THE JOURNAL
OF THE
Board of Arts and Manufactures
FOR UPPER CANADA.

JULY, 1864.

JACQUES & HAY'S CABINET FACTORY.

One of the great objects of this Journal being to keep its readers well-informed as to the manufacturing industry of the country, we propose to give a brief sketch of Messrs. Jacques & Hay's cabinet and furniture factory. Before taking our readers thither, however, it may not be amiss to say a few words about the raw material of which so large a quantity is worked up there.

The subject of Canadian woods, which has so long interested the merchant and artizan of other countries, cannot fail to engage the attention of our own people. The fact indeed of their growing so greatly in favor of late, should awaken a deeper interest in our forest productions as a source of wealth and prosperity to the country. We scarcely need specify any particular purposes for which our woods are adapted, because we believe that they are suitable to nearly all purposes to which the material is applied. At the several international exhibitions the beautiful samples of Canadian woods have elicited general admiration; and, at the late Exhibition for 1862, a commission from Lloyd's was sent to the Canadian department for the purpose of making extended investigations into the nature of these woods. The result was, that in "Lloyd's Register of British and Foreign Shipping," for the years 1863 and 1864, a number of our Canadian woods were added to their list, and raised to a high standard for ship-building purposes, in comparison with woods of other countries.

"Black-walnut, hickory, black-birch, and white and red cedar, are added to the list of timbers for vessels classed A; and black-elm, hickory, white-oak, beech, chesnut, red-cedar, tamarac and birch-pine, are allowed the highest place for outside planking from the keel to the first buttock heads in ships of twelve years in class A. The important uses made of Canadian timber in every part of the ship, inside and out, and which secure the highest standard in their registration, is shewn in table A." The jurors also in their report stated, that "at no previous exhibition in this or any other country has so splendid and valuable a display of the products of the forests and plantations been exhibited, not only when we consider the magnitude of the various collections sent from almost every country, but also in regard to the admirable care shewn in the preparation of the specimens;" and that "in point of size of specimens, excellent selection, and information given, the Upper Canada collection is undoubtedly the finest in the exhibition building."

Already we export annually in the form of logs, thirty millions of cubic feet, and of sawn timber we export every year four hundred millions of feet, board measure. The revenue derived from these in 1860, was five hundred thousand dollars.

The value of our forest products exported in

The year	1860	was	$11,012,253
"	1861	"	9,572,645
"	1862	"	9,482,897

For our finest woods the demand, we think, must grow much larger, from the fact that in South America and in the West Indies, rosewood and mahogany are becoming very scarce.

From its susceptibility of a very high polish and its peculiar adaptation for displaying ornamental carving, black-walnut will, doubtless, become the favorite wood here, as it already has in the United States.

Our cabinet makers here will act wisely in seeking, if they have not already found, the best possible methods of treating their woods so as to enhance their beauty. We are anxious that our native workmen should not be excelled, and there is no reason why they should be. With a continually advancing power and skill to work up our raw material, we should become large exporters of furniture and cabinet-ware. All that is required in the premises is rightly directed enterprise. Of this there is an eminent example in the establishment of the Messrs. Jacques & Hay.

The manufacturing part of this establishment is situated at the foot of Bay Street, on the Esplanade in this city, and is the largest of the kind in British America. If it were not for the heavy inland freights, it would possibly be much more extended, and manufacture more largely for exportation. As it is the foreign trade of the firm is confined to the best class of their furniture, some of which goes to England and some to Scotland.

The number of persons employed in all the branches of this establishment is about three hundred, and these, aided by a steam-engine of thirty-five horse power, fed with the waste of the factory, work up fully one million feet of lumber in a year. There are, of course, great quantities of other materials consumed here, as paint, varnish, glue, sand-paper, &c., of which it is not our present purpose to speak. For the benefit of our glue manufacturers, however, we would just say that

Messrs. Jacques & Hay send to England and to New York for much of their glue, because they find it *better than the home-made article.*

The main building, which contains the machinery, is a large five-storey brick structure. On its south side is a separate building, of the same material, and perfectly fire-proof, for the boiler and steam-engine. At the east end of the main building, a little to the south, and extending in that direction towards the bay to within a few feet of the Grand Trunk Railroad is another large building: this is divided into storehouses, blacksmith's shops, workshops for painters, varnishers, ornamenters in bronze, French polishers, hand polishers, and a variety of others. Hand-polishing is the most delicate kind of manipulation through which the finest articles pass, and it is confined to these. In one of these rooms the floral ornaments in bronze are laid on the common chairs. Other apartments are used for drying the painted and varnished work, which process takes about two weeks, but then, it must be remembered, that in some cases five or six coats of varnish are laid on. The visitor will be surprised, perhaps, to find that on one of the lower floors of this building a number of men are very busily employed in making boxes—altogether too small for packing furniture in—even the furniture that takes to pieces for easy carriage. There is a great deal of that sort of goods manufactured in the States for shipment to South America, and the distinctive name it bears is "knock-down" furniture, from its being easily knocked to pieces. Why should not Canada try her hand at this kind of work? But these are *tobacco boxes!*

That huge chocolate-colored frame building, immediately on the south side of the Grand Trunk Railway track, which is liable to be mistaken for a large railroad machine shop or a freight dépôt, is a two or three-storey building, filled from floor to roof with thousands upon thousands of chairs, bureaus, tables, picture frames, wash stands, &c. Through the centre of this storehouse there is a roadway, along which furniture cars pass, stopping underneath a large opening in the floor to receive their loads for the city trade, or to be shipped on the railroads or steamboats for other destinations. There is a vast deal of furniture and fine cabinet work that never enters this place at all, but is conveyed direct from the factory to their establishment in King Street.

Here the general business of the concern is transacted. The first floor comprises the counting house, warerooms, packing rooms, &c., and upstairs, warerooms, showrooms and workshops for upholsterers. On the upholstering part of the business the ubiquitous sewing machine is brought to bear. All through this building the visitor will behold rich furniture of the most elegant patterns, graceful designs and exquisitely finished workmanship: costly Étagères, wardrobes, dressing tables, luxurious couches, sofas, lounges, easy and other chairs, with an almost endless variety of articles fit to adorn the bed-chambers, boudoirs, parlors, drawing rooms, and gilded *salons* of the opulent, as well as abodes of humbler pretensions. These are being disposed of daily and their places taken by others.

Return now to the factory for the purpose of viewing the processes by which the rough timber is made to assume the forms of elegance and utility which you have just seen. You enter at the centre of the building. Mr. Craig, the obliging foreman has consented to devote a few minutes to you in the character of *Cicerone.* Pointing to some machinery you ask a question—that is, you meant to ask it, and you feel sure you did, but—what became of it? You did not hear it. You try again, and this time you would have heard it but for the piercing scream of a circular saw—there are twenty of them in the building. That one is a swinging cross-cut saw, which, in obedience to a touch of the operator's hand, approaches and cuts squarely through the thickest plank of the hardest wood in a moment.

This being the ground floor, all the heaviest machinery is here, and here begins the work. The plank you have seen cut off, having previously been run through a planer, and now being cut into the required lengths, is taken by another workman and passed as rapidly through a Whitney's patent scraper, which is an admirable contrivance for doing perfectly in less than a minute what would require an hour to do imperfectly by hand labor. It takes off a sheet of the wood as thin as tissue-paper, and when the plank or board has been evenly planed, unbroken, from the entire surface, leaving the work as even and smooth as a sheet of fine plate-glass. These pieces are now as expeditiously cut, some into one shape and some into others, as they are to form chair frames, parts of sofas, tables, &c.: this is done chiefly by gig saws. Close to one of these, convenient to receive its work from the preceding operation, is a very neatly constructed moulding machine, with two cutters. Backs of sofas, and other pieces of irregular shape are placed on the table through which these cutters pass, and have the moulding executed on them in a space of time to match the great rapidity of all the other processes. Sand-papering is very effectively done by a revolving cylinder covered with that material. Here, too, is a simple instrument for cutting at one stroke the curves in seats of wooden chairs. We omit a number of other mechanical operations of perhaps equal importance, and pass to the turning department, where we notice lathes with large knives, held diagonally above the work to be turned. As soon as the wheels are thrown into gear the wood revolves, the knive descends, and before you have time to examine the process, there is turned out a piece of workmanship more accurately executed than human hands could have produced; every piece in a thousand being exactly like each of the others. The blade of the knife is bent into the shape of the pattern to be turned, and as far as we can judge, no skill on the part of the operator is required. We need scarcely observe that for every pattern there must be a separate knife. There is much turning done in this establishment, however, where the hand still guides the tool, and guides it to admiration. Top rails of chairs, and other portions of work (requiring any arc of their respective circles) are cut by cylindrical or "tub" saws, placed horizontally with their teeth on the periphery at one end. Here is a drill or boring machine, for various kinds of work, with adjustable cutters, boring three or more holes at once. This, as well as many other of their machines, has been considerably modified and improved by themselves. Here also is an iron planer, used in repairing, as well as in making new machinery by their own machinists. This is of their own construction. Daniell and Woodworth wood planers are in constant operation. On the second floor wooden chairs are made with astonishing celerity. Justice to the inventive ingenuity of the Messrs. Jacques & Hay require that we should mention in this place, an admirably conceived and well-executed piece of mechanism for sawing and boring, at one brief operation, the several four pieces which compose the seat-frame of the cane chair. This, we learn, is one of their best and most effective applications of mechanism in the factory. For mortising there is, in a convenient frame, a vertical cutter, with a lateral movement, adjustable to the length of mortise required. The cutting of tennons, other moulding machinery, and a great variety of processes well worthy of notice must be passed over, at least for the present.

In this establishment nothing seems forgotten or neglected that could be conducive to its efficiency, safety, or comfort of the three hundred hands employed. As a precaution against accident by fire, for instance, the place is heated by steam, there being no fire whatever in the building. The glue required on each floor is kept in a liquid state by steam, conducted up through the building for that purpose, as well as for heating a drying-room, necessary for removing any moisture from parts which are to be glued together. An additional and wise precaution consists in a tank, containing eight thousand gallons of water, being placed above all, ready, at a moment's notice to be precipitated on any part of the building by means of a hose on each floor, attached to the pipe leading from the tank down to the bottom. In each room there is a vessel of filtered water, which, when necessary, is iced for the use of the men. These little attentions, on the part of the employers, to the comforts of the employed are never thrown away, and it is very agreeable to notice them. Let us hope that between the two classes the elements of progress, now so active, may evolve a more generally recognised and operative identity of interest.

There in the centre of this extensive apartment you perceive a large platform hoist moved by steam power; it is laden with some of those pieces you saw receive their shapes below, and it is here they are to become chairs. On the next floor the cabinet makers' operations interest you. This is a place of comparative quiet. The cabinet department is superintended by Mr. Rogers, to whom you are introduced by Mr. Craig, who now bids you good morning.

The skill and dexterity with which wood is converted into beautiful furniture all through this department are truly wonderful. Here are a number of boys, too, "learning their trade," under experienced workmen. Higher yet, on the fifth storey, you find busy men contributing their quota of labor and skill as repairers, carpenters, &c., but your curiosity has been awakened—you wish to look into the designer's studio. This is the place for the solution of the problem—"Given the use and material of the article to find a beautiful shape," and this is worthy the best efforts of art. The taste that has been created of late years by the great profusion of art productions must be gratified. And it must be gratified at home. Picture galleries and *collections* of works of art are not enough, all our household gods should conform to the true principles of the beautiful and the pure; not pictured walls and sculptured marble alone will satisfy; not only must the carpet vie with the natural *flora*, and the hangings speak the language of design, but whatever is to have a place in the "temple of the affections" should reveal or suggest ideas of manliness, purity, beauty and truth. We would also respectfully remind those who are engaged in manufacturing articles of furniture of whatever kind for the "lower orders," that the delf ware in the humblest cottage has borrowed forms of "grace and beauty" from Etruscan art. And also that in place of the shapeless, unmeaning "image" on the workingman's mantel-piece, we now behold a good plaster statuette; and on the wall where years ago there hung an ugly print we now see a steel engraving from one of the "masters." If legislators understood how much these things have to do with the formation of character, national as well as individual, something would be done for the encouragement of art in this country. Besides, it has been found that ART PAYS. SCHOOLS OF DESIGN in France created reputations for her manufactures and enriched her manufacturers, found employment for her operatives, improved the popular taste, and benefited the country. British manufacturers saw in the acknowledged superiority of their other resources no guarantee against the danger with which their interests were thus threatened. Legislative action was invoked and schools of design speedily became flourishing institutions. So flourishing indeed, that in a recent official communication to the Emperor on this subject danger is apprehended to French industry from English superiority in art.

To the reflecting mind no argument will be needed to prove that schools of design must be established here, unless we are to be driven out of the market by those who, in all other things, are our inferiors.

So far, however, as the establishment of the Messrs. Jacques & Hay is concerned, perhaps it is better provided for in the matter of art than some others. At any rate the designer's studio bespeaks the presence of a *mind* there. Instead of patching up and adapting old designs made for other purposes, there are numerous casts of natural specimens, many of which belong to the *fauna* and *flora* of Canada, whose beauties enter into the composition of original designs. One of these, perhaps the most elaborate, is for a side-board, made to the order of Lord Abinger, for whom sets of drawing room and library furniture have recently been made and sent home. Some of the carved work there is surprisingly beautiful. Amongst this are to be found parts of a costly table, not yet put together, ordered by the Governor-General, to be sent home by him to England.

PROVINCIAL ANNUAL EXHIBITION.

In a little more than two months the next Exhibition will take place. Are our Artists and Manufacturers preparing for it? If not, we urge upon them to commence at once; there is no time to be lost if we desire to have a good display of the arts and industrial products of the Province.

Our mechanics and manufacturers should not estimate the value of these Exhibitions to themselves by the prizes they may obtain—this should be but a secondary consideration; a spirit of emulation is excited in the mind of the competitor, and his employees catch his spirit and also determine to excel, and thus the character of our manufactures are raised to a much higher standard than they otherwise would be.

Through the instrumentality of these Exhibitions a spirit of friendly rivalry, and a desire on the part of each one to produce something superior to his neighbour, has been excited amongst our Agriculturists; and that it has resulted in great good to the Province in the improvement of the live stock and produce of the farms, is undisputed. This is also true as regards the Horticulture of the Province, which has now attained a degree of excellence that would be honourable to any country—why should not equally good results be obtained for our manufacturing industries? In many departments we have both the material and the skilled labour to work it up, and in numerous cases it is worked up to good purpose; but there is still a lack of sufficient patriotic feeling to induce parties to incur the trouble and expense of exhibiting their productions when prepared.

To the manufacturer who has a new branch of business to establish, or an old one to increase, these annual gatherings afford the best means for him to attain his object. His articles are seen and examined by thousands of persons, if worthy of inspection; and if fortunate enough to obtain prizes, the fact is announced by the public papers, and in the pages of this Journal, throughout and beyond the bounds of the Province, obtaining for his goods a greater publicity than any other means afford. We have known large businesses established within a very short space of time, by means of these Exhibitions.

AGRICULTURAL ASSOCIATION BY-LAWS.

Notice is hereby given that at the next Annual Meeting of the Agricultural Association, the council will propose the amending of clause fifteen of the By-Laws, so as to give a fixed number of *Single Admission* Tickets to members, instead of *Season* Tickets.

HUGH C. THOMSON,
WM. EDWARDS, } *Secretaries.*

Board of Arts and Manufactures

FOR UPPER CANADA.

ANNUAL EXAMINATIONS, 1864.

The Annual Examination of members of Mechanics' Institutes, according to Programme published in this Journal for November, 1863, took place on the 7th, 8th, 9th, and 10th days of June, ultimo. The subjects proposed for examination were, Arithmetic, Book-keeping, English Grammar and Analysis, Geography, Penmanship, Algebra, Geometry, Principles of Mechanics, Geometrical and Decorative Drawing, History, Trigonometry, Mensuration, Practical Mechanics, Conic Sections, Chemistry and Experimental Philosophy, Geology and Mineralogy, Animal Physiology and Zoology, Botany, Agriculture and Horticulture, Political and Social Economy, English Literature, French, German, Music, and Ornamental and Landscape Drawing.

Last year but seven candidates were examined, and five subjects only taken up. This year twenty candidates were reported, seventeen have been examined, and twelve different subjects taken up. These, with the Examiners therein, are:—

Arithmetic......	M. Barrett, M.A., M.D., U. C. Col.
Bookkeeping...	J. H. Mason, Esq.
English Grammar & Anal.	C. W. Connon, LL.D, U. C. Col.
Algebra........	James Brown, M.A., U. C. Col.
Geometry......	Jno. T. Huggard, Esq.
Mensuration...	A. McMurchy, B.A.
Eng. Literature	J. A. Boyd, M.A.
French..........	E. Coulon, Esq.
Music............	G. W. Strathy, Mus. Doc., Tr. Col.
Penmanship...	G. A. Barber, Esq.
Geom. & Orn. Drawing....	W. G. Storm, Esq.

Committee on Examinations.—Rev. Professor W. Hincks, F.L S., and Professor G. Buckland, University College, Toronto; and Professor H. Y. Hind, M.A., F.R.G.S., Trinity College, Toronto.

The Certificates awarded by the Board are for actual merit, and not for mere competition. The 1st Class Certificate indicates "Excellence;" the 2nd Class, "Proficiency;" and the 3rd Class, "Commendableness."

Certificates awarded to Candidates.

No. 1. Miss L. L. Dow, aged 17, member Whitby Mechanics' Institute. English Grammar and Analysis, 1st class certificate; English Literature, (Milton and Trench) 3rd class certificate; French, 3rd class certificate; Music, 3rd class certificate.

