THE JOURNAL

OF THE

Board of Arts and Manufactures

FOR UPPER CANADA.

FEBRUARY, 1866.

ECONOMY OF FUEL.

In the production of heat for domestic or other purposes, we are under that universal and inexorable law of nature which provides that we cannot make anything from nothing. However much we can control, modify or convert the substances and forces which are in existence around us, and make them available for our convenience and comfort, we can create nothing; but must have a substantial original to work with. Every unit of heat produced requires the combustion of a proportional amount of fuel. A table of the heating power of various combustible substances is given from Dr. Ure, on page 272, Vol. V. of this Journal; and by proper combustion these amounts of heat can be obtained from them. No ingenuity can make them produce more than is due from them; but it is generally the case that through ignorance, carelessness or negligence, fuel is dissipated without obtaining from it nearly the amount of heat which it is capable of giving, and without utilizing a great part of what is obtained. There is no necessity that this should be so. Of course there are requirements of elegance and convenience which exclude from some apartments the apparatus needed for producing and utilising all that might be; but in most circumstances we may with proper appliances obtain and use nearly all the heat the fuel is capable of giving. When we hear of the vast amount of mechanical energy which is represented by the heat derived from a given amount of fuel, and find that the best Cornish steam engines are capable of realising but one tenth part of this energy, we may be led to infer that we may not be able to realise more than a proportional amount of heat; but this is not the case, for, by the great care and attention given to the construction and feeding of the furnaces of these engines, very near the amount of evaporative power due from the fuel is obtained: the deficiency in mechanical effect is owing to the peculiar nature of the medium by which the heat is brought into mechanical action, which we will explain before we conclude.

In order to obtain the full heating effect of fuel, it is necessary that it be wholly and properly burned; that the whole oxydisable part of it be united with its proper quantity of oxygen. Whatever combustible gas or solid matter passes away unburnt, is so much of the fuel actually lost. The smoke from coal is an example of this, and many have been the efforts to prevent this loss and to avoid the disagreeable presence of smoke in the atmosphere. Many in burning smoke have not succeeded in obtaining from its combustion any addition of heating effect, whilst others have sustained actual loss by it. The most common and easy method of burning smoke has been to allow large quantities of cold air to pass over the fire, and mix with the vapours as they pass from it; but in steam engine furnaces the cooling effect of this large body of air has overbalanced the heating effect of its combustion. A president of a Society of Engineers in Scotland is reported to have stated that "coals were burned most economically when producing the blackest smoke in an ordinary steam boiler." But it is absurd to suppose that the heat derived from the burning of a part of the fuel can be greater, or even equal to that from the whole of it if properly burned; we must therefore assume that the loss, if any, must be from improper combustion. There are many complicated chemical processes involved in the combustion of fuel, and it is difficult to ascertain the precise effect of each of them. It frequently happens, from our inattention to these processes, that the heat generated in one part of the fire is wasted in another part. For instance, when fresh coal is put upon a fire in certain circumstances, as much and sometimes more of the original heat of the fire is used to distil the volatile part of the new fuel, as the subsequent combustion of its vapours will produce; indeed, it has been supposed by some, that the heating value of coal may be expressed by that of the quantity of coke which can be made from it. This, however, is an error, for 1 lb. of coal will make ⅔ lb. of coke, and by referring to the table, p. 272, Vol. V., we find that 1 lb. of coal will evaporate 10·90 lbs. of water, whilst ⅔ lb. of coke will evaporate but 8·86 lbs. We shall probably be near the truth if we say that loss is caused by burning the volatile part of the fuel by halves, first expending so much heat in making the smoke, and afterwards using too much cold air to burn it; and that our effort should be, not so much to burn smoke, as to burn fuel without producing smoke. To do this we must not only have a properly arranged fireplace, but must give constant attention to the fire. Almost perfect combustion of fuel is effected in some large steam furnaces, where attention to the fire in each of them is the whole duty of one man; but domestic fires are apt to be neglected, the proper time for their replenishment is not observed, and the fuel is not supplied in proper quantities. In such circumstances the best constructed fire-places will not prevent smoke. However, the following rules will apply, both to the construction of the fire-place, and the manner of using fuel. Let the fire be small and vigorous rather than large and slow. Let it have a good horizontal area, and not too much depth. Let it be well supplied with air in every part. Let fresh fuel be put on in small quantities and small pieces, and when there is a strong heat in the fire. It is a well-established fact that a proper quantity of heat cannot be obtained from fuel except it be vigorously and rapidly consumed. When it is brought at first in contact with a strong heat, and sufficient air, the heavy hydro-carbon vapours are not formed, the coal is burned at once, and the double process of combustion of its volatile parts, is avoided. Gas manufacturers understand this principle, and always charge their retorts when at a cherry red heat, and a readily combustible gas is produced; a lower heat would give a large quantity of heavy, hardly combustible vapour.

The method of working steam furnaces to produce the best effect, is to feed a little at a time, and often; and to spread the fuel evenly over the grating. It is by these means that the Cornish steam furnaces produce such excellent effect. Anthracite coal and coke require attention to the above rules, as well as bituminous coal, for, although they give no black smoke, they are subject to waste of another kind when burnt slowly and in deep fires. When anthracite coal, coke, or any other form of carbon is perfectly burned, the product of combustion is carbonic acid ($C\,O_2$), that is, one atom of carbon combined with two of oxygen, and the full quota of heat is given out; but carbon can be united with oxygen in another proportion, forming carbonic-oxide ($C\,O$), or one atom of carbon with one of oxygen, when much less heat is evolved—it is said only one-fifth of that due from its perfect combustion. This wasteful product is formed, more or less, in all fires, more in those that have great depth, or are insufficiently supplied with air. It is supposed to be formed, not directly by the union of carbon with the oxygen of the air, for this always forms carbonic acid; but by the carbonic acid formed at the lower part of the fire passing through the red hot coals above and taking from them another atom of carbon, and thus becoming carbonic oxide; but in the process it destroys a large quantity of the heat already generated, and if it pass away without combustion, will be the means of much loss. Carbonic oxide is, however, a combustible gas: it is that which is seen burning with a beautiful blue flame, at the top of a brisk fire of red coals, when sufficient air is supplied there to burn it, it having been formed in the fire by the process above described. A beautiful example of utilising this property of carbon is shown in the furnaces for calcining copper ore in Wales, in which a strong flame, which is required for that process, is obtained from anthracite coal, which burns naturally with scarcely any. A description of these furnaces, with diagrams, is given in Tomlinson's Encyclopædia, article "Copper," which is well worth a study. In order to prevent waste in our ordinary fires by the carbonic oxide, it is necessary to supply plenty of air all through the fuel, also some at the top to burn the gas as it passes from the fire; and also to avoid too great depth of fire, so as to give less opportunity for its generation.

Before leaving this part of the subject, we will call attention to a sanitary danger in burning carbon slowly, and without a sufficiently rapid draught of chimney. It is said that in such circumstances there is a continual flow of carbonic acid gas from the stove into the apartment, poisoning the air. Some of the so-called fuel economising stoves have produced more evil, by this means, than any saving of fuel can compensate for. For more full information on this subject, we would refer our readers to Dr. Ure's dictionary of Arts, Manufactures and Mines—articles "Chimney" and "Stove."

Fuel is subject to waste by water being contained in it when burnt, as such water is converted into steam, which passing off carries with it its latent heat. Wood, as it is generally used, contains much water: in that newly felled, as much as 50 per cent.; and after being felled a year, sometimes as much as 20 per cent. Thus, if we suppose 5 lbs of wood in its ordinary state to contain 20 per cent. of water, that is 1 lb., it will require, to evaporate this water, according to our table, more than one-fifth of the heating power of one pound of the wood, or more than 4 per cent. of the whole, and the larger the amount of water the larger proportion of the heat of the fuel is spent in evaporating it—hence dry wood is the most economical.* We hear from time to time of plans to use water as a fuel: it is assumed by the projectors of such plans that, as water is a compound of hydrogen, and as hydrogen is highly combustible, water may in some way be made to burn. A

* Newly felled or partially green wood gives out a greater amount of heat than very dry wood: this arises from the fact that in almost all dry wood used for fuel, decay has commenced, and consequently its heat-giving power is diminished.

little reflection upon the nature of combustion will shew us the fallacy of such plans. The burning of hydrogen is its union with oxygen, and the product of this union is water. Water is burnt hydrogen just as carbonic acid is burnt carbon; and in order that either the hydrogen or the carbon may be burnt again, they must be unburnt; that is, the oxygen must be separated from them. This is done when, by means of sulphuric acid and zinc, hydrogen is evolved from water in the ordinary way of producing hydrogen gas, and when the sun light in vegetable growth separates carbon from the air. Hydrogen may also be separated from oxygen by electricity, heat and other means, and afterwards used as fuel; but this is not using water as fuel, but only one of its component parts; and it requires just as much heat force, or its equivalent in electricity or chemical action, to effect the separation, as will be given out by its after combustion. This law of conservation of force might be brought to bear upon many other fallacious proposals. Any fuel which is joined to its proper quantity of oxygen cannot be combustible again, until as much force, of some kind, has been used for its separation from oxygen as is equivalent to the heat which will be evolved upon its recombustion.

We proposed to explain why so small a proportion of the mechanical energy contained in fuel is realized in that form by the steam engine. The deficiency is usually attributed to imperfection in machinery, loss by radiation, &c., but there is a large residue of heat inseparably connected with the use of steam as a mechanical agent, which no perfection of machiney can convert into mechanical force, but which may be utilized for general heating purposes. In the conversion of water at 212° into steam at the same temperature, having a pressure equal to that of the atmosphere, as much heat is required as would have raised the water, had it remained such, say 1000°. Now the whole mechanical effect which can be obtained from steam at this pressure, is by atmospheric re-action upon its condensation. Any pressure exerted by steam against the atmosphere, must be by heat applied to it in addition to that of its conversion. If steam at any pressure whatever be introduced to the cylinder of a steam engine in such quantity that, when worked expansively, it shall have at the end of the stroke a pressure balancing that of the atmosphere, we then have a cylinder full of steam which has cost to produce it the equivalent of its latent heat, but which can only produce the mechanical effect due from atmospheric pressure upon its condensation. By putting these into figures, we shall see the reason of the main discrepancy between *heat cause* and *mechanical effect*, in the steam engine, and also the theoretic principle upon which it can be reduced. Let us suppose a cylinder one foot high, holding one pound of steam, the bulk of which will be 47,001 cubic inches. Its horizontal area will be (omitting fractions) 3,916 square inches. If we take the pressure of the atmosphere as 15lbs. on the square inch, the force exerted by it upon condensation of the steam will be equal (leaving out the bulk of the resulting water, which is trifling) to 58,740lbs. raised 1 foot high. The amount of heat required to convert a pound of water into a pound of steam is equal to that required to raise 1000lbs. of water 1° Far.,* or 1000 units of heat; each unit is equal to the mechanical force required to raise 772lbs. 1 foot, therefore the mechanical energy taken from the fuel by the pound of steam is equal to 772,000 foot pounds, or more than 13 times the effect produced. There is a constant residue of 713,260 foot pounds of energy passing away unused for every pound of steam which is condensed in the engine, even when worked to the utmost expansion. Of course there is more in non-condensing engines, and still more proportionally as steam is emitted at higher pressure. Whatever amount of latent heat and elastic force remains in the steam at the end of the stroke is of no further mechanical use, except for the atmospheric reaction it will cause if it is condensed. It is so much of the energy from the combustion of the fuel lost, unless it can be applied to the purpose of heating an apartment, boiler, or some other object. The theoretic principle upon which the discrepancy between the value of the fuel used, and the mechanical effect produced may be reduced, is to increase the proportion of active to latent heat in the steam, either by bringing it to a high pressure by additional heat in the boiler, or by superheating it after it is cut off from it, and to work it to the utmost limit of expansion. Steam once made, having absorbed its latent heat, or perhaps more properly speaking, its constructural force, from the fuel, is subject to laws of expansion by heat which allow of more satisfactory mechanical results. Air has this theoretic advantage over steam—as a mechanical medium for heat—it is found ready made, requiring no latent heat to produce it, but is ready upon the first application of heat to expand with force.

*We select from the various estimates of the latent heat of steam that of 1000°, because it is a round number and more easily worked in our calculation. It is near the average of them However, a few degrees of difference will not materially affect the result.

IDLENESS travels very leisurely, and poverty soon overtakes it.

Board of Arts and Manufactures

FOR UPPER CANADA.

TRADE MARKS.

Trade Marks registered in the office of the Board of Registration and Statistics, Ottawa, and open for inspection at the Library of this Board:

Canadian Rubber Co., per D. Girouard, Montreal, "India Rubber Goods." It consists of a piece of Red Thread woven in the elastic webbing when in process of manufacture. Vol. A, folio 86, No. 46. Dated December 18th, 1865.

Lyman, Clare & Co., Montreal, "Lyman's Universal Pain Killer." Vol. A, folio 90, No. 17. Dated January 11th, 1866.

Otis Sikes, Montreal, "American Life Drops." Vol. A, folio 92, No. 26. Dated January 26th, 1866.

ANNUAL MEETING OF THE BOARD.

TORONTO, Tuesday, Jan. 16th, 1866.

The Annual Meeting of the Board, adjourned from Tuesday the 2nd inst., was held in the Board Rooms, Mechanics' Institute, at Two o'clock P.M. The Members present who recorded their names in accordance with the by-laws, were: Professor Buckland, W. H. Sheppard, Richard Lewis, J. Carty, Daniel Spry, H. Langley, H. E. Clarke, W. P. Marston, Rice Lewis and W. Edwards, of Toronto; T. Sheldrick, of Dundas; and J. Shier and M. Harper, of Whitby.

A telegram from the President, Dr. Beatty, was read, stating that the Grand Trunk morning train was so far behind time, that it would not be possible for him to be present at the meeting; the same cause would necessarily prevent the attendance of Mr. E. A McNaughton, of Cobourg.

A letter was read from the Vice-President, Professor Hincks, stating that professional duties would prevent his attending the Meeting.

On motion of Mr. Sheldrick, Professor Buckland was called upon to preside.

Certificates of Mechanic Members, and of appointment of Delegates, were submitted from the Toronto and Whitby Mechanics' Institutes, duly attested.

The Minutes of the previous Meeting of the Board were read, and signed by the Chairman as correct.

The Secretary read correspondence with the Assistant Minister of Agriculture, on the subjects referred to in last Annual Report; also on the Act to amend chap. 32 Con. Stat. of Canada, on official returns to the Bureau of Agriculture, on British Patent Office Publications, on the intention of the Government relative to the Paris Exhibition, &c.; with J. A. Perrault, Esq., M.P.P., and the Hon. David Christie, on amendments to the Patent Laws; with J. Cowan, Esq., M. P. P., and the Hon. David Christie, on amendments to chap. 32 Con. Stat. of Canada, for the encouragement of Agriculture, Arts and Manufactures; and with the Chairman of the Council of the Society of Arts, London, on an unsettled claim for balance due this Board.

The correspondence, and action had thereon by the Sub-Committee,* was approved.

The Report of the Sub-Committee for the past year was then read by the Secretary, with Treasurer's balance sheet, and analysed statement of expenditure.

On motion of Mr. Shier, seconded by Mr. Sheldrick, the Report was received and adopted.

Moved by Mr. Rice Lewis, seconded by Mr. Shier, and *Resolved*,—

That Mr. Carty and Mr. Spry be requested to audit the accounts for the past year.

Moved by Mr. Sheldrick, seconded by Mr. Rice Lewis, and *Resolved*,—

That J. Beatty, Esq., M.D., Cobourg, be re-elected President for the ensuing year.

Moved by Mr. Spry, seconded by Mr. Rice Lewis, and *Resolved*,—

That Professor Buckland be elected Vice-President of the Board for the ensuing year.

Moved by Mr. Shier, seconded by Mr. Harper, and *Resolved*,—

That Mr. W. Edwards be re-elected Secretary-Treasurer for the ensuing year.

On motion of Mr. Shier, the Chairman and Secretary were appointed Scrutineers, when nominations were made, and the ballot taken, for the election of a Sub-Committee, which resulted in the following gentlemen being selected:—John Shier, Whitby; T. Sheldrick, Dundas; H. Langley, W. H. Sheppard, H. E. Clarke, Daniel Spry, Richard Lewis, J. Carty and W. P. Marston, Toronto.

Moved by Mr. Shier, seconded by Mr. Clarke, and *Resolved*,—

That the thanks of this Board be tendered to Dr. Beatty, for the able and zealous manner in which he has discharged the duties of President of this Board during the past year, and that the Secretary communicate the same to Dr. Beatty.

