## Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for scanning. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of scanning are checked below.

L'Institut a numérisé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de numérisation sont indiqués ci-dessous.

☐ Coloured covers / Couverture de couleur
☐ Covers damaged / Couverture endommagée
☐ Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
☐ Cover title missing / Le titre de couverture manque
☐ Coloured maps / Cartes géographiques en couleur
☐ Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
☐ Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
☑ Bound with other material / Relié avec d'autres documents
☐ Only edition available / Seule édition disponible
☑ Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.

☐ Coloured pages / Pages de couleur
☐ Pages damaged / Pages endommagées
☐ Pages restored and/or laminated / Pages restaurées et/ou pelliculées
☑ Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
☐ Pages detached / Pages détachées
☑ Showthrough / Transparence
☑ Quality of print varies / Qualité inégale de l'impression
☐ Includes supplementary materials / Comprend du matériel supplémentaire
☐ Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from scanning / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été numérisées.

☑ Additional comments / Commentaires supplémentaires: Continuous pagination.

THE

# CANADIAN MAGAZINE

OF

SCIENCE AND THE INDUSTRIAL ARTS.

Patent Office Record.

Vol. XIX. JUNE, 1891. No. 6.

## EARLY AMERICAN PATENTS.

The recent celebration held to commemorate the founding of the Federal Patent Office, has called forth many retrospective articles in the press dealing with that branch of the national government service, many of which are incomplete in particulars while in general interesting. Since the subject admits of fresh treatment, the symposium of facts given may be found instructive and suggestive, because the advancement of the race and civilization is exemplified incidentally in the history of inventions in America.

It is generally admitted that the first American patent issued was that of the Commonwealth of Massachusetts to Samuel Winslow, in 1641, for a method for manufacturing salt. The record reads, *ex parte*: "None are to make this article for ten years except in a manner different from his, provided he (Winslow) sets up his works within a year." In 1656, Governor Winthrop refused to re-issue Winslow's patent. He, however, made out a document which reads as follows: "John Winthrop son of the Governor granted the *sole* privilege of making salt for twenty years in Massachusetts." Governor Winthrop was clearly a modern type of political official.

In 1642, John Clark, of Massachusetts, was granted a patent which compelled every family using Clark's "method of saving wood and warming houses at little cost," to pay 10 shillings per annum.

John Prout, Jr., Moses Mansfield, mariner, and Jeremiah Brasier, of Connecticut, were, in 1710, granted, by the State, the sole right and privilege to make linseed oil "within the colony" for the term of twenty years.

Edward Himan of Stratford, Conn., applied to the State, in 1717, "praying liberty to make molasses of Indian corn stalks." The assembly in response granted Himan a sole patent right to manufacture molasses for ten years, adding a qualification which reads: "Provided the said Himan makes as good molasses, and makes it as cheap, as that which comes from the West Indies."

Alexander Phelps, Amassa Jones and John Coleman, of Hartford, Conn., sent in a claim to the Government, that, had it been granted, might have changed the whole aspect of the revolutionary war, and deprived the Bostonians of the privileges of throwing the king's tea into the bay. In this claim, presented in 1765, Messrs. Phelps and company proceed to say that they had, "with great pains and expensive pursuits, made discovery of a plant in a distant part of this continent, bearing such resemblance and taste to the genuine foreign Bohea tea, that we are assured 'tis the same kind." After dilating upon the advantages likely to accrue to society from the discovery, they pathetically remark, "We pray your honors would grant us a patent for manufacturing, and also for vending said plant or tea within this colony, exclusive of all others for twenty years." "Their honors" rejected the application.

Up to the adoption of the Constitution in 1789 patents continued to be issued in Massachusetts, Connecticut, and elsewhere. In 1784, Col. William Pitkin, of the revolutionary army, was granted a patent for the State of Connecticut, entitling him to manufacture snuff, to the exclusion of all others for fourteen years. A man named Donovan and a resident of Norwich named Lathrop, wished to go into the business of manufacturing snuff in 1785; incidentally, Donovan wished to introduce blue dyeing and cloth manufacturing, in both of which he was skilled. They applied to the legislature for permission to pursue their business, which was rejected. Lathrop's counsel worked with Donovan, and a fresh memorial was sent in by these two, which had an undoubted republican flavor. The paper says, after passing over preliminaries: "Now, your memorialists beg leave to suggest that the Hon. William Pitkin, not being the original inventor of the art of snuff-making, nor skilled in that business, had no claim to that grant to the exclusion of those who were, and who had a good right to exercise their skill in said art for the support of themselves and families by a lawful calling; nor was it known that any legislative body *has a right* to grant away the trade and professions of the subjects of the State to any individual for his private emolument," etc. The paper then proceeds to discuss the question in a manner that must have astonished "their honors." Subsequently they sent in a memorial to the legislature, signed by 243 prominent residents of Norwich, which says among other points, "snuff is an article of trade, and should be free," but without any result.

By far the most remarkable patent issued before the establishment of the national Patent Office service, was that granted in 1788 to John Fitch for the application of steam to navigation, in the States of Pennsylvania, New York, New Jersey, etc. Fitch had previously experimented—as our readers know—believing that he had solved the problem which Fulton afterwards worked out to a historically satisfactory issue, and induced the legislatures of several States to grant him extraordinary powers to the exclusion of all other inventors. He had a rival in James Rumsey, who had worked upon the same abstract idea for several years, with a difference in the means used, and who is known to have tested it successfully as early as 1785 on the Potomac. Rumsey had previously called upon General Washington—to repeat an interesting incident—at Mount Vernon, and interested him in the scheme. He wrote to Gen. Washington, March 10, 1785, as follows: "I am not less sanguine in my boat projects than when you saw me at Richmond, and I have made such further discoveries as will render them more useful than was at first expected." Washington, meanwhile wrote to Governor Johnson of Pennsylvania, remarking that he thought Rumsey's theory of steam "an unmatured idea." Rumsey, later, wrote "to the father of his country," after referring to the model the general "had seen in motion:" "I have taken the greatest pains to perfect another kind of boat upon the principles I mentioned to you at Richmond in November last (1784), and have the pleasure to inform you that I have brought it to great perfection; it is true that it will cost something more than the other way, but when in use, it will be more manageable, and can be worked with as few hands. The power is immense, and I have quite conceived myself that boats of passage may be made to go against the currents of the Mississippi or Ohio rivers, or on the Gulf Stream (from the Leeward to the Windward Islands), from sixty to one hundred miles a day. I know this will seem strange and improbable to many persons, yet I am certain it may be performed, besides it is so simple when (understood), and is also strictly philosophical."

Fitch, like Major Bushwell, the inventor of the torpedo, was a native of Connecticut.

The first national patent ever granted as already published in this journal was issued to Samuel Hopkins, of Vermont, on July 31, 1790, for an "improved method of making pot and pearl ash." The second was for an "improved method of making candles" granted to Joseph Stacy Sampson, on Aug. 6, while Oliver Evans got the third patent on December 18, for a "superior method of making flour and meal." These three patents were the only ones granted during the first year of the United States Patent Office. In 1791, the following year, thirty-three were issued, the first being for punches for types, taken out by Francis Bailey on January 29. On March 10, John Stone took out a patent for a method of driving piles for bridges; and Rumsey, of steamboat fame in this year took out six distinct patents relating to the use of steam motive power, one of which concerns ships and boats. John Fitch was also granted a patent for his improved method of applying steam power to the same ends. Between this year and the appearance of Fulton's steamboat, a great number of patents were issued to inventors for this purpose.

Folding beds, sewing machines, stoves, clocks and washing machines seem to have monopolized a goodly share of the inventive genius of those represented in the records of the United States Patent Office up to the present time. In 1792 the first patent for a portable folding bed was granted to an inventor with a Teutonic cognomen, and since that year the evolution of that important article in the household economy has proceeded with prolific results and still they come. In the third year of the department only eleven patents were issued, of which may be named patents for an improved clock pendulum and a stove of cast iron. Among other miscellaneous issues, one for bilious pills comes to light. The era of nostrum manufacturing in America began thus early, we may observe.

The first patent relating to improvements in the piano-forte was taken out May, 1796, by James Sylvanus McLean, of New Jersey. In 1797 Moses McFarland was granted a patent for a federal balloon. In 1800 J. Grant Jr., took out a patent for a telegraph. In this year, J. I. Hawkins, of Philadelphia, took out two patents, one for inprovements in musical instruments, the other in relation to pianos. Hawkins was the first in this country to export native manufactured pianos, and in this year we find that he made and exported several of his portable upright grand piano-fortes to Manchester, England. Andrew Law, one of the first native-born American musical theorists and publishers, appears in 1802 in connection with a new method of printing music by type.

Among the many curious records in Washington granted after 1800, are a mode of setting horses' and dogs' ears, granted to Seth James in 1804; an elixir of life patent; a method for beautifying the face and transforming the features; a perpetual motion machine; a sure cure for intemperance, and numerous such peculiar patents, besides nostrums in profusion.

Two years (about 1810) before the breaking out of hostilities between Great Britain and the United States, patents for improvements in firearms first appear, and during the war they appeared in large numbers. Toward 1816, public interest in war materials relaxed, but when the invasion of Mexico called for inventive genius in that direction, American inventors were not wanting. The same may be said of the late civil war, during which period the patent office issued a great number of papers for inventions in the class of firearms, and materials for war purposes.

Adding machines and type writers appeared in the patent office records forty years ago, while a vast number of things that we except as exclusively modern can be found anticipated in comparatively ancient patent records in Washington. The telephone may be found partially illustrated in a patent taken out by Samuel Sawyer, of Boston, in 1833. Sawyer's patent was called an Acoustic Drum, and was intended to facilitate the holding of conversations at long distances. The drum or membrane, was the medium by which the sounds of the voice were intensified and reinforced after being carried from point to point through a cord or tube. During the past forty years more patents have been granted for methods of turning over music than for all other departments of invention in musical instruments combined.

The first record of historic value in the domain of photography, was Talbot's patent for producing and fixing pictures upon paper, granted in 1847. Talbot is to a large extent the inventor of the present accepted system of photography. He patented his invention several years previously in Great Britain, where he lived. Talbot's method was known at first as the "Talbotype," both here and abroad. The patent office took several years to decide whether it was constitutional or not to issue a patent to Talbot's credit, for the reason that several Americans experimented with the process. Hon. Edmund Burke, however, granted Talbot a patent in the year designated. Peasley's patent for improvements in the organ, issued in 1817, is yet more ancient and important, for the modern American organ sprang from this source. These are a few instances out of hundreds.—By Daniel Spillane in *The Manufacturer and Builder.*

## SLOW-BURNING CONSTRUCTION.

Edward Atkinson has an illustrated paper on this subject in the *Century Magazine*, from which we quote:

Strange to say, some of the worst examples of combustible architecture are to be found among our prisons, hospitals, asylums and almshouses; next, among college buildings, libraries and schoolhouses; to these may be added churches, hotels and theatres. In the year 1887, according to the tables compiled by the *Chronicle* of New York, there were burned, within the limits of the United States, 45 hospitals, asylums, almshouses or jails, being nearly four per month, in many cases accompanied by the loss of a large number of lives; 126 college buildings and libraries, being $10\frac{1}{2}$ per month; 146 churches, being $2\frac{8}{10}$ per week; 52 theatres and opera houses, being 1 per week; 515 hotels, being $1\frac{4}{10}$ per day.

The bad construction of these buildings is due mainly to habit, to fear of innovation, and to distrust of theory. These inherited faults in construction may readily be traced to their origin. In order to make this matter plain, the evolution of the modern factory will be fully described.

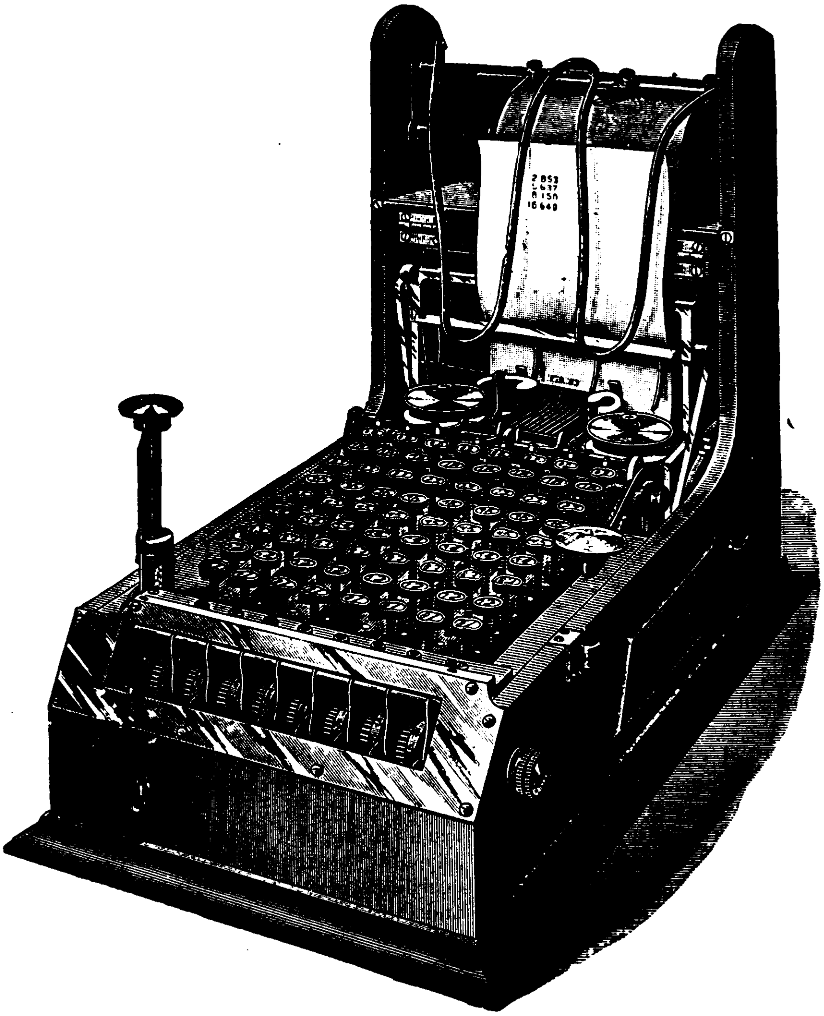
When the textile factory system was first established, water power only was applied to the movement of machinery. The larger factories were thus customarily placed in narrow valleys, or upon very limited areas of land below the falls of rivers and alongside the streams; it therefore became necessary to economize the area of ground covered by the factories, and to build them many stories in height. When other arts began to be conducted upon the factory system, the buildings were apt to be in cities or towns where the price of land forbade large areas being devoted to the purpose, and, again, buildings of many stories in height were constructed.

As time went on, however, steam took the place of water power, while cheap railway service or rapid transit made it possible to scatter the factories over a wider area. Factory buildings then began to be constructed in the open country, but apparently it did not occur either to the owner, the managers, the architects, or the builders, that the reasons for constructing a building many stories in height did not apply to places where land could be had at a very low price; therefore the customary bad and unsuitable form of construction was adopted, and is still practiced, where it is not only useless and unsafe, but less adapted to the purpose to which the building is to be put than a one-story or a two-story building would be. Moreover, the whole method of cutting timber having been developed with a view to the supply of material required in the ordinary unsafe and unsuitable method of construction, it was for many years difficult to obtain material cut in a proper way for what has been called the slow-burning use of timber. Hence it follows that the art of slow-burning construction is little known outside the limits of New England; and until very lately it was little known even there, except to those who had become accustomed to the construction of textile factories, paper mills, and other works which are customarily insured by the factory mutual insurance companies. It is only within a very short time that the methods which have been practiced for many years in the construction of textile factories—which are only the old methods of almost prehistoric time, when timbers were shaped by the axe or by hand, before the modern saw-mill had rendered the construction of a sham building possible—have been taken up by a few architects of capacity and responsibility to be applied to warehouses, churches, college buildings, and occasionally to dwelling houses.

## AN AUTOMATIC ADDING AND RECORDING MACHINE.

A machine by means of which figures may be placed in tabular order with the rapidity of ordinary type-writing, and which at the same time automatically adds the amount as the figures are listed, with no possibility of a disagreement between the listed figures and their indicated total, is represented in the accompanying illustration. The machine is adapted to record and foot up eight columns of figures, while a similar machine is also made having a capacity reaching to ten columns. As will be seen, there are eight columns of keys, the first two columns to the right, in listing amounts of money, being used for the units and tens of cents, the next three columns for the units, tens, and hundreds of dollars, and the remaining three for units, tens and hundreds of thousands, the machine being thus adapted to all amounts under a million dollars.

To record the amount 179.63, shown at the bottom of the paper just back of the keys, the operator struck key 1 in the fifth column, key 7 in the fourth column, key 9 in the third column, key 6 in the second column, and key 3 in the first column, and then pressed the up-feeding spacer lever seen to the right of the key board. The amount recorded is thus presented in plain sight before the next figures are listed, the operation of which is proceeded with after the same manner, each separate amount being exposed to view by pressing on the spacer lever, before commencing upon the following amount. The total of any number of amounts printed can at any time be seen upon the type wheels behind the glass just in front of the keys; but to print the answer on the slip at the bottom of the column, the operator presses the knob standing at the left of the keyboard. The little thumb screw on the right of the machine is to clear the register, or reduce the machine to naught, another thumb screw farther back regulating the feeding of



THE COMPTOGRAPH.

the paper, while the lever device near it is for feeding the paper backward. The machine will take paper of any width up to six inches.

The comptograph is an outgrowth of the comptometer, a universal figuring machine operated by keys, but which does no printing. The comptograph simply prints lists or columns of items and adds and automatically prints the answer beneath them at the same time. For listing checks in a bank for the use of insurance companies, for the preparation of such extended tables as are furnished by various statistical authorities, and for other purposes where clearness and rapidity of work, no less than accuracy, are difficult to obtain, this machine has already proved itself a great success. Besides its advantages in clearness and accuracy, it is said that an operator can, with very little practice, do as much work as can be done by two men in the old way. The machine is the invention of Mr. Dorr E. Felt.—*Scientific American.*

## NEW LANTERN EFFECT.

Not every one can go to Europe, but, possessed of a lively imagination, one may go there in spirit, provided only that the scenes are presented pictorially in a truthful and artistic way. Thanks first to the skill of the optician, and secondly to the modern photographic art, any one may be instructed and entertained by the modern lanternist, who will produce storm or sunshine, winter or summer, or the soft effects of moonlight at will upon the screen by the skillful manipulation of the optical lantern with a truly wonderful effect, but there are many effects which seem to be difficult of execution by means of the optical lantern. The saying is "See Naples and then die;" but what is seeing Naples without seeing Vesuvius in active eruption? Comparatively few European travelers have the good fortune to witness this phenomenon, and until now, so far as we are aware, no one has been able to faithfully represent this awe-inspiring spectacle.

Mr. H. C. Ogden, of Middletown N. Y., has come to the aid of the lanternist and the non-traveler by producing a very simple apparatus by means of which Vesuvius, in full eruption, may be projected on the screen in a very vivid and realistic manner.

