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CONTENTS OF THIS NUMBER:

FOR THE CANADIAN ENGINEER.

RAILWAY ENGINEERING.*

BY CECIL B. SMITH, MA. E., MEM. CAN. SOC. C.E., ASSISTANT PROF. OF CIVIL ENGINEERING IN M'GILL UNIVERSITY.

CHAPTER VI.

(*Continued from last issue.*)

RAILWAY LAW.

Railroads being recognized as public necessities have had great powers conferred on them by legislatures, which have also necessitated many legal restrictions to prevent the abuse of these powers. All of which in Canada has in time become formulated in the "Railway Act." This Act defines, amongst other things necessary for a railway engineer to be familiar with:—

I. The powers conferred on the Railway Committee of the Privy Council for negotiating traffic, tolls, returns, methods of operation, of construction, capital stock, and distribution of gross revenue obtained.

II. The privileges and powers granted to railway companies.

III. The duties of a railway company to the Government and to the Privy Council.

IV. The duties of the railway company to the individual, and the rights of the private individual.

Much of the matter contained is rarely needed by the engineer, and the following extracts cover the main information which he is likely to need in the course of construction and maintenance.

* This series of papers will be issued in book form as soon as they have appeared in THE CANADIAN ENGINEER.

I.—POWERS CONFERRED ON THE RAILWAY COMMITTEE.

(*a*) To regulate the speed through various classes of cities, towns and villages—which is not to exceed six miles per hour in any case.

(*b*) To regulate the use of steam whistles in towns, cities, etc.

(*c*) To regulate the means for passing from one car to another, for the safety of employees, and the methods of coupling cars.

(*d*) To impose fines for offences under these clauses.

(*e*) To enquire into, hear and determine applications, disputes or complaints regarding right of way and location questions, constructing branch lines, the crossing of one railway company's tracks by those of another railway company, the construction of railways along or across highways or navigable waters, tolls, rates, running powers, traffic arrangements, unjust preferences, discontinuations, distortions and the carrying of highways, streets, ditches, sewers, etc., over or across the lands of a railway company.

(*f*) By itself or agents, it has full legal power to enter on to property of a railway company to examine books, plans, etc., to summon witnesses and in general it is to have the same powers as a law court.

(*g*) The inspecting engineers of the Privy Council are to have every desired information, in reason, supplied to them on demand. They are to be carried free while on inspection trips, and to have the services of all company telegraph operators free while on Government business—penalties for obstructions of the inspecting engineers are also defined.

II.—THE PRIVILEGES AND POWERS OF A RAILWAY COMPANY.

These are given with the view of assisting the company in overcoming obstructive measures, of a corporation or individual, where it is evident that the public would be best served by the construction and operation of a railway.

These powers should be thoroughly considered by a company's engineer before taking any steps likely to incur the ill-will of the public, to whom the company must ultimately look for its income.

(*a*) The company or its agent may enter on crown lands or the lands of any person or corporation whatever for the purpose of survey and location.

(*b*) It may purchase land for the use of the railway, and may sell what it does not need.

(*c*) It may build anywhere within one mile of the first located filed line, or within any further distance prescribed by the special Act.

(In the Act a railway is said to be near to another when some part of one is within one mile of some part of the other railway.)

(*d*) It may fell trees within 99 feet of either side of the railway, when they are liable to fall across the track.

(*e*) It may cross or join any other railway, and enter on its lands.

(*f*) It may divert temporarily or permanently streams, highways, water or gas pipes, sewers, drains or telegraph or telephone poles, but must restore them to their former state, if possible, or put them in a state not materially altering their usefulness. (Note this with reference to keeping them open during the construction of the roadbed.)

(*g*) It may construct, operate and keep in repair its road, together with the accessories commonly belonging to a railway, and may carry traffic and collect tolls, and may, in general, do everything necessary to a successful operation of its enterprise and the accommodation of the public, but in the exercise of these or other powers the company shall do as little damage as possible, and make full compensation for damage done or loss inflicted, in a manner prescribed in the Railway or a special Act.

The essence of these general powers is compensation. It is the limitation of what would otherwise be absolute, arbitrary powers.

II. (*A*) POWERS WITH LIMITATIONS.

(*a*) No person who holds a contract for work with a railway company can be a director on its board, nor can a director or officer of a company even go surety for a contractor.

(*b*) The first charges on the income of a railway company are the penalties, if any, arising from this Act. The next are the working expenses of the road, and the third are the bonds—the latter, however, all having equal claims in proportion to remaining assets.

(*c*) The consent of the Governors-in-Council is necessary before Crown or Indian lands can be entered on, and in the case of Crown lands the right of way only, i.e., an easement, is all that can be obtained, and not ownership or full possession.

(*d*) The consent and approval of the Railway Committee must be obtained before possession or use of the land or property of another railway company can be effected.

(*e*) The ordinary amount of land obtainable without the consent of the owner is 99 feet, while exceptions are authorized by the Minister in case of deep cuts or fills and depot grounds, which is in general limited to a tract of land 1,950 feet long by 300 feet wide, but any extent of land may be purchased with the consent of the owner. Extra land is to be shown on the maps or plans filed with the Government.

(*f*) After filing plans (to be afterwards explained) the company may take possession as shown on those plans, and settle afterwards, amicably or by arbitration. This is a very necessary power, for otherwise contractors would be kept off the land for indefinite periods, the progress of the work impeded and a good chance given the contractors for suits for damages caused by delay, or for excuses for slow progress.

(*g*) The company may enter on lands not more than 600 feet from the located line, for purposes of construction or repairs, without consent of the owner, provided a sum of *money, fixed by a judge of the Superior Court, is deposited* with that court, pending the award for damages.

(*h*) Power of surveying and arbitrating in the usual way is also given whenever the company desire extra land for stone, gravel, water or earth, or on which to construct sidings or branches, or on which to convey water to the company's works.

(*i*) The company may occupy land between 1st November and 1st April, with snow fences, subject always to damages as a court may decide.

(*j*) No lateral deviation of more than one mile shall be made from the original location, except under provisions of a special Act.

(*k*) Error in name or omission of the same from plans and books of reference does not prevent the company from entering on land so affected.

III. DUTIES OF A RAILWAY COMPANY TO THE GOVERNMENT.

(*a*) On completion of location surveys; plans and books of reference showing all properties asked for, must be forwarded in triplicate to the Minister, who after ten days' notice to all interested parties, hears all counter claims and representations, and the plans, as finally decided on, are signed by the Minister, after which one copy is retained at the department, another is deposited by the company in the office of each municipality affected, while a third one is given into the hands of the company itself. After these proceedings following the action as described in Art. *f*, powers with limitations.

(*b*) All extra widths desired must be shown on the plans filed.

(*c*) Any change from the original plans or profiles must have separate plans, etc., submitted and deposited in the usual way before the alteration can be made.

(*d*) Ten days after plans have been filed in the offices of the municipalities (registry offices) and notice published in a newspaper, a notice may be served on interested parties owning land, giving

(*a*) Description of land required.

(*b*) Amount offered by the company for land or damages.

(*c*) Name of company's arbitrator if offer is not accepted.

Such notice to be accompanied by a sworn statement of a surveyor or engineer (not an arbitrator).

(*a*) That the land is needed as described for the purposes of the railway.

(*b*) *That he knows the land, or damages likely to* result, from the railway being built and operated.

(*c*) That the sum offered is, in his opinion, fair compensation.

(*e*) Should the offer not be accepted, arbitration is resorted to. This is usually outside the province of the engineer, except in giving evidence and preparing plans, but it may be useful to remember that, in considering the value of land taken or amount of damages done, the increase of values of lan[d a]djacent (*i. e.*, of same plot) not taken by the company, which is created by the construction of the railway, is to be taken into account and offset against damage inflicted.

(*f*) Before a company can unite with or cross over any railway with its roadbed or track, it must submit plans and full details of proposed mode of crossing to the Railway Committee, and give ten days' notice of application to the other company affected. The committee may make such changes or regulations as appear necessary for public safety, and apportion the cost of constructing the necessary works to the different companies, and may also, in case of level crossings, on application of either company, direct such inter-locking signal system or device to be used as, in their opinion, renders it safe for engines to pass over such crossing without coming to a full stop. This clause also applies to electric and other street railways.

(*g*) When the railway is finished, plans and profiles in triplicate of the completed work, showing land taken, names of owners, etc., must be filed as in the original survey or alterations within six months after completion of railway, under penalty of $200 fine per month.

(*h*) The scales of plans and profiles are to be as prescribed by the Minister; they are usually: Plans, 400 feet to one inch; profiles, 400 feet to one inch horizontal; profiles, 20 feet to one inch vertical, and are to be all signed by the chief engineer or president of the railway.

(*i*) Within 48 hours at furthest, after any accident has occurred on a railway line, involving personal injury, or the damage or destruction of any structure, the railway company must notify the Minister of the same under $200 per day penalty. And, if necessary, the Privy Council may appoint a commissioner to enquire into the causes, etc., of the same.

(*j*) Annual returns from 1st July to 1st July must be forwarded in duplicate to the Minister within three months after the expiration of such financial year by each railway company, of its capital, traffic, working expenditure, and any other information shown on the blank forms furnished.

(*k*) Weekly returns of traffic shall also be furnished the Government within one month after the period quoted, and a copy of the same must be posted for public view in the head office of the company.

(*l*) Twice a year accidents and casualties must be similarly reported within one month after each six months' period has elapsed, giving, (1) Causes and natures, (2) locality and time of day, (3) extent and particulars.

IV. GENERAL DUTIES OF A RAILWAY COMPANY TO THE PEOPLE AND THE RIGHTS OF INDIVIDUALS.

(*a*) A company may not obstruct the entrance to a mine, open or about to be opened.

(*b*) A company shall not impede navigation in a navigable river.

(*c*) In constructing drawbridges, bridge-piers or wharves, the manner of construction as it affects navigable waters shall be fully and entirely decided upon and directed by the Railway Committee, under heavy penalties for disobedience.

(*d*) Highway crossings.

I. A railway shall not be carried along a highway, but shall merely cross it, unless permission has been obtained from the Railway Committee, and, in crossing a highway, a good safe passage for vehicles must be kept open continually and no obstruction offered to travel.

II. In a level crossing, the surface of the rail must not be more than one inch above or below the general surface of the crossing.

III. When a highway passes under a railway, it must have at least 20 feet clear width and 12 feet clear height, and the gradient of the highway shall not exceed one in twenty, unless originally greater and left undisturbed.

IV. When a highway passes over a railway, the approaches shall not have a gradient of more than one in twenty, and must be fenced at least four feet high, and the bridges by which these highways are carried over the railway shall have a clear height of seven feet above the highest freight car hauled over the road, and over 14 feet clear width shall be given on approaches and bridges.

V. The company shall present to the Railway Committee (which notifies the municipality interested that they may oppose by a delegation) a plan and profile of every proposed highway crossing, and the committee will then decide whether it is to be changed in any way, or if a level crossing is approved of, whether a gate and watchmen are necessary to public safety, and the decision of the committee regarding details of construction, and also as to apportionment of costs between the company and other parties interested, is to be final, and followed out within a prescribed time under penalty.

VI. Sign-boards with letters six inches high shall be placed at every highway level crossing.

(*e*) Farm crossings.

One, at least, shall be made for every separate portion of land and for each disconnected portion thereof, so located as to be difficult of access otherwise than by means of a crossing of the railway.

(*f*) Bridges and tunnels.

Shall be built, maintained (and raised if necessary, whenever repaired or reconstructed), so as to maintain a clear height of seven feet between the top of the highest freight car used and lowest beam or obstruction of the bridge or tunnel.

N. B.—The Governor-in-Council may except from this clause any railway on which air brakes are used exclusively. No company shall run cars over any bridge unless constructed and maintained with safeguards, and of strength approved of by the Minister.

(*g*) Fences and cattle-guards.

Whenever municipalities are surveyed or settlement exists, fences and cattle-guards shall be built and maintained, and in case of adjacent land being occupied, this must be done as fast as rails are laid, and the company shall provide gates having proper fastenings or hurdles at all farm crossings. When this is done, it is the duty of the landowner to keep the gates closed when not in use. If left open accidentally, no action for damages against the company can be sustained, and if left open purposely, a counter-claim for damage may be entered in addition to inability of recovering for loss of animals, etc., resulting from such leaving open of gates, etc. (Fences must be turned in to the cattle-guards).

(*h*) Opening of the railway for traffic.

No company shall open its road for passenger traffic until one month after giving notice in writing to the Minister, and after an inspecting engineer sent by the Government shall have reported favorably as to the safety of the road, strength of structures, and adequacy of rolling stock.

(*i*) Repairs.

Upon complaint of the officers of any municipality, the Government shall send an inspecting engineer to examine the condition of the road, and the company shall at once make such repairs as he considers necessary for public safety. Until such repairs are made the engineer may limit the number, speed or weight of trains and engines passing the point under repair.

(*j*) No discrimination in tolls between different persons or companies for the same service shall be allowed; any special rate allowed to one must be allowed to all.

(*k*) No secret special rebate or toll shall be allowed, and any company shall on demand make known to any one any special rate, toll or rebate.

(*l*) No discrimination between places shall be allowed, unless a lesser rate is necessary to secure freight at a competing point. (This, therefore, protects local points only against one another, and not against railway centres.)

(*m*) Every company shall afford full and equal advantages to all persons wishing to ship or travel over their railway, and shall afford equal facilities to each and every connecting line or lines of railway for transfer of traffic.

(*n*) Every company affording facilities to any express company shall grant the same to any other express company demanding it.

(*o*) Every agent of the company shall receive freight or any allowable traffic when offered for shipment, under penalty.

(*p*) Every train before crossing a draw or swing bridge shall stop at least one minute to ascertain from the bridge tender that the bridge is closed and safe to cross.

(*q*) At least 80 rods before crossing every highway (on level) a bell must be rung or whistle sounded, and this must be continued at short intervals until the crossing is passed.

(*r*) An officer shall be stationed at every level crossing of two railways, and no train shall pass over it until a signal has been made to the conductor that the way is clear.

(*s*) Every train shall stop one minute at a level railway crossing as in No. 16, unless there is an interlocking system, when they may pass at such speed as the committee may allow.

(*t*) No train shall pass through thickly populated towns, etc., at more than six miles per hour, unless the track is fenced.

(*u*) No train or car shall be allowed to stand on a highway crossing more than five minutes at a time.

(*v*) All frogs, wing rails, guard rails, etc., shall be packed up to the underside of the rail wherever less than five inches space exists.

(*w*) Sections (*p*), (*r*) and (*s*) have been recently modified so as to permit of interlocking signals being introduced at junctions and railway crossings, in which case the Privy Council may permit trains to pass in or across at specified rates of speed without stopping, whenever the signals give the right to do so, but if the signals are not satisfactorily worked the council may revoke the permission.

For The Canadian Engineer.

THE VENTILATION OF PLUMBING APPLIANCES.

BY W. M. WATSON.

In a former article I showed some of the evils attached to the present method of ventilating traps at the highest points, and the danger of venting plumbing in any case. I have never been able to find out the reason why such a complicated and expensive system was invented, but have an impression that the inventor erroneously thought that there would always be an upward current from the breather pipe at the ground line to the terminating end of the soil pipe above the roof, and there certainly would be if the temperature of the atmosphere at both points were always equal, or if it were always colder above the roof than it is at the mouth of the breather near the ground line. But sometimes it is warmer, and in that case there will be a down in place of an up draught. If the purification of the interior of the house soil pipes was aimed at, then the object is often frustrated by the choking of the street line sewer trap, or by the breather getting filled with stones, dirt, or weeds, and even when every point of the house drainage is free, open, and working well, we find that by adopting the Chicago and Toronto rules we are sacrificing the greatest sanitary privilege adopted, viz., the ventilating of the street sewers above the house tops, for the insignificant purpose of securing a very small and doubtful advantage.

When the soil pipe is connected without the street line trap, direct to the crown of the main sewer, as shown in The Canadian Engineer of April, 1897, there is nearly always an upward current from the drain to the head of the S.P., because the temperature in the main sewer will generally be higher than the atmosphere, and if any exception to the rule occurred, causing a down draught, the foul odor in the house soil pipes would be forced into sewer, instead of out of the breather, which is the case at present. Since the American system of plumbing was adopted in Toronto I have noticed some of the places where fever and diphtheria have occurred, and I believe that statistics will bear me out when I say that the street line trap and vent-pipe method of plumbing is doing considerable damage. It is hard to choose between the evils of the careless putty and paint plumbing of twenty years ago and the intricate plumbing demanded at the present time in Toronto.

When Dr. Norman Allen was the medical officer of Toronto I asked him if he considered it right to spoil the ventilation of the public sewers and injure private property by compelling each owner to put in a trap at the street line of the private drain? His answer was, "No," but he reminded me that the by-law was passed by the council, and again altered within a few months, and that if another change was made so soon it would put both his department and the council at a disadvantage, because the public would get alarmed and lose confidence. The fact that the present officers who apply the law in Toronto are in no hurry to give their own private property the benefit of the Toronto plumbing by-law, proves that we might place them also as unbelievers in the system.

It is necessary to keep polluted air moving, and the vent pipes will help to do this; but to get air to circulate naturally, it must have a continuous circuit, and if branches are inserted into the line, the draughts will be spoiled, exactly as with the draught of a stove, when the smoke pipe is inserted into a chimney flue where there is another stovepipe hole open. Taking this fact into consideration, it shows that as every house must have at least three vent pipes, and two of them are branched into one, or all three are branched into a receiver, which in turn is branched into the side of the soil pipe, it makes it impossible to secure a natural draught through any of the pipes, because no continuous circuit can be formed, and the conclusion must be that the only real value the vent pipes can be, is, that they do away with any pockets where air may lodge in the waste pipes, and will prevent any chance of syphoning of the traps.

There is evidently a strong feeling in certain quarters in favor of creating unnecessary business, increasing expenses, and securing a monopoly in favor of syndicates and wealthy tradesmen, to the exclusion of the small ones. When reading the by-laws of Toronto one cannot but see that the sanitary advantages are put in the shade by the points that call for high licenses, heavy bondsmen, useless piping, labor and joints. Great waste is obvious in many places. In one case we find a sink only intended to catch water from a garden tap placed in the cellar that has about 40 ft. of 1½ in. iron vent pipe running level under the ceiling joists until it is attached to the w.c. vent. Now the friction that will have to be overcome before any movement of air can take place in a 40 ft. length of so small a pipe laid horizontally, is more than enough to totally prevent any action, and of course such a pipe is perfectly useless. In some small cottages rented for about $4 per month, having a w.c. and soil pipe through the roof, and on the opposite side of the house a sink with about two feet of 1½ waste pipe and trap attached to a properly ventilated drain, as also a vent pipe taken from the knee of the trap and continued up to above the roof, with 3 in. iron soil-pipe, costing about $14 each house, which expenditure is of no value for sanitation purposes, and it injures the current of air in the drain, and assists to dry out the sink trap.

There are a number of large towns, with a dense population closely packed together, in Europe, whose sanitary rules are of such a nature, and so well applied, that with all the disadvantages of the majority of the people working in close, heated rooms, having the fumes from grease, soap, steam, etc., to inhale, the death rate is less than either Toronto or Chicago. The mode of application of their sanitary rules is both simple and effective. Before property can have the privilege of water supply, the waterworks' rules must first be complied with; also before it can secure the advantage of a sewage outlet to the street sewer, the health and sanitary laws must be fully carried out, and if property is not supplied by these necessary requirements it cannot be inhabited. But no public body can interfere with the rights that have already been acquired, except by paying compensation, unless the property is or contains a public nuisance and is unfit for public habitation, and even in that case the courts of law are not often required, for if an owner declines to keep his sanitary and waterworks appliances in good order he will receive notice to have them corrected, and when the time given expires, and the request is not complied with, the public authorities send their own tradesmen to do the necessary repairs, and charge the cost in the tax bills. This can all be done without threatening letters or a dozen visits from inspectors, and at a cost of about one-tenth of what it cost Toronto, and also without dragging the respectable citizens and tradesmen into a criminal court, or scaring weak people with official letters. When engineers and inspectors are clothed with absolute authority, those tradesmen who are compelled to work under them might almost as well hand their business over to the fortunate official, or make special efforts to please him in some other way, for there can be a wide difference between an inspector being satisfied with the work done at two different places, and by two different firms. I have had a letter in my possession from a former engineer of Toronto, in answer to a plumber's complaint about an official who had been unreasonable, and demanded more than the law required, which stated that the inspector could not be wrong, and he must be obeyed or a summons would be issued. The complainant then applied to the mayor, and the council appointed a committee which never met or gave the plumber a hearing. This sort of management usually occurs where business is done in favor of or by the requests of syndicates and monopolists that have a strong financial backing.

All rules and regulations made for the government of the general public should be plain, clearly described, easy to understand and carry out in every detail, definite and pointed, and having illustrated diagrams and plans showing what is wanted. It is unfair and unjust to allow any single person or body of officials to have the power to harass a tradesman, so that his expenses are increased and business damaged, while another friendly business firm may evade the law, or its work be easily declared satisfactory, securing good profits. The best sanitary laws are so framed that the most ignorant mechanic cannot make an error or mistake that will in any way injure the public health, and every detail of the fitting inside the building can be observed at a glance.

For THE CANADIAN ENGINEER.

FOUNDATIONS.

BY CHARLES BAILLAIRGE.

Allow me through the medium of your journal to call the attention of Canadian architects to the very concise and lucid illustrated article on "Foundations," which appeared in your last issue. The writer says: "The foundation of a structure is much more important than any other feature of its design, as on its security depends that of the structure itself." Our Canadian architects, I am loath to say, have not of late years been up to the mark in respect to foundations. Hence so many failures of buildings, especially of country or parish churches in the Province of Quebec, and other places which I might name, where the foundation areas, not being proportioned to the weight to be supported, portions of the structure have settled down unequally, tearing themselves away from others in a disgraceful manner, or to the disgrace of all concerned. I noticed this at J——— some three or four years ago, where the whole front of the church had parted from the side or wing wall, and the salient tower from the remainder of the front, due to its still greater weight, it having sunk eleven inches below datum level, and entailed an expense of some $7,000 or more in reconstruction. Other churches, I am told, as at the St. C. and St. B., have had to be, due to distortion by unequal settlement, taken down and rebuilt in toto.

Now the question arises as to at whose door the fault of such failures is to be laid. I must unhesitatingly say that, generally speaking, the architect is or should be considered the responsible party, and I cannot in saying this be open to any suspicion of partiality towards contractors, being one once myself, having practised as such for over twenty years before entering on civic service, and am still doing so. The architect should in every case plan and specify his foundations in a way that, if so executed, they may be thoroughly reliable, and then in case of the parish, through assumed poverty or otherwise, refusing to put in such foundations, the architect should execute the work under protest, so as to clear himself thereafter and saddle the blame where it belongs. The contractor should act in a similar manner, refusing to build a building under protest both to the architect and to the proprietors or wardens, in case of an improperly and inadequately designed substructure.

If the contractor carry out a plan as specified, he cannot be blamed for any failure due to settlement, as he is not supposed to form the necessary technical knowledge to allow him to judge of insufficiency and the ability of the soil to do what is expected of it in the way of supporting the structure. But the architect is supposed to possess this knowledge, and if he does not he should acquire it, or he is no architect at all worthy of the name. It is deplorable now-a-days that the engineer has to be called in to help the architect through with his foundations, for of the two the architect is the one supposed to have the more difficult problems to deal with sometimes, as in providing against the strains and thrusts to which sidewalks, piers and pillars are subjected by arched roofs or ceilings and domes of masonry, while with the engineer all these strains are conjured into submissiveness by the homogeneity of a pinned together or riveted structure, every part of which is thus tied and bound in a way not to give. What would architects of old have done had they not known how to proportion their resistance to their thrusts? There were no engineers in those days as we have them now. To what engineer did Michael Angelo apply to tell him how stout to build his piers to stand the pressure of St. Peter's dome, to load the supporting soil with weights proportional to their breadth of base? To whom did Christopher Wren address himself to study out the stresses of St. Paul's?—to whom the respective architects of the Pantheon, the Pantheon of Paris? They would have been ashamed, humiliated, to have had to rely in such matters on anyone else's knowledge than their own. It must not be argued that it is not less infra. dig. for the engineer to call in the architect to ornament his structure, make it artistic and acceptable to the age, than for the architect to call in the engineer. No, the cases are entirely different. Art and ornamentation are a branch of architecture, the other two of the three components being constructive and distributive. Then, since the architect must know construction, he should possess all the technical elements thereof, and be able to prepare his own strain sheets, precisely as the engineer does at the present time, the architectural features in the engineer's case being a mere adjunct, while in the architect's case they are an essential.

The written protests I refer to are, of course (and may be more or less disagreeable) unpalatable to some or all of the parties concerned. The architect and contractor both fear that they may thus estrange or rile the proprietors into calling some other architect or builder pliant enough to do the needful and run all risks, "ruat coelum," but the absolute necessity of such action on the part of both architect and contractor in case of foundations of doubtful efficiency, has been so often and disastrously illustrated by the many failures alluded to, and the cost of repairing and rebuilding, that it is to be hoped that proprietors themselves, parish or other authorities, will see the necessity and philosophy of such action on the part of the architects and builders, and it certainly is not fair to saddle the contractor with the cost of underpinning or rebuilding, when they, (the authorities) have from motives of economy decided on a cheap "platform" or "grillage" foundation, where a piled or down to rack structure should have been decided on from the beginning. And in buildings in general, too much reliance is placed on the supporting powers of the outer walls. It is too easily forgotten, and more frequently ignored, that while each of the outer walls bears only one-quarter of the weight, the central wall will have double duty to perform, and hence the fact that so many structures sag at the centre. Another thing of vital importance in the rigidity of a building, and the supporting power of its floor, is that as far as possible every joint should have three points of support, or that they be made to extend from end to end of the building, while supported at the centre, or where there are two intermediate walls, that each alternate joint be made to reach and to bear upon the wall or the opposite sides of the corridors. Where this is not done the floors sag disgracefully towards the centre, and the mere walking across them causes everything in the room to shake and tremble most disagreeably, as with a certain building erected in Quebec, where not from negligence or any consideration of economy, but from sheer ignorance on the part of the architect of the difference between the strength of a beam when secured at the ends and extending to other points of support, as compared with one bearing loosely at its extremities on the supporting beams. Look at the late London, Ont., disaster. Had the joint in this case been of a single stretch from wall to wall, their combined strength, even without the beam which broke, would have gone far towards supporting the weight of the crowd in the room where the collapse occurred, and at any rate their resisting powers added to those of the incriminated beam would have prevented the accident; but on the contrary, every one of the joints were in two length width, their ends meeting on the centre beam, hence the failure.