Moved by Mr. Sheppard, seconded by Mr. Langley, and *Resolved*,—

That the thanks of the Board be tendered to the Rev. Professor Hincks, for the manner in which

* The Sub-Committee is the designation given the Executive Committee in the Statute. It is an anomaly which the amended act purposes to correct.

he has performed the duties of Vice-President during the past year.

Brief discussions took place on the subject of the Paris Exhibition of 1867, and the Hon. Mr. McGee's contemplated visit to meet this Board and the Board of Agriculture, in this city, which was finally referred to the Sub Committee elect, to take such action thereon as may be necessary.

On motion of Mr. Shier, the Board adjourned.

THE ANNUAL REPORT.

At the close of their term of office, the Sub-Committee beg to submit the ninth Annual Report, being an abstract of proceedings for the past year.

The following Institutions and Associations have been represented on the Board: Ayr Mechanics' Institute, by one delegate; Cobourg, by two delegates; Dundas, by its President; Guelph, by three delegates; Hamilton, by its President and seven delegates; Toronto, by its President and nine delegates; Whitby, by three delegates; the Toronto Board of Trade by one delegate; the Toronto University College, by Rev. W. Hincks, F.L.S., Professor of Natural History, and G. Buckland, Esq., Professor of Agriculture.

Your Committee, following in the course of their predecessors, express regret that so little has been accomplished during the year. This has arisen from no lack of interest in the important duties which, under the Statute, devolved upon the Board; but, rather, from the want of funds where-with to carry them out. While exercising a general interest in the improvement of the Arts and Manufactures of the Province, the matters so far taken up by the Board, are, its excellent Library of Reference, its monthly Journal, and the Annual Examination of Members of Mechanics' Institutes in certain Studies. The other subjects contemplated by the Statute, or otherwise desirable, are, 1st. The establishment of a Museum of Canadian and Foreign choice Manufactures, and of natural and prepared substances adapted for Manufacturing purposes; 2nd. The establishment of a School of Arts, embracing in its three divisions (*a*) *Natural Philosophy and Chemistry*; (*b*) *Drawing, Designing and Modelling*; (*c*) *Practical Mathematics*. 3rd. The awarding of medals and other prizes to successful candidates at the Annual Examinations. 4th. Assisting the various Mechanics' Institutes, and similar Associations, in the Province, to organize and successfully carry out a system of evening class instruction for adults and others engaged in industrial pursuits, by furnishing them examples, models, or even pecuniary assistance. 5th. The awarding of prizes for useful discoveries and improvements, and for essays or papers upon industrial subjects of importance to Canadian interests. These, and various other matters, might be advantageously taken up by the Board; but with a Legislative grant of but $2,000 per annum (and no other financial resources), to cover rent, salary of Secretary, and keep up the departments already in operation, it is utterly impossible to do more than is now being done.

Your Committee would again urge upon the Government the desirability of affording the Board means sufficient to carry out the scheme of a SCHOOL OF ARTS, so admirably reported upon by a special Committee of the Board, and included in the last year's Report. Such a school could be conducted, as was demonstrated by the special Committee, for a sum of not over $2,000 per annum —the present Board Rooms being well adapted for the purpose, without involving any increased expense for rent. About $2,000 more per annum —say $6,000 a year in all—would enable the Board also to carry out all the other objects above indicated; and, considering the importance of the manufacturing interests to the prosperity of the Province, it cannot be said that a grant of $6,000 per annum each for Upper and Lower Canada, would be an unreasonable sum.

Your Committee is prepared to admit, that, the interests of Agriculture are vastly greater than those of manufactures, in a new country like Canada; but, if these interests are so much greater, so are the natural advantages and facilities for the pursuit and success of Agriculture; yet, with all these natural advantages and more mature development, it is annually receiving assistance in Legislative grants of upwards of $100,000, while the interests of Arts and Manufactures are only encouraged to the amount of $4,000 per annum for both sections of the Province; and if we turn our attention to other interests and Associations, what do we find? Why, that each of the learned professions receives from 20 to 40 times as much per head, from Legislative aid, as mechanics do for like objects.

It may be said that our Universities and Colleges are open to mechanics as well as others, and that they therefore participate in the liberal grants to and endowments of these noble Institutions. Your Committee cheerfully admit that they are as open to the sons of mechanics and manufacturers as to any other classes, but, if taken advantage of by such, it is to educate them for some one or other of the learned professions. The fact of a graduate of a University or College following any of the various mechanical pursuits, is almost, if not entirely, unknown amongst us; so that it is literally true, that, our industrial or producing classes do not benefit directly by these liberal endowments; nor is there any system of instruction organised or provided for, either from public or private sources, specially adapted to the education of the mechanical and manufacturing classes, except the very small grants of $2,000 each to the two respective Boards of Arts and Manufactures for Upper and Lower Canada—an amount so small that the benefits resulting are but slightly perceptible.

Your Committee believe that well organised Mechanics' Institutes established in different sections of the Province, receiving Legislative grants as formerly, and expending them in a well prepared scheme of instruction, under the supervision of these Boards, would effect a great amount of good in the education of those for whom intended.

As a usual practice, boys intending to follow mechanical pursuits, commence their terms of apprenticeship or service at from 12 to 14 years of age, prior to which time they but little appreciate the kind of studies most profitable for them, so that evening class instruction is the only kind to reach or benefit them; and here it is that the Legislature should step in and give them every possible encouragement, by enabling the Institutions to hold out inducements to them in the way of good teachers, comfortable class-rooms, good models and examples, and, when deserving, money or other prizes.

The Mechanics' Institute of Toronto, has, for some years past, had a well organised system of class instruction in operation during the winter months. Good teachers, and an average of about 120 pupils each session, have been secured, and the following subjects taught:—English Grammar and Composition, French, Free-hand and Architectural and Mechanical Drawing, Arithmetic and Geometry, Book-keeping and Penmanship, and occasionally Elocution and Phonography. The Whitby Institute has also for two or three years past had classes established for similar studies—both Institutions conducting them with a marked degree of success, which is evidenced by the number of Candidates submitted for the final Examinations of the Board. If the various Institutions in the towns and villages had the means of establishing similar classes, and to these could be added Chemistry and Natural Philosophy, more would be done to educate the subjects of these remarks than can be accomplished by all the existing organizations of the Province, and at a cost but trifling in amount.

Your Committee avail themselves of the following extracts from an article in the *Montreal Gazette*, on this subject:—

"There is one special branch of education to which we believe it is most desirable some public attention should be directed. In the great hives of industry in Britain, by means of local subscriptions, Mechanics' Institutes have been founded, calculated to give the apprentice and journeyman mechanic, by means of evening classes and access to libraries, an opportunity to eke out the defective education which the poverty of his childhood had stopped all too soon. By this sort of education, it has been aptly said, the mechanic was made a better man. But there was another aspect of the case which has of late been taken up alike by the British Parliament and Government and by associations of wealthier men. There was felt to be a need to make the factory operative or mechanic acquainted with the rudiments of science and art, thereby to make the man a better mechanic. It was felt that a knowledge of the principles of chemistry and mechanics, and of applied science generally, would be a great boon to them, thus making them more valuable producers and by so much enriching the resources of the country. The governments of most Continental States had already done this, and in many of the great manufactories of Britain foreign chemists were employed in the laboratories, or foreign operatives in the kinds of work requiring such special scientific knowledge. Under the fostering care of the late Prince Consort, the Society of Arts undertook to bring the different Mechanics' Institutes and Workmen's Colleges into connection, to induce them to work on a system, and, by offering rewards and prizes, to induce them to teach their members these things, needful for their advancement to a proper status. This work of the Society has been supplemented by Science Schools, established throughout the country with the assistance and under the superintendence of the Government itself, by its Committee of Privy Council on Education. In another respect—in artistic merit, and beauty of design, foreign manufactures had long surpassed the British. Government has stepped in, and, by the establishment of art schools and schools of design, has trained up men who have immensely enhanced the value of British manufactures by adding to their beauty. As our manufactures are growing year by year to be very considerable, so our Government ought to take a similar care that our mechanics and factory operatives shall be made better men by access to free evening classes and free libraries; that the men shall be made better mechanics by special educational facilities in respect of art and applied science. This is the more needed in a small community without large capital, which requires special excellence in its workmen and special excellence or cheapness in its wares to win manufacturing success. The common schools are very well in their way, doubtless, but boys only get a sip of elementary instruction ere they are sent into the workshop to earn their bread. If the Government fosters these common schools, it ought also to foster those evening classes (and the institutions which establish and keep them up) where the industrious and intelligent apprentice or journeyman is enabled to carry forward his education." .

Your Committee need scarcely refer to the benefit to art manufactures and art workmen, secured by the active and liberal encouragement afforded by the British Government, during the last few years. When the first International Exhibition was held in London, in the year 1851, the art manufacturers and designers of Great Britain held but a very inferior position, as compared with France and some other continental countries; her statesmen, however, determined that this inferiority should not continue to exist, and at once established a SCIENCE AND ART Department, with affiliated schools, well supplied with models and examples, and competent certified teachers, in all the manufacturing centres of Great Britain, and what was the result? Why, at the next Industrial Exhibition, held in London, in 1862, the Commissioners representing the French Emperor reported to His Majesty that the art manufacturers of England were not only equal, but in many respects superior, to the French workmen. So much was accomplished in the short space of eleven years, by a judicious organization and expenditure of money, for that purpose; and what was done in Britain may be done here, with a proportionate success.

Having made these general remarks on the objects and aims of the Board, we now turn to its more immediate details.

The Library of Reference.

At last Report the Library contained in all 1273 volumes, and there has since been added 69 volumes, namely:—by purchase 36, Scientific and other journals bound up from the table 20, Parliamentary Publications and Transactions of Societies 19, making a total of 1342 volumes, now on the shelves. These comprise Patent Publications 588 volumes; Statutes and other Parliamentary Publications 174; Transactions of Societies 37; Architecture and Building, Dictionaries, Decoration, Encyclopedias, Engineering and Mechanics, Manufactures and Trades, and General Science, 543 volumes. Of the donations your Committee desire to acknowledge 2 volumes from the Board of Agriculture of U. C.; 1 volume from the U. S. Commissioner of Patents; and Statutes and other Parliamentary publications from the respective heads of Departments of the Provincial Government.

The Library has been kept open FREE to the public, from 10 a. m. to 4 p. m., daily, and from 7 till 10 o'clock every Tuesday and Friday evening.

It is to be regretted that the funds of the Board would not allow of a much larger addition to the number of volumes during the year; but, nevertheless, the collection is a most valuable one, and affords information on almost every practical question, as well as on general subjects.

Your Committee have reason to fear an early removal to Ottawa of the valuable Publications of the British Patent Office, placed in charge of this Board by the Bureau of Agriculture, at the time the seat of government was in the city. Should the removal take place, it is recommended that the Board take prompt action to procure another set, as the absence of a copy of this valuable work west of the city of Ottawa will be a public loss.

Annual Examinations.

Nine candidates only presented themselves for examination in the past year, in five different subjects of study; a full report of which, with the certificates awarded, was published in the August number of the *Journal.*

The various Institutes have already been notified of the Examinations for 1866.

The "Journal."

Your Committee continued to issue the same number of copies monthly as in the previous year, the funds of the Board not allowing of a larger issue. It is, however, gratifying to know that the annual loss on its publication for the past two years has been one-half less than in former years.

Your Committee have again to record their entire satisfaction with the manner in which the Journal has been conducted by your Secretary, Mr. Edwards; and as he has performed the duties of Editor so acceptably, have made a donation of $100 to him, as a substantial approval of his successful labours, agreeably to the suggestion of last year's Report.

Amendments to Acts of Parliament.

Your Committee had hoped that the new bill, so long before Parliament, would have passed, during the last session; but owing to differences existing relative to the agricultural portion of it, it has again been passed by. A short bill of amendments was passed, principally affecting the Lower Canada Board, which will be found published in the *Journal* for the present month.

The amendments to our Patent Laws have been postponed, until such time as the proposed Confederation of the Provinces is settled one way or the other. Should confederation take place, the right of patentees will be much enhanced in value.

Dublin International Exhibition.

Your Committee have great pleasure in drawing attention to the success attending the representation of Canada at the late Dublin Exhibition, as evidenced by the large number of medals and honorable mention awarded to Canadian exhibitors. This is especially gratifying to your Committee, considering the small amount of funds, and the very limited time at the disposal of the Committees of selection.

Full details having already been published in the Journal, a more extended reference is not here deemed necessary.

The Paris Exhibition of 1867.

The opening day of this Exhibition is fixed for the 1st of April, 1867; and to close on the last day of the October following. An Order in Council of our Provincial Government declares that it is intended to cause a proper representation of Canadian products to be sent to Paris; for which purpose a correspondence has been begun with the British Commissioners, through whom alone contributions from the colonies will be received, and all communications made. The time fixed for receiving the goods at the Exhibition building is from the 15th of January to the 10th of March, 1867.

Your Committee are not yet aware of what arrangements are to be made for the selection and transmission of goods, but no doubt full information will shortly be published by the Government. The Provincial Exhibitions to be held in Toronto and Montreal, in September next, would seem to afford suitable opportunities for making such selections.

Finances.

The Secretary-Treasurer's detailed statement, herewith submitted, shews, total receipts for the year, including a balance of $831.68 from previous year of $3,197.06; expenditure, $2,124.17; leaving a balance in hand of $1,072.89. In addition to this balance, there are assets, as subscriptions, &c., due on *Journal*, to December 30th, 1865, of about $150; leaving a balance in favour of the Board of about $1,222.89, available to meet current expenses to 30th of June next, should the whole of the last named amount be collected.

All which is respectfully submitted.

John Beatty, M.D.,
President.

MEETING OF SUB-COMMITTEE.

The first meeting of the Sub-Committee for the year was held at the Board rooms, on Wednesday the 24th of January. The members present were the President, Dr. Beatty; the Vice-President, Professor Buckland; and Messrs. J. Shier, H. E. Clarke, W. H. Sheppard, W. P. Marston, D. Spry, and H. Langley.

Copies of the report and proceedings of the Annual Meeting were submitted, and laid on the table.

Moved by Mr. Shier, seconded by Mr. Spry, and *Resolved*—That Messrs. Professor Buckland, W. H. Sheppard, H. Langley, H. E. Clarke, and W. P. Marston, do constitute the Book and Journal Committee for the year.

Moved by Mr. Sheppard, seconded by Mr. Clarke, and *Resolved*—That Messrs. Prof. Buckland, Richard Lewis, and D. Spry, do constitute the Committee on Examinations for the year.

The Secretary read from the Montreal *Gazette* the proceedings at a meeting of the Hon. the Minister of Agriculture with the Committee of the Lower Canada Board of Arts, in reference to the proposed Paris Exhibition of 1867; and stated that the Hon. Mr. McGee was to be in town this evening, and would no doubt expect to meet this Committee on the same subject. After some discussion the President and Secretary were deputed to wait upon Mr. McGee, to ascertain at what hour it would be convenient for him to meet the Committee, which then adjourned, subject to the call of the President.

Thursday, the 25th, 2 o'clock, p.m., the Committee again met. Mr. Carty, a member of the Committee, was also present, in addition to the members present at the previous meeting. There were also present Mr. R. L. Denison, Treasurer, and Mr. Hugh C. Thomson, Secretary, of the Board of Agriculture.

Mr. McGee said he had recently had an interview with the Committee of the Board of Arts and Manufactures for Lower Canada, the members of which urge as the most desirable course that a Union Exhibition for all Canada be held at some convenient place, from which selections might be made of suitable articles—he, Mr. McGee, did not desire at present to express his opinion as to whether the proposed or any other plan would be best; but would first request an expression of opinion from this and the other Boards interested —he might say, however, that should an exhibition be determined upon, the several Boards would have to take the entire financial responsibility; as funds would not be appropriated except for the purchase and transmission of goods.

The honorable gentleman stated that information had been received by the Government, that Canada would be allotted a limited space in that portion of the building apportioned to the United Kingdom, and that selections of very bulky articles would have to be avoided.

The conversation resulted in an expression of opinion by the members present, wholly averse to the holding of a preliminary exhibition, or exhibitions, for the selection of goods, for the following reasons, 1st. That it would seriously interfere with the success of the Provincial Exhibition, to be held in Toronto, in September next; 2nd. That suitable articles in Arts and Manufactures could not be obtained from any such exhibition; but that the better course would be to prepare a full list of such articles as it would be desirable to send to Paris from each section of the Province, and that the respective boards be then authorised to contract with competent parties for their supply With regard to agricultural products, it seemed to be the general opinion that they may be selected with advantage from the respective Provincial exhibitions.