Fig. 1 of the engravings shows the scene as it appears on the screen, and Fig 2 shows the apparatus by which the effect is produced. The main idea of Mr. Ogden is illustrated in this apparatus, but our artist has added an improvement which is designed to

FIG. 1.—ERUPTION OF VESUVIUS.

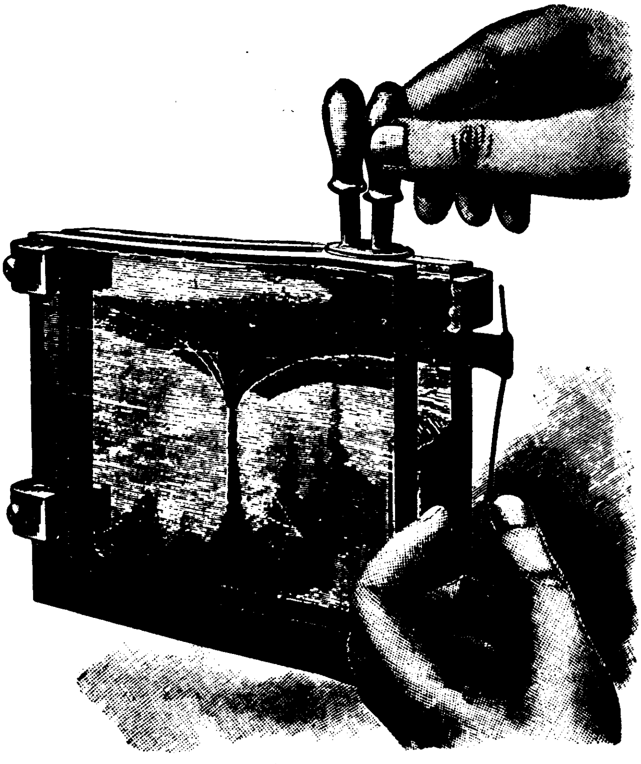


FIG. 2.—APPARATUS FOR PRODUCING THE VOLCANIC EFFECT.

represent the flowing lava as well as the upwardly projected flame and smoke.

In a glass tank attached to the lantern are inserted two curved drop tubes, with their extremities placed side by side, and on the rear of the tank is painted a picture of the volcano, which is represented mainly in profile by black varnish applied to the glass. The tips of the drop tubes coincide with the crater of the volcano, and from the crater down the sides there are transparent streaks representing lava. To the side of one of the clamps holding the tank together is attached a spring carrying a strip of metal which extends along behind the opaque portion of the picture, and is provided with teeth, as shown in dotted lines, which are designed to irregularly eclipse the transparent streaks.

In one of the drop tubes is placed a dark liquid, such as diluted ink, and in the other is placed a bright red liquid, as red aniline ink. The tank is filled with a solution of glycerine and water and inserted in the lantern. Dexterous manipulation of the flexible bulbs of the drop tubes produces red and dark streaks representing fire and heavy smoke, which are forced down in the tank and have the effect of rising in the image on the screen. At the same time the manipulation of the spring at the side of the tank alternately displays and covers the streaks representing the lava.—*Scientific American.*

## HAULAGE OF CANAL BOATS BY LOCOMOTIVES.

At a meeting of the Railway Union in Berlin, says *Iron,* Herr Wiebe described some experiments recently made on two lengths of the Oder and Spree canal, 3½ miles long in all, with a view to ascertain the best method of towing large boats. The submerged chain system is, he states, unsatisfactory, nor has the endless rope system of traction given entirely satisfactory results when practically tested during the course of the experiments, though a great many types of supporting posts and pulleys were tried. The difficulty encountered arose from the rotation of the rope as it moved onward, which tended to twist the boat painter about the rope, and the form of connection between the rope and the painter could not be depended on to stop this action. Further experiments were then made by attaching the rope to the center of gravity of a heavy towing car drawn by a light locomotive, such as is commonly used in mines. If the rope is attached directly to the locomotive, trouble may arise from the side pull of the rope tending to overturn the engine. It is for this reason that the towing car was adopted in the experiments in question. This plan is stated to have proved satisfactory, and boats have been towed by it at the rate of from 10 to 12 feet per second (7 to 8 miles per hour) though a speed of 5 feet (3½ miles per hour) will, in general, be sufficient. The tension on the tow rope in starting three heavy coal barges was as much as 1,764 pounds, but rapidly decreased as the boats gathered way.

## PROTECTING BUILDINGS FROM LIGHTNING.

Ordinarily a lightning-rod is regarded as a conduit or pipe for conveying electricity from a cloud to the ground. The idea is that a certain quantity of electricity has to get to the ground somehow; that if an easy channel is opened for it, the electricity will pass quietly and safely; but that if obstruction is introduced, violence and damage will result. This being the notion of what is required, a stout copper rod, a wide-branching and deep-reaching system of roots to disperse the charge as fast as the rod brings it down, and a supplement of sharp points at a good elevation to tempt the discharge into this attractive thoroughfare, are naturally guarantees of complete security.

I think Oliver J. Lodge has expressed well the difficulty that has always been present in my mind when I have read detailed descriptions of the effects of lightning. He says that when, in spite of all precautions, accidents still occurred: when it was found that from the best-constructed conductors flashes were apt to split off in a senseless manner to gun-barrels and bell-ropes, and wire fences and water-butts, it was the custom to more or less ridicule and condemn either the proprietor or the erector, or both, and to hint that if only something different had been done, say, for instance, if glass insulators had not been used, or if the rod had not been stapled too tightly into the wall, or if the rope had not been made of standard wires, or if copper had been used instead of iron, or if the finals had been more sharply pointed, or if the earth plate had been more deeply buried, or if the rainfall had not been so small, or if the testing of the conductor for resistance had been more recent, or if the wall to which the rod was fixed had been kept wet,—then the damage would not have happened. Every one of these excuses has been appealed to as an explanation of a failure; but because the easiest thing to abuse has always been the buried earth connection that has come in for the most frequent blame, and has been held responsible for every accident not otherwise explicable.

The ordinary theory of the formation of the high potentials that are manifested in lightning-discharges is simply this, That if, in the cloud, there is a certain quantity of electricity distributed on a given mass of fine mist it will exist there at a certain potential, depending on the capacity of this finely divided matter. Now, if these mist-particles coalesce into raindrops, the theory points out that there would be a decrease in potential of the charge. It occurred to me immediately, that if this theory had any foundation in fact, it ought to be possible to reverse the operation on the surface of the earth; that is, to receive the lightning-discharge on some large body, which would then be broken up into fine particles of vapor, which would have a considerably greater electrical capacity, and that the potential of the discharge would thereby be materially reduced, and the effects of the lightning mitigated. This was my hypothesis to work upon, and I immediately began to look through the records to see what actually happened in the case of lightning-discharges, and to see if there was any support in fact for my hypothesis.

The first book at hand was Sir William Thompson's "Papers on Electricity and Magnetism," and I found that he described in detail the case of a farmhouse in Scotland, which was struck by lightning, and in which this very dissipating effect took place; that is, the bell-wires were dissipated,—an occurrence which, as you know, is extremely common when a lightning-discharge takes place. I went on through the records, and found numberless cases of this, the oldest being that of the dissipation of the metal covering on the wooden shield of some Greek warrior. I mention this case as of interest, as it brings out a very fortunate circumstance, that when thin metal is dissipated against wood or even against plaster, no harm results to the wood or plaster. Of course, you know that it has been somewhat discussed whether this action is a dissipation through the heating of the metal, or whether it is a cold dissipation—a breaking-up into particles, as it were—of the metal. On this point I have nothing to say.

But as I went on through the records I could not make the facts accord satisfactorily with my hypothesis.

The dissipating action that I was looking for certainly took place, and is a very common accompaniment of lightning-discharges, but in spite of it, there was damage to the building. It was only after a considerable reading of the records that it gradually dawned on me that I found no case where damage to the building occurred on the same level with the dissipated conductor.

The author then described in Franklin's own words a typical case of the action of a small conductor dissipated by the discharge.

I would thus formulate what seems to be true,—that a conductor which can be easily dissipated by a lightning-discharge protects the building to which it is attached between two horizontal planes, the one passing through the upper end of the dissipated conductor, and the other through the lower end; and it is this one point that I would urge upon the consideration of the Institute. So far as I know, therefore, a conductor such as I have here—a conductor made of light copper ribbon, so that 75 feet of it will weigh only a pound, and made in sections two feet long, which shall be tacked to the building from its ridge-pole to the foundation, the joints being made of low conductivity by the insertion of insulating washers—will protect the building. The conductor will be destroyed by the discharge. Its destruction can take place even against a plastered wall without injury to the wall; but no other harm will occur so far as the conductor extends in a vertical direction. There is no need of the conductor following the shortest course to the ground. There is no need of providing a good earth connection. I can see no difference between the two ends of the metallic ribbon. You do not attempt to make a good connection at the top with the dielectric, and I do not see why you should attempt to make a good connection at the bottom. In no case on record of the protecting influence of dissipatable conductors has this protecting influence depended upon there being a good earth connection. Of course, the ribbon should not be boarded over. Free gun-powder burns harmlessly enough, but it causes damage when burned in a confined space; and the dissipation of a conductor presents similar phenomena. It would not do to run such a conductor as I suggest here part way down the building, and then make it turn up again before its final descent to the ground, as in such a case there would probably be a line of disaster from the point where the upward turn began.

In order to destroy a building in whole or in part, it is necessary that work should be done; that is, energy is required. Just before the lightning-discharge takes place, the energy capable of doing the damage which we seek to prevent exists mainly in the column of air extending from the cloud to the earth in some form that makes it capable of appearing as what we call electricity. We will therefore call it electrical energy. What this electrical energy is, it is not necessary for us to consider; but that it exists there can be no doubt, as it manifests itself in the destruction of buildings.

In spite of the best endeavors of those interested, lightning-rods constructed in accordance with Franklin's principle have not furnished satisfactory protection. The reason for this is apparent when it is considered that this electrical energy existing in the atmosphere before the discharge, or, more exactly, in the column of dielectric from the cloud to the earth, reaches its maximum value on the surface of the conductors that chance to be within the column of dielectric, so that the greatest display of energy will be on the surface of the very lightning-rods that were meant to protect, and damage results, as so often proves to be the case. The very existence of such a mass of metal as an old lightning-rod only tends to produce a disastrous dissipation of electrical energy upon its surface—"to draw down the lightning," as it is commonly put.—*The American Engineer.*

## THE TORSION BALANCE.

The defects inherent in the system of employing knife edges for the fulcrums of balances have long been recognized. A good knife-edge is difficult to make and to adjust, and as the edge wears by long and continued use, or becomes corroded, or injured by over-loading or other rough usage, its friction increases, and with it the sensitiveness and accuracy of the instrument become progressively impaired. In the case of the finest balances, the utmost care must be exercised in their use, to avoid so far as possible, these causes of deterioration, and every chemist or other investigator familiar with the use of such instruments of precision, knows how extremely difficult it is to keep a knife-edge balance in proper adjustment for any length of time.

To eliminate the above named sources of deterioration altogether, is simply impossible, since they are inherent in the principle employed. The best that can be done, is to reduce their effects to a minimum. With the class of balances used for coarser work, where the necessity for extreme accuracy does not exist, the knife-edges are less carefully made and adjusted, their wear is considerable, and the deterioration of the instrument is consequently more rapid. In the case of such instruments, however, the deterioration is not felt so promptly as in that of the extremely delicate balances, since the limits within which a departure from accuracy is permissible are wider.

The above-named disadvantages of knife-edges have led ingenious men to study the subject with the object of finding some system of weighing machinery in which they would be absent, and by universal consent the torsion, or twisting, fulcrum has long been recognized and acknowledged to offer the most scientific solution of the problem. The application of this principle in practice, however, was found to be attended with serious difficulties.

Over a quarter of a century ago, the illustrious German savants, Gauss and Weber, made an unsuccessful attempt to apply the torsion principle to balances. The form which they adopted is shown in Fig. 1, and this was the only noteworthy experiment in this direction until the year 1882, when Prof. F. A. Roeder and Dr. Alfred Springer, of Cincinnati, took up the subject, and, after many experiments, succeeded in devising a plan which has proved in practice to be a highly satisfactory one. Professor Roeder, in repeating the unsuccessful experiments of Gauss and Weber, ascertained that the principal cause of their failure lay in the fact that they attached the end pivot wires directly to the bifurcated ends of the beam (Fig. 1). When the strain came upon these wires, these ends would bend and destroy the accuracy of the weighing apparatus; and if the beam were made sufficiently heavy to resist this deformation, the sensitiveness of the balance was sacrificed, so that it became useless for delicate weighings.

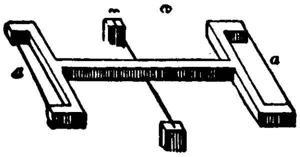


Fig. 1.

To avoid this difficulty, Prof. Roeder devised the plan of a light frame (Fig. 2), which was stiffened by passing the wire in a state of high tension over it (Fig. 3). The simplest application of this principle is shown in Fig. 4, in which two such frames are shown connected suitably with a single steelyard beam. More elaborate forms are shown in Figs. 5, 6 and 7, which are combinations of three frames and two beams, the first being a delicate balance for druggists' use, and the last two ordinary counter scales for grocers and others.

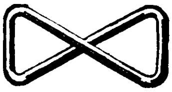


Fig. 2.—Frame.

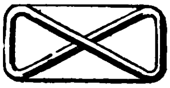


Fig. 3.—Frame with With.

Dr. Springer, who was associated with Prof. Roeder, continued the work after the death of the latter in 1884, and made a number of substantial improvements, which are embodied in the instrument known to-day as the Springer torsion balance. These instruments were first manufactured and introduced in 1882, and since that time have come into very general use, and the demand for them is constantly increasing. The commercial success of the balance may be said to have been placed beyond per-adventure on the introduction (in 1886) of the prescription scale (Fig. 5), which exhibited so many features of convenience and superiority over the knife-edge balances, for which it was offered as a substitute, that it at once achieved a popularity which it has ever since retained.

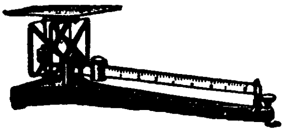


Fig. 4.

The construction and operation of the torsion balance will be understood from what follows: In its simplest form, it is composed of a light beam supported at its middle point, or center of gravity, by a stretched wire, which is firmly fastened to it (Fig. 8). A weight placed at one end of this beam will exactly balance a like weight at the other end. When the beam oscillates, the wire is slightly twisted, hence the name "Torsion." The sensitiveness of such a balance depends upon having the torsional resistance of the wire almost infinitely small. This requires a very thin wire, and as thin wires, when stretched horizontally, are not strong, the balance can be used only for very small weights. (Such a balance was Ritchie's, mentioned in the "Encyclopœdia Britannica," and was a total failure for large weights). If the wire is made large enough to have an appreciable strength, its torsional resistance prevents the balance being sensitive.

To get rid of the effect of the torsional resistance in diminishing the sensitiveness of the balance was one of the chief ends of Messrs. Roeder and Springer's efforts. They accomplished it in a number of different ways, but the simplest, and the one which is adopted in practice, is the placing of the center of gravity of the beam above its point of support. In knife-edge balances such a placing of the center of gravity would make the beam top-heavy since the center of gravity would always tend to reach its lowest point, and tip the beam. In the torsion balance, however, this top-heaviness acts in the opposite direction to the torsional resistance of the wire, and may be made to neutralize it entirely. We thus have the torsional resistance exerted to keep the beam horizontal, while the high center of gravity tends to tip it out of the horizontal. The adjustment of the position of the center of gravity so as to neutralize the torsional resistance is most easily made by having a poise placed immediately above the center of the torsional wire, and making it adjustable vertically by means of a screw and nut (Fig. 9). When the torsional resistance is entirely neutralized, the balance becomes infinitely sensitive, and any smaller degree of sensitiveness that may be desired may be obtained by simply lowering the poise. Fig. 7 shows a counter scale, which may be loaded with 50 pounds on each pan without damage, in which a ball weighing more than two pounds is used for the poise to counteract the torsional resistance.

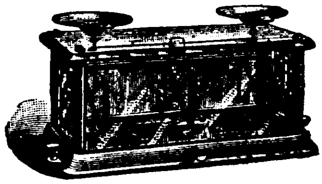


Fig. 5.

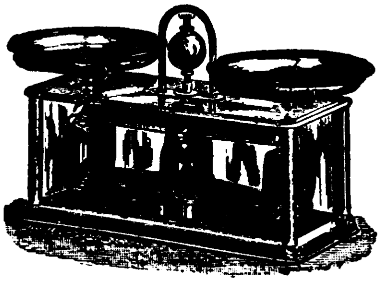


Fig. 6.

It will be obvious that as the action of the torsion balance depends upon the twisting of the stretched wires, there is no rubbing of one surface upon another, and the element of friction is entirely eliminated: furthermore, as the structure is firmly joined in all the moving parts, there can be no such thing as a shifting of the position of the parts; that there can be no alteration of the sensitiveness or accuracy of the balance by reason of any amount of use, except from the actual destruction of the wires themselves. The maximum torsional strain to which these will be subjected in use, is so far within the limit of safety that they may be subjected to shock or to over-loading within the limits of the strength of the entire structure without affecting the balance. In connection with these manifest and very important advantages over the knife-edge balance it is claimed, and we believe properly, that the torsion balance possesses all the good features that the other class has.

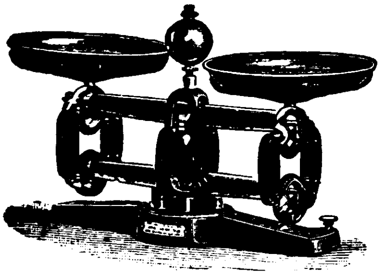


Fig. 7.

Fig. 8.

In conclusion, it will be interesting to place on record a few of the tests to which the torsion balance has been subjected by the manufacturers, with the object of demonstrating the advantages claimed for it in what has preceded, to wit:

These children, Alois and Frederika (Fig. 10) were caught by the photographer in the act of balancing themselves on a new torsion balance. The boy weighed 47 pounds, and the girl 45 pounds. The balance was not injured in the least, and a test made shortly afterwards showed that when balanced with 50 pounds on each pan, an addition of two grains to either pan caused a perceptible movement, and 10 grains gave "down weight."

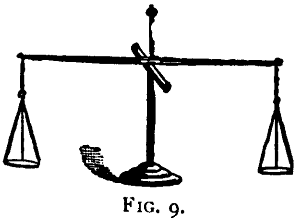


Fig. 9.

The same scale was then balanced with 50 lbs. on each pan, and allowed to vibrate freely for 48 hours. No change in its sensitiveness could be detected. It was then placed out of doors and exposed to a temperature below the freezing point, and tested again with and without load. It was then placed on top of a stove and heated till a thermometer in one of the pans registered 120 degrees, and the tests were repeated without discovering any change in its action.

