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CONTENTS OF THIS NUMBER:

PNEUMATIC POWER IN WORKSHOPS *

BY JOHN DAVIS BARNETT, M. CAN. SOC. C.E., STRATFORD.

In the early days of ironworking the tools were usually brought to the work, and they were manual. Later, as tools increased in size and stiffness, the work was brought to the machine and moved with it under or against the tool. To-day, in many operations, the bulk of metal to be handled is getting so unwieldy that it is again proving common practice to carry the machine tool to the work. Electrical and air motors are certainly factors in this evolution, even if not largely responsible for it. This paper proposes putting on record the present position of air power, as part of a craft, illustrated more especially by railway shop-work.

A natural hope, then, would be that the author should give figures, comparative between air-driven, water-driven, electrically-driven and shaft-driven machines.† Such figures the author cannot give from his own experiments, and after wide search is of the opinion that at the present day they have not been obtained; therefore, this paper must be qualitative rather than quantitative.

The author does not intend to say that air, for continuous work in plate flanging, or for high pressures in stamping and forging, is a more economical transmitter of power than water, or that pipes, air engines and motors are better or cheaper than wires and electric motors, or independent air-driven tools than steam applied through shafting and belts to a compact group of machine tools, but he is of the opinion that if many widely scattered, different and intermediate operations are to be performed; if a cold climate has to be fought; if the technical skill and knowledge of the workman employed is limited; and if the special and portable tools are more or less of home design and manufacture to suit the particular and limiting conditions of their use, then air has efficiency, economy and a wide field of usefulness. For the many and varied services it now is used in and about a railway, see the appendix. The common opinion that the compressing of air was costly and power transmission by it wasteful, has been the main obstacle to its more extended use. Prof. J. T. Nicolson, M.C.S.C.E., has (in Transactions, v. 7, p. 79) clearly proved that there is no difficulty or great first cost in securing a mechanical efficiency of 86 per cent., a thermodynamic of 92, and a main (pipe) efficiency of 96.2; and re-warming the air near to the motor, that he recommends, the author finds in practice to be easy, cheap, and so effective as to tempt him to emphasize Prof. Unwin, who says (Proceedings I.C.E., v. 105, p. 202) heat applied in re-warming compressed air is used nearly five times as efficiently as an equal amount of heat employed in generating steam.

The data and recorded experience in compressors and compressing are enormous, and do not require our attention, except to note that for delivering small volumes of air a staple article of machinery supply on the market to-day is belted-compressors, worked from the shop shafting, having single acting pistons, compound pump chambers, and intermediate air cooler, doing the compressing in two or more stages. They are automatic in action, that is, when the receiving reservoir is above normal pressure the driving belt is moved across from the fast to the loose pulley (both on the crank shaft) by means of a small air cylinder, whose piston rod is coupled direct to the belt shifter; the admission of the compressed air to this small shifting cylinder being controlled by the movement of a diaphragm, whose under side is open to the receiver pressure, and whose lift is controlled by an ordinary safety valve lever, carrying a sliding balance weight, adjustable at will. If the demand be very irregular as to amount, several such belted compressors have been used coupled up in automatic series. Also, pressure from the receiver has been used to throw a friction clutch in and out of gear, and thus secure the intermittent action of a belted compressor. For compressors generally it may be said that it is advisable, where possible, to use large units, run at fairly moderate speeds; to take the air in as free from dust as possible—the author takes it from under the external eave-trough—also to take in the coldest air possible, as for each 5° lower temperature of the entering air there is said to be a one per cent. increased efficiency in the compressor.

The shop piping or main for ordinary pressures (80 to 100 lbs.), should not be less than 1½-inch diameter, the larger the better. The author having four inch pipe spare on hand, used it with great satisfaction, as it gave ample power storage and little friction. Very slight provision is required for drainage. The main is best carried on the top of the roof tie beam, and

*A paper read before the Can. Society of Civil Engineers at the summer Convention, Toronto, June 18th.

†For such an economical comparison between small motors see Proceedings I.C.E., vol. 105, p. 308.

from the first should be liberally supplied with short branches and outlet valves, at least one to every 18 or 20 feet, with screwed ends to fit the union nuts of the flexible hose, the hose for hand tools and hoists varying from ⅜ inch to ½ inch diameter. Cords from the outlet valve lever run down to within 7 feet of the floor, controlling the position of the valve. Reservoir storage has to be proportionately the larger the more intermittent the work done—that is, the greater the extreme call for air compared with the maximum delivery of the compressor. The pipes and reservoir together should be capable of holding the total delivery of the compressor (working at normal speed), for half an hour, which is far cheaper than providing an excessively large size compressor, cheaper not only in first cost, but in daily working. This refers to steam power compressors, which are run to disadvantage at speeds so slow as to make uncertain if the fly-wheel is going to carry the crank well over its dead centre, and also the condensation on the cylinder walls, etc., is then excessive.

In ordinary compact factories, with fairly efficient steam plant, the gross cost of the motive power, that is, of fuel, oil and water, is but one per cent. of the total paid out in workmen's wages. In ironworking pneumatic power often increases a man's output of work 200 per cent. (threefold). For argument sake allow that it is only doubled. Then, if supplying one man with his proportion of the motive power were by the use of air to increase his proportion of the motive power cost by 50 per cent., it is evident we should then have a similar 50 per cent. margin for profit. As the actual cost is nearer 5 per cent., there is evidently a wide margin for extra outlay in machines or in their repair, which expenditure, per day or per man, is increased in the attempt to use pneumatic power, but in the cost of such tools as drills, rhymers, taps, boring cutters, etc., is not increased per foot run of actual work done, when compared with manual labor. Thus it is clear that if the additional machinery a factory makes or purchases in trying to use air as a distributor of power, is confined to such tools as will be often or fairly continuously used, this outlay is justified, and the cost of compressing relatively to total wages is so small that tools evidently wasteful in the use of air are economical, or rather show a net balance to the good, if the men find them portable, easily adjustable and handy to use, and their simplicity of make and freedom from repairs and breakdowns, results in but few delays to the steady output of work.

It is evident that the use of compressed air has stimulated the use of rotary-motors, and not because it was believed that they were economical converters, but because their light weight and small bulk permitted them to be used by hand. However, the making of a more perfect air engine than the steam rotaries, for which so many designs were made and patents taken out between 1830-50, has been attempted, but it is questionable if any advance has been made. The author has no information as to any attempt to use a reaction or impact turbine as a portable air motor. What has probably discouraged this is that the necessity to gear down the high speed would make the engine weighty and the friction excessive, although, as air at the same pressure is twice as heavy as steam, it looks as if air would do well in such a form of reaction engine. The most simple form of rotary motor is an eccentric or cam, forming part of the central shaft, whose length is that of the cylinder in which it rotates, and whose outer surface (belly) touches in the course of one revolution the whole internal circumference of the cylinder. A reciprocating plate moved in centrally from the cylinder wall receives the backward thrust of the air. The admission port is in front of this plate, and the exhaust port at its rear. So made, the small sizes to be held by hand, when at work, give an irregular, wobbling motion, as the shaft—or plug as it is called—is unbalanced. This long ago provoked the use of two parallel shafts or cams geared together, but the author must confess to a failure in an attempt to reverse a form of the Root blower, using it as a small motor. The later attempts make the cylinder in cross-section oval or elliptic, with several inlets and ports in its walls. The shaft, which is as large as the minor diameter of the ellipse, carries two or four movable blades or pistons in its body, whose outer edges are kept in contact with the varying walls of the cylinder, not by steel springs, but by the admission of compressed air to the bottom of the slots of the shaft in which each radial piston blade plays in and out. Without dispute, the leakage is large, judged by the standard of a reciprocating steam piston, in part due to the several reciprocating blades being subject to wear on their three outer edges, as well as looseness in their shaft slots, and also in part due to the fact that with air and steam under exactly similar conditions of surface, of metal, and of pressure, air will get past any packing more readily than steam will pass it. A suggested explanation for this is that the film of water that condensation leaves on the steam walls retards the passage of steam between smooth metal surfaces. The dynamic efficiency of such motors is low, so low as to apparently discourage any attempt at metering, indicating or brake-testing them, yet many wideawake shop managers use them in direct application to drills and taps, because, communicating a cutting speed from five to twenty times higher than can be given to the same tool by hand, they, therefore, prove cheap, although lavish in the use of air.

At the sacrifice of perfect portability much is gained by using small reciprocating engines, weighing from 100 to 200 lbs., with two to four cylinders receiving air pressure on one side only of the pistons.

Their light weight permits one man to readily move them over the shop floor; having no dead centre, gives prompt starting and regularity of turning movement; low centre of gravity gives steadiness; the strain being always in thrust, the engine is practically noiseless, and the elasticity of the air can be utilized in expansive working. The author uses double acting vertical engines (steam hammer type) of home manufacture, with single cylinder 3½ inches diameter by 6 inches stroke, averaging, with 80 lbs. pressure, 225 revolutions per minute. To re-warm the air just before it enters the valve-chest, it is passed through a 30-inch length of thin copper pipe, ⅝ inch outside diameter, bent into a four-turn truncated coil, barely 3½ inches diameter at base and 2¼ inches diameter at top, contained in a tin lamp 12 inches long by 3½ inches diameter at bottom and 1½ inches diameter at top. The lamp cistern carries a double "B" burner, using two ⅞-inch flat wicks, and burns an imperial pint of common coal oil each 30 hours. No glass chimney is required, and the flames come close to inside of coil. This lamp is bolted on close to and parallel with the cylinder, and is cheap, neat, and inconspicuous, working satisfactorily even when the engine is set at an angle of 15° or 20° out of vertical.

In transmitting motion from an independent engine on shop floor to the drill or tap, an endless cord ¾ inch or ⅞ inch diameter has been used, with light weight grooved pullies, the whole kept in tension by counterweights. This gear proved to be a nuisance because of the amount of tackle and number of pulleys required to change direction of motion. The "Stowe flexible shaft" has also been used. Even this requires a universal coupling joint at one end to meet many conditions of shop service, lengthening it from 8 feet to 8½ feet, the total weight for a No. 8 size being 65 lbs. Its life is short, the repairs excessive, the power it will transmit is small, and to do it the speed of revolution must be high; thus the head for drill or tap must be geared down and therefore made larger and heavier than is required when shaft and tool are revolving at the same speed. A shaft more certain in action, quite as portable, and having longer life, is made by using a steel rod 1 inch diameter, sliding freely inside an iron pipe 1$\frac{5}{16}$ inches outside diameter, with a universal coupling at each end. A shallow groove the whole length of the shaft and narrow feathers on the inside of the pipe insure that both revolve together; the weight of the whole is 35 lbs., and it is usually sustained by a central cord counterweighted. The ordinary length is 7½ feet, extensible to 12 feet, but by using standard gas pipe thread for all connections, duplicate parts can at any time, if required, be added, increasing the length. It effectively transmits from 200 to 300 revolutions per minute with either or both short ends set at an angle of 35° with the central length. For the convenience of the workman the portable tapping head is a light frame, with two and even three handles, carrying a pair of bevel-toothed wheels changing the plane of rotation, and permitting the man to guide or to put personal pressure on directly behind the tap, while its spindle is receiving motion from the side. The speed is such that a tap of 11 threads per inch with rhymering end to it, in all about 18 inches long, is screwed through both steel plates forming the water space inclosing a locomotive fire-box, in from 50 to 60 seconds. The drill press is of course somewhat stouter, having to carry the feed pressure screw.

The standard shape of pneumatic hand hammer (of any American patent) suggests an overgrown pistol, weighing from 8 to 9 lbs. In the smaller sizes the contained piston has a stroke of 2 or 2¼ inches, and strikes directly on the end of the cutting chisel or other independent tool, which moves freely in a socket at the centre of the outer end of the pistol. This loose tool, of ¾ octagon bar steel 6 or 7 inches long, is at outer end shaped to suit its special work, as riveting, nailing, chipping, caulking, beading, engraving, chasing, stonecutting or planishing. Quite recently an improvement has been made in this all-round useful instrument by increasing its piston stroke to 4 inches, and putting the pistol in a tubular case of cast iron weighing 80 lbs. or more. Its mass absorbs most of the reaction blow which the workman found so distressing to nerve and muscle, but as it requires to be suspended and counterweighed, it is necessarily not as portable, and cannot be used under conditions as confined and awkward as the hammer of shorter stroke and lighter weight. The hose is ⅜ inch diameter, and the pressure used from 20 to 100 lbs. As the latter hammer delivers 2,000 or more blows per minute, using of free air per minute 15 cubic feet at 60 lbs., 18 cubic feet at 75 lbs., and 21 cubic feet at 90 lbs., it readily does the work of three men; four is claimed and is possible under some awkward conditions. Men on piecework provided with such a hammer, accept one-third the old piecework price. Their cost, duty and freight paid, is from $150 to $160, and much of their product is decidedly superior to hand work. This is especially seen in beading over the ends of boiler tubes. Air is used in ordinary vertical smithy hammers, having cylinders 10 inches by 28 inches, with what economy is not known, but as no choking exhaust pipe is needed, the exhaust is very free.

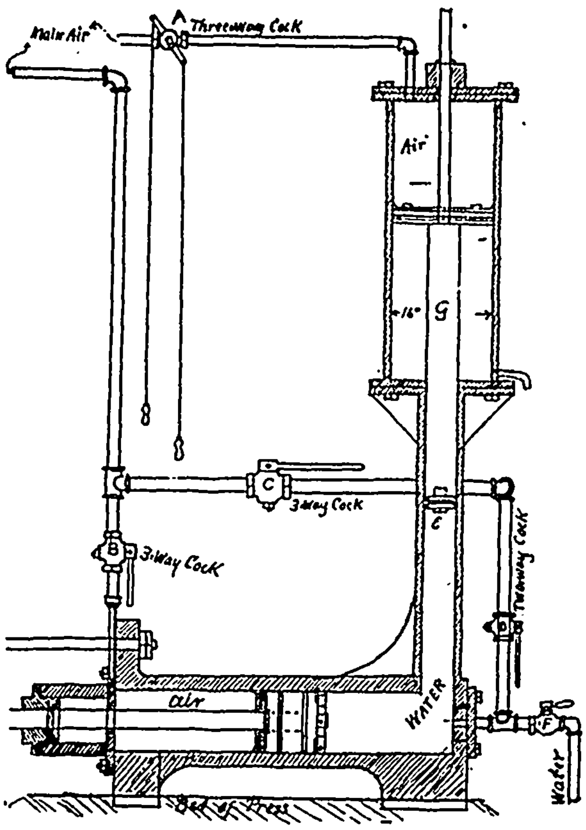
Riveting tools require little special mention, as any power riveting tool, acting by a single steady squeeze from water or steam, may be worked by air. At most the change is but one of valve or cock, so that all power movements are controlled by one handle, and if desired, the exhaust air may be directed on to the cooling rivet, as in some cases it is on the point of a drill to keep it cool. The pneumatic hand-hammer (with its rapid delivery of blows) is well suited for light tank work, that is, for rivets up to ½ inch diameter. The use of this tool—as in hand riveting—requires a holder-up. The number of rivets put home per hour, dependent on size, is increased from 50 to 100 per cent. over hand labor. The unpleasant noise it makes is in some quarters an obstacle to its increased use, and as its quickly repeated blow helps to keep up the heat of the rivet, it is probable that this rapid impact hammer will not prove to be as satisfactory on steam joints as it is on tank work, because, in hydraulic riveting, where the dead pressure can be held on the rivet while it is cooling, the amount of caulking required to finish and make a tight dry job is three or four times more than that usually required to make equally good a hand riveted boiler.