It was finally arranged that the Presidents should, as far as possible, ascertain the views of their respective Boards, and afterwards meet the Minister of Agriculture at Ottawa, some time during the first week in February, of which they are to be notified by telegram.

The honorable gentleman's attention was then called to the Free Library of Reference belonging to the Board, a hasty examination of which was all time would allow. The President requested that the valuable British Patent Office publications may not be removed from the charge of the Board; or, if removed, that the Board may be assisted in procuring another set. Mr. McGee said he could make no promises other than that the matter should have his best attention. The interview then terminated.

The Committee subsequently adopted suggestions for the guidance of their President at the proposed meeting at Ottawa, and then adjourned.

W. Edwards,
Secretary.

NEW BOOKS ADDED TO THE FREE LIBRARY OF REFERENCE.

Shelf No.

T. S.—Board of Agriculture of U. C., Transactions of, 1860–3.

K. 53.—Blinn. A Practical Workshop Companion for Tin, Sheet-iron, and Copper-plate Workers: containing Rules for describing various kinds of Patterns; Practical Geometry; Mensuration of Surfaces and Solids; Tables of the Weight of Metals, etc. By J. Blinn. With numerous illustrations.

H. 70, 71.—Bishop. A History of American Manufactures, from 1608 to 1860; exhibiting the Origin and Growth of the principal Mechanic Arts and Manufactures, from the earliest colonial period to the present time. By J. Leander Bishop, M.D.

K. 51—Bookbinding: a Manual of the Art of Bookbinding; containing full instructions in the different branches of Forwarding, Gilding, and Finishing. Also, the Art of Marbling Book-edges and Paper. By James B. Nicholson. Illustrated.

H. 65.—Bullock. The Rudiments of Architecture and Building; for the use of Architects, Builders, Draughtsmen, Machinists, Engineers, and Mechanics. By John Bullock. 250 engravings.

K. 50.—Burgh. Practical Rules for the Proportions of Modern Engines and Boilers for Land and Marine Purposes. By N. P. Burgh.

H. 69.—Byrne. The Practical Metal Worker's Assistant: comprising Metallurgic Chemistry, and the Arts of Working all Metals and Alloys; Soldering and the most Improved Processes, and tools employed by Metal Workers, with the Application of the Art of Electro-Metallurgy to Manufacturing Processes. By Oliver Byrne. With 592 engravings.

H. 67.—Byrne. The Handbook for the Artisan, Mechanic, and Engineer. By Oliver Byrne. Illustrated by 11 large plates and 185 wood engravings.

H. 68.—Byrne. The Practical Model Calculator for the Engineer, Mechanic, Manufacturer of Engine Work, Naval Architect, Miner, and Millwright. By Oliver Byrne.

H. 72.—Campin. A Practical Treatise on Mechanical Engineering: comprising Metallurgy, Moulding, Casting, Forging, Tools, Workshop Machinery, Mechanical Manipulation, Manufacture of Steam Engines, &c., &c. With an Appendix on the Analysis of Iron and Iron Ores. By Francis Campin, C.E., President of the Civil and Mechanical Engineers' Society, &c. To which are added the Management of Steel, including Forging, Hardening, Tempering, Annealing, Shrinking, and Expansion; and the Case-hardening of Iron. By George Ede. Illustrated with 29 plates of Boilers, Steam Engines, Workshop Machinery, Change Wheels for Screws, &c., and 100 wood engravings.

L. 39.—Cabinet Maker's and Upholster's Companion. By J. Stokes. With illustrations.

N. 5.—Clough. The Contractor's Manual and Builder's Price.book, designed to elucidate the method of ascertaining correctly the Value and Quantity of every description of Work and Materials used in the Art of Building, from their Prime Cost in any part of the United States; with Tables, Memoranda, &c. By A. B Clough, Architect.

—— Dussauce. Treatise on the Coloring Matters derived from Coal Tar: their Practical Application in Dyeing Cotton, Wool, and Silk; the Principles of the Art of Dyeing and the Distillation of Coal Tar; with a description of the most important New Dyes now in use. By Professor H. Dussance, Chemist.

L. 42.—Dyer and Color-maker's Companion.

H. 64.—Fibre Plants of the Colonies: a Treatise on the Cultivation, Preparation, and Cottonizing of Home-grown and Continental Flax and Hemp, &c. By J. F. Dickson.

Magistrate's Manual: being a Compilation of the Law relating to the Duties of Justices of the Peace in Upper Canada. By John McNab, Toronto.

Statutes of Canada and Upper Canada, a Synoptical Index of, up to the Sessions of 1864, inclusive, &c. J. W. Hancock, L L. B.

Patents of Canada: Abstract of Specifications, &c. Vol. 2—1849 to 1855.

K. 54.—SELLERS. The Color Mixer; containing nearly Four Hundred Receipts for Colors, Pastes, Acids, Pulps, Blue Vats, Liquors, &c. &c., for Cotton and Woollen Goods; including the celebrated Barrow Delaine Colors. By John Sellers, an experienced practical workman.

K. 55.—SMITH. The Dyer's Instructor; comprising Practical Instructions in the Art of Dyeing Silk, Cotton, Wool, and Worsted, and Woollen Goods, containing nearly 800 Receipts. To which is added a Treatise on the Art of Padding; and the Printing of Silk Warps, Skeins, and Handkerchiefs, and the various Mordants and Colors for the different styles of such work. By David Smith, Pattern Dyer.

K. 56.—ULRICH. DUSSAUCE. A Complete Treatise on the Art of Dyeing Cotton and Wool as practised in Paris, Rouen, Mulhausen, and Germany. From the French of M. Louis Ulrich, a Practical Dyer in the principal Manufactories of Paris, Rouen, Mulhausen, &c. By Professor H. Dussauce.

N. 6.—FISHER'S Photogenic Manipulation. 16 mo., cloth.

L. 41.—Gas and Ventilation. A Practical Treatise on Gas and Ventilation. By E. E. Perkins, 12mo., cloth.

H. 66.—Gregory's Mathematics for Practical Men; adapted to the Pursuits of Surveyors, Architects, Mechanics, and Civil Engineers. Plates.

K. 52.—MILES (W.) A Plain Treatise on Horse-Shoeing. With illustrations. By William Miles, author of "The Horse's Foot."

K. 57.—Marble Worker's Manual: containing Practical Information respecting Marbles in general, their Cutting, Working, and Polishing; Veneering, &c.

L. 43.—Paper Hanger's Companion. By James Arrowsmith.

L. 37.—Painter, Gilder, and Varnisher's Companion. Containing Rules and Regulations in everything relating to the Arts of Painting, Gilding, Varnishing, and Glass Staining: with numerous useful and valuable Receipts. Eighth edition.

L. 40.—TEMPLETON. Practical Examinator on Steam and the Steam-engine. By Wm. Templeton.

L. 38.—Turner's (The) Companion: containing Instructions in Concentric, Elliptic, and Eccentric Turning. Illustrated by steel plates, of various chucks, tools, instruments, and patterns.

U. S. Commissioner of Patents Report on Agriculture for 1862. 1 vol.

K. 49.—WEATHERLEY (HENRY) Treatise on the Art of Boiling Sugar, Crystallizing, Lozenge-making, Comfits, Gum Goods, and other processes for Confectionery, &c.

Selected Articles.

ENGINEERING—PAST AND FUTURE.

Standing on the confines of the old and new year, it is at once pleasant and profitable to withdraw our attention for the moment from the present, and direct it to the past and to the future. These are so linked and bound together as far, at least, as regards the progress of science, that none but exceptionably constituted minds can perfectly dissever them. We perforce mix up the teachings of the past with all our schemes for the future. The prophet involuntarily become a historian, and the historian, if he give loose for ever so little to the reins of fancy, finds the future continually obtrude itself upon his thoughts. Thus it becomes all but impossible to record the progress of events during the last twelve months without noticing the schemes for the ensuing year, which have their true origin in bygone successes. Each step leads to another, and as the engineering year has neither beginning nor end, save in a conventional and arbitrary sense, so it becomes difficult to separate that which has been done from deeds still to be accomplished. Yet nothing can so well enable us to comprehend the enormous influence exerted on our material prosperity by the engineer, as a calm and dispassionate consideration of the past. The history of the constructive arts is a record of a succession of unparalleled triumphs. The members of our profession can say with truth that they have never been beaten as a class. The individual may have failed; his art, never. No other profession can assert as much. Physicians, soldiers, lawyers, have been overthrown, *en masse*, time and again in the very moment of apparent victory. Disease still stalks through the land, and its power is not less now than it was centuries since. In only a single direction can the doctor claim to have successfully combated death; yet it is more than questionable if he could have materially reduced the death rate of our large towns, whatever he might do in rural districts, without the aid of the engineer. Great wars have terminated without bringing either glory or profit to the soldier, and where a different result has been brought about, it has of late years been invariably due to the skill of the engineer. The strong arm of the law is not yet strong enough to beat down crime. It has been said that the worst use to which a man can be put is to hang him, and justice has found that the criminal in the hands of the engineer may be still made to subserve a good purpose; convict labour has not been found wholly unproductive. All that the engineer has ever undertaken he has accomplished; and at this moment, that man who would argue that any one of the many schemes discussed in engineering circles *could* not be carried out, must possess extraordinary audacity, or know very little indeed of the scientific history of the last half century. Such is the position to which we have attained, that it is now urged but too often that engineering questions are settling down into mere commercial problems. This is going too far; and the confidence of the capitalists in the skill and talent of the engineer, leads him to overlook the fact that money cannot take the place of mental ability and vast experience. Indeed, at no time has talent been in greater request, more urgently needed, or more liberally displayed than at present; and the younger members of the profession will find on examination, that as many opportunities for acquiring distinction existed in 1865 as in any of those years to which they look back with regret—years in which they urge there were yet so many things to be done, which they feel they possessed a special mission to perform—only they were born too late. There is, too, a notion in existence that the engineers of the present day are not original, that they walk in the steps of the giants of other days, that they do not startle the world with novelties great and grand,—in short, that there is nothing new in the world of engineering science that is excellent. The idea, we need hardly say, is erroneous; things are accomplished daily such as Watt or Brindley or Stephenson never dreamed of. The magnitude of our operations has not diminished, but the number of our undertakings has increased so enormously that the noise of individual successes is swallowed up and lost in the thunder of our pean of triumph. It is, in a word, impossible to resist the conclusion, that the profession never stood higher than at this moment; while a mere glance at the events of the past year, and the works which it is proposed to carry out or inaugurate in 1866, will do much to prove that while talent and skill of the very highest order abound in our ranks, it is difficult to indicate a period when a greater amount of energy and enterprise has been displayed.

The metropolis and its immediate neighbourhood have been distinguished by the number and magnitude of the operations of which they have been the scene. The railway bridges more or less recently constructed over the Thames, form one and all remarkable examples of constructive skill. These have from time to time been noticed at such length in our columns that we need not stop to consider them very particularly. No strictly new bridges have actually been commenced during the last year, although the first stone of the road bridge at Blackfriars was laid within the last twelve months. Considerable progress has been made with the works during the summer, and it is confidently anticipated that the bridge will be opened for traffic within three years. Many difficulties have been encountered and overcome; some of these are common to all tidal streams, others were directly due to the busy river traffic. One of the most noteworthy features presented during the progress of the works was the coffer dam constructed for the purpose of putting in the embankment at the Surrey side of the stream. This dam, although only a single pile thick, was perfectly water-tight, and constituted one of the finest specimens of piling it has ever been our lot to witness. The gantry, remarkable at once for its size and its height, has proved perfectly successsful, and the works have proceeded with the utmost steadiness, for a considerable portion of the year night and day. The London, Chatham, and Dover Railway bridge close by has been completed, and its proportions are on the whole so elegant that we feel much regret that its proximity to the new road bridge will effectually shut it out from the view of those proceeding down the river. The road bridge must suffer from a similar cause. Really handsome bridges are not yet so plentiful that we can afford to lose the sight even of one.

The Thames bridges, however, sink into comparative insignificance when compared with the great metropolitan drainage works executed during the last few years. It would be impossible here to enter upon their consideration at any length; a few statistics will suffice to impart a general idea of their magnitude and importance. The first portion of the works was commenced on January, 1859, being about five months after the passing of the Act authorising their execution. There are 82 miles of main intercepting sewers in London. In the construction of the works 318 millions of bricks and 880,000 cubic yards of concrete have been used, and 3,500,000 cubic yards of earth excavated. The cost when completed will have been about £4,200,000. The total pumping force employed is 2,380 nominal horse power; and if the engines were at full force night and day, 44,000 tons of coal per annum would be used, but the average consumption is estimated at 20,000 tons. The sewage to be intercepted by the works on the north side of the river at present amounts to 10,000,000 cubic feet, and on the south side to 4,000,000 cubic feet per day; but provision is made for an anticipated increase in those quantities in addition to the rainfall amounting to 63,000,000 cubic feet per day, which is equal to a lake of 482 acres 3ft. deep, or 15 times as large as the Serpentine in Hyde Park.

In excavating for the works a large number of animal remains, ancient coins, and other curious objects, were found, most of which were deposited in the British museum. With the exception of the low-level sewer on the north of the Thames, which will drain about one-seventh of the metropolitan area, the whole of the main drainage scheme is finished and in active operation. His Royal Highness the Prince of Wales set in motion the engines at Crossness on the 4th of last April, and thereby completed the opening of the works. We may here remark, *en passant*, that the ventilation of these sewers has received some attention from the Metropolitan Board of Works during the last year; as an experiment, the southern outfall sewer is now being ventilated by the furnaces in Woolwich Dockyard.

Considerable progress has been made during the year with the Thames embankment, north. The works have been let in two contracts; the first comprises the formation of a granite-faced river wall, commencing at Westminster bridge, about 3,740ft. in length, with a portion of the low-level sewer, which will run beneath the roadway of the embankment, and a subway. Up to the present about 263,000 cubic yards of material have been supplied as filling. The second contract is for the continuation of the works 1,970ft. further, and about 20,000 yards of filling stuff have been supplied to this section of the works. The contract for the remaining length—about 900ft.—from the Temple to Blackfriars bridge, has not yet been let. The works on the southern side will consist of a solid embankment from Westminster bridge to a point near Vauxhall bridge, having a roadway 60ft. wide between Gunhouse-alley and Lambeth bridge, and a footway 20ft. wide from that point to Westminster bridge. The contract for these works has recently been let for the sum of £300,000, and they are to be rapidly pushed forward.

Although no very remarkable bridges have been actually constructed during 1865, Acts have been obtained for the erection of several of gigantic dimensions. Foremost among these is an undertaking, promoted by the North British and the Edinburgh and Glasgow Railway Companies, for crossing the Firth of Forth a little above Queen's Ferry by a high-level bridge two miles and 367 yards long. This bridge will have four openings to permit navigation, each of 500ft. span, with a head of 125ft., nineteen openings, each having a span of 100ft., ten of 175ft., and seventeen of 200ft. The piers will be of stone; the superstructure of columns and girders of iron. The works have been actually commenced, we believe, and according to the specifications green beech only is to be employed in the piles, a judicious though somewhat unusual clause, as it is well known that this wood is almost imperishable when the air is absolutely excluded. An Act has been obtained for a work of a kindred character, intended to carry a branch of the Great Western Railway across the Severn at Oldbury Sands. This viaduct will be 12,393ft. long. The principal openings for navigation will each have a span of 600ft., and a headway of 100ft. The other openings will be two spans of 265ft. wide, these being also designed for the accommodation of the main channel; also thirty openings of 150ft. span, twenty-six of 120ft., and twenty-seven of 90ft.; or 152 openings in all. The viaduct, mainly an iron structure, will be crossed by two lines of rails of mixed gauge. Mr. John Fowler is the engineer of this work. The erection further up the Severn of another railway bridge was also sanctioned last session. It (the Severn Junction viaduct) will have six openings of 100ft. span, 70ft. high over high-water mark, and twelve of 100ft. span. Its total length will be about 1,998ft. It is being erected in the interest of the Midland Company, which will obtain access by it to the Dean Forest line on the north, and be enabled thereby to have a part in "tapping" the rich mineral traffic of South Wales. Mr. James Brunlees is engineer of the Severn Junction, as also of another work sanctioned last session for crossing the estuary of the Duddon, for the Whitehaven and Furness line. The open viaduct in this case will be about 750ft. long, the shore ends being embankments. A very fine viaduct is also being erected by the London and North-Western Railway Company at Runcorn, with three spans of 100ft. each, 75ft. high, and eleven arches of stone at the ends.