A torsion balance bullion scale was shown at the American Institute Fair, New York, September, 1886, with 450 pounds on each pan, vibrating freely without arresting. During the three months of the fair its sensitiveness remained constant, an addition of two grains, or one 2,800,000th part of the load making an easily perceptible deflection of the pointer.

Fig. 10.—See-sawing on a Torsion Balance Scale.

In November, 1886, one of the prescription scales, Fig 5, was carefully tested with loads up to 8 ounces on each pan, and then was allowed to remain under this load in free vibration, never being arrested, until January, 1888, or fourteen months, when it was tested again and found to have lost none of its sensitiveness, showing easily 1-64th of a grain.

One of the counter scales made in Cincinnati in 1882 has been tested more than a hundred times, at intervals, by a man standing with one foot on each pan of the balance, and thus oscillating it. It still retains its original sensitiveness although it has never been adjusted or repaired.

◆

## ON POISONS.

Dr. Meymott Tidy's emphatic oratorical style is familiar to and popular with London lecture audiences. The announcement that he would explain to the members of the London Institution "What is a poison?" brought together an unusually large audience. The lectures delivered at the institution are marked by several excellent features. There is a chairman, we believe, but he never speaks; there are no votes of thanks. The lectures begin punctually at one hour and finish punctually on the stroke of the next, and, unless you take a very prominent seat, you can glide out at any time you like without disturbing the rest of the company. Nobody glided during Dr.

Tidy's lecture. He knows poisons very intimately, and he can tell what he knows in the most attractive style.

Toxicology, he said, is the science of poisons. How comes it to be called toxicology? The Greek word from which it was derived meant a bow, and was used to signify not only the bow but also the arrows used with it. Dioscorides, in the first century, first used the term in connection with poison, which was at that time associated with the art of smearing the arrow heads used in warfare. Thus the meaning of the word tended to enlarge itself, trying, as words do, to keep pace with scientific progress. In that Greek word *toxon* was to be found not only the derivation but the early history of poisoning.

A grim interest gathers round the history of poisoning. No doubt the first poison employed was that obtained from the snake. The subtle serpent first taught the art to man, but in those early days it was used in open warfare. But man grows wiser, and perhaps wickeder, and it was reserved for later times to taint the cup of friendship with the deadly venom. Was the suggestion too wild that if it had not been for the invention of more effective means of slaughter, the chemist would still have been called in to aid in the art of poisoning weapons? But if he had missed his chance in that respect, he could still look back to the early days of toxicology as the cradle of science.

Dr. Tidy had to deal with the question, "What is a poison?" The law had not defined it, but the law frequently demands a definition from scientific witnesses. The popular definitions of a poison are none of them sound, much less scientific. He has searched every dictionary he could put his hands on and believed that the definition in every case amounted to this: That a poison is a drug which kills rapidly when administered in small quantities. But many poisons do neither the one nor the other. The terms "small quantity" and "rapidly" were about as definite as the classical piece of chalk. "Here," said the lecturer, holding up bottles containing nearly an ounce of each, "are oxalic acid and sugar of lead, in about the quantities necessary to be taken to make sure of a fatal result. But we should hardly call these small quantities. And yet these are certainly poisons. Moreover, many of the most certain poisons are very slow in their action."

Dr. Tidy defined a poison as "any substance which, otherwise than by the aid of heat or electricity, is capable of destroying life by chemical action on the tissues or by physiological action on the organs of the body. "There's a good lot of it," he added "but I can't get it into fewer words." Of course, he explained, mechanical means were excluded. You might kill yourself by swallowing pins, but pins were not poison. Nor is a substance a poison which destroys life by merely blocking out that which maintains life. Then he took two glass jars, one containing carbonic acid gas and the other nitrogen, and dipping a taper in each, showed that it was easily extinguished. "So would you go out," he said "if you were introduced into either atmosphere. But the nitrogen is not a poison. With 20 per cent of oxygen in it you can live quite easily; but neither 20, nor 40, nor 60 per cent of oxygen would enable you to live in an atmosphere of carbonic acid gas, which is a poison." He proceeded to say that nature hates classification, but he must give illustrations of three classes of poison. First, he alluded to sulphuric acid, and showed a part of a stomach charred by the action of this poison. A caseful of stomach and other tissues, was shown, illustrating the effects of various poisons, but time did not allow of these being explained. The charring effect of sulphuric acid was explained by the familiar experiment of pouring sulphuric acid on a thick solution of sugar, showing that the effect of the oil of vitriol was to abstract the water, and thus to cause the "charring." The stomach dies. That is molecular death, and this death soon extends to the rest of the body.

Carbonic oxide furnished an illustration for a second class of poisoning. A bottle of this gas was lighted at the neck, and burned with a blue flame, "the same as that which you see just over your fire stoves. This gas is always present in coal gas to the amount of 5 or 6 or 7 per cent, and gives it its poisonous character. I don't think carbureted hydrogen burning in the gas jet is at all poisonous. I think all the poison is in the 5 or 6 per cent of carbonic oxide. How does it destroy life? In this way: The active agent of our blood is the red coloring matter called hæmoglobin. This substance abounds in wonder. I think it is the most marvelous compound, chemically, with which we are acquainted. To live and thrive and flourish we must get albumen and albumenoids. We cannot form these ourselves, but the plant can. The power of building up albumenoid substances is limited to the plant laboratory. Man has the power to change one albumen into another. He can convert albumen into peptone, for example; he can break them up into albumen lower in the scale; but he cannot go higher—*with one exception*. That exception is hæmoglobin, the red coloring matter of the blood. This hæmoglobin, which comes on the scene through a stage opening of which we know not the whereabouts, has a strange property. As a rule, substances which combine with oxygen with the greatest difficulty can be separated from it with the greatest ease; and, conversely, substances which combine with it with great ease can be separated from it only with the greatest difficulty. Gold is one of the most difficultly oxidizable of bodies, and its oxide is most easily reducible. Potassium and sodium, on the other hand, combine with oxygen with the greatest ease, but it required the genius of a Humphry Davy to separate them. Hæmoglobin is an exception in this respect also. It combines with and separates from oxygen with equal facility. The life of man depends on the perfection with which hæmoglobin performs its function as oxygen receiver, oxygen carrier, and oxygen deliverer. But when a man takes carbonic oxide, hæmoglobin combines with this almost as easily as it does with oxygen, and, having taken it, the carriage is full; it cannot take up any oxygen. But, worse than that, it cannot get rid of the carbonic oxide; the carrier cannot unload. In scientific phraseology, the combination of hæmoglobin and carbonic oxide is a comparatively stable compound. The man dies because the sequence of oxidadation is interrupted."

Strychnine was the third illustrative poison introduced. This poison was said to destroy life by physiological action. "And what do I mean," said the lecturer, "by physiological action? I mean just simply that I don't know what I mean. Not knowing how it acts, I use the phrase physiological action to conceal my ignorance. It would never do to say we did not know how drugs act, so we say it is a physiological action. But we know one thing about the action of strychnine. We can tell by means of the spectroscope that the fits resulting from the administration of strychnine coincide exactly with the abstraction of oxygen from its compound with hæmoglobin. Why it kills we do not know, and let me remark that it is one of the highest forms of knowledge to know exactly the limits of our knowledge. In fact, the term physiological action no more explains death by poisoning than the term catalysis explains fermentation."

But can chemical investigation throw no light on the reason for the poisonous character of certain elements and certain compounds? Given that we know many facts about phosphorus, for example—its atomic weight, its relations to the periodic law, its spectrum, and so on—ought we not to be able to fortell, in some degree, its action? This subject was studied first by Blake in 1841, and afterwards by Rabuteau in 1867, and by other investigators. At first it was thought that the physiological activity of the elements increased the ratio of their atomic weights, but it was afterward noted that the reverse was the case in certain groups, and the end of the researches was the conclusion that neither in regard to elements nor compounds could any reliable rule be formulated. In inquiring into this subject further difficulties occur in the strange allotropic forms of certain elements and the isomerism of the organic compounds. Illustrations of these conditions were adduced in yellow and red phosphorous, the first of which, the lecturer said, would be fatal in 2 grain doses, while of the other an ounce might be taken without injury, as far as he knew. Ozone was another mysterious body. Every one knows that oxygen is the great life-preserver and life-sustainer, Ozone is oxygen in which three atoms are condensed into each molecule instead of two. But if you put a frog into ozone, into this condensed oxygen, it will soon close its eyes, its respiration will fall rapidly, and it will die simply for want of oxygen. As an illustration of isomeric bodies take these two substances, morphia and piperine, send them to a chemist for analysis, and his report will be that they are identical in composition; and yet the one is of all things in the world that which is most calculated to send one to sleep, and the other is of all things in the world the compound to keep you awake.

In ancient times the arts of witchcraft, medicine and poisoning were bound up together. The Greek word pharmakist was used to signify dispenser of medicines, a witch, and a poisoner. One of the great services that science has rendered to mankind has been to separate these notions. The modern pharmacist no longer requires the stuffed crocodile to watch over his incantations, to aid in the composition of his medicines. And science has done more than this. It has rendered impossible the secret villainies of the old poisoners. It follows the traces of secret treachery with a bloodhound scent, and will ultimately tend to repress entirely the crime of poisoning.—*Chem. and Drug.*

## TO COLOR BRASS WORK.

A beautiful violet color is imparted to brass work by the application of chloride of antimony, says a writer in *Work.* Get the work perfectly bright and clean by the usual methods, either in a lathe or by dipping, etc.; heat it over gas-flame or spirit-lamp, so that water will steam off it but not fizz, and then apply the chloride of antimony liquor with a piece of rag or pad attached to a piece of wood; when the metal has assumed an even color, polish by rubbing with a soft cloth perfectly clean and dry, and protect with a coat of clear lacquer. Should you prefer a darker color, use either of the following recipes: (1) To one part oxide of iron, or iron filings, add one part arsenic and 12 parts hydrochloric acid. Dissolve the oxide of iron or filings in the acid, then add the arsenic, strain and bottle for use. (2) One pint of strong vinegar, one ounce of sal-ammoniac, one-fourth ounce arsenic, one-half ounce alum; dissolve in the vinegar and bottle. These mixtures are to be applied in the same way as chloride of antimony, and, as you are doubtless aware, the ultimate shades may be varied by treating with various lacquers. In all cases the work should be polished with a dry cloth immediately the desired color is obtained, and in the case of the two latter recipes the work should be lacquered at once; but with the chloride of antimony this is not essential. With regard to Florentine bronze the only recipe I know of is the following: The work having been finished bright and clean is covered with a coating of copper. Now make a paste with Spanish brown 12 parts, and black lead 1 part, in hot water. Dissolve a small quantity of oxalic acid—say as much as will fit on a sixpence—to one-half a pound of other ingredients, also in hot water, and thoroughly mix the whole; thin with hot water to a workable consistence and apply with a soft brush. When dry, polish with a medium brush. This done, the work is ready for lacquering, a pale lacquer being employed.

## COCKBURN'S TYPE-WRITER FOR THE BLIND.

On glancing at the above heading the question will arise in many minds, "How do the blind write?" It will therefore be of some interest to describe the method in common use for the purpose, and then to give a detailed description of the type-writing machine which is now superseding to a large extent the earlier apparatus.

The ordinary apparatus is shown in Fig. 2 and consists of a board A provided with a hinged flap B at the top. The paper used by the blind for writing what is known as the "Braille" type is a specially prepared thick paper with a smooth face, and the size of the sheets is about the same as ordinary foolscap. Two pins C are fixed into the board itself under the hinged flap, and two others into the flap at a distance of about $\frac{3}{8}$ in. nearer the top of the board. The sheet of paper is fixed in position by raising the flap, pressing the paper over the two pins on the board, and then closing the flap, so that there are then four holes in the sheet of paper, the use of which will be described later on. The sheet is now fixed firmly in position, and is ready to be written upon. Along each side of the board is a row of holes D equidistant from each other, and a brass fitting E stretches across the board from side to side and is provided with two pins F upon its underside, which can enter into two opposite holes in the board. The brass fitting is shown upon a larger scale in Fig. 3. It consists of two plates of sheet brass, hinged together at one end loosely so the top plate can be lifted sufficiently to allow a hole at the other end to clear a pin in the bottom plate. The bottom plate G is provided with two rows of groups of holes J, or rather recesses, each recess being hemispherical in shape. The top plate H is provided with a series of holes K of the shape shown, which exactly correspond with the groups of recesses below. The brass fitting is placed in position at the top of the board, the top plate is then turned about its hinge, the sheet of paper is inserted and clamped as previously described; the top plate is then brought back over the paper, and retains its correct position over the bottom plate, and all is ready for the operation of writing. The operator now takes a small awl with a blunt point, and, guiding the end of the awl with his fingers, places it in the angle of one of the holes in the top plate, and, pressing upon it, produces a hemispherical projection upon the lower side of the sheet of paper. It is of great importance that the paper should be of the proper thickness and quality, and the awl not too sharp, or a puncture will be made instead of a projection. Each letter is represented by a separate combination of dots, which, of course, vary in position in a somewhat similar manner to the Morse code used in telegraphy. It will be readily seen that two lines of letters can be written with one setting of the cross-bar, after which it is necessary to move it into the next lower pair of holes upon the writing board. When the whole of one side of the paper has thus been filled, the sheet is turned over, and is now lowered the distance between the holes made by the pins upon the hinged flap and those upon the board itself, so that the rows of small projections now lie between those previously written upon the other side. The great objections to the use of the board, cross-bar, and awl are the extreme tediousness of the process, and also the fact that the use of the awl for any length of time produces cramp in the fingers.

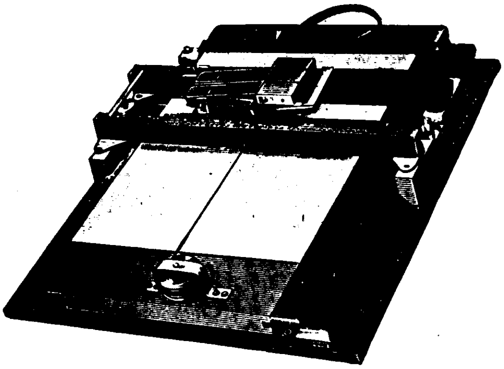


FIG. 1.

The Cockburn type-writer does away with the use of an awl in the fingers, and substitutes a set of three keys similar to those used in ordinary type writers.

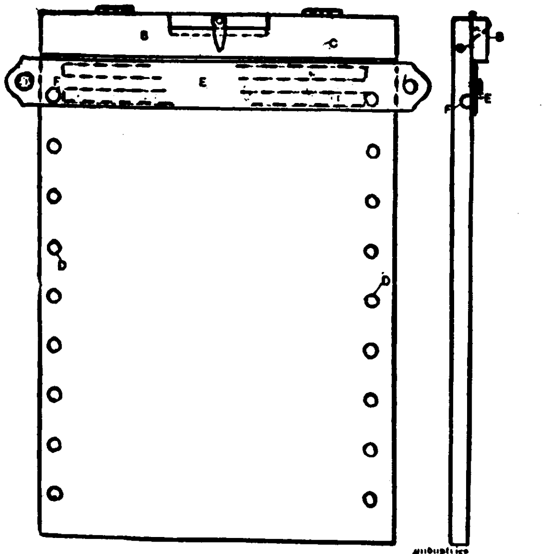


FIG. 2.

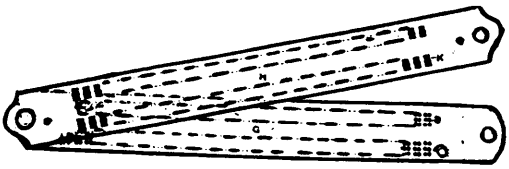


FIG. 3.

Fig. 1 represents a general view of the machine in working order. It will be seen that the board with the hinged flap is present as in the old apparatus, and the same method of fixing the paper is employed. Instead of the cross-bar composed of two brass plates a carriage is here used, which can slide from top to bottom of the board; a cord is attached to the slide and passes round a drum in which a spring is coiled. There is thus a constant tendency for the slide to move towards the drum. This is prevented by a spring catch, which strikes against pins, the pins acting for the same purpose as the side rows of holes on the simple board. After writing each line the spring is released, and the slide passes down sufficiently far to enable another line to be written. The slide itself carries a bar with recesses or holes as in the simple form. Upon the slide is fixed a traveller, to which is attached a cord, which passes round a drum containing a coiled spring; the traveller has thus a tendency to cross the board. It carries three keys which act upon punches in such a way that the punches cause the paper to enter the recesses in the cross-bar and produce the projections. Supposing the traveller to be at one edge of the board; then one, two, or three punches will be depressed, as the case may be. A fourth key is then pressed, which projects beyond the other three, and this releases a pawl from the tooth of a rack fixed to the cross-slide, and allows the traveller to advance the distance between the two rows of three recesses. The punches may then be again depressed, and next time the fourth key allows the pawl to pass over a wider space, in order to separate the groups forming letters. A bell is placed on the cross-slide which gives notice when the traveller has reached the end of its course. The traveller is then brought back, the cross-slide lowered, and a new line can be written. At the edge of the board are placed marks which enable the operator to tell at what distance from the top of the paper he is writing, and along the edge of the cross-slide are pins by which he can tell how far across the paper he has written.

The machine is a very ingenious contrivance, and appears to have received the approval of all who have used it. A considerable number of them are now in use.—*Industries.*

◆

## IRIDESCENT GLASS.

A visitor at the Metropolitan Museum of Art in this city cannot fail to notice in his tour of the galleries the exquisite ancient Cyprian glass ware, with its gorgeous iridescence surpassing in brilliancy of color anything ever produced by artificial means. So far as is at present known, this effect can be produced only by the corrosive action of the air and moisture of the soil in which these objects have been buried for centuries.

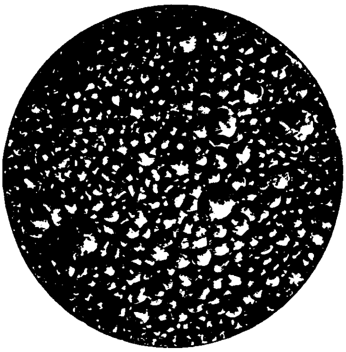


Fig. 1.—Iridescent Film.—Magnified.

Glass having a similar appearance, but without the same brilliancy of color, has been found elsewhere, and a certain degree of iridescence has been imparted to glass of modern manufacture by flashing it during the annealing process with stannous chloride, thus depositing on the glass an exceedingly thin film, which decomposes the light and thus yields a pleasing color effect. Glassware of this kind is beautiful, and was at one time much in demand, but at present it can hardly be found on sale.

Through the courtesy of General L. P. Di Cesnola, director of the Metropolitan Museum of Art, the writer has been enabled to examine specimens of ancient Cyprian glass secured by him in his archæological explorations in Cyprus.