Common shop practice in the home manufacture of air lifts is to use for the cylindrical barrels seamless tubes of iron or brass, smoothed internally by forcing a slug through; for the piston rod cold rolled steel screwed at its lower end into the lifting hook shackle, and for piston head two cast iron disks with one thickness of leather packing between. To secure the satisfactory action of this leather packing a sprung ring of round steel or brass wire cut shorter than the barrel circumference, and bent larger than its diameter, is put inside the turned over edge of the leather packing, and the lower and smaller of the iron disks has cast in it, in its outer upper edge, a recess to clear and allow for the free play of this sprung wire ring. The two cast heads or covers, and the barrel which is slightly recessed into them, are held together by through bolts, outside the barrel. So made, of medium length, a 4-inch costs $18 and a 6-inch $28. Under such conditions of cheap make, the friction of working varies from 3 per cent. in the large sizes to 20 per cent. in the very small, that is 4-inch and under. This compares favorably with epicycloidal and differential hoisting tackle, but lacks, of course, its certainty of sustaining power. If two cast-iron sprung rings are used as packing in a solid piston head, the barrel needs boring out from end to end, and if not in fairly continuous use is liable to have the friction increased by rust. In a spring testing machine made by the author, with two cast iron spring rings ½ in. wide by ⅜ in. thick, working in a 20-in. cylinder, new and well lubricated, it took 100 pounds to start the piston, as indicated by a Salter balance, and 90 lbs. to keep it moving. In so simple a type of hoist it is a matter of indifference which way the cylinder is set. Given sufficient head room it is suspended vertically from a two-wheeled tandem trolley moving on a single bar runway, so that load, hoist and trolley have horizontal freedom. If head room is wanting it is set horizontally, and the outer end of the piston rod coupled to a chain passing over one or more pulleys, thus changing the direction of the pull, and so used the piston rod on upper surface has been notched so as to form a rack into which a pall falls, thus locking the suspended weight at any height ; and when the hoist cylinder is put on to an old hand crane it is often set at an angle, being for convenience of attachment secured to the diagonal strut. A flexible hose of small diameter gives it elastic connection with the shop air-main. The widest variation in practice is in the controlling valve used, a three-way plug-cock being the cheapest to make and the most troublesome to keep tight. Mitre valves or flat valves with recessed elastic seating are more certain. They require a separate spindle (and cotton-packed gland) for each valve, but each pair is movable by one double-ended lever. Where air enters the barrel of hoist a very small hole or self-closing check valve is desirable, so as to prevent the load running down dangerously fast in case of injury either to the air-main or to the supply hose ; also it is desirable to have a check or stop on the piston rod so coupled to valve that in case of over-stroke the valve is reversed and air is admitted to the opposite side of piston cushioning it. The same end may be attained by the piston itself striking and opening a supplementary valve, or if the non-working end of barrel is open to the atmosphere by small hole in the side of the barrel, so locating this hole that the piston will block it and the confined air act, first as a cushion and then as a stop. Such a hole sucks in the shop dust and grit, increasing friction and leakage, so that a valve admitting compressed air or exhaust air only, is the better practice. It is perhaps over the wide surface of a foundry floor, and in the midst of its sand, grit and dust, that pneumatic hoists best show their good qualities, and Russel & Co., of Massillon, O., who early appreciated their value, two years ago were using 26 cranes of 5 ton capacity, cupola stock elevator, and many simpler hoists of from 400 to 1,000 lbs. capacity. Under such shop conditions every foot of air exhausted adds to the health and comfort, and therefore working capacity of the moulders.

In trying to use a portable suspended hoist, and move it under a long length of shop roof, in most cases —even of modern equipment—the flexible air-hose has to be detached, and after the hoisting cylinder has been moved to a new location the air-hose recoupled to the air main branch. To avoid this delay and inconvenience the C. & N. W. Ry. Co. use a long length of air-hose, equal to half the total length of the runway that carries the hoist, coupling the hose to the air-main at the centre of the length of the runway. Then, at points some twenty feet or more apart, the hose is suspended from a two-inch grooved pulley running freely on a horizontally tight-stretched wire. Each such suspending pulley requires an independent wire, and the wires are arranged so as not to be in the same vertical plane. The result of this ingenious arrangement is that as the hoist moves towards the centre of its runway it crowds or loops the hose, and then when closely massed each suspending pulley runs past its neighbor as the hoist passes the centre, then, extending and straightening the looped-up hose, the hoist is free to travel as far to the left hand of the centre (or point of connection to the shop main) as it was originally to the right hand of that point. R. Quayle is so far satisfied with this plan that he has now underway some such arrangement to permit a jib crane, traveling on a single floor rail, to propel itself or to hoist at any point in the length of a 500 feet shop.

The most obvious advantage of air over water as a transmitter of power is its freedom from frost troubles. It is, however, possible under some conditions to effectively combine the two, not only without frost risk, but with added economy and a much wider range of application, without the machine being so large as to interfere with the workman's freedom of movement and his ease in handling the material to and from the tool. This is done by using a pair of tandem differential cylinders, the outer or upper side of the piston of the larger receiving the full air pressure and delivering that power through the piston rod at higher pressure per square inch to the water contained in the smaller cylinder. A third and independent piston at opposite end of small cylinder is coupled direct through its piston rod to the forging die. As developed in detail by J. W. Harkom, M.C.S.C.E., at Toronto, the differential cylinders are vertical, the large (air) cylinder being high up—that is, well above the working level of the man—and the smaller cylinder is made longer than its piston travel, and just above ground level opens direct into a third cylinder, set horizontally. The second and third cylinders are actually one and the same, but in the middle of its length is bent to a right angle, and has a piston at each end not coupled together, so that the distance between these pistons is variable, and the space between them filled with water admitted by valve from the city mains. The piston rod of the third or horizontal cylinder at its outer end carries the forging die, and the piston has water pressure on one side and air pressure on its relief side, so as to carry the die back after the forging squeeze has been given. All the fluid used is that contained between the two small pistons, and is a quantity variable at will, and this is the key to the economy in the volume of the air used. The dies being variable in depth, and the forgings in thickness, the position of the third piston should be variable in position, both before and after the forging movement. When the movement for any particular set of forgings is to be small, the maximum quantity of water is forced in by opening a valve coupled to the city water-main, which lifts the large air piston up closer to the top cover of the large cylinder, and thus effectually shortens its possible length of stroke. If the amount of water (and, therefore, the distance between the two small pistons) was not definitely adjustable, there would be a large loss of air when a small die were in use—or a shallow forging being made—due to the necessary filling and emptying of the cubic contents of the large cylinder at each stroke. The return (after making a stroke) of all pistons is assisted by compensating balance weights, coupled by chains to the piston-rods or tail-rods, and air pressure being always on the relief side of the forging (third) piston, the die is withdrawn from the forging as soon as the air is permitted to escape from the top of the large air cylinder. This is controlled by a three-way cock overhead, with two light cords coupled to its double ended lever, the handles on lower ends of cord just clearing the workmen's heads. Opening a single drain-cock at lowest level gets rid of all the water when men leave the shop at night.

It is an advantage in trying to secure perfect alignment in the boring and planing of large cylinders, pump barrels, etc., that both these operations be done on the one machine table without resetting the work, and this has of late been done by M. C. Bullock Co. of Chicago,* the one operation following the other, but with a suitable air motor and flexible hose it should not be difficult to do both operations at once, although the author is



not familiar with any portable air motor on the market powerful enough to do the boring in as short a time as the planing usually occupies. It is also possible to do the milling out of the steamports by a second air motor while the boring is being finished, the whole needing but one attendant, as when on piecework one man regularly attends to three milling machines.

To summarize, air is in practice proving to be a fairly cheap and most convenient transmitter of power, allowing fine subdivision and transportation to remote points, with the crowning and unique quality of suffering no appreciable loss when held in storage. For intermittent service it is of great value, allowing widely varying speed of tools, dispensing with long lines of shafting and belts, giving free head room, and increasing the shop light as well as lessening the first cost of roof frames when they have not to carry shafting. The pipes require no coating; they radiate no heat, and therefore can be put in close corners without increasing the fire risk; their direction is readily changed in any plane without risk of pocketing or water-hammer, and leaky joints (we all get them) are not a nuisance or a risk. In no case are exhaust pipes required, and in most if not all cases the exhaust adds to the men's comfort.

APPENDIX.

LIST OF PNEUMATIC TOOLS AND MACHINES AT THE TOPEKA WORKSHOPS OF THE A. T. AND S. F. RY.

One riveting machine of 10 ft. reach, with pneumatic crane, 1 riveting machine of 6 ft. reach with frame, 1 combination flange punch and riveter, 2 truck riveters, 1 bridge riveter, 1 frame riveter, 1 tank riveter, 1 mud-ring riveter, 1 staybolt breaker, 1 staybolt cutter (nipper), 20 rotary motors, 4 brotherhood engines, 1 grinder, 1 saw, 6 hammers (hand), 1 punch, 1 angle-iron shears, 1 bolt machine, 3 hammers in smithy, 1 large punch and shears, 1 bulldozer, 1 rail saw, 1 rail drill, 2 rail benders, 1 stamping machine for tin shop, 1 bolt shearer, 1 port miller, 3 letter presses, 6 pulling down jacks, 12 car jacks, 2 drawbar jacks, 3 painting machines, 1 washer maker, 3 rivet holders, 2 tube rollers, 8 pumps, 1 transfer table, 1 driving wheel revolver used in setting slide valves, 30 hoists in shop, 3 hoists 10 feet lift outside, 1 device for handling oil, 1 hose coupling fitter, 1 tool for tearing down old car roofs, 1 drop pit, 1 device for delivering sand, 1 device for extracting oil from waste, etc., 1 shunting locomotive (traction engine), 1 device for securing sheets at flange fire, 1 device for cleaning coach cushions, 3 paint burners, 1 whitewashing machine, 1 device for handling work in brass foundry, 1 turntable revolver.

Air is also used for testing brakes in shop and yard, cleaning boiler flues, cleaning the shops and engines, and in self-moving dead locomotives from erecting to paint shop. Although this makes a good show for one set of shops, it is far from marking the limit of compressed air as applied in railway service to-day. It is used for moving crossing gates; track interlocked derailers; single semaphores and semaphores interlocked with switches and gates, and this, too, at points 18 miles away from the compressing plant; in timber preserving by injection; in moving capstans and winches for hauling and shunting purposes; in coaling locomotive tenders; in lifting their ashes out; in sifting, lifting and delivering sand to locomotives; in delivering sand to rail; actuating whistle signal; moving the rocking firegrate; opening the firehole door; ringing the bell, and perhaps the best known of all, in actuating the continuous automatic brake. Also on other rolling stock for controlling snow-plow wings and aprons; ice flanges and scrapers; doors of dump and drop-bottom cars, and for tilting ballast cars; and inside shops for bending pipes; cleaning pipes from internal scale; testing pipes and their jointing; with gas jets for heating tires and other rings of metal; as a blow pipe for straightening bent wrought iron frames; for spraying fuel into oil furnaces; for belt shifting on counter shafts; for machine brakes to stop tools at a definite point: for supplementing the wheel and axle hydraulic press; for axle box and journal press; with sand as sandblast for cutting and scouring; and for scrap shears and scrap tumblers at far end of yard where the noise is least annoying, and where there is ample space for scrap sorting.

DISCUSSION BY THE C.S.C.E. OF PNEUMATIC POWER APPLIED TO WORKSHOPS.

After the reading of this paper the following discussion took place:—

The Chairman: You have before you this morning a paper of immense practical value from one who is a practical engineer and who has for several years had practical experience of air machines. The subject is dealt with in very plain and simple language, and which lays before each one of us the great advantage of air as one of the powers to be applied to manufacturing purposes.

Mr. Barnett mentioned that one of the items named in the appendix is that air is used for whitewashing. Now, that may seem a very small business to bring before a body of learned men. Nevertheless, the whitewashing of a large shop 120 feet wide and 300 or 400 feet long, the point of its roof being 90 feet above the floor level, is an awkward and expensive job when done by hand under the old arrangement. The operation with compressed air is very simple. The whitewash is made and run through a very fine sieve, three or four pounds of tallow being put with each barrel of whitewash, making a sort of emulsion. This is put into

*American Machinist, January 2, 1896.

an iron barrel and the air pressure let in on the top. A pipe from below communicates with the hose, to which is attached a branch about 10 feet long, made of ¾ pipe, so as to give the operator great freedom of swing. The nozzle is 2¼ or 2½ inches wide and barely 1-16 of an inch in depth. The natural result of allowing the whitewash to be delivered from such a nozzle of course would be to deliver it as fluid; but as it is necessary to deliver the whitewash in the shape of a spray, a small pipe is put in at the base of the hose to permit the air to enter, forming the central jet in the middle of what might be called the column of fluid whitewash, acting as an injector That turns the whitewash into very fine spray. There will be no success if the whitewash is not turned into spray. Whitewash applied as described adhered with such tenacity to the windows, which by neglect were left uncovered, that it cost sixty cents to clean each window in the shop. The whitewash holds on to brick work and wood work with a very firm grasp indeed. Th whitewash was lime and water, with three or four pounds of tallow added when the lime was being slacked and mixed up. The presence of the tallow could scarcely be recognized in the whitewash itself, but it does increase the tenacity. In the second operation the windows were protected from the spray by covering them with paper felt.

For THE CANADIAN ENGINEER.

THE POWER OF THE FUTURE.

BY THOMAS FROOD.

I.