For The Canadian Engineer.

ROAD MATERIALS AND CONSTRUCTION.

BY W. M. WATSON.

When making roads we have the privilege of copying the system of construction used by the makers of the old Roman roads, which are yet sound and firm, and the later methods used by Metcalf, Tilford and Macadam, who revived the Roman and Swedish process of road-making in a lighter and less expensive form. This country is rich with first class materials, which only require to be intelligently put together to make good roads. Each old road-making sample shows us that every road and street must have its roadbed well drained. When making a new road the sod and small under brushwood should remain, if convenient, intact, because the rootlets make a tough foundation to build the stone bed on. In places where artificial banks have to be made to raise the level of the road, or when crossing bogs, marshes and soft places, a good thickness of pea straw or brushwood, etc., should be laid across on the soft material before commencing to build the stone foundation.

When the Romans set out a new road, they cut a trench along each side line at least one foot deeper than the bottom of the intended roadbed. These were filled with large boulders, or a rough drain was made, with outlets at short distances into some natural water course, which efficiently drew off all the water from the under side of the foundations. Macadam rounded his roads a little on the surface, the crown being at the centre, giving them a gentle fall to each side. He constructed his roads by laying down three, four, or more layers of stone about six inches thick, rolling each layer down even on the surface to the same shape and grade that the road would finish. He suited his material used to the nature of the ground and the traffic that would afterwards use the road, always placing the largest lumps at the bottom, and rubble varying from one inch down to one-quarter inch for the top course, having the whole rolled h rd and tight together, but using no sand or soft mater . except water. Hard frost cannot hurt a road that has a dry foundation.

Short residential streets might be made to fall a little to a central channel only about one inch deeper than the road surface, placed vertically over the main street sewer, having iron storm water grids that would serve both the purpose of ventilating the sewer and drawing the water from the street. This methed does away with the nuisance of having costly trapped gullies, with large pockets filled with decayed matter, throwing off disagreeable odors, close to the sidewalks and the houses. It saves digging across the street to the gullies, besides the value of the branch lines of pipes from the centre sewer to the gullies. It allows the wagons to get close to the sidewalks, and gives a width of dry road during a rain storm and frosts near to the houses where it is most needed. It also prevents the traffic from passing over the main drain where the road is weakest. Then the roadbed and foundation falling to the centre can be easily made to drain itself into the main pipe sewer, and last, but not least, the side of the streets will not be so slippery as under the present system in frosty weather. This method of grading streets is by far the cheapest, and the pavement is more durable and healthier for our climate.

We now come to roads suitable for traffic in populous cities, requiring smooth surfaces, and we revive again the customs and road materials used by the old Babylonians, and of Egyptians. There are numerous kinds of materials manufactured for roads and sidewalks that will stand any kind of weather, and that may be got at a reasonable cost, wearing from 20 to 50 years, and always be neat in appearance and comfortable to the wearer during the whole of the material's lifetime.

For instance, where high temperature destructors are used to destroy the garbage, the residuum is a very hard burnt clinker and fine ash. C. & A. Musks, of Bootle, Eng., have invented a press and other machinery to manufacture the clinkers into concrete flags equal to stone, and less liable to retain moisture, and I here give a report published of the manufactory at Liverpool, of slabs made from one-third cement and two-thirds clinker, and ash taken from the garbage destroyer.

COST OF MANUFACTURE OF ONE YARD OF CLINKER CONCRETE FLAGGING, 2½ INCHES THICK.

Materials.	Cost.	Remarks.
65 lbs. of Portland cement	10¾d.	Varies with cost of cement.
152 " of clinker................	nil.	Really a saving of 1¾d.
Water	¼d.	This item could be dispensed with where pressure is obtained by using steam power of destructor.
Labor	5½d.	
Plant contingencies and supervision	3¼d.	
Total cost per yard	1s. 7¾d.	

The total cost of manufacture is thus about 1s. 7¾d per square yard, without reckoning the saving in using the clinkers. The sizes of the slabs that are made are 2 feet by 2 feet, 2½ feet by 2 feet, and 3 feet by 2 feet, each being 2½ inches in thickness.

Some of these slabs have been laid twelve months and show no sign of wear. From the experience already gained, engineers believe that this class of flag will have a life as long, if not longer than stone, and owing to the porous material with which they are made, the clinker paving slabs have a foothold much better than the natural stone.

TESTS MADE AT LIVERPOOL OF MACHINE-MADE CLINKER CONCRETE FLAGS 2½ INCHES IN THICKNESS.

Age of flag.	Breaking load applied at centre of flag.	Age of flag.	Breaking load applied at centre of flag.
4 months	........1,804 lbs.	6 months	........2,061 lbs.
4 "	........1,474 "	6 "	........1,966 "
4 "	........1,742 "	4 "	........1,859 "
4 "	........1,917 "	4 "	........1,659 "
4 "	........1,608 "	4 "	........1,589 "
4 "	........1,752 "		

Concrete sidewalks made from granite chips and cement are pleasant and safe to walk on for about eight months in the year, the balance they are very slippery and dangerous. Wood sidewalks are slippery in wet weather, unsanitary, and at all times unsuitable. So that something in the shape of slabs that can be taken up and again replaced, and that are not slippery, also having a smooth surface, seems to be in demand. In places where they use a suitable wood set on a well drained thick concrete foundation, for street pavements, its wearing power is almost equal to good stone, having the advantage of being noiseless and easy for horses' feet. The wood most in favor at the present time in Europe is Australian hard wood, the best being called karri and jarrah. See table of strength, etc., below, prepared by James P. Norrington, C.E., London, England:—

	Local Name.	Weight per cubic foot in lb.	Breaking stress in lb. per square inch.	Elasticity in lb. per square yard.
West Australia.	Karri	65·00	215·00	7,070·000
	Jarrah	56·00	171·00	2,940 000
New South Wales.	Ironbark	73·85	25·08	5.526 400
	Blackbutt	63·69	21·70	3.105·979
	Mahogany	75·06	19·75	3.741 376
	Tallow wood	72·06	16·16	2,274·790

Colonel Bell, United States Consul, at Sydney, strongly recommends his own countrymen to use the Australian hardwood for paving in place of their own lumber. A test made of wood pavements at Euston Road, London, Eng., by James P. Norrington, C.E., proved that at the end of three years, the wear of jarrah and karri was only ¼-inch, and with yellow deal, it was worn down 1⅜-inches. I suppose our Canadian light cedar blocks would have gone out of sight altogether. The same engineer gives the cost of pavement complete with one foot thick concrete foundation to be $3 per square yard.

For sidewalks, cement and brick are good wearing when properly made, having a dry foundation of broken clinkers or coarse gravel. Tar pavements are smooth, durable and noiseless when made with well-seasoned material. The tar should be stored in a cistern for over six months before using, so that the volatile oils and moisture come to the top, and are removed, then mix the tar with clean, small broken stone, say from one to three-eighths in size, heated to a high temperature, so that the stone will absorb the tar without ignition. The longer the material is mixed before being used, the better road it will make, say within two years. This kind of road can be freshened and repaired with boiling tar and sharp sand when defects occur.

The best and most durable roads are made of pure genuine asphalt scientifically mixed with suitable materials; but, unfortunately, this is seldom except on sample patches, and the adulterated article cracks, gives out, and rots away under vibrating traffic. Asphalt is found in several countries, the best quality and largest supply is at present at Trinidad.

Asphalt is black and brittle at an ordinary temperature; when broken, the fracture takes the shape of a shell; when two pieces are rubbed together, an agreeable odor is emitted, having no resemblance whatever to coal tar. Crude asphalt weighs 65 lbs. per cubic foot, and refuses to attract moisture. It becomes partially soluble in turpentine, ether, petroleum or naphtha. Almost from the creation of man, what is now called asphalt seems to have been known and used. Its use and value is now being increased. Asphalt pavement is a composition with pure refined asphalt as the basis, mixed with 68 parts of sharp sand, 15 of powdered limestone, and 17 of asphalt, all the portions heated to a high temperature, and mixed by machinery while hot, and afterwards stored in a dry place or carted in a covered wagon to the place needed, and laid down warm. When laid on a firm and strong concrete foundation, the road will wear well, and stand heavy traffic.

For THE CANADIAN ENGINEER.

FRICTION.

BY WILLIAM PERRY.

Friction is greatly influenced by the hardness or softness, smoothness or roughness of the surfaces rubbing against each other. It is in proportion to the pressure or load, that is, a double pressure will produce a double amount of friction, and so of any other proportionate increase of the load. The friction does not depend upon the extent of surface, the weight of the body remaining the same. The friction is greater after the bodies have been allowed to remain at rest for some time in contact with each other, than when they are first so placed; as, for example, a wheel turning upon gudgeons will require a greater weight to start it after remaining some hours at rest than it would at first. The cause of this appears to be that the minute asperities, which exist even upon the smoothest bodies, gradually sink into the opposite spaces, and thus hold upon each other; it is for the same reason that a greater force is required to set a body in motion than to keep it in motion. If about one-third the amount of a weight be required to move that weight along in the first instance, one-fourth will suffice to keep it in motion. The friction of axles does not at all depend upon their velocity; thus, a railroad car traveling at the rate of 20 miles an hour, will not have been retarded by friction more than another which travels only 10 miles in that time, it appears, therefore, that the amount of friction is as the pressure directly without regard to surface, time or velocity. Friction is greatly diminished by unguent, and this diminution is as the nature of the unguents, without reference to the substance moving over them. The kind of unguent which ought to be employed, depends principally upon the load; it ought to suffice, just to prevent the bodies from coming into contact with each other. The lighter the weight, therefore, the finer and more fluid the unguent should be.

As regards friction in water pipe, it does not matter whether the water is flowing down or up hill, or whether the pressure is light or heavy, or in long conical and smooth pipes, or whether it is flowing to or from the small end. The total friction will be the same in one or both directions in the first case, and the same in both directions in the last case. In the conical pipe, however, the friction per unit of length or per lineal foot will be less than the average at the large end of the cone, and more than the average at the small end. The total frictional head will be the same as though the whole pipe had a uniform diameter, just equal to the diameter in the conical pipe at the point where the friction is equal to the average for the whole length. I wish it to be understood that when I speak of friction in water pipe, I mean literally what I say—resistance encountered within the pipe by the water, friction in water pipe, not of water pipe. The velocity and resistance vary in different size pipe. If in a section of water pipe we take two points 100 feet apart, and find that with a given number of gallons flowing per minute, the actual pressure in the first instance is 100 pounds, and in the latter 99, we figure that the sum of the resistance in that length of pipe is one pound, or the loss by friction is one pound. If we go another 100 feet we get but 98 pounds, or the friction loss will be two pounds, and the ratio of loss will extend for miles in length. If the number of gallons flowing in the pipe is doubled, still keeping the pressure at 100 pounds at the first point, we shall get about 96 pounds at the second and about 92 at the third point, and we find by doubling the velocity of the flow, we increased the friction loss four times. It is surprising to note the great increase of loss from friction in small over large pipe, discharging equal quantities of water.

Discharging Pipe.	Gallons per minute.	Velocity in feet per second.	Friction in pounds
2½ inches	300	19.6	23.06
3 "	300	13.6	11.2
4 "	300	7.66	2.66
6 "	300	3.40	0.37
6 "	1,000	11.3	3 88
8 "	1,000	6.38	0.94
12 "	2,250	6.38	0.63

In the face of all such facts, towns and villages will use small pipe. I could mention quite a number of towns to-day with a water supply only fit for household service, and crippled in case of fire.

The internal surface of fire hose in a number of cases adds to the loss of pressure by friction to a much greater degree than is generally supposed. The writer's interest in this matter has grown from a desire to obtain better and more reliable information on these very important points. Installing quite a number of fire protection plants in the Dominion has enabled me to go very fully into the matter of friction in hose and pipe; in canvas hose there is a loss of from 25 to 50 per cent., rubber hose from 10 to 30 per cent. Yet from time to time you will see some new-fangled coupling introduced. I came across one some time ago arranged as a cone; the idea of the inventor was no doubt to prevent blowing out from the hose. It was 2⅛ x 2⅜ in. inside, and intended for fire department 2½ hose. With a test on ordinary rubber hose there was a friction loss of 38 pounds, and with the ordinary 2½ coupling under the same pressure 18 pounds on the same hose. Quite a number of such are on the market. All contractions in couplings, projecting washers, automatic cut-off valves, are very detrimental to the efficiency of flow of water, and are first-class friction producers.

CANADIAN NICKEL.

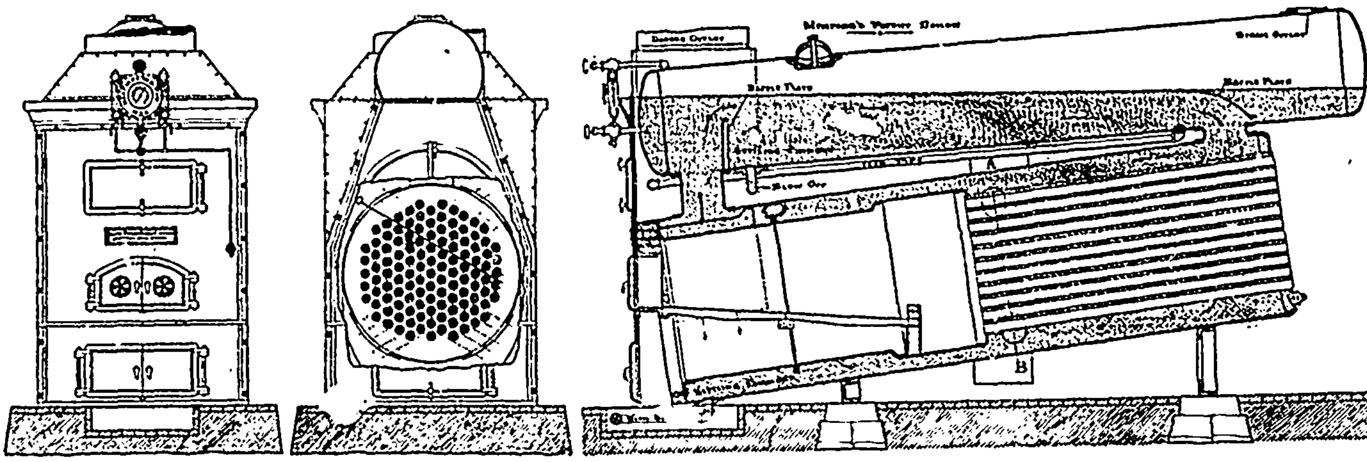
There is nickel ore in Ontario and New Caledonia, a French possession in the Southern Pacific, which can be profitably placed on the market. The market is world wide, for nickel has been decreed by the leading metallurgists to be necessary to the naval construction of the future, and the demand for warships is limited only by the credit of the nations or the endurance of their taxpayers. The copper bearing Ontario nickel ore is the more profitable, and its competition, although the development has been slight as yet, is said to have almost ruined the French company. Would not these facts lead us to expect to find a great industry in Ontario mining, smelting and refining nickel? Instead of that we have the Canadian Copper Co., whose mines, its manager, R. M. Thompson, stated before a committee of the United States Congress, "are owned entirely by Americans, and in treating whose ores they use American coke." He also stated that the $28,000 per month which the company was obliged to spend in Canada is made up for by the expenditure of $100,000 per month in the United States.* "The Canadian Copper Company is a United States corporation chartered by the Ohio Legislature, in which is only one little stockholder in Canada, holding perhaps one hundred or two hundred shares of the company," stated the president, Stevenson Burke, before the same Congressional Committee. The question now before the Dominion Parliament is whether Canada should not in her own interests place an export duty upon the ore and also upon the nickel matte, which is the product of the smelting process, heavy enough to render it necessary for the company to erect refineries in Canada and give Canadian labor the benefit of the working of Canadian ore. The boards of trade in various leading cities and towns have endorsed this proposal. The sentiment of the public generally seems to be that Canada should have reasonable use and profit of her resources, and that export duties seem the most feasible way of securing it.

It was rather a curious circumstance that at the meeting of the Federated Canadian Mining Institute held in Montreal some little time ago, so determined an effort was made by some of the members to secure an expression of opinion which might be used in the service of this alien corporation. It is certain surely that no stockholder of the company was present because it was a meeting of Canadians, and we have the president's statement that the members of the Canadian Copper Co. are all citizens of the United States, with one exception, and it is hardly likely that out of Canada's millions of people, that one man was present. We are credibly informed that the Canadian Copper Co. paid a ten per cent. dividend last year and carried a comfortable sum to the rest account. We hope the Canadian nickel company may soon do the same.

*See Sixth Report Ontario Bureau of Mines.

MUMFORD'S IMPROVED BOILER.

On this page we illustrate a new boiler intended to meet the demand for greater economy and efficiency than are obtained from the ordinary brickset boiler. The water circulation is similar to that of a water tube boiler, and for very high pressure it is built with a corrugated furnace. It was designed by J. A. Mumford, and is manufactured in Canada by the Robb Engineering Co., of Amherst, N.S., and in the United States by a large concern in Erie, Pa. The furnace has ample room for mixing the gases, and is surrounded by water so that the direct and radiant heat of the fire is readily absorbed. The heated gases pass directly through well-proportioned tubes, and return around the shell of the boiler and underneath the drum; thus, it is claimed, making every square foot of the boiler effective as heating surface, and enter the smoke stack with sufficient temperature remaining to produce good natural draft.



By covering the case and drum with a non-conducting material the loss of heat is reduced to a minimum. The water circulates continuously from the front to the back of the boiler, up the back connection to the drum, where the steam freely separates from the water, and down the front connection to a point below the fire This positive circulation admits of using forced draught, increasing the horse-power of the boiler without foaming or priming, the increased temperature increasing the speed of the water circulation, the makers claim, without any evil effects.

Special arrangements are made to avoid trouble with bad water. The feed pipe enters the drum near the back end, and part of the sediment is deposited in a settling chamber at the front end of drum and may be blown out. Additional impurities that are carried down the front connection are deposited in another settling chamber below the furnace. This leaves very little, if any, impurity to form scale on the furnace and tubes, and it may be removed by a scraper inserted through hand holes in the shell, the tubes being spaced so that all can be cleaned. Doors are placed in the casing opposite these hand holes which also give facilities for cleaning the outside of the shell. The Robb Engineering Co inform us that they have already installed two of these boilers in Montreal, and others in Lethbridge, N.W.T., Fort William, Ont. and Parrsboro, N.S., while a number more are ordered.

THE NAVIGATION OF THE AIR.

Editor CANADIAN ENGINEER:

In your issue for November I notice an article on "The Navigation of the Air," by C. Baillairge, C.E., and thinking some of your less scientific readers might be left in the dark through the nature of his article, I am led to make a few remarks, in the hope that they may somewhat clear the obsurity as to the principle, method and nature of the most successful attempt at aerial navigation in the last few years.

In the article Mr. Baillairge says, "that there never has been an attempt (at imitation), as with flying machines, to imitate in the balloon the shape of a bird on the wing;" and then again he says, "there must be (imitation), to be successful in directing them" (balloons). Now here we have a man trying to advocate an old and exploded theory, that of navigating the air with a machine that is itself many times lighter than the element in which it floats. Not on, remember, as in the case of the ship, which case he tries to parallel with that of the balloon, and says, "as man has become (successful) in propelling vessels through the water, by building them in imitation of the fish." Here we see what similarity exists between a fish and a modern steamship, such as the "Lucania," as ships, I believe, move partly through and partly over the water, whereas the fish moves entirely beneath and through that element. Now as to the propelling power, with reference to that of the fish, again we fail to see the similarity between the two. The fish propels itself by its tail, using its fins as auxiliary motors; but in the steamship, where is the mechanism representing the tail or the fins of the fish? It is true you will find the respective motors in the same relative position, but the resemblance between them I think is very slight. One being an oscillating movement of a fan-shaped appendix, the other a rotary motion of a blade screw. So that we see that the supposed likeness, referred to by Mr. Baillairge, does not really exist.

Then he continues: "Nor will flying-machines ever prove a success until some closer imitation has been arrived at, than heretofore, of the winged denizens of the air." Now, to take some other problems that have been solved by our inventors and mechanical engineers, not in the way suggested, by adhering strictly to Nature's models, but by radical departure in some instances. Firstly, had we imitated the ox or the horse and made the machine which draws our trains to-day, walk on legs, instead of roll on wheels, we undoubtedly would not have had trains whisking us through space at 60 and 112½ miles per hour. Secondly, had our marine architects imitated the fish and his oscillating tail we would not have had a "Campania" or "Lucania" crossing the Atlantic in less than six days, or a torpedo boat rushing through the water at 37¾ miles an hour.

Then is not a flying machine proper, the "aerodrome," a nearer imitation to nature's model than the "soaring machine," advocated by Mr. Baillairge, which is merely what is known as a "steerable balloon," slightly modified? I think so, inasmuch as it is vastly heavier than the air, which fact is true of nature's various models. Then again, he continues, with reference to the relative buoyancy of the balloon against that of the air-ship, "thus, as it is, the balloon is buoyant, but without the proper shape to render it possible to direct its motion, while the 'sky-flyer'—this we interpret to mean air ship, though we never have heard the term used before—is deficient in the opposite sense of having the power of direction without the buoyancy." We doubt if the latter part of the above statement will stand investigation, for surely had the author made the slightest pretence at ærodynamics or æronautics he would have known that the flat or concave surface of any considerable extent (not being prohibitively heavy) when held rigidly at an angle of from 3° to 8°, and moved rapidly forward in a horizontal line, does not need any buoyance outside of itself to retain it in space, its own onward movement being sufficient. That this is the true principle of air navigation has been proved by Langly, Maxim and others. And we may say here without going further, that our inability to steer balloons is not on account of their shape but on account of their weight, or more correctly speaking, the absence of the above property. Had a balloon got the weight, still retaining its floating qualities, there would be little difficulty found in directing its motion.

A little further on Mr. B. tells us to "try to conciliate or combine the two requirements or desiderata."—that of the balloon and air-ship—the two he says must be blended. Believing him to be an advocate of the rule, that "nature must know best," and that in experiments nature's models should be followed as closely as possible, his argument here seems not a little inconsistent. Here we would ask him, if instituting a compartment filled with gas in his flying machine or bird-like structure is imitating nature's model? and if so, in what part of the bird's anatomy the balloon-like structure is located? Further on continues the author, "there is another cause which helps the bird to soar on air" (the first cause mentioned was the bird spreading its wings and extending its tail so as to underlap them, thus forming a kind of æroplane) "this is the very heat generated by the bird's body." Then he asserts that the heat generated by the bird rarifies the air contained in the cavity between the wings. Now, to the generality of us this statement is rather confusing, for heretofore, we were not aware that any cavity existed between the wings, though there may be something of that nature beneath them, it is generally believed that between the wings is located the birds body. As for the air being rarified by the heat of the bird's body and imparted to the cavity or concaved surface of the underside of the wing, thus having a tendency to lift still further or at least retain in space, we think this factor too insignificant to be reckoned with, as figuring out on a scientific basis will prove. In the next paragraph, the writer asserts that "the soaring of the birds of prey is due to their flesh-eating propensities, which creates in the blood a vast amount of carbon, and when brought in contact with the oxygen of the air, in rapid respiration, sets fire to the interior. Now here we have the bird of prey making a veritable furnace out of its stomach by its own action, and the heat generated thereby being used balloon-like, to help maintain its position in space. Then he says with reference to the soaring faculty of the bird, no other explanation can be offered save the one he adduces. Surely this is a sweeping assertion. He then makes reference further on to the "ball-cock" or nozzle mystery, of which he says he gave the first explanation, here again we think he is not quite correct, but he does not give data to his explanation. He states that "increased buoyancy might be obtained under a flying-machine or parachute." Here in particular, as all through his article, he seems to be mixing matters by using such terms as "balloon," "flying-machine," "air-ship," "sky-flyer," "ærostat," "imitative bird," "æroplane," and parachute," some we think peculiar to himself, but most of them universal terms used to designate a particular style of machine for navigating the air, but in this article they all seem to relate to his peculiar machine, whatever he intends to name it, and to the mind of the average reader renders his article rather obscure. Surely it must be a singular looking object that could be called literally a flying-machine or parachute. Then going further with the matter of buoyancy it is asserted that by causing a jet of steam, or a jet of gas or atmospheric air to issue from ball-nozzles or concentric cones, so as to come in contact with the concaved roof of the flyer, and by the mere effect of the friction, suck the air from the funnel-like space enclosed by the jet, thereby forming a vacuum within, and in this way producing buoyancy sufficient to float the flyer, the overplus power of the buoying contrivance to be applied in propelling the "bird-like structure" through the air. Here I would ask the author if he has ever got down to facts and calculated the power and weight of engines or motors of other kinds necessary to compress air or produce steam sufficient to supply ball-nozzle or concentric cone of the number necessary to lift a given weight say of 500 lbs., less the weight of engines (which is not a prohibitive weight, I think, for a practical "sky-flyer") or the area of ceiling or roof for the cones or nozzles to play upon. We think not, or he would have seen that the idea was too absurd to even dwell upon for a moment. But as the writer penned the foregoing statements he seems to have been reflecting, for in the next paragraph he says: "But better still, let the buoyancy be provided for in advance of starting by making the structure a balloon or space-enclosing one" Then he proposes to steer his balloon or soaring machine—for such it really is—by making the propeller shafts capable of separate action, and alternately increasing or decreasing one or the other's speed, in order to keep the balloon on her true horizontal course. How he is going to alter his balloon's vertical course or altitude he does not state, but we presume that this must be brought about by the escape of gas or ballast. With the method of steering suggested above it strikes us that quite a complement of engineers would be required, some one of them at all times would have to be perpetually working throttle, reversing lever, governors or electric switchboard, etc. etc. Here again the writer seems to have reflected on his preconceived method of steering, for in the next sentence he says, "and if the aerostat were provided with a rudder." Again as in other places throughout the article his second thought is infinitely better than the first. At the next bound the reader and his thought of air-ships is landed head over ears among astronomy and astromers, which having nothing in common with æronautics we will pass over without further comment.