When we speak of so many works we are apt to forget their real magnitude, and it may be worth while to pause for a moment and compare those vast bridges with others which have become in a sense historical. The Great Bridge over the St. Lawrence at Montreal has a total length of 9,184ft., with twenty-five openings: one having a span of 330ft., and the rest spans of 242ft., with a headway of 60ft. The Britannia Bridge over the Menai Straits is 1,487ft. long without the abutments, with two spans of 230ft. each, one of 458ft. 8in., and one of 459ft.; and the Saltash Bridge, 468ft. Against these we have the Forth Bridge with a length of 10,550ft.; the Severn Bridge with a length of nearly 12,000ft. Can it be maintained that we have no giants in the profession in these latter days?

Among the projects which are as yet merely schemes and nothing more, two of a very remarkable character deserve passing notice; they both contemplate the construction of bridges across the Mersey at Liverpool. One of these is a carriage and footway bridge, which is intended to commence at Derby square, near the top of Lord street, on the Liverpool side, and to terminate on the other side in Hamilton square, Birkenhead; the total length of the stone-work being about a mile and a quarter. It is proposed that the bridge be carried on lattice-work piers, set on stone foundations, the two central spans to be 1,500ft. wide, with a height of about 160ft. above high-water level!

The other scheme for crossing the Mersey has been taken up by the Liverpool and Birkenhead Railway and Road Company, which proposes to unite the railway lines running to Birkenhead on the one hand with the Lancashire lines running into Liverpool on the other, by a viaduct across the Mersey about a mile or so above the heart of Liverpool. The scheme includes about four miles of railway, the viaduct being about 1¼ miles in length. The designs have, we believe, been prepared by Mr. Brunlees. The lines on each side of the viaduct will run on the one side to the Liverpool central station, and on the other to the Birkenhead station, on gradients (descending) of 1 to 100ft. The viaduct shall, it is proposed, cross in an angular direction from Dingle Point to Bebbington, and the lines crossing it will be connected by easy curves to the right and left with the lines on the Lancashire and Cheshire sides. The principal opening of the bridge will have a headway of 120ft. above ordinary high-water mark, two spans of 500ft. each, and twenty-two others of 300ft. each. It is intended that the bridge shall be of lattice girders, and of lattice and bowstring for the two wider spans. The foundations to be of stone, reaching to about 2ft. above high-water mark. It is exceedingly probable that the scheme will be ultimately carried out.

In Mechanical engineering the progress of improvement has been steady rather than remarkable. Builders of marine engines have devoted more than usual attention to the means of securing economy of fuel, and the results obtained have been upon the whole satisfactory. The competition instituted by the Government between the frigates Octavia, Constance, and Arethusa, has, we regret to say, proved absolutely barren of results. The only facts made public, have already appeared in the pages of the *Engineer*. For the rest, the very makers of the engines have been kept in total ignorance of the details of the experiments, such as they were; and they have not even been permitted to see the indicator diagrams. The ships were engined more than four years ago, and the policy which has led to such a negative termination cannot be too highly condemned. Surface condensers enjoy considerable favour, although they have not attained to the position once expected for them. It is not probable that any further great improvement in the economical working of the marine engine can be secured, without the adoption of some system by which the sulphates of lime and magnesia may be precipitated in a separate vessel by heat, before the feed is forced into the boiler. With the introduction of an efficient separator it will become possible to use higher pressures, larger measures of expansion, and lighter machinery than are now practicable; and we believe that were attention once fairly turned in this direction much good might be done. The tendency to the formation of railways of steep inclination, or more strictly, the necessity for such lines, has led to the construction of locomotives of a very peculiar description. The mid-rail system, as developed by Mr. Fell, is apparently capable of great things. He has already obtained the concession for the construction of a temporary line over Mount Cenis; and, as it is, the two experimental engines which have already worked these inclines have been so comparatively successful, that there is no reason to doubt that the traffic will be carried on with considerable punctuality in all states of the weather. It has been urged that the mid-rail would be unnecessary, were sand properly used to increase the adhesion of a six or eight coupled engine specially designed for heavy grades. The best answer to this is found in the fact that in certain states of the weather Mr. Fell's first engine, when used at Whalley-bridge, was unable, although sand was freely used, to do more than propel itself up inclines of one in thirteen, when the gripping wheels were not in action, simply because the adhesion of the bearing wheels was insufficient. On throwing the horizontal wheels into gear the engine easily hauled a load of sixteen tons. A single fact of this kind is of course sufficient to overset any number of theoretical reasons to the contrary. Mr. Fairlie has adopted a different system, as he does not contemplate working inclines of excessive steepness; and he succeeded in producing a very efficient engine, which should be light on permanent, and especially suitable for a heavy goods traffic. We believe that Messrs. James Cross and Co., of St. Helens, are at present executing more than one heavy order for engines built on Mr. Fairlie's system, for Welsh and South American lines. We have so recently described the first engine of the kind built, that we need not dwell further on it just now. Not only have steep inclines, but sharp curves, to be dealt with; indeed, the latter, if less difficult to cope with, exert a far more injurious influence from their numbers. Mr. W. B. Adams, who has long and persistently advocated a radial axle box instead of the somewhat cumbrous bogie, has succeeded in introducing his system on more than one line with success. The best results have been obtained by applying the radial axle box to the trailing wheels only of a six-wheeled engine, which is thus reduced at once to the condition of those four-wheeled engines which long remained in favour, because of the surpassing ease with which they traversed curves. Locomotives of this type have recently been specially constructed to work the Great Northern Railway traffic between Hatfield and the Metropolitan Company's station at Farringdon street. They were placed upon the line about two months since, and have so far proved perfectly successful. The great object which Mr. Sturrock had in view, in the construction of those engines, was to dispense with a separate tender and to obtain as much tractive force as possible, and the power of traversing with facility the sharp curves and steep gradients of the Metropolitan and the London, Chatham and Dover (Metropolitan) lines. The new engine is well proportioned and compact, having six wheels, two under the foot-plate and four between the fire-box and the smoke-box. The latter are 7ft. 6in. from centre to centre, and are coupled in the usual way. The axle of the trailing wheels is placed at a distance of about 12ft. from the nearest driving centre, making a total wheel base of 19ft. 6in. The lateral play of a few inches from side to side of the radial axle boxes, with which the wheels alone are fitted, permits the engine to pass round the curves of a radius which no engine with such a wheel base dare otherwise attempt. The cylinders of the engine are 16½in. in diameter, the tank on the foot plate holds 1,000 gallons of water, equivalent to a supply for a run of thirty miles. The weight upon each pair of wheels is thirteen tons. The chief difficulty with tank engines hitherto has been the lessening of the weight on the driving wheels, by the gradual consumption of the water from the tank, but in the arrangement of those engines the difference of weight on the driving wheels is estimated at only about a quarter of a ton out of twenty-six tons. These engines have run with with perfect steadiness at above fifty miles an hour.

In shipbuilding we have nothing very novel to record. The composite system appears to hold its own, and even to make considerable advances. Steel, too, is being largely adopted, both in the form of plates and angle bars. The success with which Clytemnestra stood the terrible ordeal of the Calcutta cyclone must yet be fresh in the memory of our readers. With such an example before them, it will be strange if other shipbuilders do not follow the example set them by Messrs. Jones, Quiggin and Co. It is possible that the comparative high price of steel has done more to retard its adoption than any notions as to its unreliable qualities entertained by shipowners. This objection only requires time for its removal. In the first place the labours of Mr. Bessemer have done much to cheapen steel, and will do much more; and in the second the weight of material required to construct a hull of similar dimensions from steel is so much less than when iron is employed, and the capacity of the ship is thereby so largely augmented, that the question connected with first cost are reduced within very small dimensions indeed. The "U" bow, as it has been introduced into our navy, has not proved very successful; possibly because it has invariably been combined with a projecting beak, which, however useful or even necessary in a war vessel intended to act as a ram, is certainly inimical to speed. The Pallas, intended to have been one of the fastest ships in the navy, has proved very much the reverse, and her lines forward have therefore been altered, with what result remains to be seen. The race between the Salamis and the Helicon has not done much to bring the beak into favour, and it is worth considering whether the prospective advantages to be derived from its use, can compensate for the direct loss of speed which is directly entailed by its employment. While on the subject of war vessels it may be well to allude to the progress made in the construction of guns and system of plating. A rather pungent controversy has taken place between Messrs. Parsons and Palliser on the subject of strengthening old cast iron guns—and new ones as well—by lining them with a tube of iron or steel. Into this controversy we have no intention to plunge; but it appears that both gentlemen have succeeded in producing useful weapons, which deserve some attention at the hands of our Government. Mr. Frazer's improvements in the construction of heavy ordnance may be said to have brought the coil system to the utmost perfection of which it is capable, and we are now in possession of smooth-bore guns, weighing 12 tons, and capable of firing 40lb. to 60lb. charges with perfect safety. How they will stand rifling remains to be seen; we are disposed to believe with success. In any case these guns are heavier than anything to be found in the French navy, and they are capable of doing fearful execution on 4in. and 4½in. armour plates. It is strange that the Admiralty refuses to adopt the best method of plating—as far at least as regards keeping out shot—yet produced, that invented by Mr. Chalmers. We shall possibly return to this question ere long. At the present moment reliance is placed principally on mere thickness of metal, and although the small armoured vessels designed by Mr. Reed have been successful upon the whole, that success is not sufficiently encouraging to render it likely that the growing tendency to construct enormous vessels will be at all abated. We find with some pleasure that in addition to the iron-clad frigate Hercules, ordered to be built at Chatham Dockyard, the Lords of the Admiralty have decided on the construction there of the first of an entirely new kind of turret-ship (?) combining all the latest improvements in that particular principle of construction. The preparation of the designs for the new vessel has been entrusted by the Admiralty to Mr. Reed, from whose plans and under whose superintendence the new turret-ship will be built. She is intended to carry two turrets, each plated with armour of enormous thickness, and sufficiently powerful to mount 600-pounder Armstrong guns. In the drawings and plans for the Hercules, now in course of preparation at the Chatham Dockyard, Mr. Reed originally designed that vessel as combining the broadside and turret principles in the same ship; but, in conseqeence of the decision of the Lords of the Admiralty, just determined upon, to have an experimental vessel built entirely on the turret principle, the turrets intended to be placed in the Hercules will be dispensed with, and she will accordingly be constructed as a broadside ship, with armour-plates exactly double the thickness of those of the Achilles and Warrior. The new turret-ship will be built simultaneously with the Hercules. We are anxious to know what part Captain Coles will be permitted to take in her construction and design.

In telegraphy, the entire interest of the scientific world has been concentrated on the Atlantic cable expedition. It may be urged that notwithstanding what we have said in the first paragraph of this article, here the engineer has been beaten. But such a statement would not be true. Until the entire scheme of an Atlantic cable has been given up it is useless to talk of defeat; and the failure of the last attempt was due to a concatenation of circumstances with which engineers had very little to do. The subject is disagreeable and we think it better that it should be suffered to repose with the cable in the depths of mid ocean. We feel no hesitation in stating that the expedition failed from causes over which the engineer had no control, and which would render an attempt to lay a cable between Kingstown and Holyhead an equally uncertain and difficult undertaking. We can only hope for better things in future, and we heartily wish the company every success in their renewed attempt. There is in our opinion small hope that the old cable can be raised, and we think the less time wasted in the endeavour the better. We believe that the construction of the new cable has been commenced, and, with due precautions there is nothing to prevent 3,000 miles of its length from being paid out with as much success as 1,600 miles of its defunct predecessor.

During the past year the world has lost many men of eminence. Sir Joseph Paxton and Captain Fowke, the designers of the glorious structure of 1851, and of the much abused, and we must add, the highly meritorious edifice of 1862, have both gone to their rest. John Dixon, of Darlington, the compeer of the elder Stephenson, has also passed away. What a flood of memories must the announcement of his unexpected decease have brought to those who fought the first battles of our magnificent railway system. Nicholas Wood, too, has gone to his rest full of years and renown. Mr. Neilson, the inventor of the hot blast; Mr. Appold, so well known for his centrifugal pumps; Mr. Elkington the patentee, and in one sense the inventor, of electro-plating, and many others—some of greater, some of less note—have been taken from us, leaving their works and their example as engineers and men as an heritage to posterity, the memory of which shall never pass away.

THE CALDER SOAP WORKS, WAKEFIELD.

(*From the London "Grocer."*)

"Commencing our survey of the premises, we are taken by our guide to the furnace-room, where the preparation of the black ash or crude soda is going forward. This furnace occupies a large square in the centre of this room, which contains also a series of iron tanks. The use of these will be presently explained. To produce the soda, three substances are required, namely, sulphate of soda, carbonate of lime, and coal. These are mixed together in certain proportions, cast into the reverberating furnace, and tapped or drawn off, when fused to a liquid state, into iron cars holding about four hundredweight each. These cars are wheeled to a convenient distance, emptied, and the calcined mass, which when cool bears the appearance of a worthless cinder, is broken with hammers into small lumps and transferred to the tanks, where in combination with hot water, by which the carbonate of soda is dissolved, it forms the solution so indispensible to soap makers. The proportion of carbonate of soda contained in the black ash, we are informed, averages about twenty-two and a half per cent. The lye is not, however, ready for use, for it contains impurities consisting chiefly of a compound of sulphur, and to prove the presence of this our guide dipped a sixpence into the tank, which was instantly acted on by the sulphur.

"The operation of extracting the sulphur is one that involves the use of several stupendous vessels, each of which, if filled to the brim, would hold nearly seven thousand gallons of liquid. These are called bleaching tuns, and in their capacity may be compared to the ponderous store vats used by extensive brewers. The crude solution is pumped from the tanks into these vessels, and a jet of atmospheric air made to permeate through it, after which it is boiled for several hours with lime, small quantities being chemically tested from time to time to ascertain whether the neutralisation of the sulphur is complete, and whether the lees has been rendered sufficiently caustic by the action of the lime. This being accomplished, the liquor is run off by means of a pipe at the base of each vessel to another series of tanks, from which it is pumped to the top story of the soap house.

"We now arrive at the commencement of the actual manufacture of soap. The building in which this is carried on has been planned upon an extensive scale. It measures a hundred and twenty feet by thirty-nine, and is seventy feet high, with a chimney sufficiently tall to serve as a landmark for a large area of a surrounding country. In order to follow the several processes *seriatim*, we must commence at the top of the building, where not only the lye but every other material is stored. The advantage gained by adopting this system is in the ease with which the various materials may be transferred through pipes or shoots to the required level.

"At the word of command sent up from below, a large platform desends, and having esconced ourselves in the centre of it, we move rapidly upwards, passing floor after floor in sucession, until we reach the uppermost story. Here we are shown the store tanks containing the lees, and in regular order, along the full length of one side of the building, a series of large vessels sunk in the floor. These contain the various descriptions of oil and tallow, and are connected by pipes with the soap coppers on the floor below. Both tallow and oils are brought up in hogsheads by the hoist just described, which is worked by steam power. As the casks arrive each one is rolled to the tank into which the contents are to be transferred. This performance is termed "blowing out" the oil and tallow, for the reason that, in order to cause the palm oil or tallow, which is in a solid state, to run, a jet of steam is introduced and turned by the workmen in all directions, which increases the temperature and causes the contents to run out in the form of oil.

"One of our standard dictionaries — we think Johnson's—gives the definition of garret as the top room in the house, and the definition of cockloft as the room above the garret. We have called the apartment we have just passed throu h the top floor of Messrs. Hodgson and Simpson's large building, but, like the great dictionary writer, we have a still higher one in reserve. Mounting a very, very steep staircase, we arrive at an observatory, from which the country round for miles can be viewed by day and the heavens by night through a telescope that always waits the pleasure of amateur astronomers. This is the retreat to which on summer days the members of the firm retire to enjoy their *otium cum dignitate*, and, under the influence of a soothing weed, concoct new plans for the spread of soap and civilisation.

"But we have been wandering from our task, and must leave the pure air of heaven for the far less agreeable fumes emitted from the soap-pans. These we find to be mostly in a state of transition from old to new. The growing demand made upon the Calder Works has necessitated the substitution of larger coppers and the addition of several new ones. These are all being erected upon the most improved principle, and, instead of being set in solid brickwork, are covered with non-conducting felt, well plastered and whitewashed. Thus the space given by the base of each copper being narrower than the brim is economised, and in case of fire or other accident any portion of each copper is accessible.