Steam has had its day, and a glorious triumph it has achieved; gas and electricity now contend for the primacy, and at present writing gas leads by a head. That what we term, for want of a better phrase, electricity, will ultimately become the primal force of earth —and, mayhap, of the universe—is my firm conviction. Meanwhile, there is a store of its lowest manifestation, viz., gravitation, running idle, enough for the needs of Ontario for the next century. In the early settlement of Ontario, harbors were the most desirable points, when wind on sails was the prime motor of commerce. Now the points to be sought after are those at which power is most accessible. Coal and gas fields, oil territory, water-power, peat bogs, and any new source of energy, will settle the sites of future industries. The iron and steel works at Hamilton are a fine illustration of present conditions; while the power companies of Niagara and Sault Ste. Marie point to the coming conditions of the industrial world. Situated at a centre of population, on a fine harbor, with excellent railway facilities, those works depend entirely on transport for any measure of success. The iron must be carried from Hastings or Algoma to meet the coke from Ohio, and be handled by men trained in the great iron centres of America or Europe. The ore must be got for a trifle, the transport down to lowest handling, and all wages cut finely to leave a margin for capital.

Now, let us select a site, say in Algoma, where a good harbor, rich ore and abundant forest combine to furnish all that is needed except the machinery and labor to turn out the finished product; where the land cleared for charcoal would furnish sustenance for the workman; where a healthy climate, pure water, abundant room to expand, and a chance of an independent home, would inspire the workman to activity and prudence; where the whiskey demon could be entirely eliminated and unsuitable associates boycotted, and which site will give best prospect of permanence? I could name sites where iron, copper, nickel, peat, hardwood, water power and shipping facilities by either water or rail could be obtained—all on one location. The older towns of Canada have had their day; and the manufacturer of the future who can find his material, food, fuel and power unlimited, will find it cheapest to carry the workmen and tools to the work, and carry out the finished commercial product for distribution.

Any attempt to convey a clear idea of the water-power now running idle in Ontario would be useless. Visit Ottawa, Hull, Arnprior, Pakenham, Almonte, Smith's Falls, Carleton Junction, Renfrew, Pembroke, Peterboro', Trenton, Niagara, the Grand River towns, the Maitland and Saugeen towns, Clarksburg, and a host of other prosperous towns maintained by water power, and we have only viewed a few *fringes* of Ontario's grand garment of power, health and beauty!

The southern watershed of the Georgian Bay alone will amply vindicate my assertion. Beginning with the Severn and Muskoka Mills, not using one-tenth of their power, take the Magnetawan, and Seguin at Parry Sound; the French with its affluents alone could supply half a million horse power within 100 miles of its mouth; the Whitefish River is good for a hundred thousand more during its course, and I have passed several really useful streams so far. The Spanish River at Ramsay is as wide as the Humber and falls nearly 100 feet before it enters Lake Huron. On its affluent, the Vermillion, above 30 available mill sites could be selected; while its affluent, the Onoping, has a fall of 150 feet in 20 chains, within sight of the C.P.R. main line. A single fall on the Spanish, three miles from the Soo Line, is 60 feet in a few rods, and one mile below Spanish Crossing it falls 20 feet in one drop. The Sable, which joins the Massey, has more power than the Gand River, if utilized equally carefully. The Blind River would rival the Credit, and the Mississagua is nearly equal to the Spanish in length and volume; while the Garden and Echo are each full of power and foam. A moderate estimate of the power flowing into Lake Huron, from below the "Soo" to Waubashene, would exceed five million horse power, which at $20 per horse power, makes a grand total large enough to pay off the debt of Toronto and leave a margin. In conclusion, the rocky banks at the falls, and the numerous lakes feeding these rivers, render the control of water and maintenance of dams much less expensive than along streams in alluvial soil, with no lakes for storage.

II.

Knowing that "capital will never prospect," but fasten its grip upon any enterprise when its success is *sure*, and it is still hampered for means to operate profitably, we will premise that a number of young mechanics combine to be their own masters, receive God's gifts at first hand and utilize all the profits of their honest labor, organize a union of interests, wide enough to include all desirable classes for a new colony, and arrange terms of admission. I would suggest making two classes of stock to suit varied circumstances: mechanics' and farmers' at $200 per share, and workmen's at $100 each, with right to raise it to the higher grade whenever the holder is able. Agree upon the enterprise to be engaged in—wood-working, mining, pulp, or a union of several, with farming in all cases. Appoint men to select a site, and inspect all its advantages and drawbacks before final location. Then pay up and bank the stock, build boarding-houses, erect mills, and make enough clearing to ensure safety from forest fires—the latter is a prime essential. You are now ready to invite colonists, and begin your electric railway, carrying your power with you as you clear the forest, carrying back logs to the mill, firewood for homes and steamers, and the workmen to and from their labor. If a live wire is used, when the track is idle, it could be cutting wood with a platinum wire incandescent, or hauling logs up by steel-wire rope and pulleys. In fact the water-power in form of electricity would accompany our pilgrims, like the stream from Horeb, to lighten their toils, supply their wants, and be a "pillar of fire" over their home at night. As soon as land enough is stripped of the forest to furnish a few fields, cattle and sheep would gladden the landscape, gardens bloom, and comfort begin to prevail. To every share a coupon might be attached, entitling holder to a village lot, a park lot, or a farm block, as he preferred. Each would thus own a spot of earth of his own as a home, and would love it as his. As the road progressed inland, new power and resources would be developed; a fresh base of supply secured where it would intersect the C.P.R.; branch lines occupy valleys leading too far from main line; mines, fire clay, mica, building stone, and other valuable materials, would be found, and what is now the wreck of the lumberman become a scene of prosperity and beauty, and a veritable backbone to the province. Mechanics, farmers, day laborers, and men of leisure, might all join in the harmonious development; the shiftless could not get in; the dissolute would find no attraction; whiskey would have no place in the plan, but the schoolmaster would be in every hamlet, and the messenger of glad tidings have a permanent pass on that railway. Managers and foremen would be elected only from shareholders and by shareholders.

In the course of sixteen years' sojourn in Eastern Algoma, half of which was spent in travelling along construction work of C.P.R., or fire ranging and prospecting for timber and minerals, I have satisfied myself that there is room for a large population of prosperous farmers and mechanics who might carry with them many of the advantages of the older settlement, as well as leave many of its drawbacks behind. Where consumption is only found in hereditary cases, ague unknown, malaria only resulting from gross neglect of drainage about sawmills, the water strong in iron and free from lime, and north of "the blizzard line" in winter, but with more sunshine in the year than anywhere further south—this district has much to commend it. All hardy fruits ripen, and the field strawberry, currant, plum and cranberry, are indigenous in every part. I might indicate four or five lines of profitable settlement, but some lawyer would be likely to take up the harbor and so block the entrance; but on general principles, I may suggest a line starting east of the outlet of French River, running north, crossing the river, touching the extreme west arm of Lake Nipissing, the C.P.R. at Markstay, and thence up Sturgeon River, etc., to James' Bay. This would all be in new territory and chiefly clay land. Another would open up the Mississagua settlements, cross near Chapleau, and follow down the Moose. The first thirty miles of this route is fairly well settled, the balance little known. Short lines by the dozen could be projected along the "Soo" line, opening good areas of land, and utilizing fine water-power.

OF MUCH INTEREST—TO US.

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For THE CANADIAN ENGINEER.

A QUESTION IN MECHANICAL DESIGN.

BY R. W. KING, M. CAN. SOC. C.E.

It is general in bicycle construction, where the pedals are screwed into the outer ends of the cranks, to have a right-hand thread in one crank and a left-hand thread in the other. Standard pedal makers also make their pedals in pairs, the spindle of one having a right-hand thread and the other a left. The question is: on which side of the bicycle should be the pedal with the left-hand thread? The reasons for asking are that somebody wants to know, and some one is not satisfied with the answer and reasons given by some who claim to know.

In the point above referred to exception has been taken to the practice carried out by some firms of bicycle manufacturers, one of whom claimed that every detail of manufacture has been based upon scientific tests, made under the guidance of a council of twenty-one "expert engineers" (names not being given). Can it be possible that in a multitude of such counsellors there is not always safety?

We take it to be admitted, in the first place, that the object for putting a right-hand thread on one pedal spindle, and a left on the other, is that the friction between the pedal and its spindle may tend to screw the spindle into the crank end, and keep the parts in place should they by accident have become loose, for the same reason that the nuts that keep the wheels on a wagon axle and such like are made with right-hand threads on the right hand side of wagon, and left-hand on the left side. That was originally a great idea, when one comes to think of it—well worthy a council of 21 engineers even, and is an abiding tribute to the ingenuity of man.

In the mechanism first referred to, the threads are found arranged as above stated; but let us examine the conditions here, as they are different to those of the wagon.

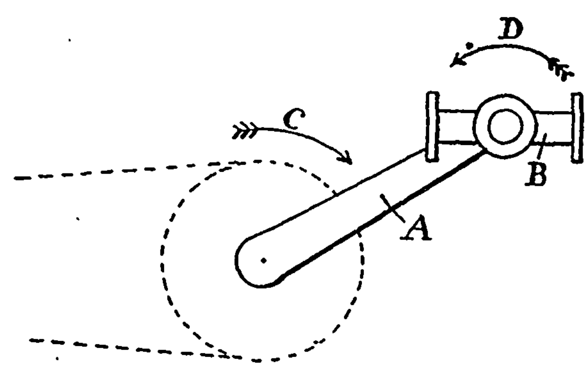


Fig. 1

Let *A*, Fig. 1, represent crank on right-hand side of bicycle, *B* the pedal, which is practically held in the same horizontal plane while forcing the crank to revolve. The revolutions of the crank round its axis being in the direction of the arrow *C*, the revolution of the pedal round its axle will evidently be in the reverse direction, as indicated by arrow *D*; therefore, ordinarily speaking, to allow for the lightening of the pedal spindle by the friction of the pedal, the thread on this spindle should be left hand. When this has been pointed out, it has been admitted correct under ordinary circumstances, namely, without ball bearings, but we are told to look further, as it has been decided and actually shown by experimental tests under competent supervision that the action of ball bearings is to reverse the direction of friction, inasmuch as the upper surfaces of the balls travel in a reverse direction to their lower. This makes the question appear somewhat more complicated, and inasmuch as it is found that on this latter point there is a difference of opinion, both in theory and practice, by "experts," the writer puts his question, which might otherwise appear trivial.

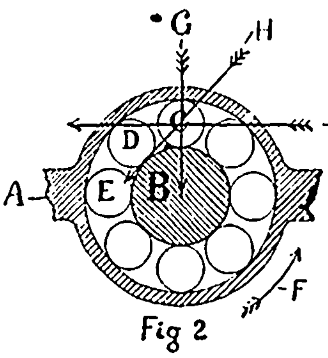


Fig 2

In examining further, let *A*, Fig. 2, represent the hub of pedal, *B* the pedal spindle, *C*, *D* and *E* some of the balls of the bearing; the direction of motion of the driving pedal as compared with the driven spindle is represented, as before shown, by the arrow *F*. The question is in revolving the pedal *A* in direction (with reference to spindle *B*) as indicated by arrow *F*, or left hand, in what direction will the friction produced tend to revolve the spindle *B*, so that we may know whether a right or left-hand thread should be provided in such instances when they occur in mechanical design?

In the ideal ball bearing there would be next to no friction at all, the balls having a true rolling motion against surfaces unimpressable, or so tempered as to have, when impressed, a perfect recoil; the main element of friction we need to consider is that occasioned by the covering of the balls or their paths with a mixture of dust and dried oil, which may be continued till the balls refuse to revolve and the friction becomes intense.

Taking the uppermost ball, *C*, Fig. 2—which when it is carried to the highest point, receives practically most of the pressure—in the ideal state all the force due from the pressure of the foot on the pedal will practically pass in the direction of the line of force indicated by arrow *G* straight to the central point, where it will be most efficient in the propelling of the machine, no force being consumed to compel the balls to revolve; but cover the balls or their paths with a non-elastic yielding substance, and it will pile up against the balls to obstruct their progress, as represented by darkened portions in the paths of ball *C*; force is then called into effect to cause the balls to revolve, and this force must be in a direction opposed to the obstacles. One obstacle is shown between the ball and its case, the other between the ball and its spindle, both having the same effect, namely, obstructing the frictionless turning of the case *A* round its spindle *B*. The upper obstruction between the ball *C* and its case *A* tends to carry the ball *C* round with the case, and the lower obstruction between the ball *C* and its spindle *B* tends to carry the spindle round with the ball in direction indicated by arrow *F*. It is evident, therefore, that the line of direction of the main propelling force has to assume a position somewhat as indicated by arrow *H* to supply the power necessary to overcome the friction of the bearing. In an extreme case of friction, the whole propelling force would assume a direction as indicated by arrow *J*, none being employed to propel the machine as at *G*; but all being employed in a direction tending to turn the spindle *B* in direction of arrow *F*, or left hand. Therefore, in a bicycle, the pedal spindle fitted with a left-hand thread should be on the right-hand side of machine, and also, it appears, there can be no difference in this respect between ball bearings or others. The writer would be pleased if any one differing from him would give another solution for this problem.

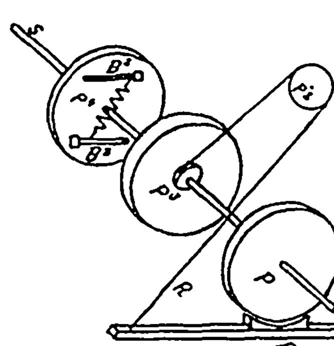
For The Canadian Engineer

ELECTRICITY FROM THE WIND.

(Concluded.)

Since writing the paper from which the foregoing abstracts have been compiled, experience has suggested a few changes.

Regarding the working of the system which I have just described, let me say that while at first it proved generally satisfactory, I soon found that owing to its being so complicated, it required much more attention than I had anticipated. Especially was this the case with the dynamo brushes. As the speed was almost constantly changing, I soon found some kind of an automatic arrangement to move the brushes would be required. This necessity added to the complications and turned the course of my experiments in another direction If you employ a sufficiently strong wheel to allow of a brake being used to check the speed whenever the velocity attempts to rise above that required, a centrifugal ball regulator can be arranged to automatically apply the brake and keep the speed from

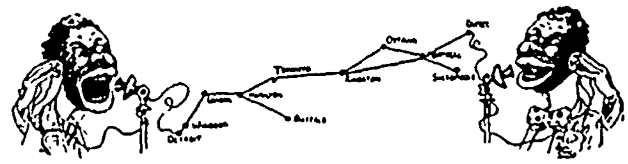


becoming abnormal, in the following manner: In figure 3 let *S* represent a shaft to which the dynamo is belted, and upon which a pulley *P* is keyed for receiving a frictional brake *B*, and to the swinging end of the brake let there be attached a rope *R*, passing over a loose pulley P^2 and having its other end fastened to a small pulley made fast to one side of a larger loose pulley P^3, on the shaft *S*. Let the side of pulley P^3, which is opposite the small attached pulley, be hollowed out in such a way as to form a projecting rim or flange from that side of its periphery. On the same shaft *S*, and opposite the concave side of loose pulley P^3, place a tight pulley P^4 (which is represented here removed from P^3 in order to show the mechanism), with two centrifugal frictional balls B^2, so arranged that whenever the velocity of the shaft *S* begins to rise above that required, these frictional balls B^2 grip the inside of the periphery of P^3, and turn the loose pulley P^3. When P^3 turns it pulls on rope *R*, which in turn applies the brake *B*, and checks the speed. At the same time, the centrifugal balls B^2 release the loose pulley P^3, which lets off the brake *B*. I have seen this system in operation, and believe it to be the best method yet devised for running a dynamo by wind power. It holds the speed very steadily, is simple in construction and inexpensive. Of course, the wheel must either be so strongly constructed that a violent wind will not wreck it, or one of the modern vaneless wheels be used. These wheels are made in sections, and so constructed that the sections bend backward in a hard wind, and are brought into place .again by a strong coil spring.

