eggs with their wet feathers.

WASPS AND THEIR NESTS.

The common wasp is found all over the globe, and is known by its long slender body, colored yellow and black, and by its four wings, two of which are folded double over the back when in repose.

The true wasp is always social, living together in large numbers. Wasps may be divided into three classes, male, female, and neuter; only the two latter are provided with stings. One radical difference between the bees and the wasps is that the wasps do not secrete wax. They build their nests of a gray or reddish paper, formed of fibrous substances that they tear off with the powerful mandibles and fasten together with their gluey saliva. The arrangement of the cells is also slightly different. Another peculiarity is the desertion of the wasps' nest at the first frost.

The perfect females pass the winter hidden in the moss, on the ground, or in the holes in walls or trees. In the spring they awaken from their long sleep and start out to seek food. They attack the blossoms of the young fruit trees, and, later, the currant bushes. This is the best time to destroy as many wasps as possible, for each female wasp that is killed prevents the formation of a nest.

The food of wasps and the mixture they feed to their larvæ is much more varied that the nourishment of the bees. Wasps are fond of all kinds of sweet things, especially honey, which they often try to steal from bee-hives. Their tongues are too short to obtain honey directly from flowers, but they attack the ripe fruit where the skin has been broken by rain or birds; they drink the sweet sap exuded by trees, and from these substances they make a tolerably sweet honey, which they store away or feed to their young. Wasps will also seize living insects, even spiders, and tear them apart to feed to the larvæ. In the autumn they will even come inside the window to seize the housefly, and in the woods, one can often notice the sudden disappearance of all flies at the approach of a hornet. They will voraciously devour the meat exposed on the stalls in the market, and often cause serious loss to the careless butcher.

Wasps are much more nocturnal in their habits than bees; and it must be remembered that in the evening, when it is perfectly safe to handle a beehive, it may be dangerous to attack a wasps' nest, as the wasps may still be flying in and out.

In France, the wasps generally make their nests in holes, either in the earth or in trees and walls, and under the roofs of houses. Nests have even been found in old barrels and deserted beehives, the remnants of whose honey had probably served to nourish the intruders.

The underground nests are very brittle and easily broken, as they are made of bits of decayed wood and bark glued together. They are the color of fallen leaves. The common wasp and the "*German wasp*," are very similar, and generally build their nests in the abandoned holes of the field mice and moles. They dig out the earth to enlarge the nest, and spread it in little piles about to hide the entrance to the hole.

In the ordinary nest the comb is protected by a concentric covering and divided into three distinct parts: 1st. One or perhaps more combs or layers of hexagonal cells. 2nd. Pillars that join and support the different combs. 3rd. An outside covering composed of several membranes of paper, which is covered with a sort of gluey varnish that is secreted by the wasps' tongues, and gives the nest a silvery varnish. On account of this varnish and the convex form of the nest, neither the rain nor cold can penetrate into it, consequently the temperature of the nest is higher than that of the atmosphere, sometimes being fourteen or fifteen degrees warmer.

The mother wasp commences her nest in the beginning of summer, and first constructs a foundation of woody fibers, which she builds up in the form of a capsule, forming in the centre eight or ten cells, to which she adds new cells when necessary.

The first eggs are always working wasps or neuters, and the mother wasp is forced to leave the nest frequently to obtain nourishment for them. Afterward, when these are grown, they do all the work, enlarging the nest, providing food for the later larvæ; and from this time the working wasps, which can easily be distinguished by their more slender bodies, are the only ones that are found flying.

From the first of August to November the mother only lays the eggs of males and perfect females.

The larvæ (Fig. 1), which are white and without legs, are attached to the cells by the extremity of their abdomen, and hang head downward. There are two brillant spots on their heads, and their mouths are stronger than those of the bee larvæ, as they receive tougher food. When the larvæ are fully grown they turn over and weave a slight tissue of silk around themselves and the cell, then, resuming their old position, they close the opening of the cell with a thicker silk, and remain quiet for several days. At the end of that time the larvæ have become nymphæ, which are the complete wasp, covered with a thin skin, through which can be seen the three divisions of the body, with their developed organs folded under the abdomen. These nymphæ are at first white, and then gradually become colored, commencing always with their black eyes; and for several days after they have broken their coverings the wasps are less yellow than they become afterwards. When fully grown the wasp tears the silk tissue and breaks open its cell with its mandibles and flies out of the nest.