And now to conclude with the suggestion to the writer, that if he has such implicit faith and confidence, and believes the principle of his machine to be the only and ideal air-ship of the future, the best method of proving whether his ideas are correct or not would be to have one built on a practical scale and make or attempt to make a flight with it. The danger of such a course is made all too apparent by the history of Dr. Woelfert and his balloon, "Duetschland," which caused the death of the doctor and his assistant, Herr Knobe, on the 12th of May last, at Berlin. This balloon embodied many of the features of the "sky-flyer." For practical matters on æronautic and ærodynamics, I would refer Mr. Baillairge to articles by H. S Maxim, S. P. Langely, Lilienthal and M. Tatin, also Æronautical Annual, 1896-7. GORDON M. LOCKHART, M.E.

Winnipeg, Man.

The Waterloo and Hespeler Electric Railway wants $40,000 from Berlin and Waterloo, Ont., to extend their line to these towns.

For THE CANADIAN ENGINEER.

THE SWEDISH IRON AND STEEL INDUSTRY AS SHOWN AT THE STOCKHOLM EXPOSITION.*

BY ERNST A. SJOSTEDT, M.E., MONTREAL

Sweden has for centuries been so well-known as a mining and iron producing country that it was expected to have something very interesting in this line to show the world at the Stockholm Exhibition last summer. But even to the most expectant and partial a genuine treat was here in store. For in a most picturesque neighborhood of the beautiful Swedish capital we found the varied products of the country brought together—not in a more or less haphazard manner, but of the choicest only, and this most tastefully and systematically arranged and displayed. The iron industry especially showed a remarkable life and activity; and the more we studied the different exhibits the more we must marvel at the truly wonderful material shown, the like of which has not been produced elsewhere in the world. In fact, such toughness and strength combined with such remarkable softness and pliability as the best grades of the Swedish iron possesses cannot even be approached by other nations, and its tool steel armor plates and projectiles stand highest in the world's market. Compared with any of the great iron-producing countries, Sweden occupies but an insignificant place, for while Great Britain and United States each produced about 8,600,000 tons of pig iron in 1896, and Germany 6,400,000 tons, Sweden can boast of only 545,000 net tons. But what here lacks in quantity is amply made up for in quality, as we soon will see.

In what a healthy condition the Swedish iron mines are, and of what superior purity the ores used at the Swedish furnaces, can be gathered from the following data:—The total number of (net) tons of iron ore raised in 1896 was 2,245,980, as compared with 1,088,120 tons in 1891. The principal producing districts and representative mines are:

		Net tons.
(1)	Grangesberg (Dalarne), with an output of	704,000
(2)	Gellivara, Luossavaara and Kurunavaara	660,000
(3)	Norberg (Westmanland), about	171,000
(4)	Dannemora (Upland) "	60,000
(5)	Striberg (Nerke) "	44,000
(6)	Persberg (Vermland) "	30,000

Of these, the Grangesberg and Gellivara ores are rich in iron (57 to 68 and 60 to 68 per cent. respectively), but high in phosphorus (.05 to 1 25 and .08 to 84 per cent.), and for this reason cannot be used in the Swedish blast furnaces where quality is aimed at, but are exported, the former principally to Germany and Austria where they are used in the basic (Thomas and Gilchrist) processes, and the latter to England, Germany, Belgium and France. All the other representative ores are exceptionally low in phosphorus—from .001 to .03 per cent.—and also in sulphur—from .01 to .05 per cent.—except the Dannemora "pyrite ores" with about 1.25 per cent. sulphur; which, however, are so thoroughly roasted that they do not contain more than .02 to .05 per cent. sulphur when being ready to use in the blast furnace. Upon these two points, the very possibility of the present active condition of the Swedish iron trade rests. And the practice of the great corporations holding the purest ore mines never to sell or export any of their ores, but keeping them for consumption at such works only in which they are interested, gives them practically a monopoly of the best pig iron and steel billet trade, and enables them to obtain a price for their product, in and out of Sweden, that would make an American ironmaster feel quite envious, although he may not be disposed to take all the numerous small precautions used here, which, however, are indispensable for obtaining such results.

As most of the iron ores are magnetites (in 1896 87.4 per cent. of the whole production was magnetites, and 12 6 per cent. red hematites), and as the red ores often are so mixed with the magnetic ores that they also are attracted by the magnets, the simple miner's compass has of old been quite an important factor in the discovery and tracing of the Swedish iron ores. During the last 20 to 25 years, however, the more complicated, but also much more accurate and scientific instruments designed by Prof. Thalen† and Mr. Tiberg‡ have come in quite common use. Together with the mining maps, models of the mines are generally made of a series of horizontal and parallel glass plates, on which the sections are drawn in clearly defined colors, representing the different minerals and rocks encountered. These models are without doubt both neat and instructive, and the idea well worth imitating at every mine, as it shows at a glance all the shafts, levels and work-

*Abstract from a series of articles written for *The Iron Age* while at the Exposition.

† Thalen's Magnetometer, described by the writer in the Journal of the U.S. Association of Charcoal Workers, Vol. VIII., p. 262.

‡ Tiberg's Magnetic Inclination Balance, described by the writer in the Trans. of the Mining Association of Nova Scotia, Vol. II., p. 117.

ings, and thus gives a much surer and clearer idea of its condition than any number of sectional maps possibly can do.

The blast furnaces of Sweden—as well as in the Lancashire process of making wrought iron—are all using charcoal as fuel, and in most of the other metallurgical operations, such as the roasting of the ores, in the heating and open hearth furnaces, etc., the generator gases from wood, forest and mill refuse are used to a great extent. The coal mines of Sweden, namely, which occur only in the extreme south part, in Skane, and from which in 1896 nearly 250,000 net tons of coal were raised, are not of sufficient purity for the iron industry, but are mostly used in the manufacture of firebricks, as good fire clay is associated with the coal beds. Hence it is that sawdust and slabs from the mills, branches and stumps from the forest—in fact anything of a combustible nature—is carefully saved and used in the gas producer, where it is made into pure gaseous fuel, free from sulphur, and thus most admirably suited for the iron and steel processes. Besides the abundance of waterfalls furnishes power for this as well as most other industries, thus leaving for the smelting processes, the lumber and pulp industries, almost the exclusive use of the raw materials of the forest. And as of old the Swedish ironmasters also have been large forest owners, the interests of both these industries have been identical, and the future and continuous prosperity of both have been looked forward to by planting, as well as cutting, and by a systematic working of and most scrupulous saving of the forest products.

Of all the iron and steel exhibits at the Stockholm Exposition it can be said that this excelled in exceptionally good products, and showed an unusual taste and system in arrangement. Conspicuous was also the diversity of products from the same works, showing how few of them really confine themselves strictly to any one particular branch, and how many convert their own raw material—pig iron billets or ingots—either into a half-finished product or into even the smallest articles of trade, many also going into the manufacture of lumber, pulp and paper, etc. The reason of this is evidently to avoid being dependent on the price fluctuation of the raw material, and to enable them to throw the bulk of their working force on that branch, among the different ones pursued, which at the time promises the largest profit.

Owing to the great demand for Swedish bicycle tubes during the last few years quite a new important industry has of late sprung up—namely, the manufacture of tubes of all dimensions. Another healthy branch of the iron industry is evidently the open hearth—especially the basic—process, which is growing in great favor, and from which large castings, as well as small samples were shown at most of the exhibits that testify to the great excellence of the material.

In 1896 there were 140 blast furnaces in operation, producing 544,858 net tons of pig iron, as compared with 502,625 tons in 1890—thus showing but a slight increase, which again is principally due to the limitation of the blast furnace fuel (the charcoal). The average output per furnace and working day was 14.3 net tons in 1896, and 13 3 in 1890, and the largest furnaces (at Domnarfuet) having produced an average of 28.9 net tons, while, of course, some of the smaller furnaces make considerably below the average. The tendency of the Swedish iron industry is indicated from the following table, which gives the proportions of the different kinds of pig irons manufactured in 1892 and 1895:

	1892. Per cent.	1895. Per cent.
For Lancashire and puddling	62.12	52.70
" Bessemer and open hearth	30.53	43 46
" laundry purposes	2.05	1.69
" malleable castings	1.10	1.86
Sprigel	0.19	0.29
	100.00	100.00

For the further manulacture of the pig iron into wrought iron and steel there were, in 1895, 137 different works, and the number of furnaces and the quantity of each class of iron produced were as follows:—

	Net tons.	
306 Lancashire forges, producing	190,517	
35 Franch-Comte forges, producing; 33 Walloon forges, producing; 16 scrap forges, producing	15,484	
Puddling furnaces at only 4 works, producing	1,975	
		207,976
30 Bessemer converters, producing (Of which 19,672 tons are basic steel)	107,247	
33 open hearth furnaces, producing (Of which 22,060 tons are basic steel.)	109,383	
5 crucible steel furnaces, producing	659	
		217,289
6 blister steel furnaces, producing		720
Total net tons		425,985

In order to give an idea of the different kinds of manufacture, and the growth during the last few years the following table is of interest

1 metric ton 1.102 net ton. =0.984 gross ton.	1894. Total metric tons.	1894. Per cent. Lancashire puddling.	1894. Per cent. Bessemer and Martin.	1895. Total metric tons.	1895. Per cent. Lancashire puddling.	1895. Per cent. Bessemer and Martin.
Blooms, billets, etc., for export	8,083	0.1	99 9	9,488	0.14	99 86
Iron and steel bars	146,786	67.8	32.2	168,270	61.32	35.68
Other shaped iron and steel not hereafter specified	8,324	8 0	92 0	12,171	1.29	98 71
Hoop iron, horse nails	78,092	59.3	40.7	78,168	55.63	44.37
Wire, in coils	25,764	40 4	59 6	26,038	32.38	67 62
Heavy plates	10,850	0.7	99 3	12,028	0.51	99 49
Rails	3,644	..	100.0	2,884	..	100.00
Fish plates and rail plates	384	45.3	54.7	387	40 31	59 69
Wheel tires	1,391	..	100.0	900	..	100.00
Axles	1,975	34 9	65.1	1,897	17.34	82.66
Anchors and other heavy forgings	1,009	59.2	40.8	695	28.63	71.37
	286,302	55.3	44.7	312 926	49 86	50.14

From this we see that the percentage of Bessemer and Siemens-Martin metal in the manufacture of domestic material was below that of Lancashire and puddled iron until a couple of years ago, when it exceeded it; and the increase in this direction is steadily growing. Another table, showing the relation between hammered and rolled billets and bars and the increasing preference for the rolled product, may also be of interest:

Year.	Hammered. Tons.	Hammered. Per cent.	Rolled. Tons.	Rolled. Per cent.
1892	46,693	34.1	90,306	65.9
1893	43,072	31.8	92,479	68.2
1894	39,738	29.5	94,896	70.5
1895	37,381	24.2	117,229	75.8

Among the several iron exhibits, those of the Sandviken, Domnarfuet, Bofors and Tinspong were the most conspicuous, and the mentioning of a few of their articles will only go to demonstrate the opinion already advanced in regard to the excellent qualities of the Swedish iron and steel, as well as the superior skill displayed in the manipulation.

As samples of special skill in cold rolling long iron bands, the Sandviken Steel Company exhibited an iron band eight inches wide and 2,293 feet long, weighing 1,155 pounds, which decorated the walls and the ceiling of their pavilion, and as a contrast to this "heavy weight" we noticed a "light weight" champion of 4,205 feet in length, and 2⅜ inches in width, but only 43 pounds in weight. The thickness of this cannot be measured in the ordinary manner, as it is only about 0.0012 inch; but a still thinner one, measuring 0.0008 inch was also among these unique exhibits. Another "record breaker" was a band saw 12 inches wide and 214 feet long, handsomely polished and hardened, and "ready for work;" so was also a hot rolled band 290 feet long, 8 inches wide and 5 32 inch thick, weighing 1,241 pounds and made in one heat. This is believed to be at the same time, the heaviest and longest band ever produced in a similar manner in any part of the world. Below this coil was placed a billet of the size from which this band was formed, measuring 11 feet by 7¼ by 4⅜ inches, which object lesson makes one realize with what skill and dexterity this great change of dimensions must have been accomplished—as the result of only one heat.

Domnarfuet Iron Works—the largest iron and steel works in Sweden, and the largest in the world based on charcoal as fuel—displayed some heavy chilled castings, *e.g.*, two 26-inch rolls, about 11 feet in length, and weighing 16,975 pounds each; also open hearth castings, among which two 31-inch rolls of 17,195 pounds weight, and a piston of over six feet in diameter and 3,858 pounds in weight; so also a multitude of samples which had been subjected to the most trying mechanical tests, under heavy drop hammer or by strong torsion and bending, to prove the excellent quality of the material, as none showed any sign of a break or flaw. The superiority of the Domnarfuet tool steel was proved by showing the work done by some of them (duly attested): One of the turning tools had cut and turned off 2,336 pounds of open hearth steel shavings, 566 pounds of cast-iron turnings and 50 pounds of shavings from a chilled cast-iron roll; while a 2-inch spiral drill had bored holes of together about 14 feet depth, making 130 pounds of chips. Among car wheels exhibited by the Sandviken Iron Co., one pair had served during 21 years, and traveled 458,296 miles, and a pair of locomotive tires which had been running 236,817 miles in ten years; also a car axle that, after having run 444,845 miles, was tested and had to be bent 39½ times at an angle of about 10 inches from the neutral axis before it broke.

At Bofors and Tinspong guns, armor plates and projectiles are made, of which the latter especially are renowned at home and abroad, and their power of endurance was shown at a trial practice at Creusot, when the three Tinspong 5.9 inch composition projectiles passed unharmed through the 9.8 inch armor plates made by the French works for the Swedish Government.

The good welding quality of the Swedish steel, as well as the skill of the blacksmith, was demonstrated in a most interesting manner by a piece of steel in the shape of a cube, the end sections of which showed nine small steel squares of different hardness. This effect had been obtained by a perfect welding together of nine square steel bars, with carbon ranging from 0.2 to 1.0 per cent., after which this composite bar had been cut in pieces and polished.

In order to show to what great expense the Swedish ironmaster is prepared to go in order to gain even the slightest advantage in quality of product, it is interesting to note that at some of the works using the purest ores obtainable, they are actually killing out the birch wood, and in its stead planting pine, solely on account of that shade of a difference in amount of phosphorus present in the hard wood, over and above that in the soft wood. But as the trade gives preferences to him who can show the absolute lowest percentage of phosphorus in the steel—if even a difference of .001 per cent.—the wis ironmaster will go even to such a sacrifice—cost what it may, as long as the importer is willing to pay for it—and this England, at least, is always prepared to do for *the very best* material.

Peculiar to the Swedish iron works are their large number of dwelling-houses owned by the companies, but, generally, furnished rent free to the workmen Although both expensive to build and to maintain, at most of the works this rather patriarchal system is adhered to, instead of allowing the men to buy their own plot and house. Generally, these are neatly built cottages of brick or logs, and pleasantly situated in some park or the woods surrounding the works, and give the impression of prosperity and comfort.

METAL IMPORTS FROM GREAT BRITAIN.

The following are the sterling values of the imports of interest to the metal trade from Great Britain during March and the three months ending March, 1897, 1898:—

	Month of March.		Three months ending March.	
	1897	1898.	1897.	1898.
Hardware and cutlery	£4,955	£2,113	£12,018	£5,418
Pig iron	20	639	455	2,541
Bar, etc.	830	78	3,031	2,285
Railroad	3,295	....	3,847	6,922
Hoops, sheets, etc............	2,700	869	6,311	3,653
Galvanized sheets	2,615	1,916	5,841	4,549
Tin plates....................	23,141	7,034	61,542	25,549
Cast, wrought, etc., iron	2,252	2,162	7,004	6,133
Old (for re-manufacture)	96	323	572	403
Steel	5,302	5,295	10,235	15,935
Lead	791	1,121	2,070	2,703
Tin, unwrought	947	2,087	5,444	3,476
Alkali........................	2,606	2,617	4,522	5,516
Cement	750	81	1,843	1,988

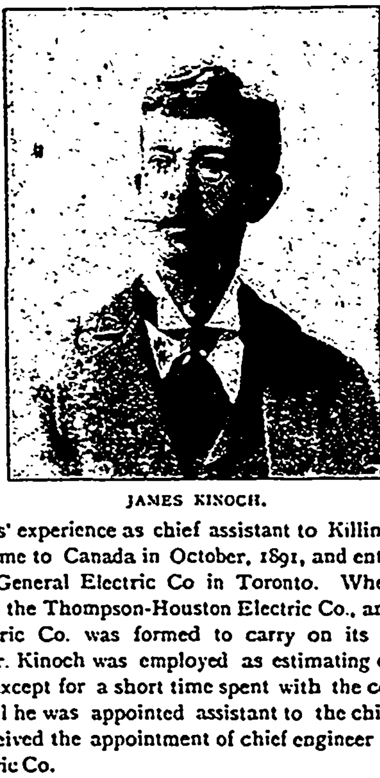
MONTREAL ISLAND BELT LINE RAILWAY.

We described at some length in our last issue the Montreal Island Belt Line Railway. The following additional details of the equipment have kindly been supplied us by C. H. Wright, electrician, and R. Weisford, engineer of the company: The generator is the well-known Canadian General M.P. 200 belted dynamo, and runs at a nominal pressure of 550 volts. The switchboard is the standard marble generator panel, made by the same company, and furnished with its circuit breaker, switches, etc., while the indicating instruments are of the Weston switchboard pattern. The four closed cars are mounted on Taylor double trucks, and equipped with G E. 1,000 motors. The two 45-feet cars are mounted on Taylor double trucks, with G.E. 1,200 motors. The five 30-feet cars are mounted on Brill single trucks, with G.E. 800 motors. The cars are made by the General Electric Company and the Ottawa Car Company. They are lighted with about 225 candle power of incandescent lamps. The line is 00 trolley, with a parallel feeder of 0000 bare wire from the power house, and tapped every 1,000 feet to the end of the line. Bracket construction is used, and the trolley wire is 22 feet from the ground, soldered ears and Crayhead brackets make the overhead work very durable. The bonding is 0000 solid wire, with malleable iron thimbles sweated on. Rails were drilled in the pile with upright hand drills. The cars are controlled by a non-inductive telephone system from the superintendent's office at the power house. The car sheds are located at the power house, so that all the operations of the line are controlled from this central point. The line is completely fenced with Page steel wire fence. The River Side power house of the Montreal Belt Line Railway is situated on the banks of the St. Lawrence, and in the middle of its line. The power house is built of pressed brick of the Ormstown manufacture. The size of the building is 44 feet by 84 feet. The engines and boilers are made by Goldie & McCulloch, Galt, Ont., and consist of one double tandem compound Automatic Cut-off engine, size 13 x 24 x 36 inches. The wheel, 16 feet 6 inches, is belted directly to generator. The boilers are made from the best homogeneous steel, and are double riveted with 84 tubes in each, and tested to 180 lbs. pressure. The condenser pumps and boiler feed pump are made by Northey of Toronto, whose wares are well known to manufacturers. Size of condensers are 6 x 12 inches, and 9 x 12 inches. Size of boiler duplex feed pump 6 inches, 4 inches x 7 niches. The horse power of the engines is 300.

JAMES KINOCH, CHIEF ENGINEER CANADIAN GENERAL ELECTRIC COMPANY.

Jas. Kinoch was born at Blair Gowrie, Perthshire, Scotland, in 1866. The greater part of the years spent in securing his education were passed in London, where he attended the City of London Middle Class School. His technical education was completed at the City and Guilds of London Institute, under the tuition of such able instructors as Profs. J. Perry and W. E. Ayton, and Sylvanus P. Thompson. He graduated from the Institute with great credit to himself.

After completing his technical studies Mr. Kinoch entered the employ of the Globe Electric Engineering Co., where he remained for three or four years. He then became secretary of the Orient Electric Light Co., which position he retained for nearly two years



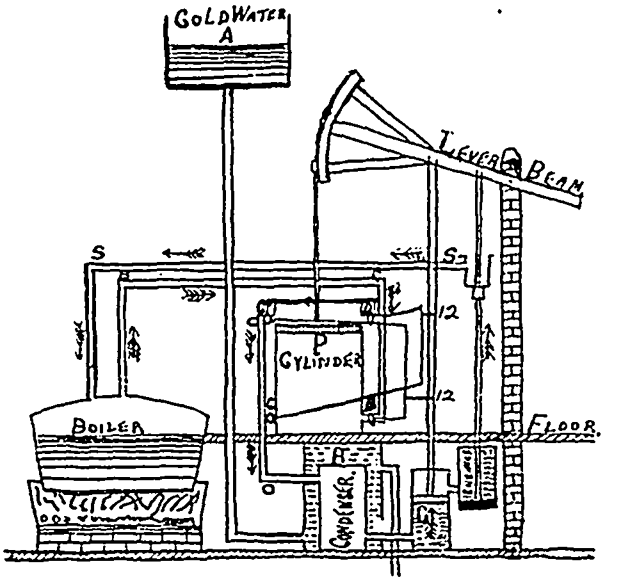
JAMES KINOCH.

After two years' experience as chief assistant to Killingworth Hedges, Mr. Kinoch came to Canada in October, 1891, and entered the service of the Edison General Electric Co in Toronto. When this company combined with the Thompson-Houston Electric Co., and the Canadian General Electric Co. was formed to carry on its business in the Dominion, Mr. Kinoch was employed as estimating clerk. He filled this position, except for a short time spent with the construction staff on the road, till he was appointed assistant to the chief engineer, and last month received the appointment of chief engineer to the Canadian General Electric Co.

THE STEAM ENGINE.

Editor THE CANADIAN ENGINEER.

SIR,—In a former paper to your readers I drew their attention to the horse-power or duty, and to Newcomen's atmospheric and steam engine which Watt repaired for the University of Glasgow. His attention was directed to improvements which he saw could be made, and he and Dr. Roebuck went to work to make a new one of a useful size for the Doctor's mine, in his house and in his Carron iron works he fitted rooms for the purpose, there we left him, getting his patterns and casting ready. They had undertaken a big job, as all their tools had to be planned and made. We will now follow him into his room, where he had his steam engine working. Herewith I present a sketch of the engine that was in his mind some time before. The condenser is below the steam cylinder, in a tank of cold water to help the spray or jet of water inside, also he had two pumps connected to the main beam to draw the water out of the tank, and also to fill the boiler feed tank. Here, you may observe, his engine worked with steam both sides of the piston. It was made to work any machinery, as well as pumps in a mine. This condenser formed a better vacuum than could be formed before, and his engine made about fifteen to twenty strokes per minute and ran much higher pressure steam, and by making the vacuum in the condenser as good as possible, so that he might gain 12 or 14 lbs on the square inch, or, in other words, his pressure of steam on the piston may be that amount less in the boiler, his valve levers are connected to the main beam. The next gain he wanted to make was to keep the cylinder warm, it being exposed to the cold air, as well as the pipes to it from the boiler. He conceived the plan of having another cylinder fitted around it and cased with wood, and let in a little steam at the top, and the condensed water ran out at the bottom.



WATT'S ENGINE.

A, B, cold water tanks. *C*, outlet for cold water. *D, F*, pumps for drawing off hot water and sending it along s s back to the boiler. *P*, tight-fitting piston. *a, d*, cocks for letting steam into the cylinder. *b, c*, cocks for letting steam out of the cylinder *e, e*, pipe which carries steam from boiler to cylinder. *o, o*, pipe which carries steam from cylinder to condenser. *1, 2*, rods connecting the cocks with the lever-beam.

which answered well. This engine he called a condensing engine, and so it is to-day. The piston rod was put through the cover with a gland and stuffing box, as we have to-day, but his workmanship was not so good as ours is: for want of suitable tools, he had quite a difficult piece of work to plan and make the parallel motion. The former engines had a chain over a circular piece at the end of the main beam, the piston rod being a square bar, and a little motion of the piston in the cylinder did all that was required. His piston he made of iron, with a cover or follower, with a space left to pack or caulk in plaited hemp and tallow; when the follower was screwed down it squeezed it against the sides of the cylinder and made it steam-tight. This make of piston I have packed, and it worked well in a slow-motion mine engine with low pressure. Mr. Watt had many other difficulties to be overcome; he yet had taps for admitting and letting out the steam, which were opened and shut by the motion of the main beam, not by hand, as in Newcomen's. But a better sort of arrangement had to be planned out and made; time and money were going away, and none coming in. He lived with the Doctor, and many people were talking about Watt and his new engine.