Having thus far directed attention to the retrospect of my subject, let me now ask you to turn to the prospect. Who has not pondered on the mighty force of the wind, and entertained a belief that it would be the power of the future. There is no reason why it cannot be utilized now for storing electrical energy, where other power is expensive; and only one bar to its superseding nearly every other form of power—the cost of the storage battery. If the time ever comes when we can produce inexpensive accumulators, then we may expect not only will cities, towns and villages have cheap electricity, but isolated country homes will be lighted, heated and furnished with power for all kinds of outdoor and indoor work so cheaply that the genius of old in the parlance of to-day, "wouldn't be in it."

UNDERGROUND CABLES AND LONG-DISTANCE TELEPHONES.

A work of great importance, and of some interest from an engineering point of view, is being quietly carried out by the Bell Telephone Co., in Montreal, in the alteration of their chief lines from an overhead to an underground system. This has already been done in Toronto, and in Montreal a start was made some time ago on St. Catherine street, where a conduit was laid from Mountain street to St. Christophe containing 20 ducts. A section of these telephone conduits disclosed a square, subdivided into smaller squares in which the cables lie. The conduit is put four or five feet below the surface of the roadway, and is embedded in cement to protect it from the picks of the water, gas or sewer-pipe men. Three materials are used for these conduits, some being made of creasoted wood, some of cement-lined iron pipe, and some of vitrified clay. The last named will be most extensively used if it resists the frost, as it seems likely to do. Each duct is about six inches across and holds a cable containing one hundred wires, and the conduit contains from four to thirty-two ducts, so that some of these conduits will have over 300 wires. The method of laying a conduit is as follows: A trench having been cut in the roadway—usually at the sides, between the sewer and gas mains—the sections of the conduit can be carefully laid, end to end, in cement, so that each division forms a continuous tube. About every 500 feet, but preferably at a street corner, a manhole is built, and from the starting point the cables are drawn through the ducts by long wire rods, which are coupled and uncoupled as the cable is pulled through. By these manholes repairs can be made and new cables drawn in. In England the wires in such cables were insulated with gutta percha, which accounted for the unsatisfactory telephone service in large towns there, where the lines were laid underground. Here the insulation is made of manilla paper soaked in paraffine, the wires being wrapped in strips of this paper, the wrapping being done by machinery. The wires being thus covered and insulated, as well as made moisture proof, the whole is gathered in a cable covered with lead pipe. To ensure them further against moisture, the cable-head ends from which distribution is made above ground are imbedded in a body of paraffine wax. In the three miles of conduit now being laid in Montreal there are 127,000 feet of ducts and 40 manholes. The conduits are located as follows: St. Charles Borrommee from St. Catherine to Craig, contains 6 ducts; Craig, from St. Charles Borrommee to Victoria Square, 6 ducts; St. Sulpice and Place d' Armes, 8 ducts; Notre Dame, from St. Sulpice to McGill, an average of 32 ducts; St. Francois Xavier, 10 ducts; St. Nicholas, 4 ducts; St. John, 12 ducts; Hospital, 4 ducts; St. Sacrament, 6 ducts; St. Peter, 10 ducts; McGill, from William to St. James, an average of 8 ducts. This large work, which is being carried out with but little disturbance of the streets, will cost the company $100,000.



As the local telephone service has made a revolution in the conditions of social life, so is the long-distance telephone working a quiet but none the less certain revolution in the business world. In the United States the long-distance telephone is superseding the telegraph for certain business purposes, and vast sums are now spent every week by merchants, brokers and the heads of large corporations in talking between distant cities. The distance between New York and Chicago is 900 miles, and the charge for using the telephone line between those two cities is $9 for three minutes, yet this line is in almost momentary request, and if appointments for conversations are made and not kept to the minute, the tariff is charged. What an emphasis is put upon the value of time and the importance of punctuality, when one is taxed $9 for being three minutes late! Recently a New York broker held the Chicago line about an hour and a quarter, and at the end of the talk he had a bill of over $200 to pay, but he exclaimed as he paid it: "That was the most profitable hour and a quarter's talk I ever had, for I have cleared $10,000 by it." The long-distance telephone in Canada is being introduced by the Bell Telephone Co., who are at great expense converting their local services gradually into a complete system of metallic circuits, which system is necessary to a satisfactory operation of the long-distance lines. The metallic circuits are complete in Toronto, and by the time the company are ready to occupy their new building in Montreal a metallic system will be complete in that city, when a person in one city will be able to talk with a person in another, and will be able to hear his correspondent as clearly as if they were only a block apart. Subscribers at any intervening point can, of course, use the same line. The tariff will be according to distance and will average about half a cent a mile, which is just half that now charged in the United States. As the lines now run between Toronto and Montreal, the distance is about 400 miles, so that the charge for a three-minute talk will be $2 for the first three minutes, and 50 cents per minute after that. Night rates will be one-half the day rates. The line between Toronto and Montreal is now complete, but until the metallic circuits are complete in the latter city the only transmitters adapted to the work are in the company's own offices. Still, even with the old system, it is possible to talk to points as far north in Ontario as Bracebridge, in Muskoka, and to Wiarton and Kincardine; conversation can also be carried on with Detroit and Buffalo on the American side, and to New York by repeating at Buffalo.

The places noted on the sketch above mark the present range of the Bell Telephone Co.'s long-distance lines, but the system will be extended as required in the future. The wire used for this service between Montreal and Toronto is a No. 10 copper wire, that between Chicago and New York being a No. 6.

OPERATING ENGINES WITHOUT A NATURAL SUPPLY OF CONDENSING WATER, OR THE CONTINUOUS USE OF INJECTION WATER.*

BY E. J. PHILIP.

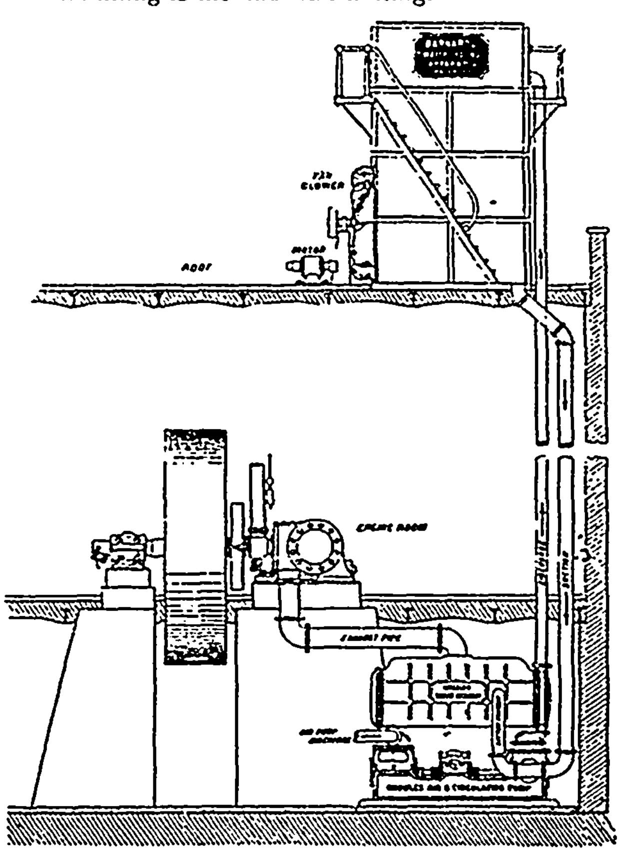
The subject is somewhat new, and information on it must be taken from the few plants that are now operated upon this principle. Like all other new departures in steam engineering, there is very much to be learned and studied before everything in connection with it is properly understood. In a paper of this kind we can only go into the leading points about it, as the subject is so large that a whole volume might be written on it to cover fully the whole ground. From observation throughout the country it is evident that the principle of running condensing engines is not as thoroughly understood as it should be, for we have many cases where there is a sufficient supply of water within reach, and still the engines are exhausting into the atmosphere. This, perhaps, because many think the expense of putting in and maintaining a condenser is greater than the saving would warrant. As an illustration, take an ordinary high-pressure engine of, say, 100 h.p., using, say, 4 lbs of coal per h.p. per hour and running 10 hours per day, the coal consumption would amount to two tons per day. The water consumption per h.p. in that case would be represented by 30 lbs. per h.p. hour. If a condenser is added, the same power would only require, say, 22 lbs. of water, making a saving of 26 per cent. The total coal consumption for the year, running 365 days, would be 730 tons. If the coal can be put in for $3.00 per ton, the year's consumption would amount to $2,190. The cost of adding a condenser to such a plant, including the necessary piping, should not exceed $300. The cost of operating the condenser will be about 6 per cent. of the power of the engine, and is equal to $131. The interest on the condenser investment at 6 per cent. is $18, making a total cost of $149 per year to maintain and operate it. Twenty-six per cent. of the coal account would be $569, from which deduct $149, the cost of operation, leaving a net gain of $420. This in many cases would make a dividend for the owners where there is none at present. In cases where the water for condensation is not procurable except at considerable expense, it can be used over and over again, and be cooled by air. The idea of cooling water in this way originated in Germany, and was applied for the purpose of cooling beer. The first cooling tower was filled by the branches or trees, or brush. The air used was only the natural current due to the warm water. This, of course, required a very large tower to get an amount of cooling surface to be effective, as the air current was necessarily very slow. The air is the cooling medium, and is indirectly the condensing medium. If you wet your hand and hold it in a current of air, you will feel a cold sensation, because the water is being evaporated and is taking up the latent heat of evaporation from your hand and the surrounding air. The specific heat of air is .2375, while that of water is unity.

If we depended upon the direct absorption of heat by a rise in temperature of the air, we would have to raise about 4 pounds, or 55 cubic feet, one degree to absorb a heat unit. Consequently we would have to raise 1,000 cubic feet of air 55 degrees to condense one pound of steam at atmospheric pressure. But when air is brought into direct contact with water, there is a cooling action due to evaporation much greater than is due to the elevation of temperature. When a pound of water is evaporated in this way, five times as much heat disappears as when a pound of water is raised from the freezing to the boiling point, and every pound of water so evaporated absorbs heat enough to condense one pound of steam. Now, by having an arrangement whereby we can pass a strong current of air over a quantity of water, favorably disposed to be acted on by the air current, we can by evaporation of a quantity reduce the temperature, and that is what takes place in a cooling tower, which is an apparatus designed to distribute the water so as to expose a large surface to be acted on by the air. Now, for every pound of water evaporated there is a reduction of temperature which will allow of a pound of steam being condensed, and just bring the remainder to the original temperature. It will be plain, therefore, that in operating a cooling tower there can be no more water used than when running non-condensing. In fact, there is not as much, because there is not as much water evaporated in the tower as there is condensed, as the surface of the tower and pipes have a cooling effect; also, the direct rise in temperature of the air takes away a quantity of heat without evaporating any water.

The engine will require less steam, consequently there is a smaller quantity of feed-water used than when running non-condensing. The system, therefore, allows a plant which has to buy even its feed-water, to run condensing at a less expense for water than when running non-condensing. The details of the system are, at the start, like an ordinary condensing plant. The steam leaves the engine, passing through the condenser, is here condensed by water taken from a small reservoir instead of some natural supply. The water passes to the air pump and is pumped out, forming a vacuum as in an ordinary condensing plant; but now, instead of letting it run to waste, it is elevated to the top of a tower, either by the air pump itself, if the tower be low, or by an auxiliary pump if the tower be high. This is preferable in any case. The water is distributed over the surface of the filling tower, falling to the bottom through the up-coming current of air, and the temperature is thereby reduced sufficiently to be discharged into the small reservoir from which the condenser takes its water, and is used over and over again. The details of the tower are: At the top of the tower is an arrangement to distribute the water over the whole surface of the interior. This distributor has taken many forms, some of which are quite ingenious. Some of the latest are the revolving distributors, illustrated in *Power* for March, and other mechanical papers. This distributor is mounted in the centre of the tank on ball bearings, and the water issues from the cross pipes like the ordinary lawn sprinkler, and distributes the water evenly. Another distributor which is used in towers with what might be termed partition filling, is made with a little trough across the top of each parti-

*A paper read before the Canadian Electrical Association.

tion, with main channels feeding them. The tops of the small troughs are made like a saw on their edges, so that the fine streams of water run through the hollow of the teeth and spread over the surface of the partitions, making a very even distribution. There are numerous other forms, such as perforated plates, screens, etc., all of which will work, but do not distribute as well as the two mentioned. The filling of the tower or material over which the water is distributed, has taken even more forms than the distributor. From the time when brush was used to the present and latest wire filling, the same idea was at the bottom of every change, namely, to make a given size tower do more work. The cooling effect in a given size tower is a very important point in metropolitan plants, where room is valuable. The first filling was brush. Then round poles were tried. About the same time and at different times since pans have been tried with some success, but were never equal to the tower system. The next was a partition tower, or a board filling. This has taken a great many shapes, the boards being arranged to break up the water and air currents in every conceivable manner. Sheet iron has been tried in various forms, some like stove pipes and others arranged in sheets. The latest and best filling is tile and wire netting.