A third species, less known, is the red wasp, which frequents only the woods and builds its nest underground. The nests are small and not populous. These underground nest-builders may be distinguished from the common wasp by their abdomens, which are not all yellow and black, but are either red or striped with red. These wasps have numerous enemies, among whom the volucellis are the most formidable, as they are colored somewhat like the wasp, and consequently can easily penetrate into the nests and eat the larvæ, thus rendering us a great service in those warm dry seasons when the wasps' nests are overflowing with their intolerable breed.

The hornets' nest is much larger than all other varieties, and is usually built in hollow trees or under large roots on the ground, or in old walls, chimneys, etc. These nests, which are composed of a sort of pulp of decomposed wood, are very friable. They have a single envelope, and are always placed in some hole for an additional covering and protection. Hornets are very irritable and will attack in crowds any one who they think will hurt their nest. They seek to attack the places where the body is unprotected by clothes, and as their repeated stings are very dangerous, it is best always to rush to the nearest water and completely submerge one's self.

Strange to say in spite of the hornet's peculiarities and carnivorous instincts, it has one friend in the insect world. It is a large black coleoptera, the *Vellcius dilatus*, distinguished by the peculiarity that, when disturbed, it drops its body and trains it on the ground like a little lizzard. This insect follows the wasp in the evening into the nest, of which it makes itself the protector. It furiously attacks all insects that are hurtful to the young wasps, especially the centipedes, which they continue to shake long after the insect has been torn to death by their powerful mandibles. It is also possible that the strong odor of muck about the *Velleius* may be pleasant to the hornets and agreeably perfumes their nests. In return, the hornets permit it to eat some of the honey, of which it is very fond.

Though this insect is very timid at first, it soon becomes accustomed to any one who will properly nourish it, and can be easily domesticated in order to observe its habits. It can be taught to take honey from the end of a fine brush, and it will cling so tightly to its food that it is difficult to make it let go.

There are a few wasps that build their nests entirely uncovered, simply attached to the branch of a tree. These nests are made of woody fibers, torn from decayed wood or plants, and are very flexible and elastic.

The concentric envelopes on the outside of the nest have such a great resemblance to gray filtering paper, that it would seem as if the wasps had preceded man in the invention of paper. This species is the wood wasp, Fig. 3. It is a little smaller than the common wasp; the female has a more velvety body, and the neuter is quite smooth. This species is spread all over Europe, except perhaps in Lapland.

There is another group of wasps that are distinguished by the inferiority of their nests, which are never provided with an envelope to protect them from the weather. These nests are simply a comb supported on a strong stand; the cells are oblique or recessed, and more or less numerous according to the size of the brood.

These wasps are more slender than the ordinary wasp, fewer in number, less irritable, and much less destructive to fruits and plants. In the month of April this wasp (Fig. 2) can be seen commencing his little nest in some warm spot exposed to the sun but well sheltered from the rain. These wasps are so gentle that even if the nest is carried away the mother wasp will not offer to sting, but clings to the nest or flies close to it. If the branch with the nest on it is carried into a house she will still follow and continue to feed her eggs. When these are hatched they readily become accustomed to the presence of man, and it is possible to observe, at home, the habits and development of these curious insects.

Probable Cause of the Longevity of Turtles.—So far as we are aware, no attempt has been made to explain the unusual longevity of turtles, whose lives, as is well-known span over a century. There appears to be no longer-lived animals than these beings of slow gait and slow manner of life. The following facts may throw light on the cause of their great age. In the first place they are protected by their solid shell from the attacks of snakes, fishes and birds; young turtles, we are informed by Prof. J. W. P. Jenks, are sometimes carried off by herons, but in adult life they are probably rarely eaten by other animals. Has any one ever found any empty turtle shells? As some turtles lay but two or three eggs a year, nature seems to have counted upon an immunity from the ordinary evils of childhood in these animals. It is probable that the larger proportion of, indeed most, young turtles when hatched survive, and when two or three years old, are fitted to resist successfully ordinary fish and avian enemies. They are not exposed to vicissitudes of weather; the fact that the period of egg laying (in New England from June 10-20) is so constant, and varies so little at different seasons, shows that they are hardy and tough. Finally, the persistence of the type of gigantic tortoises on the Galapagos islands, indicate the wonderful vitality of this type of life in resisting prolonged climatic and geological changes.—*A. S. Packard, Jr.*