Watt's mind was fully engaged in planning a valve, in the place of the taps. His leading idea was to have the two valves connected, so that when the top valve opened to let in the steam on top of the piston, the one in the bottom will open to let it out from under the piston at the same time into the condenser. Out of these ideas grew the old Cornish D. and equilibrium valves, also the lever nozzle and foot valves for the condenser. He found his boiler not large or strong enough, because he wanted more steam and higher pressure, and the saving of more steam, also condensing it every half stroke must be done in less time. To do this he got a large tank made and put his condenser into it and covered the condenser all over the top and sides with cold water, the pipes through which the steam passed into the condenser and the condensed water came out to the feed pump, passed through the sides of the tank and the water in it, so that the steam was condensed in much less time. The water in the tank was pumped for use or waste; being warm, cold water was running into the tank to take its place: the two pumps were connected with the main beam. By this plan he had saved a large amount of steam and his engine ran much better and faster, he then put a safety valve on the boiler, and two gauge taps, and caused the fire to burn faster by enlarging and raising the chimney, but he soon found the heat he had in the furnace was 75 per cent. more than was found in the water and steam. In fact, he calculated that only 25 per cent. went into the steam, he also found it took 6 lbs of water at 32 degrees to condense 1 lb. of steam at 15 lbs. He found that one inch of water at 32 degrees will expand into one cubic foot or 1,728 inches at 15 lbs. There are reasons for believing that these several states of matters are determined by certain conditions affecting the molecular arrangements. We find that one pound of hydrogen, united with eight pounds of oxygen, will produce nine lbs. of water, giving off a considerable quantity of heat. It must be borne in mind that these two elementary substances exist as free gases, so that they can be united or used separately. The word latent means hidden and in this sense we will use it. If we take a glass flask, put it on a stand with a lamp under it, one that will give off a continuous and even heat, put into the flask one pound of water at 32 degrees; watch it taking in the heat, and in one minute, the thermometer will be, say 10 degrees higher. We will now remove the lamp and water, and put into the flask one pound of ice, put back the same lamp and watch the time it requires to melt the ice into water. It takes 14 minutes, but the thermometer marks only 32 degrees the same as the ice did. If the lamp put 10 degrees into the water from 32 degrees to 42 degrees in one minute, then the lamp must have put into the ice $10 \times 14 = 140$ degrees, but the thermometer does not show it, this is what is called latent heat concealed in the ice, which is required to bring back the ice to water. We will now put the lamp on again with the one pound of water which came from the ice at 32 degrees and watch the time it will require to boil up to 212 degrees, the thermometer says steam. It has taken about 18 minutes, or 18m. $\times 10° = 180° + 32° = 212°$. Now without disturbing any part of it, watch the time it will require to boil all the water away, and force the steam into another flask through a connecting glass tube, 95 minutes or $5\frac{1}{2}$ times the 18 minutes the time it took to boil from 32 degrees up to 212, and yet the temperature has not risen by the thermometer above 212 degrees, 10 degrees in one minute being raised by the thermometer has become our unit 14m. $\times 10° = 140°$. 18m. $\times 10° = 180° \times 5\frac{1}{2} = 990° + 180° + 140° = 1310° - 212° = 1098°$ latent heat in that one pound of ice, up to steam equal to the pressure 15 lb. atmosphere, and if we get steam up to 60 lb., 14 steam atmospheres, we will get into that steam 294 degrees or 82 degrees above 212 degrees; 8 atmospheres will give $342° =$ to $130°$ above $212°$. Fahrenheit's thermometer. After laying these figures before you, $1098°$ latent heat and sensible heat $212° + 1098° = 1310°$ for one atmosphere 15 lb. or 4 atmospheres 60 lb. $1310 + 82° = 1392°$ or 8 atmospheres, $1392 + 130° = 1522°$ in steam 120 lb.

About the year 1766 little was known about the air or atmosphere. Watt was very anxious to know something more about it, for he could not burn the fuel without the air, and he wanted to know how to regulate its supply to his furnace in a practical way.

Watt's boiler is what is called the wagon boiler; the bottom sides and ends are curved inward, the top is like the cover of a wagon curved up, made strong with stays to resist the pressure of steam, say 50 lbs. It was built in with bricks, with a chimney behind; when the fuel was put into the furnace, he found it required to ·e of a light article so as to give a blaze to drive out some of the heavy atmosphere, the chimney and furnace being full with a weight to be overcome by the blaze. The oxygen and hydrogen in the air combined to form drops of water on the cold boiler, and until sufficient heat has been raised to change the water back again into gas, and the atmosphere is driven out of the furnace and chimney, and the bricks have taken in sufficient heat, the fire must burn; and to create a draught in the furnace and chimney the fire must burn, and a large amount of fuel consumed; the heat cannot be brought back or saved for use again, it has done its duty in lifting a weight out of the chimney. Watt complained that not more than 25 per cent. of the heat is caught in the water and steam, while 75 per cent. was gone up the chimney to warm the atmosphere. We will now learn a little from our scientific friends about it; it is a mechanical mixture, not chemically combined, and when in its purest state consists of oxygen, 20.96; nitrogen, .79, and carbonic acid gas, .04, one cubic foot at 32° with a pressure of 14.7 lbs. or 30° mercury weighs 565.1 grains, and one pound is equal to 12.387 cubic feet; it varies one grain for each degree of heat, and is 773 times lighter than water at 32°; the mean weight of a column one foot square, say 45 miles high, weight 2,124.7 lbs. $\div 144 = 14.7$ lbs. per square inch, or $\div 62.5$ will support a column of water 34 feet high, or $\div 846$ lbs (the weight of a cubic foot of mercury); it will support a column of mercury 30 inches high. If we build a chimney 60 feet high, for a boiler 60 inches diameter by 16 feet long, with tubes sufficient for an engine 24-inch cylinder and a 36-inch stroke, the inside flue of the chimney should be at least 24 inches square. A round flue is the best; we have at the bottom of the chimney the atmosphere pressing $2124.7 \times 4 = 8498.8$ lbs. This great weight must be moved before we can reverse the pressure and cause an upward draught, and to do so we must burn some pounds of light fuel, and also to heat the brick in the furnace and chimney; this heat has to be kept up or maintained by the burning of the fuel, beside the heat or energy put into the steam for actual work every minute. I do not wonder at Watt being much surprised to find that his engine did not get more than 25 per cent. of the heat or energy produced from the fuel. The engineers of to-day are complaining of the same thing, and many of them say: "We have brought the engine to a nice appearance for workmanship, economy and usefulness, but the principal part we have so far not handled successfully, viz., how to build in our boilers; are they made of the right stuff and shape, and our chimney," could not some other material be used, mica, or anything that will not give off so much heat? When this 25 per cent. loomed up in Watt's mind, he planned a different shape boiler In one he put two large tubes in a round shell with a fire in each; but he found, if both the fires were not kept alike, it did not do justice to the boiler, and the water inside he then put in one large tube, and put the fire into it, hoping to get more heat into the steam than when the fire was outside, he found it worked better; this plan is now generally adopted in different shapes, but this plan did not, nor does it now, save the large percentage of heat leaving the boiler and going up the chimney to keep out the pressure of the atmosphere and give an upward draught or upward current not to burn, the air or oxygen, as some say, but to change the hot atmosphere and fuel into gas. A large number of new inventions have been made within the last few years, yet we are not perfect, but there is plenty of room for new plans left."

THE CONSTITUTION OF HYDRAULIC CEMENTS.

A series of experiments to determine the constitution of hydraulic cements has recently been made by S. B. Newberry and W. B. Newberry and described in a paper read before the Society of Chemical Industry. The questions which the authors have attempted to solve are as follows:—

1st. What proportions of lime must be employed for given percentages of silica and alumina in a clay? 2nd. Can a general formula be stated, applicable to all clays, which shall indicate the proportion of lime which will give the best result with each? 3rd. What effect has the presence of oxide of iron in the clay used on the proportion of lime required, and on the quality of the resulting cement? 4th. Is the presence of alkalies in the raw materials necessary to the production of good cement? 5th. Is magnesia capable of replacing lime in cement mixtures, or is it inert, as has often been stated, and how does magnesia affect the quality of the cement obtained?

The plan followed in the efforts to solve these questions was that of synthesis with pure materials, which materials were as follows:— 1st. Silica; ground quartz, in impalpable powder, containing 99.19 per cent. silica. 2nd. Alumina; C. P. precipitated, containing 99.50 per cent. alumina, .20 per cent. soda, .05 per cent. iron oxide and .25 per cent. silica. 3rd. Carbonate of lime, precipitated chalk, containing 99.7 per cent. calcium carbonate. 4th. Iron oxide; red, German C. P. 5th. Magnesia; German, C. P., containing only traces of silica, alumina and lime.

All these materials were in the form of a perfectly impalpable powder, and none of them left any residue on a sieve of 180 meshes to the linear inch. Mixtures of these materials, in calculated proportions, were made by rolling backward and forward on a large sheet of paper, then sifting three times through a 60-mesh sieve. The mixtures were then moistened with water, made into a cake, dried and broken into small pieces for burning. The burning was done in a Fletcher gas furnace, using gasoline gas as fuel.

The conclusions to which the writers are led by the above experiments may be briefly stated as follows. 1. The essential constituents of Portland cement are tri-calcium silicate, with varying proportions of di-calcium aluminate. This composition may therefore be expressed by the formula—

$$X\ (3CaO.SiO_2) + Y\ (2CaO.Al_2O_3).$$

From this formula it may be calculated that the correct proportion of lime, by weight, in Portland cement, is 2.8 times the silica plus 1.1 times the alumina. 2. Iron oxide combines with lime at a high heat, and acts like alumina in promoting the combination of silica and lime. For practical purposes, however, the presence of iron oxide in a clay need not be considered in calculating the proportion of lime required. 3. Alkalies so far as indicated by the behavior of soda, are of no value in promoting the combination of lime and silica, and probably play no part in the formation of cement. 4. Magnesia, though possessing marked hydraulic properties when ignited alone, yields no hydraulic products when heated with silica, alumina or clay, and probably plays no part in the formation of cement. It is incapable of replacing lime in cement mixtures, the composition of which should be calculated on the basis of the lime only, without regard to the magnesia present.

—The Government of New Brunswick has placed an order with the Good Roads Machinery Co., of Hamiton, for ten steel Champion road graders. The company is also shipping one of its well known Champion rock crushers, road rollers and engines to the town of Magog, Que.

TO ESTIMATE HORSE POWER.

Editor CANADIAN ENGINEER:

(a) In the question below please inform me in THE CANADIAN ENGINEER why "3" and "2" are used, that is, where they get the "3" and "2" in the text book of which I am studying. The question is: Required the horse power of an engine having one cylinder 30 inches diameter, 36 inches stroke, making 90 revolutions per minute, boiler pressure 75 lbs. per square inch, cutting off at ¼ stroke, vacuum 26 inches, mean effective pressure on piston throughout stroke 50.5 pounds per square inch.

$$\frac{30 \times 30 \times {}^{\cdot}7854 \times 50{\cdot}5 \times 3 \times 90 \times 2}{33000} = 584{\cdot}1234 \text{ H.P.}$$

(b) Does black oil in a boiler destroy the scale, or does it injure it?

YOUNG ENGINEER.

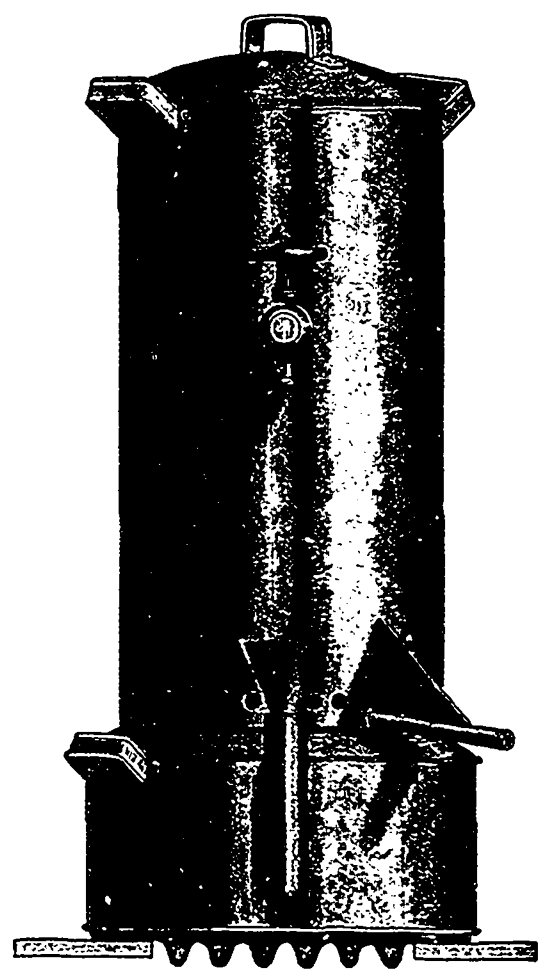
Midland, Ont.

(a) The "3" referred to here by our correspondent is the number of feet in the stroke, and the "2," is the number of revolutions per minute.

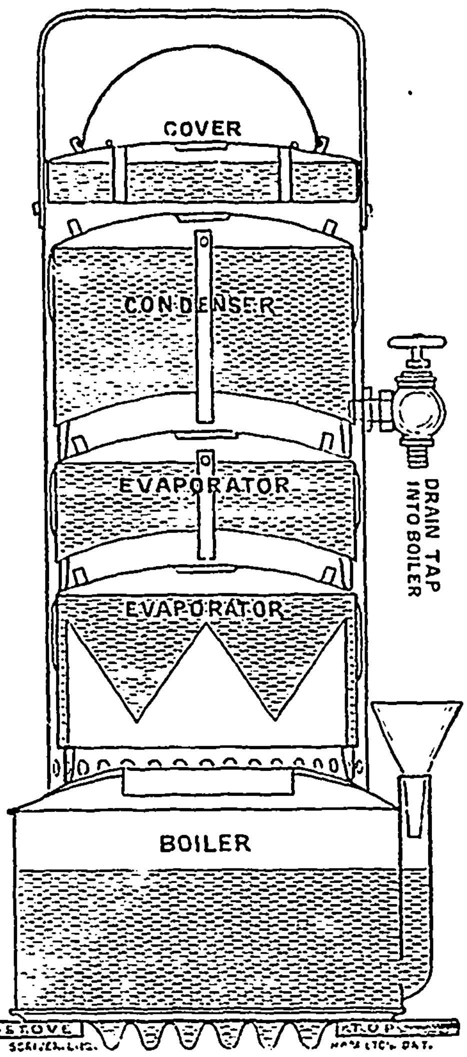
(b) The Boiler Inspection and Insurance Co. does not allow the use of oil as described. We would advise "Young Engineer" to write to some of our advertisers for information on the subject of scale in boilers.

DISTILLED WATER.

The accompanying illustrations show the New-Life Water Still for producing aerated distilled water for drinking, culinary and hygienic purposes. The action of the apparatus is as follows: The water to be operated upon is placed in the lower vessel or boiler, and when boiling is placed on the kettle, and the steam passes into, around and under the evaporators, heating them to nearly boiling point, by which a part of the water they contain is evaporated and is condensed by contact with



the upper vessel or condenser; a constant current of air passing through the holes at the bottom of the condenser is carried up and sterilized by coming in contact with the steam, and, the maker claims, combines with the product, which is pure distilled water, freed from all calcareous, organic and deleterious matter. The water is pleasant to the taste, satisfying, will relieve thirst, and can be borne by a weak stomach when "raw water" is not possible, and being divested of all injurious solids, acts as an absorbent, assisting nature to carry on the natural functions of the system.



The New-Life Water Still is the invention of J. H. Killey, mechanical engineer, Hamilton, and is protected under industrial design No. 1,360, and manufactured by the New-Life Still Co., 37 King William Street, Hamilton, Ont.

ONTARIO LAND SURVEYORS.

The sixth annual meeting of the Association of Ontario Land Surveyors was opened pro forma at the Repository of the Association in the Parliament Buildings, Toronto, on Tuesday, 22nd February, and adjourned to meet at the same place on the 8th March and the two following days. At the adjourned meeting the chair was occupied by T. Harry Jones, of Brantford, president. The attendance was larger than at any of the last three preceding years, and a lively interest in the proceedings was shown throughout.

Meetings of the council of management, board of examiners, and the standing and special committees for the association, year 1897-98, occupied the morning of the first day, the first session of the general meeting being held in the afternoon. The minutes of the previous meeting having been published in the annual report for 1897, the formality of reading them was, on motion, dispensed with Letters were read from C. E. Gauvin, president of the corporation of Provincial Land Surveyors of Quebec; W. F. King, Dominion Astronomer; Capt. E. Deville, Surveyor General; Herbert Wallis, past president of the Canadian Society of Civil Engineers; Professor McLeod, secretary of the Can. Soc. C.E.; also from Joseph Kirk, of Stratford, an active member of the association, now in his 88th year, and from Sandford Fleming, C.M.G. A communication from the mayor of Hamilton, through E. G. Barrow, city engineer, inviting the association to hold its next annual meeting in that city, was also presented, and M. J. Butler and George Ross were appointed a committee to frame a suitable reply thereto. The president then introduced Wm. Hamilton Merritt, who exhibited a field equipment for prospectors, and explained the method of operating it. Its weight being only 27 lbs., it is easily transported, and would serve a useful purpose. The annual address of the president was next read, and a brief account of the history of the association during his term of office therein presented. V. Sankey, chairman of the council, presented the report of the council, including those of the board of examiners and secretary-treasurer, the financial statement being then handed to the auditors for verification. From these reports it was shown that the association had lost nine members by death during the preceding year, and eleven candidates had been admitted to practise at the two meetings of the board of examiners.

Reports of the committees on Publication, and on Repository and Biography, were read by Captain Gamble and H. L. Esten, the president announcing that a suitable album had been procured, and requesting that members who had not already done so would present their photographs to the last-named committee. In the absence of V. M. Roberts, his paper on "Acetylene Gas and its Uses" was read by H. H. Gibson. This paper set forth the advantages of acetylene gas over other luminants. H. D. Q. Sewell then read a paper on "Progress on the Lake of the Woods," being a supplement to a former article which he had contributed.

D. D. James read a paper by V. M. Roberts on "Water Power from the Niagara River," and discussion of various sources of water power in Ontario and Quebec for conversion into electric energy followed the reading.

After referring to a number of schemes of power development, which were more or less visionary, the writer took up the plans of thé Welland Power and Supply Canal Co. to construct a power canal from the Welland River to Lake Ontario. The proposed canal will be fifteen feet deep, one hundred feet wide at the bottom and one hundred and sixty feet wide on the water line, and the slope of its sides and banks two to one, having its intake on the Welland River near the village of Montrose, and will flow through the townships of Stamford, Niagara and Grantham to Lake Ontario, being fed by the Niagara and Welland rivers. The Welland River rises in the county of Wentworth, a few miles south of the city of Hamilton, and flowing through a comparatively level country empties into the Niagara River about two miles above the Falls and is navigable for some thirty miles above its mouth A canal or cut was made some years ago by the Dominion Government from Chippawa, a small village at the mouth of the Welland River, southerly across the northeast corner of the township of Willoughby into the Niagara River, to allow vessels bound for Welland to enter the river without risk, connecting with the Welland Canal at Port Robinson. The current of the Niagara River forces its waters through this cut, and its influence is felt some twelve miles up the Welland River. Seven miles north of the Welland River the canal reaches what may be termed the Bluff, to distinguish it from the Niagara escarpment, of which it forms a prominent and isolated portion; seven miles north of this point is Lake Ontario. Between the point of intake and Lake Ontario there is a difference in elevation of 316 feet, of which 184 feet is available at the Bluff, 66 feet in the vicinity of the Queenston and Grimsby stone road, 33 feet in the vicinity of the Niagara stone road, and 33 feet at or near the mouth of the Eight Mile Creek, every foot of which can easily and with advantage be utilized for the development of power.

The engineering features in connection with this immense undertaking are, for the most part, of an extremely simple nature; difficulties similar in all respects to those which will have to be surmounted, having already been successfully overcome in the construction and maintenance of the new Welland Canal, which lies about two miles to the west, and is a standing proof of the feasibility of the power canal. In the spring of the year when the disruption of the ice which has formed in the Welland River during the winter months takes place, the extremely swift current of the Niagara River, above the Falls, keeps the mouth of the Welland River open and carries the ice away immediately, preventing ice jams. The intake of the canal will leave the Welland River about three-quarters of a mile above Montrose bridge, at such an angle with the river as will afford protection from ice coming down stream, and crossing a small knoll, enters the bed of a creek flowing into the Welland River about half a mile lower down, and follows its course for about one mile and a quarter, thence almost due north across the height of land to the bluff, crossing under the Allanburg cut-off of the Grand Trunk Railway and the St. Catharines and Niagara Central Railway, and over the Great Western Division of the Grand Trunk Railway, thence following the general course of the Eight Mile Creek to Lake Ontario.

The deep cut on the proposed canal will be about 65 feet, the slope of sides of cut and canal will be two to one in earth, and have a batter of one in twelve in rock. A short distance south of the crossing or aqueduct over the Great Western Division of the Grand Trunk Railway a regulating weir will be constructed of first-class masonry. The aqueduct will be similar in all respects to that on the new Welland Canal where it crosses the same railway about one mile to the west, being composed of a masonry tunnel, covered with puddle clay properly tamped and rammed to form the bed and banks of the canal. A storage basin or reservoir and head race will be constructed at the bluff, which presents about six thousand feet of almost perpendicular sides, in the form of a semicircle, down which the water will be conveyed through steel tubes to the turbines. From the bluff to Lake Ontario the cutting will not be heavy, the canal being formed alternately in cut and fill, masonry dams and sluiceways being built at the point of power development.

At the opening of the evening session the president announced that a committee of the Can. Soc. C E. desired to confer with the association, represented by a committee, on the subject of the proposed incorporation of civil engineers in Ontario. Messrs. Sankey, Butler, Niven and Gaviller were then appointed to discuss the matter with the representatives of the civil engineers, and report to the association before the close of the annual meeting An interesting report on "Exploration" was then read by E. Stewart, chairman of that committee, and discussion ensued, after which a paper on "Forestry in its relation to Land Surveying" was read by T. H. Southworth, Provincial Clerk of Forestry, who showed the immense importance of attention to this subject to the future of Canada. His statements were heartily endorsed by several speakers, M. J. Butler adding facts and statistics in support. The Economic Resources of the Hudson Bay District was the subject of a paper by J. W. Tyrrell, whose experience and observation in the far north made him an undoubted authority on many of the particulars as to the wealth of that part of the Dominion, so little known to the great majority of Canadians. Capt. J. D. Williams presented a paper on "Some Causes of Loss in Gold Mining in Ontario"

Wednesday morning session opened with an announcement by the president that the publishers of THE CANADIAN ENGINEER had kindly presented to the association a number of copies of its issue of February, 1898, containing a biographical sketch of Wm. Ogilvie, the most prominent member of the association. A. W. Campbell, chairman of the committee on engineering, then read a comprehensive report of the works which had come under the notice of that committee during the year.

Capt. W. F. Van Buskirk read a paper on the Sewerage Purification Works of Worcester, Mass., and replied to several questions brought up by members in that connection

The capacity of the works is now upwards of 15 million gallons per day, providing for the entire dry weather flow of the sewers. The lime used for precipitation is slaked and mixed with water in two tanks, 8 x 6 feet each, the mixture being agitated by compressed air delivered by perforated wrought iron pipes placed in the bottom of the tanks. The milk of the lime is delivered to the main outfall sewer by an iron pipe entering at a point about 100 feet above the screen chamber. Sulphate of alumina was formerly used with the lime, but was discontinued. The quantity of lime used is about 900 lbs. per million gallons of sewage, or 40 tons per week, at a cost of $6 per ton. This quantity is much less than is generally used, owing to the fact that the sewage of Worcester contains at times large quantities of iron salt from wire works, which is run into separate tanks and used gradually in connection with the lime. After receiving its charge of lime the sewage passes through a screen chamber, where all large substances are removed, thence flows down a mixing channel with rather a rapid fall to the channels between the settling tanks, whence it is directed, along with a small amount of the sewage containing the iron salts, into the various tanks by means of movable flash boards. The sewage passes slowly from one tank to another, the solids in suspension gradually sinking to the bottom, until it reaches the last one in operation, whence it flows out over a weir to a channel which conducts it to the river. The effluent looks bright and transparent, but appears to contain a considerable quantity of lime in solution at times, as the stones with which the outlet channel is paved were coated with lime. From one to three tanks are "cut out" each day, and after being allowed to stand quiet for a short time, the clear liquid is drawn off by means of hinged floating arms from pipes provided with valves passing through the walls of tanks. The sludge deposited in the bottom of tank is then run off to the sludge well through masonry channels located under the sewage channels between the tanks. It is then pumped from the well by a Shone ejector, the air for which is compressed by power from a water wheel driven by the effluent from the tanks of the main outlet. After leaving the well the sludge is deposited on beds, where the water is gradually drained off. The sludge has not been utilized to any great extent, but it is reported to be growing in favor, and presses are being put in which will leave the material in a form that will permit of economical handling or disposal.

Notwithstanding the fact that nearly all of the suspended matter is removed, the town of Millbury entered action a short time ago to compel the city of Worcester to further purify its sewage, and in consequence of such action the city employed Samuel M. Gray and Dr. Drown to make a report on the plant. They have recommended that the effluent from the works be further purified before being discharged into the river, and for this purpose an area of ten acres is being prepared for sand filtration. There is a little doubt, however, whether this will abate the nuisance or not, as the river bed and mill ponds are still covered with the organic matter deposited before the works were put in operation, and during heavy storms since that time when the whole of the sewage was not passed through the tanks. The report above mentioned affords further evidence of the fact that purification by chemicals is an incomplete process and that the lime and organic matter remaining in the effluent may give trouble when discharged into streams and small bodies of water. The experience of Worcester is particularly interesting as being in all respects similar to the experience of England, where it is found that notwithstanding the many improvements in settling tanks and in the methods of applying chemicals, it is not possible to produce effluents of sufficient purity to be discharged into the smaller rivers without causing complaints, and as a consequence the effluents are generally subjected to further treatment by rapid filtration through gravel coke, or some such material. Chemical precipitation, it is true, may in some cases give a degree of purification sufficient for the conditions which obtain, but the writer is of opinion that it will in most cases prove less expensive to treat sewage by rapid filtration through gravel, aided by a current of air and when the conditions demand complete purification, the effluents can be filtered in the ordinary way at a very high rate per acre. It has been shown by experiments conducted by Board of Health of the State of Massachusetts, that rapid filtration through gravel or coke gives an effluent comparable in all respects with that obtained by chemical precipitation under the most favorable circumstances, and has the advantage that the sludge is disposed of, as it is consumed in the pores of the filter. Recent experiments in England confirm the conclusions of the Massachusetts Board of Health, and we may expect in the near future to find many of the chemical plants supplanted by more scientific and less costly methods.