No. 2. John G. Robinson, aged 17, Whitby Mechanics' Institute. Arithmetic, 2nd class certificate; English Grammar and Analysis, 2nd class certificate; English Literature (Trench and Craik) 2nd class certificate.

No. 3. Wm. H. Ballard, aged 18, Whitby Mechanics' Institute. Arithmetic, 1st class certificate; English Grammar and Analysis, 2nd class certificate; Algebra, 2nd class certificate; Geometry, 3rd class certificate.

No. 4. James H. Panton, aged 17, Whitby Mechanics' Institute. Arithmetic, 3rd class certificate; English Grammar and Analysis, 3rd class certificate.

No. 7. Miss S. E. Brown, aged 17, Whitby Mechanics' Institute. English Grammar and Analysis, 3rd class certificate; English Literature, (Milton and Cowper) 3rd class certificate.

No. 8. Miss M. C. Rowe, aged 19, Whitby Mechanics' Institute. Music, 3rd class certificate; Crayon Drawings, 1st class certificate.

No. 10. J. J. O'Connor, aged 19, Whitby Mechanics' Institute. Arithmetic, 3rd class certificate; English Grammar and Analysis, 3rd class certificate; Penmanship, 2nd class certificate.

No. 11. George Dickson, aged 20, Whitby Mechanics' Institute. Arithmetic, 3rd class certificate; English Grammar and Analysis, 2nd class certificate! Algebra, 3rd class certificate; Geometry, 3rd class certificate; Penmanship, 3rd class certificate.

No. 12. Joseph Betts, aged 18, Whitby Mechanics' Institute. Arithmetic, 3rd class certificate; English Grammar and Analysis, 2nd class certificate; Geometry, 3rd class certificate; Penmanship, 3rd class certificate.

No. 13. Robert Palen, aged 18, salesman, member Toronto Mechanics' Institute. Bookkeeping, 2nd class certificate.

No. 14. Robert Mills, aged 19, clerk, Toronto Mechanics' Institute. Bookkeeping, 2nd class certificate.

No. 15. Alfred White, aged 18, salesman, Toronto Mechanics' Institute. Bookkeeping, 3rd class certificate.

No. 16. John Nimmo, aged 26, salesman, Toronto Mechanics' Institute. Bookkeeping, 1st class certificate.

No. 18. Charles Bell, aged 25, plasterer, Toronto Mechanics' Institute. Crayon Drawings, 2nd class certificate.

No. 19. Alfred C. Edwards, aged 16, clerk, Toronto Mechanics' Institute. Penmanship, 1st class certificate.

No. 20. Miss H. R. Wilson, aged 26, Toronto Mechanics' Institute. Crayon Drawings, 1st class certificate.

The Examiner in *English Grammar and Analysis*, in his report on Paper No. 50, (Miss L. L. Dow) says, "It bears marks of the most decided EXCELLENCE; I do not know that I ever examined a paper reflecting greater credit on its author."

The Examiner in *Geometry* reports, "The gentlemen represented by Nos. 53 (J. Betts), 55 (Geo. Dickson), and 57 (Wm. Ballard), have acquitted themselves most creditably. They have evidently taken the greatest pains in making themselves acquainted with the four books of Euclid; and I regret that in consequence of their not being successful with the deductions, I cannot recommend a higher certificate than that for 'commendableness' should be awarded them." On Paper No. 54 the report says, "His papers are written out with great carelessness, and are nearly all incomplete. The carelessness is the more improper, perhaps, from the fact that he could, in my opinion, if he had taken the trouble to do so, have done all the propositions from Euclid correctly."

The Examiner in *English Literature* reports on Paper No. 58 (J. G. Robinson) that it "is well entitled to a 2nd class certificate, falling, in fact, not far short of being worthy of a 1st class place;" and "that had not No. 50, (Miss L. L. Dow) through some unfortunate oversight, omitted a portion of the work relating to *Milton*, in the 2nd section of the examination thereon, I doubt not but that this candidate would have won a 2nd class certificate."

The Examiner in *French* reports on Paper No. 50, (Miss L. L. Dow) "that the translation from French into English is the best part of the Paper."

The Examiner in *Music* reports on Papers No. 50 (Miss L. L. Dow) and No. 51 (Miss M. C. Rowe), "that No. 51 answers the greater number of questions, but that the answers of No. 50 evidence a greater advancement in the knowledge of music."

We have not time or space to comment on the examinations in this number of the *Journal*, but may do so in the next issue. The following are the remainder of the papers set by the Examiners, five of which were published in the June number.

ENGLISH LITERATURE.

(Three hours allowed.)

I.—CRAIK'S "ENGLISH LANGUAGE."

I. "It is in the highest degree improbable that the retirement or expulsion of the inhabitants of Roman descent, can have been so complete as these statements would make it. From the number of settlements which both history and their remains on or under the soil prove the Romans to have possessed in all parts of the country, from the Channel to the Friths of Forth and Clyde, comprehending many towns and villas, as well as mere military stations, it is evident that in the space of between three and four centuries, during which the island had been a Roman province, it had been extensively colonized, like most of the other provinces, from the original central seat of the empire, and that the portion of the population thus formed must in all likelikood have been very considerable and very widely diffused."—*Page* 12.

1. Indicate the words in the above extract that are of Latin, Greek, or French origin, specifying the language from which each word is derived.
2. What philological remains are there of the occupation of England by the Romans? Classify all the accessions to our vocabulary from Latin sources.
3. Under what circumstances, and when, did the Romans occupy and relinquish England?
4. Explain the full import of all that is meant in the expression "from the Channel to the Friths of Forth and Clyde."
5. Compare the Danish with the Roman occupation of England, both as regards territorial extent and philological influence.
6. When Craik speaks of the "original central seat of the empire," what changes in the organization of the Roman Empire does he refer to?
7. Does it follow, from what is said, that all the Roman inhabitants spoke the Latin language? Give reasons for your answer.

II. Mention the various uses of the terminal *e* mute in early and in modern English.

III. Account for the spelling of the auxiliary verb "*could*." What distinction does Chaucer make between "*ye*" and "*you*"? What pronouns were represented by the form "*hire*," employed by him?

IV. Craik speaks of "the Saxon Shore," "aureate terms," and "lingua franca." Write short explanatory notes upon each phrase.

V. Craik states *five* prominent facts which constitute the external evidence that we have in regard to the sources of the English language. Mention these facts in chronological order.

II.—TRENCH'S "STUDY OF WORDS."

I. "For I am persuaded that I have used no exaggeration in saying, that for many a young man, 'his first discovery that words are living powers, has been like the dropping of scales from his eyes, like the acquiring of another sense, or the introduction into a new world,'—while yet all this may be indefinitely deferred, may, indeed, never find place at all, unless there is some one at hand to help for him, and to hasten the process; and he who so does, will ever after be esteemed by him as one of his very foremost benefactors."

1. Compare this passage, as regards its philological character, with the foregoing quotation from Craik.
2. Define what you mean by rhetorical and syntactical figures; and point out all examples of each in the above passage.
3. "*Many a young man;*" we commonly hear said "*many men,*" "*a great many men;*" Tennyson, speaking of the eyes of "The Miller's Daughter," says, "they have not shed *a many tears.*" Are all these four expressions correct? If so, how do you reconcile them in parsing.
4. How many different parts of speech may the word "*while*" be, in different connexions? Illustrate your answer by examples.
5. Give one or more synonyms for the words "*discovery,*" "*deferred,*" and "*esteemed,*" distinguishing accurately the shades of meaning in each. In how far is the word "synonym" a misnomer?

II. Give the derivation of, and (where applicable) the transmutations of meaning in the following in the following words: "*tawdry,*" "*knave,*" "*bigot,*" "*dunce,*" "*pagan,*" "*roué.*"

III. "Many words, formerly slang, are now used by our best writers, and received, like pardoned outlaws, into the body of respectable citizens." What is the meaning and derivation of "*slang.*" Give English examples of the truth embodied in the above passage, from our own and former times.

IV. Mention some words the history of which dates from the Crusades. What mistakes are involved in the spelling of the following words: "*posthumous,*" "*plurisy,*" "*analyze,*" "*sirname,*" "*shamefaced.*" How should these words be correctly spelt? Give your reasons.

V. Mention the most important contributions to English philology, before and since Trench commenced to write, and give some estimate of the effect of his labours upon this subject.

I.

ENGLISH LITERATURE.

(*Three hours allowed*)

I. MILTON: PARADISE LOST, BOOKS I., II.

(1) ————— "He his wonted pride
(2) Soon recollecting, with high words, that bore
(3) Semblance of worth not substance, gently rais'd
(4) Their fainting courage, and dispell'd their fears.
(5) Then straight commands that at the warlike sound
(6) Of trumpets loud and clarions be uprear'd
(7) His mighty standard: that proud honour claim'd
(8) Azazel as his right, a cherub tall;
(9) Who forthwith from the glittering staff unfurl'd
(10) Th' imperial ensign, which full high advanc'd
(11) Shone like a meteor streaming to the wind,
(12) With gems and golden lustre rich imblaz'd,
(13) Seraphic arms and trophies; all the while
(14) Sonorous metal blowing martial sounds;
(15) At which the universal host up sent
(16) A shout, that tore Hell's concave, and beyond
(17) Frighted the reign of Chaos and old Night."

I. Point out and name all the figures in this passage.

II. Indicate the words that are of Latin, Greek or French origin, specifying the language from which each word is derived.

III. What is the meaning of the words "recollecting," "advanc'd," and "reign," in lines 2, 10, and 17?

IV. Specify any peculiarities of rhythm and prosody in the above extract.

V. Cite passages from any English poets written in imitation of lines 10 and 11.

VI. In what connexion do you read "Seraphic arms and trophies," in line 13?

VII. What do you understand by the term "Chaos," as used by Milton?

II. COWPER: "THE TASK."

I. "But is amusement all studious of song
And yet ambitious not to sing in vain
I would not trifle merely though the world
Be loudest in their praise who do no more
Yet what can satire whether grave or gay
It may correct a foible" &c.

Punctuate this passage; and paraphrase it so as to express the meaning fully in ordinary prose.

II. "O for a law to noose the villain's neck,
Who starves his own; who persecutes the blood
He gave them in his children's veins!"

Rewrite this, so as to show the grammatical connection of the various words and members of the sentence.

III. "He charms a world whom fashion blinds
To his true worth, most pleased when idle most;
Whose only happy are their wasted hours."

1. Point out and name the figures in these lines.

2. Rearrange the words so as to exhibit the author's meaning.

IV. "Gnats have had, and frogs and mice, long since,
Their eulogy: those sang the Mantuan bard,
And these the Grecian, in ennobling strains;
And in thy numbers, Philips, shines for aye
The solitary Shilling."

Explain fully all the allusions in this passage.

V. "The learned finger never *need explore*
Thy vig'rous pulse;"
"And howl and roar *as likes them.*"

Parse the *italicised* words in the above lines.

VI. Cowper uses the following words in this poem: "Vortiginous," "histrionic," "oscitancy," "stercoraceous," "tramontane," "prelibation." Give the meaning and derivation of each.

II.

I. Sketch the history of blank verse as an English measure.

II. Compare the blank verse of "Paradise Lost," with that of "The Task," and specify the chief metrical peculiarities which characterize each poem.

III. Contrast briefly, the poetical genius of Milton and Cowper, as displayed in these poems.

IV. Wherein consists the appropriateness of the name "The Task," and of the titles of the various books comprised therein?

V. Mention some of the most important contemporaneous events which Cowper refers or alludes to in his poem.

VI. Hayley, in his life of Cowper, says:—"Perhaps no author, ancient or modern, ever possessed so completely as Cowper, the nice art of passing, by the most delicate transition, from subjects to subjects that might otherwise seem but little, or not at all, allied to each other; the rare talent,

'Happily to steer,
From grave to gay, from lively to severe.'"

Exemplify this remark from "The Task," and discuss the advantages and disadvantages to Cowper's poetry, arising from this faculty of transition.

MENSURATION.

(*Three hours allowed.*)

I. For finding the area of a parallelogram, show that the following is true:—"Multiply one side by its distance from the opposite side." Deduce also the area of a triangle from the above. One side of a parallelogram is 25 yards; distance from opposite side, 12·4 yards. Find area.

II. A ladder, 40 feet long, may be so placed that it shall reach a window 31 feet from the ground on one side of a street; and by only turning it over, without moving the foot out of its place, it will do the same by a window 19 feet high on the other side of the street. Find width of street.

III. Show how to find area of a trapezoïd, having given the two parallel sides, and distance between them. Given, 40, 15 and 28 rods to be the two parallel sides and perpendicular respectively. Find the surface.

IV. Having given the three sides of a triangle, find its area in terms of those sides Modify your expression for equilateral and isosceles triangles. Given sides 218, 322, 436 yards respectively. Find area.

V. Find length of perpendicular from the joining of two rafters on a cross beam; length of rafters 18 and 28 feet, that of beam 40 feet.

VI. State how to find area of a circle. Find the side of a square, equal in area to a circle whose radius is 15 yards.

VII. The bounding circles are 20 and 30 yards in radius. Find the area of the space enclosed between their circumferences.

VIII. State how to find the curve surfaces of the following bodies: (1) Right cylinder, including both ends. (2) Right cone. (3) Frustrum of a right cone. (4) Sphere.

IX. (1) What will be the cost of painting a conical spire, at 8d. per yard; height being 118 feet, circuit of base, 46 feet? (2) The ball on the top of St. Paul's Church, London, is 6 feet diameter; what did gilding cost at 3½d. per square inch?

X. How many bricks will it take to build a wall 10 feet high and 500 feet long, of a brick and a half thick, reckoning the brick 10 inches long, and 4 courses to the foot in height?

XI. A gentleman has a circular plot containing an acre, wishing to raise its surface two feet; he digs a trench all round the plot, reserving a foot-path, a yard wide, between outer edge of plot and trench: how deep must trench be, supposing it to be four feet wide, and what cost of digging at 9 cents per cubic yard?

FRENCH.

(Three hours allowed.)

Translate into English:

GUILLAUME.

Qui l'a vue autrefois, la verrait bien changée:
Sa beauté par les pleurs est déjà ravagée;
Elle est là, toute seule, au fond de ce palais,
N'ayant, pour la servir, ni dames, ni varlets;
On l'évite avec soin, comme un être funeste,
Comme si dans son souffle on respirait la peste.

ROBERT.

Mais ceux qu'elle a guéris, Guillaume, car je sais
Qu'elle a sauvé la vie à maint et maint blessés,
Et ceux qu'elle a nourris de son pain, faut-il croire
Que de leur bienfaitrice ils aient perdu mémoire?

GUILLAUME.

Ils n'ont pas seulement oublié ses bienfaits,
Comte; ils tournent encore ses vertus en forfaits.
Par ses soins dévonés les blessures guéries,
Ne l'ont été, dit-on, que par sorcelleries;
Et, quant à sa largesse envers les indigents,
Elle achetait ainsi l'âme des pauvres gens.
Voilà quels sont les bruits qui courent par la ville.

ROBERT.

O peuple ingrat et lâche! O multitude vile!
—Que fait le Roi?

GUILLAUME.

Le Roi défend Madame Agnès.
Et les excès répondent aux excès.
Il chasse les prélats, leurs clercs et leurs chanoines;
Il fait par des routiers piller leurs patrimoines;
Car, tous ses serviteurs l'ayant abandonné
De routiers mécréants il s'est environné.
C'est lui!

PHILIPPE, parlant du dehors à l'abbé de Saint Denis.

N'excitez pas encor ma colère,
Sire abbé! le bercail ne vous importe guère
Pourvu que vous mangiez vos rentes en repos,
Et buviez largement le vin de vos clos,
Vous ne prenez pas garde à mon peuple en souffrance. [France!
—Par Saint Charles le Grand, et tous les Saints de
Je ferai déguerpir, tenez-vous-le pour dit,
Quiconque des prélats gardera l'interdit;
Je saisirai les biens de ces pasteurs indignes;
Je raserai leurs clos, et couperai leurs vignes.
—Allez!

Agnès de Méranie, Ponsard.

Grammatical Questions.

1. *L'a vue.* Why feminine? Give the rule of the past participle followed by an infinitive; also followed by an adjective or past participle, so, rewrite *nous l'avons vu prise—prendre.*

That write according to knowledge of the rules bearing on these two sentences,

nous l'avons vu prise,
nous l'avons vu prendre.

2. *Verrait, guéris, nourris, faut, croire, aient courent, fait, buviez, prenez, tenez, allez*—their primitive tenses.

3. *Qui.* When a nominative, when an object? What here, and how?

4. *Toute seule.* What part of speech does *toute* belong to? Its rules—along with those of *quelque.*

5. *Ni.* When two nominatives singular are connected by *ni, ou, de même que,* etc., and when of different persons, what are their rules?

6. What are the different meanings of *faut,* followed by au *infinitive,* a subjunctive, or preceded by a dative?

7. *Quant—quand—voici, il y a.* To what part of the speech do they belong? How used?

8. *Que fait le roi.* With what other expressions do you throw the noun after the verb? In what cases does the pronoun, a subject, go after the verb, although no question is meant?