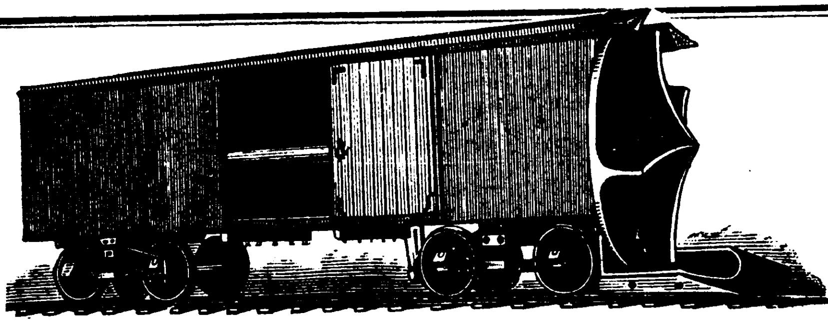
TOOL DRESSING.

There are few jobs in the machine shop that make so much general annoyance as that of tool dressing. The machinist has his own personal notion of the style and shape, the hardening and temper of the tool he uses, and the tool dresser in the smithy must ignore all his experience and observation, for the time being, to cater to the machinist's whim. In short, the forger becomes only a helper to the fancy of the machinist. On the other hand, the machinist has frequently to encounter the obstinate peculiarities of the forger, who insists on teaching the machinist about work he alone understands. Good forgers dislike the job of tool dressing because of its annoyance, and so it frequently happens that this work is bandied about in the smith shop until it rests at last with the least careful man. Some machnists also insist in dabbling at the forge and greatly annoy the smith by their meddling. Indeed, this interference is carried much too far for the benefit of good order, proper work and reasonable profit. It is too much the custom to consider the tool dresser as a man at call for the machinist, and where every lathe and planer hand has his own whims they make it somewhat lively for the smith.

To such an extent is this personal whim carried that there are few machine shops where there is a uniformity in shape of alterable tools; at every lathe and planer the tools differ in form or vary in temper—the workman is known by this peculiarity as much as by his personal name. There is no proper reason why this should be, any more than that each workman should alter the size and change the shape of rule or gauge. There are determinate and exact forms for turning and planing tools adapted to cast iron, wrought iron, steel and brass, and these forms, once ascertained, should be kept and used as standards for the shop. Models of tools should be kept for exemplars and no departure from these should be allowed except for special cause and for particular work.

One of the most common faults with the ordinary turning and planing tools in use in our machine shops is the excessive clearance—they are not made and ground to the right angle to keep down to the work, but are so constructed that the point and cutting edge alone offer resistance, as well as alone do the cutting. There is no sense in this except that with a tool so constructed the workman can plow, and gouge, and dig, and make great pretense of work, and then blame the iron in the casting and the iron in the shaft for the irregularities of surface when it comes from planer or lathe. The cutting portion—point or edge—of a tool for such rigid material as iron or steel, should be as nearly on the moving plane of the work as possible, and the heel of the planer tool should be raised as slightly as possible above the level of the cutting point. To be sure, such a construction necessitates more frequent grinding, perhaps, when the work is rough and demanding; but it gives better results, and when there is after-finishing to be done it will pay the proprietor, if it does not please the piece operator.—*Ex.*

M. Bigourdan has made a series of observations of Encke's comet. The comet will be in perihelion on the 15th of November.



CENTRIFUGAL SNOW PLOW.

The vast systems of railroads in the United States north of latitude 40 every winter become obstructed with snow, and a great expenditure of time, labor and means are required to clear the tracks; indeed, in some sections the roads are abandoned for a large part of the winter, for want of a suitable arrangement to create a passage for the trains. Recognizing these difficulties, a prominent Western inventor, Mr. J. W. Haughawout, of Traer, Iowa, has constructed a snow plow which by centrifugal force completely clears the track, no matter how large the drift. By actual experiment it has been found that the plow can be run through a drift of from five to fourteen feet at the rate of twenty miles an hour, completely clearing the tracks. Clogging of the plow is an impossibility.

As shown in our engraving on this page, it consists of an apron and a wheel revolving in a vertical plane, and mechanism for controlling the action of said wheel, which is detachably secured to the forward end of a car, or rigidly secured to a car especially adapted for the purpose, and containing the necessary mechanism for revolving it.