"We have already noted the connection by leaden pipes of the oil and lye tanks above with the copper below, of which there are twelve, capable of producing two hundred and fifty tons of soap per week. We saw one being newly filled, the lye and melted tallow entering by separate pipes and amalgamating as they met. When the pan is sufficiently full—ample room being left for the ebullition—a tap is opened which permits the entrance of a continuous supply of steam. By this means the mixture is boiled for the necessary length of time, which is regulated by the simple test of appearance, while the proper proportion of each material run into the copper is ascertained by testing the lye which is precipitated to the bottom of the pan. The coppers are placed in two rows on either side of the room, which is nearly the full length of the building, and very wide. These enormous vessels present a wonderful contrast to those of older construction. Here and there we notice a small wooden ladle, not unlike the toy spades frequently seen in the hands of children on the sea beach. These are used for taking out samples from the coppers from time to time in order to watch the progress of the boiling. Looking down the wide staircase leading from the soap house to the frame room, we notice the wreck of several of the comparatively small coppers long since abandoned. These are being removed for the enlargment of the frame room, and to admit of certain improvements in the engine and boiler rooms.

"When the superintendent decides that the contents of a copper have been sufficiently boiled, the steam is shut off, and a valve at the extreme bottom opened to allow an exit for the spent lye. By this method, which is comparatively new, a saving of some hours' of hand pumping is made. Here again also advantage is taken of the laws of gravitation. Formerly the soap was ladled from the coppers by hand—a process occupying several hours, and requiring the labour of about twenty men. Now, each pan is connected with the frame room by an inclined channel, through which the melted soap can be passed in half an hour. The principal frame room, since its enlargement and improvement, is an almost exact square of about one hundred and twenty feet. It is divided into numerous passages, crossing each other at right angles, formed by rows of frames. We first take a bird's-eye view of this large room from the steps, and then traverse the miniature streets, walled on either side by blue mottled, golden yellow, or some other description of soap. Above are a series of wooden channels extending from the boiling house in parallel lines over the rows of frames. Each section of the latter is connected with the main channel by a branch, and the main channel receives its supply from those which slant downwards from the pans. The frames are of the orthodox pattern and size, and the only excuse makers have for retaining them is, that they find it difficult to depart from a long-practised habit which was one of the many restrictions of the old Excise regulation. When the soap has become quite cold—and as each frame holds a mass weighing half a ton this does not take place very rapidly—the frame is removed, and the large block transferred to another department, where a number of men instantly proceed to reduce it to bars. This is accomplished much in the same manner as a provision dealer cuts up a firkin of butter. A rule made for the purpose marks the points of division; and a strong, though slight copper wire is then drawn through the mass. The bars are afterwards piled crosswise, so as to allow a free circulation of air on all sides; and after remaining for a reasonable length of time to dry, they are packed for transmission to our friends the grocers.

"All the boxes and packing cases used in this establishment are made on the premises. Steam power is applied to a series of circular saws in a mill, where a number of men are continually employed in cutting up wood for this purpose. The pieces are sent to the joiners' shop as required, where strong boys, whose extraordinary ability in driving in nails at the shortest notice is only exceeded by their anxiety to multiply boxes as if by magic, hammer away with a hearty good will readily accounted for by the fact that they are paid by the piece, and have therefore a wholesome inducement to be industrious.

"The store-rooms are in proportion to the general extent of the premises, and are divided into sections for the different descriptions of soap. Apart from the main building is a mechanics' room, where all the machinery-fittings are executed at Messrs. Hodgson and Simpson's own forge, and by a staff of experienced men. All the steam used for boiling and other purposes is generated in four double cylinder boilers, conveniently situated. The engine, which is for the pumping and other machinery, occupies the position between the furnaces and the department where the lye is refined.

"We have now exhausted our survey of all that immediately concerns our readers, but our attention is called to a bone-crushing mill, and a manufactory for nitro-phosphate manure, which has been successfully carried on as a branch business by Messrs. Hodgson and Simpson for many years."

Machinery and Manufactures.

BOILER INCRUSTATIONS.

Mr. Charles F. Chandler, professor of analytical and applied chemistry in the school-of-mines of Columbia College, has made a report on water for locomotives and boiler incrustations to the directors of the New York Central Railroad. He analyzed water from all the stations between Syracuse and Rochester (N. Y.), and also analyzed the incrustations; and examined the various articles and methods employed to prevent incrustations and corrison, and experimented on the boilers. The following are his general conclusions:

The Formation of Incrustations.

The analyses show that the incrustations consist chiefly of the carbonates of lime and magnesia and the sulphate of lime. The two carbonates are insoluble in pure water, and owe their presence in the waters of springs and rivers to free carbonic acid, which forms with them soluble bicarbonates. When such waters are boiled this carbonic acid is expelled, aad the carbonate of lime and magnesia separate in the form of insoluble powders, portions of which adhere to the sides of the vessel containing the water. The carbonic acid acting as a solvent is so loosely combined with the carbonates, that exposure to the air is sufficient to cause the separation of a portion of it, an equivalent quantity of the insoluble carbonates separating as a deposit. The more slowly the carbonates are precipitated from their solution in carbonic acid, the more compact are the deposits, and the more firmly they adhere to the surfaces with which they come in contact. In caverns, by slow evaporation, hard stony stalactites and stalagmites are formed; while in boilers, unless sulphate of lime be present in considerable quantity, the deposits consist usually of a fine loose powder or mud. Various alkaline substances, by appropriating this carbonic acid, cause the precipitation of the insoluble carbonates. Potash, soda, and ammonia, as well as their carbonates, produce this effect, as does also lime water. In the latter case, the lime added, unless an excess be used, is also deposited as carbonate; consequently no alkaline salts are substituted for the carbonate removed, as is the case when the other substances are employed.

It is seen from the above that the carbonates may be removed, without decomposition, by simply depriving them of their solvent, the carbonic acid. The sulphate of lime is soluble in water, one part of the sulphate requiring about 400 parts of water for its solution. One gallon of water is capable of holding about 150 grains of sulphate of lime. The solubility of sulphate of lime in water is modified by the presence of other substances. The chlorides of calcium and magnesium, alcohol, etc., and even a high temperature diminish, while the chlorides of sodium and ammonium, sugar, and various other organic substances, somewhat increase its solubility. Hyposulphate of soda is said to increase its solubility tenfold. Above 212° F. the solubility rapidly diminishes as the temperature increases. At 255° F., equivalent to a pressure of 30 pounds, its solubility is diminished nearly three-fourths; at 272° F., equivalent to a pressure of 45 lbs., nineteen-twentieths, and at a temperature of 280° to 300° it may be said to be totally insoluble.

Sulphate of lime does not require the presence of carbonic acid for its solution. It is deposited in boilers on account of the high temperature and its limited solubility, and forms, in the absence of the carbonates, as in marine boilers, a hard crystalline scale, sometimes an inch or more in thickness. When the carbonates of lime and magnesia are present, the deposits vary from a loose powder to a hard crystalline incrustation, according to the relative proportions of the three substances.

In practice sulphate of lime can only be removed from water by undergoing decomposition; for example, by carbonate of soda, which forms carbonate of lime, which is deposited as a powder, and sulphate of soda, which remains in solution. As much as thirteen hundred pounds of incrustation has been taken from a locomotive boiler at one time. A locomotive in running 40 miles will take in 1,800 gallons of water, equivalent to 45 gallons per mile, a quantity which seems incredible. Accepting this as a basis for calculation, we have 765 grains, or more than an ounce and a half of earthy matter as a possible average of the quantity which enters the boiler per mile. Multiplying this by 1988, the average number of miles run on this section of the road by each of 56 locomotives, in one month (December), we have 217 pounds of incrusting matter entering a boiler per month, or 2,604 pounds per year. Nor is this necessarily a maximum, as some boilers receive the larger part of their water from stations furnishing water much below the average in purity.

The Effect of Incrustations.

The injurious action of the incrustations is threefold:—1. Being very poor conductors of heat, and occupying a position between the boiler plates and the water, they cause a great loss of heat and consequent waste of fuel. This waste is estimated at 20 per cent., and in some cases as high as even 47 per cent., of the fuel used. Nor does this waste require a very thick incrustation, a very small fraction of an inch of scale being sufficient to exert a decided influence on the quantity of fuel necessary to produce the required power. This loss of heat involves, of course, a corresponding loss of power. 2. For the same reason they cause an over-heating of the boiler-plates, which often become red hot, though only separated from the water by a thin scale. Such over-heating is sure to cause a rapid burning out of the metal, and may result in an explosion of the boiler, should the expansion of the boiler plates loosen and detach the scale so as to expose the over-heated surface to the water. 3. The corrosion of the metal occurs most rapidly in those parts of the boiler upon which the deposits are most liable to accumulate.

The Corrosion of the Boiler Plates.

The only substance contained in the water which can be supposed to act upon the iron are the alkaline salts, chlorides of potassium and sodium, sulphates of potassa and soda, and chloride of magnesium. That these substances do affect iron is shown by introducing slips of iron and copper connected with a galvanometer into their solutions. A galvanic current is produced, which is a certain indication of chemical action; although the short duration of such an experiment precludes the possibility of any considerable corrosion of the iron.

The impression which prevails among some of the employés of the road, that the corrosion is due to some acid, is not confirmed by the analyses of the water. No free acid, except carbonic, exists in any one of them; and the presence of the carbonates of lime and magnesia renders the existence of any other free acid impossible.

The copper and brass tubes, used in locomotive boilers on account of the rapidity with which they "make steam," must greatly facilitate the corrosion of the iron. The copper is rendered electro-negative, while the iron in the electro-positive condition is corroded. That the incrustations have some influence on the corrosion is proved by the fact that plates which suffer most are those upon which the incrustations most rapidly accumulate: the lower or "belly plates" of the boiler. This coincidence may be owing to the fact that the deposits subside most in those parts of the boiler least disturbed by currents. It would be well to ascertain whether an arrangement by which the water entering the boiler could be made to produce currents in those parts not directly over the flues or fire-box, would not materially diminish both the deposits and corrosion.

As a somewhat anomalous fact, it may be mentioned here, that even chemically pure (distilled) water is not adapted for "feeding" boilers. Some of the condensers used in connection with marine boilers, for condensing the waste steam, are found to furnish water which produces effects quite similar to those noticed in the locomotive boilers. It is even stated that the addition to this water of a small quantity of water containing chloride of sodium and sulphate of lime (sea water) suffice to prevent the corrosion.

The corrosion of the locomotive boilers is not evenly distributed over the surface of the plates, but is confined to pits and grooves which are most abundant along joints, and in fact wherever the surface of the metal may have been bruised. The surface of the boiler plates is harder, and less readily attacked, than the interior; which it protects, as the skin of an apple protects its interior from decay. In trimming down the rough edges, where the plates lap and where braces are riveted to the plates, the boiler-makers are liable to cut through this hard surface with their chisels, and at these points the corrosion is most rapid.

After a careful consideration of all the facts of the case, I am satisfied that the corrosion of the plates is due to the saline substances already mentioned, aided by the electro-positive condition of the iron (induced by contact with the copper or brass tubes); by the presence of bulky incrustations; and by the high temperature of the water.

The Means for Preventing Incrustations and Corrosion.

Numberless substances and methods have been proposed from time to time, for preventing the bad effects of impure water in boilers. Most of the methods are designed merely to prevent and remove incrustations: but corrosion is much aggravated by the presence in the boiler of calcareous deposits. Methods which prevent incrustations must, therefore, diminish corrosion. Some of the methods to be mentioned are applied to the water before it enters the boiler; in other cases, substances are introduced into the boiler itself. In most cases, the salts of lime and magnesia are either precipitated in fine particles as a loose mud or rendered permanently soluble.

Filtration, which removes suspended impurities, is in this case useless, as the salts to be removed are in solution.

Distillation is particularly recommended, and employed to a considerable extent, for marine boilers using sea water. This method of purification is impracticable for locomotives.

Boiling expels the free carbonic acid, and causes the separation of the carbonates of lime and magnesia, and if conducted at a high temperature, under considerable pressure, results in the almost complete precipitation of the sulphate of lime. This would, however, merely transfer the incrustations from the locomotive boiler to some other vessel, and would, therefore, be valueless in this case.

Lime-water is employed on a large scale at Woolwich. The lime combines with the free carbonic acid, causing the precipitation of the carbonates of lime and magnesia. The proportion of lime water added varies with the amount of free carbonic acid present. In a few hours the carbonates settle, leaving the supernatant water clear. As the lime added is also deposited as carbonate, nothing is introduced which remains in solution. The sulphate of lime is not affected. This method is readily applied and inexpensive. It merely requires extra tanks for the lime water, and for settling the sediments. It is specially applicable to water containing little sulphate of lime.

Baryta-water, which affects the sulphate as well as the carbonates, has been proposed, but its high price puts it entirely out of the question.

Carbonate of Soda.—This salt precipitates the carbonates of lime and magnesia, by withdrawing the free carbonic acid. It also decomposes the sulphate of lime, forming carbonate of lime, which is deposited, and sulphate of soda, which remains in solution. This is very effective, and not expensive. Added in excess, however, it is said to produce priming and leakage. *Carbonate of potash* would answer the same purpose, but is more expensive; *caustic soda* and *potash* behave in nearly the same manner. *Carbonate of ammonia* has the same effect on the lime salts, but does not precipitate the magnesia. Carbonate of soda is preferable to the other substances of this class, on account of its low price. It may be advisable to employ caustic soda in some cases, on account of its superior efficacy in loosening hard scales.

Chloride of Barium decomposes sulphate of lime, forming sulphate of baryta, which is deposited. This would be too expensive in this country, besides being objectionable on account of the chloride of calcium left in the water. Hydrochloric acid is sometimes added with the chloride of barium to dissolve the carbonates of lime and magnesia, and form the soluble chlorides of calcium and magnesium. In excess this acid would attack the boiler plates.

Carbonate of Baryta decomposes sulphate of lime, with the formation of sulphate of baryta and carbonate of lime, both of which separate as a deposit. The carbonates of lime and magnesia contained in the water are not affected. This method may be applied to water which has been freed from its carbonates by lime water, the carbonate of baryta being introduced into the boiler. Carbonate of lead, which behaves in a similar manner, has been suggested for the same purpose; larger quantities would, however, be required, and it is much more expensive.

Chloride of Ammonium.—This salt is very effective in decomposing the lime and magnesia salts, even after they have been deposited, forming soluble chlorides of calcium and magnesium, carbonate of ammonia, which is rapidly expelled with the steam, and sulphate of ammonia, which remains in solution. The quantity added should, at least, equal the quantity of carbonates of lime and magnesia and sulphate of lime present in solution. When it is desired to loosen a considerable deposit, hydrochloric acid may be cautiously added at the same time. The acetate and nitrate of ammonia resemble the chloride in their action, but are neither as powerful nor as low-priced.

Chloride of Tin has been used by a French engineer. He employed about eight pounds per week for an engine working twelve hours daily. He recommends for large boilers one pound of the salt for every sixteen cubic feet of water. The chloride of tin is decomposed, forming an insoluble basic salt which is deposited, and a soluble acid salt which dissolves the lime and magnesia sediments. It is not equal to chloride of ammonium in effectiveness, and is far too expensive for general use.

Hyposulphate of Soda has been proposed on account of its property of increasing the solubility of sulphate of lime. It would be too expensive in practice.

Catechu, Nutgalls, Oak-bark Shavings and Saw-dust, Tan-bark, Tormentilla-root, Mahogany, Log wood.—These substances all contain more or less tannic acid, associated with soluble extractive and coloring matters. When they are introduced into the boiler, the soluble constituents are dissolved by the water, and basic tannate of lime is formed, which separates as a loose deposit, which does not adhere to the sides of the boiler. It is preferable to use the aqueous extract, as saw-dust, chips, etc., are liable to find their way into the cocks and tubes, although they act mechanically, receiving incrustations, which would otherwise fasten themselves on the sides of the boiler. In selecting one of these substances, one would endeavor to secure the largest quantity of tannic acid and soluble extractive matter for the lowest price. Some of these substances are said to be very effective; one half pound of catechu being sufficient for 100 cubic feet of water. From 4 to 6 pounds of oak chips have been recommended per horse-power, or a half bushel of mahogany chips for every 10 horse-power.