9. *C'est lui.* When are *je, tu, il, ils,* replaced by *moi, tui, lui, eux.*

Translate into English:

Nous avions arrêté que nous irions diner sur les bords de la mer, pour manger des huîtres du lac Lucrin et boire du vin de Falerne. Nous nous acheminâmes donc vers le lieu désigné, où des provisions, prudemment achetées à Naples et envoyées d'avance, nous attendaient, lorsqu'en arrivant près des ruines du temple de Vénus, nous aperçumes un groupe de prome neurs qui s'apprêtaient à en faire autant. Nous nous approchâmes et nous reconnûmes, qui? Barbaja, l'illustre impressario, Duprez, notre célèbre artiste, et la *diva* Malibran, comme on l'appelle par tout le monde. C'était une bonne fortune pour nous qu'une pareille rencontre; et il fut arrêté à l'instant que nos deux diners seraient réunis en un seul. Ce point essentiel arrêté, comme il fallait encore un certain temps pour apprêter le banquet commun, et que, nous n'étions qu'à deux cents pas des étuves de Néron, où le gardien nous offrait de faire cuire nos oeufs, nous acceptâmes la proposition, nous lui mîmes à la main le panier qui les contenait, et nous marchâmes derrière lui. Le pauvre homme ressemblait fort aux chiens de la grotte. A mesure que nous approchions des étuves, son pas se ralentissait. Malheureusement la curiosité est impitoyable. Nous fûmes donc insensibles aux gémissements qu'il poussait, et, à la porte des étuves ouverte, nous nous précipitâmes dedans.

Impressions de Voyage—Dumas.

Grammar Questions.

1. When are *si, quelque, quoique, parceque, jusque,* elided?

2. What is the feminine of adjectives ending with *gu, g, ou, eau, et, an,* and exceptions—Examples.

3. When can *aucun, nul,* be used in the plural?

4. Give the use and niceties of *autrui, soi, personne, quelque chose, tout autre, rien.*

5. Feminine of *cheval, chasseur, moine, duc, favori, fat, courtisan, chrétien, paysan, auteur, acteur, empereur, acteur, bouc, taureau, chien.*

6. Meanings and genders of *pendule, journée, cuiller, voile, vase, pique, coche, an, année, cuillerée, jour.*

7. What mood does *que* govern? Exemplify.

8. Give the concordance of the past tenses of the subjunctive, with those of the present indicative and future absolute—Example.

9. When an adjective qualifies two nouns what is the construction, if it cannot be placed last?

10. What prepositions do *espérer*, *venir*, *aller*, *continuer*, govern before infinitives?

11. Give the plural of *détail*, *gouvernail*, *naval*, *bleu-clair*, *casse-tête*, *perce-neige*, *arc-en-ciel*, *belle-de-nuit*, *bleu*, *monsieur*.

12. Give the verbs that require pronouns as direct or indirect objects after them.

Translate Idioms:

Il fait jour—Charles se fit jour avec mille fantassins—Il faut s'entendre—Quel saint homme que votre père!—Send for him—Call him up—Do not take the horse away—I am coming—I fell upon him and sprained his ankle—How often do you attend church on Sunday?—I will attend to your wants.

Translate into French:

Nothing is more characteristic of the times than the care with which the poets contrived to put all their loosest verses into the mouths of women. The compositions in which the greatest license was taken were the epilogues. They were almost always recited by favourite actresses; and nothing charmed the depraved audience so much as to hear lines grossly indecent repeated by a beautiful girl, who was supposed to have not yet lost her innocence.

Our theatre was indebted in that age for many plots and characters to Spain, to France, and to the old English masters; but whatever our dramatists touched they tainted. In their imitations, the houses of Calderon's stately and high spirited Castilian gentlemen became sties of sin, Shakespeare's Viola a procuress, Moliere's Misanthrope a ravisher, Moliere's Agnes an adulteress. Nothing could be so pure or so heroic but that it became foul and ignoble by transfusion through those foul and ignoble minds.

Macaulay's History of England.

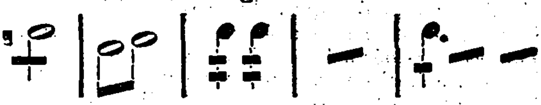
MUSIC.

(*Three hours allowed.*)

THEORETICAL ELEMENTS.

1. Write the different notes and their corresponding rests.
2. Explain the effect of 1, 2 and 3 dots after a note or rest.
3. What kind of note would express the value of the third dot after a minum? and what kind of rest the second dot after a crotchet rest?
4. What note is equal in value to 8 semiquavers?
5. Express the value of a minum by a note, dot and rest.
6. Express 4 semiquavers, 1 crotchet with 2 dots, 1 semiquaver rest, and 1 crotchet rest, by means of one note.
7. Express the different time the following bars would belong to:

8. Name the keys major and minor whose signature is 5 ♯'s.
9. Name the keys major and minor whose signature is 4 ♭'s.
10. What is the relative minor to E? and relative major to F minor?
11. Explain the following musical terms:
    Adagio, Allegro, Cres., dim., legalo, Staccato.
12. Write the following abbreviations in full:

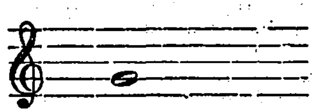


13. What is the meaning of enharmonic change? Give examples.

HARMONY.

(1) Explain what an interval is.

(2) Give the different intervals in general use with their inversions as far as an octave, from the following note



(3) What notes of the scale form the common chord on the key note?

(4) What is the difference between a major and minor triad or common chord?

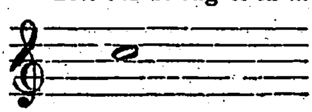
(5) How many positions can a triad have?

(6) What is meant by an inversion of a chord?

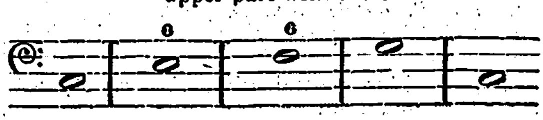
(7) How many inversions can a chord have?

(8) Give the figurings of the 1 and 2 inversions of the common chord.

(9) Write the different triads the following note can belong to in the same key



(10) Fill in the upper parts from the following figured bass, beginning the upper part with the 8th



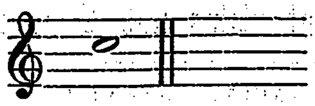
(11) What are the principal fundamental basses in every key?

(13) How many inversions can a chord of the dom. 7th have?

(12) Write the chord of the dom. 7th to the key of E ♭.

(14) Write the different inversions of the dom. 7th, and resolutions, with the figured bass of each.

(15) Write the different chords of the dom. 7th, and resolution that the following note can belong to



(16) What is the meaning of modulation?

(17) Modulate from F to its relative minor, from B ♭ minor to its relative major.

(18) Modulate from C to D ♭ by 1st invers. of its dom. 7th.

(19) Give examples of the chords of the diminished 7th, 9th, 11th and 13th, with their resolutions.

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Patent Laws and Statistics.

CANADIAN PATENT LAWS.

We had hoped that the efforts put forth for the past few years, to secure amendments to the Patent Laws of this Province, so as to assimilate them to the laws of all other enlightened nations, would ere this have been successful. Another session of Parliament has however come and gone, and nothing has been done, except to submit to His Excellency the Governor General, the following Report, by the late Minister of Agriculture, the Hon. L. Letellier :—

"The following statement demonstrates, that notwithstanding that the number of applications for Letters Patent is greater, and the revenue from this source has been larger, nevertheless, the increase has not been so rapid as in former years. This is easily explained by the fact that the public have, for the last two years, been anticipating important modifications of the law regulating this species of property. On the other hand, patents are evidently acquiring greater importance than heretofore, since the number of transfers has increased This increase indicates a salutary development of the spirit of industrial enterprise, which cannot fail to benefit the commercial and agricultural interests of the Province. This progress is a matter which demands from the Government serious attention, and a thorough consideration of the means best adapted to the perfecting of this branch of the administrative service, in such a manner as to define more clearly and more efficaciously the respective rights of inventors and of the public.

COMPARATIVE STATEMENT OF BUSINESS TRANSACTED —1861-'62-'63.

Year.	Applications.	Patents granted.	Transfers registered	Drawings registered.	Trade Marks registered.	Fees received
1861.	160	142	55	2	3	$3012.70
1862.	180	160	72	—	17	3,650.90
1863.	207	156	78	4	1	3,759.75

For several years past, it seems to have been admitted that our laws relating to the granting of letters patent for the protection of inventions and discoveries, require certain modifications and the enactment of new provisions, with the view of simplifying and regulating this branch of the public service.

The gradual increase in the business of the Patent Office affords, from day to day, further proof of the necessity of an early revision of the law relating to that department.

Of all the modifications which have been discussed, for some time past, the most important are undoubtedly those which would have the effect of assimilating our laws more closely to those of the nations now at the head of civilization, and permit inventors from all countries to enjoy amongst us that protection which is now afforded them almost everywhere.

The expediency and advantages of such a measure have frequently been debated. I think that the reasons given, and which seem to suggest themselves the first from a simple examination of the question, militate strongly in favor of a more liberal system than that which is possible under the present law.

Now, by enabling the subjects of other countries to take our letters patent amongst us, upon the same footing as our own people, we shall at once throw open to inventors residing in our country a vast and fertile field, from which they are at present excluded—the States of the neighboring Union, which, by recent enactments, have offered the protection of their laws, upon the same footing and upon the same conditions as to Americans themselves, to all inventors the subjects of countries in which protection is extended to American inventions.

By following this example of liberal legislation, we should at once put an end to the position of inferiority in which our own people, as well as all other British subjects who come to reside amongst us, are now placed.

But there is a more pressing consideration which seems to me deserving of our immediate attention, and which should induce us to adopt a more liberal system, inasmuch as it affects more directly the interests of the greater number; I mean the stimulus which must of necessity be imparted to our own manufacturing industry, by affording protection to machinery and improved processes originating in other countries, but which, for lack of adequate protection, no one ever seeks to introduce amongst us. It is quite evident that the establishment of new machinery, the preliminary cost of experiments, the construction of models, &c., necessitating as they do, a certain outlay of capital and the incurring of risk, to which those who have only to copy what has been already effected are not exposed serve, to a certain extent, to deter foreign inventors and capitalists who might be disposed to establish new branches of manufacture in our midst, which, by employing within the country our primary agencies, the arms of our people and our native power, would have the effect of augmenting the general prosperity. By making it a simple condition for the protection afforded to patentees that the machinery or improved production should be manufactured within the Province, a provision adopted in France and several other countries, consumers would be protected against an outside monopoly and our manufacturers against unfair competition. I might refer to several machines and manufacturing processes which would receive much more attention and be developed in our midst, if the holders of foreign patents could obtain in this country the same protection which is afforded to them elsewhere. I shall cite but one case of this kind, because it affects more immediately the interests of the agricultural classes, to show that certain products which are now neglected or lost would become available for useful purposes, and that consumers and the public generally would themselves reap the greatest advantage from such a measure.

A company composed of capitalists from the United States have purchased from the inventor the proprietorship of a new, economical and highly ingenious process, by means of which textile plants, wood, straw and other ligneous substances are disintegrated in a few minutes, and the fibres thus prepared are at once fit for the carding or paper making machine, without the process of steeping or of the use of alkalies. This method, which would become a source of wealth by at once rendering profitable the culture of flax, hemp, &c., belongs, as above stated, to an American company, who will naturally decline investing a large amount of capital amongst us unless they obtain the protection of a patent. The striking importance of this case naturally induced me to select it from amongst a host of minor instances.

I deem it unnecessary to dwell any further upon the necessity of following, in the matter of patents for inventions, the example of liberality and of reciprocity afforded us in this respect by older countries, more advanced than ourselves in the development of the various branches of manufacturing industry, a course the adoption of which, it would seem, they have never had reason to regret.

Another consideration which should go far to induce us to modify our laws in this direction is, that the Province must necessarily derive from the fees to be levied a large amount of revenue; for a majority of the Americans who incur the expense of taking out a patent at home, would not fail to claim protection here. Now, as the department charged with this branch of the public service already meets its expenses out of the revenue derived from the comparatively small number of patents granted, it could without any large increase of expenditure, receive a far larger number of applications, which would thus give a large net surplus, increasing from day to day.

U. S. PATENT OFFICE, 1863.

The following tables are taken from the Annual Report of the U. S. Commissioner of Patents, for the year 1863; and show a remarkable degree of activity on the part of inventors, in spite of the deplorable and tremendous strife of civil war, then and now raging amongst them:—

No. 1.

Number of applications made during the year 1863	6,014	
Number of patents granted, including reissues and designs	4,170	
Number of caveats filed during the year	787	
Number of applications for extension of patents	40	
Number of patents extended	48	
Number of patents expired 31st December, 1863	968	

Of the patents granted, there were to—

Citizens of the United States	4,048	
Subjects of Great Britain	58	
Subjects of French Empire	37	
Subjects of other foreign governments.	27	
		4,170

No. 2.

Statement of money received during the year 1863.

On applications for patents, reissues, &c.	$178.617 00
For copies and for recording assignments.	16,976 29
	195.593 29

No. 3.

Statement of expenditures from the patent fund.

For salaries	$89.559 94
For contingent expenses	42,715 29
For temporary clerks.	54.488 41
For withdrawals	1,680 00
For refunding money paid by mistake	720 50
For judges in appeal cases.	800 00
	189.414 14

No. 4.

Statement of the patent fund.

Amount to the credit of the patent fund January 1, 1863	$38,361 15
Amount paid in during the year	195.593 29
Total	233,954 44
Deduct amount of expenditures during the year	189,414 14
Leaving to the credit of the patent fund, January 1, 1864, the sum of	44.540 30

Another table gives the increase in the business of the patent office during each of the past 26 years, from which we learn that the number of

	1843.	1853.	1863.
Applications were.	819	2,673	6,014
Patents issued	531	958	4.170
Fees Received	$35,315 81	$121,627.45.	$195.593 29

Table exhibiting the business of the office for twenty-seven years, ending December 31, 1863.

Years.	Applications filed.	Caveats filed.	Patents issued.
1837	....	....	435
1838	....	....	520
1839	....	....	425
1840	765	228	473
1841	847	312	495
1842	761	291	517
1843	819	315	531
1844	1,045	380	502
1845	1,246	452	502
1846	1,272	448	619
1847	1,531	553	572
1848	1,628	607	660
1849	1.955	595	1,070
1850	2,198	602	995
1851	2,258	760	869
1852	2 639	996	1,020
1853	2.673	901	958
1854	3,324	868	1,902
1855	4,435	906	2.024
1856	4.960	1,024	2,502
1857	4,771	1,010	2.910
1858	5,364	943	3.710
1859	6,225	1.097	4.538
1860	7,653	1,084	4.819
1861	4,643	700	3.340
1862	5,038	824	3 521
1863	6,014	787	4,170

Proceedings of Societies.

WHITBY MECHANICS' INSTITUTE.

The Annual Meeting of this Society was held in the Institute on Friday evening, May 27th, the President, R. J. Wilson, Esq., in the chair.

After the Annual and Auditor's reports had been read and adopted, the following gentlemen were elected office-bearers for the current year:—R. J. Wilson, President; M. O'Donovan, 1st vice; G. H. Dartnell, 2nd vice; M. Thwaite, Recording Secretary; Thos. Kirkland, Corresponding Secretary; Jas Bain, Treasurer; H. Fraser, Librarian. *General Committee*, Messrs. J. Ferguson, K. Maclennan, M. Harper, J. Shier, G. Y. Smith, J. H. Greenwood, J. Bengough, J. H. Perry, Geo. Cormack, and Blake.

Report.

"Your committee in presenting a report of the proceedings and management of the Institute during the past year, avail themselves of the opportunity to congratulate you upon its present flourishing condition, and the warm interest taken in it by the general public. While, in many parts of the Province, similar institutions have suspended active operation from want of sufficient patronage and support, yours has not only been sustained, but enabled to make large provisions for future usefulness and success. This intelligent favour and encouragement has not only made the discharge of our duties, more easy and pleasant, but has enabled us to supply a want which would soon have made itself seriously felt. The public hall and building required thorough overhauling and repairs so much, that we felt it would not, under any circumstances, be advisable to allow it to remain undone until another year; we have accordingly expended $201 in that work, relying in a very great measure upon the support of the community to make good the outlay. This, we are happy to say, they have generously accorded. In the library, it was necessary to make considerable additions of new books, in several departments; we have therefore laid out one hundred dollars in the purchase of ninety odd volumes, which increases the number to 1109. The number of readers during the year, has been 176, and the number of volumes issued 2309, being an average to each reader of 13 volumes. The lectures, of which there have been nine delivered, were well attended and the course has been well sustained.

In the early part of the season, a pic-nic was held, which, while made a source of pecuniary profit, was, we have reason to believe, of much greater and more advantage in bringing the Institute more prominently and favourably before the public. Your committee recommend similar annual festivals in future, as a means of much good. Evening classes for instruction in the ordinary English branches of education were kept up during the winter, and although, by no means unsatisfactoy, as an experiment have not been monetarily successful—balance sheet showing a loss of nine dollars occasioned by them. The attendance was not large, there being 17 scholars during the first quarter, and thirteen during the second quarter. A public discussion class was opened, and several debates held and essays read, your committee have however to regret the apparent apathy of the young men in this vicinity to its numerous advantages, but few among them taking either part or interest in it. Efforts should be made to sustain and increase the usefulness of and attendance upon both these important classes, as they will add materially to the welfare of the Institute and its individual members. Your committee suggest a classification of studies at evening classes so that particular nights be devoted to specialties instead of a general teaching in each branch as heretofore pursued.

Three re-unions were held, which proved highly successful and popular, the net receipts being over fifty dollars. In holding these, your committee while deeply indebted to many of the members for assistance, cannot but call your attention to the decided unwillingness by most at doing more than forming part of the audience. If these pleasant entertainments are to be successfully maintained, as your committee sincerely hope they will, there must be a more active support given by the members, otherwise they will soon deteriorate both in matter or use. In this connection, your committee trust they will not be considered invidious in making acknowledgment of the very kind services rendered them by Mrs. Garvin, Capt. Dartnell and J. V. Ham, and also the great kindness shown by J. V. Ham Esq., in allowing them the use of one of Rainers *Piano Fortes*. The membership is 209 against 187 last year, showing an increase of 22 members, twelve of whom have passed the preliminary examination and entered to obtain certificates of merit from the Board of Arts and Manufactures.