This apron is made of boiler iron, of suitable thickness, bolted together, and so situated that the forward end thereof, rests a slight distance above the rails, and gradually inclines upward as it approaches the car until it reaches the blade of the wheel, where it runs horizontally backward parallel to the ends of the blades, which work over it. This portion of the apron immediately under the wheel, instead of lying parallel to the track, as at the front end, is formed in the arc of a circle of little larger diameter than the circumference of the wheel, thereby affording no room for the snow to become clogged or impacted on the apron, which would be the case were the angles formed as at the front end, where the sides ascend at an angle of about forty-five degrees to where the rounded portion of the apron stops, and are then continued vertically upward a suitable distance.

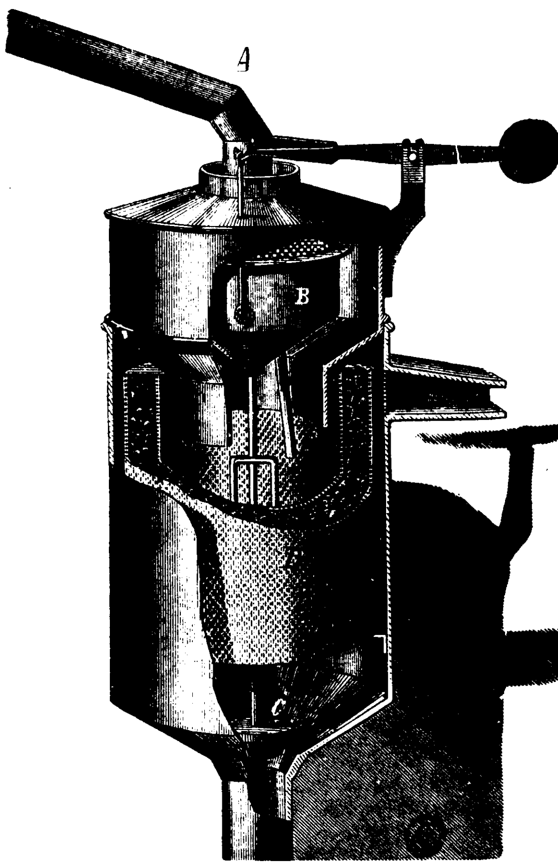
The hub of the wheel has any suitable number of blades secured thereto, which keep the apron clear of snow. This hub is made sufficiently large, and projects out some distance from the blades, and is tapered to a point, so that it can more easily part the snow and direct it to the paddles or blades, where it is thrown by centrifugal force up at an angle of about thirty-five or forty degrees.

The back, or that portion of the plow which rests against the car, forms a stop, which prevents the snow from passing between the blades, and is provided on the top with pivoted wings extending over the top of the wheel, which completely break the current of snow arising from either side, caused by the wheel being rapidly revolved, and throw it at an angle of about forty degrees; and when the wheel is in snow above its hub, it will throw the snow out at the top, between the blades, just about the same angle, thus preventing snow from going directly upward, which would return on the train or track.

This mechanism can be attached directly to the front of a locomotive, and operated either by the front wheel or by any suitable mechanism.

When attached to a car with machinery inside for running it, if desired, two bevel gear wheels can be journaled to a bearing having a sliding motion and operated by a lever, so that one wheel is always in contact with bevel gear wheel. By this arrangement the motion can be reversed, thereby allowing advantage to be taken of high winds and low sides of cuts.

Instead of using only one cleaning wheel, as above described, two smaller ones may be used side by side and operated by substantially the same mechanism as for the single wheel. If, however, two wheels are used, the apron will have to be somewhat modified, so that the snow will be parted in the center of the apron, and directed towards each wheel, which can be done without much additional expense, the mechanism employed for driving the one wheel being sufficient for that purpose.—*Am. Inventor*.



ZUBER'S FILTER.

IMPROVED FILTER.

The engraving shows an improved filter which purifies the water passing through it and removes the sediment automatically.

The invention consists in a cylindrical vessel containing a tubular sieve, D, filled with charcoal, and provided with a spout at about half its height, and with a valve opening in the funnel shaped bottom, closed by a valve, C, attached to a rod carrying a cup-shaped vessel, B. This vessel is connected with one end of a balanced lever, so that when the water enters the filter through the pipe, A, the cup-shaped vessel is filled and descends, the valve closing the aperture in the bottom of the vessel, when the water rises in the cylinder, passes through the sieve and charcoal, is purified, and passes off through the spout. When the supply of water is cut off, the water is removed from the cup-shaped vessel by the siphon, E, and the weight of the lever raises the vessel, B, and the valve, C, so that the sediments can be washed off through the bottom by the water running from the filter.—*Scientific American*.

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