A microscopical examination of this glass shows that the surface is covered with exceedingly thin transparent films formed by matter dissolved from the glass. The body of the glass is pitted over its entire surface with minute cavities, which are circular or elliptical or oblong in outline, and either spherical, ellipsoidal, or cylindrical in respect to their concavity, and the films conform to the pitted surface of the glass. These films, of which there are many superposed, are so thin as to float in air like down when detached. They decompose the light by interference due to reflections from the front and rear surfaces of the film, and give rise to the gorgeous play of color for which these ancient specimens of glass are noted.

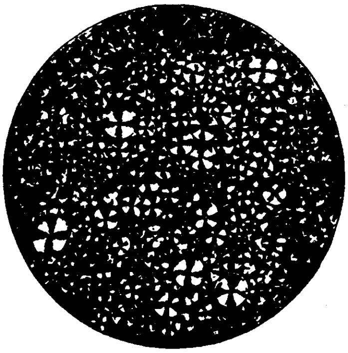


Fig. 2.—Iridescent Film.—By Polarized Light.

The appearance of the film from this glass when highly magnified is illustrated in Fig. 1. The color effect is, of course, wanting. By transmitted light the color is complementary to that shown by reflected light. Examined by polarized light, the color is heightened still more with all the changes that may be brought about by rotating the polarizer, analyzer, or the object itself. The figure under polarized light without the color is shown in Fig. 2.

If the effects secured by long ages of treatment in Nature's laboratory could be produced artificially on modern glass at a reasonable cost, it would seem to be an object well worth striving for.—By Geo. M. Hopkins in the *Scientific American.*

◆

## WHITE ACID.

"White acid" is a name used by glass etchers to designate mixtures of hydrofluoric acid with various chemicals which are used for matting the surface of glass. The discovery of white acid is due to Berzelius, who, while engaged in his investigations on the properties of glass, made the discovery that fluoride of ammonia had the property of matting or opaquing glass. Since that time it has been found that other alkaline fluorides possessed the same power, and during the last few years this has been taken advantage of on a large scale for producing ornaments on glass of the greatest beauty. It is employed, principally, for producing ornamental figures on door lights, although it is used very extensively for decorating glass ware for table use, and also for the various sorts of globes used on lamps and gas fixtures. Extremely fine effects may be obtained on mirrors, and the silvering may be placed on either the same or the opposite side from the etching.

During the last few years, etching on glass has shown itself as a formidable rival to the sand blast, the work generally being indistinguishable from that produced by the latter, except that acid is capable of producing effects of a much greater fineness and delicacy. The grinding is much more even and therefore more easily cleaned.

In Germany, where the art has been carried to a much higher point of perfection than elsewhere, a number of formulæ for matt-etching are in use. Within a short time some of these have been published in various scientific journals, but they all belong to the category of what might be called slow acids, and are very unreliable and uncertain in their action and possess very poor keeping qualities. They are made without the ammonia salt and are dependent on soda and potash for their action, take a long time to work, and are too uncertain for practical use.

There is no doubt whatever but that the white acid compounded with fluoride of ammonia is the best. In using other white acids, spots and streaks often form in the glass, and these cannot always be removed by repeating the etching. With ammonia acids, however, any streaks which may appear, either from applying the acid unevenly or from imperfections in the glass, may be removed by repeated etchings. The following recipe is one which is used by several practical glass etchers and is said to give good results. It is of German origin, and the only objection to it is that it is too complicated, which objection may also be raised to other recipes from the same source.

In a container of lead the following mixture is made:

| | | |
|---|---|---|
| Distilled water | 500 | parts. |
| Fluoride of ammonia (strong) | 500 | " |
| Sulphate of ammonia | 50 | " |
| Sulphuric acid | 100 | " |

This solution is ready for use within two hours and may be tested by immersing a piece of clean glass, which should get a nice, fine matt-surface after five or six minutes.

In practical experience the writer has found that a simpler method of preparing the acid than the foregoing is capable of giving good results. Besides being cheaper, it is possible to recover the materials in it, should it for any reason get out of order.

A container of sufficient size is filled one-third full of ordinary commercial hydrofluoric acid. Carbonate of ammonia is then added. About equal parts by weight may be used. When effervescence has ceased, a small slip of clean glass is immersed in the mixture and permitted to remain 6 or 8 minutes. Upon withdrawing, it is rinsed in clean water, wiped, and dried. If examination shows that it has become evenly translucent over its entire surface, the mixture is all right and may be used for regular work. If, however, it is deeply and irregularly etched, with some parts clear and some parts ground, the acid is in excess and carbonate should be added. If, on the other hand, the glass seems to be only partially affected by the acid, and, while being slightly ground all over, is transparent, too great an amount of ammonia has been used, and acid must be added.

With a little experience, it is possible to keep the balance between the alkali and the acid, so that good results can be obtained. All white acids are subject to change in their actions from day to day, but in none of the recipes the writer has used can it be so easily regulated as in the foregoing. Before trusting any important work to the action of white acid, the acid should be tested with a clean piece of glass, and by followig the hints given, the acid can be corrected to give the proper action.

In preparing glass for etching, any of the ordinary resists may be used. The drawing may be either put on glass by means of a ruling pen dipped in asphaltum properly diluted; by means of a brush; or by means of the somewhat antiquated process of covering the entire plate with Brunswick black and scraping away the parts which it is desired to grind. The best method, however, is that in which tin foil is used, a description of which must be deferred to some future time. The design can also be transferred or photographed on glass if desired.—Nicholaus T. Nilsson, in the *Scientific American.*

## TWISTED NAILS.

The newest thing in nails is a twisted wire nail, which is a cross between a screw and an ordinary plain wire nail. This idea is of English origin, and it is supposed to represent as great an improvement upon the plain wire nail as that useful invention is over the old cut nail. As is well known, the common cut nail tears and crushes the fibers of the wood as it is driven, and its tapering shape destroys the greater portion of its holding powers when it is partially withdrawn. The plain wire nail being pointed and smooth, does not crush the wood fibers as the cut nail does, but presses them aside. As the diameter of the nail is the same throughout its length, it fits as tightly and holds as firmly when partially drawn as when driven home The twisted wire nail not only crushes the fibers of the wood less than the other two forms of nail, but by its screw shape possesses a much greater holding power than either of the other forms. Quite similar to this screw modification of the wire nail is the recent American idea of making a wood screw that will drive nearly as well as a nail and yet can be withdrawn by means of a screw-driver as readily as any screw.

## HOW AN OCEAN GREYHOUND IS FED.

On the City of Paris there are 60 firemen, who feed the fiery maws of 54 furnaces, that create steam in 9 boilers. Fifty coal passers shovel the fuel from the bunkers to the furnace door, and the firemen toss it in. There is something more than mere shoveling in firing. The stoker must know how to put the coals on so that they will not burn too quickly nor deaden the fire. He must know how to stir or poke the fire so as to get all, or nearly all, the heat out of the coal. Service in the fire-room is divided into six watches of four hours each. The fireman works and sleeps every alternate four hours. After the first day from port two out of every six furnaces are raked out to the bare bars during the first hour of each watch. Thus, in a voyage, all the furnaces are cleaned once in twenty-four hours. The steam goes down a bit in the hour while the cleaning is going on. The stokers shovel into the furnaces fifteen tons of coal every hour, or 360 tons a day. The ship usually takes in 3,000 tons at Liverpool or New York, and has between 500 and 800 tons left when she arrives at the other side. The engineers' department is entirely distinct and separate from the firemen's. On the City of Paris there are twenty-six engineers, including hydraulic and electrical. They are educated in engine shops on shore, and a certain number of them go on ships every year. They are all machinists, so whenever the machinery breaks down they know how to repair the damage. In case the chief engineer should be disabled any assistant could take his place.

◆

## TEMPERING TOOLS.

The following is said to be the Swiss method of hardening cast steel for cutting tools. Mix in a suitable vessel four parts of pulverized resin and two parts of train oil. Stir well in this one part hot tallow. Into this mixture the article to be hardened is plunged at a low red heat and held there until thoroughly cooled. Without cleaning off, the piece again is put into the fire and suitably tempered in the ordinary way. An examination of steel thus hardened indicates that the hardening is deeper and more uniformly distributed than is commonly the case, and that the steel is less brittle. Articles thus hardened have excellent and durable cutting qualities.

◆

## A TRADE SECRET CARRIED TO THE GRAVE.

"An item in the Register a few days ago," said a gentleman yesterday, "regarding the $800,000 gun secret in the head of one Crosby, reminds me of a similar valuable secret lost, in the head of a man named Southwick who lived near Worcester, Mass., fifty years ago. That State, as you know, is engaged largely in the manufacture of palm leaf hats. The leaf is brought there as it is cut from the tree, sorted and trimmed, and then bleached in large chambers, the same as hams are smoked. The bleacher used is sulphur. After the leaf is bleached and whitened, it is then split into straw, as you see it in the hat, by drawing several blades of the leaf under the thumb across a series of steel blades, set apart the width of the straw desired, fine or coarse, precisely as our grandmothers split straw for hats and bonnets. These shops are so thoroughly impregnated with sulphur fumes as to nearly stifle a person not accustomed to them. Steel shears lying on the benches and knives carried in the pockets of the workmen, and the steel blades used for splitting the leaf, though made of watch spring steel, soon lose their temper entirely and become worthless, so also the grinding of these blades on emery wheels draws the temper, thus involving great loss and waste. This man Southwick discovered a process for tempering these blades so that neither the sulphur nor emery grinding would affect the temper. He would occasionally make a razor blade when he felt like it, which would retain its cutting edge superior to any ever made. Of course there was great demand for his work. He had an old, dilapidated blacksmith shop, in which his son assisted him in ordinary blacksmith work. Whenever he tempered a lot of blades he would lock the door, close all the windows tight, and permit no person to enter. When he had got the money for his work, he would go on a spree until his money was gone. The cutlery companies of the country offered him fabulous sums for his secret, or to even go there and temper steel, even secretly, but he refused all offers. Various artifices were tried by his son and others to gain the secret, but failed. He died a drunkard's death and his secret went with him. His steel when tempered had the appearance of platina and it could be ground all up on an emery wheel or dry grindstone, without drawing the temper. As evidence of his genius, there was exhibited at an exposition of mechanics, a small, very fine needle, sent from England. Southwick made a bolt, passed it through the eye of that needle, cut a thread and put a nut at each end of it, and it was sent back to England to show what a Yankee could do. That, you must understand, was long ago, before the wonderful machinery now used by watchmakers was known. He was not an intelligent man, and whether his secret was chemical or not could not even be learned.—*The Hub.*

◆

## THE ARTESIAN WELL AT SPRINGFIELD, SOUTH DAKOTA.

We give an engraving herewith of this well as it appears in operation. It is 592 feet deep, 8 inches diameter. The pressure of the water is 60 pounds to the square inch. By using the proper nozzles on the pipe it throws a solid stream 8 inches diameter 12½ feet high, a 6 inch stream 26 feet high, a 4 inch stream 62 feet high, a 2 inch stream 88 feet high. It furnishes power to drive a 60 barrel flour mill, with a large surplus.

Our engraving is from a photograph by Mr. B. W. Burnett, of Tyndall, South Dakota.

A correspondent of the *Rural New-Yorker* describes another well located near Aberdeen, South Dakota. It has a depth of over 1,000 feet. The pipe is six inches and the pressure about 150 pounds to the square inch. From it the owner expects to irrigate his farm of 800 acres.

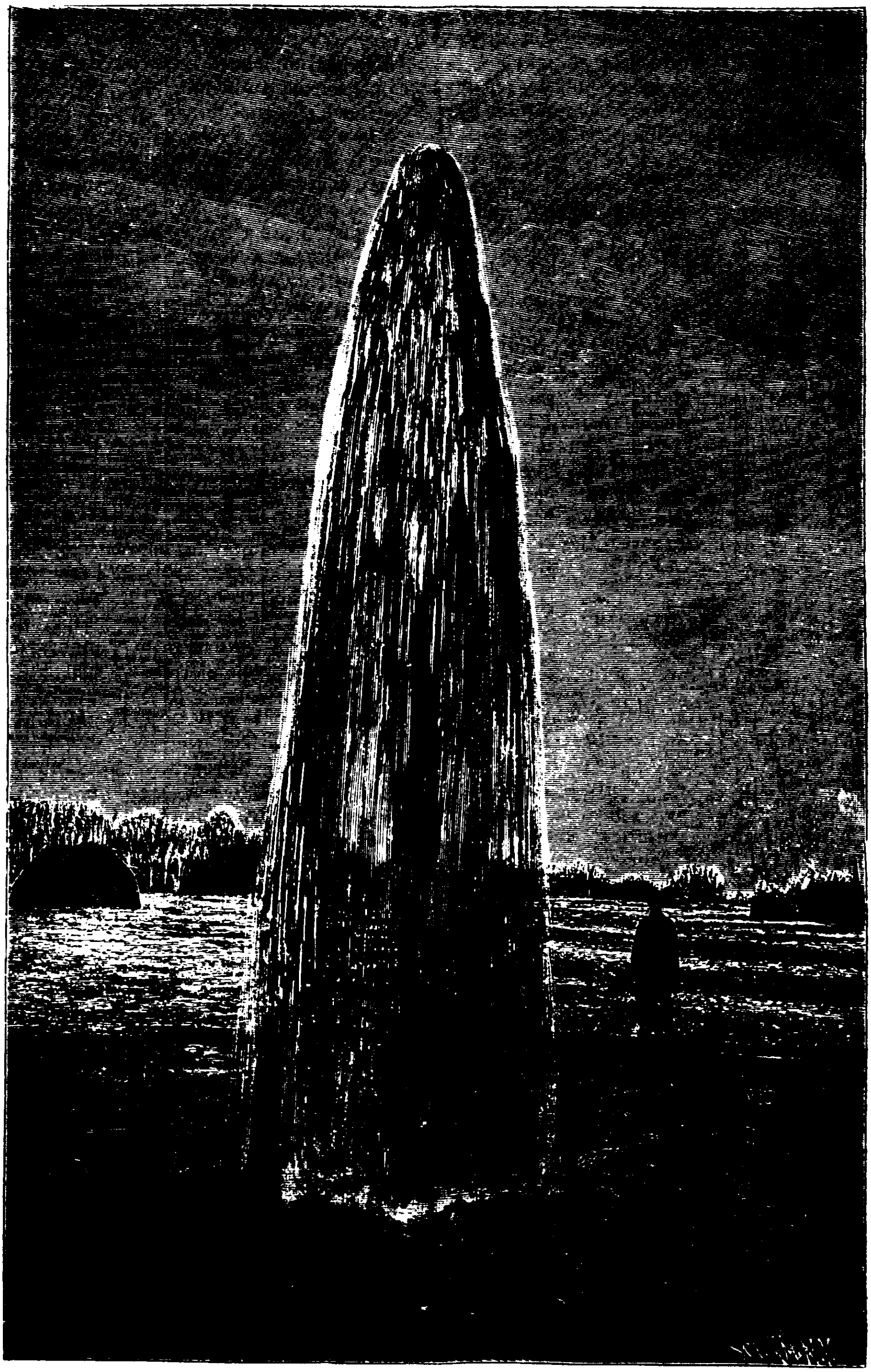
The supply of water appears permanent and bountiful, and if half the expectations of the people be realized, a new era will dawn upon Dakota. Already a number of farms, level and well located, are watered by means of artesian wells and give excellent results. Of course all farms cannot be irrigated. A farm must be smooth and with a gentle slope, with the water at the highest point, in order to give the best results. Still, there are many such that could be made very productive with abundant water.—*Scientific American.*

◆

A sugar fifteen times sweeter than cane sugar, and twenty times sweeter than beet sugar, is reported by a German chemist from cottonseed meal. It cannot be sold to compete with the ordinary article.

◆

A wet silk handkerchief, tied without folding over the face, is a complete security against suffocation from smoke; it permits free breathing and at the same time excludes the smoke from the lungs.



ARTESIAN WELL AT SPRINGFIELD, SOUTH DAKOTA.

Any of our readers who went to the Queen's Hall to hear the free lecture on electricity given before the Royal Society of Canada by Professor McGreggor, as our papers advertised, came away, although with much valuable information in regard to the solution of salts, without that knowledge of electricity which they had hoped to obtain. It seems to have been purely a blunder on the part of the Society, as the lecture was to have been on the solution of salts, and not on electricity as the papers intimated.

The meeting of the Montreal convention of electrical engineers which was to have been held in August, has been postponed to September, the 8th, 9th and 10th. This is a very wise move, for owing to the great heat in this city during July and August, many people, who would otherwise be enthusiastic in welcoming the convention, will be absent from the city at that time. It would be a pity indeed, for any of our citizens to miss such a valuable opportunity of seeing so fine an exhibition of electrical apparatus as it is proposed to offer, and also to miss the opportunity of seeing so many prominent electrical engineers from all parts of the continent.

Professor Elihu Thomson and Professor Aaron have lately won distinction in Paris by having the first prize of 100,000 francs, offered by the municipality for the best and most economical wattmeter, divided equally between them. Professor Thomson's meter is a marvel of simplicity as well as mechanical design and is truly worthy of its inventor. The principle depends on the rotation of a copper disk, mounted on the same shaft as the armature of an electric motor, in a strong magnetic field. The resistance offered to the disk in rotating through this powerful field increases proportionally with the speed of rotation. By this means the speed increases as the load. The axle of the rotating disk is geared to suitable registering scales which register in watthours.

Professor Aaron's meter is of larger design and by being operated by clock-work has to be wound up at intervals.

Although Montreal is behind certain other more favored cities in not having an electric street railway, many of our citizens would gladly welcome such a system of rapid transit, if it were practicable. It must be recognized that the City Passenger Railway has to contend with difficulties which are not encountered to so great an extent in those cities which have resorted to the desired system with more or less success. The winter's snow, which burdens our streets, presents the most formidable obstacle. It would be impossible to keep the tracks clear for many weeks—a necessity which now compels the use of sleighs instead of cars for the time being. In fact the snow is packed down in the streets sometimes to a depth of from three to four feet. To have an electric system merely for the seasons when the track is clear would raise a serious problem as to the disposal of the large number of horses required by the winter sleighs.

As the business of the city increases, however, and the suburbs continue to extend, the need of some more economical and efficient method of transit becomes more and more felt, and surely Canada's metropolis should have a system adequate to the need. If an electric street railway is not practicable, an electric overhead one-track system, or an underground, might be taken into consideration. The problem is one which will more and more commend itself to those who regard with practical interest the city's progress.

## A FEW REMARKS ON THE EDISON-LALANDE BATTERY.

BY W. B. SHAW.

This new cell only lately brought on the market is likely to fill a long felt want. Amongst many favorable points we may mention the following:—

1. "Constancy, and freedom from polarization" (thus making it useful for "closed" and "open" circuit work.)
2. "Low internal resistance."
3. "Freedom from 'local action,' evaporation, and creeping salts."

This cell has been used with excellent results in fire alarm work (our own city using quite a number of cells for this purpose.)

For dental work, small motors, telegraphy, telephony, watchman's time registers; electric gas lighting, etc., not to speak of domestic incandescent lighting.

This last clause may require a little explanation.