The tile tower has been described in *Power* and other mechanical papers. It is very satisfactory. One point against this filling for a large tower is its great weight. The wire or Barnard tower is filled with wire netting rolled up loosely and set up on end. In these towers a settling chamber is provided at the bottom, and a heavy grating is placed across some distance above the water. In this space the fan discharges its air. On top of the grating is placed the tile or wire, whichever filling is used, and it is continued on up as far as it is able to support itself, breaking joints, so as to break up the streams of water. There is a portion of the tower carried on up above the filling, to allow the particles of water to settle out of the air current. This prevents a spray flying from the top of the tower, and also any of the water being wasted. Information on the formula for calculating the size of towers is not very extensively known. As far as can be learned, about 50 square feet of cooling surface is required per h.p., when a large quantity of air is used, say 100 cubic feet of air per h.p., and varies with the amount of air and with the arrangement of the filling. In making up estimates the term h.p. does not give definite information. because the amount of steam used per h.p. varies from 15 to 45 lbs. per h.p. per hour, according to the size and type of engine. The only way is to get the water consumption of the engine and figure from that, the same as for running condensing. When an engine is using, say 25 lbs. of water per h.p. per hour, it will require about 4·8 cubic feet of tower for each h.p., with sufficient air and wire filling. With tile filling the cubic capacity required is about 6.5 cubic feet per h.p.

Cooling towers are becoming numerous. We have one in Canada, at Montreal. Two have lately been started at Detroit, and reported as giving excellent satisfaction. The accompanying illustration of Geo. A. Barnard's towers arranged for surface condenser, with the tower on the roof of a high building, will illustrate one application of the system. Further illustrations are not exhibited, because several of the mechanical papers have lately fully shown the different applications of it. It is estimated that the cost of operating a cooling plant is from 2½ to 5 per cent. of the power of the engine, which leaves a large net balance in favor of the apparatus, fully justifying its application on plants of any magnitude, or where the cost of coal exceeds $1 per ton. If a tower is placed on the roof, a surface condenser should be used; and the ascending column of warm water is balanced by the descending column of cool water, and the actual head the pump works against is the height of the tower. If the tower can be placed in the yard, a jet condenser may be used, unless the object is to get pure water for the boilers. In the beginning of this paper the cost of adding a condenser to a 100 horse-power plant was shown to effect a net saving of $420, or 20 per cent. nearly. The cost of adding a tower to such a plant should not exceed $700, the interest on which at 6 per cent. is $42, leaving a net saving of $378. This would make a very good showing on such a small plant, and would in most cases be much larger. Another point is, in cases where engines are carrying a full load and a little more power is required, attaching a condenser would increase the power about 20 per cent., thereby avoiding buying a new engine, the plant carrying this extra load at the same expense for coal and water.

For The Canadian Engineer.

THE MANUFACTURE OF MOTOR VEHICLES.

BY J. H. KILLEY, HAMILTON.

Thousands of French, German, English and American engineers, mechanical, electrical and chemical, are at work on the problem of getting up a simple and effectual horseless carriage, suitable for every kind of land travel. It is conceded that the person who can invent and construct a light, inexpensive, practical and mechanically simple horseless vehicle, that can be handled by any man or woman of ordinary intelligence, will acquire both fame and fortune from his exertions. In the past France and Germany have paid more attention to automobiles than any other people in the world. At present England, the United States and Canada are moving in this direction, and many hundreds of patents have been taken out for improvements, or supposed improvements, on the machines already in use. In Paris, France, there are four hundred and fifty registered automobile carriages in use, with the factories running full of orders for more. The European roads are much more suitable for this method of transport than the average American road, but the advent of these carriages in large numbers, which, like the bicycle, will surely swiftly come, will necessitate an immediate improvement in our roads to take full advantage of this new system of locomotion.

Mechanics and inventors have been spurred on to extraordinary exertions by the contests that are to be held for prizes all over this continent and in Europe. This must lead in the near future to the appearance of a thoroughly practical and simple road wagon. Already the motors are being simplified in every detail, and the amount of gasoline or coal oil fuel for a given power reduced to a great extent in proportion to the power utilized. It is found in some of the motors experimented on that the amount of oil consumed does not increase with the increase of power. This is a very important discovery. It is the opinion of practical mechanics of high standing that the intricate and clumsy mechanism for the conveyance of the power to the wheels seriously operates against commercial success. Another important matter is having the driving wheels so attached to the shafts that on going around corners and taking sudden turns the wheels will accommodate themselves to the altered circumstances. In France, where so many carriages of this kind have been built, they do not attempt to make the bodies of the carriage as light as they do here. Greater strength is required in a motor vehicle than in a bicycle, as in one case a man power is the most required, while in the other the motors will realize from 3 to 5 or 6 h.p., perhaps equal to that of 20 men, together with the weight of the machinery and passengers. Wheels constructed on the bicycle principle are therefore not suitable for these machines, as is evidenced by the fact that the French and German builders have not adopted them, but continue to use ordinary wooden wheels, sometimes with rubber tires. It is claimed by the French builders that improper construction of the carriage frames and wheels has been largely responsible for many of the failures of the carriages to give satisfaction. So far as can be judged, both steam and electricity are unsuitable for automobile carriages, the only successful motors being some form of vapor gas engine, and gasoline seems to be the favorite.

It may be reasonably expected, considering a large number of the most skillful mechanics in the world are engaged in perfecting these carriages, that by the year 1900 they will have come into general use. The praise and profit will come to those who can place on the market the best and most serviceable machine. It is possible that the automobile carriage of the future is not in sight yet, but it is at no great distance from view. They will soon be made in as large numbers as bicycles are at present, and will be a large, and, for the initiators of it, a profitable industry, as they can be made at comparatively little cost with special tools; all the parts of each size being like the parts of a sewing machine, each a counterpart of the other and interchangeable. Furthermore, no heavy or very expensive tools would be required to build them.

A number of large factories in the United States are now being fitted out for the manufacture of these vehicles. Capitalists in Canada are also organizing for this purpose and will commence operations as soon as a thoroughly suitable carriage and motor is selected; this one of our best Canadian mechanical engineers is endeavoring to do for a company, and he may go to Europe for this purpose. At present mechanical engineers of reputation allow that the gasoline and coal oil motors are taking the lead. Every improvement now being made simplifies the construction, increases the power, lessens the dead weight, and does away with annoyance from odors. Thus everything goes to show that before the 19th century passes into history horseless vehicles will be common in all civilized communities, establishing factories for their manufacture, employing many thousands of men, just as the steam engine now does, but on a very much more extensive scale, as the carriage will become a necessity.

For THE CANADIAN ENGINEER.

CANADIAN TIMBERS.*

(Concluded.)

Red Pine.—This tree ranges a little further north than the white pine, especially to the westward. It is easily distinguished from the latter by its smooth, scaly and reddish bark, and its long coarse leaves in the form of tufts on the ends of the twigs. It grows in clumps and groves, sometimes of considerable extent, but seldom singly, and the ground among these trees is almost always open and free from underbrush. It has been sometimes erroneously called "Norway pine." Its average size is less than that of the white pine. It is more resinous and less durable than the latter, and does not command so high a price. It is used for piles, wharves and cribs, dams, railway ties, in building boats and decked vessels, for frames of wooden buildings, flooring, and many purposes for which Scotch fir is employed in Great Britain.

White Pine.—This is the largest and most valuable of our trees. Heretofore, it was an abundant timber in the southern part of the eastern half of the Dominion; but it has been cut away so rapidly and indiscriminately for both export and home consumption that the supply is becoming limited, and the average quality of a lower grade. Before much was known about the geographical distribution of our timber trees, there was a popular impression that the white pine had a much greater range than it actually possesses, and it is now necessary for us to husband carefully what remains. Westward it does not extend to Lake Winnipeg or Red River, and only occasional trees are found north of Lake Superior. It occurs only on the most southern of the head branches of the Moose and Noddawai Rivers. Eastward the northern limit strikes the Lower St. Lawrence near Mingan; but it is found of good quality in Gaspe and all the Maritime Provinces and Newfoundland. It is probably our longest lived tree and old specimens may have attained the age of 500 years. White pine is used in larger quantities, and for a greater variety of purposes than any of our other woods, and its properties are so well known that they scarcely require to be described to a Canadian.

Hemlock or Hemlock Spruce.—This is one of our largest coniferous trees, but the timber is of inferior value. It is hard and coarse grained, and liable to shakes, but is a durable wood. It holds spikes and nails well, and is used for railway ties, mine timber, wharves, barn floors, sheeting for shingling upon, etc.

*Report of a lecture delivered before the Applied Science Graduates' Society of McGill University, 2nd April, 1896, by Professor Robert Bell, B.A. Sc., M.D., LL.D., and published exclusively in THE CANADIAN ENGINEER.

Hemlock lives for about 200 years, but the old trees become unsightly from many of the branches breaking off. The species is more southern in its range than the white pine, and does not extend north or west of Lake Superior, but is found for about seventy miles up its east side. It does not grow anywhere within the watershed of Hudson Bay, nor on the Lower St. Lawrence far below Quebec, but is abundant in our Maritime Provinces.

Canoe Birch.—One of the most northern and at the same time most widely diffused and abundant of the deciduous trees of Canada. It is popularly known as white birch, and it would be as well for botanists to adopt this name and find some other for the smaller, scarcer and less useful tree to which they at present restrict this term. The wood of the canoe birch is white and close grained, but softer than that of the yellow or the black birch. It is a favorite wood for spools or bobbins and a great variety of small wares, and it makes excellent charcoal. A new use has been found for it in the manufacture of a successful imitation of mahogany by staining it to a reddish color.

Yellow Birch.—Found everywhere in the British American provinces, from Newfoundland to Manitoba, south of the 49th parallel. It is one of the largest trees. The wood close-grained and valuable for ship building, flooring, furniture and inside finishing of houses, fuel, etc.

Black Birch.—Not so abundant, but about as large a tree as the last, which it resembles, but has a darker bark. The wood is also darker, having somewhat of a rosy hue, and from this circumstance it is more highly prized for furniture.

Black Ash.—This is a tree of small to medium size, and grows mostly in swamps and on moist lands along rivers. The wood is brittle, with a coarse grain, which, however, looks well when polished, and hence is much used for bedroom furniture. It is the most northern tree of its genus, its range extending from Newfoundland to Lake Winnipeg and taking in the southern part of the drainage basin of James Bay. It also occurs along the upper part of the Albany River and thence southward.

White Ash.—A larger and more valuable tree than the last, but more southern in its habit and it grows upon dry or rocky land. Its northern limit runs from Sault Ste. Marie to Quebec city, and it is not uncommon in New Brunswick and Nova Scotia. The green or western and the river ash are distinct species, and are scarcer than either of the above. The wood of both is intermediate in quality in many respects between the black and white ash.

American Elm.—This is also known as white elm, grey elm and swamp elm. A large and beautiful tree found throughout the better part of the Dominion from the Rocky Mountains to Nova Scotia, and also in the southwestern part of Newfoundland. The character of the wood varies greatly according to the soil and the situation in which it grows. On dry rocky land it is tough and of a darker color than when grown elsewhere, and this variety is often called rock elm; but this name properly applies to a smaller species which seldom attains more than one foot in diameter. On low or wet ground, the wood of the American elm is light colored and coarse in the grain, but a new use has been found for this variety. It is steamed and sliced into sheets by revolving short logs upon a long knife-edge. These make excellent fruit barrels, cheese boxes, etc., and it has now assumed a higher value on this account. The tougher varieties are in demand for ship-building.

Bur Oak.—This is the white oak of Manitoba and the country round the west end of Lake Superior. It is also abundant in Nova Scotia. The timber is of excellent quality, but the tree does not grow to so large a size as the next.

White Oak.—Of the eleven species of oak found in Canada, several are locally called "white oak," but the white oak proper is confined to the provinces of Ontario and Quebec. In the first, it was formerly common in the valley of the Ottawa, and thence westward to Georgian Bay and throughout the lake peninsula, but most of the trees fit for export have been cut down. Large trees in groves were formerly found as far north as the head of Lake Temiscaming. In the other province it is not found much to the north of the city of Quebec.

Red Oak.—This is the most northern species of oak in Canada. It grows to a large size, but its wood is too brittle to be of much value. When "cut on the quarter," it exhibits the markings peculiar to the oaks in a beautiful manner, and is now being much used for furniture.

Sugar Maple.—In Ontario and Quebec, the northern limit of this tree runs near the 48th parallel from Michipicoten on Lake Superior to the mouth of the Saguenay, but the sugar maple is also found, though often sparingly, throughout the whole region south of the St. Lawrence, and also in the maritime provinces and southwestern Newfoundland. Westward it does not extend beyond Lake of the Woods.

Basswood, or Linden.—The northern limit of this species runs from the east side of Lake Superior to near the city of Quebec and thence in the same latitude through northern New Brunswick. It is a large tree with soft, fine-grained wood, which is used for many of the same purposes as white pine. Is also used for building canoes and in carriage and sleigh making.

Besides the foregoing trees, Dr. Bell spoke of the butternut, black walnut, red cedar, flowering dogwood, tulip-tree, the hickories, chestnut, black and soft maples, beech, ironwood, buttonwood, cottonwood, aspen, balsam-poplar, cherries, thorns and willows.

THE OUTLOOK FOR THE ELECTRIC RAILWAY.*

BY F C. ARMSTRONG, CAN. GENERAL ELECTRIC CO., TORONTO.

It is a significant evidence of the confident spirit with which we have learned to regard the sure and rapid progress of modern electrical invention that we accept to-day without comment and as an established practice what was but yesterday a matter of tentative and doubtful experiment. This rapidity of achievement has characterized the development of the electric railway, in common with the other great departments of electrical industry, and has already been productive of results of which we can scarcely as yet appreciate the economic and social importance.

Up to within the past year, however, the application of electric motive power for railway purposes has been practically limited to the improvement, amounting to a revolution, of the street railway proper, and an extension of its field as the suburban railway. The work in this direction, though difficult in detail, is necessarily limited in range, and at the present moment may be said to have reached a stage approaching finality. The street railway motor of to-day may be considered,

*A paper read before the Canadian Electrical Association.

in view of the conditions under which it operates—limited space, exposed position, light weight and severe service, as a highly efficient and satisfactory machine. The controlling apparatus has been developed to an equally high degree of perfection, ensuring in the best types a maximum economy of current, and reduction of strain on the motors under varying conditions of operation, and even adding to its normal function the duties of an electric brake. In the power-house, the substitution for the small belt-driven generator, of the large, compact, slow-speed direct-connected unit, with its steel frame and iron-clad armature, leaves little room for improvement in the way of higher efficiency, closer regulation or greater durability. Improvements in design and material have done much to remedy the unsightliness and unreliability of the devices used in overhead construction and the standard pressure of 500 to 600 volts is found, even for suburban extensions of considerable length, to be commensurate with a reasonable copper economy. From a financial point of view the position of the electric street railway is equally assured and satisfactory. No field for legitimate investment is now more favorably considered than that offered by the securities of a well-managed and well-equipped electric railway in a city or town of any size suitable to its capitalization. As evidence of the financial importance to which the electric street railway interests in Canada have attained, may be cited the fact that there are at present in operation, or being constructed in the Dominion, 36 electric street railways, having a total mileage of close upon 600 miles, using 750 motor cars, with a total generating capacity of 19,500 kilowatts, and representing an actual investment in round figures of over twenty millions of dollars.