Potatoes, Starch, Bran, Linseed-meal, Gum, Dextrin, Irish Moss, Slippery Elm, Marshmallow-root, Glue.—These substances form, sooner or later, a slimy liquid in the boiler, which prevents more or less completely the settling and hardening of the deposits. Some of them may even hold the lime and magnesia in solution. Potatoes have been used for many years, wherever steam-engines are employed; half a peck or a peck are thrown into the boiler weekly. Linseed-meal mixed with chopped straw was employed on a German railway, a peck at a time being introduced into each boiler. Some writers object to these organic substances on the ground that they are liable to cause frothing.

Sugar, Molasses, Corn or Potato Sirup.—Both cane and grape sugar form soluble compounds with lime salts, and consequently prevent their separation as incrustations. One engineer found that ten pounds of brown sugar protected his boiler for two months, another that six pounds of corn-starch sirup had a similar effect. Another used molasses with success, introducing a gallon at a time.

Blowing-off.—The frequent blowing off of small quantities of water, say a few gallons at a time, is undoubtedly one of the most effective and simple methods for removing sediments and preventing their hardening on the sides of the boiler. The water entering the boiler should be directed in such a way as to sweep the loose particles toward the blow-off cocks, that when these are opened they may be carried out with the water. This blowing off should take place at least two or three times daily, perhaps much oftener. Great care should be taken to avoid emptying the boiler while there is still fire enough to bake the muddy deposits. Washing out frequently is very efficacious.

Metallic Zinc, attached to the plates of the boiler so as to secure actual contact, is probably one of the best preventives of corrosion. As already mentioned, the iron protects the copper and brass tubes by rendering them electro-negative, being itself much more rapidly corroded in consequence. Zinc bears the same relation to iron that iron does to copper, and may be made, therefore, to bear the corrosion. Rolled zinc is preferable to slabs, as the latter are very crystalline, and are consequently very unevenly corroded, soon becoming brittle and working loose.

Incrustation Powders, bearing generally the names of their proprietors, are extensively advertised and sold. They are either worthless or are sold at such extravagant prices as to make their use extremely ill-advised. I have examined several of them. Those which are at all valuable consist of one or more of the substances already mentioned, and the only novel result of their use is the payment of many times the commercial value for a fair article. One which is put up in tin boxes, containing about one pound, at $2 50 each, contains—carbonate of lime, 95·35; carbonate of magnesia, 0·67; oxyd of iron, 4·15; total, 100·17. It differs little from some of the incrustations in composition, and is of no value whatever. Another contains—logwood, 75·00; chloride of ammonium, 15·00; chloride of barium, 10·00; total, 100·00. This is a very good article, but at the price for which it is sold it cannot be used in quantities sufficient to produce much effect. In fact, chloride of barium is too expensive to be used in this country at all.

In conclusion, I would advise as follows:—1. The use of the purest waters that can be obtained; rain water, wherever possible. 2. Frequent use of the blow-off cock. 3. That the boilers never be emptied while there is fire enough to harden the deposits. 4. Frequent washing-out. 5. Experiments on the efficacy of zinc, lime-water, carbonate of soda, carbonate of baryta, chloride of ammonium, some substance containing tannic acid, linseed-meal, and the electro-magnetic inductor.

It has been estimated that every horse employed in farming, consumes one sixth of what he cultivates.

CANADIAN MANUFACTURES.

One of the principal sources of the wealth and prosperity of a country lies in its manufactures. The great and lasting celebrity which Great Britain has attained, and the power and influence which she wields in the scale of nations, have undoubtedly been largely acquired by the magnitude and superiority of her manufactures. These admit of such an indefinite expansion and such an infinite variety, that all degrees of physical and even mental power can find within them a ready adaptation. In the United States, also, the beneficial effects of this department of industry can be readily observed. In Canada, however, the agricultural element is at the present time the most important; and we cannot, at least for some time, look for any extraordinary progress in this direction. But whatever new branches of manufacture are started among us deserve to receive every encouragement at the hands of the public. During the past ten years we have made much progress in manufacturing—all things considered. And we trust they will progress still more rapidly in future. Some short time ago we reviewed the condition of the province, from a manufacturing point of view. We enumerated some of the many branches of industry with which the credit of the country was being built up; and which, through the enterprise and energy of our manufacturers, had been rendered alike remunerative to them and beneficial to the country. We have now to notice another branch of manufacture established in our midst, which is being extensively carried on. On a recent occasion, through the courtesy of the proprietors, Messrs. de B. Macdonald & Co., we had the pleasure to witness the manufacture of crinoline-wire and hoop-skirts—an important feature of Canadian industry. The variety of processes necessary to convert the rough, unpolished wire into the graceful and elastic skirt are as novel as they are interesting. The round wire is first drawn through polished steel rollers, by which it is flattened out; then passed through a furnace of molten lead into whale oil. Thus hardened it is again drawn through molten lead, which reduces it to the temper or elasticity required, and is then fit for covering. The machinery for the latter purpose is one of the most ingenious piece of mechanism which we have ever seen. There are about two hundred circular disks, upon each of which are revolving sixteen small spools holding thread, and all these intermingling and working within the other, with most extraordinary rapidity, and with perfect harmony. These "braiders," as they are called, are decidedly a most unique and curious device.* The multifarious operations are carried on with an exactness and precision which could not be arrived at with ordinary physical labour, and the time consumed is not a tittle of that required if the work were performed by hand. Each of these little machines will in an ordinary working day, cover three hundred and fifty yards of skirt wire. This is certainly a large result, and we congratulate

[* We presume the machine or "braider," here described, is similar to the braider used in the manufacture of whips, and which we have for some years been familiar with in the establishment of J. Threlkeld, of this city.—ED. JOURNAL.]

Messrs. de B. Macdonald & Co., on the successful inauguration of so necessary an article of manufacture. We are glad to see such articles being made in Canada, thus saving to Canadian buyers the amount which would otherwise be spent in paying the cost of transportation from the United States or Europe, besides the customs dues and other necessary expenses. It is quite certain that articles of this class can be produced here for at least 20 per cent. cheaper than they can be imported; and we trust that the trade of the province will in this case encourage home manufactures to such an extent as to render unnecessary any importations from other countries. We understand that these gentlemen contemplate some extensive additions to their establishments, which will enable them to produce some two hundred dozen of these goods per day—representing a value of about two thousand dollars—and giving employment to two hundred or more persons, principally women and girls. These are said to earn on an average four dollars per week each, which is certainly a very remunerative figure. This is, we believe, the only establishment in British North America where the entire process of manufacture is conducted, from the rough, unpolished wire to the finished and fashionable skirt. The enterprise is evidently a valuable one to the country, if properly managed.—*Trade Review.*

UTILIZING SAWDUST—OXALIC ACID.

Sawdust is converted into oxalic acid on an extensive scale in England, by a very simple process. The sawdust is first saturated with a concentrated solution of soda and potash, in the proportion of two of the former to one of the latter; it is then placed in shallow iron pans, under which flues run for a furnace, whereby the iron pans are made hot, and the saturated sawdust runs into a semi-fluid state. It is stirred about actively with rakes, so as to bring it all in contact with the heated surface of the iron, and to granulate it for succeeding operations. It is next placed in similar pans, only slightly heated, by which it is dried. In this state it is an oxalate of soda mixed with potash. Is is then placed in the bed of a filter and a solution of soda is allowed to percolate through it, which carries with it all the potash, leaving it tolerably pure oxalate of soda. It is then transferred to a tank, in which it is mingled with a thin milk of lime, by which it is decomposed, the lime combining with the acid to form the oxalate of lime—the soda being set free. lastly, the oxalate of lime is put into a leaden tank or cistern, and sulphuric acid is poured in; this takes up the lime, and sets free the oxalic acid which readily crystallizes on the sides of the leaden cistern, or on pieces of wood placed for that purpose. This is the cheapest process yet known for making oxalic acid. Another interesting use made of sawdust of hard woods, such as rosewood, ebony, etc., is that recently known in France under the name *bois durci.* The various kinds of sawdust used are reduced to fine powder, and mixed with blood into paste; other materials are doubtless added, for, when pressed into moulds it is a jet black, and receives the most beautiful impressions.—*Scientific American.*

BOILER INSPECTION.*

The subject for the evening was "Boiler Inspection." Mr. Miller read a paper giving a sketch of the origin and progress of the Manchester Boiler Inspection Association, and advocating the adoption of the plan in New York. A discussion followed, in which it was generally agreed that such a system of inspection, in addition to the inspection by the public authorities, would be found advantageous, and paid for by the owners of boilers, as it has been in Manchester. The Manchester association was begun by a few proprietors of boilers, who thought they needed advice from men of more skill than they could afford to employ constantly to run their engines. They agreed to employ a competent engineer to inspect their boilers monthly, and give them such advice as he thought would be useful to them. They also agreed to invite others to join them; and to form an association, if enough were desirous to become members. Their numbers increased; and, in less time than was anticipated, they were able to pay for the whole time of an engineer and other employees. The result was, that many improvements were made, and dangerous faults pointed out and removed; and the boilers under the inspection of the engineer were nearly exempt from explosions, while others around them continued to explode as usual. Reports to the association were made, by its engineer, of outside explosions; and their causes were pointed out, and probably served as useful warnings. The forms of boilers were criticised; devices to keep them clean were observed and discussed; and all the furniture of boilers was studied and explained; and boiler economy generally was inquired into, and soon better understood than it would have been without the information gathered by the engineer, and imparted by him in his reports, and in his visits for the purpose of inspection.

Last year the Manchester association had sufficient funds to employ draughtsmen to make careful drawings of the boilers under the care of the inspectors; and to keep records of their economy. From these records of facts the members can learn much about the advantages of different kinds of boilers, fuel, treatment, and circumstances affecting the durability and economy of boilers. An insurance fund was also commenced; and boilers were insured up to a certain amount. It was held that this special boiler insurance, by an association that studied and inspected boilers, would reduce the extra premiums now charged on buildings that have boilers in or under them; and that in this item enough would be saved to pay for the voluntary inspection.

It was also held that the advice of a good engineer, given in his monthly visits, would save much that is wasted by common engine-men. Above all, it was urged that the safety of life ought to be more carefully guarded than it can be without the monthly supervision of the best engineers.—*American Artisan.*

Manners are more esteemed in society than virtues; though the one is artificial, like false brillants, and the other pure, like real jewels.

* Society for the promotion of Science and Art, N.Y.

STEAM-BOILER EXPLOSIONS.

The *Scientific American*, in commenting on the explosion of the *St. John's* boiler, says :—

"In the history of boiler explosions these two truths stand out prominently: first, those who have investigated the subject most thoroughly are best satisfied that these disasters do not usually result from the mysterious action of uncontrollable forces, but from mechanical defects; second, when sufficient care is taken to avoid these defects, boiler explosions are entirely prevented.

No other persons have examined so many bursted boilers as the experts appointed for this purpose by the Manchester Boiler Association, and no examinations have been made with more care and fidelity. In every case, so far, those intelligent engineers have found some fatal defect in the construction of the boiler, or some impropriety in its management. Not one case has yet come under their observation in which the disaster was produced by any mysterious and uncontrollable agency.

During the long years in which the late John L. Stevens was running his steamboats on the North River, it was his practice to crawl into his boilers after every trip, to sound their plates with a hammer, and to give them a careful inspection. It was also his practice to pay his engineers twenty-five cents per day extra if they would abstain entirely from the use of ardent spirits. Mr. Steven's boilers did not explode.

The Cunard steamers have now been running twenty-five years, rolling and driving their way through the storms of the Atlantic, and no boiler in any one of them has given way. Why not? The theorists may answer as they please—our own opinion is, that it is because they are thoroughly made and properly taken care of.

In so complicated a fabric as a modern steam boiler, where hundreds of pieces of iron are fastened together in various directions, of course any unequal expansion of the several parts from the different temperatures to which they may be exposed, should be provided for; but this provision is only one element in proper construction, and there is no element which has received more attention.

STEARAFFINE CANDLES.

Our attention has been called to the new registered candles lately introduced to the trade by Messrs. Wilkie and Soames, of the Thames Soap Works, Greenwich, under the name of Stearaffine. As may be inferred from the name, they are manufactured from a mixture of stearaffine and paraffine. The result is a very white and hard candle, capable of being highly finished and tinted with the same colours used in those made from paraffine. When lighted they are semi-transparent for some distance from the top, and look very handsome. The light emitted is, if anything, superior to that produced by paraffine alone, while there is a perceptible difference in the cup in favour of the stearaffine. By way of testing their durability in comparison with other candles, we made an experiment, of which the following is the result:—

A six candle, Stearaffine, will burn 9h. 0m.
" " Paraffine, " 8h. 25m.
A six candle, Mould, will burn 7h. 20m.
" " Stearine " 7h. 15m.

This proves the stearaffine to be of longer duration than either stearine or paraffine. They are made in all the known sizes, and are retailed at one shilling per pound. We are informed that the demand for them is very great, and that the manufacturers have created additional works in order to meet the increase in this branch of their business.—*Grocer*.

Useful Receipts.

Remedy For Hard Times.

Produce much; consume little; invest your money in industrial projects; vote for honest candidates, if they are nominated for you; if not, bestir yourself to get them nominated.

To Dissolve Silk.

A concentrated solution of chloride of zinc, which has been boiled with an excess of the oxyd of that metal until it does not discolor litmus, will dissolve silk. By means of the dialyser the silk can be separated from its solvent in the form of a colorless and inodorous solution.

New Way of Filling an Ice-house.

The Utica *Herald* says that the ice-house of L. R. Lyon, of Lyon's Falls, N. Y., has not been empty for twenty years, nor has a pound of ice ever been put into it. The building is constructed after the ordinary method, and when it is designed to fill it, a rose jet is placed upon the water-pipe, and as the water comes through it is chilled and dropped into the ice-house, where it forms one mass of ice.

To Weld Cast-Steel.

Cast-steel may be welded as easily as iron by using the following flux: sixteen parts of borax and one of sal ammoniac, melted and kept boiling over a slow fire for one hour, and, when cold, pulverized. The steel must then be heated as hot as you dare without burning, the powder strewed over the scarf, and proceed as with any other weld.—*Scientific American*.

Vegetable Ivory.

Vegetable ivory shows a red stain where a drop of oil of vitrol is applied, which again disappears on washing it with water. Bone or genuine ivory does not show this reaction.

Pomatums.

(1) A good pomade for general use: One pound of beef suet or two pounds of lard. Care must be taken to procure them as fresh as possible. And, after being separated from all skin and fibre, they must be pounded in a mortar, and then placed in a covered pan of earthenware or metal. This must stand in a vessel of hot water until the fat slowly becomes liquid. It will be found that all the refuse will then be separated, and will sink to the bottom of the pan. The fat in its liquid state is then passed through a filter (clean flannel is the

best). The perfume must now be added, and may be either essence of lemon, bergamot, or any other scent preferred; about three drachms will suffice for the quantity of fat warmed. After this, with a wooden spoon, or knife, the mixture should be continually stirred or beaten until it be thoroughly cool.

(2) One pint of olive oil, two ounces of white wax, one drachm of tincture of cantharides; oil of roses, two drops (or any other scent preferred). Put the oil in a jug, on a hob, and dissolve the wax in it, and then mix in the other ingredients; to be poured into the pots while hot.

To make Hard Soap.

Pour four gallons of boiling water over six pounds of washing soda (sal soda) and three pounds of unslacked lime. Stir the mixture well and let it settle until it is perfectly clear. It is better to let it stand all night, as it takes some time for the sediment to settle. When clear, strain the water, put six pounds of fat with it, and boil for two hours, stirring it most of the time. If it does not seem thin enough, put another gallon of water on the grounds, stir and drain off, and add as is wanted to the boiling mixture. Its thickness can be tried by occasionally putting a little on a plate to cool. Stir in a handful of salt just before taking it off the fire. Have a tub ready soaked, to prevent the soap from sticking, pour it in, and let it settle until solid, when you will have from the above quantity of ingredients about forty pounds of nice white soap.

WAXES.

Black Sealing-wax.

1. Shell-lac 2 parts; yellow resin 3 parts; ivory black 2 parts. Powder fine, and mix by melting carefully.

2. Yellow resin 15 pounds; lard 1 pound; beeswax 1 pound; lamp-black 3 pounds. Mix with heat.

Soft Sealing-wax.

Yellow resin 1 part; beeswax 4 parts; lard 1 part; Venice turpentine 1 part; colour to fancy. Mix with a gentle heat.

Gold Coloured Sealing-wax.