Notwithstanding the large outlays which have been made, expenses incurred, and improvements effected, your committee have to report a deficiency in the receipts of only $20, 33 after payment of all expenditures, as shown by the subjoined statement."

TORONTO MECHANICS' INSTITUTE.

At a meeting of the Board held on the 4th of last month, the Directors determined upon holding an Exhibition some time during the present year, of a description similar to the exhibitions held by this Institute in years past; and which were then found to be so interesting and instructive to those who visited them, and pecuniarily profitable to the Institute.

The character of the exhibition will be best understood by the following

PROGRAMME:

1st. "That an exhibition be held in the rooms of the Institute during the present summer; that it be continued open for a term of not less than one week; that the net proceeds thereof be applied to the liquidation of the floating debt of the Institute;

and that the following do form part of the programme of objects proposed for such exhibition:

(1) Specimens of natural history, such as stuffed birds, animals and fishes, preserved insects, minerals, dried plants and woods.

(2) Antique and curious specimens, natural, mechanical and artistic; numismatics, &c.

(3) Fine Arts and Decorations, ancient and modern; embracing architecture, paintings in oil and water colours, drawings, sculpture and modelling, dye-sinking and engraving, photography, and decorations and designs of every kind.

(4) Machines, and models of machines, and scientific apparatus.

(5) Articles of home or foreign manufacture displaying rare merit in design, workmanship or material; and raw materials for manufactures.

2nd. That an Exhibition Committee be appointed to consist of the President, and Vice-President, Dr. Connon, Messrs. H. E. Clarke, J. H. Richey, Js. Rollo, W. P. Marston, W. Edwards and D. Spry; and that said Committee be authorised to issue a circular to the citizens setting forth the nature and objects of the exhibition, and soliciting their assistance by contributions of suitable articles thereto on loan; and also to make such personal canvass throughout the city as may be necessary.

3rd. That the President apply to Sir Wm. Logan for loan of a complete set of the minerals of Canada for exhibition.

4th. That the Exhibition be opened on Thursday, the sixth day of October next, and that the charge for admission thereto be ten cents on ordinary occasions; but that on two days to be hereafter determined, and during the hours intervening between the opening and six o'clock P.M., on such days, the charge be twenty cents each admission, so as to enable parties who may desire to do so, to make a quiet and careful inspection of the objects on exhibition."

The Programme will, no doubt, be yet further elaborated. Probably music, addresses, and scientific experiments will, from time to time, be introduced during the continuance of the exhibition, so that both entertainment and instruction will be afforded visitors thereto. The greatest care will, we believe, be given to the safe keeping and return of all articles entrusted to the Committee of management; and as the building is isolated, and will be well guarded during the time the goods remain in it, contributors need fear no damage to their property while there. We anticipate a very interesting exposition in the several departments of the programme.

Useful Receipts.

FURNITURE POLISH.

Melt 3 or 4 pieces of sandaric, each the size of a walnut, add 1 pint of boiled oil, and boil together for 1 hour. While cooling, add 1 drachm of Venice turpentine, and if too thick a little oil of turpentine also. Apply this all over the furniture, and after some hours rub it off; rub the furniture daily, without applying fresh varnish, except about once in two months. Water does not injure this polish, and any stain or scratch may be again covered, which cannot be done with French polish.

To give a gloss to household furniture, various compositions are used. The following are some of them.

Furniture cream.—Bees-wax 1 lb., soap 4 oz., pearl-ash 2 oz., soft water 1 gallon; boil together until mixed.

Furniture oil.—Acetic acid 2 drachms, oil of lavender ½ drachm, rectified spirit 1 drachm, linseed oil 4 oz.

2. Linseed oil 1 pint, alkanet root 2 oz.; heat, strain, and add lac varnish 1 oz.

3. Linseed oil 1 pint, rectified spirit 2 oz.; butter of antimony 4 oz.

Furniture paste.—Bees-wax, spirits of turpentine, and linseed oil, equal parts; melt and cool.

2. Bees-wax 4 oz., turpentine 10 oz., alkanet root to colour; melt and strain.

3. Bees-wax 4 oz., resin 1 oz., oil of turpentine 2 oz., venetian red to colour.

AMALGAMS.

When mercury is alloyed with any metal the compound is called an amalgam of that metal; as for example, an amalgam of tin, bismuth, &c.

Amalgam for Electrical Machines.

1. Fuse 1 oz. of zinc with ½ oz. of tin, at as low a temperature as possible; then add 1½ oz. of quicksilver, previously made hot; mix, pour out, and when cold reduce it to powder, and triturate it with sufficient quicksilver to bring it to a proper consistence.

2. Zinc 1 part; tin 1; quicksilver 2. Melt together.

3. Zinc 2 parts; tin 1; mercury 5.

4. *La Beaume's.* Pour into a chalked wooden box 6 oz. of quicksilver; put into an iron ladle ½ oz. of beeswax, with 2 oz. of purified zinc, and 1 oz. of grain tin; set it over a brisk fire, and when the metals are melted pour them into the box, avoiding the dross. When cold reduce it to powder, and mix it with lard. Keep it in a box covered with tallow, and spread it on leather for use.

Liquid Amalgam for Silvering Globes, &c.

Pure lead 1 oz.; grain tin 1 oz.; melt in a clean ladle, and immediately add 1 oz. of bismuth. Skim off the dross, remove the ladle from the fire, and before the metal sets add 10 oz. of quicksiver. Stir together, avoiding the fumes.

Amalgam for Varnishing Plastic Figures.

Melt 2 oz. of tin with ½ oz. of bismuth, and add ½ oz. of quicksilver. When cold grind it with white of egg, and apply to the figure.

Solutions used in Electrotype Manipulations, &c.

1. *Acid Solution of Copper for the Decomposing Cell.* Saturated solution of sulphate of copper 2 parts, sulphuric acid 2 parts, water 6 or 8 parts.

2. *Gold Solution.* Dissolve 2 oz. of cyanide of potassium (by Liebig's method) in a pint of warm distilled water, add ¼ oz. of oxide of gold, and agitate together.

3. *Silver Solution.* Dissolve 2 oz. of Liebig's cyanide of potassium in a pint of distilled water; add ¼ oz. of moist oxide of silver (precipitated by lime water from a solution of the crystallized nitre), and agitate together till the oxide is dissolved.

4. *Solution in which Steel Articles are dipped before Electroplating them.* Nitrate of silver 1 part, nitrate of mercury 1 part, nitric acid (sp. gr. 1·384) 4 parts, water 120 parts.

5. *Solution, or Pickle, for immersing Copper Articles in before Electroplating.* Sulphuric acid 64 parts, water 64, nitric acid 32, muriatic acid 1. Mix. The article, free from grease, is dipped in the pickle for a second or two.

Volatile Soap for Removing Paint, Grease Spots, &c.

Four table-spoonfuls of spirits of harts-horn, four table-spoonfuls of alcohol, and a table-spoonful of salt. Shake the whole well together in a bottle, and apply with a sponge or brush.

Selected Articles.

BODILY WORK AND WASTE.

By Francis T. Bond, *M.D.*, *B A.* (*Lond.*) *F.C.S.*, *Principal of the Hartley Institution, Southampton.*

(From "Popular Science Review.")

There is no truth which modern science has established with greater certainty than that every manifestation of physical force involves the metamorphosis of a certain quantity of matter; or to put it in a still simpler form, that every exercise of power is made at the cost of a certain consumption of material. Whether it be the steam which propels our locomotives, or the elastic gases which project our cannon balls, the subtle fluid by means of whose vibrations we convey our thoughts with the rapidity of lightning from one end of the earth to the other, or the still more useful contrivances by which we turn night into day, and maintain the genial warmth of summer amidst the snows of winter—all these exhibitions of force, mechanical, electrical, or thermal, alike involve the disintegration, or, in other words, the *waste*, of some form of matter for their production. Without the combustion of coal or wood there would be no steam for the locomotive, no heat for the fireplace; without a similar, but more rapid, combustion of gunpowder, or other explosive substance, there would be no development of elastic gases in the cannon to propel its ponderous missile; and combustion in these, as in all cases, is essentially a process of waste in which the active part is played by that most energetic of all wasters, the oxygen of the atmosphere. The fluid which circulates in the telegraphic wire is developed at the expense of the acid and the metals of which the batteries at its extremities are composed; and the light which illumines our streets and public buildings is generated by the waste (using the term in its chemical, not, of course, in its economical sense), in gas works, of coal which was produced ages upon ages ago by the submergence and partial decomposition of ancient forests.

Now all these various ways of obtaining power may at first sight appear so very simple in their nature that it may seem trivial to allude to them. Irrespective, however, of the consideration that the simplest phenomena are often those which exhibit in their most intelligible form the grandest and most important laws of nature; and obvious as the fact may seem that the man who attempted to work a steam engine without supplying coal for its fire would stand but little chance of seeing its wheels revolve, it is doing no injustice to the majority of our readers to suppose that they have never asked themselves what the fuel really does in such a case as this, and why it is so essential in the production of steam? It is probable that the idea may never have suggested itself to them that these and dozens of other instances of a similar kind which might be quoted, all go to show that without the disintegration, or waste, of some form of matter, whether it be coal, or metal, or tallow, or gunpowder, there is no production of any form of force, no real acquisition of power of any kind. And, like Columbus' egg, simple as this truth may seem when once clearly demonstrated, and often as men have lighted fires to warm themselves by, and long as they have employed the explosive properties of gunpowder to carry conviction to the minds of their *intelligent* fellow-creatures, it is only quite in recent years that its reality has come to be distinctly recognised, and that we have begun to learn that perpetual motion, and other patent processes f r extracting something out of nothing, are ideas worthy only of the sages of Laputa.

It may however be said, that all exhibitions of force do not involve a waste of matter. We may be told, for instance, the stream of falling water which turns the river-side mill exerts its power on the mill-wheel in virtue of the force of gravitation which draws the water downwards, and gravity is a force which so far as we can see, does not involve the waste of matter as a condition of its manifestation. But this is an exception which is probably more apparent than real, and which is due rather to our ignorance of the nature of gravitation than to any deviation from a law which so unquestionably obtains in the vast majority of phenomena with which we are acquainted. For it is by no means unlikely that gravity which is itself a cosmical force, acting through space upon the most distant elements of the universe, may be the local manifestation in our world of disturbances in the relations of matter going on in spheres existing at infinite distances from it.

The propulsive force, too, of the breeze by which the ship is driven through the resisting waves, at first sight appears to be a case of force exerted independently of matter or its relations. But here again the exception is only apparent and not real. For science tells us that the breeze is the offspring of heat acting upon the atmosphere, in which it produces currents; and that the heat comes from the sun, whose material relations exhibit, even to our superficial observation, a state of disturbance which is eminently suggestive of a more profound and incessant disorganization going on beyond our ken.

We may, therefore, take it as unquestionable, that so far as the inorganic forces of nature are concerned, their manifestation in all cases involves the contemporary occurrence of waste, decomposition, or decay. But what are we to say of the forces which are given off by organized bodies? This thinking, talking acting machine which we call man, whose brain is continually giving off *nerve*-force, which is as constantly stimulating some one or other of his muscles to give off *motor* or mechanical force, and whose whole organism is incessantly maintained by the operations of the *chemical* and *physiological* forces which digest his food, convert it into the various tissues of his body, and again reconvert those tissues into the simpler forms in which, when they have served their part, they are eliminated from the system—whence does he obtain all these forces, or, more properly speaking, all these different varieties of force, which are so indispensable to his existence? Here, too, we must recur for an answer to these questions to the great law of the relations of waste and power to which allusion has before been made. The human body is continually wearing away; as truly though perhaps not so evidently, burning away as if it were a bushel of coals in a domestic grate. And it is from this ceaseless process of waste which is going on everywhere within it, that it derives the power which it expends in the various forms of work which it continually carries on. There are probably very few of the readers of this article who have the faintest idea of the amount of force which they are exerting every day of their lives. Let us see if we can manage, without wandering into details whose due appreciation would require a knowledge of the more profound departments of physiology, to form an estimate of the amount of work which the body of an ordinary man performs in the twenty-four hours, and of the waste of bodily substance of which that work is the equivalent.

We may roughly divide the constituents of the animal frame into three groups. In the first we will place substances which are actually incorporated into its organization in the shape of bone, muscle, &c; to the second we may assign those which are destined to minister to the building up of the animal fabric, in the shape of the raw materials derived from the digestion of the food in the alimentary canal, and in the third, we shall place those constituents which, having discharged their functions in the animal economy as elements of the various tissues, are thrown off as waste, and as such give rise to what are commonly known as the excretions of the body. It is obviously to this last class that we must look for the measure of the wear and tear of the body and of the evolution of force of which that wear and tear is the exponent.

Now of all the different substances which are thus thrown off from the body as the result of the decay which is continually going on within it, there is one, urea, which is preëminently important, not from its mere predominance in bulk over all the others, but because it is the one which gives us the most accurate guage of the amount of waste of which it is the product.

If we were to be told that the quantity of urea which is daily manufactured and eliminated from the body of a healthy man, weighing about 150lb., varies from 400 to 630 grains, it is probable that many of us would not be much the wiser for the information. We must, therefore, see if we can learn what this represents in another way.

The daily work which is performed by the body of an ordinary human being may be classed under four heads. (1) There is the *vital* work, or that which is required to keep the machinery of life going and in proper order; *e. g.*, to make the heart beat, the stomach digest, the liver secrete bile, and so on; just as a certain portion of the power of a steam-engine is expenced in merely moving the machinery which sets it in action. (2) Then there is what may be called the *calorific work*, or that which is required to maintain the temperature of the body, and which will obviously be much greater in winter than in summer, and in cold climates than in warm ones. Although this is intimately connected with the preceding variety of work, still it is for many purposes sufficiently distinct and important to justify our considering it under a separate head. (3) Next we have the *mechanical work* which is involved in the physical exercise we take, such as walking, talking, eating, &c. (4) And, lastly, there is the *mental work*, which we each of us perform in the acts of thinking, seeing, hearing, and in the exercise of our nervous functions generally. One of the great problems which physiology has of late been endeavouring to solve is, how much of the total daily work of the body is absorbed by each of these four departments of bodily activity separately; or to put the question in another point of view, how much of the total daily waste of the body is due to them severally? The recent researches* of a distinguished medical divine—for, by a strange coincidence, though a clergyman by profession he is also a physician by education (the Rev. Professor Haughton, M.D., F.R.S., of Trinity College, Dublin) have thrown a good deal of light upon this obscure and difficult subject. With the view of giving our readers a general idea of the relations of bodily work to bodily waste, we will briefly recapitulate the nature of these researches.

We have before stated that the total amount of urea which is formed in the body of a healthy man of 150 lb. weight, *per diem*, fluctuates from 400 to 630 grains. Of this amount Dr. Haughton calculates, from data to which it is impossible for us here to refer, that 300 grains are the result of that division of work to which we have above given the designation *vital*. Hence it follows that each pound of man requires an amount of daily waste which is represented by 2 grains of urea merely to keep it alive, and prevent it from becoming subject to the ordinary chemical laws of inert matter.

But if this 300 grains of urea represents a certain amount of bodily waste, that bodily waste in its turn represents a certain amount of work done, or force expended; and to estimate what that work is, we must find out the equivalent, in some definite and easily calculable form of work, of a

* *Dublin Quarterly Journal of Medicine*, 1859, 1860.

definite quantity, say one grain of urea. This Dr. Haughton has done. But before stating the results at which he has arrived on this point, it should, perhaps, be mentioned, for the benefit of those to whom this subject may be entirely new, that it is used to calculate all varieties of mechanical force in terms of a single unit, and that unit is the force which is required to raise one ton avoirdupoise one foot from the earth. For instance, a man who walks twenty miles a day can be shown in so doing to perform an amount of mechanical work which, if applied in another way, would raise a weight of 150 lb., *i. e.*, about the weight of his own body, one mile in the air. Again, the ordinary daily work of a street paviour, who works ten hours a day, and whose occupation consists in lifting, at definite intervals, a hammer weighing 5½ stone, is equivalent, if applied as before mentioned, to lifting a weight of one ton 352 feet in the air. In this way the foot ton, as it is called—*i. e.*, one ton lifted one foot—becomes the unit of measurement of dynamical force generally.

Now, let us recur to the consideration of the force which is expended in the daily waste of 300 grains of urea. From a series of elaborate calculations Dr. Haughton estimates that the mechanical equivalent of this quantity of urea is one ton lifted 769 feet or 769 foot-tons. That is to say this enormous force—a force which is more than equal to that expended by two street paviours during a hard day's work, is used up in merely keeping a man of 150 lb. weight alive for the same period. We may put the same fact in another point of view by saying that the amount of force required for this purpose would lift the man's body a little more than two (2·18) miles in the air during the twenty-four hours.

From similar, though perhaps somewhat more doubtful calculations, Dr. Haughton estimates that the amount of bodily waste which is caused by one hour's hard mental labour involves an expenditure of force which is equal to lifting 111 tons one foot in the air.

Let us further suppose that in addition to the mere act of living, an average man of 150 lb. weight undergoes bodily labour equivalent to lifting 200 tons one foot daily, and that the total amount of his day's mental work is equivalent to two hours hard study, and the "little bill" of his daily expenditure of force will stand as follows:—

Vital Work	300·00	grains of urea	= 769	foot-tons
Bodily work	77·38	" "	= 200	"
Mental work.........	86·00	" "	= 222	"
Total urea	463·38	=	1191	tons raised

one foot: or one ton raised 1191 feet; or the weight of the man's body (150 lb.) raised a little more than 3 miles.