To run small incandescent lamps without the aid of a dynamo is the aim of nearly every amateur; but they have probably found (like the writer) that to do so by means of any of the various "bichromate" or "acid" cells at present on the market, is anything but a success.

Suppose we take, however, the type *T* cell of Edison-Lalande battery, whose output with one charge of solution is 900 amp. hours, we can then run a 1 or 6 candle power lamp drawing 2 amps. of current, for 450 consecutive hours, providing, of course, we have a sufficient number of cells grouped together to make up the *voltage* required by the lamp.

Two lamps would run consecutively half that time, or more lamps for a proportionately less time.

We do not promise a large light, but the afore-mentioned lamps are sufficient for bed-rooms and the like, and a number of such could be wired up for lights, the cells of battery being located in a convenient place.

Now let us see where this cell "sprung" from, of what it is composed, and how it acts.

This cell is a modification of the De Lalande and Chaperon which attracted considerable attention at the time of its appearance on account of its simplicity and other advantages.

The De Lalande and Chaperon cell, however, was of a somewhat cumbersome description, the outer jar being of cast iron, having an ebonite cover from which was suspended the zinc element coiled in spiral shape.

The bottom of the outer cell, which constituted the negative electrode, was covered with copper oxide, on top of which was poured a solution of caustic potash.

The cover was hermetically sealed by means of flanges and nuts.

The mechanical arrangement of the De Lalande-Chaperon cell, in spite of the electrical advantages which it offered, militated no doubt against its being widely used, and it has dropped into comparative obscurity.

Mr. Edison, however, persuaded of the important electrical qualities possessed by this type of battery, has recently conducted a long series of costly experiments with it, and has succeeded in perfecting a cell which combines the simplest mechanical arrangements with the fulfilment of all the requirements of a satisfactory galvanic battery.

The elements employed in the Edison-Lalande cell are:—

Zinc as the positive, and

Black oxide of copper as the negative.

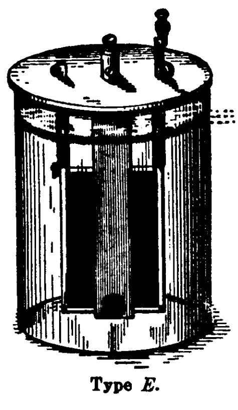
The exciting fluid being a simple solution of caustic potash.

Copper turnings are roasted to produce oxide of copper, which is then ground to powder. This powder is compressed into blocks by means of powerful hydraulic presses, the blocks afterwards being sawn up into various sized plates to suit the different types of cells.

The types are as follows:—

| | | | | | | |
|---|---|---|---|---|---|---|
| Type | *A*, | Capacity | 15 | ampere | hours, | Small Telephone model. |
| " | *C*, | " | 50 | " | " | Telephone and Annunciator model. |
| " | *E*, | " | 150 | " | " | Small Telegraph model. |
| " | *G*, | " | 300 | " | " | Western Union Teleg'ph model. |
| " | *K*, | " | 300 | " | " | Phonograph model. |
| " | *M*, | " | 600 | " | " | Motor model. |
| " | *P*, | " | 600 | " | " | { Electric Lighting and Telegr. Locals models. |
| " | *T*, | " | 900 | " | " | ditto. |
| " | *F*, | " | 150 | " | " | Cautery model (for Physicians.) |

Type *F* delivers 20 amperes of current.



Type *E*.

The internal resistance of the *E* cell as in the adjoining cut is only .025 of an ohm.

The negative element is hung from the cover of the jar by a light frame work of copper, one end carrying the binding post. On each side of the copper oxide element a rolled zinc (amalgamated) plate is suspended, these plates being prevented from coming into contact with the negative element by means of vulcanite buttons.

In most batteries the zinc is attacked more vigorously near the top than at the lower part of the plate; this fact has been specially noted in the Edison-Lalande cell, and the zincs are in consequence made slightly tapering, the thick end being uppermost.

When the cell is put into use, the water is decomposed, the oxygen forming with the zinc oxide of zinc, which in turn combines with the potash, forming an exceedingly soluble double salt of zinc and potash which dissolves as rapidly as it is formed; the hydrogen liberated by the decomposition of the water reduces the copper oxide to metallic copper.

This deoxidized copper we understand will be "allowed for" if returned to the manufacturers or their selling agents.

A layer of heavy paraffine oil placed on the solution is the preventative for evaporation and climbing salts.

From the foregoing it may be concluded that the Edison-Lalande cell is adapted to wide ranges of work, and will prove itself in many ways an undeniable competitor over others. The Edison-Lalande Co. have lately appointed a Montreal Electric Supply house as their Canadian agents.

L'ANNÉE ÉLECTRIQUE, ou exposé annuel des travaux scientifiques, des inventions et des principales applications de l'électricite à l'industrie et aux arts, par PH. DELAHAYE, ancien élève de l'Ecole polytechnique. 7'année 1891. 1 volume in-18 jésus. Paris, Baudry et Cie, éditeurs, 15 rue des Saints-Pères. 3 fr. 50.

This work is an annual now in its seventh year, published at Paris in the interest of electrical invention and progress. It sets forth the "principal applications of electricity to industry and the arts." Ample use is made of the leading publications, including English and American journals, with the result of a concise survey of the last year's work in this rapidly developing science. The author "furnishes to specialists a number of useful indications, and gives to the general public in a simple form, and in language intelligible to all"—that is to say, to those who may read the French original—"an idea of the services which may be expected of an industry so young and already so fruitful in marvels."

Translating further—"The true utility of the work consists in making known the new or perfected types of electric material, dynamos, regulators, incandescent lamps, batteries, telegraphs, telephones, etc.; in passing in review the new processes of utilizing the electric current for medicine, the transmission of force, metallurgy, industrial chemistry; in fine, in the scientific domain, to follow the researches relating to the measurement of electricity, to its propagation and to frequent inexplicable phenomena of which it is the cause."

Such a survey of electrical interests, grouping the achievements of the year, and exhibiting the present outlook of a science so full of promise, is a service of much importance. A similar annual in English is something to be desired.

## THE LARGEST DIRECT CURRENT DYNAMO IN THE WORLD.

Although the construction of unusually large dynamos was until lately unfavorably received by some of our most eminent scientific men, who have claimed that a dynamo if made of large dimensions would soon wear out with frequent use, yet there have been constructed in Switzerland by the Machine Works Co. of Oerlikon, within the past year, two machines of

600 horse-power each, for the Aluminium Industry Co., limited, of Zurich. These colossal machines each have an output of 14,000 amperes at 30 volts pressure, making thus 420,000 watts, when run at only 200 revolutions per minute. This, however, may be increased to 500,000 watts when circumstances require such an increase.

The field magnets consist of 24 poles arranged around the inside of an enormous cast-iron ring, the whole thus resembling a wheel toothed on the inside of the rim. The total casting before winding weighs 12 tons or 12,000 kilos, with an outer diameter of 3·6 meters, and an inner diameter, within which the armature revolves, of 2·43 meters. The armature, which is of the drum type, is coupled directly to the turbine-wheels, operated a short distance above the Rhine falls. The commutator, which consists of 120 segments, is about 1·8 meters in diameter. This enormous size will be accounted for when the strength of the current is taken into account. The brushes are 120 in number, 50 millimeters in width, and in sets of five. Of these, twelve are alternately in connection with a large copper ring. Two rings are requisite for each machine, each ring containing something like 3,000 kilos of copper. It is interesting to note what an important metal these machines have to produce from cryolite, for, in order to have these copper rings perfectly solid and strong, a little aluminium has to be mixed with the copper before casting.

Notwithstanding the fact that these machines are so powerful, the company employs a smaller one of 300 horse-power to excite the fields of the larger, to light the company's buildings, and to supply electricity to motors.

## RAIN CLOUDS AND LIGHTNING.

BY OTIS K. STUART.

In a recent article on "the Striking Distance of Alternating Electromotive Forces," Mr. Robert Shand, one of the ablest of the corps of assistants to Prof. Elihu Thomson, calls attention to a remark made by Prof. Thomson, concerning the electromotive force of lightning discharges. Prof. Thomson has given considerable attention to the subject of auroras, lightning, and other atmospheric phenomena of an electrical nature, as was evidenced by his recent able lecture before the citizens of Swampscott, on the subject of thunder storms, and this remark is, therefore, worthy of more than passing consideration.

Mr. Shand states that he has heard Prof. Thomson remark (we suppose, during the course of conversation) that the "phenomenal values" of the electro-motive force, which are usually referred to in connection with lightning discharges, may be more fanciful than real. The electro-motive force may break through one layer of the cloud and "act as a sort of electric wedge, capable of opening a path for itself, as it were, through many hundreds of feet." This suggestion is very curious as being in its way, confirmatory of Clerk Maxwell's idea as to the action of electro-motive forces through high resisting media. Clerk Maxwell, as Mr. Shand had said, likened this action to the splitting of wood by a wedge. First one layer of resistance is pierced by an electro-motive force, then another layer, perhaps of less resistance than the first, then another and so on until, as in the case of wood, the whole resisting medium is pierced.

It is quite likely also that the conformation of the surface of a charged cloud may govern, to a large degree, the value of the electro-motive force of a lightning discharge. It has been noticed that after a flash of lightning there is frequently a sudden increased precipitation of rain. Even when a flash occurs during a violent down-pour, the precipitation immediately succeeding the flash is still more violent, and the rain drops are often larger than the average during the storm. If we suppose the cloud to project downwards from some part of its under surface, so that it presents a *point* to the earth's surface, it is clear that the cloud will be discharged from this point rather than from any other, not only because of the shorter distance between it and the earth, but also because the cloud does present this point. Gravitation acting upon the cloud would tend to accumulate the denser parts at its lower portions, and the projection thus formed would therefore serve as a comparatively good conductor to the passage of the electricity, which is another reason why the discharge would take place, with a moderate electro-motive force from this projection. Granting that the cloud behaves like a huge condenser consisting of successive layers of dielectric, the electro-motive force, piercing the interior or top layer of highest resistance, would find each succeeding layer in its downward path of lower and lower resistance, and its progress thus becoming easier and easier.

The characteristic phenomena of rain storms which are accompanied by lightning and thunder, are such that we may consider the rain clouds as huge, inverted, irregular cones, with the densest portions at the apexes. The centres of such storms are always the positions of greatest rain-fall, unless when affected by such disturbing influences as wind, temperature, etc. This volume of water precipitated decreases gradually from the center outward to the circumferential limits of the storm, where it is zero. There is generally a small area where the precipitation is very heavy, and all around this area there occurs a much lighter fall, the very lightest being at the storm's edge, which assumes the shape of an irregular circle.

The cloud thus acts as a wedge for entering the air between it and the earth. The striking distance is thereby decreased, there is a rough sort of point from which the discharge may readily take place, and the projection itself forms a comparatively good conductor to the passage of the electric current. If the projection were quite sharp (as might easily be the case, considering the dimensions of a cloud), and projected downward a considerable distance from the main body of the cloud, there might be a vivid discharge of comparatively low electromotive force and large current volume.

The same reasoning applies, though not with equal force, of course, to lightning discharges between cloud and cloud. Wind could readily cause a projection from one surface of a cloud toward another cloud. There would be a lessening of the distance between the two, and the formation of a projection conical in shape, from the surface of one or both of them, and when the two clouds had approached each other close enough, the discharge of comparatively low electro-motive force, would take place. If we consider the lighter portions of a cloud as driven more rapidly by the wind than the heavier, these latter, by lagging behind the former, would form such a projection, and in this case, the projection would be a comparatively good conductor of discharge current.

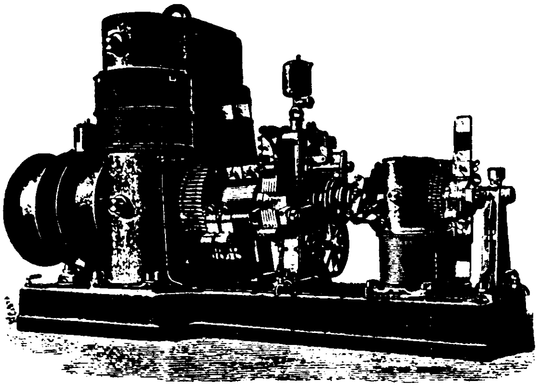
It is popularly supposed that the sudden down-pour of rain which generally at once follows a heavy lightning flash, is caused in some way by the flash itself. Of course, this is known not to be the case; and in view of the considerations above presented, it is quite possible that the sudden increased precipitation may be the real cause of the flash at that particular moment. By reducing the resistance through the striking distance, the increased precipitation offers a path for the discharge which, without this increased precipitation, it would be unable to follow; that is to say, the electro-motive force would not be high enough to pierce the dry air, but *is* high enough to follow the path of the multitude of large rain drops. Owing to the greater velocity of the light, we see the flash before we see the drops, but the latter really start on their journey before the former.—*Electrical Engineer.*

◆

## HOLMES' TRAIN LIGHTING DYNAMO.

Many attempts have been made to light trains electrically, the chief difficulty being in the variation of speed of driving the dynamos. Separate engines have been used, but have been found unsatisfactory. We illustrate a solution of the problem, due to the ingenuity of Mr. J. Holmes, of Newcastle. The inventor explains his dynamo as follows:

Practically the E. M. F. of an ordinary separately excited dynamo varies directly as the speed, so if the speed be increased, say, from 500 revolutions per minute to 1,000 revolutions per minute, the electromotive force will be doubled. The electromotive force varies directly as the strength of the magnetic field, so that, if the strength of field of a separately excited dynamo be reduced in the same proportion as the speed at which its armature revolves be increased, the electromotive force of the armature will remain practically constant.



HOLMES' TRAIN LIGHTING DYNAMO.

To produce this result two dynamos are arranged having their armatures upon the same shaft, so as to revolve together, but influenced by separate magnetic fields. One is the main generating machine, the other is for regulating the strength of its magnetic field. The magnets of the machines are separately exited from an external source, such as a set of accumulators, and the magnets of the generating armature are provided with two distinct exciting circuits. One circuit is an ordinary high resistance shunt circuit, and the other is of less resistance, and is coupled up to the source of current so as to have the small regulating armature in series with it. The regulating armature is so coupled up that its electromotive force opposes the electromotive force of the regulating armature and external source of supply. The high resistance shunt circuit is so proportioned that, at the highest speed at which it is intended to run the generating armature, it, without the aid of the regulating circuit, will give a magnetic field of an intensity proper for the required E. M. F. in the generating armature. When thus driven, the second exciting circuit ought to have no current passing through it, and this is secured by making the E. M. F. of the regulating armature at its highest speed equal, and opposite, to the external source of E. M. F. produced in the second coil of the generating machine. If, however, the speed falls, the E. M. F. of the regulating armature is reduced in the same proportion, and is no longer equal to the external E. M. F., and a current will flow through the second exciting circuit of the magnets of the generating dynamo, thus increasing the intensity of the magnetic field to make up for reduction of speed, maintaining a practically uniform E. M. F.

The armature is driven by belting from the axle of the guard's van, and a set of accumulators excite the field magnets. A centrifugal governor automatically switches the storage batteries in or out. The brushes which collect the current from the two armatures are made of wire gauze, and are placed radially, the "lead" being automatically altered to suit the direction of rotation. The connections to the armature are changed at the same time.

This dynamo is used by the Midland Railway Company for their express trains, and has also been applied to French, German, and Russian railways.—*Industries.*

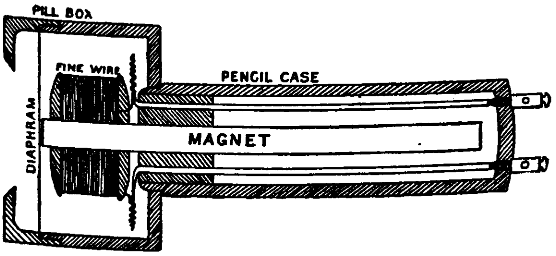
◆

## HOW TO MAKE A SIMPLE BELL TELEPHONE.

For the benefit of our younger readers we will explain a simple method by which a good telephone receiver may be constructed from a pill-box and a pencil-case, with the addition of a few other necessaries. The apparatus will be found to work well, and for experimenting with a microphone, it will afford a great deal of instructive amusement.

Obtain at the druggist's an ordinary wooden pill-box from two to two and one half inches in diameter. Then procure a long circular wooden pencil-case, such as is sold for school use, about one inch in diameter. The cover of the pencil-case may be removed and discarded as it will not be necessary to use it. Now take the pill-box and drill a hole through its bottom so that the box thus drilled may fit tightly upon the pencil-case in the groove made for the cover. Slip the pill-box down the groove as far as possible, and trim off that part of the pencil-case which projects beyond the bottom on the inside of the box. Drill a hole in the cover of the pill-box about one inch in diameter. Obtain a piece of ferro-type plate such as an old tin-type, for the diaphragm, cut it in a circular form in order to have it rest all around on the edge of the box, but without interfering with the fit of the cover. Now placing the cover with the hole drilled, over the diaphragm, the case of the telephone is completed.

It is now necessary to obtain a piece of hard steel for the magnet, one quarter of an inch in diameter, and long enough to fit conveniently into the case without protruding beyond the diaphragm. A good way to magnetize the steel is to place it on one of the excited field-magnets of a dynamo for about five minutes, when it will be found to have acquired a certain amount of magnetism which it will always retain. The magnet thus obtained must then be fixed so that it may be inserted into the case and held firmly there. To do this procure a cork that will fit tightly into the pencil-case, or as we must now call it the handle, and drill a hole through this cork so that the magnet may be pushed through with considerable effort. Placing the magnet in the case, the cork will fit into the handle, and the end of the magnet, projecting out of the handle, will almost touch the diaphragm. In order to produce the variations in the magnetic field which cause vibrations in the diaphragm, thus producing the sound, wire is wound on the end of the magnet which projects out of the handle, and in order to keep this wire from spreading when wound, procure two wooden buttons about an inch or an inch and a half in diameter: drill them so as to fit tightly upon the end of the magnet, separate them so as to enclose a space about five-eighths of an inch in which the wire is to be wound. This should be about one quarter of an ounce of No. 36 B. & S. silk-covered copper wire. The two ends of this wire are connected to two pieces of No. 18 copper annunciator wire respectively, these two heavier wires being brought through the cork by means of separate holes, and from that down the handle and out similiar holes in the end of the handle. Let about two inches of the heavy wire project, if no binding posts are used, in order to make connections to a battery or to another instrument. When binding posts are used, take the cotton covering off the two wires just where they come through the holes in the handle, cut that part of the wires off which project beyond the handle, and screw a post into each hole, the thread of the screw thus cutting into the wire, making metallic connection. The binding posts add very much to the convenience of the instrument, but are not, however, necessary. The magnet is adjusted so that it almost touches the diaphragm, the cover is put on and the simple telephone is ready for use. Reference to the cut given of the cross section of the telephone may perhaps aid in its construction.



Cross-Section of Simple Telephone.

Two such instruments without a battery could be used on a private line between two houses or from the top of the house to the bottom. One instrument and a battery of any kind, preferably of the Leclanchè type, would do for experiment with a microphone, by means of which the walking of a fly across a carbon rod is made audible.