1. Bleached shell-lac 1 pound; Venice turpentine 4 ounces. Melt, and add gold coloured talc as required.

2. Bleached shell-lac 3 pounds; turpentine 1 pound; Dutch leaf, ground fine, 1 pound or less. Mix with a gentle heat. The leaf should be ground or powdered sufficiently fine without being reduced to dust.

Green Sealing-wax.

Shell-lac 2 parts; yellow resin 1 part; verdigris 1 part. Powder and mix by heating slowly.

Scented Sealing-wax.

1. Balsam of Peru 2 parts; sealing-wax composition 130 parts. Mix with a gentle heat.

2. Sealing-wax composition 99 parts; essence of musk 3 parts. Add the latter when the wax is cooling, and stir well.

3. Wax composition 96 parts; oil of lavender 4 parts; oil of lemon 3 parts. As before.

Blue Sealing-wax.

Shell-lac 2 parts; smalts 1 part; yellow resin 2 parts. Powder, and mix carefully with heat.

Red Sealing-wax.

1. Shell-lac 2 parts; resin 1 part; vermillion 1 part. Powder fine, and melt over a slow fire.

2. Yellow resin 14 parts; Venetian turpentine 4 parts; beeswax 1 part; red or orange lead 5 parts. Mix with heat.

3. Oil of turpentine 1 part; lard 1 part; vermillion 2 parts; gum-lac 12 parts. Mix with a gentle heat.

4. (Very fine.)—Shell-lac 4 parts; Venice turpentine 1 part; Vermillion 3 parts. Mix.

Engravers' Border Wax.

Beeswax 1 part; pitch 2 parts; tallow 1. Mix.

Black Bottle Wax.

Common resin 20 pounds; tallow 5 pounds; lamp-black 4 pounds. Mix with heat.

Red Bottle Wax.

Common resin 15 pounds; tallow 4 pounds; red lead 5 pounds. Mix with heat. Any colour may be employed.

Marbled Sealing-wax.

Take wax of different colours and melt them in separate vessels, and when they begin to cool a little stir them all together, and form the mass into sticks.

Practical Memoranda.

Absorption of Heat.

The following table shows the influence of surface as to the capability of a body being warmed, and supposing 100 incident rays of heat to fall on a surface of lampblack, and the whole to be aborbed.

Blacklead would also absorb		100
Writing paper	"	98
Common glass	"	90
China Ink	"	85
Rock salt	"	72
Silvered glass	"	27
Mercury	"	23
Polished iron	"	23
Polished zinc	"	19
Polished steel	"	17
Platina, slightly pol.	"	24
" in thin leaves	"	17
Tin	"	14
Speculum metal, pol.	"	14
Brass, highly polished	"	7
Copper	"	7
Gold	"	5
Silver, polished	"	3

Lampblack absorbs all the rays of heat from whatever source they fall upon it, and the absorptive power of metallic surfaces, though small, is uniform for different sources. The less intense the source of heat, the greater is the amount usually absorbed. Franklin observed that when peices of cloth of different colours, but the same size and texture, were placed on newly fallen snow, the snow melted with greatest rapidity under the cloths of darker colour, the absorption being greatest with black, less with blue, still less with green, and diminishing with purple, red, yellow, and white."—*Tomlinson.*

Analysis of certain Organic Substances.

	Carbon.	Hydrogen.	Oxygen.	Nitrogen	Total.
Sugar	42·225	6·600	51·175	—	100
Starch	44·250	6·674	49·076	—	100
Gum	42·682	6·374	50·944	—	100
Lignin	52·53	5·69	41·78	—	100
Tannin......	52·590	3·825	43·585	—	100
Indigo	73·260	2·500	10·43	13·81	100
Camphor ...	73·38	10·67	14·61	·84	100
Caoutchouc	87·2	12·8	——	—	100
Albumen ...	52 883	7·540	23·872	15·706	100
Fibrin.......	53·36	7·021	19·685	19·934	100
Casein	59.781	7·429	11·409	21·381	100
Urea	18·9	9·7	26·2	45·2	100
Gelatine ...	47·881	7·914	27·207	16·998	100
Picromel ...	54·53	1·82	43·65	—	100
Hordein	44·2	6·4	47·6	1·8	100
Emelin......	64.57	7·77	22·95	4·3	100
Veratrin ...	66·75	8·54	19·60	5·04	100
Qinchonin ..	77·81	7·37	5·93	8·89	100
Cuinin	75·76	7·52	8·61	8·11	100
Brucin	70·88	6·66	17·39	5·07	100
Strychnin ..	76·43	6·70	11·06	5·81	100
Narcotin ...	65 00	5·50	26·99	2.51	100
Morphin....	72·340	6·366	16·299	4·995	100

Conducting Power of Metals.

The relative conducting power of forged iron, steel, and cast-iron, are 436, 397 and 359, taking silver, which is the best conductor, at 1,000.

Atmospheric Pressure.

The body of an average sized man presents a surface of about 2,160 square inches, or 15 square feet, and consequently sustains at the sea level a total pressure of 34,400 lbs., or nearly fourteen tons and a half.

Statistical Information.

Gold and Silver.

In forty years, from 1790 to 1830, Mexico produced, according to the *Mining Journal*, about $32,000,000 worth of gold, and $699,000,000 of silver. Chili, $13,000,000 of gold and $91,000,000 of silver. Russia, $18,000,000 of gold, and $7,000,000 of silver. Buenos Ayres $20,000,000 of gold, and $136,000,000 of silver. Total 1,016 millions of dollars, or $25,400,000 per annum. The *London Engineer* says silver was formerly found in such quantities in Spain, that, according to Pliny, Hannibal extracted a daily quantity equal in value to about $1,500, from a mine worked by him near Carthagena. Cato delivered into the Treasury 2,500 lbs. of silver in bars, and 120,000 in money, besides 400 lbs. of gold, all of which he accumulated in Spain. Helvetius, who was once Governor of Andalusia, delivered 37,000 lbs. of silver coin, and 40,000 lbs. in bars.

More than 500,000 oz. of silver are annually obtained from British lead ores, by Pattinson's process; and during 1864 there was obtained from five mines in Merionethshire 2,336 tons of auriferous quartz, which, when crushed by the amalgamating process, produced 2,887 oz. of gold, the value of which was nearly $50,000.

Export Trade from 1850 to 1864-5.

Exports to	Gt. Britain.	British Colonies. In North America.	British Colonies. In West Indies.	U. States.*	Other Countries.	Totals.
1850...	$3,803,399	$1,808,776	$8,376	$5,933,243	$108,281	$12,943,795
1851...	6,021,401	1,037,519	3,912	4,917,429	164,144	13,810,604
1852...	6,756,857	812,139	13,961	7,536,155	188,495	15,307,607
1853...	11,465,408	1,380,466	....	10,725,455	229,974	23,801,303
1854...	10,876,714	1,529,275	8,989	10,418,883	185,329	23,019,190
1855...	6,738,441	1,023,447	3,749	20,002,291	420,533	28,188,461
1856...	10,467,744	1,086,041	10,803	20,218,654	263,775	32,047,017
1857...	11,102,045	875,239	....	14,762,641	266,699	27,006,624
1858...	8,898,611	960,428	....	13,373,138	240,432	23,472,609
1859...	7,976,758	840,475	7,025	15,586,917	355,806	24,766,981
1860...	12,839,069	723,534	....	20,698,396	376,889	34,631,890
1861...	18,907,105	1,030,939	12,382	16,283,374	380,395	36,614,295
1862...	15,224,417	826,871	13,775	16,980,810	550,252	33,596,125
1863...	17,463,718	935,196	57,542	22,534,074	841,002	31,831,532
½1864...	4,728,280	348,090	14,016	8,699,093	94,029	13,883,508
1864–5	14,726,008	1,065,057	41,313	25,812,923	835,850	42,481,151

* The exports to the United States include the "Estimated amounts not returned at inland ports."

Thus our Total Export Trade has trebled since 1850. Our exports to the States have quadrupled. These to other countries have, however, expanded most, being now eight times what they were fifteen years ago. Our exports to the British North American Colonies have remained about the same figure.—*Trade Review.*

Marine Disasters, U. S., 1865.

The New York *Shipping List* gives the following Statistics of the whole number of vessels belonging to the United States which have been lost during the last twelve months:

	No.	Value.		No	Value.
January	34...	$690,000	July	22...	$500,000
February	26...	302,000	August	35...	1,092,000
March	29...	625,000	Septem.	34...	603,000
April	23...	795,000	October	49...	850,000
May	18 ..	330,000	Novem.	77...	1,500,000
June	18...	650,000	December	80...	1,800,000
				445	9,737,000

British Railway Locomotives.

At the close of 1863 the railways of Great Britain had 6,643 locomotives; at the close of 1846 they had 7,203—increase 560. At the close of the latter year the number on English and Welsh railways was 5,708, Scotch railways 1,072, and Irish railways 423.

Copper.

Chili furnishes England with most of her copper. Out of 66,916 tons of ore imported into England in 1864, 20,664 were from Chili; and of pure copper, Chili also furnished 304,380 cwt. out of an aggregate of 498,780.

Railroad Returns.

The Railroad Traffic Returns show that the various lines continue to do an enormous business. The statement for November is as under:

	Nov. 1865.	Nov. 1864.
Great Western Railway.......	$320,006	$223,815
Grand Trunk Railway........	584,426	472,805
Welland Railway	16,528	4,346
Northern Railway	46,684	21,429
P. Hope, Lindsay & Beav.Ry.	9,478	6,850
Port Hope & Peterboro' Ry..	5,357	....
Brockville & Ottawa Ry......	8,881	5,852
Prescott & Ottawa Railway...	8,770	8,470
Total	$1,000,130	$738,567

There were 1,960 miles open in 1864, and 2,050 in 1865.

The various classes of traffic which made up the monthly aggregate of 1865 were:—Passenger, 373,047; Mails, &c., 33,105; Freight, 593,980.—*Globe.*

Miscellaneous.

The Poison of the Rattlesnake.

Dr. J. W. Burnett recently related before the "Boston Natural History Society" some experiments and investigations made with the rattlesnake, which will be found interesting to those inclined to pet the venomous beast. We give an extract below:

"The virulence of the poison of these animals is too well known for special description. I will only add, there is good reason for the belief that its action is the same upon all living things, vegetables as well as animals. It is even just as fatal to the snake itself as to other animals; for Dr. Dearing informed me that one of his specimens, after being irritated and annoyed in his cage, in moving suddenly, accidentally struck one of its fangs into its own body; it soon rolled over and died as any other animal would have done. Here then we have the remarkable, and perhaps unique physiological fact, of a liquid secreted directly from the blood, which proves deadly when introduced into the very source (the blood) from which it was derived! With the view of ascertaining the power and amount of this poison, Dr. Dearing performed the following experiment:—The snake was a very large and vicious one, and very active at the time. He took eight half-grown chickens, and allowed the snake to strike at each under the wing as fast as they could be presented to him. The first died immediately; the second after a few minutes; the third after ten minutes; the fourth after more than an hour; the fifth after twelve hours; the sixth was sick and drooping for several days, but recovered; the seventh was only slightly affected, and the eighth not at all. With my second remaining specimen I was desirous of performing several experiments as to the action of this poison on the blood. The following is one:—The snake was a very large and vicious one, and as any one approached the cage, began to rattle violently; but twenty-five or thirty drops of chloroform being allowed to fall on his head, one slowly after the other, the sound of his rattles gradually died away, and in a few minutes he was wholly under the effects of this agent. He was then adroitly seized behind the jaws with the thumb and forefinger, and dragged from the cage and allowed to partially resuscitate; in this state, a second person held his tail to prevent his coiling around the arm of the first, while a third opened his mouth, and with a pair of forceps pressed the fang upward, causing a flow of the poison, which was received on the end of a scalpel. The snake was then returned into the cage. Blood was then extracted from a finger for microscopic examination. The smallest quantity of the poison being presented to the blood between the glasses, a change was immediately perceived—the corpuscles ceased to run and pile together, and remained stagnant without any special alteration of structure; the whole appearance was as though the vitality of the blood had been suddenly destroyed, exactly as in death from lightning. This agrees, also, with another experiment performed on a fowl, where the whole mass of the blood appeared quite liquid, and having very little coagulable power. The physiological action of this poison in animals is probably that of a most powerful sedative acting through the blood on the nervous centers. This is shown by the remarkable fact that its full and complete antidotes are the most active stimulants: of these, alcohol, in some shape, is the best."

The Forces in Nature.

"The concussion of 1 pound of hydrogen with 8 pounds of oxygen is equal, in mechanical value, to the raising of 47,000,000 pounds one foot high. I think I did not overrate matters when I said that the force of gravity, as exerted near the earth, was almost a vanishing quantity in comparison with these molecular forces; and bear in mind the distances which separate the atoms before combination—distances so small as to be utterly immeasurable; still, it is in passing over these distances that the atoms require a velocity sufficient to cause them to clash with the tremendous energy indicated by the above numbers. After combination the substance is in a state of vapor, which sinks to 212°, and afterwards condenses to water. In the first instance the atoms fall together to form the compound; in the next instance the molecules of the compound fall together to form a liquid. The mechanical value of this act can be also calculated; 9 pounds of steam, in falling to water, generate an amount of heat sufficient to raise 956 into 9=8,614 pounds of water 1° Fahr. Multiplying this number by 772, we have a product of 6,718,716 foot-pounds (a foot-pound is a pound raised one foot high) as the mechanical value of the mere act of condensation. The next great fall of our 9 pounds of water is from the state of liquid to that of ice, and the mechanical value of this act is equal to 993,564 foot-pounds. Thus on 9 pounds of water, in its origin and progress, falls down three great precipices; the first fall is equivalent to the descent of a ton weight, urged by gravity, down a precipice 22,320 feet high; the second fall is equal to that of a ton down a precipice 2,900 feet high; and the third is equal to the descent of a ton down a precipice 433 feet high. I have seen the wild stone-avalanches of the Alps, which smoke and thunder down the declivities with a vehemence almost sufficient to stun the observer. I have also seen snow-flakes descending so softly as not to hurt the fragile spangles of which they were composed; yet, to produce from aqueous vapor a quantity of that tender material which a child could carry, demands an exertion of energy competent to gather up the shattered blocks of the largest stone avalanche I have ever seen, and pitch them to twice the height from which they fell."—*Tyndall on Heat.*

Nitro-Glycerin.

The last number of *Le Genie Industriel* has an article by M. Alfred Noble, engineer, setting forth at length, the advantages of nitro-glycerin over gunpowder for blasting rocks. The economy claimed is in the cost of drilling the rocks, as much smaller holes suffice, owing to the greater explosive force of nitro-glycerin. M. Nobel says that this force is in hard rocks from eight to ten times that of ordinary blasting powder, and in soft rocks from twenty to thirty times.

"Four principal causes contribute to its superior explosive force:—1st, its great specific gravity, which permits the introduction into a hole of nearly double the weight of powder which the same hole will receive; 2nd, its perfect gasification, leaving no solid residue; 3rd, its richness in oxygen, which produces complete combustion; 4th its extraordinary suddenness of explosion.

"According to Regnault, gunpowder, in burning, forms, theoretically, 260 times its volume of gas, taken cold, but in practice, owing to incomplete combustion, it does not exceed 200 volumes.

"It is evident that gunpowder, the combustion of which is very incomplete, cannot produce an elevation of temperature so great as nitro-glycerin, of which all the carbon is transformed into carbonic acid, and all the hydrogen into water. This is proved in practice by the fact that a small addition of nitro-glycerin to powder communicates much more brilliancy to the flame. It is difficult to measure the heat of an explosive substance, but, in view of the above mentioned circumstance, it will be admitted that the temperature of the flame ought to be nearly double that of gunpowder. We shall have then for powder 200 volumes, which, with a quadruple expansion, will be 800 volumes, and for nitro-glycerin 1,288—in round numbers 1,300 volumes—which, with an octuple expansion, will be 10,400."

Nitro-glycerin is made by dropping glycerin into a mixture of equal parts of strong nitric and sulphuric acids. It is a heavy oily liquid, its specific gravity being 1·6. It is insoluble in water, and the usual plan is to fill the hole above it with water in place of tamping, and then to fire it with a safety fuse, having a heavily charged percussion cap at its lower end. This mode of firing has been patented in France and other countries.

According to M. Nobel, nitro-glycerin does not explode by direct fire, decomposing itself with flame by contact with an ignited body, but being extinguished so soon as the hot body is removed. He also says that it detonates under a violent blow of a hammer, but only the part that is struck explodes; the fire is not propagated to the surrounding portions. A few drops spread on an anvil may, by repeated blows, produce a series of explosions. By the gradual application of heat it explodes at 180° Cent.—356° Fah. It is a very permanent compound, preserving itself indefinitely, and not being decomposed by either phosphorous or potassium.