At this point, and at a meeting held in the city of Toronto, it is peculiarly fitting by way of contrast and as epitomizing the development of less than one decade, to quote from a catalogue issued nine years ago, in 1887, bearing the title "The Van Depoele System of Electric Railways," in which under the heading "Facts about running the Toronto Electric Railway in 1885,' we find the following: "Plant consisted of one engine, automatic, 10 x 16 cylinder, 150 revolutions per minute; one electric generator, forty-horse power; one electric motor, thirty-five-horse power; one motor car, weight six tons; three passenger cars, each two tons. Average number of passengers carried, eighty-three per car; estimated weight of passengers per train, 16 tons; total weight of train, 11 tons; length of track, one mile (with one grade of six per cent.); average speed, 30 miles per hour; passengers carried in five days, 50,000; average consumption of coal per day of ten hours, 1,200 lbs.: distance travelled in ten hours, including stopping to take on passengers, 200 miles."

The generator in the case, it may be added, was a 40-light arc machine, having, it is stated, "an electromotive force of 1,300 volts, and an intensity of current of about 18 amperes," and the single motor, belted to the axle, was a 35-light machine of similar type. In the same catalogue we find a description of each of the Van Depoele roads in operation at the date of its issue. The list is a short one—Montgomery, Alabama, 1½ miles; Detroit, Mich., 1¾ miles; Windsor, Ont., 2 miles; Appleton, Wisconsin, 4½ miles; Port Huron, Mich., 3 miles, and Scranton, Penn., 2 miles; a total of 14¾ miles. It is amusing to note following this modest list of roads installed, the bold challenge that "as the matter now stands we have more miles of electric railway now in successful operation than all the other electric railways in the world combined."

Coming now to a consideration of the subject of this paper, it is not unreasonable to augur from the success of the electric railway in the past, an outlook for the future equally brilliant and promising. We may leave out of consideration the work which still remains to be done in affording rapid transit for the cities and towns which are as yet either working without street railways altogether, or in which the existing systems are still operated as horse or cable roads. The horse as a propulsive agent for the street car, is steadily pursuing his course to his destined place in the museum, while the cable, in spite of the tremendous inertia of invested capital, is, except in the most congested portions of the larger cities, rapidly giving way before the greater economy of electrical operation. The recent electrical equipment of the extensive Pittsburg cable systems, involving the abandonment of an investment of many millions of dollars, may be instanced in this connection.

The field for future development in electric traction lies in two distinct directions; in the first place, in the equipment and operation of that recent but now most important factor in transportation—the light or secondary railway—which will in time take form as a network of feeders and channels of distribution for the large centres of population and the great trunk railways; in the second place, as a successor of the steam locomotive in the operation of the trunk systems themselves.

It is in the first direction in which already some development has taken place, that we may expect the most substantial immediate progress. The possibilities of the light railway have of late been the subject of anxious and careful scrutiny on the part of political economists in England and on the continent generally, as a possible relief for the present acute and world-wide agricultural depression. Without going into the social or economic phases of the question, it seems undoubted that from all the large centres of population and production we may expect to see systems of light railway lines radiating to the limits of their spheres of commercial influence, and affording at a minimum of cost an adequate means of transportation and interchange of the products of the farm on the one hand, and of the factory on the other.

For such a system, requiring a frequent and flexible but not a heavy or high speed service, no enormous investment of capital would be required. The use of the public highway would save the otherwise heavy outlay for right of way, and its grade could, for the most part, be conformed to. The track and roadbed, even with rails heavy enough for standard freight cars, can, it has been shown, be laid for little more than the cost per mile of a first-class macadamized roadway. The depreciation charges, under normal conditions, would be certainly no greater, and the cost of equipment and operation with electric power, even with the transmission limit of our five hundred volt direct current apparatus, such as to render practicable the working of such systems over a considerable range. We have in Canada several examples of this class of railway, as yet on a limited scale, but in each case affording facilities for transportation, both of passengers and light freight, recognized as being of the utmost value to the public. Each of those roads is, it is encouraging to note, yielding a fair return for the money invested. In the same way the branch lines and feeders of the trunk railways, which are now operated in many cases at a loss, mainly by reason of the inadequate service to which they are limited by the use of the steam locomotive, would, if electrically equipped for a light and frequent service, become a productive part of the system to which they stand at present in the relation of a necessary evil.

It seems, therefore, reasonably clear that in the development of the system of secondary railways which are coming into being as the result of a pressing economic necessity, the electric motor is to find a new and widely extended field of usefulness. The great desideratum at present for this work is a successful alternating railway motor which, it is safe to anticipate, will be added to the list of standard equipment in the very near future. Under present conditions, while the use of the booster or of polyphase transmission apparatus with rotary transformers has made commercially possible the supply of current for distances up to twenty miles, or even more, from the power house, their availability has been lessened by the drawback of excessive loss in the one case and of great cost in the other.

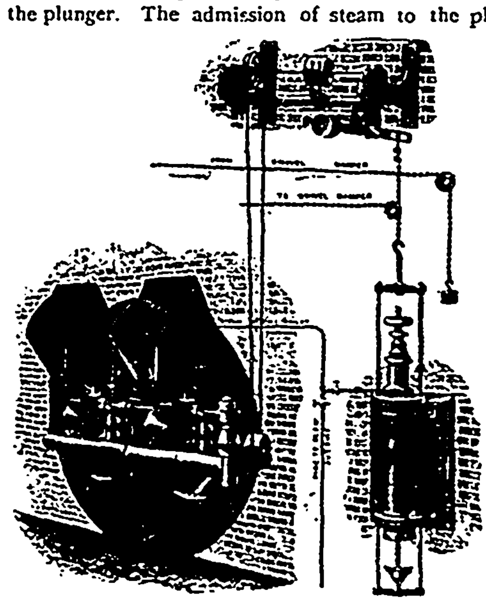
Before leaving this part of the subject, however, it would be as well to point out, in view of the alacrity with which the possibilities which we have been discussing are being taken up as a new and promising field for the exercise of their peculiar abilities by the versatile and talented class of gentlemen known as promoters, that there is no reason to suppose that such a wholesale programme of light railway construction and conversion of existing steam branches would be an immediately profitable or possible undertaking. In many cases the gains made will be in the form of a general public benefit rather than a concrete return in dividends for the money invested. The smaller and more profitable openings for the construction of these lines will afford a field for private enterprise, but any comprehensive scheme will undoubtedly demand, in the form of governmental aid, the support of the public, who will be its main beneficiaries.

We may now consider briefly the position likely to be attained by the electric motor as a successor to the steam locomotive in the operation of the great trunk lines. Here the conditions differ materially from those which have led in so short a time to a practically complete possession of the field of street railway traction, and which seem likely to produce similar results in the case of the secondary railways. It must be conceded that no opening or necessity exists for the construction of new trunk lines operated electrically in competition with existing steam roads. The eventual triumph of electricity over steam, for heavy locomotive purposes, will come in due course as a result of the establishment of its superiority for the service, but its general adoption will be delayed beyond that point by a natural reluctance to wipe out the capital represented by existing equipment. It must be recognized that the evolution which attends all branches of mechanical development has produced in the steam locomotive of to-day a type admirably adapted to the work which it has so far been called on to perform. It is in the continual demand on the part of the public for higher and higher speeds between terminal points, and the still more imperative necessity, in the face of keen competition and lowering rates, for a reduction of operating expenses to the minimum point, that we may expect to find ultimately the most favorable contributing cause for the general adoption of electric motive power on the trunk systems. The direct rotary action of the electric motor and the practical limitation of its power only by the capacity of the stationary source of supply, entail the possibility of an increase in rates of speed up to the highest point at which a perfectly constructed roadbed without grades and curves will hold a car on the track. A recent study of the operation of the Pennsylvania Railway would seem to show that such savings in fuel, labor and maintenance accounts would follow its re-equipment for electric traction as to make it commercially desirable, even under present conditions.

It is no extravagant prediction to say that members of this Association who witnessed, in 1885 and 1886, at the Toronto Exhibition, the modest beginnings of electric traction in Canada, will see it supersede the steam locomotive in the operation of the Canadian Pacific and Grand Trunk Railway systems.

THE CURTIS DAMPER REGULATOR.

The Curtis damper regulator consists of a composition cylinders accurately bored and reamed, within which is a long, loose-fitting plunger, fitted with water grooves, thus being both tight and frictionless. As the pressure is always one way, the plunger merely rests on the collar of the rod, and there can be no cramping even if the rod should be out of line with the bore of the regulator. The motion of the plunger is communicated by a yoke and chain to the lever of the damper, on which is hung sufficient weight to open the damper and overhaul the plunger In some styles of damper regulators it is needful to have street-water pressure to do the work, and in many cases this is not available, and is always sloppy and wasteful of water. Where street pressure is not available, steam from the boiler is condensed in long coils of pipe, in order to obtain under pressure the large quantity of water requisite to operate the regulator. All this waste is avoided when using the Curtis regulator, as the steam used would not make a quart of water a day. The plunger is operated by steam direct from the boiler, and the whole pressure in the boiler is therefore available to operate the damper if needful. As a matter of fact, only so much pressure is used as is requisite to lift the weight, usually not more than 10 lbs. to the inch on the plunger. The admission of steam to the plunger is



graduated by the side set screw, so that the same stately, steady movement is accomplished with either high or low steam. The admission of steam is controlled by a sensitive, metallic diaphragm, which operates the valve on a motion of a two hundredth of an inch, or one-eighth of a pound pressure. To operate it, a given load—say 60 or 100 pounds to the inch—is produced on the regulator diaphragm, by screwing the handle in. When the pressure in the boiler reaches the limit, it lifts this load, and permits steam to enter the space over the plunger, slowly pushing it down and closing the damper. When the boiler pressure falls below the limit, the valve closes, and the pressure, passing from the bottom to the top of the piston, puts the piston in equilibrium, and allows the weight, slowly settling down, to open the damper, thus controlling the pressure at the desired limit. All the working parts are of the best composition, and in operation have been tested by ten years' service, and found to be practically indestructible. The accompanying illustration shows a Curtis Damper Regulator as used in a large establishment in England to control the pressure of the boiler by throwing an automatic stoker in and out of action, according to the steam pressure.

The makers guarantee that the motion of the damper will begin to change from one direction to the other on a variation of steam pressure of one-quarter of a pound either way from the point at which it is set to operate.

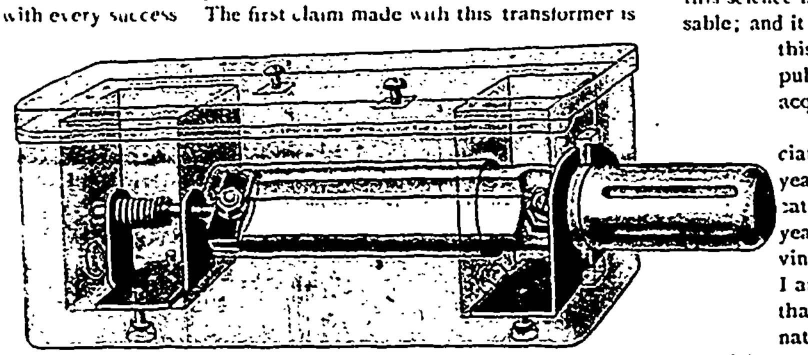
The hook in the top of the yoke is a turn-buckle, by means of which the chain can be lengthened or shortened at will, so that the damper can be shut so close as to prevent combustion, and at the same time not throw out gas. By means of the clamp on the plunger rod at the bottom, the amount of opening of the damper can be changed at different seasons or with different coal.

The D'Este & Seely Co., manufacturers of the Curtis Regulator, make the following claims for this mechanism: "Long experience has demonstrated that with our regulator, a damper partly open is just as effective as it would be wholly open without the regulator, and great economy is effected on strong drafts, by using only part of the damper area. We have saved 15 per cent. of the fuel while reducing the stroke of the damper from 10 inches to 3½ inches. We guarantee a saving of 8 or 9 per cent. over the best hand regulation, or the old style (diaphragm and lever), and it often comes up to 15 per cent. of all the fuel Now a word as to the reasons why we are willing to guarantee and why we do accomplish these savings We open the damper as wide as is needful for perfect combustion and burn the fuel at a high temperature, with enough air to eliminate the carbonic oxide. A few moments of this sharp combustion raises the pressure the one-eighth or one-quarter pound requisite to close the damper, which shuts close enough to stop combustion and hold the heated gases in the tubes until they have given out their heat to the water. Then the pressure falling the one-eighth or one-quarter pound, the damper opens and the process is repeated. The damper is closed before clinker has time to form, and opened before the fuel is cooled injuriously."

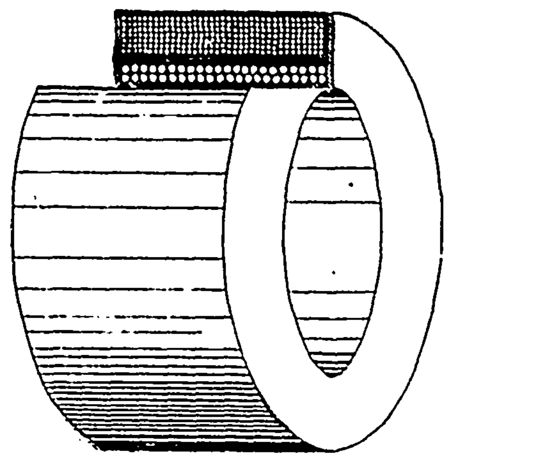
The company have about 1,200 of these regulators in use in the United States, and are establishing a successful trade in England and Canada.

THE PACKARD TRANSFORMER.