A paper on "Evidence," that mysterious bugbear of candidates for admission to practice as land surveyors, was presented by M. J. Butler, whose training and practical experience in this connection fitted him to the task, and in the subsequent discussion it was suggested that Mr. Butler prepare a text-book on the subject, so far as it related to land surveying.

Sudbury waterworks was the subject of a paper prepared by L. V. Rorke, and, in his absence, read by D. D. James. This paper formed a valuable addition to the collection of articles on waterworks already published in the annual reports. Professor C. H. McLeod, secretary of the Canadian Society of Civil Engineers, having arrived from Montreal as a representative of that body, was welcomed and introduced by the president. The report of the Committee on Polar Research was read by J. W. Tyrrell, chairman.

The first order of business for the afternoon session was a paper by Jas. Hutcheon on "Specifications," containing many valuable hints.

A. P. Walker then read his paper on "The York Street Bridge," extracts from which appeared in the last issue of THE CANADIAN ENGINEER. "An Illustration of the Necessity for Accurate Descriptions" was the subject of a paper by George Ross, who gave the history of an important question of title to lands at Point Abino, Lake Erie, which had been the cause of much litigation. P. S. Gibson, well known to all surveyors admitted within the last thirty years, next read a paper on "Assessment Plans," describing the requirements of such plans and exhibiting a specimen sheet of a set recently prepared by him for the township of York.

The report of the Committee on Land Surveying, with Question Drawer, was presented by M. Gaviller, chairman, with answers to several knotty points sent in by members who appreciated the advantage of having an advisory board of experienced practitioners, whose duty it is to give the benefit of their opinions to any who seek them. A list of cases compiled by M. C. Schofield, an active member in the 80th year of his age, after 55 years of practice, was referred to the incoming committee for classification, and a question as to the position of shore or bank of a lake or river from which a road allowance is laid off, was also held over. The report of the Standing Committee on Topographical Survey was read by L. B. Stewart in the absence of the chairman, Otto J. Klotz. This committee continues its work, notwithstanding the lack of present results, but its efforts will eventually be crowned with success. M. J. Butler presented a description of sand cement, the product of recent improvements in manufacturing methods. This paper may be more fully discussed in a later issue. The evening was devoted to the annual dinner, that function which has done so much to promote a closer acquaintance among individual members, and which this year eclipsed all previous occasions in point of attendance and enjoyment.

The session of Thursday morning opened with the presentation of the report of auditors, which was read by H. L. Esten. A paper on the Kinburn Swamp Drain, prepared by F. W. Farncomb, was read in his absence by the secretary, and described a case where the judicious investment of a few thousand dollars had resulted in the reclamation of waste lands, the value of which had amounted to several times the amount of the sum expended H J. Bowman read a paper entitled Arbitrators and Witnesses, dealing with the respective attitude which should be taken by each. In the absence of W. M. Davis, his paper on "The use of Field Tile for Large Drains," was read by A. S Code The writer showed the superiority of tile drains for several reasons The following table gives approximately the comparative cost of open and tile drains of various depths.—

COST PER ROD.

Depth.	Open Drain.	Field Tile 6 in.	8 in.	10 in.	12 in	14 in.	18 in.
3 feet	$1 08	0 90	1.20				
4 "	1 80	0 96	1 26	1.86	2.19	3 00	
5 "	2 52	1 27	1.60	2.00	2 40	3 60	5.00

It would appear from the above that for depths up to 5 feet, and for sizes of tile up to 12 inches, the tile drain has the advantage, considering only first cost, and taking all things into account field tile of any size capable of carrying off the water, and for any depth, are cheaper than an open drain. In deciding on the size of tile it is not necessary to provide a capacity that would be ample for a culvert, neither is it safe to calculate on a drain having twelve months in which to dispose of the annual rainfall In this latitude a rainfall exceeding one inch in twenty-four hours is exceptional, so that this quantity may reasonably be taken as a basis for our calculations. Not more than one-half the rainfall can be depended on to reach the trunk drain, a proportion which decreases as the area of the watershed increases. If the water can be removed within forty-eight hours, as a rule, no damage to the crops will result, therefore a trunk drain that will convey about 900 cubic feet of water per acre in twenty-four hours will be ample for ordinary drainage; lateral drains will require a greater capacity depending on the facility with which the rainfall reaches the tile.

Tile over twelve inches in diameter should not be less than two feet in length, as they can be laid more evenly; they should be particularly well burned, and moulded from the toughest clay; many qualities of clay, which make fair tile of small size, are totally unfit for hose of large diameter The thickness should increase from one inch for 12-in. tile to 1¾ inch for 18 in. tile Two factors of vital importance in drainage are perfect alignment and grade, the curves should not have a less radius than 60 feet An accurate grade can best be obtained by means of "boning rods;" that is, by placing two bridges across the trench about 300 feet apart, the tops being adjusted so that a line joining the top of one with the top of the other will be parallel with the grade line. A rod equal in length to the distance of this line from the grade line is then used to obtain the exact elevation of each tile; this method is especially advantageous when working in quicksand. Catch basins or manholes should be placed about 1,000 feet apart to admit of easy inspection of the drain; they should have a pit 18 inches below the grade line for the purpose of intercepting sand; they also provide a convenient means of connecting lateral drains Wherever possible, these catch basins should be placed at crossings of fences.

In accordance with the usual practice, the report of the committee on entertainment was taken as read, and ordered to be printed in the annual report. Professor McLeod addressed the association on the subject of proposed incorporation of civil engineers in Ontario, and explained its objects and its relation to the position occupied by land surveyors The discussion on the report of council was begun, and lasted the remainder of the session. In the afternoon the discussion on the report of council was continued, and by-laws numbers 45 and 46 were ratified. Under motions, the papers on "Unrecorded Original Field Notes," by J J. Murphy, and "Lake Erie Survey," by Otto J. Klotz, also the report of the committee on drainage, were taken as read, and ordered to be printed in the report.

Since the date of the meeting the balloting for the election of officers for the ensuing year has resulted as follows:—

President—P. S. Gibson, elected by acclamation.
Vice-President—H. J. Bowman "
Sec.-Treas.—T. G. Van Nostrand "
For Council of Management—F. L. Foster and J. L. Morris.

The report of the committee appointed to confer with representatives of the Can. Soc. C.E., was presented by Major Sankey. A cordial vote of thanks was tendered the retiring president for the manner in which the duties of that office had been fulfilled by him, after which the meeting adjourned.

MANUFACTURE AND USE OF SAND CEMENT.

The following extract from a paper by C. B. Smith, McGill University, Montreal, was read by the author at the recent meeting of the Canadian Society of Civil Engineers in Montreal:

The use of sand cement has increased in Europe, and particularly in Denmark (where it was invented), during the past five years, and it has been tested by several American engineers, with satisfactory results, and has been used in the proportions (1 to 1) to 3, in the concrete for the foundations of St. John's Cathedral, New York, in which 3,000 yards were used, and in other places.

The advantages claimed for the material are, that where great strength is not required, mortars will be more dense, stronger, and will work more smoothly on the trowel, in which a portion of the sand has been ground together with the cement, before use in the mortar Another claim is that the cheaper grades will replace lime mortar in plastering, as it will set and dry quicker, and also, again, that in dock walls a very dense concrete can be produced which will prevent the destructive percolation of sea water.

Tests made at St. John's Cathedral foundations gave the following results:—

(1) Sand cement (1 to 1) Concrete. 2 sand 3 gravel		Compression. 1 week—2,144 lbs. per sq. in. 2 weeks—2,312 lbs. per sq. in. 4 weeks—2,588 lbs. per sq. in.
(2) Sand cement Mortar.	(1 to 1) sand cement 3 sand.	1 week's tension 156 lbs. 2 weeks' tension 188 lbs. 4 weeks' tension 200 lbs.
(3) Portland cement. Mortar, 1,500 bbls.	1 cement. 3 sand.	1 week's tension 137 lbs. 2 weeks' tension 170 lbs. 4 weeks' tension 179 lbs.

The paper concluded with a description of the plant at Glen Falls, N Y., where tube mills and flint pebble balls are used in grinding, and a statement that the American sand-cement output is ground very fine (5 per cent. residue on 180 mesh sieve), the tests will show higher results than those in the table which is added, giving tests made in Europe on sand cement mortars of various proportions.

The usual proportions in America are (1 to 1) and (1 to 6), the former competing with Portland cement and the latter with lime.

(The manufacture of sand cement has been begun in Canada by the Rathbun Co., of Napanee Mills, and the St. Lawrence Cement Co., of Montreal)

EXTRACT FROM EUROPEAN TESTS IN GERMANY AND DENMARK.

TENSILE (WATER).

Mortar.	1 wk. lbs.	4 wks.	3 mos.	6 mos.	1 year.
(1 to 2) to 2......	142	242	299	384	400
(1 to 3) to 2......	114	185	228	271	326
(1 to 6) to 2......	57	114	156	..	220
(1 to 12) to 2......	43	114	128	157	142
(1 to 24) to 2......	28	57	57	57	57

COMPRESSIVE (WATER).

Mortar.	1 wk. lbs.	4 wks.	3 mos.	6 mos.	1 year.
(1 to 2) to 2......	1,080	1,795	2,148	2,578	3,365
(1 to 3) to 2......	497	1,080	1,637	2,008	2,485
(1 to 6) to 2......	200	384	667	....	1,050
(1 to 12) to 2......	171	384	726	796	866
(1 to 24) to 2......	128	270	370	370	383

TESTS ON SAND CEMENT.

MADE IN M'GILL COLLEGE LABORATORIES

(a) (1) Iron-clad brand Orlen Falls (1) Sand:—

	Tension. 1 wk.	Tension. 4 wks.	Compression. 1 wk.	Compression. 4 wks.
Neat.	475	602	3,380	4,650
(1 to 1) to 3....	73	105 pressed.		
(1 to 1) to 3....	..	185 rammed.	1,060	1,120 rammed.

Blowing test good residue 1.5 % on No. 100 sieve.

(b) (1) Aalborg, Denmark. 1 Sand (Cathedral brand).

(1 to 1) to 1	279	398	1375	2012
(1 to 1) to 3	44	66	..	300

This is from a barrel which was supposed to be damaged.

Residue 1.2% on No. 120 sieve. 0.7% on 100 sieve.

" 18 0 % " 180 "

(c) (1) Star (Rathbun). 1 Sand (Ensign brand).

4 months, 800 lbs.

Neat.	1 wk.	2 wks.	1 wk.	2 wks.
(1 to 1) to 3..	66	95 pressed	..	400 pressed.
(1 to 1) to 3..	183	192 rammed	..	880 rammed.

Residue 0.6% on 100 sieve.

" 1.0% on 120 "

(1) Star (Rathbun). 6 Sand (Jubilee brand).
4 months, 340 lbs.

Neat.	1 wk.	2 wks.	1 wk.	2 wks.
(1 to 6) to 1..	213	230 pressed.	..	1350 pressed.
(1 to 6) to 1..	242	292 rammed.	..	2112 rammed.
(1 to 6) to 2..	184	215 "	1225	.. "

0.3% residue on No. 100 sieve.
1 3% " " 120 "

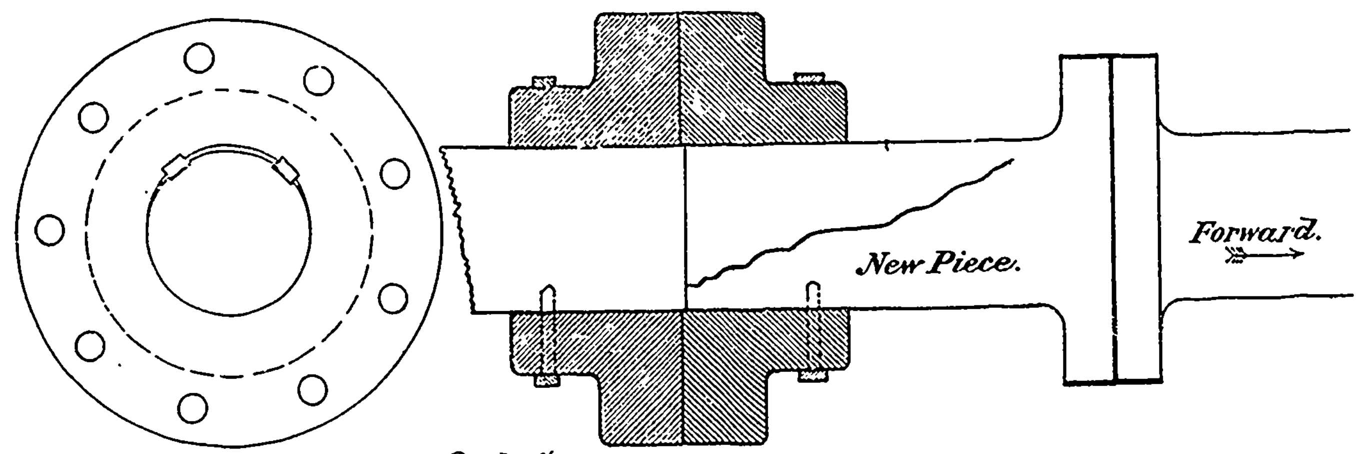
(1) Star (Rathbun). 1 Sand (Citadel brand).

	Tension.		Compression.	
Neat.	1 wk.	4 wks.	1 wk.	4 wks.
(1 to 1)......	332	475	1800 (!)	3837 •
(1 to 1) to 3..	135	141 rammed	470	687 rammed.

0.2%, residue on 100 sieve.
0.5% " 120 "

REPAIRS TO S. S. MONARCH.

The accompanying sketch illustrates the method devised by Wm. Golding, consulting engineer to Lloyds Surveyors, at the port of New Orleans, L. A., for repairing the fractured shaft of the steamship Monarch, which vessel cleared from that port on the 25th of November last, for Liverpool, carrying one of the largest cargoes ever taken from an American port, consisting of 22,535 bales of cotton 60,000 bushels of grain, 11,200 sacks of meal; 29,068 staves and 242 head of cattle Soon after sailing, a fracture developed in one of the 8 sections of the tunnel shaft, necessitating the return of the vessel to New Orleans, where she arrived without assistance on the 30th of November, 1897. To renew and remove the shaft would require several weeks' time, necessitating the removal of a large portion of the large cargo. It was therefore decided in the interest of a l concerned, to repair the shaft in place, and make the renewal at port of destination.



Scale 1/16 Full Size.

As shown in the sketch, the shaft was cut off in place, while the vessel lay at anchor in the river, the new piece was forged, turned and fitted; the large coupling cast, bored and turned, and the entire work completed in less than 12 days after the vessel's return; the success of the undertaking is attested by the arrival of the vessel in due time, at port of destination. The value of vessel and cargo was estimated to be $1,250,000.00

PROSPECTOR'S OUTFIT.

Editor CANADIAN ENGINEER:

A frend of mine who intends to go prospecting before long through the Omenica district, asks if it would be advisable to take an inexpensive outfit for testing ores, with a suitable textbook on same.] He knows nothing whatever of analysis or assaying. Will you kindly give me your opinion on the matter, and if you think it would be judicious for him to take an outfit such as mentioned above, what would it need to consist of and what work on the matter would you recommend as the most suitable, that is to say, the simplest and most practical? By giving information asked for you will greatly oblige

Yours truly,
SUBSCRIBER.

British Columbia Southern Railway,
Wardnor, B.C., 5th April, 1898.

[ED.—We would advise your friend to secure a copy of either "Gold and Silver Ores," by W. Hamilton Merritt, or "Pocket Mining Manual," by J. H. Chewett, both of which will be found in the book list on page III. of this paper. The following is a list of articles required for field work, it being taken for granted that the prospector is already in possession of a rough knife for scratching minerals, a pocket compass and a small magnifying glass:—

Sampling—1. "Mixing cloth," or smooth waterproof sheet, 4 feet square. 2. Brush, broad (varnishing brush). Panning—3. Gold-pan, Russia iron (not to be used with quicksilver) 4. Iron mortar, 5 in. by 6 in., and pestle. 5. Sieve, brass wire, 40 mesh, in tin dish with cover. Pan-Amalgamation.—6. Two gold pans, one ordinary iron, the other graniteware. 7. Nitric acid, strong, in 2 oz. glass-stoppered bottle. 8 Mercury, 1 lb. in bottle. 9. Sodium, ⅛ oz. in bottle, with naphtha. 10. Hand-scale, "Traveler's letter and parcel balance," weighing ¼ oz. to 12 ozs., for weighing mercury and pulp. 11. Balance, hand scale with sliding weight on beam, very sensitive, from 0 1 to 5 grains, for weighing beads of bullion and weighing out charges for quantitative blow-pipe assay. 12. Mercury retort, small, Russia sheet-iron 1½ x 1¾ inches, or small cast iron retort, with cover and pipe to collect mercury. Also sheet of Russia iron 8 inches square (with hole for supporting the Russia iron retort in the centre) for quartering when sampling. 13. Porcelain dish, and porcelain thimble, small, for parting in. 14 Graniteware cup and saucer, small size. 15. Brass wire sieve, 60 mesh. 16. Wooden pestle. 17. Sheet lead, pure, 2 ozs. 18 Sheet silver, pure, ⅛ oz. 19. Borax glass, ground, 1 oz., in deep round tin box. 20. Soda, 1 oz, in deep round tin box. 21. Litharge, 4 ozs., in deep round tin box. 22. Bone-ash, 2 ozs., in deep round tin box. 23. Paraffine lamp, tin, with ⅛ lb. paraffine 24. Blow-pipe. 25. Two clay pipes, one mounted for cupelling, the other for heating mercury. 26. Charcoal, 3 pieces, sawn square. 27 Pincers for small buttons. 28. Steel anvil, ¼ x 1½ x 2 inches. 29. Small piece thin asbestos card. 30. Hammer, small. 31. Magnet. 32. Smooth-headed bolt, for making cupels in clay pipe. This outfit will determine the value of free milling ores as low as of any economic value, it will enable the proportionate yield in concentrates to be qualitatively tested as to their precious metal contents. Quantitative determination of concentrates outfit. 33. Plattner's ivory button scale. 34 Clay crucibles, 1 doz. 35. Clay capsules, 2 doz. 36. Fletcher's blow-pipe furnace with side hole. 37. Camel-hair brush. 38. Flour, ¼ oz (?) in tin box. 39. Methylated spirits, ¼ pint. 40. Common salt, fine, ½ oz, in tin box. 41. Nitre, ½ oz., in tin box. 42. Spirit lamp, tin. With the above mentioned outfit free-milling ores can be tested, and value determined as low as $1.50 per ton for gold ores, and much lower for silver ores, if desired. Also the value of the concentrates, or of melting silver ores, can be approximately estimated. The weight of the outfit is about 20 lbs.]

CO-OPERATIVE SETTLEMENT.

Editor CANADIAN ENGINEER:

SIR,—The prospect of early work on the Georgian Bay and Ottawa Ship Canal, together with the agitation for a railway to James' Bay, give point to a suggestion I made regarding a co-operative settlement by men of intelligence and some financial means. I know a point where these enterprises must intersect, if the shortest route, with the best land adjacent, are considered important. The shore of the Georgian Bay is rockbound round the north, and admission must be sought where a bay or navigable river penetrates the coast range of granite or Huronian mountains. Spanish River, Parry Sound, Cutler and Thessalon, are examples of such entrances; while French River, White Fish, Blind and Mississagrea Rivers are barred by falls at their mouths. Now a navigable bay, penetrating to the arable land, and accessible in all weathers, is a very desirable point from which to start a colonization road. If, in addition, unlimited water power, cheaply controlled, be added, with a choice of routes through good country for

50 miles to form a Hinterland, then I hold an ideal location will be selected. The port and settlement would be on Laurentian territory, with iron, mica, granite, galena and gold, as minerals to be expected; its rear would be the contact with Huronian, on the same lines as the Wahnapitae gold formation. The probabilities would amount almost to a certainty, that paying mines would be one of the assets of the colony; that the port would be a distributing point on the James Bay railway; and that a good farming background would give stability and weight to the commercial, manufacturing and mining features of the enterprise.

As suggested before, an electric railway to progress with the onward wave of settlement, should be a prominent feature. Supposing Sudbury to be the first objective point on the James Bay route, our line would run obliquely to N. E. of it, and act as an auxiliary rather than a rival. While the first cut of pine has been taken off the district, the hardwood, pulp timber and bark is yet untouched, and might amount to a valuable consideration. A company with, say, 1,000 shares of $100 each, to be sold at par only, and employing only shareholders (if enough offer) to do the work; with no speculators, and no drones, with a store at which all supplies are furnished at cost; and with all mechanical appliances furnished by the members at special rates, with electric light, power, carriage, and even board, at rates to meet actual outlay, the conditions of settlement would be so much superior to the general conditions of pioneers that colonization would be shorn of its chief discomforts. If you could leave the crowded streets, vile odors, competitive battle, dress parade, and taxes of city life; but carrying school, church, library, literary and musical socials with you, into a healthier climate, with more profitable employment, abundant fuel, fruit and flowers—in short a natural life—who would hesitate to embark in it? You cannot choose your company in city life—you may in the country.

Homo Senex.

THE DOMINION ESTIMATES.

RAILWAYS.

Intercolonial Railway—		
Sundry improvements	$280,600	
Extension to Montreal, to pay rental to Grand Trunk Railway Company for railway from Chaudiere to Montreal, to be operated as part of the Intercolonial Railway	210,000	
		$490,600
Prince Edward Island Railway—		
Improvements		18,500

CANALS.

Soulanges Canal—Construction	1,610,000
Cornwall " enlargement	160,000
Farran's Point "	325,000
Rapide Plat "	250,000
North Channel, straightening and deepening	50,000
Galops "	1,275,000
River Reaches	50,000
Lake St Francis, removal of boulders, etc.	50,000
Trent	603,200
Sault Ste. Marie—Construction	45,000
Lachine	155,000
Lake St. Louis Channel, straightening and deepening	65,000
Grenville—Enlargement	40,000
Williamsburg Canals	9,000
Murray Canal	1,000
Rideau "	875

HARBORS.

Nova Scotia—	
Various wharves and breakwaters	38,900
Prince Edward Island—	
Piers, wharves, etc.	40,650
New Brunswick—	
Wharves, dredging, etc.	43 200
Quebec—	
Piers, breakwaters, wharves, dredging, etc.	97,700
Ontario—	
Wharves, dredging and piers	234,200
Manitoba—	
Repairs, improvements, etc.	28,000
North-West Territories—	
River and bridge work	5,000
British Columbia—	
Improvement of channels, etc.	51,500

PUBLIC BUILDINGS.

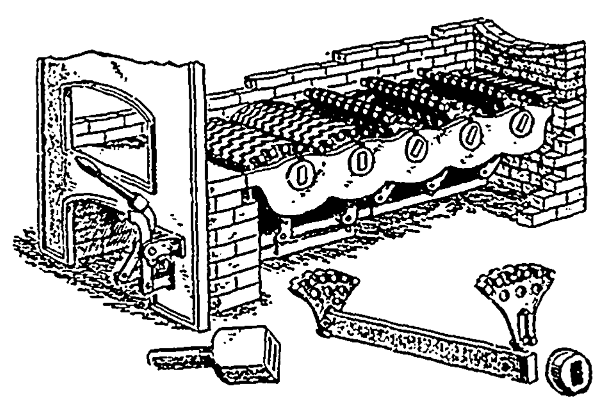
Nova Scotia—	
Halifax drill hall	18,000
Kentville public building	5,000
Liverpool "	5,000
Ontario—	
Kingston drill hall	10,000
Sarnia public buildings	5,000
Manitoba—	
Portage La Prairie post-office	8,000
British Columbia—	
Victoria public buildings	16,000

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

The eleventh annual dinner of Hamilton No. 2, C.A.S.E., was held in the Commercial Hotel, April 7th. There was the usual large attendance, and the evening passed most pleasantly. The menu was excellent, and was done full justice to before the toast list was presented by the chairman, R. Mackie. During the evening music was interspersed by Messrs. Jardine, the Eleon Club, J. R. Dixon, Stanley, Hastings, A. Child, W. G. Blackgrove, F. Mitchell, and D. Marentell. J Bain acted as accompanist. The dinner committee was R. Mackie, chairman, Joseph Ironside, secretary; P. Stott, W. R. Cornish, W. Stevens, R. E. Chillman, R. C. Pettigrew. The toast list was as follows. The Queen, Canada our Home, responded to by A. Hartwell; Mayor and Corporation, responded to by Alds. Hernside and Pettigrew; Manufacturers, responded to by J. McGlauchlin, of Toronto; Educational Interests, responded to by J. S. Williams; Executive Head, responded to by E. J. Philip, A. M. Wickens, of Toronto; Sister Associations, responded to by Messrs. Mooring and Dixon, of Toronto; Hamilton No. 2, responded to by R. Mackie; The Ladies, responded to by A. P. St. John; Host and Hostess, responded to by Messrs. Moxey. A pleasant feature of the evening was several selections by the gramaphone, operated by Mr. Morrice.

ROBERTSON'S SHAKING AND DUMPING GRATE BARS

The shaking and dumping grate bars of which the accompanying engraving gives an idea are manufactured by Jas. L. Robertson & Sons, 204 Fulton St., New York, who are successors to the Heine & Robertson Co. The firm is very favorably known to the trade, not only in the United States, but in Canada as well. The makers state that nearly seven years use,



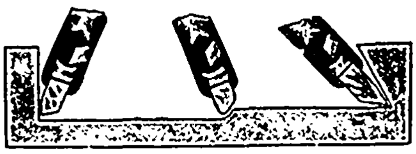
under conditions of unusual severity, has demonstrated their efficiency and durability, and the recent changes in design, tending to greater strength, enable them to promise even more satisfaction in the future. The grate is composed of a series of replaceable leaf castings, a best quality wrought iron cross bar, protected from the heat, and durable bearings in which, it is claimed, friction is reduced to a minimum. Frames for seven sections and under are made without truss.