To balance this side of his debtor and creditor account, our average man would have to consume an amount of food sufficient to furnish him with the nitrogen contained in 463 grains of urea. Hence he will find it desirable to take a considerable portion of animal food in his diet, because that kind of food contains in proportion to its bulk a much larger quantity of nitrogen than vegetable substance do; for if he does not do this, he will have to augment the amount of vegetable material which he ingests to such an extent as seriously to embarrass his digestive functions. It is for this reason that the labouring man, who cannot procure meat, has recourse to cheese, which, although difficult of digestion, contains a considerable quantity of nitrogen.

But, the reader may not improbably ask, if all this enormous quantity of force is expended by a living man during the short space of twenty-four hours, whence does it all come? And this is a question which is by no means easy to answer, clearly within the limited space which is left to us. In general terms, however, it may be said that the force which the animal economy expends in the discharge of its various functions, is intimately incorporated with the food which it ingests for the support of its material framework. Animals live at the expense either of other animals or of vegetables—in both cases of previously organized structures. Every process of organization involves the absorption and fixation of force in the created organism. Hence every organized structure is, as it were, a reservoir of force. The force which the plant receives from the solar heat is stored up in its cells, to be dispersed again gradually to the atmosphere in the shape of heat when it decays, or rapidly, when it burns as coal; or, if consumed by an animal as food, is incorporated, with the elements of the plant, into the tissues of the animal which consumes it. These animal tissues thus become storehouses of power, which, as they waste and decay, is given off in the various forms which their peculiar character adapts them to eliminate. Thus the nervous tissues give it off as nerve force; the muscles, as motor force; the fatty elements of the body, as heat; and so on. One of the most interesting branches of Dr. Haughton's researches is the determination of the amount of force which is stored up in human muscles.* By a series of careful observations and calculations, he finds that the muscles which sustain the arm in a horizontal position—the central portion of the deltoid and the supraspinatus—weigh 5⅛ ounces, or 2,242½ grains, and that the work which they do in sustaining the arm until it becomes exhausted is equivalent to lifting half a ton through one foot. Hence it follows, that 1 lb. of such muscle contains stored up in it, sufficient force to raise 1·56 ton through the same distance. This statement will go far to explain the origin of a portion, at least, of the force which is expended daily by the body of a living man. When it is remembered that during his waking hours the voluntary muscles of man are rarely at rest for more than a few seconds together, it will be seen that we have, in their constant waste alone, a fertile source for the evolution of force. But it is to the action of the involuntary muscles that we must look for the most abundant origin of the force which he is ceaselessly eliminating, and more especially to that most important of all the involuntary muscles, the heart, which, from the time he draws his first breath till his eyelids close in death, is never at rest. Most people are aware that the heart is simply a muscular bag, divided into four cavities, and that the circulation of the blood through the blood-vessels, which is so essential to the maintenance of life, is mainly due to the force with which the muscular walls of the heart contract on the blood as it passes through

* "Outlines of a New Theory of Muscular Action." 1863.

these cavities. Few, however, would imagine the force which this small fleshy bag—no larger than one's double fist, and only weighing about nine ounces—exerts on the mass of blood which it is called on to propel. Dr. Haughton has most ingeniously estimated that the force which the heart expends in the twenty-four hours is equivalent to lifting 124 tons one foot! This estimate would be almost incredible, if it were not obtained by two totally different methods of calculation, used as checks upon one another. And if this amount of force is expended by the heart in twenty-four hours, how rapid must be its waste, and how vigorous must be the nutrition by which that waste is repaired. Few instances could be quoted which show more forcibly than this does the wonderful perfection of adaptation, and the concentration of activity which the higher organized structures exhibit.

To those who are not familiar with the subject of physiological dynamics these statements, generally, will probably appear little short of incredible, so difficult is it for the imagination which is untrained in the teachings of science to realise the fact, that the apparently simple and unlaborious functions of mind or body can involve the expenditure of force at all. The most unscientific observer cannot fail to perceive that the arm which works the paviour's rammer, or the legs which bear the weight of the body over the many miles of a long day's walk, must in the performance of these offices, exert a considerable amount of force; but he does not so readily appreciate the manifestation of the same phenomenon in the silent decay of the whole body when at rest or in the unconscious exercise of the mind. Those, on the other hand, who have learned with what a mighty energy nature works even in her most simple operations—that the force which holds the elements of a single grain of water together is equal to that which is contained in a very powerful flash of lightning, will know that, although there are some of Dr. Haughton's calculations which, from the uncertain state of our knowledge, must at present be received with some degree of reservation, the general character of his results is quite in unison with the dynamical laws which the researches of Joule, Mayer, and other physicists have during recent years established.

INFLUENCE OF AIR ON HEALTH.

Some persons are scarcely aware of how much has been done in less than a century. Within a comparatively short period railways have branched in all directions, both at home and abroad, like the fibres in a spider's web; steam-boats are travelling every ocean; and gas, which began to enlighten the darkness of cities in our time, is now rapidly extending its usefulness, not only in small towns, but even in villages; the application of other discoveries are no less wonderful; but, notwithstanding, it is not ninety years since the composition of the air we breathe and of the water we drink, was made known. Chemistry, at the period alluded to, was only beginning to free itself from the shackles of alchemy, and to look forward not merely to become a practical and controllable art, but also to erect itself into a science.

Soon after the composition of the air was made known, it was believed that in all places, whether in crowded cities or on open plains in the country, that composition was constant; that is, that the amount of oxygen and nitrogen was always the same by measure. This inference, undoubtedly, was drawn from the small quantity of air operated in the eudiometrical experiments which were resorted to. These gave the quantity of oxygen and nitrogen, but the infinitessimal quantities of certain impurities, excepting carbonic acid gas, escaped observation. But within the last five-and-twenty years, more extensive analyses have been carried out, which have given rise to more accurate results, and we are now better informed respecting the evils which increased and concentrated populations are continually producing in atmospheric deterioration. The subject has been carefully handled both at home and abroad, and it has been already shown at page 11, vol. i., that the composition of the atmosphere is affected according to circumstances, and this having been thoroughly proved, it behoves us to be constantly endeavouring by changing the air of our appartments, to render it more fit for the offices of life, than when it is "cribbed, cabined and confined," or where ventilation is entirely disregarded.

We may refer to Liebig, as well as to others, who have considered this subject abroad, and we might show that the chemists of our own country have not been backward in prosecuting the subject. Amongst others Dr. Robert Angus Smith has played his part in a very careful and successful manner.

Both air and water have a most important influence on health. The general feeling that town has always been found to differ from the country in respect to the health of man, the lower animals and plants, is a more decisive experiment than any that can be made in a laboratory.

Although men of high standing have been found to deny that any difference exists between the air of the largest towns, or of the most crowded rooms —for reasons already given—and that of the open country, it seems to be only a proof that men accustomed to experimental inquiry are apt to forget the value and force to be attached to those apparently less rigorous observations, which the senses are constantly and unconsciously making, and to believe only that which can be demonstrated by the proper processes of a laboratory. The inquiries made by the Sanitary Commissioners, years ago, have completely established the fact, that crowded towns are dangerous places; and although it is still an open question whether a well-regulated town or country life be the most healthy it is sufficiently established that our towns have been subject to many dangers, which we are in self-defence trying to avert, by acting according to natural laws as far as there acquaintance has been made.

Most persons from the country must have felt, that the entrance into a large town is like the entrance into another climate. Inhabitants of the sea coast or of the hills perceive the change rapidly, and the effect on them is often decidedly bad, and it requires time to acclimatize them to the atmosphere of the new situation. It appears that we can bear the gradual deterioration of air; but we find ourselves surprised at the state of the air in which we find persons sitting in a close and crowded room, and who are perfectly unconscious of any want of attention in their sanitary state.

It is the oxygen of the air which purifies all impure matter, and bodies which are impure have a tendency to mix with the air, after which they become purified, or they mix with the soil of an open country, in which, by the same source of oxygen, they are also rendered pure. The air of a town contains a portion of all exhalations which arise in a town. These are in a great measure, the produce of living bodies, and are exhalations which can never be got rid of, but which, probably are not at all dangerous, unless they become accumulated. There are also exhalations from sewage, and from the combustion of fuel. Various manufactures give out a variety of effluvia, and we cannot walk through a large town without perceiving that no street is entirely free from effluvia, and that every street seems to have a peculiar odour of its own. Even every city, nay, every town, and, we may almost add, village is known by its odour. Although custom causes us to forget that odour to which we are constantly exposed, a frequent change gives us an acuteness of smell, by which we may understand that both houses and streets may fairly be complained of, when the inhabitants are not all aware of the evils by which they are surrounded.

That animals constantly give out a quantity of solid organic matter from the lungs may be proved by breathing for some time into a bottle through a tube, when the condensed breath will be collected at the bottom of the bottle. If this condensed breath be placed on a piece of platinum, or on white porcelain, and evaporated, and the residue burnt, the smell of organic matter will be evident. If the condensed breath be left to stand for a few days, it will then be inhabited by animalcules, which may be seen by a good microscope. Animalcules are now generally believed to come from the atmosphere, and to deposit themselves on places favourable to their existence. Thus they only appear where there is food or materials of a peculiar kind, adapted to their wants. Their presence is a proof of decomposing matter. A liquid of the kind just named must be injurious by giving out unwholesome vapours.

SPALLANZANI, many years ago, showed that the seeds of the plant *mould*, constituting mouldiness, are constantly floating in the air, and when they come in contact with anything favourable to their growth, they germinate. This may be shown by taking two fresh specimens of newly made paste; place one under an exhausted receiver, the other expose to the air; the former will not become mouldy, but the latter will in a short time.

Thus far as regards organic matter, and the emanations resulting therefrom having an influence which is destructive of atmospheric purity. It is not now only necessary to call attention to impurities which are strictly of an inorganic kind, or nearly, namely the very minute particles which are always floating in the air, and which only render themselves visible in a sunbeam darting through an opening into a room.

These impurities exist in all places, in the most remote districts as well as in the most crowded cities. They possess no odour; their action on the respiratory organs would probably in time be attended with mischief, were they not collected by the mucous of the fauces, and thus rendered harmless. Not so with the invisible particles of matter, the presence of which is sometimes evidenced by some peculiar odour, while at other times no evidence is given of their presence, except by the baneful influence they are capable of exercising on the human frame.

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DR. ROBERT ANGUS SMITH has called attention to the organic matter which he has repeatedly obtained from the moisture condensed on the windows and walls of a crowded room. If after being collected by means of a pipette it be allowed to stand some time, it forms a thick, apparently glutinous mass; but when examined by a microscope, it is seen to be a closely matted confervoid growth, or organic matter converted into confervæ as it probably would have been converted into any kind of vegetation that happened to take root. Between the stalks of these confervæ may be seen a number of greenish globules constantly moving about, various species of volvox, accompanied also by monads many times smaller. When this happens, the scene is certainly lively and the sight beautiful, but before this occurs, the odour of perspiration may be distinctly perceived, especially if the vessel containing the liquid be placed in another vessel containing boiling water. When this exhalation from animals is condensed on a cold substance it in course of time dries up, and leaves a somewhat glutinous organic plaster constituting the substance which we often see upon the furniture of dirty houses, and in such cases there is always a disagreeable odour perceptable. This is the cause of the necessity for constant cleaning; it is the reason why that which is not cleaned becomes dirty.

Water or dampness is necessary to the spontaneous decomposition of organic matter, and it is thought that, in a warm climate, this coating of walls and furniture would not be so dangerous as where everything is exposed to moisture a considerable part of the year. In a warm and dry climate it will probably be diffused more into the atmosphere, and not be so much retained as it is by the water which dissolved it, or to which it attaches itself. This kind of matter would perhaps not be poisonous if taken into the stomach, but it is known to be inimical to health when breathed into the lungs, which is shown by the inconvenience we experience in the air of crowded rooms. It consists of carbon, hydrogen and nitrogen, and by oxydation no doubt forms carbonic acid, water and ammonia. From it the ammonia of the atmosphere is in a great measure derived. Ammonia is not injurious unless in large quantities, and may be considered as one of the most wholesome forms in which nitrogen and hydrogen, as gases, pass into the air, and it is the neutralizer of sulphuretted hydrogen when it is given off along with that gas in sewers and cesspools. It is not so very long when, in numbers of houses in the metropolis, and in large country towns, the privies were often merely cesspools in the cellar, or in a small yard, and were it not for the correcting property which ammonia has as regards sulphuretted hydrogen, such houses as contained these open places would have been intolerable. The sulphide of ammonium formed by the action of ammonia on sulphuretted hydrogen is eventually converted, through the agency of the oxygen of the air, into hyposulphite of ammonia, the sulphur being partly precipitated and partly oxydized, a portion of the hydrogen combining, at the same time, with the oxygen of the air, and thus the poisonous properties of sulphuretted hydrogen become annihilated.

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If this did not take place, it would be impossible for men to exist as they do for hours in the sewers of the metropolis. It is true the sewage is not stagnant in the sewers; but were its decomposition would take place more rapidly, perhaps than oxidation of the deleterious gases could be accomplished. The dilution with a large quantity of water, also renders the change less rapid than it otherwise would be. One portion of the sewage is continually displaced by a succeeding portion, and its course along the sewer, is constantly becoming supplied with water scarcely rendered impure; it is always moving, and always being diluted. It would seem therefore, that as ammonia is not injurious, unless in large quantities, it may be considered as one of the most wholesome forms in which nitrogen and hydrogen pass off from decomposing matter into the atmosphere. In cases where there is no exposure, or, at least when the substance is in water, inflammable gases are produced, which was first shown by PRIESTLEY, and which has since been to a certain extent explained by LIEBIG. It appears that when decomposition commences, oxidation of one portion necessarily takes place, leaving the other portion without oxygen, except when an abundant supply can be obtained. DALTON found the gas from the floating island at Derwentwater to contain carburetted hydrogen and nitrogen. When nitrogen comes off alone, or as ammonia, the same division of a substance into oxidised and deoxydized occurs, as in the fermentation of sugar, where carbonic acid, a body oxidised, and alcohol, a body to a great extent deoxidised, occur. We have only to suppose compounds of carbon, hydrogen, and nitrogen, coming from decomposing matter, to show us the great danger. It is not to be depended upon that these bodies always appear in modes of combination mentioned above, as they combine variously, and they are capable of forming the most active poisons with which we are acquainted.

Although a large quantity of water may mask decomposition, or retard it, by preventing access of air to all the matter preparing to undergo decomposition, yet a certain amount of moisture is essential to chemical changes, and the consequent escape of odour from sewage, as well as from many other bodies. The vapour of water is a vehicle for organic matter, and water also favours decomposition in bodies, so that, as they decompose, the vapour is given off. From what cause soever, it will be found that moisture rapidly facilitates the escape of odour. We ascertain by breathing on a mineral what its nature may be. The moisture of an evening affects the scent of flowers, and even the watering of them causes them to emit their odour. The moist state of the atmosphere, or a shower, is the cause, as we often experience, of great fragrance in a flower garden. But whilst this is being effected, the same laws are operating for injurious effects wherever there is a reservoir of putrid matter, for then the exhalations are so abundant that bubbles of gas, the result of decomposition, may be seen to arise from filthy water.

Dr. ANGUS SMITH observes that it is not improbable that the state of the atmospheric pressure may cause this, as Mr. G. W. BINNEY has shown that the gases in coal-pits are caused to escape rapidly during a depression of the barometer. We all are in the habit of observing that rain is likely to come, when we perceive an odour from sinks or drains, the escape of odoriferous matter being consequent upon a lighter atmosphere, the gases escaping which had been retained under a higher atmospheric pressure.

Bodies that are moist will give out more organic vapours than those in a drier condition. If there be abundance of water, as in a lake, large river or sewer, the vapours will to a great extent be dissolved, even if the same kind of decomposition were to proceed as in merely moist or marshy ground. We may expect then that soil, if moist, will give out, not pure vapour of water, but water carrying up organic matter within it. Wet soil is a little acid generally, and when very acid, is bad land; but when made alkaline by matters producing ammonia, it becomes fertile. This neutralizing of acidity in a soil is frequently effected by lime. This state of almost neutrality of soil is also regulated by nature, and a fertile alkalinity is attained by the rapid decomposition of organic matter through moisture and warmth. In this alkaline and warm state more vapours will of course be given off, and the ammonia will assist in passing off organic matter into the air.

The substance obtained from dew collected by condensation on a glass cylinder, and allowed to drop into a glass vessel below, was found by Dr. SMITH to be very different from that obtained from the condensed vapour of a warm and crowded room, of which we spoke in a former article. The residue from dew, unlike that from the condensed vapour of a room, is almost devoid of nitrogenized matter, and is rather agreeable than otherwise. It is not improbable that the *matter* resulting from dew may be made a measure of its amount in the atmosphere; if so, the decided difference between that of the country and that of crowded rooms is to be remarked, and may probably form a good guide towards a knowledge of comparative purity of atmosphere. In walking along the fields in an evening, when there is much dew, it may be observed how much effect a dry soil has; indeed, the climate of a field will be found to vary almost every yard. Every cause of cold, the formation of a drain, the looseness of any spot its being higher or more level, or more sheltered, is indicated by this delicate thermometer, the rise of vapour and the perception of cold. If we ascend higher, the same is seen on a large scale—on miles instead of yards. A house may be in a clear atmosphere, and the lawn before it in an impenetrable fog. One foot in height makes a difference, and one foot also of level distance, if the ground differ in quality. The damper places give a feeling of freshness, and cause a slight irritation of the nose. Every wall causes a certain amount of dampness; and even on a windy day, a leafless hedge will protect the ground on one side from evaporation. In these respects, therefore, every field and house in the country, and probably every house and street in town, has its own peculiar climate.—*Sanitary Reporter.*

Machinery and Manufactures.