Prior to this year the Packard Electric Company, of St. Catharines Ont had never manufactured their transformers in Canada, but imported them all from the Warren factory. Since then they have been pushing the transformer trade and meeting with every success The first claim made with this transformer is



its regulation. The makers say: "Tests have shown that we have the highest regulation on the market of any transformers, efficiency and life being equal. Our small 10-light transformers regulate within 2½ per cent., whereas our 100-light transformers regulate within 1¾ per cent. This, as you will appreciate, is an extremely small drop. The reasons for this regulation are shortness of magnetic circuit and the entire absence of any bolts in the iron, as well as only one break in the magnetic circuit. Our circular coil also requires shorter wire than any other form, and we use a very large cross-section of copper, and all wire in the transformers is active and has no dead ends We have, of course, as well as other manufacturers, made a special study of insulation and we now use a form of insulation which will stand the very low temperature that many of our transformers are subjected to in winter, in the Dominion. This is of very great importance where 2,000 volt primaries are used and is absolutely necessary, that no infinitesimal cracks should be formed in the insulation by any temperature the transformer may be subjected to any winter. We feel that we have attained practical perfection in the mechanical construction, and the use of vulcabeston spools is far in advance of the old style rectangular form, necessitating the taping that has been freely used in the past and is generally used to day. Vulcabeston is almost as strong as brass, and no abrasion of the insulation can possibly take place. This makes the finished coil mechanically perfect. We do not claim any higher efficiency than the best transformers on the market, as this has everything to do with the quality of the iron used, but we use the best iron that can be obtained. We feel that our fusing device,



which we send you an electro of, is mechanically and electrically correct. In breaking the circuit it is as positive and sharp as a knife switch and is always absolute and reliable in making contact. There are no delicate springs to get out of adjustment and no tools are necessary for re-fusing. All plugs are interchangeable, and, as our fuse boxes are on opposite sides of the transformer, there is no danger in blowing. It makes the lineman's work easy, and this, with the ordinary intelligence of a lineman, is an important point. We make a special line of transformers for low frequency, and the results we are obtaining with these are highly satisfactory in every respect."

ADDRESS BY PRESIDENT AMES OF THE ONTARIO ASSOCIATION STATIONARY ENGINEERS.

After thanking the members for his re-election, the president said "As a member of this association, I will be ready at all times and under all circumstances to advance its interests, and the interests of the engineers generally The interests of the engineers in this country depend largely on their own endeavors to procure an education in the principles involved in operating a modern steam plant The rapid strides made almost daily in the advancement of this science make an up to-date knowledge of these facts indispensable; and it is being recognized that the opportunities offered by this and other similar societies, together with the various publications connected therewith, greatly facilitate the acquiring of such a knowledge.

"I am glad to be able to state that the Ontario Association has progressed very favorably during the past year, as is evidenced by the fact that over 150 certificates have been issued by the Registrar for the current year, making in all some 700 now in force in this Province. That such a showing is eminently satisfactory, I am sure you will agree with me, knowing as you do that the engineers of this Province are not, unfortunately, under a compulsory law. The reduction of renewal fees on, I think, two previous occasions, has without doubt had a beneficial effect. I would respectfully suggest, however, that the fees, as at present, remain for at least another year, viz., $1, 75 cents and 50 cents for 1st, 2nd and 3rd class respectively, this being as low as possible consistent with the raising of a revenue sufficient for the proper carrying on of the affairs of the association.

"I will now call your attention to the very important question of legislation. As you are doubtless all aware, a joint committee from the Ontario Association and Canadian Association of Stationary Engineers was appointed, for the purpose of drafting a measure, to be presented at the last session of the Ontario Legislature, such as would procure for the Province a compulsory license law. This very laudable attempt, for the carrying out of which the members of the said committee deserve all praise, I regret very much to say, fell through, owing to the lateness of the session.

"I would at this time like to impress upon the officers and members of this board, and also upon the officers and members of the Canadian Association throughout the province, the absolute necessity of a compulsory law; and I am quite sure that the majority of the engineers and steam users will heartily indorse any action the Government may take tending in such direction. Appalling boiler explosions have been very frequent of late, attended by great loss of life, leaving out of consideration the amount of property destroyed and the employees thrown out of work. I would ask that this question now receive your most careful attention, and that a joint committee of the O.A.S.E. and C.A.S.E. be appointed at an early date to draft a workable measure, such as will comply with the interests of engineers and steam users at large. I do not hesitate to say that the steam users of this province are beginning to realize that the aim of the O.A.S.E. and the C.A.S.E. is to place before them a class of men capable of handling modern steam plants on a safe and economical basis, a not unimportant matter in these days of close manufacturing competition. The above mentioned societies are striving, to-day, to make better, more careful and more intelligent engineers of their members, and I trust that every success may attend them in all directions. I desire to see the engineers of this province, wherever a sufficient number can be brought together, take steps for forming local associations, with the view of acquiring mutual instruction and improvement.

"I am pleased to state that no one complaint has reached me from any source whatever, as regards misconduct, intemperance or incompetency. I will also ask you to consider the advisability of changing our present date of meeting to the 24th of May, as it will afford a greater number of those interested an opportunity of attending. In conclusion, I ask your earnest and undivided attention to the business that may be brought before you, and to refrain from useless and needless discussion, that all the questions may be disposed of in the limited time at our disposal."

A NEW PRODUCT OF ASBESTOS ROCK.

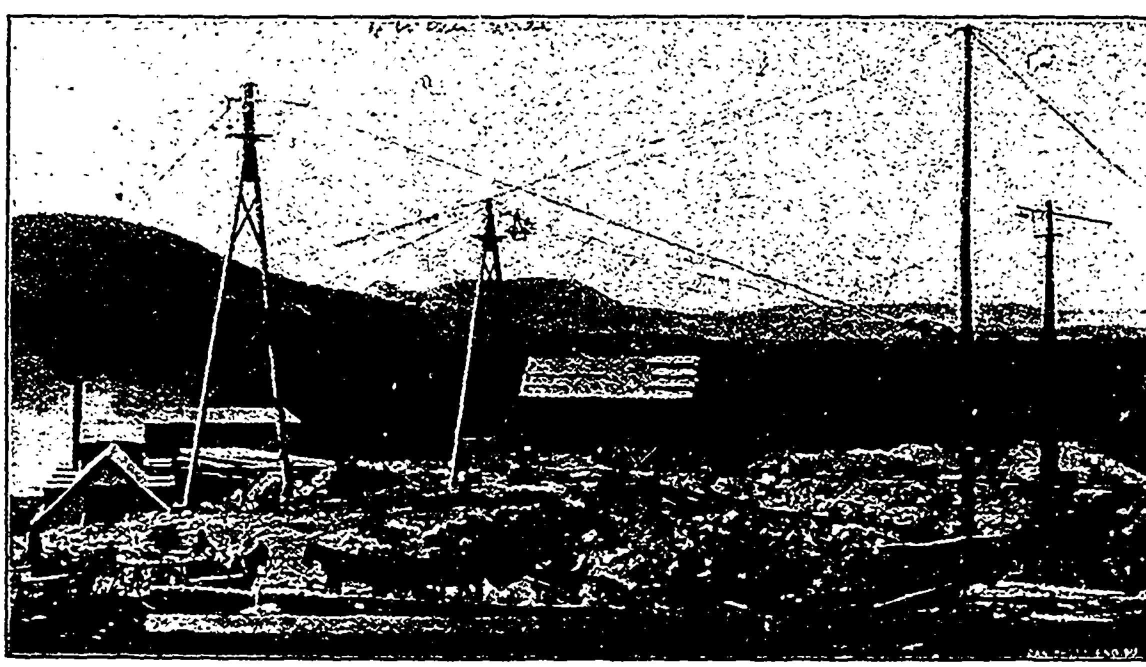
A year ago last May the Jeffrey asbestos mine, one of the oldest and largest in the asbestos region of Quebec, stood idle, and the adjoining village of Asbestos, which depended upon the mining operations, wore a deserted look, and its population was reduced to 300 or 400. To-day, owing chiefly to the enterprise and administrative genius of Feodor Boas, of St. Hyacinthe, the old mines are not only in active operation, but the village has more than doubled in population within the year—being now 900—and an entirely new industry has been created in addition to the work formerly carried on here. If he is a benefactor to his race who causes two blades of grass to grow where only one grew before, Mr. Boas will surely be known as a benefactor to Canada, and more particularly to Quebec, in an eminent degree; for the new industry which Mr. Boas has introduced will utilize millions of tons of asbestos rock which has heretofore been counted waste, and will bring into commerce an article of great importance in the construction trades. By a series of experiments it was found that the sections of asbestos rock lying between the layers of fibre were themselves reducible in part to a fine fibrous pulp, which can be made into a wall plaster. This wall plaster—to which the Danville Asbestos & Slate Co., of which Mr. Boas is the head, have given the very apt name of "Asbestic wall plaster"—has been applied to walls and to various surfaces of metal, etc., under varying conditions of temperature and exposure, and under each condition it has so far proved itself vastly superior in every point to any lime and sand plaster. Being of asbestos, it is, in the first place, incombustible, while its reputed non-conducting properties make it a warmer material for winter; it is lighter by a larger percentage than sand plaster; it is very elastic and will not crack with age or by the settlement of walls; its adhesive properties are remarkable, and finally its adaptability for walls or piping subject to exposure to extremes of heat and cold, may be naturally inferred from the nature of asbestos itself. Any one of these points of superiority would give it a place in the commercial world, but when all these points are combined in one article and when the raw material of the article itself is recovered from what has hitherto been carted to the waste heap, it will be seen that asbestic wall plaster is a new creation. The asbestic wall plaster sticks to tin, sheet iron or other metal almost like glue, and a sample the writer saw on a hot air pipe was subjected to an amount of pounding and bending which would have broken ordinary plaster into fragments. Thos. Curran, of New York, in a report made on asbestic, says it is also a non-conductor of sound, and adds these remarks: "As we know asbestos is fireproof, it is not necessary to say anything further on that point. It is a non-conductor of sound; it will not crumble and there is an immense saving in working it." Such firms as F. Hyde & Co., Alex. Bremner, W. & F. P. Currie & Co., P. Lyall and Thos. Pringle & Son, of Montreal, have made tests of the asbestic wall plaster, and not only endorse most of the claims for it, but predict that it will revolutionize the plaster trade. It is produced in two grades known as "rough" and "finish." The former, when applied to walls, will be of the nature of asbestos felt board, and the latter, which is pure asbestos fibre of great fineness, gives a beautiful and marbly finish to the plaster. It is said that while the cost of asbestic plaster does not exceed that of good lime and sand, its covering capacity is far greater than ordinary plaster.

The following are the directions for use: For Roughing Coat.—Slack one barrel of lime, and while liquid run through a sieve into a box large enough to hold one ton (20 bags) asbestic rough. Mix thoroughly, adding the requisite amount of water. Grounds should not be more than ⅜ inch on lath and ¼ on brick.

After the lime and asbestic is thoroughly mixed, it is best to allow it to stand at least 24 hours before being used.

For Finishing Coat.—Mix one part of lime to two of asbestic finish, and gauge with plaster of Paris for harder finish. Owing to the adhesiveness of the material the darby should be covered with zinc.

A representative of THE CANADIAN ENGINEER visited the mines and works a few days ago and was much impressed with the work being carried on by this enterprising company, which has a capital of $250,000, and the chief shareholders in which are Feodor Boas, Maritz Boas, of St. Hyacinthe; J. N. Greenshields, of Montreal, and the H. W. Johns Manufacturing Company, of New York. The last-named company are among the largest manufacturers of asbestos fibre in the world. When the asbestos trade became depressed a few years ago, the product of the Jeffrey mine—which was the first or one of the first opened in Quebec about 25 years



THE JEFFREY MINE—NOW OWNED BY THE DANVILLE ASBESTOS AND SLATE CO.

ago—fell away, and finally the mines were closed. The present company was formed, and last year opened it up as before stated, and to-day it is one of the most promising industries in the Province of Quebec Though the asbestic branch of the business is in its early infancy, they are already putting up from 200 to 400 tons of this material a week, and there are lying around the mines between 8,000,000 and 10,000,000 tons of rock, which had during the last quarter of a century been carted off as worthless, but can now be converted into the new wall plaster As to the future supply, both of the pure long fibre and the asbestic producing rock, it is impossible to form an estimate. That it is enormous, may be gathered from the fact that the mines here underlie a surface of 75 acres, and of the five large pits now worked some are 300 feet across and excavated to a depth of 100 to 140 feet, with no sign of diminished quality or quantity. Six hoisting engines are at work lifting rock, one of them having just been put in at a cost of $2,000 Steam power is used, the engine room containing a battery of four boilers of 120 horse power, each, the main engine being 700 horse power, with a fly-wheel of 18 feet diameter Rope transmission is used to distribute power, the farthest pit being 600 feet away. For reducing the rock there are 14 stone crushers some weighing 48 tons and taking in a piece of rock of a ton weight at a time.

DANVILLE ASBESTOS AND SLATE CO.'S WORKS—DISTANT VIEW SHOWING HILL OF ASBESTOS.

NEW ASBESTOS WALL PLASTER FACTORY.

The building in which the asbestic is manufactured is 250 feet long and five stories high, and is so erected on the hillside adjoining the mine that stone laden wagons can drive straight to the doorways of all five stories to deliver their loads. Special machinery has been designed to manufacture the asbestic. After the rock has gone through the big crushers it is further reduced and carried on through a series of carriers, blowers and separators, till it is delivered automatically into bags in some cases, and in others into large rooms in which the atmosphere is charged with a constant storm of snowy fibre, which steadily deepens on the floor till it is waist high. The company have erected, and are now enlarging, their own machine shops, and, though but little over a year in operation, now employ 200 hands. The careful plans and excellent equipment of these works reflect the highest credit on the organizers, and if the province of Quebec, with its great water powers and other natural advantages, had a few more men like the Messrs. Boas, its industrial progress would be greater than it is.

GARSON & CO., St. Catharines, Ont., has been awarded the contract for the Petrolia water works at $131,945. This is exclusive of the pumping plant.

ACETYLENE GAS.*

BY GEO BLACK.

Calcium carbide and acetylene gas have been known to scientists for many years, but that it had an industrial future and commercial possibilities of the highest order is the discovery of Thos. L. Willson, a Canadian.

Sir Humphrey Davy observed that when carbon and potassium were heated sufficiently to vaporize the potassium, a carbide was formed. In 1836 Brezelius announced that the black substance formed in small quantities as a by-product in producing potassium from potassic carbonate and carbon, was carbide of potassium. Wohler in 1862 made carbide of calcium by fusing an alloy of zinc and calcium with carbon. He ascertained that it decomposed in contact with water, forming calcic hydrate and acetylene. Berthelot in 1866 described sodium carbide or acetylene sodium. He discovered that the high temperature of the electric arc within an atmosphere of hydrogen would unite with carbon of the charcoal terminals and form acetylene gas In 1888, Willson, in trying to form an alloy of calcium from some of its compounds in an electric furnace, noticed that a[1] mixture containing lime and powdered anthracite acted on by the arc, fused down to a heavy semi-metallic mass, which, having been examined and found not to be the substance sought for, was thrown into a bucket containing water near at hand, with the result that violent effervescing of the water marked the rapid evolution of a gas, the overwhelming odor of which enforced attention to its presence, and which on the application of a match burned with a smoky but luminous flame and numerous explosions. It was acetylene gas. To Willson is due the credit of discovering how to make calcium carbide, at the price of about one cent a pound in unlimited quantities, instead of the rare laboratory product obtained in grains, at the rate of about $10,000 per pound, thus producing not only a new light, but for manufacturing and commercial purposes opening up a vast range of new combinations of hydro-carbons at a much cheaper rate than ever existed before. The possibilities of cheap carbide for light or chemical combinations places Willson in the front rank of the scientific men of the age.