He does not understand how the sample, ten pounds, which exploded at the Wyoming Hotel, could have been ignited; but he has found that organic textures charred by sulphuric acid will ignite nitro-glycerin, and thinks that may give a clue. If lighted by a match, it burns like oil; but if heated to 360° it explodes. It is less dangerous than gunpowder. Three hundred pounds were exploded close to a large building in Stockholm, and did little damage beyond breaking the glass.

A Protest Against Pharaoh's Serpents.

On the 13th of November, a meeting of the Pharmaceutical Society, of Great Britain, was held at Edinburgh, and, in the course of the proceedings, the following communication was read from Dr. Stevenson M'Adam on the poisonous ingredients in the new toy called Pharaoh's serpents:—"The chemical toy which is now sold largely in many shops in this city, at prices ranging from three pence to one shilling each, is composed of a highly dangerous and poisonous substance called the sulpho-cyanide of mercury. The material is a double-headed poisoned arrow, for it contains two poisonous ingredients, viz., mercury and sulpho-cyanic acid, either of which will kill. Experiments have been made by me upon the lower animals, and I have found that one-half of a sixpenny Pharoah's serpent is sufficient to poison a large-sized rabbit in an hour and three-quarters. A less dose also destroys life, but takes longer to do so. The toy therefore, is much too deadly to be regarded as merely amusing; and, seeing that it can be purchased by every school-boy, and be brought home to the nursery, it is rather alarming to think that there is enough of poison in one of the serpents to destroy the life of several children; and the more so that the so-called Pharoah's serpent is covered with bright tinfoil, and much resembles in outward appearance, a piece of chocolate or a comfit. I hope that the rage for the Pharoah's serpents will die out in Edinburgh without any disastrous consequences, though such have occurred in other places; but it is certainly an anomaly in the law of the kingdom that a grain of arsenic cannot be purchased except under proper restrictions, and that such articles as Pharaoh's serpents, containing as deadly a poison, may be sold in any quantity, and be purchased by any school-boy or child."

Inspiring Air under various Influences.

The following interesting results were obtained from experiments made by Dr. Edward Smith, on the quantity of air inspired throughout the day and night, under various influences. The total quantity of air inspired in twenty-four hours, allowance being made for intervals amounting altogether to 40 minutes, during which records were not taken, was 711,060 cubic inches; or an average of 29,627 cubic inches per hour, and 493·6 per minute. The quantity was much less during the night than during the day. There was an increase as the morning advanced, and a decrease at about 8 h. 30 m., p.m., but most suddenly at about 11 p.m. The average depth of respiration was 26·5 cubic inches, with a minimum of 18·1 cubic inches in the night, and a maximum of 32·2 cubic inches at 1 h. 30 m., p.m. The mean rate of the pulse was 76 per minute. The amount of breathing was greater in the standing than in the sitting posture. It was increased by riding on horseback, according to the pace, also by riding in or on an omnibus. In railway travelling the increase was greater in a second than in a first-class carriage, and greatest in the third-class and on the engine. Bending forward whilst sitting lessened it. The quantity of inspired air was increased by exposure to the heat and light of the sun, and lessened in darkness. When tea was taken an increase was the result; coffee caused a decrease. Supper of bread and milk also caused a decrease, but milk by itself or with suet caused an increase. An increase was obtained with the following articles of diet, viz., eggs, beef steak, jelly, white bread, oatmeal, potatoes, sugar, tea, rum. The following caused a decrease, viz., butter, fat of beef, olive oil, cod-liver oil, arrow-root, brandy, and kirchenwasser.—*London Engineer.*

Stimulants.

It is generally agreed that excessive use of stimulants is injurious; even those who have become so addicted to them that they suffer pain without them admit that they are injurious; and some go so far as to denounce tea and coffee as injurious. On the other side are many who maintain that stimulants when not abused, are beneficial. We assume that the latter are more correct, for the purpose of an argument on a kind of stimulus that has been accidentally tried, to a small extent.

It has been observed, in sinking shafts, and other works in which the men worked under pressure, in an atmosphere more dense than usual, that they had more energy. And it has been proposed to vary the pressure of the air breathed by invalids. Now we think it worthy of inquiry, and of experiment, whether this kind of stimulus may not be better than those in common use.

Washington Irving, in his "Tour on the Prairies," says that after sleeping in the open air for many weeks, it seemed almost suffocating to sleep in a room, even with windows wide open; the sensation was that of unwholesomeness, after enjoying the pure air for so long a time. And every observing person must have noticed the *anti*-stimulating effects of the air of crowded and unventilated rooms; the effects of the contaminated air in them seems to excite a craving for stimulants; and it may not be unimportant to consider whether we do not need more stimulus than we usually get in our houses, in which we are shut up most of the time; and whether compression of the air might not excite us to greater energy. Of course the purity of the air is the first to be attended to; but when extraordinary work is to be done, may not the stimulus of increased density give the temporary energy required for it?

That intellectual labour is aided by stimulants is held by many; and the opinion is confirmed by the habits of a great portion of intellectual labourers, who have used spirits, coffee, tea, tobacco, and sometimes opium, to such excess as to injure them, and to excite the general censure of others. We assume, for the argument, that these were not *mere* indulgences, but had something of the invigorating effect claimed for them; and we inquire whether the stimulus of compressed air would not be as effective and less injurious. If the answer be favourable to a trial, an engineering question will arise. How can we best construct rooms to bear pressure, and supply them with air?

The use of iron for buildings suggests the answer. It is practicable, at little cost, to construct rooms to bear five or six or even fifteen pounds outward pressure, and to light them well; and the supply of air by pumps is a matter of no difficulty. And it may be observed that the compression will warm the air. The engineering question will easily be settled, if the proper authorities deem it likely that compressed air may be useful to men who now use common stimulants, or to invalids.—*American Artisan.*

Length of Geological Periods.

All the facts of geology tend to indicate an antiquity of which we are beginning to form but a dim idea. Take, for instance, one single formation —our well known chalk. This consists entirely of shells and fragments of shells deposited at the bottom of an ancient sea far away from any continent. Such a process as this must be very slow; probably we should be much above the mark if we were to assume a rate of deposition of ten inches in a century. Now the chalk is more than 1,000 feet in thickness, and would have required, therefore, more than 120,000 years for its formation. The fossiliferous beds of Great Britain, as a whole, are more than 7,000 feet in thickness, and many which, with us, measure only a few inches, on the Continent expand into strata of immense depth; while others of great importance elsewhere are wholly wanting with us, for it is evident that during all the different periods in which Great Britain has been dry land, strata has been forming (as is, for example, the case now) elsewhere, and not with us. Moreover, we must remember that many of the strata now existing have been formed at the expense of older ones; thus all the flint gravels in the south-east of England have been produced by the destruction of chalk. This again is a very slow process. It has been estimated that a cliff 500 feet high will be worn away at the rate of an inch in a century. This may seem a low rate, but we must bear in mind that along any line of coast there are comparatively few points which are suffering at one time, and that even on these, when a fall of cliff has taken place, the fragments serve as a protection to the coast until they have been gradually removed by the waves. The Wealden Valley is twenty-two miles in breadth, and on these data it has been calculated that the denundation of the Weald must have required more than 150,000,000 of years.—*Lubbock's Pre-historic Times.*

Work and Waste.

Every manifestation of physical force involves the metamorphosis of a certain quantity of matter. Prof. Houghton, of Trinity College, Dublin, asserts, as the result of his investigations, that, in the human organism, there is a definite relation between the amount of force exerted and the amount of urea generated. The urea formed daily in a healthy man, weighing 150 pounds, fluctuates from 400 to 650 grains. Of this, 300 grains are the result of vital work, that is, of force expended in the motions of the digestive organs and the heart, and in sustaining the temperature of the body at a uniform rate. This amount exceeds all other force generated and expended in the system, and is equal to that required to raise 769 tons one foot high. In addition to the mere act of living, the working man undergoes bodily labour equivalent to lifting 200 tons one foot high daily, which requires the formation of 77·38 grains urea. *The force expended in two hours of hard mental labor involves an expenditure of power equal to lifting* 222 *foot-tons,* and a generation of urea weighing 86 grains. Thus we have a minimum formation of urea during 24 hours, amounting to 477·38 grains, for which there is expended force equal to 969 foot-tons.—*Annual of Scientific Discovery for* 1865.

In commenting on the above, the editor of *The Circular* (Wallingford, Conn.) says:—Those who fancy that the student or the writer who sits almost motionless at his desk is 'doing nothing,' should note the above statements, particularly the one we have italicized. According to the test given by this writer, the brain-worker expends in two hours more lifting force than the Irishman does in a whole day's digging in a canal."—*American Artisan.*

Town Sewage.

The Authorities of the "Chorlton" District, England, have instituted an action against the trustees of the Bridgwater Canal, for a Nuisance. The *Gaslight Journal* says:—

The defendants reply, "We are not guilty; we "are the sufferers by the pollution of rivers from "which we draw our legitimate supply of water". The trial will be amusing and profitable to the lawyers. In the end, no matter by whom created, the nuisance must be abated. The residents near polluted rivers and canals now see how fortunate it is that all England was not compelled, as Mr. Chadwick intended, to adopt the water-closet system, before any arrangements had been made or could be made for the construction of intercepting main sewers. Nothing can be cleaner or more luxurious than the water-closet system where it can be carried out in perfection, as it will be in the metropolis when the Thames embankments and the sub-incumbent sewers are completed. But in many districts of England where physical geographical difficulties are in the way of the safe disposal of sewage rivers, the best security against poisonous nuisance is to be found in dry deodorization. Coal ashes are a wonderful deodorizer, and the mixture is worth something, at the worst and lowest, the cost of cartage for manure, if the quantity weekly produced be not absolutely overwhelming. But then some pains must be taken to mix the dust and the foul stuff by plain sensible directions which working people can understand. The water-closet system in a village or small town deprives the neighbourhood of valuable garden manure, and is often an unmitigated nuisance into the bargain—the cause of chronic stinks on land and poisoned rivers.

Coal-gas Explosions.

If sixteen parts of air be mixed with one of coal gas, the mixture will explode feebly, and with little force; but if the proportions be gradually altered from sixteen parts of air and one of coal gas down to ten parts of air and one of coal gas, the violence or explosive power of the mixture will be seen to increase gradually, until this latter mixture is reached, when the explosive power attains its maximum. If, now, we still go on diminishing the proportion of atmospheric air, we shall perceive that the explosive power of the mixture also dsminishes until we reach a point at which two parts only of air are mixed with one of coal gas when the power of explosion in the mixture ceases altogether, or becomes *nil.* Briefly, then, seventeen parts of atmospheric air and one of coal gas will neither explode nor burn; ten parts of air and one of gas wlll explode violently; and two parts of air and one of gas will burn, but will not explode; and within the range of these limits mixtures may be formed having any required degree of explosive force.—*Scientific American.*

Vegetable Electricity.

A Dr. Baconia, of Milan, who has been experimenting on electricity produced from vegetable substances, finds that a few alternations of slices of beetroot and walnut wood will set free electricity enough to excite convulsions in a frog, when conveyed to its muscles by means of a conductor formed of scurvy grass.

South American Meat.

ANOTHER attempt is being made to bring to Europe the immense supply of good meat wasted in South America. Mr. Liebert, of Hamburgh, has, it is said, attempted the manufacture of Liebig's "ex tractum carnis" at Feray Bentos, in Uruguay and sends home about 4,000 lbs. yearly. He is now increasing his establishments, has concluded a contract with the British Admiralty, and hopes soon to supply the extract at 16s. a pound. Each pound is the equivalent of 130 lbs. of meat, and will furnish broth for 128 men. The extract in its best state is absolutely free from fat or gelatine, and is now used very largely in continental hospitals.

Phosphate of Iron in Blood.

Mr. James Bruce says that the red particles in blood are caused by phosphate of iron, for by adding this preparation of iron to blood, or to the white of an egg beaten up with distilled water, a beautiful red color is produced. Mr. Bruce further states that its presence in the blood serves the purpose of heating and thinning it, promoting its intestine motion, as well as helping it through its passages (from its superior gravity) by increasing its weight and force against them, therefore, any obstruction in the glands or capillary vessels must sooner be removed by such metallic particles than by those which are lighter. Iron, he adds, is the only metal friendly to the human constitution; but its use, where iron medicines are called for, must not be persevered in for any length of time, as any large excess in the blood would only serve by its pressure against the sides of the vessels to cause internal hemorrhage. The last fact was evidenced in the treatment of the cattle plague, the excrements of the cows being mixed with blood, where large doses of iron were administered, and which is not one of the recognized symptoms of the epidemic.

To Clear a Boat of water without Bailing.

A correspondent of the *Scientific American* writes:—

"If you have a boat that leaks badly, and it is in a strong current, or if you are towing it up stream, all you have to do to keep it dry is this: bore a hole in the bottom and insert a piece of tin or iron, half round, through the hole, letting it extend a few inches below the bottom of the boat, and all the water will run out without any labour. I think a ship at sea could be kept afloat if you could keep her going four miles per hour."

Poisonous Matter in Tobacco.

One good Havana cigar is found by Dr. Richardson to yield, when the smoke is condensed, a sufficient amount of poisonous matter to induce active convulsions in a rabbit, and six pipes of common shag tobacco will yield sufficient poison to destroy a rabbit in three minutes.

Water Barometer.

Mr. Alfred Bird, analytical chemist, of Birmingham, has constructed a water barometer which shows the fluctuations of atmospheric pressure thirteen times more accurately than they are shown by a mercurial barometer. The water in it seems to be in perpetual motion, resembling respiration; the times of the oscillations being about 4′ 20″, and their lengths from 1-30th to 1-20th of an inch. The water is deprived of air, and the water in the reservoir is covered with olive oil. An interesting diagram of the fluctuations of atmospheric pressure during a thunder-storm is given, also an engraving of the instrument, and a long description of its construction, are given in the *Chemical News* of Dec. 8:

How to Cure Scalds from Steam.

All readers of the *Scientific American*, but more particularly engineers, should read and remember the simple remedy here given for a most painful affliction. Engineers are often exposed to burning by steam, and it fortunately happpens that the materials here recommended as a sovereign cure are always at hand. The *Medical and Surgical Reporter* says:—

"Mary S., æt. 30, was scalded a few days ago with the steam from hot ashes. The scald is on the middle of the chest, and about one foot square. The surface is raw, and covered with lymph. It is only a superficial scald, embracing the cuticle, and, at some points, the true skin. It is covered with granulations. The pain she suffered for a few days was intense; she could not sleep at all, but when the ordinary white lead, mixed to a thick cream, with linseed oil was applied, in her own words. 'it took her up to heaven.' She is doing well under its use. No danger exists from lead-poisoning, and if it did, sulphuric acid lemonade would be the only prophylactic needed."

Sulphuric acid lemonode, we take to mean water slightly acidulated with vitrol.—*Scientific American.*

Decimal Weights and Measures in Germany.

A special commission, which has been recently appointed by the Federal States of Germany, for the purpose of equalising the different standards of weights and measures prevailing in the country, has decided in favour of the French metre and its cubic multiples; and there is little doubt that the new standard will be approved by the various States.

Production of Aniline.

It requires as many as 2,000 tons of coal to produce a small circular block of aniline, 20in. high by 9in. wide. This quantity is sufficient to dye three hundred miles of silk fabric.—*London, Eng.*

Vinegar-Eels.

Vinegar-eels live in water that has sugar in it, and in saccharine fruits and roots. In water with 5 per cent. of sugar they increase in great numbers; and the increase becomes more rapid until the water holds 40 per cent of sugar. When it holds 50 per cent. they perish. They are found only in vinegar made from fruit. They live in fruit that has fallen, and in roots; and they have powers of locomotion through earth, and live in it for some time.

Storing Corn.

In Russia corn is stored in pits dug in the soil, the sides of which are hardened by long exposure to fire. Before the grain is introduced straw is ignited in the pit to purify and dry the air. The grain is thrown in and packed close. It has been thus preservéd forty years, it is said.

Blood-stains.

A few years ago a man under trial for murder in Western New York asserted that blood-stains on on axe found in his possession were from a dog which he had killed. The case was referred to Prof. Hadley, of Buffalo, who was purposely kept in ignorance of all the circumstances. Submitting the blood stains to microscopic inspection, he declared that they were from a dog, thus confirming the poor man's testimony.