SCRAP-IRON FORGINGS.

We once asked a blacksmith, of great experience in his trade, his opinion of making fine forgings for first-class work out of scrap-iron; whether merely accumulating shreds of iron and fagotting them up indiscriminately would produce a superfine piece of material at the completion of the job. The answer was laconic and unequivocal; said he —"Good scrap-iron will make good material, and poor iron will always be poor iron." This is precisely our own opinion in most respects. Skilful manipulation and successive heats may indeed make inferior iron a little better than it was, but the idea that superior forgings can be made out of refuse scrap, or bits of poor iron, is an erroneous one, palpably so to those who will take the trouble to think for a moment. In establishments where only the best iron is used, such as the Ulster, Lake Superior, or Salisbury brands, the scraps will of course be of the first quality; but as for the miscellaneous combination of every conceivable sort of cuttings that are sometimes "piled" in blacksmith-shops—such as curry-comb backs, old iron skates, kitchen pokers, bitts, auger-shanks, or ordinary rolled iron—making good iron, it is unreasonable to suppose it.

"But," says the practical reader, who possibly objects to this view, "no matter if the quality of the iron is inferior at first, you have admitted that successive heatings and workings will improve it so much that at length it becomes of an excellent quality." Our answer to this is that the experiments of Mr. William Clay, an Englishman, who has made the subject a study, prove that, up to a certain point, working iron over and over is advantageous; but after the maxium is reached the strength decreases in the same ratio that it rose. In twelve experiments with ordinary No. 1 iron (whose original tensile strength was 43,904 pounds), through six trials the strength was increased to 61,824 pounds, but upon continuing the working of the same iron up to the twelfth experiment, the quality deteriorated to the original figures, 43,904 pounds.

From these experiments it is easy to see that iron highly refined, and particularly scrap-iron which may have been worked and re-worked an infinite number of times before it was piled, is the very worst material that can be used for forgings that require great strength, homogenity, and tenacity. For another reason scrap-iron is bad for large forgings, and that one is the different welding points at which different qualities of iron unite. Iron manufacturers are well aware of this peculiarity, and in piling iron for rolling, the hardest and most refined metal is placed outside, and the softest, or what is known as puddled iron, in the centre of the mass. Were it not for this precaution the exterior would be burned before the center was fully heated.

Gun barrels, known as the stub-and-twist, or Damascus pattern, are made from scrap-iron and steel, but of the best quality, and they are more valuable from their peculiar appearance than from any special value in the selection of the material or the manner of their construction. The "regulation rifle," made at Springfield, is rolled from pure soft iron, and is one of the strongest weapons of its kind in the world. There are very many places where scrap-iron forgings can be used with economy and to great advantage; in fact there is no other way of utilizing the continual waste of the smithery; but where a uniform and even wearing surface is required, scrap-iron is the worst that can be used. The practical workman knows that in turning a scrap-iron shaft there are many degrees of difference in the hardness of certain portions, and we can call to mind several instances where pieces of hard steel have been cut out of journals and replaced with soft iron. Many engine shafts pound in their bearings in spite of all the efforts of the engineer to prevent it, by lining up or screwing down, and very often the trouble can be remedied only by turning the journal anew. Some portions of it were softer than others, and wearing faster, caused the shaft to become oval, so that the more the "binder" was brought down the worse it behaved. Links for working valves, in fact all parts that require homogenity, either for bearing surfaces or mere finish, should be made from iron of one kind, if it is desired to obtain the best results.—*Scientific American.*

STEAM BOILER EXPLOSIONS.

The following practical remarks conclude an article or "Locomotive Boiler Explosions," in the *London Mechanic's Magazine* of a recent date.

"The time has almost gone by when an explosion was regarded as the result of mysterious agency. It is pretty well known now, that but two causes can lead to the bursting of a steam generator under the conditions of legitimate working. These are simply congenital weaknes, due to bad materials or an imperfect method of construction, or induced weakness, the result of overheated plates, or corrosion. More than 80 per cent of the explosions which occur yearly are the result of this last cause. If we take a hypothetical case of three boilers, of precisely the same form and construction, worked under precisely the same conditions, and exposed to like sources of deterioration, but carrying different pressures; the time when each will explode may be as certainly reckoned on as the moment when a watch wound up to-night will be completely run down. Suppose that one carry 100 lbs., another 75 lbs., and the last 50 lbs. of steam; the first may last five years, the second seven, and the last nine or ten years, simply because the process of destruction may have so far weakened all the boilers that, in five years, they are incapable of carrying 100 lbs. steam, but yet retain strength enough to carry 75 lbs. Therefore, only that one carrying 100 lbs. will be destroyed then; the others must wait until corrosion has done a little more, but they will go in turn. The end of all flesh is death, and the end of all boilers is explosion. An old writer quaintly remarks that, "If a man lives long enough he will certainly die." In the same way, if a boiler is worked long enough it will explode, in spite of all the safety appliances which ever were or ever will be invented. At best these can only provide for the occurrence of certain phenomena which, without this provision, would cause an explosion; but they certainly cannot provide for the occurrence of *all* the phenomena which produce explosions. Until a safety-valve or a fusable plug, is invented which shall stop a leak or put on a patch, or arrest the progress of corrosion, neither one nor the other can prove its title to be esteemed as an infallible specific. The only certain preventive is careful, properly organized and thorough inspections; and the reports of our steam-boiler societies prove its efficacy daily.

"Experience goes to prove that fully as many explosions occur while the engine is in motion, or while the boiler is under steam and the engine at rest, as at any other time. It is almost impossible to trace any connection between the withdrawal of a portion of steam from a boiler and the subsequent explosion of the latter. Could it be proved that the gage either rose or fell perceptibly, the case might be different; but the hand seldom moves, instantaneously at least. The only remarkable phenomenon is, the sudden rise of the water in the glass gage; and this rise from its character would seem to denote a dilation of the whole body of fluid, not a mere foaming or priming, for the gage shows a rise of "solid water" invariably, and not foam, when the boiler is properly full. It is not likely that either of these explosions will ever be found to present any unusual phenomena; but the lesson which they convey is not the less instructive. Inspection, and careful inspection alone, can secure safety, and the sooner steam engine proprietors become convinced of the truth of this proposition, the better for the entire community."

FLY WHEELS.

The fly wheel is the most elegant mechanical device in existence. It answers its purpose when properly designed, and put to work as it should be, with almost absolute perfection. It is very inexpensive, never wears out, causes very little friction, wastes an insignificant amount of power, takes up, in one sense, but little room, is equally applicable to reciprocating, rotatory machinery, under a host of varying circumstances and conditions, and, in short, fulfils every demand which can be made on its powers with an ease and certainty which entitle it to rank in the foremost place as an example of the accurate adaptation of certain means to a desired end. By whom it was invented is a question which has never yet been satisfactorily answered, and in all probability never will be. For the first idea of its application to the steam engine the world is indebted to Fitzgerald, an Irish professor, who proposed, in 1757, that it should form part of Papin's engine, working with rack-headed piston rods, gearing alternately into a pinion on the main shaft. Up to that time the crank had never been fitted to the steam engine. It has been urged that the fly wheel was practically unknown previously to this date, but there can be no doubt that such a statement involves a gross error. Old spinning wheels worked with a treadle and crank are still in existence, constructed much more than one hundred years ago. The fly wheel is one of those things which never were invented. Its application to machinery is a growth, not a creation, and the history of that growth goes back so far that it is totally indistinct, lost, and shrouded, in the mists of the past. No interest was attached to it until it became an all but indispensable adjunct to the steam engine, and therefore no records exist calculated to clear up that which is obscure. If there were any pecuniary advantages to be derived from tracing a lineal descent from its inventor to some individual of the present generation, we should hear a great deal more of the matter. The world always does hear much in such cases, but as the fly wheel in its simple form never was patented, and as its use is open to all mankind, it is seldom indeed that the question is asked, From whence did this thing come? and with this state of affairs we may rest and be thankful.

The duties performed by a fly wheel are very simple. Within its periphery,—speaking in general terms, which neglect the effect produced by the arms and centre bars—is stored up at particular periods a certain amount of power, absorbed in the impartation to the mass of a slightly increased velocity of rotation; and this power, by a law of nature as inexplicable and mysterious—and let us add, as simple withal—as the action of gravity, must there remain stored up even to the end of time, unless the motion of the wheel be reduced, or stopped altogether. Further, all this power will be returned intact to the machine, when the speed of the wheel is reduced exactly that amount which it was previously increased in order that the power thus returned might be taken up. As a result the fly wheel cannot produce perfectly regular motion. It can only prevent sudden and violent irregularities of motion. At the moment when the piston arrives at, say, the middle of its stroke, the strain on the crank pin, and the power of this last on the wheel, will be at or near a maximum; the velocity of the wheel then becomes slightly accelerated. As the crank arrives at the dead points its effect is lost; then the wheel gives out its store of power, but in so doing, its speed must fall off to exactly the rate which it possessed before it was accelerated: thus during every revolution of a single cylinder engine, there are two periods of retardation and two periods of acceleration, and the mechanical value of these periods will depend on the speed and weight of the wheel; and thus, although the irregularity can never be wholly eliminated in such engines, it can always be brought within reasonable limits. The maximum velocity occurs—when the pressure on the piston, or rather on the crank pin, is pretty uniform—when the crank is at an angle of about 140 degrees; and the minimum when it is at about 20 degrees from the dead point; and the duty of the fly wheel is involved in rendering the difference between these two velocities as small as may be deemed necessary. We have no desire to burden our pages with abstruse formula, but the following rule, given by Professor Pole for finding the weight in cwts. of a fly wheel, will be found generally useful, and is certainly not abstruse;—

Let H = Effective horse power of engine,
R = Mean radius of fly wheel,
N = Number of revolutions per minute,

Then in round numbers the weight in cwts. will $= \frac{90{,}000\ Hn}{R^2\ N^3}$

In this formula n represents the degree of irregularity which is admissible, and this will of course depend on circumstances, and may be anything between 20 and 60. Where no great degree of uniformity is required, the former value will answer: for the finest cotton spinding machinery the latter is not too great. For ordinary practical workshop use, however, n may be eliminated, by substitution, and the formula then becomes—

$$\text{For ordinary machinery, } W = \frac{2{,}000{,}000\ H}{R^2\ N^3}$$

$$\text{For purposes where a maximum regularity is requisite, } W = \frac{5{,}000{,}000\ H}{R^2\ N^3}$$

In other cases some value between these will be found most suitable.* The determination of the diameter for any given power, and the velocity, cannot be settled exactly by any rule, as these things depend almost wholly on circumstances seldom quite within the control of the engineer. In corn mills the rim of the wheel should, as a general rule, run faster than the stones, in order to prevent back lash, and this holds good in the case of many other machines, as well as corn mills.

It is as well to remember that the pressure on the area of a piston does not accurately represent the pressure on a crank pin when the engine is in motion, because the velocity of a heavy piston, connecting rod, cross-head, and guide blocks, represents a very considerable amount of momentum; and thus at the beginning of a stroke the strain on the crank pin is less, and towards the end greater, than that due to the pressure on the piston. From this it follows that an engine might easily be constructed which, while working steam very expansively, would exert a strain nearly constant on the crank pin. It would only be requisite to proportion the gravity of the mass of metal reciprocating, the speed, the grade of expansion, and the initial pressure in order to attain this end. Thus fast running engines with heavy cross heads, &c.; will not require nearly so ponderous a fly wheel, if they are worked expansively, as at first sight may seem necessary in consequence of the varying pressure on the piston. For such engines the rules we have just given need not be departed from. Slow running expansive engines are usually so wasteful of fuel that they are not very popular; at least, steam is seldom cut off very early in their cylinders, and we need not, therefore, take them into consideration. Simple as the fly wheel is, there are many problems involved in its action worth the attention of the practical mechanic, and we purpose returning to the subject.—*Mechanics' Magazine.*

* The sectional area of a fly wheel rim in inches, $\frac{11{\cdot}42\ W}{D}$

CONCENTRATION OF POWER.

On the concentration of power depends the solution of important mechanical problems daily encountered by the engineer in the practice of his profession. In its practical form the concentration of power is embodied in the reduction of the dimensions of any motor to minimum limits, no matter what its individual construction, or the nature of the principles under whose administration it gives forth power. The problem, thus stated, involves in its solution many points of technical detail which can only meet with proper treatment at the hands of those practically, as well as theoretically, acquainted with the working of machinery, because all the difficulties met with in dealing with small machines intended to develop a high power are encountered in their working, seldom or never in their mere construction. The whole subject is one possessing no common interest, the struggle for concentrated power having produced some of the most elegant and important mechanical arrangements ever called into existence by the excogitations of mankind.

It is needless to complicate the subject just now by any disquisition on the origin of power. We know that no machine or system of machines, however complex or ingenious in construction, can do more than direct in o the required channels certain proportions of those forces which are developed by particular laws of nature over which we possess a very limited control. To originate power in themselves is beyond the capacity ot wood, iron, stone, or, in short, any constructive materials at our disposal. The water wheel stands still until the stream is permitted to flow into its buckets; but the stream does not possess volition —it also would stand still but for the action of gravitation, a force in the abstract wholly independent of man's control or influence; obeying certain well-known laws, from which it never departs, and perpetually operating throughout the entire universe. Why a larger body should attract a smaller one, we do not know; we can only recognise and avail ourselves of the fact. In like manner, the steam engine is incapable of doing more than converting to useful purposes, a certain proportion of the force stored up in the fuel which heats the water from which the steam is raised. In either the fall of water or the combustion of fuel, a certain force is merely set free or called into action; it is never created by the aid of machinery of the existence of which, all the forces in nature are wholly and entirely independent. Thus, whenever a pound of coal undergoes the process of combustion, power previously stored up is set free; and precisely the same mechanical effort is requisite to evaporate a pound of water in an open vessel, as in a closed generator connected with a steam cylinder and piston. Were it not that pure force or power has existence independently of mechanism, there would be little room for improvement in the construction of machines. We should expect to find their dimensions bear an inv riable proportion to the amount of power which they were intended to produce, while the least possible variety would be permitted in matters of detail, on which their working would doubtless almost, if not altogether depend It is therefore perhaps fortunate that the existence of power is wholly separate and distinct from that of machinery, for, as it is in the abstract incapable of change or alteration in its nature, we are enabled to adopt just that arrangement of wood, iron, &c., in separate parts which we find most convenient, well knowing that so long as a few laws are attended to which will prevent the waste of force, its nature, character, or existence can be in no way imperilled. And we thus find that the dimensions of a machine really bear no relation whatever to the amount of power which it may render available, other than those which are impressed by certain properties of the materials of which it is composed, such as their tensile or transverse strength, their liability to wear by friction, and the nature of the modes by which the developed forces are subsequently transmitted. In practice, we meet with instances of the truth of this proposition continually. The ponderous Cornish engine, with all its arrangements of colossal beam, huge cylinder, and vast boilers, developes less power, perhaps, than the little locomotive which hauls a train of coal waggons laden with material for the supply of its furnaces. It is needless to multiply examples with which all our readers must be sufficiently familiar.

Power is force in motion, and therefore the question of relative velocity is a matter of great importance in the construction of all machines, but more especially of those which are intended to concentrate a great capacity for work in a very small compass. Most of the forces at our disposal will operate, under certain conditions, at any speed deemed most desirable. These conditions are in general easily secured, and, therefore, we find that nothing but considerations, totally apart from the development of power *per se*, prevent us from resorting to the use of even minute mechanism whenever its employment becomes desirable from the exigencies of situation, &c. Practically speaking, the great obstacle to the concentration of power is found in friction. A given strain being placed at our disposal, the amount of mechanical effect, or, more exactly, power, which that force or strain can give out, will be measured directly by the space which it passes over in a given time. Consequently, small machines intended to do much work must run at a high speed. A resistance of 1 lb. overcome at a speed of 33,000 ft. per minute, is a horse power just as much as 33,000 lb. overcome at the velocity of 1 ft; but at high speeds all the trouble ever given by friction becomes magnified, and special arrangements for lubrication, and particular forms and dimensions for the rubbing parts or surfaces must be adopted, or the machine will altogether fail in the performance of its duties. When the friction problem is solved no difficulty whatever is met with in the concentration of power, provided the conditions under which that power is produced in the first instance, by some one or other of the natural forces, are complied with. Thus, a cannon ball, at the moment it leaves the muzzle in its flight, is the very impersonation of concentrated power due to high velocity. This, perhaps, is scarcely an instance strictly analogous to anything found in machinery. Turbines, however, now and then furnish fine examples of the production of immense power within a very small space. At St. Blazier, in the Black Forest, a Fourneyron turbine, only 20 in. diameter, under a fall of 172 ft., gives 56 horse power, although its entire weight is but 105 lbs. Another turbine at the same place, of but 13 in. in diameter, under a head of 354 ft., makes 2,200 revolutions per minute, using 1 cubic foot of water per second, and driving 8,000 spindles, besides looms, &c., in the mill to which it is attached. In cotton mills, spindles are frequently driven at 11,000 revolutions per minute. Now, if one of these spindles is fitted with a disc 12 in. in diameter, its periphery will attain the enormous velocity of 33,000 ft. per minute, and therefore it will require just 1 lb. of resistance at this periphery to render a horse power necessary to overcome it; and *vice versa*, were the force impressed on the disc sufficient to overcome this resistance, it would give out a horse power. The late Mr. Richard Roberts has driven spindles for the experiment, at 60,000 revolutions per minute; a greater speed, perhaps, than was ever before attempted in any machine. High speed lathes, circular saws, and some other machines supply us with examples, where an immense amount of power is concentrated within a very small space. These are, however, strictly speaking, negative examples illustrating the expenditure, rather than the development of force.