L'ASSOCIATION DE SECOURS MUTUELS DES INGENIEURS MECANICIENS.

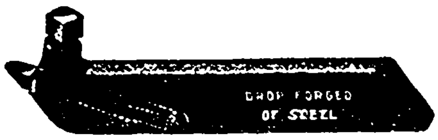
This association held its annual meeting on the 25th ult. under the presidency of Ephrem Valiquet. Associated with him were Louis Gayon, Factory Inspector; Alex. Bonin, Prof. at Laval University; J. A. Rodier, and the association's legal adviser. The election of officers resulted as follows: President, Ephrem Valiquet; 1st Vice-pres., Henri Beauchamp; 2nd Vice-pres., Mathis Guimond; Treas., Wm. Gendron; Fin. Sec., Eteinne Leroyer; Corresponding Secretary, Alex. Blair; Asst. Sec., Jos. Guimond; Trustees, Magnus Lessard, Arthur Coulombe, Alphonse Provost; Conductor, Arthur Alix; Door-keeper, Telesphore Leclaire; Employment Agent, Ephrem Valiquet; Delegates, Gendron, Denis, Coulombe. After the elections many good speeches were made, tending to emphasize the fact that the objects of the association were mutual benefit and improvement, not what is understood as labor organization in any form.

INTERESTING TO LATHE OWNERS.

A practical substitute, of self-hardening steel, for forged tools for general lathe and planer work, especially adapted for economical use, is shown in the accompanying cuts. These tools possess, the makers claim, all the good points of a forged



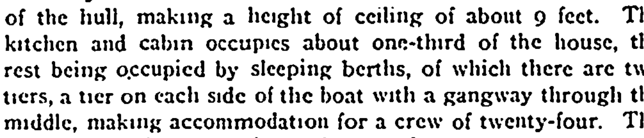
tool, and are made in variety of sizes in straight right and left hand offset, and in the form of a boring bar. The makers claim a saving of 90 per cent. tool steel, that is, one pound of steel used in a holder will do the work of 10 lbs. used in the old way, and also a saving of 70 per cent. in grinding. The Goldie-McCulloch Co., McClary Mfg. Co., Toronto Electric Motor



Co., Bertram & Sons, J. J. Stevens, and many other leading Canadian manufacturers, have adopted these tool holders. Further information can be obtained from the Aikenhead Hardware Co., Toronto.

AN OTTAWA RIVER HOUSE BOAT.

Bannerman & Findlater, manufacturers of boilers, etc., Ottawa, who recently moved into their new premises, which were rebuilt on a larger scale after the fire of last year, have recently turned out an interesting job in the shape of four lumbermen's "house boats," for the Upper Ottawa Improvement Co. These are the first iron house boats built in Canada, two of them being for use at Quio (Chats Lake), and two on the Ottawa, at Pembroke. These boats—a diagram of which is given herewith—are scow-shaped, each 51½ feet long over all, with a keel of about 42 feet; 12 feet wide at the top, and 11 feet



across the bottom and 3 feet deep. The bow tapers to an extent of about 6 feet, and the stern 4 feet. The keel is formed of a piece of timber 7 inches deep and 6 inches wide, and is protected by an iron shoe. The house stands 6 feet above the top of the hull, making a height of ceiling of about 9 feet. The kitchen and cabin occupies about one-third of the house, the rest being occupied by sleeping berths, of which there are two tiers, a tier on each side of the boat with a gangway through the middle, making accommodation for a crew of twenty-four. The house is clap-boarded with an iron roof.

NEW PLANT FOR THE WAR EAGLE MINES.

The War Eagle Cons. Mining & Dev. Co., of Rossland, B.C., have just closed a contract with the James Cooper Mfg. Co., Limited, Montreal, for a Duplex Ingersoll-Sergeant Air Compressor, and a 300 horse power Electric Hoisting Engine. The compressor is a Duplex machine of the latest type having two 24¼" by 48" air cylinders, and is ample at normal speed to furnish sufficient air for 50 drills. It will be operated by a 500 horse power motor, and in place of belting, 22 cotton ropes will be used to drive the machine. As an evidence of the size of this machine, it may be stated that the fly wheel is 20 feet in diameter and will weigh, when finished, about 25 tons. Mr. Mills, the Consulting Mechanical Engineer for Mr. Gooderham, after an extended tour through the mining districts of Montana, California and British Columbia, and after making exhaustive tests of the efficiency of the various types of compressors, decided to adopt the piston inlet type of machine as being the most economical. The hoisting engine, which is to be operated by electricity, is of 300 horse power, and has double drums arranged for two-compartment shaft, and is capable of hoisting from a depth of 3,000 feet, the normal working load being 8 tons, and the speed 1,000 ft. per minute. The motor for the hoisting engine is of the induction type, and can work up to 600 h.p. It is reversible and can run at any speed up to synchronism. Not only will the compressor be the largest machine ever built in Canada, but both the compressor and hoisting engine will be the largest machines on this continent operated by electricity, and it speaks well for the enterprise of Rossland mines, that they are foremost in the field of up-to-date machinery. The motor for the compressor is a 400 h.p. synchronous machine and will run at 200 revolutions per minute. The electrical equipment is being furnished by the Canadian General Electric Co., of Peterboro, Ont., and the machinery when completed will aggregate about 15 carloads. The plant is to be delivered on cars in ten weeks from receipt of order, and should be on the ground inside of three months. The power will be derived from the works of the West Kootenay Power Co. The War Eagle mine has now been proved to a depth of 625 feet, giving an estimated amount of ore in sight of $3,500,000. In one place the vein is exposed to a width of 50 feet, giving an average assay of $25. The force of miners is to be increased to 50 men.

CANADIAN ELECTRICAL ASSOCIATION.

At the last meeting of the Executive Committee of the Canadian Electrical Association, it was decided to hold the convention on Tuesday, Wednesday and Thursday, the 28th, 29th and 30th of June, in Montreal. The headquarters of the association during the convention will be at the Windsor Hotel, where the business sessions and the annual banquet will be held. The draft programme, recommended by the local committee of arrangements, with some slight amendments, was adopted, and is as follows:

First Day.—Executive meeting 9.30 to 10 a.m.; session, 10 a.m. to 1 p.m.; session 2 to 5 p.m.; 7.30 p.m., trip round Mount Royal by special Park and Island cars, afterwards ascending Incline railway, to lookout on mountain to view the city under illumination.

Second Day.—Session, 9 to 12, noon; cabs and busses from Windsor Hotel at 1 p.m. to visit: (1) Bell Telephone Company's new building; (2) Street Railway Company's power house; (3) power house and works of the Lachine Rapids Hydraulic & Land Co., returning to city at 7.30 p.m.; 9 p.m. annual banquet of Association at Windsor Hotel.

Third Day.—Session, 9 to 12 a.m., election of officers and visit to McGill University; 1.30 p.m., visit to Royal Electric Company's lighting station and factory, then by special G.T. train to visit the works of the Chambly Manufacturing Company at Chambly.

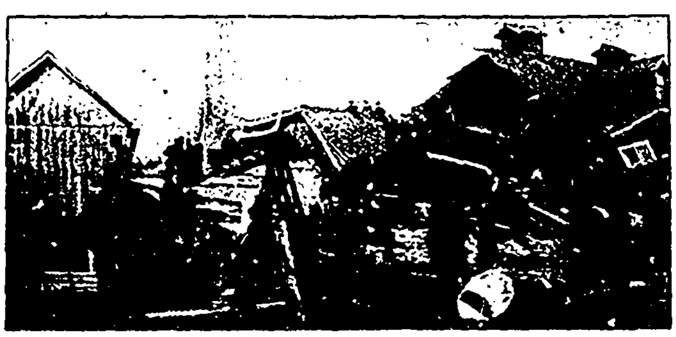
A number of very interesting and instructive papers relating to various phases of electrical work have been promised and are in course of preparation. Negotiations are in progress with the object of securing special transportation rates to enable a large number of the western members to participate in the proceedings of what will undoubtedly be a very pleasurable and instructive occasion.

THE E. & D. WHEEL.

The factory of the Canadian Typograph Co., manufacturers of the celebrated "E. & D." bicycle, is pushed to its full capacity. The Globe, in a recent notice of this wheel, says: "The bearings of this bicycle were invented in Canada in 1895, by Canadians, and the wheel is built only in Canada and exported throughout the world. It is the first and only Canadian bicycle that has successfully entered the United States market, and Canadians have a particular reason for feeling proud when it is known that this wheel commands a higher price than any wheel in the United States, and that it is sold there at an advance of from $15 to $20 above its price in Canada. Perfection of movement has always been the particular theme of this company, and they have every reason to feel proud of the reputation they have gained in so short a time by their wonderful hub. We are informed that they have never yet supplied a cone or ball for this bearing, nor ever been asked to replace one. They defy their competitors or others to show a cone out of their wheel, no matter how long it may have been in use, that shows the slightest indication of wear. They also challenge the public to destroy one of their bearings or to make it bind, no matter how tight it may be screwed up. The wheel is guaranteed to run the year without being oiled or cleaned, no matter how many miles it is ridden, or how much dirt is encountered. The bearings also are guaranteed against wear for three years. They never require to be adjusted or interfered with. The Typograph Company has a special model this year, which includes the Doolittle automatic brake. Simple back pedalling applies the brake, and when once applied, the foot can be removed and the brake remains, while forward pedalling immediately releases the brake, so that the rider has complete control of his wheel, whether his foot is on the pedal or not. This model also includes a new gear case, composed of aluminium and celluloid. It can easily be removed and leaves the chain and sprockets at all times exposed to view. It is also so arranged that the back wheel can be adjusted without in any way disturbing the case.

BOILER EXPLOSION AT ORILLIA.

The boiler at Miller's tannery, Orillia, Ont., exploded on Good Friday evening, wrecking the building and causing damage to the extent of over $5,000. At the close of the holiday, the fireman, thinking to get an early start in the morning, filled the furnace with wood ready for lighting and in that condition left the place. It is supposed the wood took fire from the heat of the bricks from the previous firing, and that the safety valve had become stuck, preventing any release of steam. An idea of the wreck may be gained from the accompanying illustration. Two fragments of the boiler narrowly missed a train passing at the time. The crown of the boiler went through a barn a great distance from the scene, and the angle at which it struck



the building showed that it must have been thrown at least half a mile high. In view of the terrible treatment received by the crown, at the hands of the steam fury, it is remarkable how gently it handled the window sash shown in the left foreground of the picture. This sash was used as a skylight, and was fixed in the roof right over the boiler. This sash was found after the explosion in the position shown, with not a single pane of glass broken. The mere concussion of air broke the glass in several houses near by, and how this window sash with all its contents passed through the explosion unshattered is a phenomenon. One theory is that it was lifted as on a cushion of steam, and so let down flat to the ground. Even so, its safe descent is remarkable, and how it was torn out of its frame, in the first place, without breaking the glass, is still more remarkable.

It is decided that Agincourt is to be the location of the instrument of the Magnetic Observatory now in the Queen's Park, Toronto. William Menzies will be in charge. The building to be erected will consist of a circular stone underground chamber of some 30 feet in diameter, topped by a brick structure for the making of absolute determinations. In the underground room, the needles of vertical force, horizontal force and the declinator will make photographic records of the earth's magnetic currents. The new building, it is estimated, will cost in the neighborhood of $4,000, and that the utmost care will be exercised in its erection can be seen from the fact that every stone put in the walls must be tested to ascertain that it contains no iron to disturb the delicate working of the magnetic instruments within.

Industrial Notes.

Belleville, Ont., will buy a road roller.

The new high school, at Fergus, Ont., will probably cost $5,000.

St. Thomas, Ont., will spend $36,000 on school buildings this summer.

The town of St. Cunegonde, Que., wants another bridge over the Lachine Canal.

Tenders are called for the Victoria Hospital, London, Ont., which is to cost $70,000.

A Y.M.C.A. building, to cost $6,000, is to be built in St. Catharines this summer.

Knox Church, Stratford, Ont., is to be altered and remodelled at a cost of $7,000.

R. F. Watts, Ottawa, Ont., is said to have invented a new roller boat which is rectangular in shape.

Sarnia, Ont., proposes to bonus a paving brick manufactory which would use shale from Alvinston, Ont.

Sheldon & Son, of the Aylmer, Ont., Iron Works, have received a large order for windmills from Australia.

J. Bloom, who ran a sawmill at North Glencoe, Ont., was killed by falling on the circular saw, March 31st.

The I.O.O.F. will build a town hall in Essex, Ont., one flat of which is to be leased by the town at $300 per year.

Lefebvre & Co., St. John's, Que., are putting an acetylene gas machine into their vinegar and canning factory.

Park, Blackwell & Co., Toronto, have decided to erect a new pork packing establishment. It will cost $100,000.

The city engineer of London, Ont., has proposed a dyke to surround the suburb of West London at a cost of $150,000.

The pumping plant at the high level reservoir, Montreal, requires a new large high duty pump, which will cost about $70,000.

The contract for the new Verity Company's buildings, Brantford, Ont., was let to Havill & Whitham, Brantford, for $50,750.

S. S. Jewett & Co., brass founders, Buffalo, N.Y., have no intention of establishing a brass foundry at St. Thomas, Ont., at present.

Ridgetown wants W. E. Hall's furniture factory to move there from Galt. It has been offered a bonus and exemption from taxation.

The Simpson-Merner Furniture Co., Berlin, Ont., of which Senator Merner is the head, will erect a large addition to its works this summer.

Extensive improvements are to be made in St. Andrew's Church, Perth, during the coming summer. It is estimated that $10,000 will be expended.

The Sarnia Gas & Electric Light Co. has closed a contract for a modern gas producing plant, with the Western Gas Construction Co., of Fort Wayne, Ind.

E. F. Head, architect, Rat Portage, Ont., has been instructed by the school board to prepare plans and specifications for a twelve room school building.

J. E. Belcher, C.E., County Engineer, Peterboro, Ont., has prepared plans for the Mudlake bridge, partly embankment and partly floating, to cost $25,000.

J. W. Meyers & Co., Listowel, Ont., have decided to make $7,000 improvements to their flour mill. They will also build an elevator, 30 x 48 feet, this summer.

The incorporators of the Dominion Aluminum Roofing Company, Montreal, are: Abel Huot, Lucien Girard, Antoine Collard and Nap. Plessis, contractors.

The Leviathian Belting Co., Boston, Mass., has opened an office in Quebec, at No. 101 St. John St., and has appointed L. H. Gaudrey as its representative in the district.

At Hartland, N.B., it has been decided to form a joint stock company to build a bridge. The government will be asked to guarantee the bonds for a term of 15 years.

Another pulp mill is to be built on the Sissaboo River, near Weymouth, N.S., as the Fredericton Reporter notes that a new company has been organized for the purpose.

The Ottawa Board of Trade has taken action that may soon lead to the establishment of a Technical School, in order to encourage the manufacturing industries of the city.

The Metallic Roofing Co., Toronto, has just supplied one of their metal ceilings for the chapel of the Central Prison. These goods are particularly adapted for church work.

The Rat Portage Lumber Co., of Rat Portage, Ont., is expending in the neighborhood of thirteen thousand dollars in special improvements on its planing mill, saw-mill, etc.

The London, Ont., water commissioners have decided to continue the conduit to Byron, so as to tap Griffith's springs, which will add 250,000 gallons per day to the city's water supply.

Two spans of the Saskatoon bridge on Qu'Appelle, Long Lake and Saskatchewan Railway, were carried away by ice April 19th. In the meantime crossing will be effected by ferry.

Dartmouth, N.S., has a proposition before it to bonus a pulp mill to have a capacity of 20 tons per day. The promoters have secured options on suitable water power and land in the town.

The Donoghue Bros., Kingston, will erect on their property, near the Montreal Transportation Company's elevator, a grain elevator with a capacity of between 80,000 and 90,000 bushels.

M. A. Cleveland, who has a contract on the public works, Cardinal, is now starting in on his rock work, after placing an order with this same company for one of their latest model Sergeant drills.

F. G. B. Allen, supt. of the Cement works at Napanee Mills, Ont., has fitted up a laboratory in his residence. The office has also been moved to the station, the old office and laboratory turned into an engine room.

Some Ottawa people are looking for a suitable location and water power, to build a large pulp mill. If suitable site can be secured, with good shipping facilities, building operations will be commenced early this summer.

The respective county authorities of Norfolk and Simcoe, Ont., have decided to recommend that a new steel bridge, 150 feet long, be constructed over the Big Otter Creek, between the townships of Bayham and Middleton.

A man who has large experience in steel and iron manufacture, is coming out from England to take hold of Thos. Doherty's latest invention in that line, and will remain in Canada a couple of months at least, it is said.

The Manufacturers' Committee of the Brantford City Council propose a general exemption from all but school taxes, upon all machinery and tools for local manufacturing industries, employing a given number of hands.

The McClary Manufacturing Company, London, Ont., is filling an order from a San Francisco house for $7,000 worth of stoves, tin and graniteware, for the Yukon trade. The goods, which will fill six cars, will be shipped direct from London.

The Niagara Falls Metallic Furniture Company, Limited, has been incorporated with a capital of $24,000. The officers are as follows: Pres., R. P. Slater; Vice-pres., W. Phillips; Sec., J. E. Stephenson; Treas., Dr. E. T. Kellham; Manager, Wm. Hess.

W. Harris, Day's Mills, Algoma, Ont., offers power and mill-site free, with small bonus, to any responsible party who will erect any kind of wood-working, furniture or handle factory. Any amount of good hard wood and other timber near the site.

John F. Stewart, for many years manager of the James Stewart Manufacturing Company, Woodstock, has been succeeded by his brother, Adam A. Stewart. J. F. Stewart still retains his interest in the business, and the presidency of the company.

The James Cooper Mfg. Co., Limited, Montreal, has just completed shipment for Larkin & Sangster, contractors, Iroquois, Ont., of four Lidgerwood double cylinder, double drum hoisting engines, with five Sergeant drills, and quarry bar outfit.

The molders in the Waterloo Mfg. Co.'s foundry, struck recently for an advance of 25 cents per day; as no notice was given the management of dissatisfaction beforehand, the strikers did not receive any consideration, but were replaced by outside labor at once.

J. Zryd, G. Zryd, O. Zryd, J. E. Schmidt, Annie M. Zryd, Hespeler, Ont., have been incorporated as the Zryd Gas Machine Company, of Hespeler, Limited, to manufacture, buy, sell and deal in acetylene gas machines and parts thereof, capital, $5,000.

The village of Andover, N.B., has been recently incorporated and proposes to put in a fire protective waterworks system of 2¼ miles of piping. C. L. B. Miles, C.E., has been engaged to make the necessary surveys and plans. Tenders will be shortly called for.

L. McGlashan, manager of the Ontario Silver Works, Humberstone, Ont., intends making a large addition to the factory. The new wing will be about 100 x 40, brick. A large dynamo and gas engine will be among the plant to be placed in the new addition.

The Council of Westmount, Que., have passed the by-law authorizing the loan of $350,000, to be used in the construction of parks and other public improvements, among which are a contagious disease hospital to cost $15,000, a dump and incinerator to cost $10,000, and municipal buildings, $25,000.

The People's Heat & Light Co., of Halifax, is increasing their plant for greater facility in handling materials at the power house, and has placed an order with the James Cooper Mfg. Co., Montreal, for a standard Lidgerwood 30 horse power link motion and friction double drum cylinder hoisting engine, which will be shipped at once.

Andrew Bell, C.E., Almonte, Ont., on behalf of a company, has asked the Carleton Place town council for a franchise to put in a system of waterworks similar to the one in Perth, Ont. He wants a similar franchise for Almonte, and the company he represents is said to be willing to spend $100,000 in each town to put in a first-class system of waterworks.

The following have obtained incorporation under the style of the Jacques Cartier Pulp Company, to carry on the business of pulp and paper manufacturing; acquire water powers on the Jacques Cartier river and elsewhere, develop electricity to be supplied for motor and lighting purposes, etc., etc.: E. Goff Penny, R. Archer, Wm. Strachan, W. Currie and R. Law, Montreal.

The dynamite factory of the Ottawa Powder Co., situated on the Chelsea Road, on the Quebec side of the river, about four miles north of Ottawa, was recently blown up. No person was injured or killed. The damage to the plate glass in Ottawa amounted to over $2,000. The cause of the explosion is not known. This is the third time that the factory of the Ottawa Powder Co. has been blown up.

The Wm. Hamilton Mfg. Co., Peterboro, has in hand the entire equipment of a sawmill, which the C.P.R. is erecting at Cool Creek, about 60 miles west of McLeod, N.W.T., in the Douglas Fir District. The equipment of the mill is of the most modern type, and it will have a capacity of 100,000 feet in ten hours. The entire plant comes from the Hamilton shops, including a battery of six boilers, handsaws, etc.

James E. Smith, who at the time of the Windsor, N.S., fire, had charge of the reed and rattan department of the Windsor Furniture Mfg. Co., has entered into a partnership with H. B. Murphy, of the firm of Wood & Murphy, and will commence manufacturing reed and rattan goods. The factory will be in Falmouth, N.S., near the mill of F. H. Manning, who is now erecting a building, and will supply the new firm with power, water, etc.

The Dominion Plumbing and Supply Association was formed in Montreal recently, letters calling the meeting being sent out by Geo. Booth, of Toronto. The object of the association is for the better protection of the trade. The officers elected were: J. Reid Wilson, Montreal, president; A. A. McMichael, Toronto, vice-president; W. H. Wiggs, Quebec, second vice-president; while the Executive Committee will be formed of Col. F. Massey, W. Greig, A. Lariviere, J. M. Taylor and H. Wright.

The Ontario Board of Health recently approved the plans for the village of Hintonburg, which is putting in a system of sewage; for Mount Forest and Port Colborne, which are putting in waterworks; and Rat Portage, which is also constructing waterworks and extending its sewage system.

The James Cooper Mfg. Co., Limited, Montreal, has just secured an order for an additional plant for the Regina Gold Mine, Limited, of Rat Portage, consisting of duplex cross compound condensing Ingersoll-Sergeant piston inlet compressor, ten drills, battery of boilers, pumps, heaters and all necessary connections to install plant complete. The first shipment in this contract has now gone forward.

Thompson & Co., Sherbrooke, Que., have agreed to install, in Lennoxville, a system of waterworks. The water will be taken from Haskell Hill, about half a mile distant. The reservoir will have a capacity of 400,000 gallons, and will be about 125 feet above the town. The contract will have to be finished within eight months from the date of the signing of the contract. There are to be twenty hydrants placed in the streets for fire purposes. A number will be placed in and about the buildings and grounds of Bishop's College.

The James Cooper Mfg. Co., of Montreal, has completed shipment of contract for complete mining plant entered into with the Montreal-London G. & S. Dev. Co., to equip the Dufferin property, at Salmon River, N.S. This plant consists of a duplex cross-compound condensing Ingersoll-Sergeant piston inlet air compressor, eight drills, battery of three boilers, one 50 horse power and one 40 horse power Lidgerwood link motion and friction double compartment shaft hoisting engines and all necessary piping and connections to install plant complete ready for operation.

Some important experiments were recently made in the Workman Engineering Building, at McGill University, by Profs. Adams and Nicholson, of the Faculty of Applied Science. They consist of taking filings or turnings of brass, copper, tin and other metals, and by means of pressure, securing therefrom solid bars of metal, differing very little in appearance and strength from castings. The machine used in these experiments brings to bear upon the filings and shavings about 78,000 lbs. pressure to the square inch, and this has the effect of welding them into a solid bar of metal.

The Canadian Photo-Engraving Bureau is extending its premises, having leased another flat in the building in which it is located, at 16 Adelaide St. West, Toronto, and is now making extensive alterations and improvements in it. Part of this extra flat will be used as an office, giving them greatly increased accommodation, and the balance as a photo department. It is their intention to establish a first-class photograph department, fully equipped for all kinds of commercial photography, such as landscapes, buildings, interiors (daylight or flashlight), and articles of any kind. The combination of the photograph gallery with the photo-engraving business, is a good one, and will be a great advantage to those having cuts to be made, where the photos have to be taken from the article or building.

Prof. Callendar, who has just resigned from the staff of McGill University, has designed a platinum electrical resistance thermometer, capable of measuring temperature to the ten thousandth part of a degree. The extreme delicacy of the instrument makes it a valuable aid in securing accurate observations of the temperature of lake and river water, during the various seasons of the year, as no thermometer is available for such minute measurements. A long series of observations of the temperature of the St. Lawrence has been made this winter by the McGill professors, in all of which the new instrument has been used. By its aid it has been found that the greatest deviation that takes place in the winter during the ice-forming period, is only about one thousandth part of a degree. Prof. Callendar's invention is, undoubtedly, of great interest to the scientific world.

The Wm. Hamilton Mfg. Co., Peterboro, Ont., has recently completed the engines for a large stern-wheel steamer, for J. A. Mara, Vancouver, B.C. The wheel is 19 feet in diameter with buckets 9 feet long, which take a dip of 30 to 34 inches; on either side of the wheel the cranks are placed. The crank shaft is a steel forging 10 inches in diameter and 24 feet long. The engines are aft on each side. The boiler is placed well forward, about 70 feet from the engines. The engines run 30 revolutions per minute, and the boiler pressure will be 160 lbs. The power developed is calculated at 2,300 h.p. Speed, 18 miles per hour. The cylinders are 17 inch and 6 foot stroke. The connecting rods are 24 feet from crosshead to the crank pin, and are built up of plates. From the head of the cylinders to the outside of the paddle wheel will be 48 feet. The boiler is of the locomotive type, 62 inches in diameter, by 7 feet long. In the barrel are 212 inch tubes, 14 ft. long. The furnace is 7 ft. by 5 ft. by 6 ft. high inside. The Hamilton Company has now in hand a duplicate set of these engines, building to the order of the C.P.R., for one of their boats running from Vancouver to Fort Wrangel.