◆

When the mosque of St Sophia, in Constantinople, was built, more than one thousand years ago, the stone and brick were laid in mortar mixed with a solution of musk, and the building it is said has been infected with the odor ever since. Probably age has imparted a musty odor, from which the musk story was fabricated.

◆

## EDISON'S PHOTOPHONOKINETOGRAPH.

Mr. Edison is justifying the title of "the Wizard of Menlo Park" which has been applied to him, by one of his latest novelties which he hopes to perfect in time for the Chicago Exposition. It is called by the formidable name printed above, and is likely to prove one of the most entertaining as well as remarkable of his many ingenious electrical adaptations. He is reported in the *Electrical Engineer* to have said, "My intention is to have such a happy combination of photography and electricity that a man can sit in his own parlor and see depicted upon a curtain the forms of the players in opera upon a distant stage, and to hear the voices of the singers. When the system is perfected . . . . . each little muscle of the singer's face will be seen to work, every color of his or her attire will be exactly reproduced, and the stride and positions will be as natural as those of the live characters."

A sufficient number of consecutive portraits per second is made upon a moving sheet, which being unrolled at the same speed will, by a well-known principle of optics, picture the scene with movements as in life. The phonograph is also employed and thus voice and movement are simultaneously reproduced with the effect of a vocal and animated picture. Should this extraordinary device be made practicable — and the "Wizard" seems capable of almost any achievement — we shall be prepared to expect anything in the way of scientific entertainment.

◆

## EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

*(From Houston's Dictionary.)*

*B. A. Ohm.*—The British Association Unit of Resistance, adopted prior to 1884.

The value of the Unit of Electric Resistance, or the ohm, was determined by a Committee of the British Association as being equal to the resistance of a column of mercury at 0° C., one square millimetre in area of cross-section and 104.9 centimetres in length. This length was taken as coming nearest the value of the true ohm deduced experimentally from certain theoretical considerations. Subsequent re-determinations showed the value so obtained to be erroneous. The value of the ohm is now taken internationally, as adopted by the International Electric Congress in 1884, as the resistance of a column of mercury 106 centimetres in length, and one square millimetre in area of cross-section. This last value is called the *legal ohm*, to distinguish it from the B. A. ohm which, as above stated, is equal to a mercury column 104.9 centimetres in length. Usage now sanctions the use of the word *ohm* to mean the legal ohm.

This value of the legal ohm is provisional until the exact length of the mercury column can be finally determined.

The following are the relative values of these units, viz.:

1 Legal Ohm............ = 1.0112 B. A. Ohm.
" " ............ = 1.0600 Siemens Unit.
1 B. A. Ohm............ = .9889 Legal Ohm.
1 B. A. Ohm............ = 1.0483 Siemens Unit.
1 Siemens Unit.......... = .9540 B. A. Ohm.
" " .......... = .9434 Legal Ohm.

*Back or Return Stroke of Lightning.*—An electric shock, caused by an induced charge, produced after the discharge of a lightning flash.

The shock is not caused by the lightning flash itself, but by a charge which is induced in neighbouring conductors by the discharge. A similar effect may be noticed by standing near the conductor of a powerful electric machine, when shocks are felt at every discharge.

The effects of the return shock are sometimes quite severe. They are often experienced by sensitive people on the occurrence of a lightning discharge at a considerable distance.

In some instances the return stroke has been sufficiently intense to cause death. In general, however, the effects are much less severe than those of the direct lightning discharge.

*Balance, Coulomb's Torsion*—An apparatus to measure the force of electric or magnetic repulsion between two similarly charged bodies, or between two similar magnet poles, by opposing to such force the torsion of a thin wire.

The two forces *balance* each other; hence the origin of the term.

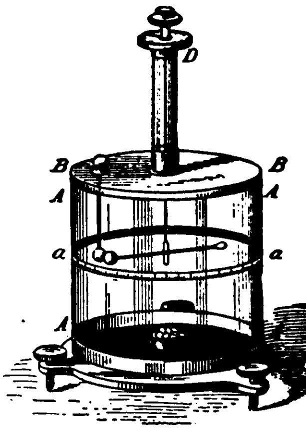


FIG. 38.

Fig. 38 represents a Coulomb torsion balance adapted to the measurement of the force of electrostatic repulsion. A delicate needle of shellac, having a small gilded pith ball at one of its ends, is suspended by a fine metallic wire. A *proof-plane* B is touched to the electrified surface whose charge is to be measured, and is then placed as shown in the figure. There is a momentary attraction of the needle, and then a repulsion, which causes the needle to be moved a certain distance from the ball on the proof-plane. This distance is measured in degrees on a graduated circle *a a* marked on the instrument. The force of the repulsion is calculated by determining the amount of torsion required to move the needle a certain distance towards the ball of the electrified plane-proof.

This torsion is obtained by the movement of the *torsion head* D, the amount of which motion is measured on a graduated circle at D. The measurement is based on the fact that the torsional force of a wire is proportional to the angle of torsion.

*Balance, Hughes' Induction.*—An apparatus for the detection of the presence of a metallic substance by the aid of induced electric currents.

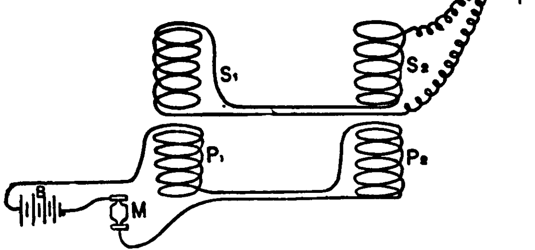


FIG. 39.

Two small *primary coils* of wire $P_1$ and $P_2$, Fig 39, are placed in the circuit of the battery B, and *microphone* M. Two small secondary coils, $S_1$ and $S_2$, are placed near them in the circuit of a telephone, T. When the induction between $P_1$ and $S_1$ is exactly equal to that between $P_2$ and $S_2$ no sound is heard in the telephone, since the currents induced in $S_1$ and $S_2$ exactly neutralize or balance each other's effects.

If a single coin or mass of metal be introduced between either $S_1$ and $P_1$, or $S_2$ and $P_2$, the balance will be disturbed and a sound will be heard, since some of the induction is now expended in producing electric currents in the interposed metal, and a sound will therefore be heard in the telephone. But if precisely similar metals are placed in similar positions, between $S_1$ and $P_1$, and $S_2$ and $P_2$, no sound is heard in the telephone, since the inductive effects due to the two metals are the same.

The slightest difference, however, either in composition, size, or position, destroys the balance, and causes a sound to be heard in the telephone.

A spurious coin is thus readily detected when compared with a genuine coin.

A somewhat similar instrument has been employed to detect and locate a bullet or other foreign metallic substance in the human body.

*Balance, Wheatstone's Electric*—A device for measuring the value of electric *resistances.*

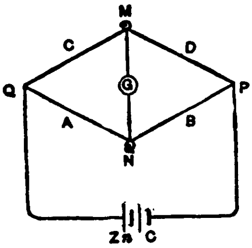


FIG. 40.

A, B, C and D, Fig. 40, are four electric resistances, any one of which can be measured in *ohms,* provided the absolute value of one of the others, and the relative values of any two of the remaining three are known in ohms.

A voltaic battery, *Zn* C, is connected at Q and P, so as to branch at P and again unite at Q, after passing through the conductor D C and B A.

A sensitive galvanometer, G, is connected, at *M N*, as shown.

The passage of a current through any resistance is attended by a fall of potential that is proportional to the resistance. If then the resistances A, C and B, are so proportioned to the value of the unknown resistance D, that no current passes through the galvanometer G, the two points, M and N, in the two circuits, Q M P and Q N P, are at the same potential. That is to say, the fall of potential along Q M P and Q N P, at the points M and N, is equal. Since the fall of potential is proportional to the resistance it follows that

$$A : B : : C : D,$$

$$\text{or } A \times D = B \times C,$$

$$\text{or } D = \left(\frac{B}{A}\right) C.$$

If then we know the values of A, B and C, the value of D can be readily calculated.

By making the value $\frac{B}{A}$ some simple ratio, the value of D is easily obtained in terms of C.

The resistances A, B and C, may consist of coils of wire whose resistance is known. To avoid their magnetism affecting the needle during the passage of the current through them, they should be made of wire bent into two parallel wires and wrapped in coils called *resistance coils*, or a *resistance-box* may be used.

There are two general forms of Wheatstone's Balance, viz,: the box form, and the sliding form.

*Balance, Wheatstone's Electric,—Box or Commercial form of Wheatstone's Bridge.*—A commercial form of bridge or balance in which all three known arms or branches of the bridge consist of standardized resistance coils, whose values are given in ohms.

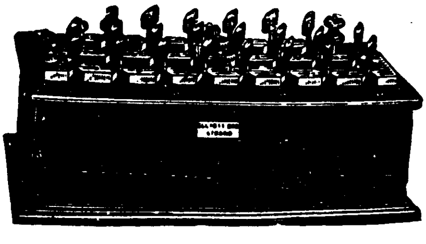


FIG. 41.

The box form of bridge is shown in perspective in Fig. 41, and in plan in Fig. 42. The bridge arms, corresponding to the resistances A and B, of Fig. 40, consist of resistance coils of 10, 100, and 1,000 ohms each, inserted in the arms $q\ z$, and $q\ x$, of Fig. 42. These are called the *proportional coils*. The arm corresponding to resistance C, of Fig. 40, is composed of separate resistances of 1, 2, 2, 5, 10, 10, 20, 50, 100, 100, 200, 500, 1,000, 1,000, 2,000, and 5,000, ohms. In some forms of box bridges, additional decimal resistances are added.

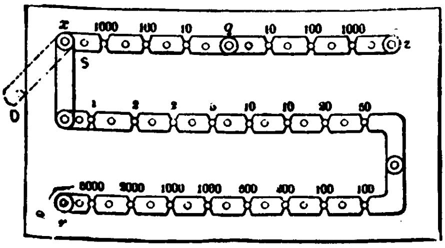


FIG. 42.

The resistance coils are wound, as shown in Fig. 43, after the wire has been bent on itself in the middle, in order to avoid the effects of induction, among which are a disturbing action on a galvanometer used near them, and the introduction of a spurious resistance in the coils themselves.

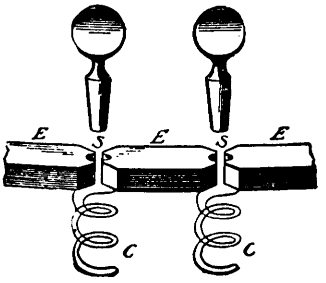


FIG. 43.

To avoid the effects of changes of resistance occasioned by changes of temperature, the coils are made of German silver, or preferably of alloys called *Platinoid* or *Platinum Silver*. Even when these alloys are used, care should be taken not to allow the currents used to pass through the resistance coils but for a few moments.

The coils C C′, are connected with one another in series by connecting their ends to the short, thick pieces of brass, E E E, Fig. 43. On the insertion of the plug keys, at SS, the coils are cut out by short-circuiting. Care should be taken to see that the plug keys are firmly inserted and free from grease or dirt, otherwise the coil will not be completely cut out.

The following are the connections viz. : The galvanometer is inserted between $q$ and $r$, Fig. 44 ; the unknown resistance between $z$ and $r$ ; the battery is connected to $x$ and $z$. A convenient proportion being taken for the value of the proportional coils, resistances are inserted in C, until no deflection is shown by the galvanometer G. The similarity between these connections and those shown in Fig. 42, will be seen from an inspection of Fig. 44. The arms A and B, correspond to $q\ x$ and $q\ z$, of Fig. 42 ; C, to the arm $x\ r$, Fig. 42 ; and D, to the unknown resistance. We then have as before

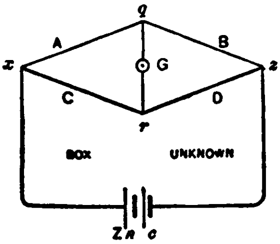


FIG. 44.

$$A : B : : C : D., \text{ or } A \times D = B \times C, \therefore D = \left(\frac{B}{A}\right) C.$$

The advantage of the simplicity of the ratios, A and B, or 10, 100, and 1,000, of the Bridge Box, will therefore be manifest. The battery terminals may also be connected to $q$ and $r$, and the galvanometer terminals to $x$ and $z$, without disturbing the proportions.

◆

## THE NEW ENGLAND PORTELECTRIC COMPANY'S SYSTEM OF TRANSPORTATION.

Since the close of the exhibition of the model of the Portelectric in the "Old South Church," Boston, over a year ago, persistent and unremitting efforts have been made to determine all the conditions necessary for the construction of a commercial line for practical business purposes. Much delay has been caused in the progress of the work by the severe and uncalled-for test to which the invention was put by the contracted course which the company was compelled to adopt, and which gave little opportunity for straight runs, so essential to the development of high speed.

The present experimental track is situated at Dorchester, Mass., and the tests have been carried on under the supervision of Mr. J. T. Williams, the inventor of the system, assisted by Prof. A. E. Dolbear, the electrician of the company. In a report recently made by Mr. Franklin L. Pope we gather some interesting details as to the methods employed and the possibilities of the system.

The experimental plant at Dorchester comprises an endless track, Figs. 1 and 2, elevated upon a wooden trestle a few feet above the ground, 2,794 feet in circuit, consisting of one tangent of 492 feet, and another of 430 feet long, united at their ends by two curves, one of which is 1092 feet long and 282.5 feet radius, and the other 780 feet long and 234.4 feet radius.

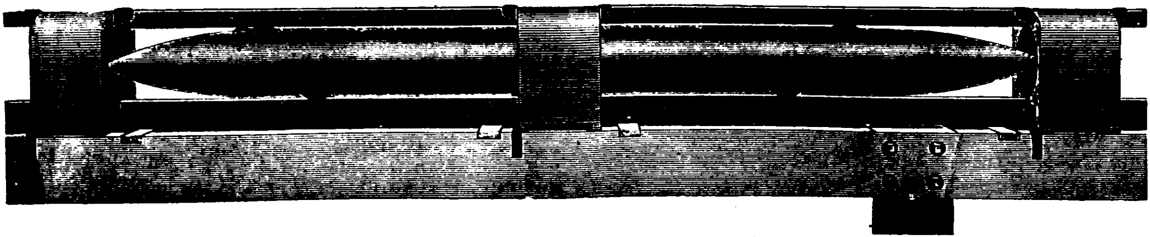


FIG. 3.—CARRIER OF THE PORTELECTRIC SYSTEM.

The track in the first tangent of 588 feet, is level, while in other portions of the circuit are grades rising to a maximum of 4½ per cent., or 227 feet per mile.

The track consists of an upper and a lower rail, formed of bar-steel ¾ inch by ¼ inch, fastened by countersunk screws to stringers. The upper stringer is of wood, 2 inches square, and the lower also of wood, 2 inches broad by 4 inches deep. The upper rail is supported and braced at intervals of about 3 feet.

The carrier, Fig. 3, is a hollow cylindrical projectile of wrought iron, with ogival ends, the cylindrical portion being 8 feet long and 10 inches in diameter, the length 12 feet over all, and the weight approximately 500 pounds. It has capacity to contain, say, 10,000 letters, weighing perhaps, 175 pounds. It is provided with two flanged wheels above, and two underneath, all of which, being fitted with ball-bearings, revolve with very slight friction.

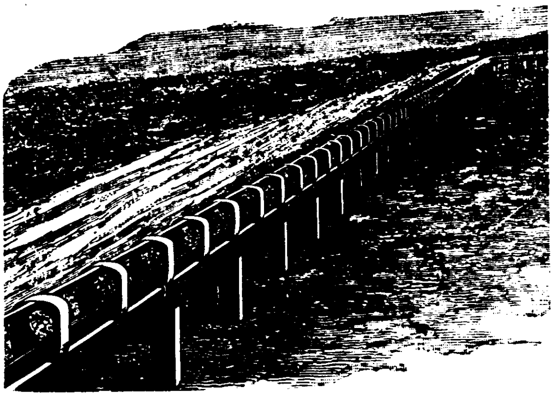


FIG. 1.—PORTELECTRIC TRACK AT DORCHESTER, MASS.

The propelling power is derived from a series of hollow helices of insulated copper wire, each of which encircles the track and carrier. These are fixed along the permanent way at intervals measuring 6 feet from centre to centre. Each helix is composed of 630 turns of No. 14 copper wire, in five layers, weighing about 20 pounds, and having a resistance of about 5 ohms. A contact wheel, mounted upon the carrier, and running in contact with the upper track-rail (which is divided into sections, and utilized as an electric conductor), connects the several helices in succession with the source of electricity as the carrier moves forward upon the track.

The electric current is supplied by a dynamo having a maximum capacity of about 8,000 watts, or a little over ten horse-power, driven by a steam engine rated at ten horse-power.

Experiments were first made to determine the maximum speed of carrier which could be obtained from the appliances in use at the time of inspection. This was found to be 2,784 feet in 56.5 seconds, or 49.3 feet per second, equal to 33.5 miles per hour.

The consumption of electric current, or rate of electric work while the carrier was in motion, was between nine and ten electric horse-power. The maximum tractive effort with a current of ten amperes was found to be 80 pounds. The electrical force producing this magnetic attraction was 6,300 ampere-turns.

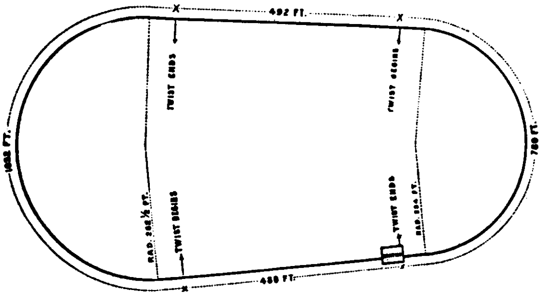


FIG. 2.—DIAGRAM OF EXPERIMENTAL PORTELECTRIC LINE.

The rate of acceleration was found to be as high as 4.5 feet per second. The force of traction required to produce this acceleration, with the carrier of 500 pounds' weight, is about 70 pounds.

A tractive effort of 70 pounds, exerted upon the carrier moving at the rate of 50 feet per second, requires the expenditure of 6·3 horse-power, or 4,712 watts. As the average electrical energy supplied appeared to represent something like 8,000 watts, the efficiency of the helices and carrier, considered as an electric motor, may be estimated at about 60 per cent., which figure agrees very well with other determinations of solenoid magnets.

There are eight hundred and eighty helices, and seventeen thousand six hundred pounds of insulated wire per mile in the helices, in addition to that in the main conductors.

As each coil is ordinarily in circuit for only a fraction of a second at a time, it is evident that a volume of current per unit of sectional area may be used with impunity in this case, which would be wholly inadmissible under ordinary conditions.

The provision for power required to propel the carrier at the assumed rate of 150 miles per hour, may be taken at fifteen hundred volts and seven amperes per forty miles of single track, or about 0.33 horse-power of *generating capacity* per mile. This may be estimated, including steam plant and buildings, at $125 per horse-power, or, say, $45 per mile.