As the power of steam is the most universally applicable of all the forces used for driving machinery, its concentration becomes a matter invested with considerable importance. A great deal has been done in the production of small high speed engines of late years, but a great deal more remains to be done before the principle can be regarded as approaching those limits, beyond which it may be neither safe nor prudent to carry it. The "Great Britain" locomotive has frequently given out 1,000 horse power for many minutes together, with a pair of 18-in. cylinders 24-in. stroke, the weight of the engine in working order being little over 35 tons, or, with the tender, 50 tons. This may, perhaps, be considered as a maximum effort which it would not be advisable to attempt to maintain. Taking the work done, then, at but half this, or 500 horse power, we have still over 14 horse power per ton; or, if we neglect the weight of the wheels as in no way necessary to the development of this power, we have at least 15 horse power per ton of machinery. One of the steam fire engines, tried last year at Sydenham, developed nearly 30 horse power, the weight being under 50 cwt. This estimate of power does not pretend to strict accuracy, as the indicator was not used, and the power was calculated merely at an assumed pressure, some 20 or 30 lbs. less than that in the boiler. Still if we disregard the weight of the wheels, driving seats, &c., we find that the amount of power developed very nearly equals that of a first-class locomotive, weight for weight. Modern express engines give out 350 horse power as a matter of daily occurrence, and even goods' engines sometimes a great deal more. It is needless to say that in all these cases the power is obtained by an extremely high velocity of piston. In stationary engines, seldom confined in space, the march of improvement goes slowly, but, nevertheless, steadily on; and we trust ere long to see the clumsy beam and its appendages banished for ever in favour of high speed horizontal engines, working expansively. The "Allen" engine, exhibited in 1862, inaugurated a change of practice, which is slowly making its way. This engine had a piston speed of 600 ft. per minute, and ran 150 revolutions with an ease, steadiness, and absence of heating, not greater, perhaps, than was to be expected from the care taking in designing the machine to the minutest details; but very satisfactory, nevertheless, in that it furnished a complete refutation to arguments now and then brought forward, dug up, as it were, from old-fashioned practice, to prove that a high speed engine must in the nature of things be a failure.

In order, then, to concentrate power, it is only necessary to impart a high velocity to some member of a system of mechanism which first receives the direct effect of the original moving force, as the piston of a steam engine, or the bucket vanes of a turbine. No theoretical objections exist to the adoption of this course. The practical objections are found to reside chiefly in friction, and the difficulties met with in carrying out a complete and thorough system of lubrication. In the case of vertical spindles heavily loaded, and running at high velocities, it is necessary that the footstep should be worked to some curve, which will extend the bearing surface and prevent the extrusion of the lubricant. In the case of steam engines, the main shaft bearings seldom give trouble if properly made, especially if the weight of the fly-wheel is sufficient to keep the shaft down steadily in the lower brasses. The connecting rod head, with its brasses and the crank-pin, are not so easily dealt with, and it cannot be denied that the annoyance which these occasion, has done much to retard the introduction of high speed engines. The fact is, that the brasses will not permit of that amount of looseness or play which may exist in any other bearings almost; because of the destructive hammering action which ensues. It is not easy to say why tightening a brass should make it heat; we find in every-day practice that a bearing which supports perhaps 1 cwt. per square inch, without undue friction so long as it is left moderately slack, will become almost red hot in a few minutes, if an additional pressure of not more than a few pounds per square inch is brought on it by screwing down the cap. Until we can give a satisfactory explanation of this phenomenon, it is not easy to see how its occurrence can be guarded against. Meanwhile, it is the source of all the trouble ever met with from a connecting rod end. The best remedy appears to consist in increasing the bearing surface very considerably, and providing an effectual method of lubrication, either by a telescope pipe from an overhead vessel of oil, or, in cases where the engine stands for a few hours out of the twenty-four, by boring a large cavity in the crank-pin, and filling it with tallow, a transverse apperture conveying the lubricant when melted to the surfaces where its presence is required. Attention to little matters of detail and good workmanship are really all that are required to ensure the success of any motor running at a high speed.

Notwithstanding a great reduction in the dimensions of any engine, power can scarcely be said to be concentrated while the boilers remain very large. In many cases, a small boiler is imperatively dictated, and it yet remains to be seen if peculiar arrangements cannot be adopted, by which a very small furnace and a fierce combustion will do the work of one much larger with equal economy. Hitherto fire boxes have been rapidly burnt out under such conditions; perhaps this has been occasioned by the over thickness of the plates. Locomotive fire boxes frequently burn down to a thickness of little more than one-fourth of an inch very quickly, although they will last for years without much subsequent deterioration. A generator might possibly be constructed with excessively thin cold drawn steel tubes, through the substance of which the heat would pass so quickly to the water that their destruction would be almost indefinitely retarded.

THE HISTORY OF THE HYDRAULIC PRESS.

As the celebration of centenaries seems to be one of the fashions of the time, perhaps we may be allowed to celebrate, in a mild way, the second centenary of the hydraulic press. We may say that we may even feel in manner bound to this our celebration of the anniversary of the invention of this mighty mechanical agent, because, just as with regard to the origin and histories of immortal bards, there are some very mistaken and dubious accounts current as to the origin and history of the hydraulic press. The first birth of this machine, only second in value and importance to the steam engine, may be said to date from 1664; for in that year was published the" *Traité de l'équilibre des liqueurs, et de la pesanteur*," by that extraordinary man, Blaise, Pascal. He wrote:—" *Si un vaisseau plein d'eau, clos de toutes parts, a deux ouvertures, l'une centuple de l'autre, en mettant à chacune un piston qui lui soit juste, un homme, poussant le petit piston, égalera la force de* 100 *hommes qui pousseront celui qui est plus large, et en surmontera* 99." He goes on to say that, " in whatever proportion are sizes of the openings, if the forces on the pistons be as the openings, these forces will be in equilibrio." Pascal then, with remarkable clearness and method, points out that the principle of virtual velocities found in the lever, the inclined plane, &c., is also to be seen in this machine, " as the space gone over by the little piston is to that passed by the large piston, as the force of the second is to that of the first." The first hydraulic press was of an essentially rough-and-ready kind, as it consisted simply of a barrel filled with water, in communication with a long vertical tube. The hydraulic pressure, however, burst Pascal's wooden barrel with the same efficiency as the cylinders of some ill-constructed and badly cast presses are now broken this day. We next here of the hydraulic press in Leopold's " *Theatrum Machinarum*," published in 1720. A practical application of its principles was made about 100 years ago by a distinguished anatomist of that day, named Wolf. In order to examine animal tissues, he stretched his specimen over the broad and short leg of an inverted syphon, the lodger leg being filled with water. The hydraulic pressure thus distended the substance stretched over the short leg of this, probably now obsolete, " anatomical syphon " At last came that remarkable man Joseph Bramah, born nearly in the middle of the last century, and the Richard Roberts of his time. Although it has been ignorantly stated in Mr. Smiles's last work that he was not a first class inventor, we must beg to differ from this opinion; and we feel confident that a thorough examination of his life will show Bramah to have been only second to Watt in pretty much the same relation as the hydraulic press is inferior in importance to the steam engine. He was the true and original inventor of many of the machine tools, for the honour of whose introduction several different men have scrambled during the last 50 years. Many of the inventions of the great, and as yet but insufficiently appreciated, Bramah are still as much adjuncts to our daily English life, as "household words" are "familiar in our mouths." In 1795, Bramah obtained a patent for a "*new invented hydrostatical machine, capable of becoming the primordial, or first cause of motion in all kinds of inanimate movements whatsoever, and may be employed instead of pumps, or any other hydraulic engine, for the purpose of raising water through any given space.*" Bramah, by this patent, converted the seemingly absurd "hydrostatic paradox" into a living mechanical truth. Pascal was thus the scientific discoverer, the inventor on paper, of the hydraulic press; Bramah was the practical mechanical inventor. A beautifully executed hydraulic press, the first ever made, inscribed, "J. Bramah Invtt. et. Fectt., 1796," is now in the Kensington Meseum, contributed for exhibition by the director of the Museum of Economic Geology, under the fostering care of our distinguished Superintendant of Specifications.

Since Bramah's patent, two great improvements, apart from the different special improvements and alterations incidental to special requirements, have been applied to the hydraulic press. The first of these is the arrangement for packing the joints; the second is the mode of strengthening the cylinder of the press.

We all know how much more difficult it is to make a water-tight joint than a steam-tight joint, with equal pressures behind each. This difficulty had of course to be encountered by Bramah. In all modern presses the packing is formed by casting an annular recess in the neck of the cylinder of the press; into the recess is fitted a cupped leather collar, which is itself steadied in the middle by a metal ring formed in segments. This cupped leather collar is generally beaten into shape out of a circular piece of leather, from the inside of which has been cut a circular disc. This annular dish, as it were, is inverted towards the water, which thus enters, and the very pressure tends to keep the joint tight. The combined simplicity and elegance of the whole scheme are evidence of a stroke of genius, and its invention sheds great honour on whoever invented it, although, at the same time, we may remark that the same general idea is imbodied in the ordinary pump bucket, used in common suction pumps, and in the larger draw-lifts for mines. But who is the inventor of the cupped collar? That is the question, and one to which we will devote a few moments' attention.

In the first place, this contrivance is not described or delineated in Bramah's patent. Bramah is, however, generally credited with its invention in the common text-books, and Bramah appears to have at first used a hempen and leathern packing, fitted into a common stuffing-box. In Mr. Smiles' late work,* he states, on the authority of Mr. James Nasmyth, that the late Mr. Henry Maudslay was the inventor of the self-tightening collar of the hydraulic press. Mr. James Nasmyth again gives the authority of Mr. Henry Maudslay himself for his statement. There can be no doubting the good faith of both the late Mr. Maudslay and of Mr. Nasmyth, but it is a pity that Mr. Smiles did not make some attempt to verify the question. Mr. Nasmyth was Mr. Maudslay's apprentice, and it is not customary to take the interested evidence of either masters or men, however honourable the individuals themselves may be. We think that a reference to page 394 of the "Compendium of Practical Inventions," published as long ago as 1819. will dispel these illusions with regard to Mr. Maudslay, and will place the crown, or rather collar, on the right man. † It will there be seen that the invention is distinctly ascribed to the late Benjamin Hick, of Bolton, the well-known and distinguished engineer. In alluding to a drawing and description of the cupped leather collar, the writer says: —"This simple mode of making the junction of the ram and cylinder water-tight was invented by *Benjamin Hick of Bolton*, several years ago, and is now universally practiced. In the old method of fitting up this part, an enlargement of the cylinder was made at the mouth, in which the leather was placed, and then secured by a loose ring, called a collar-plate, placed over it, and as large in diameter as the head of the cylinder, to which it was attached by ten or twelve screws, which, from the unavoidable inequality of their bearings, were continually subject to accidents." The "Compendium of Practical Inventions" was thus published only five years after the death of Bramah himself; the same statement will be found in a work published at an anterior date. The late Mr. Benjamin Hick was the first agent, or, rather, the firm of Thwaites, Hick, and Rothwells, of Bolton, in which Mr. Hick was the managing partner, were the first agents, in Lancashire for the sale and manufacture of Bramah's presses. Considering how much Benjamin Hick achieved in the cause of mechanical science, it is rather surprising that his name is not oftener mentioned in the front rank of the mechanics of the age we are fast leaving behind.

We now come to what may be termed the second great improvement made in hydraulic presses since Bramah's death, and in this category we place the proper construction of cylinders intended to stand high pressures. We have alluded to this principle in an article in one of our late numbers under the heading of "*The hoop tension of thick cylinders.*" As long ago as 1825 Professor Barlow showed that the outer portions of a thick cylinder add very little to its strength, as but little of the strain is transmitted to the outside layers. His law is that "in cylinders of metal the power exerted by different parts varies inversely as the square of the distances of the parts from the axis." In this we see the explanation of the continual failures of the presses used in launching the "Great Eastern." Although the rams were really only 10 in. in

* "Industrial Biography: Iron workers and Tool makers." London: John Murry, 1862.

† The "Mechanic; or Compendium of Practical Inventions." Vol. 2. Liverpool, 1819.

diameter, and although the sides of the cylinders were as much as 7½ in. thick, yet they nevertheless burst under pressures of less than five tons to the square inch. The practical rule given by Pro. P. Barlow to find the thickness of metal for a hydraulic press is:—"Multiply the pressure per square inch by the radius of the cylinder, and divide the product by the difference between the cohesive power of the metal per square inch, and the pressure per square inch; and the quotient will be the thickness sought." According to the usual calculation, a press which would have to stand twice the pressure to be undergone by one of the same size, would accordingly have its sides made twice as thick; whereas it will be seen that the doubly-strained press will have to be made rather more than twice as thick. But mere thickness of metal has limits of several kinds, and recourse should be had—in presses required to stand much pressure, or to be very light—to hoop tension, by shrinking on rings, or by straining on coils of wire, upon the plan patented by Mr. Longridge. To this plan, rather than to idly wait for the discovery of a new cast metal, should the makers of hydraulic presses look for means of improvement. So much for the cylinders, while the rams and tops and bottoms could be cast much lighter than they usually are by the use of well chosen metal, and by a proper arrangement of webs.

To enumerate the different applications of the hydraulic press would be to compile a catalogue of almost every engineering operation in which the exertion of a very great power is reqired. After having been used for many years in making clay pipes for drainage and water supply, lead and pewter pipes for plumbers and gas-fitters, the hydraulic press is now used for what appears a somewhat similar, and almost still more important application—that of cold-drawing steel tubes. In India, Egypt, and the other cotton countries, the press is used to compress the cotton to such an extent that one ton weight only measures 40 cubic ft. The Australian bales of wool, and the hay sometimes sent out abroad for the army, are compressed for packing in the same way. Hydraulic presses, generally placed vertically, are used for extracting the oil from linseed, rape seed, and hemp seed, and also for almond, olive, and nut oils. The press is also used in the manufacture of stearine candles, and in expressing the essence from hops, and the tannin from the bark. In all experiments on the strength of materials were the specimens are of large size, and whether they be tested up to only proof strength, or to destruction, the hydraulic press is indispensable. It is accordingly used for testing bars either by extension, compression, or flexure; for testing chains, chain cables, anchors, iron beams, and girders. Messrs. Hick, of Bolton, having punched holes, by means of hydraulic pressure, about 8 in. in diameter in 3 in. plates, with an exertion of force of more than 2,000 tons. A small tool on this principle is now used for punching plates, instead of the common boiler-maker's "bear," and the lightest and most useful lifting jacks are those on the hydraulic principle. Robert Stephenson used the hydraulic press for hoisting the tubes of the Britannia and Conway bridges; by means of presses the "Great Eastern" was at last launched, and by this means hydraulic lifts now replace expensive dry docks, and patent slips. One of the most important applications of the hydraulic press is made of it in late years to forging large masses.—*Mechanics Magazine.*

CALORIC ENGINE.

Mr. Roper, of Boston, lately explained, with the aid of diagrams, the caloric engine lately in use at the Sanitary Fair, to the Polytechnic Association of the American Institute at New York. This engine is designed to be used were small power is required. Its pecularity is, that it does not use, upon the piston, common air, heated, but only the products of combustion. The air to supply oxygen for the combustion of anthracite coal is pumped in; the carbon is burned rapidly and completely, under pressure, and the resulting carbonic acid gas and uncombined nitrogen gas from the air, are passed from the generator to the piston, which is in the form of a hollow plunger, so arranged that it is packed and fitted only at the top, where there is the least heat. In this way the common difficulty of lubricating a hot cylinder and piston is obviated. The generator of heat is surrounded with fire-brick or soapstone, which prevents the iron from being burnt. The engine is single-acting; that is, the power is applied to the piston moving in one direction, during which movement the air to feed the fire is pumped in; the momentum accquired at the same time, by balance or fly-wheel, is used to carry the piston back to its original position. The diameter of the air-pump in the engine at the Fair is 12 in.; that of its piston is 16 in.; the difference in the areas of the pump and piston, multiplied by the usual pressure, 8 lbs. per square inch, shows that this engine exerts a two-horse power. It requires about 10 lbs. of coal per hour, it occupies five square feet of room, and weighs 3,000 lbs.

AN ENORMOUS SCALE.

An enormous scale, the largest perhaps in the country, has just been finished at Cleveland for the Fort Pitt Works in this city. They are intended to weigh the monster twenty-inch gun, and are of the following dimensions: Length, 30 feet, breadth, 7½ feet, and 4 feet in height. They will weigh from two pounds and a half up to one hundred tuns, and are so nicely and accurated adjusted that the weight of half a pound will turn the beam. A half pound weight on the beam weighs one tun on the scales. They are built entirely of wrought iron, with the exception of the lever heads, which are cast. The pivots are made of wrought-iron steel edges, for the purpose of securing greater strength and durability. The cost of these scales, when set up in Pittsburgh, will be $2,000.—*Pittsburgh Chronicle.*

British Railways.

There are now in the British islands 375 distinct railway companies, who own 11,500 miles of road. They carry above 80,000 passengers yearly, and above 80,000,000 tons of merchandise and minerals. They give employment to probably not less than 200,000 persons.

Practical Memoranda.

THE MECHANICAL POWERS, AND THEIR APPLICATION.

The simple Mechanical Powers are six in number, viz., the *Lever*, the *Pulley*, the *Wheel and Axle*, the *Inclined Plane*, the *Wedge*, and the *Screw*. All machines are formed by combinations to a greater or less extent of these six elements. The mechanical effects, however, of the whole, are ultimately resolvable into that of the lever.

By means of the Mechanical Powers a great weight may be sustained, or a great resistance slowly overcome, by the application of a small force. Or, a great velocity may be imparted to a small weight or resistance, by the use of a great force or power.