Of interest to engineers throughout Canada is the advent of a new company known as the Canadian Chemical Compound Co. The principal promoters are A. M. Wickens, E. J. Philip, D. J. LeRoy and Richard Jeffrey, all of Toronto. The new company will manufacture boiler compounds, of which it has three special brands, suited for waters of different character. As the public may well be sceptical of the virtues of a patent medicine which claims to cure all diseases, so engineers may doubt the efficacy of any one boiler compound which claims to be suitable for waters of every locality. The Canadian Chemical Compound Co. not only has three different brands suited to the waters of most localities in Canada, but they undertake in exceptional cases to prepare special compounds where the water is heavily charged with any unusual foreign element. The three special brands will, however, remove scale from almost any class of water, and leave no injurious effect on the boilers. Messrs. Wickens and Philip have long made a study of this subject, and anything that they would place on the market will be received with confidence by steam engineers of Canada, among whom they are so well known. The new company has issued a very neat booklet, which will be sent free from its offices in the Temple Building, Toronto.

Electric Flashes.

The Vankleek Hill Electric Company, Limited, has received an Ontario charter for incorporation.

The electrical pumping plant in the Perth, Ont., waterworks is reported to be giving complete satisfaction.

The Canadian General Electric Co. has sold to Alex. Dobson, of Beaverton, Ont., a standard 20-K.W. Edison dynamo.

The Rathbun Co., Deseronto, is building a freight motor for the Longue Pointe section of the Montreal Island Belt Line Railway.

Larkin & Sangster, contractors, Iroquois, Ont., have purchased from the Canadian General Electric Co., a 35-light arc dynamo with lamps.

The Canadian General Electric Co. has put in the last of the four 4,000-light single-phase alternators ordered by the Toronto Electric Light Co.

The Halifax Tramway Company has installed two 5,000-light monocyclic alternators from the works of the Canadian General Electric Company.

The Canadian General Electric Co. is furnishing to the Linde British Refrigerating Co., Montreal, two 50 h.p. and one 15 h.p. Induction motors.

The British American Corporation, Vancouver, B.C., has ordered a 100-light dynamo, with search lights and engine, from the Canadian General Electric Co.

The Canadian General Electric Co. has closed a contract with the corporation of Port Arthur for a railway car body equipped with G.E. 1,000 motors.

The Consolidated Electric Co., Victoria, B.C., is preparing to develop a large amount of power at Goldstream near the city. The plant will cost about $100,000.

The B. C. Bullion Extracting Co. has made a contract with the Canadian General Electric Co. to supply a 100 horse-power synchronising motor, and a 50 horse-power induction motor for their works, which are about a mile and a half from Rossland, B.C.

An Electrical Engineers' Association for the maritime provinces was formed in Halifax last month. James Waddle, Charlottetown, P.E.I., was one of the delegates present.

The London, Ont, Electrical Construction Company is said to be willing to establish itself in Kingston, Ont., if exemption from taxes, free site and free water are granted.

The Canadian Pacific Navigation Co., Victoria, B.C., has purchased from the Canadian General Electric Co., for one of their steamers, a mu' i olar direct connected set with marble switchboard.

Price Bros., Quebec, have ordered from the Canadian General Electric Co. a complete electric and steam plant for the Assiniboine Block, Winnipeg, Man. The generating plant will have capacity for 400 lamps.

Hamilton City C uncil has voted to buy from the Hamilton, Chedoke & Ancaster Electric Ry. the Becket mountain drive and quarry for $12,000 This makes the construction of the road almost a cer.a. a.,.

D. Maxwell & Sons, St. Mary's, are installing an electric plant for lighting their factories, and have purchased for the purpose a 350-light Edison dynamo, manufactured by the Canadian General Electric Co.

The Manitoba Gas & Electric Light Co., of Winnipeg, has ordered from the Canadian General Electric Co., a 6,000-light direct-current generator to run at 150 revolutions a minute, also a 125-light brush arc machine.

The Canadian General Electric Co. has closed a contract with the Laurentide Pulp Co., at Grande Mere, Que., for two 55-kilowatt moderate speed direct current dynamos with marble panels and instruments complete.

As announced in another column, the chair of electrical engineering, in McGill University, is vacant by the retirement of Prof. Carus-Wilson. Applications for the position will be received by the secretary up to 20th June.

Letters patent have been issued to the Toronto Electric Motor Company, Limited, capital $50,000. Those incorporated are: J C McLachlan, H S. Albertson, G McLachlan, J. W. Thompson and W. A. Turbayne, Toronto.

The Toronto Railway Company is refitting its long Yonge St. cars with G.E. No. 800, four-motor equipments furnished by the Canadian General Electric Company. The old two-motor equipments did not furnish enough tractive force.

The Peoples Electric Co., of Windsor, Ont., is making extensions to the electric system and has placed an order with the Canadian General Electric Co. for all the material required, including over 1,000-light capacity in transformers.

The Windsor Hotel Company, Montreal, is making extensive alterations in the electric installation, and has ordered from the Canadian General Electric Co. two 1,000-light slow-speed multipolar generators with marble switchboard panels.

The Montreal Street Railway Company has determined to construct the Cote des Neiges line, and the management is waiting the return of James Ross from England to commence operations, which it is expected will be by May 15th.

The authorities of the Longue Pointe Asylum, Montreal, are building a branch street railway to connect the institution with the Montreal Belt Line, and the Canadian General Electric Co. is supplying a 110 K.W. steel-frame railway generator to furnish power.

The London Electric Co. is putting in a 6,000-light 300 K.W. alternator to extend the sphere of their lighting operations, and two 160 K.W. direct-current, direct-connected generators for power. These machines are being supplied by the Canadian General Electric Co.

The Ingersoll Packing Company has contracted with the Canadian General Electric Co., Limited, for a complete installation of incandescent lamps, arc lamps, motors and generator for their factories at Ingersoll, Ont. The generating apparatus will consist of a 25-kilowatt 125-volt multipolar dynamo of the C.G.E. Co.'s latest and most approved type.

The Cataract Power Co., Hamilton, is making progress with its power development at Decew Falls. The works are expected to be completed in eight or ten weeks.

The Ontario Rolling Mill Co., Hamilton, is rapidly rebuilding the works recently destroyed by fire; they intend installing the most modern system of electric lighting throughout, and have placed an order with the Canadian General Electric Co., for one of their latest types of multipolar direct current dynamos having a capacity for 300 lights.

W. Doherty & Co., Clinton, Ont., have commenced work on their new factories, which they expect to have completed early in May. The new works are to be lighted throughout by electricity, and for this purpose they have closed a contract with the Canadian General Electric Co. for a 500-light dynamo, two 10 h.p. motors, and all wiring material required.

The Hon. John Haggart, W. A. Allan, A. Charlebois, Sir Sanford Fleming and R. G. Code, of Ottawa, are applying for incorporation as the Canadian Electric Water & Power Co., of Ottawa, capital $10,000, to establish waterworks and manufacturing electric machinery and electricity for the purposes of light, heat and power in the cities and towns of Canada.

J. R. Scott, an enterprising citizen of Napanee, has closed a contract with the Canadian General Electric Co. for a 100 K.W., 4,000-volt, three-phase generator of the revolving field type, for the purpose of supplying light and power to Napanee from a water power 8 miles distant. He will also supply light and power to intermediate points such as Napanee mills, Camden East, and Newburgh.

The Montreal Cotton Co., of Valleyfield, Que., has just placed an order with the Canadian General Electric Co. for two 600 h.p. three-phase generators, to be direct connected to turbines. This installation is a duplicate of the generators installed by the C.G.E. Co. over a year ago, and which have given entire satisfaction. With these four generators and station apparatus the company will have one of the most modern power stations on the continent.

The Electric Reduction Co., of Buckingham, Que., is putting in a 1,000 h.p. three-phase generator for electrolytic work. This machine is wound for a potential of 60 volts, and is of the revolving field and stationary armature type. It runs at 160 revolutions per minute, 75 volts, and is direct connected to a water-wheel. The equipment is of the same type as that furnished by the Canadian General Electric Co. to the West Kootenay Power & Light Co.

The Hamilton and Lake Erie Power Co. has been given by the government the power to increase its capital stock from one to three million dollars, and extension of time for three and six years respectively to begin and complete the work. Hon. W. R. Scott appeared for the promoters, and said the works were costing a very large sum and an extension of capital was needed. When completed there would be a great reduction in the cost of power in that district.

The Hon. J. Lanctot, M.D., of St. Henri; A. G. Bourbonniere, A. Christin St. Amour, Montreal; L. A. Sauve, St. Ignace du Coteau du Lac, and A. McNown, Cornwall, have applied for incorporation under the name of "La Compagnie d'Electricite de Soulanges." The object of the proposed company is to operate telegraph and telephone lines in the county of Soulanges, with a capital stock of ten thousand dollars. The principal place of business will be at Coteau Landing.

The Manitoba Gas & Electric Co., Winnipeg, is making very extensive alterations and additions to its plant, and have placed an order with the Canadian General Electric Co. for a 300-kilowatt alternating generator of their monocylic design, and one 125-light brush arc dynamo to be direct connected to vertical engine. The Canadian General Electric Co. is thoroughly overhauling the outside construction work, and equipping the system with their standard type H. transformers throughout.

L. A. Campbell, for several years chief engineer of the Canadian General Electric Company, has been appointed general manager and electrical engineer of the West Kootenay Power and Light Company. Under the superintendence of Mr. Campbell, this company has already installed 2,000 horse power for delivery to Rossland, B.C., and has a waterway developed for 7,000 horse power altogether. The company supplies power to the celebrated War Eagle mine, whose plant is referred to elsewhere in this issue.

At a meeting of the Royal Electric Engineering Society, held a short time ago, K. B. Thornton, of the Royal Electric Co., read a paper on Alternating Current Arc Lamps; also at a meeting of the society, held March 31st, W. F. McLaren and R. F. Morkill, of the Royal Electric Works, read a paper on Alternating Current Motors. Mr. Dix, of the same Company, will read a paper at the next meeting, April 14th. The society are holding their meetings in the Board Room at the Royal Electric Co.'s General Offices, which has been very kindly loaned by Mr. W. H. Browne.

It will be remembered that in the action taken by the Montreal Street Railway Company against the Montreal Park & Island Railway Company, on account of loss from the fire at the exhibition ground buildings, when a number of cars leased by the Street Railway Company to the Park & Island Company were destroyed, the Superior Court granted the Street Railway Company $5,786 damages. From that judgment there were two appeals, one from the Street Railway Company itself, claiming that the amount granted was too small, and another from the Park & Island Company, asking that the action be dismissed. The Court of Appeal held that there had been no fault or negligence on the part of the Park & Island Railway Company or its employees and the damage to the cars had been caused by an irresistible cause. Under those circumstances the judgment of the court below must be reversed, and the action of the Street Railway Company must be dismissed.

The Toronto Electric Motor Company's business has again out-grown its premises, though two or three extensions have been made since it was established in Adelaide St. The Company is now building a factory of its own in Pearl St., and expects to move into its new premises in the course of a month. Among the orders awaiting delivery on the books are 100 arc lamps, for the Citizens' Light and Power Co., Montreal; a 5 horse power motor for T. H. Dryden, Toronto, and one of similar size for R. Anderson, Ottawa; two 30 horse power motors for the Mail and Empire, a 30 k.w. generator for the elevator at Coteau Landing (owned by John S. Metcalfe & Co., Chicago), a 60 k.w. generator for R. E. T. Pringle, Montreal, and a 130 k.w. generator, and a 140 horse power motor for the T. Eaton Company, Toronto, the last-named being the sixteenth machine furnished by this firm to the great departmental store. Another interesting installation is a 200-light dynamo and a 20 k.w. power generator for the Rat Portage Lumber Company, to be used for lighting the mills and for operating an electric locomotive for a tramway running throughout the Company's yard.

Mining Matters.

The Dominion Coal Co. is building a large number of cars.

Oil is reported in the township of Brooke, near Alvinston, Ont.

The Canadian Mining Institute has applied for a Dominion charter of incorporation.

Another oil well at Point Edward, Ont., is completed, and its pumping qualities tested with satisfactory results.

The Hamilton Board of Trade has asked the Dominion Government to impose an export duty on nickel ore.

The British Columbia Smelting & Refining Co. has transferred the smelter at Trail, B.C., to the C.P.R. Company.

The Iron Mask Mine, Rossland, B.C., is putting in one of the Jenckes Machine Co.'s smaller size hoisting engines.

The discovery of an extensive deposit of valuable iron ore is reported to be made in the Laurentides, about eighty miles from Montreal, on property owned by Adolph Trempe, brother of the Montreal detective of that name.

British Columbia business still continues brisk. The Jenckes Machine Co. reports the demand for mining machinery quite active.

The Rossland branch of the Jenckes Machine Co. recently placed a No. 5 Cameron pump with the Center Star Mine, also a No. 6 with the Monte Cristo.

The Dominion Government has authorized the issue of free miners' licenses at the summits of the Chilcoot and White passes, at the head of Lynn Canal.

The receipts from the corporation natural gas plant last year in Leamington, Ont., were $10,406.14, and the expenses in connection with the plant were $770.

Large coal beds are said to have been located on or near the line of the proposed Glenora and Teslin Lake Railway, about fifty miles from Telegraph Creek.

The Boundary Creek District, of British Columbia, is coming forward, and it is very likely that a number of large development plants will be put in during the coming season.

E. E. Pettigrew, of Winnipeg, has placed an order with the Jenckes Machine Co., Sherbrooke, for a five-stamp mill complete, with thirty-five horse power engine and portable boiler.

The property of the Non-Magnetic Asbestos Co., of Point au Chene, Que., is advertised for sale in another column; the sale to take place on the 15th. The property is reported to be a very valuable one.

The Canadian Rand Drill Company has sold to R. O. Jennings, Fort Steele, B.C., a big power pump for use in the hydraulic mining plant which the Jennings Company is installing on Brewery Creek.

Texada Islands, off Jervis Inlet, B.C., will, it is said, soon have a smelter. The plant was ordered by the Van Anda Company, which has brought ten cold-copper properties on Texada to an advanced stage of development.

The Kenneth Mining and Development Co., at Rossland, B.C., is making an addition to its equipment in the shape of a 7 x 10 double-cylinder hoisting engine, with boiler and all appliances complete, furnished by the Jenckes Machine Co.

Vivian & Sons, Swansea, Wales, and the Elbois Metal Company, of Burryport, South Wales, have, it is said, as the result of the success of trials, decided to come into the British Columbia market for the purpose of smelting all kinds of ore and furnace products.

John Fenton, farmer, who lives near Ryckman's Corners, Ont., has had natural gas on his farm for several years, sufficient to heat and light the house, and recently a big flow of gas was struck at a depth of 200 feet. The previous flow was from a well 460 feet deep.

The Brookfield Mining Co., North Brookfield, N.S., has bought a hoisting engine and other machinery from Austen Bros., for use on the Dunbrack property, recently purchased by them. They propose to sink a shaft about 200 feet and then drive levels to thoroughly test the belt.

Development still continues on the Golden Cache Mine, Rossland, B.C. The company claim to have a narrow claim streak, running $200, with the rest of the ledge containing average values to pay $1 net. Contracts, amounting to $40,000, have been let for electric and hydraulic plants.

The Electric Reduction Co., of Buckingham, Que., is proceeding to develop the water-power, and as a first step has placed an order with the Jenckes Machine Co., Sherbrooke, Que., for a pair of 45" crocker turbines, to be installed complete with wheel cases, draft-tubes, governor, etc.

The emery found on the East shore of Lake Winnipeg has been pronounced by experts to be of the very finest quality. The deposits are known to extend over an area of twenty-five square miles. About 50 claims have been taken up. Deposits of aluminum and quicksilver have also, it is said, been found.

The proposed British Columbia Chamber of Mines has been established. The initial meeting was held at Vancouver, B.C., with Dr. Selwyn, F.R.S., in the chair, and representatives of mining interests from different districts present. Twenty-five signed as representative and five as associate members. The following were elected an executive committee: W. A. Carlyle, W. Pellew Harvey, W. White, H. Abbott, H. Cohen, Barclay Bonthrone, A. St. G. Hamersley, F. S. Taggart, C. C. Bennett, Dr. Selwyn and Dr. Bell-Irving.

The B. C. Goldfields Co., of Toronto, has recently placed an extensive order with the Jenckes Machine Co., for a ten-stamp battery complete with two vanners, two ore feeders, grizzly, Blake-Marsden crusher, and all the various apparatus making up a complete modern milling plant. The outfit is to be delivered at Nelson, B.C.

The British Columbia Copper Co., Anaconda, B.C., have just contracted with the James Cooper Mfg. Co., Limited, Montreal, for the installation of an Ingersoll-Sergeant ten-drill compressor plant, complete with ten drills, battery of boilers, Lidgerwood hoisting engines, pumps, heaters, and all necessary equipment to make the plant complete.

Dr. J. B. Porter, Professor of Mineralogy at McGill, is now in the mining regions of Nova Scotia, at the head of a large field prospector's class from McGill University. They will examine portions of Cape Breton, and the Guysborough gold fields, remaining in the east about six weeks. The class was sent out through the generosity of W. C. McDonald.

Dr. Gilpin, inspector of Nova Scotia mines, has sent to the Provincial Government a report on the result of his recent official trip to Whycocomagh Cape Breton. He says the gold discoveries are very valuable but does not go into minute details. Dr. Gilpin found very rich quartz and also free gold in sand taken from the bed of the Whycocomagh River.

The annual report of the B. C. Dept. of Mines has been presented to the Legislature. It shows that the total output of minerals, including coal, in 1897, was valued at $10,455,268, an increase of 40 per cent. over the previous year's yield. The gold value was $2,646,000; silver, $3,272,000; lead, $1,390,000.17; coal, $2,648,562. West Kootenay produced to the value of $6,765,000.

An oil well has been struck on the farm of Benjamin Boothroyd, about a mile from Thamesville, Ont. F. Carmen is the proprietor of the well. One night there were two hundred barrels pumped in twelve hours, and the average yield is still almost equal to that. There is another well on the adjoining farm, the property of John Herbert, which promises to be almost equal.

An Edmonton despatch says that letters to Rev. Father Husson and R. Hardisty confirm the report that "Cayuse" Graham has come across the mountains from the head waters of the Pelly River, and has struck pay dirt at ten to twenty dollars a day. Graham crossed the Upper Liard, west of the mountains, in November, and reached Fort St. John on February 1st, with horses and sleds.

A letter recently received by Bishop Pascal, of Prince Albert, from Rev. Father Mancel, stationed at Hay River Mission, in the North-West Territories, states that a party of prospectors have found rich gold deposits on both Hay and Buffalo rivers, emptying into Great Slave Lake. These rivers are located about 700 miles north of Prince Albert on the Regina and Prince Albert route to the Klondyke.

F. C. Flannery, secretary-treasurer of the Toronto Smelting Company, proposes erecting at Madoc, Ont., a plant to treat the mispickel ores of Hastings County: he recently showed samples of the arsenic produced at the company's small test-mill at Millbridge, Ont. The company has now a ten ton water jacket smelter, which is to be put up at Madoc, and started as soon as possible. The company will treat the mispickel ores for arsenic with gold and mineral wool as bi-products.

Free mining machinery to the value of $128,780 was admitted into Canada during the fiscal year ended 30th June last, having been supplied by the following countries: Great Britain, $9,266; Denmark, $2,451; Germany, $2,864, and the United States, $114,239. Of this amount Ontario got $30,308; Quebec, $24,812; Nova Scotia, $21,520; New Brunswick, $452; Manitoba, $695; British Columbia, $44,087, and the Northwest Territories, $5,897. In addition to these should be mentioned diamond drills purchased in the United States of a value of $19,880. Among the dutiable articles we find 184 steam pumps, valued for duty at $24,860.

Marine News.

The contract for repairs to the steamer Rosedale was awarded the Caledonia Iron Works, Montreal. The repairs will amount to about $28,000.

The Geological Survey of the United States has ordered a large number of canoes from the Peterboro Canoe Company for the use of exploring parties in Alaska.

The propeller Persia has been bought by W. A. Geddes, Toronto, and Jacques, Montreal, Capt. Crangle and J. H. G. Hagarty having sold to those gentlemen their interest.

Clinton B. Sears is considering the matter of raising the bones of the old steamer Winnipeg, of the Collingwood line, which lie in shallow water at the bottom of Duluth harbor.

The Canadian General Electric Co is equipping, with incandescent light, a steamer being built by the British Columbia Iron Works, for the Klondyke Exploration Co., Limited.

The Canadian Pacific Navigation Co. has purchased from the Canadian General Electric Co., a 125-light, incandescent plant for a steamer running from Vancouver to the Stikine River.

The British Columbia Iron Works Co. has ordered a 6-kilowatt incandescent dynamo from the Canadian General Electric Co., for a steamer which it is building for the Klondyke trade.

The Canadian Development Co., Victoria, B.C., of which H. Maitland Kersey is Managing Director, has ordered three incandescent light equipments, for new steamers, from the Canadian General Electric Co.

The Hudson Bay Company has placed a contract with the Canadian General Electric Co. for two 100-light incandescent equipments, to go on their new steamers, running from Vancouver and Victoria to the Stikine River.

Messrs. Cameron, Collingwood and Burton, of Barrie, have arranged to place the City of Collingwood and the Majestic on the route between Collingwood, Owen Sound, Sault Ste. Marie, Port Arthur, Fort William and Duluth.

The Allan Line has given a contract for the construction of a ten thousand ton steamer, to be known as the "Sicilian" and a sister ship to be the "Tunisian." The length is five hundred feet, beam 60 feet, speed sixteen knots, capacity 1,050 passengers.

The directors of the Richelieu and Ontario Navigation Company have appointed a new official, to be known as inspector of stewards. H. Bouchard, who has been in the employment of the company for 17 years, has received the appointment, with headquarters at Montreal.

J. A. Mara, late member of parliament for Yale and Kootenay, is building a river steamer at Vancouver for the Yukon traffic. She is said to be the largest boat that will be employed on the rivers up North, being 520 feet long, 32 feet beam, 5½ feet depth of hold, and will cost in the neighborhood of $25,000.

The Canadian General Electric Co. has a contract for supplying three direct-connected units for the C.P.R. steamers which are to go on the Stikine route. These units will consist of a 4-kilowatt, 70-light incandescent dynamo, direct-connected to a vertical high-speed engine, running at 606 revolutions per minute.

W. Bell Dawson, engineer in charge of Tidal Survey, has this year issued, in neat pamphlet form, Tide Tables for Charlottetown, Picton and St. Paul Island, C.B., for 1898, with Tidal Differences for Northumberland Strait, and for the open Gulf shore, from Miramichi along the north coast of Prince Edward Island.

The Canadian General Electric Co. is installing a Direct Connected Lighting unit on board the C.P.R. steamship Athabasca, consisting of a 500-light incandescent dynamo, direct connected to a 50 h.p. high speed "Ideal" engine. This unit, which is very compact, occupies a floor space of less than 6 ft. x 9 ft. The dynamo is of the latest steel frame multipolar type, with ventilated armature. A marble switchboard, on which are mounted a standard equipment of instruments, is also part of the new equipment, which when finished will be the most complete on any of the steamers now running on the upper lakes.

Capt. Crawford will again this year be Commodore of the Hamilton Steamboat Company's fleet. He will sail the Macassa in the spring and fall and the Modjeska during the busy season. Capt. Maddicks will be in command of the Macassa while Capt. Crawford is on the Modjeska.

The total number of casualties to British and Canadian sea-going vessels in Canadian waters, and to Canadian sea-going vessels in waters other than those of Canada during the year, as stated in the report to Parliament, of the Dept. of Marine, was two hundred and thirteen, representing a tonnage of 80,317 tons register, and the amount of loss, both partial and total, to vessels and cargoes, as far as ascertained, was $718,293. The number of casualties to inland vessels was twenty-seven, tonnage, 5,726; loss, $48,350. The number of lives reported lost in connection with these casualties was thirty-four.

The following candidates, recently examined by W. L. Waring, St. John, N.B., have passed and will be granted marine certificates: Geo. H. Waring, jr., of St. John, second engineer of Prince Rupert, chief engineer's certificate, valid in Great Britain; Fred. John Lewis, of St. John, second-class certificate, valid in Great Britain; Charles Helman Hanson, of Chatham, third-class certificate; Geo. Frederick McRoberts, of St. Andrews, fourth-class certificate; George Herbert Burpee, Sheffield, Sunbury County, fourth-class certificate.

The Manhattan Steamship Company was incorporated Jan. 1898, with a capital of $1,000,000, with the following directors: J. J. Hillman, Philadelphia, president; Jos. D. Huggins, New York, vice-president; N. L. Newcomb, New York, general mgr.; H. E. Alexander, Wm. F. Weiss, Thos. W. Buck, Roland F. Hill, Tunis G. Bergen, New York; Isaac C. Ogden, Orange, N.J.; Beverley S. Reed, Boston; C. Everett Evans, Taunton, Mass. The offices of the company are at 11 Broadway, New York. Contracts have been given for the construction of three steel twin screw passenger and freight steamers. The dimensions of these steamers are 250 feet long by 45 feet beam. Each of these steamers contains two engines, 22 x 36 x 55 x 28 inch stroke; six boilers, 11 feet 6 inches in diameter by 12 feet 6 inches long, giving a sea speed of 17 knots per hour. These steamers are of the most modern construction, with large space devoted to cold storage. The company will operate a steamship service between New York, Maine and the maritime provinces. Pier No. 1, North River, New York, has been leased at a rental of $35,000 a year for a period of ten years.