The actual cost of the electric power required to propel the carrier at this rate may fairly be taken at five cents per horse-power hour, including cost of attendance at stations. The mere cost of *power* for propelling a carrier from Boston to New York would therefore not exceed seventy-five cents per trip.

Excessive estimates of the cost of a double-track line, making liberal allowances in all directions, do not exceed $35,000 per mile, or about $7,000,000 for a line between Boston and New York.—*Electrical Engineer.*

## THE MANUFACTURE OF BIRCH OIL.

A profitable industry, and one of which but little is known to the world at large, is carried on among the hills of New England. It is the manufacture of birch oil, and five years ago it was an industry that paid the limited number of men engaged in it a very handsome return for their labor, but the placing upon the market of an adulterated oil has cut down the price of the pure article and now the manufacturer fails to realize the liberal reward for his labor that he did formerly.

Birch oil has a market value as a flavor. It is used largely in the manufacture of confectionery and is sold almost invariably, under a label that calls for the essence or extract of wintergreen. Pure extract or essence of wintergreen does not exist, nor is there any need of it, for the clarified oil of birch gives one a perfect wintergreen flavor, and is so pungent that the smallest drop placed upon the tongue will blister it.

The manufacture of pure birch oil is now confined to the State of Connecticut, where there are eight mills now in operation. Ten years ago the industry was known only in Pennsylvania, and all the birch oil marketed passed through the hands of one wholesale drug firm in Philadelphia. The increased demand for the oil resulted in its adulteration, and in the manufacture by a company of German chemists in Philadelphia of what is known to the trade as a synthetic oil.

Ten years ago hardly anything was known of the manufacture of birch oil outside of Pennsylvania, and the secret of clarifying the oil was known to only a very few. About that time Rev. Tom Dickerson, of Essex, Connecticut, saw an opportunity to turn the vast forests of birch that crown the hills of New England into profitable use, and he sent his son to Pennsylvania for the purpose of learning the process of manufacturing the oil. The son secured a position in a birch mill, where he worked eighteen months, and during that time he had got an idea of how the work was done, and he managed to learn what chemicals were used in clarifying the oil. With this knowledge young Dickerson returned to Connecticut and engaged with his father in the manufacture of the first birch oil ever extracted east of the Keystone State.

The first birch mill was built at Joshuatown, a dilapidated hamlet on the Connecticut River, nearly opposite Essex, and there Tom Dickerson & Son began the work that in three years gave them both an independent fortune. The success of the shrewd minister stirred the blood in the veins of some of the observing Yankees, and within two years there were six birch mills in operation within a radius of ten miles of Joshuatown, and this number has increased to eight. Although the clarifying of the oil is not an open secret, it is known to a large number of men who are engaged in the business.

With a capital of twenty-five hundred dollars a man can set up his plant and begin the manufacture of birch oil. The best and most profitable mills are equipped with six watertight wooden tanks, about six feet square. In some cases these tanks are so built that a fire may be set under them for the purpose of boiling the water that they contain. These tanks have copper bottoms. In many of the mills the work is done by steam, and in such cases there must be a furnace and boiler, and a coil of steam pipes is laid in the bottom of each tank. With tanks, pipe, boiler, a few glass jars, and a good supply of fresh, cold water the manufacturer is ready for business.

The farmers are paid three dollars a ton for birch brush that must not be more than two and a half inches in diameter, and the only variety of birch used is the black, mountain, or sugar birch. From the yellow and white birch no oil can be extracted.

If the farmer does not live more than six miles from the mill, he can, by working early and late, manage to cut and haul to the mill one ton a day. This, to the average New England farmer, is very profitable work, and the building of birch mills in their midst has been of great benefit to a large number of them. Many of these men who have birch to sell are not so favorably located as others. There are many men who drive a slow-going ox team to the mill with but half a ton of brush, and the distance that they travel going and coming is more than twenty miles. Their compensation for the day's labor of three yoke of oxen and themselves is one dollar and fifty cents, but these men are satisfied with that, and in most cases their farms are clear of mortgage and they are not indebted to the village storekeeper.

The brush is chopped into pieces of from one and a half inches to five inches long, by a heavy machine built with heavy knives, on the principle of a hay cutter. One ton of brush can be run through a cutter in an hour if kept steadily running.

These short pieces are thrown into the tanks, in which about a foot and a half of water has been placed, the fire is then built or the steam turned on and the water set a-boiling. While the water is being heated, the covers of the tanks are shut and "plastered" or sealed around the edges with rye flour paste. This is to prevent the steam from escaping.

The water in each tank is kept at a boiling point six hours, at the end of which time the life of the birch is extracted.

Entering each tank near the top is an iron pipe, through which the steam escapes and passes through a coil placed in a barrel that is kept full of running water. In this manner the steam is condensed and drops into a glass jar, placed under a pipe at the bottom of the coil, for its reception.

Birch oil in a pure state is much heavier than water. Thirteen fluid ounces weigh a pound, and instead of rising to the top of the condensed steam, it settles to the bottom of the jar, where in its action when the jar is moved, it very much resembles quicksilver.

In its crude state the oil is of a copper hue. If boiled in tanks with copper bottom, or if cooked over a steam coil, it is of the darker hue of iron. The most popular and the cheapest method of clarifying the oil is as follows :

The oil in its crude state is poured upon a woolen blanket that is then laid upon the top of the brush in a tank. The covers are "plastered" down and the water set a-boiling. The steam passes through the blanket, which absorbs the particles of copper and iron, and the oil drops into the receptacle at the bottom of the worm of a hue that is a very light green or like the essence of lemon. Clarifying the oil by the use of chemicals is much more expensive and generally less satisfactory.

A tank six feet square will hold a ton of brush and each ton yields four pounds of oil. The mills are run during the season, night and day, and each tank is filled three times. The daily product of a six-tank mill is about seventy-five pounds of oil per day. Five years ago, the oil brought three dollars and fifteen cents a pound readily, but now the price is one dollar and a half a pound, but even at this reduced figure the birch oil manufacturer is able to pay his running expenses and make a neat income besides.

The product of the eight mills in Connecticut is handled by one firm in Essex, Connecticut. The mills do not run during the summer, because of the trouble of preparing the brush for the cutter, it being necessary to remove the foliage. The season opens about the first of October and the mills run until the last of April.

The oil of birch in an adulterated form is used in tanning leather to imitate Russia leather, which has a very peculiar odor. For a long time tanners were at a loss how to give American hides this odor. They finally discovered that birch oil would do it, and now a great deal of it is used for that purpose.

Further information on the subject will be found in the Scientific American Supplement, No. 336. — *Scientific American.*

## DOMESTICATING CAMPHOR TREES IN THE UNITED STATES.

Although the camphor tree is a native of China, Japan and Formosa, the authorities of the United States Department of Agriculture state that it has been a subject of distribution by the department for nearly thirty years. It is a very ornamental plant and has been used to some extent as a shade tree. The trees thus distributed are grown from seeds, the plants being raised in the nurseries of the department. The camphor tree flourishes in perfection in some of the Southern States, especially along the Gulf coasts. It grows rapidly from the seed, and the Department of Agriculture has frequently received seeds from this source which, when sown in a garden border, as a common garden pea is sown, rapidly vegetate and form plants from eighteen inches to two feet in height the first season. While the camphor tree flourishes best in warm climates, it will stand 20 degrees of frost without being injured, and any locality where the thermometer does not show lower than 20° F. is fitted for the growth of the plant. A large number of trees were raised by the U. S. Department of Agriculture in 1877 from seed sent from South Carolina, where trees are growing. Plants obtained from this seed were sent into the Southern States mainly as ornamental or shade trees. It was found that it answered well as a shade tree, especially in Florida, though not much was expected of it in the way of producing camphor as a commercial product.

Interest in the growing of camphor trees has recently been stimulated by the great increase in the price of gum camphor. This advance was caused by the quantities of the article which have been used in the manufacture of smokeless powder, and also by the increasing demand from makers of celluloid goods both in this country and in Europe. Before the introduction of celluloid goods about all the uses to which camphor was put were the preserving of clothing and fur goods from the depredations of moths, and in medicine, but now large quantities of the commodity are used in celluloid manufacture, and for the production of smokeless powder. The principal source of supply is in Southern Japan, and the method of extracting the gum from the wood was fully described in the *Scientific American* of April 5, 1890. The methods used in this process, as was then shown, are of an exceedingly primitive character, and this has prevented any material increase in the supply of camphor to meet the increased demand. In April, 1890, machinery was constructed at Pittsburg, Pa., for distilling camphor by more rapid processes, and this was shipped to Hiogo, Japan, but no advices have yet been received of the success of the experiment. The price of camphor is still maintained at a high figure, which will probably have the effect of still further stimulating the interest in the domestication of the tree in this country, with a view to extracting the gum for commercial purposes. Twelve months ago not less than five thousand plants were sent out by the Department of Agriculture from the gardens at Washington, and many thousands of plants are now growing there from seeds sown three months ago.

The method pursued by the department in disposing of the trees is to send them to parties applying for them, who reside in sections of the country where the trees are likely to do well, and suggestions are also made to certain persons to take the trees, experiment with them, and report. The following is a statement from a person who had been thus favored: "A camphor tree received from your department, six years ago, has grown up into a fine tree, some fifteen feet in height. It is a very ornamental tree, and is valuable on that account alone, but if this is the tree from which the camphor of trade is obtained, I would be obliged if you would inform me how to get it. I have tried cutting the bark, but could not see any exudation of gum."

Camphor is generally obtained from the tree by chopping the wood and roots into small pieces and boiling them with water in an iron vessel till the camphor begins to adhere to the stirring utensil. The liquor is then strained and the camphor concretes on standing. It is afterward mixed with a finely powdered earth, and sublimed from one metallic vessel into another. In Japan the chips are boiled in a vessel to which an earthen head containing straw has been fitted, and the camphor sublimes and condenses on the straw. Crude camphor very much resembles moist sugar until it is cleaned. The refining process by sublimation requires care and experience.

There is a tree found on the island of Sumatra which furnishes an oil called camphor oil, which is obtained from incisions in the tree. Solid pieces of camphor are also found in the cracks of the wood, which is usually obtained by felling the tree, cutting it into blocks which are split and the camphor extracted. This article is rarely met with in commerce, and the tree is too tender for the climate of the United States.

The Department of Agriculture will have a large supply of camphor trees ready for distribution next spring, inquiries having been received from many localities, regarding the domestication of the tree in this country.

Camphor trees have done well in California. A tree in Yuba County, in fourteen years, reached a height of fifty feet. One recommendation of the tree for ornament alone is its exemption from insect parasites, which, especially in the coast regions, trouble all indigenous evergreens and materially stunt their growth.— *Scientific American.*

## THROTTLING ENGINES.

During the last few years it has become quite the fashion with a large class of engineers to abuse the throttling engine to the best of their ability, and to make all kinds of unfair comparisons between the older method of regulating and the more recent types of automatic expansion gears. In many instances such comparisons are not made in quite so disinterested a manner as might at first appear, while almost invariably it will be found that the advocate of some intricate valve gear takes very great pains to compare the best results given by his gear with the very worst specimen of a throttling engine he can possibly find. Such comparisons are, needless to say, as worthless as some of the automatic cut-off gears which are supposed to give nothing less than absolutely perfect steam distribution and exact regulation of speed. In point of fact, however, the throttling engine is very much in the position of the dog with the bad reputation. We do not, however, wish it to be inferred that we consider this type of engine to be as economical or as generally efficient as the automatic cut-off engine, but we contend that the older form of engine has been most unfairly and most unreasonably condemned. Take, for example, the case of a compound condensing engine indicating, say, 1,000 i. h. p. With Corliss gear, reducing the clearance spaces, diminishing the initial condensation, and giving that apparently indispensable feature, a sharp cut-off; with carefully arranged and well lagged jackets and a steady load to drive—such an engine would, we think, be considered as doing very well indeed if it could be run with 2¼ lb. of coal per indicated horse power per hour. Now, we have before us indicator diagrams and particulars of a test made several years ago of an ordinary compound condensing throttling engine, indicating about the same power, with a coal consumption of 2.2 lbs. only. The two high pressure cylinders are 22 in. diameter, the two low pressure 40 in. diameter, the stroke 6 ft., the steam pressure about 90 lbs. per square inch, and the number of revolutions per minute 38. Each tandem engine formed by one high and one low pressure cylinder drives cranks at right angles. It will be noticed that neither the steam pressure nor the piston speed is particularly favorable to economy. The valve gear, which is of the simplest possible construction, consists in each engine of two ordinary simple slide valves, driven by a single eccentric, and without expansion slides or any other means of varying the expansion, the steam pressure being regulated by ordinary throttle valves controlled by a common Watt governor. We may note in passing that the test was made by one of the most trustworthy engineers of the present day, and withal a disinterested party. Here, then, we have the simple, much abused throttling engine giving somewhat better results than the much vaunted automatic engine. Are we to suppose that if this engine was fitted with Corliss gear, efficiently jacketed, and run at a higher speed and with increased pressure, it would show the 20 to 30 per cent. economy sometimes claimed for these embellishments. If so, we should indeed have an economical motor. Theoretically the throttling engine is far less efficient than the automatic cut-off type; practically the difference need not be very material, provided the conditions are favorable to the throttling engine, and that it is as well cared for as its rival. We believe that the non-fulfilment of this last condition has much to do with the disrepute into which the throttling engine has fallen. The throttling engine is not supposed to be economical and is not therefore as well looked after as a Corliss or similar engine, the economical working of which has often a direct effect upon the reputation of the builders, and this is in general sufficient to insure its receiving careful supervision. Again, much of the abuse which has been bestowed upon the throttling engine takes its rise from the proverbially uneconomical small engines, which are usually of the throttling type, for obvious reasons. Small automatic engines, however, do not give sensibly better results than the throttling engine under the same conditions as to pressure and *piston speed.* But as we have said, it is not always politic to make such direct comparisons. Meanwhile, steam users owning good throttling engines need not believe all they are told with regard to the enormous waste of fuel which their use incurs. Given a tolerably good engine, driving a fairly constant load, there is no reason why the throttling engine should show anything like the 20 per cent. loss so often insisted upon, provided always that the engine is developing about its maximum power. If little variation of speed obtains, then with an engine of suitable size for the load, the initial pressure should not be materially lower than the boiler pressure, since it is possible to work with the throttle valve nearly wide open, so little wiredrawing is occasioned. As is well known, underloaded engines of whatever type are uneconomical, and to throttling engines this applies most forcibly. The economy of the automatic engine is, of course, chiefly due to the varying of the volume instead of the pressure of the steam used per stroke; and when the power requirement fluctuates to any extent, the advantage of this type of engine becomes very evident. But, as we have said, with a fairly constant and suitable load to drive, there is or should not be a very marked difference. Irregularity of speed, due to the difficulty of governing throttling engines, is also used as an argument against their use, but, as this is purely a question of the choice of a suitable governor and throttle valve, it may be dismissed as being beside the question at issue.—*Mechanical World.*

## WHY DOES SOLID IRON FLOAT ON MOLTEN IRON?

This question, which has puzzled a good many observers, was satisfactorily explained by Dr. Anderson in a recent paper on steel read before the Iron Institute, London. When a piece of solid iron is thrown into a pot of molten iron or steel the solid metal at first sinks, which shows that its volume is less than the melted metal. But soon the solid piece becomes heated, which causes it to expand, its volume increased, and it rises and floats on the surface of the molten mass. The action is the same both with iron and steel. Mr. Wrightson said:

"The experiment was frequently made by throwing a piece of iron into melted steel. They could see it go down, and might think that it was on account of the impetus which the iron had attained in falling that height, but as a matter of fact if the iron were put upon a fork and lowered, it would go down; but in the course of a few seconds it came up again, and kept on expanding until the piece of iron was a considerable distance above the surface of the metal. Then it decreased in volume, and of course became of the same volume as the molten metal which it joined. Any one could see by the distance that the piece of iron went above the surface that it was of considerably less density than the molten metal."

## HOW TO SPLIT A GRINDSTONE.

When a stone is new and four feet in diameter, ten inches is none too thick, but when that stone wears down to twenty-four inches it should be split. It is too clumsy, but will make two nice stones if carefully split. To do this turn a deep groove in the stone before it is removed from its hanging. The groove should be three inches deep, and three-fourths of an inch wide outside, tapering to as narrow a line as possible to be made at the bottom. This groove done, the shaft and collars removed, the groove is driven full of dry pine wedges. Put them in carefully, all equally tight. Throw the stone in to water, let it lie over night and it will split nicely.

## DANGERS OF PHARMACY.

Mr. George Weddell contributed lately a paper on this subject to the Newcastle-on-Tyne Chemists' Assistants' Association. The full title of Mr. Weddell's paper was—"Some Dangers of Pharmacy in Storing, Handling, Manufacturing, Dispensing, and Selling Dangerous Drugs and Chemicals." In this paper he said he was only opening a rather extensive subject. He had been favored with assistance from Mr. Atkins, of Salisbury; Dr. W. Inglis Clark and Mr. Dott (Duncan, Flockhart & Co.), Messrs. Smiles and D. Mackenzie (T. & H. Smith & Co.), and Mr. Peter Boa, of Edinburgh; Mr. Lane (Woolley, Sons & Co.), Manchester; Mr. Martindale, Mr. C. Umney, and the editor of the *Chemist and Druggist*, London; also from his local *confreres*, Messrs. Bambridge, Clague, Park, and B. S. Proctor; and from Mr. Linford (Lofthouse & Saltmer), Hull. Mr. Weddell said it was impossible in a single evening to go thoroughly into all the dangers of pharmacy, but promised that if members of the calling would assist him by sending him their experiences of danger, whether physical, chemical, physiological (poisons), or legal, he would, when leisure permitted, bring the matter in a more or less compact form before the general body of chemists and druggists. He also asked them to consider nothing too commonplace, or, on the other hand, too uncommon, to be communicated, and promised due acknowledgment to contributors. The points on which he invites information are dangers incurred in—

Storing,
Handling,
Manufacturing,
Dispensing,
and
Retailing

Inflammables.
(Also notes on Spontaneous Combustion.)
Explosives.
Corrosives.
Poisons { Vapors,
Liquids, and
Solids.

The following are among dangerous substances and compounds mentioned by Mr. Weddell:—

INFLAMMABLES.

Mixtures of H and O
Cotton wool (near gas).
Sugars (in syrup making).
Spirits (in heating or measuring near light).
Ethers.
Ac. carbolic (in liquefying).
Fats and oils.
Carbons?
Hydrocarbons.

EXPLOSIVES.

Siphons of aerated water.
Potass. chlor. (powdered in iron mortar, or trampled under foot on floor).
Mercuric oxalate (in powdering),
Argentic oxalate (in powdering).
Fulminates of silver and mercury.
Argent. oxid.
Phosphorus, amorphous.
Picric acid and picrates.
Nitroglycerine.
Sulphur hypochlorite (in tapping stopper).
Hypophosphites (in powdering).