The Lever.

Levers are of three orders:

In the first order, the fulcrum is between the weight and the power.

In the second order, the weight is between the fulcrum and the power.

In the third order, the power is between the weight and the fulcrum.

The bent lever has no peculiarity except that of form, which is given to it for convenience in use. Its properties are those of the first order.

In order to preserve an equilibrium between the power and the weight, they must be to each other inversely as their distances from the fulcrum.

Case 1. *When the Lever is of the first order, or when the fulcrum is between the power and the weight.*

Rule. Divide the weight to be raised by the power to be applied; the quotient will give the difference of leverage necessary to support the weight in equilibrio. Hence, a small addition either of leverage or weight will cause the power to preponderate.

Example 1. A ball weighing 3 tons is to be raised by 4 men, who can exert a force of 12 cwt. Required the proportionate length of lever.

3 tons=60 cwt.; and $\frac{60}{12}=5$

In this example, the proportionate lengths of the lever to maintain the weight in equilibrio, are as 5 to 1. But, although the ball is sustained by a force of only one fifth of its weight, no power is gained, for the weight passes through only one fifth of the space passed through by the power.

Example 2. A weight of 1 ton is to be raised with a lever 8 feet in length, by a man who can exert, for a short time, a force of rather more than 4 cwt. Required at what part of the lever the fulcrum must be placed.

$\frac{20 \text{ cwt.}}{4 \text{ cwt.}}=5$; *i.e.*, the weight is to the power as 5 to 1; therefore,

$\frac{8}{5 \times 1}=1$ foot and a third from the weight.

Example 3. A weight of 40 lbs. is placed one foot from the fulcrum of a lever. Required the power to raise the same when the length of the lever on the other side of the fulcrum is five feet.

$\frac{40 \times 1}{5}=8$ lbs., the power.

Case 2. *When the lever is of the second order, or when the fulcrum is at one end of the lever and the power at the other, with the weight between them.*

Rule. As the distance between the power and the fulcrum is to the distance between the weight and the fulcrum, so is the effect to the power.

Example 1. Required the power necessary to raise 120 lbs. when the weight is placed six feet from the power and two feet from the fulcrum.

As 8 : 1 :: 120 : 30 lbs., the power.

Example 2. A beam 20 feet in length, and supported at both ends, bears a weight of two tons at the distance of eight feet from one end. Required the weight on each support.

$\frac{40 \text{ cwt.} \times 8 \text{ feet}}{20 \text{ feet}}=16$ cwt. on the support that is furthest from the weight; and $\frac{40 \times 12}{20 \text{ feet}}=24$ cwt. on the support nearest to the weight.

Case 3. *When the lever is of the third order, or the weight is at one end of the lever, the fulcrum at the other, and the power is applied between them.*

Rule. As the distance between the power and the fulcrum is to the length of the lever, so is the weight to the power.

Example. The length of the lever being eight feet, and the weight at its extremity 60 lbs., required the power to be applied six feet from the fulcrum to raise it.

As 6 : 8 :: 60 : 80 lbs., Ans.

The Pulley.

Pulleys are of two kinds, fixed and moveable.

The fixed pulley affords no economy of power, but merely changes its direction. The movable pulley changes its position with that of the weight, and effects a saving equal to half the power. An equilibrium is preserved between the power and weight, when the weight is equal to the product of the power and twice the number of movable pulleys.

Rule. Divide the weight to be raised by twice the number of pulleys in the lower block; the quotient will give the power necessary to raise the weight.

Example. Required the power to raise 600 lbs. when the lower block contains side pulleys.

$\frac{600}{6 \times 2}=50$ lbs., the power.

The Wheel and Axle.

The wheel and axle act as a revolving lever; and in order to obtain an equilibrium between the power acting on the circumference of the wheel, and the weight or resistance acted on by the circumference of the axle, the power must be to the weight as the radius of the axle is to that of the wheel. One or more radii of the wheel, or winches, are often substituted for the wheel in the simple machine; and in compound machines the action is communicated by teeth or cogs, forming wheel and pinion work.

Rule. As the radius of the wheel is to the radius of the axle, so is the effect to the power.

Example. A weight of 50 lbs. is exerted on the periphery of a wheel whose radius is 10 feet. Required the weight raised at the extremity of a cord wound round the axle, the radius being 20 inches.

$$\frac{50 \text{ lbs.} \times 10 \text{ feet} \times 12 \text{ inches}}{20 \text{ inches.}} = 300 \text{ lbs., the weight.}$$

The Inclined Plane.

The inclined plane acts as a mechanical power by sustaining a portion of the weight to be raised, while the direction of the applied force is changed from the perpendicular to one more or less horizontal, and the weight moves upwards on it in a diagonal between them. Equilibrium is sustained when the power is to the weight as the perpendicular height of the inclined plane is to its inclined length or hypothenuse, when the power acts in a direction parallel to the inclination of the plane; but as the height is to the base when in a direction parallel to the base.

Rule. As the length of the plane is to its height, so is the weight to the power.

Example. Required the power necessary to raise 540 lbs. up an inclined plane 5 feet long and 2 feet high.

As 5 : 2 :: 540 : 216 lbs., the power.

The *length*, in the above rule, must represent that of the inclined surface, or of the base, accordingly as the power acts parallel to either of these surfaces.

The Wedge.

The wedge may be regarded as two inclined planes, united by a common base, acting on two weights or resistances at once, or on a fulcrum and a weight, between which it moves, generally, in practice, by the impulse of successive blows.

As in the inclined plane, equilibrium consists in the power being to the resistance as the back of the wedge is to its length, or to the length of its side, accordingly as the resistance acts perpendicularly to the central line of length or to that of the side.

Case 1. *When two bodies are forced from one another by means of a wedge, in a direction parallel to its back.*

Rule. As the length of the wedge is to half its back or head, so is the resistance to the power.

Example. The breadth of the back or head of the wedge being 3 inches, and the length of either of its inclined sides 10 inches, required the power necessary to separate two substances with a force of 150 lbs.

As 10 : $1\frac{1}{2}$ :: 150 : $22\frac{1}{2}$ lbs., the power.

Case 2. *When only one of the bodies is movable.*

Rule. As the length of the wedge is to its back or head, so is the resistance to the power.

Example. The breadth, length, and force, the same as in the last example.

As 10 : 3 :: 150 : 45 lbs., the power.

The Screw.

The screw is an inclined plane, and may be supposed to be generated by wrapping a triangle, or an inclined plane, round a cylinder. The base of the triangle is the circumference of the cylinder; its height, the distance between two consecutive cords or threads; and the hypothenuse forms the spiral cord or inclined plane.

Rule. To the square of the circumference of the screw, add the square of the distance between two threads, and extract the square root of the sum: this will give the length of the inclined plane. Its height is the distance between two consecutive cords or threads.

When a winch or lever is applied to turn the screw, the power of the screw is as the circle described by the handle of the winch, or lever, to the internal or distance between the spirals.

Case 1. *When the weight to be raised is given, to find the power.*

Rule. Multiply the weight by the distance between two threads of the screw, and divide the product by the circumference of the circle described by the lever. The quotient is the power.

Example. Required the power to be applied to the end of a lever three feet long, to raise a weight of five tons with a screw of $1\frac{1}{4}$ inch between the threads.

$$\frac{11200 \text{ lbs.} \times 1{\cdot}25}{36 \text{ inches} \times 2 \times 3{\cdot}1416} = 61{\cdot}9 \text{ lbs., the power.}$$

Case 2. *When the power is given, to find the weight it will raise.*

Rule. Multiply the power by the circumference of the circle described by the lever, and divide the product by the distance between two threads of the screw: the quotient will be the weight. The example is the converse of that in the former case." —*Hazlett's Hand-Book.*

Shingles rendered Fire-proof.

Mr. John Mears says, in the Boston *Cultivator*, that he has prepared shingles in the following manner, and after an experience of eleven years, and using seven forges in his blacksmith's shop, he has never seen a shingle on fire, nor has a nail started. The shingles are prepared in the following manner;—"Having a large trough, I put into it a bushel of quicklime, half a bushel of refuse salt, and five or six pounds of potash, adding water to slack the lime and dissolve the vegetable alkali and the salt—well knowing that pieces of an old lime pit, a soap barrel, or a pork tub, were not the best kindling stuff, and having long since learned, while at the Vineyard Sound, that hot salt-water white wash endure far longer than that made with fresh water, absorbing moisture, striking into the wood and not peeling and washing off. I set the bundles of the shingles nearly to the bands, in the wash for two hours; then turned them end for end. When laid on the roof and walls, they were brushed over twice with the liquid, and were brushed over at intervals of two or three years after."

What is a "Quarter" of Grain?

One of the speakers at the Meeting of the Corn Trade, at the London Corn Exchange, gives the following Standard Weights to the Quarter of Eight Bushels of the different Grains.

Wheat	496	lbs. to the Quarter.	
Barley,	400	do	do
Oats,	320	do	do

Thus a quarter is as much a part of the Imperial table of measures as a bushel, and is simply eight bushels of grain, varying of course, in weight with the kind of grain.

Statistical Information.

Emigration to Canada and the United States.

The following table gives the number of emigrants who arrived in Canada and the United States from 1830 to 1860, and shews the increase in proportion to the whole of the two countries at the later date to be 36·06 for Canada, and 35·05 for the United States, giving us a surplus of 1·01 over our neighbours:

	CANADA.	UNITED STATES.
1830	28,000	23,327
1831	50,256	26,633
1832	51,746	60,482
1833	21,752	58,640
1834	30,935	65,365
1835	12,527	45,374
1836	27,728	76 242
1837	21,901	79,340
1838	3,266	38,914
1839	7,439	68,069
1840	22,234	84,066
1841	28,086	80,289
1842	44,374	104,565
1843	21,727	52,496
1844	20,142	78,615
1845	25,375	114,371
1846	32,753	154,416
1847	90,150	234,968
1848	27,939	226,527
1849	38,494	297,024
1850	32,292	369,980
1851	41,076	379,466
1852	39,176	371,603
1853	36,699	368,645
1854	53,183	427,833
1855	21,274	200,877
1856	22,439	200,436
1857	32,097	251,306
1858	12,810	123,126
1859	8,778	121,282
1860	10,150	153,640
1861	19,923	
1862	22,176	
1863	19,419	
	978,316	4,933,913

The population of Canada in 1867 was 1,842,265; in 1860 it was 2,507,657. The population of the United States in 1830 was 12,866,020; in 1840 it was 17,069,453; in 1850 it was 23,191,876; in 1860 it had reached 31,445,080.

Linen Import and Manufacture.

Our civil war, along with other results, has tended to stop the supply of cotton, to prove the inadequacy of other countries for a sufficient yield of the right staple, and consequently, to substitute other fabrics. The effect is marked very clearly in English trade returns. Linen has been produced in an unparalleled quantity there, and exported to us more largely than ever before. In the first three months of 1862 the total value of linen piece goods exported from England was £982,013; in 1863 it was £1,-327,895, and in the corresponding period of 1864, £1,869,785. This production and export includes white and plain piece-goods; checked, prints, and dyed ditto; cambrics and lawns; damasks and diapers; sail cloth, thread, and hosiery. The total value of exports of linen manufactures of all kinds in the first quarter of 1864 amounted to £1,998,-452, against £1,454,777 in the corresponding quarter of 1863, and £1,088,363 in the corresponding period of 1862. The export nearly doubled in three years. This country, too, was the largest consumer and customer for this wonderful increase, which amounts to no less a sum than £,910,089 or $4,550,445 for a single quarter, and $18.201,780 per annum. We import to the value of £378 735 in 1862, £556,774 in 1863, and £914,917 in 1864. This is an increase in linen goods of £536,182, or about $2,681,000, in one quarter, produced in two years. The increase in a year, at this ratio, would be $10,723,640. The last returns show that the increase is still increasing; and that, although some suffering has been produced among British operatives by the cotton famine, and some mills rendered less valuable, the suffering is compensated in another quarter by an excessive and unparalleled consumption of linen.

These facts show that linen manufactures here are starting at the right time. The creation of so good and sudden a demand cannot but carry up prices. The duties will be added to that cost and render linen manufactures very valuable. We have some manufactures of this kind and evidently need more. Their erection will lead to the immigration of skilled operatives, and thus we shall be permanent gainers through a lesson and discipline of loss. It will also stimulate the prodution of flax and hemp, and thus we shall have another crop added to the vast variety that already vary our agriculture. Kentucky and Missouri cannot supply even their former yield now. Other States may therefore prepare to meet a profitable demand, and do it safely, since it has been shown that flax-growing does not injure the soil, as it was supposed to do.—*United States Gazette.*

The Submarine Cables of the World.

From an official communication of the Gutta-percha Company, London, to Cyrus W. Field, Esq., it appears that 52 lines of submarine cable have been laid by English firms in different parts of the world, all of which are in successful operation with the exception of that between France and Algiers, and it is supposed that that was injured by lightning. The longest line in operation is that between Malta and Alexandria, 1,535 miles. The deepest water in which working cable rests is 1,550 fathoms—1¾ miles—between Toulon and

Corsica. The aggregate length of working lines given in the table is 5,105 miles, and this does not include a number of short lines laid in different parts of the world, nor those laid by Felten & Guilleaume, of Cologne, amounting to more than 1,000 miles. One line has been laid 13 years, five have been laid 11 years, four 10 years, and others shorter periods.

Miscellaneous.

PUBLIC DRINKING FOUNTAINS.

The Metropolitan Association has been instrumental in the erection of nearly eighty fountains. The number is large, but the mouths are many. Others besides the positively poor will occasionally satisfy thirst by drinking from a fountain which has a fair and attractive appearance. Clerks and others, of a somewhat superior grade, and particularly young people of almost all classes, relish a draught of clear, cold water in the heat of the day. These eighty fountains are planted in the midst of three millions of people, and Mr. Gurney states that not less than a quarter of a million of persons drink of them daily during the heat of the year. But must we consider the remaining two millions and three-quarters indifferent to the limpid tricklings of these beneficient institutions? If we calculate that one-third of the metropolitan population are of an age, status, and mode of life which may render a public drinking fountain occasionally acceptable to the individual, we find that at the rate of water drinking already observed the metropolis ought to have 320 fountains instead of 80. Then there are the cattle, and of course the dogs. In regard to the latter there is the "Home for lost and Starving Dogs;" but Mr. Gurney has a special regard for the "thirsty" ones. When we remember what hydrophobia means, our very selfishness may be quickened with philantrophy, and we may feel the importance of satisfying even the thirsty cur, so as to lessen the risk of our being bitten by that worse than an Indian tiger—a "mad dog." It is hard to imagine how much the inferior creation may suffer from thirst in our arid streets during the heat and drought of summer. The spectacle presented by our horned cattle, and even by the poor helpless sheep, as they are driven through our streets when the weather is far from cool, is often anything but creditable to our civilisation. Mr. Gurney says that, "the provision made for the relief of the sufferings of cattle and dogs from thirst falls far short of what is required," and we can readily believe it. Nor is it consistent with the public safety to ignore the fact. Thirst and fever are almost synonymous, and a mad bull is even worse than a mad dog, while the sufferings of cattle before they are killed may account for the deteriorated appearance so often presented by our beef and mutton, and which is in striking contrast with the tempting-looking joints to be seen in the shops of provincial butchers.—*English Paper.*

[If drinking fountains such as above described could be established in all our cities and populous towns in Canada, they would prove a great convenience as well as comfort to thirsty passers-by, and would serve the cause of temperance and morality more perhaps than almost any other simple institution. Multitudes during our warm summer days are drawn to the taverns to procure wherewith to slake their thirst, who would otherwise, if such fountains were provided, abstain from the intoxicating cup. Could not our municipal authorities of towns wherein water-works exist, have simple water-taps placed in *shaded nooks* around our market places, and along our principal thoroughfares; and so as to secure a clean glass and a pleasant drink at all times, place such taps in care of aged or infirm individuals, who might charge a cent a drink to all persons able to pay—thus effecting a public good, and affording an honest livelihood to such as would otherwise be dependant upon the charitable public for a subsistence. Where water-works are not in existence, public pumps might be established under similar regulations to those above suggested.—Ed. Journal.]

The Big Trees of California.

Let us walk upon the "big tree" stump. You see it is perfectly smooth, sound and level. Upon this stump on the 4th of July, thirty-two persons were engaged in dancing four sets of cotillions at one time, without suffering any inconvenience whatever, and besides these there were musicians and lookers on.

Across the solid wood of this stump, five feet and a half from the ground, (now the bark is removed, which was from fifteen to eighteen inches in thickness), measures twenty-five feet, and with the bark twenty-eight feet. Think for a moment; the stump of a tree exceeding nine yards in diameter, and sound to the very center. This tree employed five men for twenty-two days in felling it, not by chopping it down, but by boring it off with pump augers. After the stem was fairly severed from the stump, the uprightness of the tree, and the breadth of its base sustained it in its position. To accomplish the feat of throwing it over, about two and a half days were spent in inserting wedges and driving them in by the butts of trees, until at last, the noble monarch of the forest was forced to tremble, and then to fall, after braving "the battle and breeze" of nearly three thousand years. —This noble tree was three hundred and two feet in height, and ninety-six feet in circumference at the ground.

A short distance from the above lies the prostrate and majestic body of the "Father of the Forest," the largest tree of the whole group, half buried in the soil. This tree measures in circumference at the roots, one hundred and ten feet. It is two hundred feet to the first branch. By the trees that were broken off when this tree bowed its proud head in its fall, it is estimated that when standing it could not have been less than four hundred and thirty-five feet in height. Three hundred feet from the roots, where it was broken off by striking against another tree, it is eighteen feet in diameter.—*Hutchin's Wonders of California.*