Considerable discussion is going on in marine circles in St. John, N.B., on the subject of marine engineers' permits. The regularly qualified engineers are not satisfied with the present system of granting such permits, and claim that there are many inconsistencies in the laws with regard to granting papers to men to make them marine engineers and in the rulings of the men who are in power to grant the papers. The engineers who study the laws, say that a fourth class engineer who is compelled to have certain machine-shop experience, and also experience in the engineering of a steamboat, is not permitted to take charge of the machinery of any passenger boat, and the man who holds the permit has not to have all these qualifications and can run any passenger boat of nine-horse power. The act provides that a temporary certificate may be granted and be in force for a term not exceeding one year to an applicant "sufficiently qualified by his knowledge of steamboat machinery, and his experience as engineer on a steamboat, authorizing him to act as an engineer of a steamboat carrying passengers, having an engine of not more than four nominal horse power if the engine is a single cylinder engine, or nine nominal horse power if the engine is of the compound type.

Everything in the marine line is rushing at Gravenhurst, Ont., "We had the launch of a new steamer built last winter for Homer & Co., of this town," writes a correspondent. "She is 65 feet long, 14 feet beam, 6 foot hold. She is built all of oak timber, and calculates for a passenger steamer will carry 130 passengers. Her speed is 12 miles an hour. She was built by Davis & Sons, Kingston. The same firm have a contract to enlarge the steamer "Kenozha," for the Muskoka Nav. Co. They are adding 18 feet to her length, making her 126 feet long. There will be new cabins, 56 feet long, built on the promenade deck, besides new pilot house, and captain rooms on the hurricane deck. Her rebuilding will cost $3,000, and is to be ready for work by June first."

Railway Matters.

The Quebec Central Railway is making extensive additions and improvements at the car shops in Newington. A new engine house, with a capacity of ten engines, has been erected.

The Grand Trunk will lay 120 miles of new track this summer between Niagara Falls, Sarnia and Windsor. The new rails will weigh 80 pounds to the yard; that which is down at present weighs from 56 to 66 pounds.

The managers of the Ottawa & Parry Sound R. R. have purchased sixteen new mogul engines in anticipation of a great increase in the grain business. They are ten-wheelers, and weigh 156,000 pounds each, without the tender or water in the boilers.

The Grand Trunk Railway Company will move the head offices of two branches of the construction work to Toronto. General Roadmaster Ferguson will be established here with his staff, and offices are also being prepared for the superintendent of bridges.

Both the G.T.R. and C.P.R. are introducing a new code of lamp signals to use on their freight trains. In addition to the usual tail lamps there will be an extra large one placed on the top of the conductor's van, and will be known as the copula lamp. This lamp will be an extra safe-guard against rear accidents. The engineer will also be in better communication with the end of the train.

Sir William Van Horne, at the annual meeting of the C.P.R. shareholders, remarked, in connection with the double-tracking of the Montreal-Toronto line, that it is ultimately intended to double track from Port Arthur to Winnipeg, and from Montreal to Farnham, and steps had already been taken in that direction, but the Montreal-Toronto section was regarded as the most urgent.

The following new appointments on the Canada Atlantic Railway went into effect recently. Mr. C. J. Smith is now general traffic manager; Mr. J. E. Walsh has been appointed assistant general passenger agent; Mr. W. P. Hinton has been appointed assistant general freight agent. These officers will have their headquarters at Ottawa, where the general offices of this company are located. Mr. M. A. Overend has been appointed foreign freight agent, with headquarters at 115 Board of Trade Building, Montreal.

Premier Greenway's Manitoba Ry. scheme includes 80 miles south-east from Winnipeg towards Lake of the Woods, upon which a guarantee of $8,000 per mile is given, controls rates secured as on the Dauphin railway, also large reductions on cordwood and sawlogs, which, it is believed, will bring the mill to Winnipeg. Next year arrangements will be made to connect the line with the Rainy River railway, and thus secure the road to Lake Superior, with a ten-cent rate scheme; also includes extending the Dauphin railway 140 miles north to the Saskatchewan River, through the fertile Swan River valley; also on a guarantee of $8,000 per mile, the government being secured by a first mortgage on the road. This will be half way to Hudson's Bay.

In the case of P. Hannaford v. the G.T.R., the plaintiff claims a year's salary ($6,000), in lieu of notice, and claims that his discharge was without cause and illegal, putting in evidence a letter from Sir Charles Rivers-Wilson, in which it was stated that nothing but absolute necessity caused the directors to dispense with Mr. Hannaford's "valuable" services. The company, on the contrary, claim that Mr. Hannaford had used his position for purposes other than the interests of the company; that he had employed servants of the company to do work for himself; that he had promoted his son without getting the approval of the general manager of the company to the promotion, and that, in any case, he knew of and approved an agreement signed by the employes of the road to accept a month's warning at any time. Strong evidence was given by several employees that they had done work for Mr. Hannaford on his private residence, both in time and with materials paid for by the company.

Word has been received at Kincardine, Ont., of the death of L. B. Hamlin, C.E., formerly, it is said, resident of that town. Mr. Hamlin was county engineer of Bruce for some years. He was engaged on the Government service in the Yukon country, and was frozen to death in the Klondyke.

Personal

W. J. Harkom, Montreal, is appointed assistant to the mechanical superintendent of the C.P R.

The death of Captain Campbell occurred on the S.S. "Lake Ontario" on Saturday, April 2.

Geo. Booth, Toronto, was elected treasurer of the Canadian Manufacturers' Association at the recent annual meeting.

D. J. Macdonald, B.C. Provincial Mine Inspector, resigned his position on April 10. He has taken a position with a mining company and will reside in Rossland.

James Warren, C E., Walkerton, Ont., has been appointed town engineer for Waterloo, Ont. The town is without a map, and the first thing Mr. Warren will have to do is to make one.

The Chatham city council has appointed Charles Topp, C E., of Bracebridge, city engineer. The salary will be $1,000, and the present waterworks engineer's services will be dispensed with, it is said.

At London, Ont., April 11th, Miss Mary Rolston was married to Samuel Break, general manager of the London Electrical Construction Company, and formerly superintendent of the London Street Railway.

J. A. Sheedy, of the Illinois Bridge Works, Chicago, Ill., has been appointed master of bridges and buildings on the Grand Trunk Railway system, in place of William Crawford, of London, Ont., resigned.

T. E. McLelan, manager of the Berlin and Waterloo Street Railway, has resigned his position to go to the Klondyke. He will be succeeded by Hedley H. Hilborn, of Montreal, who has been in the service of the Montreal Street Railway.

H. B. Spencer has been appointed superintendent of the Eastern division of the C.P.R and the Montreal-Ottawa line, with headquarters at Ottawa. J. E. A Robillard, the former superintendent, will have charge of the Labelle and St. Jerome branch of the C.P.R.

P. A. Dickson, aged 40, died at Brantford, April 24th. He was for a number of years electrician for the Brantford Electric Power Company, leaving there last summer for British Columbia, where he contracted a severe cold, which resulted in his death.

Mons. Ephrem Valiquet, who has just been elected president of L'Association De Secours Mutuels des Ingenieurs Mecaniciens, was presented by W. Rutherford & Sons with a handsome silver jug as a token of respect on the occasion of his leaving their employ to become foreman for Lymburner & Mathews, of Montreal.

William Wilson, engineer of the S.S. "Alert," died suddenly a short time ago, he having, up to the hour of his death, been in perfect health. He was a native of Glasgow, Scotland, and came to St. John's, Nfld., 37 years ago, as engineer to Baine Johnstone & Co ; since then he has been with Bowring Bros., in the Tug Co., and for the past 11 years an employee of Job Bros

Prof. Hugh L. Callendar, F.R.S., of McGill University, has been appointed to the Quain professorship of physics at University College, London, vacated by the resignation of Professor Carey-Foster. The friends of Professor Callendar cannot but be pleased at his appointment to what is considered a leading professorship in England, but there is not so much rejoicing at McGill, where his talents will be greatly missed. When accepting Prof. Callendar's resignation the McGill Faculties of Arts and Applied Science unanimously passed a resolution of regret in which they expressed their appreciation of his great merit and ability.

John Watson, the well-known stationary engineer, died recently at his home in Montreal.. Mr. Watson was born in Edinburgh, Scotland, seventy-eight years ago, and came to Montreal when about twenty-six years of age. He was for a number of years employed by the Grand Trunk Railway, and had the distinction of making one of the party that accompanied the first engine run over the line to Lachine. Afterwards he went into business for himself as a machinist on Chenneville street, and later was in partnership with his brother, the late Thomas Watson. When the new post-office was built he accepted the position of engineer there, where he was up till about four years ago.

The harbor master of Montreal, Captain Thos. Howard, who died recently at his home in that city, was born at Shinroan, Queen's County, Ireland, on September 15, 1826, and came to Canada in 1842. For a time after his arrival he was in the employ of the late Hon. John Hamilton, and later on entered the service of the Richelieu & Ontario Navigation Company. For some years he commanded the "Banshee," "St. Lawrence," and other vessels of the company plying between Montreal and Western ports, and was subsequently appointed manager of the Ontario division of the company. In March, 1881, he was appointed harbor master at Montreal, a position which he held until the day of his death.

Prof. C. A. Carus-Wilson has announced his intention of resigning the chair of Electrical Engineering at McGill University on September 1. He came to Montreal in 1890, having been previously on the staff of the Royal College of Engineering, Cooper's Hill, England. His resignation will be a great loss to McGill College. His future permanent address will be "Hanover Lodge, Kensington Park, London W., England." During May, Prof. Carus-Wilson will give the Cantor lectures on electric locomotives at the Society of Arts, London, and throughout the summer he proposes to devote special attention to electric railways, a subject of great and increasing importance in England now. The volume on electro-dynamics which he has written for Messrs. Longmans, Green & Co. (London and New York), will be published at once.

Chauncey M. Depew retired from the presidency of the New York Central on April 20th and was succeeded by S. R. Callaway. Mr. Callaway is a Canadian, entering the office of Mr. Hickson at Montreal in 1863, when 13 years of age. In 1865 he went as secretary to Gilman Cheney, manager of the Canadian Express Company, and left there in 1869 to enter the service of the Great Western Railway under W. Wallace, the superintendent at London, and subsequently private secretary to W. K. Muir at Hamilton. Mr. Callaway retired from the Great Western to enter the service of the Detroit and Milwaukee, of which road he was superintendent from 1875 to 1878. Upon the absorption of the D. & M. Railway by the Great Western Mr. Callaway was appointed general superintendent of the Detroit and Bay City Railway, and in 1880 general manager of the Chicago and Grand Trunk and president of the Western Indiana railways. In 1884 Mr. Callaway accepted the position of vice-president and general manager of the Union Pacific Railway and the allied lines of nearly 6,000 miles. In 1887 he was elected president of the Toledo, St. Louis and Kansas City Railway, and since then he left that road to accept the presidency of the Lake Shore and Michigan Southern Railway.

FIRES OF THE MONTH.

April 1st.—The Sine Creamery, Sine P.O., Ont., destroyed.——April 2nd —Geo. H. Hees, Sons & Co., window shade factory, Davenport Road, Toronto. Loss, $40,000, being rebuilt.——April 8th.—G. W. Green's wood-working factory, Ashburnham, Ont. Loss, $8,coo ; insurance, $4,500.——April 8th.—Lebel & Wilson's Lead Works, London, Ont. Loss, $4,000.——April 11th.—Chadwick Bros., Hamilton, metal spinning shop. Damages about $200.——April 13th.—F. Routhier & Sons, foundry, Vankleek Hill, Ont. Loss, $3,000 ; insurance, $1,000 ——April 13th.—Small saw mill, Newbury Junction, N.B. (Jas. Carr, Woodstock, N B., proprietor). Loss, $2,000.——April 19th.—Doan's tannery, Clinton, fire starting in the boiler room. Total loss ——April 19th.—Ore house at the Payne mine, Nelson, B.C. Loss, $10,000.——April 19th.—Gaw's planing mill, Place D'Armes, Kingston, Ont. Loss, $12,000 ; insurance, $5,000.——April 23rd.—The cupola of Wortman & Ward's foundry, London, Ont. Damages, $500. ——April 30th.—The Rathbun Co.'s terra cotta works, at Deseronto, Ont., plant destroyed. Loss about $100,000 ; partially insured.——May 1st —Jas. McLatchie's machine shop, Cardinal, Ont Loss about $5,000.

IMPULSE WATER WHEELS.*

By J. T. Farmer, Ma.E.

The development of power by means of impulse water wheels, has been receiving considerable attention during the past ten years. Water power is to be met with under varying conditions and in various surroundings; and the means best adapted for the utilization of the power vary with those conditions and surroundings.

Among the means devised by man at different times before the advent of the impulse wheel for utilizing the water power that was going to waste around him, one has easily taken the foremost place, and, indeed, has, by a process of the survival of the fittest, practically ousted all other methods from a position of being worthy of serious consideration. The turbine has at the present day almost entirely taken the place of the earlier devices in use, which have either been consigned to museums as curiosities or are regarded as picturesque additions to the landscape.

The impulse water wheel probably differs as much from the various forms of turbine in construction and in action as the turbine does from an overshot or breast water wheel. The previous statement with regard to the turbine must therefore be further modified so far as it is found that the impulse motor is finding favor with those who utilize water power.

*From a Paper read before the Canadian Society of Civil Engineers.

It has been said that "countless wealth is being squandered in all the torrents and water courses of the world." But it might be added that unless the proper means are taken for its utilization, wealth of energy avails little more to man than that of the tides of Jupiter.

It seems at first sight a very simple matter to place a wheel in position to take up the energy of water; but in practice that arrangement is generally found to involve more or less costly construction in the way of dams, basins, canals, flumes and even tunnels. This is particularly the case where the use of turbines is contemplated, and this consideration is frequently sufficient to annihilate the expediency of thus attempting to utilize a known and otherwise available source of power.

These adverse conditions are forcibly illustrated in the mountainous districts of the North American Continent. Water power is there in abundance, but it is that of mountain torrents: as a rule inconsiderable in volume of water, but, on account of the configuration of the country, affording large heads. The latter circumstance makes any constructive work very costly, and in most instances would put the use of an ordinary turbine out of the question.

It was from such causes that the Western States became the birthplace of that system of water power of which the essential feature is an impulse water wheel. The simplification made possible in this system is that of the substitution of a pipe and nozzle of insignificant dimensions for the massive head race and wheel pit associated with the use of a turbine.

The first impulse wheels brought into use were of the very crudest description; with the increasing use of the system, however, came the development which attends every invention which has a large field of usefulness open to it. The impulse wheel of the present day ranks as fairly efficient among the various means of utilizing natural energy.

At this stage it becomes a question to what extent it may be desirable to employ the impulse wheel outside the conditions under which it first sprang into existence. This problem is specially interesting in a country where there is an abundance of water power, and at a time when the utilization of water power is assuming the place of one of the most important engineering questions of the day. The object of this paper is to record the results of some experimental research on this subject, and also to discuss the question by the light of those results and from other considerations.

The history of the development of the impulse water wheel may advantageously be sketched briefly. The first wheels of this class were simply provided with flat projections on the rim of the wheel, and the jet was arranged to impinge normally on these flat surfaces. This was what was known as the hurdy-gurdy. It can easily be shown from theoretical considerations that the ideal efficiency of such a wheel is 50 per cent., but it is probable that most of those in use did not give a greater efficiency th n from 20 to 30 per cent.

The first notable improvement was that of substituting hollow cups for the flat vanes, so that the jet struck the interior part of the cup and was deflected back again until it left the vane, traveling, with respect to the vane, in almost the opposite direction to that in which it was traveling before impact. This formation at once largely increased the efficiency, but in practice the efficiency was still far from what it theoretically might be.

The next modification was that of so curving the surface of the cup that the jet might follow the surface with very little deviation at the first point of contact. Thus some wheels are formed with a conical projection in the interior of the cup at the point where the jet strikes the surface, so that the water on striking may begin to pass along the generating lines of the cove, and may gradually be deflected further to follow the curved sides of the interior of the vane. The more common construction is to place a wedge-shaped projection across the interior of the cup or vane. This modification was introduced about 1880. The function of the wedge is two-fold.

(1) To prevent the heaping of dead water upon the vane during its passage through the arc of action, or the part of its path in which the vane receives the jet of water. (2) To give the diverted streams a direction of motion which will finally carry them clear of the wheel.

In a bucket unprovided with any conical or wedge-shaped projection, there is no sudden angular deflection of the water. Some of the water is heaped upon the flat surface upon which the jet is impinging, thereby forming a curved surface over which the following water is deflected. With a stationary vane on which the stream is continuously playing, the loss of force due to this cause is very slight. When, however, the impact is taking place intermittently on a moving vane, the dead water is discharged after very inefficient action at the end of every short period of action, and the total loss in effective work may be considerable. This loss is reduced by placing a solid projection in the bucket, which takes the place of that formed by the water and leaves all the water free to be deflected in the most efficient manner. As regards the second function of the wedge, it is well known that when a stream of water strikes normally upon a surface, it is deflected equally in all directions. This is illustrated in the wheel bucket. The same action takes place when the stream strikes centrally upon the apex of a cone. This is undesirable in the case of the vane of a water wheel, as the water which is deflected towards the centre of the wheel gets into position to strike the back of the following vane, thus opposing the useful effect of the action. Then the jet strikes a wedge, it is cut into two portions, which are deflected away from one another in a plane perpendicular to the cutting edge of the wedge. In a wheel this motion causes the water to be discharged at each side of the wheel where it is free from all liability to interfere with any following parts of the wheel.

Numerous modifications of the form of the curved surfaces of the buckets have been brought out at different times by inventors with a view of modifying the passage of the water over the vane in some particular, but it is not necessary to describe them more particularly.

Of the impulse wheels in use at the present day the best known is probably the Pelton water wheel. These wheels are made in sizes varying from 6 in. to 6 ft. in diameter, according to the head of water available, and the velocity required. These wheels have been applied under heads ranging up to 1,700 feet, and, as has been said, there is no doubt that under such conditions the highest efficiency is realized. On the other hand, there are said to be instances in which Pelton wheels are running with good results under heads of from 50 to 75 feet.

The writer recently made a series of tests on a small wheel of this class, catalogued as the Pelton Motor No. 3. This wheel is approximately 18 in. in diameter, and the weight of the whole machine is given as 320 pounds.

The tests were made in the hydraulic laboratory of McGill University, and a brief description of the methods employed will be given. It was impossible to make tests with heads as high as some of those under which these motors run. The maximum head employed was that afforded by the city supply from the high-level reservoir, which gives a pressure of 125 lbs. per square in. in the laboratory, equivalent to a head of 290 feet. Lower pressures were also obtained by throttling the supply from the same source. These trials will give an idea of what may be expected of this type of motor when used under ordinary heads of from 100 to 300 feet. In many districts these are as large heads as are commonly met with. Also, where it is proposed to take power from a water-works system, the pressure under which water is supplied would rarely exceed 125 lbs. per square inch. In the present series of trials the wheel tested was small compared with many in use: the effective work done did not in any case exceed 7 horse-power. There is no doubt that with a machine designed on a larger scale, as with larger heads, the efficiency would show some increase over the values found in the present case. The results obtained in these experiments are offered as bearing directly on the question of the utilization of this system for small amounts of power under the conditions usually met with in districts outside those referred to as abounding in very high falls of water. With reason and judgment, the general conclusions arrived at by the consideration of these results may be extended to cases where the machinery and the generation of power is on a larger scale.

For the purposes of trial the wheel was set up as received from the makers, and the auxiliary apparatus was fitted in accordance with their instructions. The water, after passing through the valve which was used to regulate the pressure, was led along a length of 2½-inch pipe straight for 8 or 10 feet before reaching the nozzle. A Bourdon gauge was fitted on the supply-pipe less than one foot from the mouth of the nozzle-tip. This gauge was arranged on a pressure-chamber, enveloping the pipe and communicating with the interior through a series of small holes. Before being used the gauge was calibrated by means of a gauge tester. In the experiments the pressure in the pipe of course varied slightly. The pressure was read at intervals of one or two minutes, and the mean value during the whole trial was accepted as the pressure under which the flow took place. The extreme variation of the pressure was about one pound per square inch.

Three different sized nozzle tips were supplied with the wheel. These nozzles tapered gradually on the inside from the diameter of the supply pipe to that of the actual orifice. The outlet diameters were: .5277 in., .6307 in., .7532 in. Sets of trials were made, using the largest and smallest of these nozzle tips, the largest giving the more satisfactory results. The water was discharged from the motor into a flume beneath, whence it ran into measuring tanks, and all the water used was thus actually measured. For the purposes of these trials two tanks were used, each of the capacity of 1,000 gallons; these had both been previously calibrated. The power given by the wheel was estimated by means of an absorption brake and a revolution counter. The shaft was provided with an 18-in. diameter brake wheel of special design, and the power was taken off this. In the earlier trials the brake consisted of one or more cords embracing a suitable arc of the periphery of the brake wheel, and having spring balances attached to the tight and slack ends to indicate the corresponding tensions in the cord. As the power varied slightly all the time, both readings were taken at intervals of one or two minutes, and the means used in calculating the final result of the trial. Later a direct-reading, self-adjusting brake, designed by Mr. Withycombe, was substituted for the cords and spring balances with very satisfactory results.

An ordinary revolution counter was used, but arranged to be thrown in and out of engagement with the shaft at the beginning and end of each trial. The necessary readings could thus be made at leisure, ensuring greater accuracy.

In addition to the revolution counter a tachometer was connected to the shaft. This served as a guide when adjusting the load on the brake wheel previous to a trial to give a desired speed of running. It also served to indicate any considerable departure from the intended speed which might take place during a trial, and which would vitiate the accuracy of the calculated results.

Before passing to the examination of the experimental results of the trials, it may be well to make a brief theoretical analysis of the subject. The elementary theory of an impulse wheel is very simple—so simple, indeed, that no attempt seems to have been made to consider to what extent known and observable phenomena may modify theoretical calculations; but rather the elementary theoretical result is generally taken as the last word which can be said on the subject from a theoretical point of view.

In the following investigation the efficiency is deduced from a consideration of the circumstances, as far as they can be mathematically expressed, under which the mechanical action takes place.

In the elementary theory of the impulse water wheel the assumptions generally made are substantially as follows:

1. That the jet has the theoretical velocity due to the available head of water. 2. That the jet strikes the vane centrally and tangentially to the wheel. 3. That the jet passes over the surface of the vane without any loss of relative velocity. 4. That the vane is so formed as to turn the stream through an angle of 180 deg. completely back on itself.

(To be Continued.)

FIRES AND FIRE-PROOF CONSTRUCTION.

Editor CANADIAN ENGINEER:

SIR,—I have, as requested, looked through the pamphlet you were kind enough to send me, on the Paris Charity Bazar Fire, by Arch. E. O. Sachs, author of Fires and Public Entertainments, Modern Opera Houses and Theatres, etc.

This paper was prepared by the author for the Architectural Association, and read at its second ordinary meeting, session of 1897 98, Hampden W. Pratt, F.R.I.B.A., president, in the chair, and was commented on after its reading by Richard Roberts, L.C.C., vice-chairman Theatres Committee, London County Council; Sid. Gamble, A.M.-Inst. C.E., F.S.I., second officer Metropolitan Fire Brigade, Major Fox, chief officer Salvage Corps; Thomas Blashill, F.R.I.B.A., F.S.I., superintending architect London Common Council; Capt. Dyson, chief officer Windsor Fire Brigade; William Archer; Henry Lovegrove, A.R.I.B.A., F.S.I., district surveyor for Shoreditch; Max Clarke, A.R.I.B.A. It has been published by the British Fire Prevention Committee, C. and E. Layton, publishers, Farringdon street, London.

I find the consensus of opinion in this case to be that while the fire was caused by an explosion of some of the essential oils used in the exhibition of the Kinemetographic views, the conflagration and the destruction of the building were disastrously hastened by the fact of the roof drapery having been immediately ignited by the explosion, the flames in an instant running along the whole building, some 300 feet in length by about 40 in breadth, setting fire to the woodwork and flimsy paper and other decorations of the interior, which, falling from above directly onto the heads of the lightly-clad ladies in attendance, set fire to their hair, their head gear and dresses, thus causing the simultaneous and almost instantanoous death of 124 persons on whose heads and shoulders at the same time the broken glass from the continuous skylight was falling, cutting into their flesh and inflicting painful wounds and bruises. Still, quick as the destructive element was in bringing about this most terrible result, the committee is of opinion that had the several emergency doors which were barred and bolted at the time, been opened as they should have been by persons told off in advance to do the duty, not one half of the fatalities would have occurred, maybe not one tenth of them, as the victims issuing into the open could have been cared for by outsiders, who would have seen to the safety of all of them and have probably reduced the casualties in most cases to more or less severe injuries to be got over in course of time.

Mr. Sachs recalled the Vienna Ring Theatre fire of 1881, with its 450 fatalities; the Opera Comique fire in 1887, with a death roll of 115, and other great catastrophes; the Exeter theatre fire of 1887, where 160 lives were lost, followed by a serious fire at Oporto with the loss of another 100 lives. He might also have remembered the Bordeaux theatre fire, the Santiago church horror, where 2,000 souls were hurled into eternity, and the Brooklyn theatre fire of 1872 (I believe), where 276 more lives were sacrificed. Mr. Sachs comments upon the fact of how soon these disasters fade from memory, most of them, he says, having been forgotten within from three to seven days of their occurrence.

The London Committee calls on Parliament, or intends doing so, to interfere and force municipalities to attend to the safety of the public by refusing to sanction the erection of such flimsy and dangerous structures and decorations, and I am certainly at one with the committee in refusing to understand how it is to be considered as interfering with the individual liberty and action to enact such laws, any more than legislating on compulsory vaccination and other hygienic safeguards to the public health: for, as above set forth, there is no doubt that, had not the incriminating ceiling cloths been there, or one of asbestos or other inflammable material, and parties at hand to open the seven doors of the building aggregating some 40 feet in width, the Charity Bazar horror would not have been to any extent as serious as it has proved to be.

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