MIXTURES.

Pot. chlor. c. antim. nig.
" c. hypophosphites.
" c. glycerine.
" c. ammon. sulphuret.
" c. morph. mur.
" c. sulphur.
" tannin.
Pot. permang. c. glycerine.
" c. alcohol.
" c. fe. redact.
Pot. bichrom. c. alcohol.
Pil. phosphori.
Sp. terebinth. c. $H^2SO^4$.
Iodine and iron.
" and liq. ammon. fort.
Nitrate of lead and charcoal.
Ac. chromic. and glycerine.
Strong acids and glycerine.
Tr, nucis vom. c. acid. nitromur. dil. (burst).

CORROSIVES.

*Sulphuric acid* (spurts of water added to it instead of it to water. What application?)
*Nitric acid.* (What application?)
*Nitric acid fumes.* (What application?)
*Hydrochloric acid.*
*Chromic acid.*
*Chlorine.*
*Bromine.*
*Hydrofluoric acid.* (Application?)
*Sodium.* (Application?)
*Phosphorus.* (Application?)
*Caustic soda.* (Application?)

POISONS

of various kinds were mentioned by the author, with precautions to be observed; and also a number of dangers of various kinds to be guarded against at the retail and dispensing counters, such as transposition of labels on liniment and mixture bottles; labeling strong drugs "Poison," or "With caution," even (when for internal use) in giving customers what they ask for; protest or caution, if necessary; badly dried bottles for kali; when temperature rises, see to stoppered bottles, in case they burst; volatile liquids not to be kept on a high shelf; carbon bisulph., etc.; powdering chrysarobin, corrosive substances, plumbi acet., potass. cyanide, etc.; a mixture of calomel and gum forms a cement; in pills, danger of not having active ingredients (strychnine, ext. physostigmatis, etc.) thoroughly mixed; putting nitric or other strong acid in dirty bottle (turpentine, etc.); using distinctive bottles for external applications.

In closing, Mr. Weddell briefly touched on the legal dangers which beset the unwary pharmacist, such as drugs not up to requirements (Sale of Food and Drugs Act); drugs under common names (citrate of magnesia, milk of sulphur, sweet spirit of niter, etc.); sale of S.V.M. on Sundays; sale of same for drinking or without license; use of same in preparations capable of being used internally; use in patent medicines (although unknown to seller); use of still without license, or for methylated spirit preparations; sale of medicated wines without license (if capable of being used as a beverage); acting as an apothecary (do not take pay); ships' medicine chests (not to requirements); stamp duty; poisons not labeled, or insufficiently so; sale of medicines capable of being used for improper purposes; buying goods dishonestly acquired, etc.—*Scientific American.*

## WHAT MAY BE PATENTED.

The Washington *Chronicle* gives the gist of the American patent laws as follows:

A United States patent will be granted to any person who has invented or discovered any new and useful art, machine, manufacture, or improvement thereof, not known or used by others in this country, and not patented or described in any printed publication in this or any other country, before his discovery or invention thereof, and not in public use nor on sale for more than two years prior to his application, unless the same is proved to have been abandoned.

In this connection the word "art" means the process or method of producing an old or new result. If a method of doing anything contains one or more new steps, the process is new and patentable.

The word "machine" means any device or thing by means of which a mechanical result may be produced, such as a pin, a churn, or a locomotive.

The word "manufacture" means a made-up article such as furniture, clothing, harness, and the thousands of things which are offered for sale.

"Composition of matter" means a chemical compound of ingredients, such as hard rubber, liquid glue, medicine, etc.

Patents may also be obtained for designs for manufactures and works of art, for three, seven, and ten years.

Trade marks may be registered for any arbitrary sign or symbol which is not descriptive; the government fee is $25. Such marks are the exclusive property of the registrar for thirty years, and the time may be extended.

A "label" is any descriptive tag, print, or impression to be placed upon any article or its case, and it may be registered for twenty-eight years. The government fee for a "label" is $6; but if it contains any special mark or symbol, the office decides it to be a "trade mark" instead of a label.

## HINTS TO YOUNG ENGINEERS ON THE MANAGEMENT OF BOILERS AND THEIR CONNECTIONS.

Before washing out your boiler let the steam run down and the boiler cool off as much as possible ; open and wash with a hose immediately after running the water out. In cases where it requires a pressure to get the water out, never blow off with more than from 15 to 20 lbs. of steam, and be sure there is no fire in the furnace when blowing off. To get out sediment and scale that has been left in the bottom of the boiler after blowing off, make an iron scraper, use for a handle a half-inch iron pipe, attach a hose to the end and play the scraper back and forth in the boiler, letting the water run through the handle ; the sediment will all run off through the blow-off pipe.

In using rubber gaskets on hand roll and man hole plates, the best way to insure a fit is to lay the sheet of packing over the plate and mark it by rapping it with a hammer. If the edges of the plate are sharp, hit hard enough to most cut through. After you place the gasket on the plate put a few turns of candle wick under the inner edge, and you will have no trouble in making a tight joint.

In packing valve stems, use a little cylinder oil on your packing. Your valves will open and close easier and the packing will last much longer. When a valve stem leaks, do not try to burst it by screwing it up, but put in fresh packing.

In packing water glasses be sure that your connections are in line, and do not screw your packing too tight. See that the steam gauge has a syphon and do not let it get filled with sediment, so as to choke the gauge.

Do not let your ash pit fill up ; if you do you will burn and warp your grate bars. Keep your combustion chamber clean.

Be sure that your safety valve is in working order ; start it from the seat every day. Have a string attached to the end of the lever, run through pulleys to a convenient place so it will be handy to pull and save climbing on top of the boiler occasionally. Take the valve apart and clean it. See that it works easily and does not bind.

See that your water column does not fill up ; blow it out often from the bottom ; shut the steam connections on the top so that the pressure will all come from the bottom, and clean out all sediment that may be there, but do not forget to open the steam connections when you are done.

Read all you can pertaining to your business. When you get hold of an article that is worth reading, do not half read it, but study it carefully. Get all the theory you can and mix it with your practice, and you will come out on top in the end, and when you go to do a job about your plant, do it right, as a steam plant is no place to slight work, and will tell on you very quick.—*Electrical, Mechanical and Milling News.*

## THE MANAGEMENT OF PETROLEUM LAMPS.

In view of the numerous fatal and other accidents caused by petroleum lamps, the following suggestions as to the construction and management of such lamps have been made by Sir Frederick Abel and Mr. Boverton Redwood, chemist of the Petroleum Association, after investigating the causes of lamp accidents :—

1. That portion of the wick which is in the oil reservoir should be inclosed in a tube of thin sheet metal, open at the bottom ; or in a cylinder of fine wire gauze, such as is used in miners' safety-lamps (28 meshes to an inch).

2. The oil reservoir should be of metal, rather than of china or glass.

3. The oil reservoir should have no feeding place nor opening other than the opening into which the upper part of the lamp is screwed.

4. Every lamp should have a proper extinguishing apparatus.

5. Every lamp should have a broad and heavy base.

6. Wicks should be soft and not tightly plaited.

7. Wicks should be dried at the fire before being put into lamps.

8. Wicks should be only just long enough to reach the bottom of the oil reservoir.

9. Wicks should be so wide that they quite fill the wick holder without having to be squeezed into it.

10. Wicks should be soaked with oil before being lit.

11. The reservoir should be quite filled with oil every time before using the lamp.

12. The lamp should be kept thoroughly clean, all oil should be carefully wiped off, and all charred wick and dirt removed before lighting.

13. When the lamp is lit, the wick should be at first turned down and then slowly raised.

14. Lamps which have no extinguishing apparatus should be put out as follows : The wick should be turned down until there is only a small flickering flame, and a sharp puff of breath should be sent across the top of the chimney, but not down it.

15. Cans or bottles used for oil should be kept free from water and dirt, and should be kept thoroughly closed.

## GAS AT FIVE CENTS PER THOUSAND.

It is announced that a company already in operation at Litchfield, Ill., will pipe fuel and illuminating gas into East St. Louis. Mr. Henry O'Hara, a capitalist of St. Louis, who is prominent in the enterprise, says they have a process for manufacturing gas from Lima (O.) oil, which costs 1¼ cents a gallon. This amount of oil renders over 1,000 feet of gas. They have eight miles of pipe down, and are furnishing families at a rate which for lighting a large house and supplying three stoves with fuel takes but $54 per annum from the proprietor's pocket. The plant they are putting into Litchfield will cost some $60,000. From this they propose to lay an 8-inch gas main to East St. Louis, 37 miles, and deliver their product there at a price far below that which the company now in power there can do. They claim that they can give light and heat to the city at five cents per 1,000 feet of gas, or give it away for a long time and scarcely feel it, the production costs so little. In explaining the process, Mr. O'Hara said : "A bench, that is, a plant with twelve retorts, will cost about $5,000, and will supply a town of 6,000 inhabitants, it would produce 60,000 feet of illuminating gas daily, and 13 times as much fuel gas ; here are the figures—120 gallons of crude petroleum $1.50, gas for operatives 30 cents, one workman one day $2, total $3.80—product 200,000 feet. The crude oil is introduced to the furnace direct from the tanks. Steam forces it into spray, and, mingling, both absorb the elements from the air, and a chemical degeneration commences that winds up in non-condensable, non-explosive gas. For intensity of heat the fuel gas excels. I have seen Swedish iron, which requires 4,500°, made with it, and also crucible steel not only made, but melted and burned up in a few minutes." —*American Manufacturer.*

# MACMILLAN & CO'S.

# TEXT-BOOKS FOR STUDENTS.

**BALFOUR. A Treatise on Comparative Embryology.** By F. M. Balfour, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. With Illustrations. Second Edition, reprinted without alteration from the First Edition. In 2 vols., 8vo. Vol. I., $4.50 ; Vol. II., $5.25.

**COTTERILL. Applied Mechanics: An Elementary General Introduction to the** Theory of Structures and Machines. By James H. Cotterill, F.R.S., Associate Member of the Council of the Institution of Naval Architects, Associate Member of the Institution of Civil Engineers, Professor of Applied Mechanics in the Royal Naval College, Greenwich. Medium 8vo. $5.00.

**DANIELL. A Text-Book of the Principles of Physics.** By Alfred Daniell, M.A., LL.B., D.Sc., F.R.S.E., late Lecturer on Physics in the School of Medicine, Edinburgh. With Illustrations. Second Edition, revised and enlarged. Medium 8vo. $3.50.

"Prof. Daniell's book is unquestionably the best elementary text-book for advanced students that has as yet appeared in the English language, and while written especially with the view of adoption in medical colleges, is a valuable book to any school aiming to present the subject in a scientific and philosophical manner."—*The Chicago Tribune.*

**FOSTER. A Text-Book of Physiology.** By Michael Foster, M.D., Sec. R.S. Professor of Physiology in the University of Cambridge. With Illustrations. Fourth Edition, revised. 8vo. $5.50.

**GAMGEE. A Text-Book of the Physiological Chemistry of the Animal Body.** Including an Account of the Chemical Changes occurring in Disease. By A. Gamgee, M.D., F.R.S., Professor of Physiology in the Victoria University, the Owens College, Manchester. 2 vols., 8vo, with Illustrations. Vol. I., $4.50. [*Vol. II. in the Press.*]

**GEGENBAUR. Elements of Comparative Anatomy.** By Professor Carl Gegenbaur. A Translation by F. Jeffrey Bell, B.A. Revised, with Preface by Professor E. Ray Lancaster, F.R.S. With numerous Illustrations. 8vo. $5.50.

**GEIKIE. Class-Book of Geology.** By Archibald Geikie, LL.D., F.R.S. Profusely illustrated with woodcuts. 12mo. $2.60.

"We have no hesitation in declaring the book an excellent one, containing exactly such material as renders it especially fitted for instruction. More than that, to the person with no geological turn of mind, the whole matter is so well combined, and the explanation so simple, that by reading the volume, nature's action in the past, as in the present, can be better understood ; . . . will awaken on the part of the student curiosity and interest, for at once it can be seen how observation, generalization, and induction go hand in hand in the progress of scientific research."—*New York Times.*

**GEIKIE. Text-Book of Geology.** With Illustrations. Second Edition, revised and enlarged. 8vo. $7.50.

"A noble and masterly work."—*Christian Advocate.*

"In all respects a comprehensive and exhaustive text-book of geology ; discusses every phase of the science in the light of the latest researches and opinions, and is at once acceptable to the student and general reader."—*Philadelphia Times.*

**MUIR. The Elements of Thermal Chemistry.** By M. M. Pattison Muir, M.A., F.R.S.E., Fellow and Prælector of Chemistry in Gonville and Caius College, Cambridge ; assisted by David Muir Wilson. 8vo. $3.25.

**MÜLLER. The Fertilization of Flowers.** By Professor Hermann Müller. Translated and Edited by D'arcy W. Thompson, B.A., Professor of Biology in University College, Dundee. With a Preface by Charles Darwin, F.R.S. With numerous Illustrations. Medium 8vo. $5.00.

**PHILLIPS. A Treatise on Ore Deposits.** By J. Arthur Phillips, F.R.S., V.P.G.S., F.C.S., M. Inst. C.E., Ancien Elève de l'Ecole des Mines, Paris, Author of "A Manual of Metallurgy," "The Mining and Metallurgy of Gold and Silver," etc. With numerous Illustrations. 8vo. $7.50.

"In closing Mr. Phillips's volume we may congratulate him on having enriched our scientific literature with a contribution of substantial value, which will probably remain for many a day a standard work of reference on its peculiar subject. Nor will its use be limited to English students, for the author's wide knowledge of American ore deposits will probably render his book equally acceptable on the other side of the Atlantic."—*London Academy.*

**SMITH. A Dictionary of Economic Plants: Their History, Products, and Uses.** By John Smith, A.L.S., etc. 8vo. $3.50.

**VINES. Lectures on the Physiology of Plants.** By Sydney H. Vines, M.A., F.R.S. 8vo. With numerous Illustrations. $5.00.

**WIEDERSHEIM. Elements of the Comparative Anatomy of Vertebrates.** Adapted from the German of Robert Wiedersheim. By W. Newton Parker. With additions. Illustrated with 270 woodcuts. 8vo. $3.00.

**ZIEGLER. Text-Book of Pathological Anatomy and Patho-Genesis.** By Professor Ernst Ziegler, of Tübingen. Translated and Edited for English Students by Donald Macalister, M A., M.D., B.Sc., F.R.C.P., Fellow and Medical Lecturer of St. John's College, Cambridge, Physician to Addenbrooke's Hospital, and Teacher of Medicine in the University. With numerous Illustrations. Medium 8vo.

*Part I. GENERAL PATHOLOGICAL ANATOMY. $3.50.*
*Part II. SPECIAL PATHOLOGICAL ANATOMY. Sections I.—VIII. $3.50.*
*Part III. Sections IX.—XII. $3.50.*

**Macmillan & Co.'s new complete Classified Catalogue will be sent free, by mail, to any address on application.**

**MACMILLAN & CO., 112 Fourth Avenue, New York**

## PATENT AGENTS AND ATTORNEYS.

**DETROIT.**

A. Barthel. Jas. Whittemore.

THOS. S. SPRAGUE & SON, Solicitors of United States and Foreign Patents, No 37 Congress St. West, Detroit.

**TORONTO.**

PATENTS PROCURED IN CANADA, UNITED STATES and Foreign Countries. Donald C. Ridout & Co., Solicitors of Patents, 22 King Street East, Toronto.

**WASHINGTON.**

C. A. Snow. E. G. Siggers.

C. A. SNOW & CO., Solicitors of Patents, 710 G Street, N.W., opposite U. S. Patent Office, Washington, D.C.

**MONTREAL.**

F. H. REYNOLDS, Solicitor of Patents, and Expert in Patent Cases, Temple Building, St. James Street, Montreal. Agencies in Washington, London, and all chief cities.

J. EMILE VANIER, Civil and Hydraulic Engineer, Patent Solicitor, Imperial Building, 107 St. James St., Montreal.

**OTTAWA.**

A. HARVEY, C. E., Patent Attorney and Notary Public, Ottawa, Canada. Established 1884, with 20 years professional experience in Canada, England and Germany. Patents, Designs, Trade-marks, Copyrights, in Canada, United States, England and all foreign countries. Preliminary and Expert Examinations, Infringement Experting. Offices, 135 Sparks Street. Address, Postal Box 1071; Telegraph: Harvey. Bell Telephone 347.

## ELECTROTYPERS, &c.

**ENGRAVINGS**
**ELECTROTYPES**

Patentees write for Specimens
BISHOP'S
169 St. James Street,
MONTREAL.

## Industries!

A Journal of Engineering, Electricity and Chemistry

FOR THE

**MECHANICAL AND MANUFACTURING TRADES.**

**PUBLISHED EVERY FRIDAY.**

ANNUAL SUBSCRIPTIONS.

| | Thick Paper | Thin Paper |
|---|---|---|
| **Great Britain, Post Free,** - - | **$6.00** | **$6.00** |
| **The United States, Canada, and countries included in Postal Union, Post Free,** | **9.00** | **8.00** |
| **India, Ceylon, Straits Settlements, China, Japan, &c., Post Free,** - | **10.75** | **9.00** |

SUBSCRIPTIONS PAYABLE IN ADVANCE TO

**GEO. CAWLEY, 358 Strand, LONDON, W.C.**

MANCHESTER, 70 Market St.; GLASGOW, 93 Hope St.;
YOKOHAMA, (JAPAN) 32 Main St.

# HELLIWELL'S PATENT.

## GLAZING WITHOUT PUTTY!
AND
## ZINC ROOFING WITHOUT EXTERNAL FASTENINGS!

***Direct Importers of Vieille Montagne and Lipine Zinc.***

WATERTIGHT. FREE FROM RATTLE. SAVES ALL OUTSIDE PAINTING. NO DRIP FROM CONDENSATION. OLD ROOFS RE-GLAZED.

**30,000 ft. of old Putty Roofs have been Re-Glazed on this System. Extensively used by H.M. Government, and generally throughout the country for STATIONS, MARKETS, PICTURE GALLERIES, and every description of Roof and Horticultural Buildings.**

*References to most Eminent Engineers and Engineers of all the leading Railways. For particulars apply to*

**T. W. HELLIWELL, BRIGHOUSE, YORKSHIRE; AND 5 WESTMINSTER CHAMBERS, LONDON.**

**To preserve Wood against Decay, Dry Rot and Fungus.**
**To preserve Ropes and Leather against Weather.**
**To prevent Dampness in Walls,**

APPLY

# CARBOLINEUM AVENARIUS

REGISTERED.

Used with immense success by Military Authorities, Boards of Works, Railway Companies, Tramways, Mines, Engineers, Builders Contractors, Public Gardens, Estates, Breweries, &c.

***For Prices and Particulars apply to***

## PETERS, BARTSCH & CO., DERBY, ENGLAND.

**Carbolineum Avenarius can only be had from Peters, Bartsch & Co., or their Authorized Agents.**