Calcium carbide, $Ca\,C_2$, is a dark brown, dense substance, having a crystalline metallic fracture of blue or brown appearance, with a specific gravity of 2.262. In a dry atmosphere it is odorless, but in a moist atmosphere it emits a peculiar smell, resembling

*A paper read before the Canadian Electrical Association.

garlic or phosphorus. When exposed to air in lumps it absorbs moisture, and the surface becomes coated with a layer of hydrate of lime, which to a certain extent protects the rest of the substance from further deterioration. It is not inflammable and may be exposed to the temperature of a blast furnace without taking fire, the exterior only being converted into lime. When brought into contact with water or its vapors at ordinary temperatures, it rapidly decomposes, one pound when pure generating 5.892 cubic feet of acetylene gas at a temperature of 64° F. It is manufactured from powdered lime and carbon in the shape of ground coal, coke, peat or charcoal, these two substances being fused together in an electric furnace The lime and carbon, having been ground to a fine powder, is intimately mixed in a certain proportion and fed into a crucible or furnace, the lower part of which has a carbon plate which is attached to one of the dynamo terminals; the other terminal is connected to an upright carbon resembling the upper carbon of an arc lamp, but much larger, being about three feet long and 12 by 8 inches in cross section. An alternating current is delivered by means of transformers to the carbons at about 100 volts and 1,000 amperes. A small portion of the mixture is fed into the furnace, the upper carbon is raised about three inches to form an arc, and the mixture is fused by the intense heat which ranges from 3,500 to 4,000 deg. C., while that of the ordinary smelting furnace is only 1,200 to 1,500 deg. C. The carbon is gradually raised and fresh mixture fed in till a mass of molten carbide about three feet high is made, when the current is turned off and the carbide allowed to cool. The noise of the arc is said to be very peculiar, especially when the supply of mixture begins to fail.

To positively ascertain the cost of this product, the *Progressive Age*, of N.Y., sent three commissioners to T. L. Willson's aluminum factory at Spray, N.C., in March last, to investigate thoroughly, and their report is published in that journal under date of 16th April, 1896. The commission consisted of Messrs. Houston and Kennelly, well-known electricians, and Dr. Leonard P. Kinnicutt, director of the Department of Chemistry at Worcester Polytechnic Institute, who investigated thoroughly and took full charge of the factory during two separate days, making two runs of the substance and taking samples with them for testing in their own laboratories. Notwithstanding that the factory at Spray was only an experimental one, and the greatest possible output only one ton per 24 hours, and the fact that transportation of material was excessive, costing $3.05 per ton for coke and $4.55 per ton for lime, and estimating $11 per day for labor, including a superintendent at $4 per day, they figure the cost at $32.76 per ton. Messrs. Houston and Kennelly add a separate estimate for the production of five tons daily under more favorable circumstances, but with water power at $5 per year as at Spray, and figure the cost at $20.04 per ton. They add, "the cost of producing calcium carb. electrically, is evidently limited by the cost of lime, coke and electric power, no matter what the scale upon which the process is conducted. If we assume a perfect electric furnace, in which neither material nor energy is wasted, we know that one ton of carbide would require for its production 1,750 lbs. of lime and 1,125 pounds of pure coke. It has also been calculated from thermo-chemical data that 1½ electrical h.p. hours will be almost precisely the right amount of energy to produce one pound of carbide, or 3,000 h.p. hours per short ton of carbide. Consequently, if L is the cost of lime in dollars per ton, C the cost of coke per ton, and P the cost of an electrical h.p. hour, a theoretically perfect plant would yield carbide at a cost per ton, exclusive of labor and fixed charges, of $0.875\,L + 0.5625\,C + 3{,}000\,P$. For example, if lime (assumed pure) costs $2.50 per short ton, coke (assumed pure) cost $2 75 per short ton, and an electrical horse-power of 300 working days of 24 hours each costs $12 at furnace terminals (0 1667 cent per working horse-power hour), the limiting cost of carbide in a perfect furnace would be $8.73 per short ton. We may therefore summarize as follows: Calcium carbide by the electric furnace cannot be manufactured cheaper than $8.73 per short ton—for material and power—exclusive of electrode carbons, labor, depreciation, interest and other fixed charges. Owing to impurity of materials and departure from theoretical perfection in the electric furnaces, we found at Spray the actual cost of material and power, irrespective of electrode carbons, labor, etc., is $1.335\,L + 1.125\,C + 5122\,P$. Under favorable conditions such as we believe can be realized in particular localities, the total cost per short gross ton on a plant whose output is five tons daily, might be $20. Under the actual conditions existing at Spray during our tests, we find the total cost to be $32.76 per short gross ton, if the plant were worked continuously."

In the above lowest estimate of Messrs. Houston and Kennelly they place horse-power at $12, whereas Mr. Willson has secured water-power at Spray, and also in Canada, at a cost not exceeding $5 per h.p. On this basis, and assuming L at 2.50, C at 2.75, and P 5 00, the figures would amount to 2.18 + 1.55 + 2.08, or a total of $5.81. The cost of lime and coke, however, is placed at a very low figure, but it is evident that the true theoretical minimum price is between $5.81 and $8.73.

I have also the following estimates of cost at the Niagara Falls establishment, to produce one ton of carbide, at rate of 10 tons per day:

It requires	200 electrical h.p., 24 hours at $20 per year,	$10.95
"	1,440 lbs. coke, at $3.50 per ton	2.52
"	1,800 lbs. lime, at $4.50 per ton	4 05
"	Labor, depreciation, etc., etc..................	6.18
		$23.70

It is noticeable that this estimate is somewhat in excess of the theoretical values as laid down by Messrs. Houston and Kennelly, and may be improved on as experience is gained. I was informed that the first run of carbide manufactured at Niagara Falls early in May gave about 25 per cent. better results than their estimate, and that they hoped to improve still more as they gained experience and the men got used to their work.

Mr. Willson commenced to erect a factory at Merritton, Ont., in April, on the old Welland canal, where he has secured 1,500-horse power at locks 8, 9 and 10, and expects to turn out carbide at the rate of 7½ tons daily at the lowest possible cost. He has also secured a very large amount of power in the Province of Quebec, where he intends to manufacture not only for Canada, but for export to foreign countries. It is quite evident from the report of the Progressive Age commissioners, and from the experience of the Niagara Falls Company, that calcium carbide can be made and sold at a price to compete with ordinary gas and electric light.

It takes to produce 100 lbs. carbide, as shown theoretically 87½ lbs. lime and 56¼ lbs. of carbon: of the latter 37½ lbs. combine with the metal calcium and 18¾ lbs. combine with the 25 lbs. of oxygen of the lime, and escapes from the furnace as carbon monoxide, in accordance with the following formulæ:—

CaO	$+ 3C$	$= CaC_2$	$+ CO$.
87½ lbs.	+ 56¼ lbs.	= 100 lbs.	+ 43¾ lbs.
CaC_2		$= Ca$	$+ C_2$.
100 lbs.		= 62½ lbs.	+ 37½ lbs.
CO		$= C$	$+ O$.
43¾ lbs.		= 18¾ lbs.	+ 25 lbs.

Calcium carbide contains 62 5 parts of calcium and 37.5 parts carbon in 100, and when brought into contact with water acetylene is generated to the extent of 5 89 cubic feet of gas to each pound of carbide used; or by weight 100 lbs. of carbide and 56¼ lbs. of water evolve 40.63 lbs. of acetylene gas and form 115.62 lbs. of calcic hydrate (slacked lime) in accordance with the following formula:—

$$CaC_2 + 2H_2O = CaOH_2O + Ca_2H_2.$$
$$100 \quad + 56.25 \quad = 115.62 \quad + 40.625.$$

The acetylene gas so generated contains in 100 parts 92.3 parts of carbon and 7.7 parts of hydrogen, or in the 40.625 pounds generated from 100 lbs of carbide we have 37½ lbs. of carbon and 3⅛ lbs. of hydrogen.

Acetylene can be produced from carbide by the addition of water and distributed and stored in a gasometer, or the gas may be compressed into a liquid and kept in a suitable cylinder and drawn off as required for consumption, a reducing valve being adjusted to give the necessary pressure for burning. One cubic foot of liquid expands into 400 cubic feet of illuminating gas, so that a large supply may be stored in a very small space, but for experimental purposes and for a limited supply it is preferable to make the gas direct from carbide and store it in a gasometer. The pressure necessary to liquefy acetylene depends upon the temperature. At 67° it requires a pressure of nearly 600 lbs., and 32° 323 lbs, at 28.6° below zero 135 lbs., and at 1,160° below zero 15 lbs. We see that there is no danger of freezing it in any habitable place. As an illuminant acetylene surpasses in brilliancy all other known illuminants. When burned at the rate of five cubic feet per hour it gives 240 to 250 c.p., whereas the best coal or water gas rarely exceeds 22 candles for each five cubic feet burned per hour. Acetylene gas thus gives 10 to 12½ times the light of ordinary gas, or 1,000 feet is equivalent to 10,000 to 12,500 of ordinary gas. Acetylene is a commercially pure gas, containing 98 per cent. acetylene and 2 per cent. of air, the latter having slight traces of other substances. It is clear and colorless, with specific gravity of 0 91. When a light is applied to it in open air, it burns with a bright yellow but very smoky flame, on account of its extreme richness in carbon, but when confined and delivered under suitable pressure it gives an extremely pure white light resembling the oxy-hydrogen light, and is the nearest approach in color and purity to sunlight of any known artificial light.

Acetylene, when made from expensive chemicals, was known to be very poisonous, but as made from lime and carbon it is proved to be less injurious than ordinary gases. Its strong pungent smell is a safeguard, as no one can remain in an atmosphere of it a sufficiently long time to be harmed. Moissan, of France, and others made exhaustive experiments with acetylene and coal gas on animals, and proved that coal gas was much more poisonous than acetylene.

Acetylene, when mixed with 1¼ times its volume of atmospheric air, becomes slightly explosive, and reaches its maximum explosibility with 12 volumes of air, decreasing till at 20 volumes it ceases to be explosive Coal gas reaches its maximum explosibility with 5 volumes of air, so that ordinary gas is more explosive than acetylene. Accidents and explosions reported recently have given the impression that the gas is very dangerous. Let us examine this feature. Take the case of the accident in Quebec last winter. An ingenious mechanic made his own dynamo, furnace and carbide; he was experimenting with the gas under pressure, to liquefy it so as to get it into the smallest possible space He had an iron pipe 8 inches long and 4 inches diameter, with cast iron ends, a pressure gauge at one end and a valve at the other He had reached a pressure of 360 lbs. to inch, and observing that the gas was escaping around the valve, he used a hammer to stop the leak, when a portion of the metal broke away and the gas escaping struck him in the eye, penetrating the brain and killing him instantly Ordinary air under similar conditions would have been as fatal. It was afterwards found that the iron ends were thin and porous and the wonder was that they stood the pressure There was no explosion; the coroner's verdict was "accidental death." The explosion at New Haven, Conn., 21st January last, was caused by men experimenting with liquid acetylene, under a pressure of 600 lbs. to the inch, and I presume all accidents reported might be traced to unauthorized parties experimenting with crude apparatus, and ignorant of the necessary conditions for safety

When I first saw acetylene gas in September, 1894, I felt sorry for the electric companies because I thought the gas companies would readily adopt the new gas and regain their former monopoly of lighting But I do not feel quite so downcast now, I realize that the margin of cost of production is not so great, and believe that gas companies will feel the competition equally with electric, unless they adopt the new gas for use pure, or as an enricher to their present output. It is said to be useful as an enricher for coal gas, but not so suitable for water gas. Prof. Lewes of England, one of the best gas authorities there, suggests that gas companies should distribute a low illuminating coal gas of about 12 c.p. through their mains for heating, cooking, etc., and that each place using illuminating gas be supplied with a cylinder of acetylene to be fed into the illuminating pipes in a certain determined proportion. By some such process as this, there remains a large field for coal gas.

The incandescent light has held first place for interior illumination on account of its steadiness, purity, coolness, and not withdrawing oxygen from the air nor adding noxious elements to it. Acetylene will divide this field with the incandescent bulb, as its flame has a temperature of 900 to 1,000 degrees C., while ordinary gas has 1,400 deg. C, but as only one-tenth to one-fifteenth of the quantity is used for equal light, its heating effect is slightly in excess of the incandescent bulb

Taking the theoretical E.H.P. necessary to produce one ton of carbide as 3,000 h.p hours, and using the same for a supply of electric light by incandescent 4 watt lamps, we have the following: 3,000 × 746 = 2,238,000 watts ÷ 64 gives 34,970 16 c.p. lamps for one hour, or 1,453 burning 24 hours continuously. The same power equals one ton carbide, which burned in ½ foot burners gives 31,500 16⅔ c.p lights, or 1,313 burning 24 hours. This gives a margin apparently in favor of electric lighting, but you cannot use all your electric lights at the source of cheapest production, nor run a continuous even load for 24 hours, but have in addition to sustain losses in distribution more than proportional to the distance conveyed; also lamp renewals. With the carbide it is different; it can be made at the place of cheapest production on a constant load night and day, and a small sum transports the carbide to any place desired, where it can be used to its full power without loss. Figure out for yourselves the problem of transmitting electric current for use 10 to 100 miles from source of production and transporting carbide by freight the same distance, and the comparison will be largely in favor of carbide. Hence, for using in close proximity to the power house on a steady even load day and night, the cost will be about the same if power costs the same, but as that is not practicable in electric lighting, the margin is in favor of carbide, but not to such an extent as to seriously hurt the electric companies employing the best apparatus under the most improved conditions, as may be found in large cities, but it is possible in small towns where the best and most economical conditions cannot be obtained and a thorough manager secured, electric lighting may suffer. The ease of distributing this gas is remarkable. Owing to its high illuminating power, very small main pipes may be used, and as frost does not affect it the pipes need only be laid below the surface, so that little or no expense need be incurred in piping a town If the cost of mains equals cost of poles and wires, the central station or gas house only requires a small tank for a generator and a gasometer of a suitable size, as compared with engines, boilers and dynamos running when only one light is required.

In the discussion which followed the reading of this paper a number of points were raised by the members. The cost of water-power at $5.00 per annum per h.p. was thought too low, as $20.00 is charged by the Niagara companies. The fact that coal gas is not so extensively used as water gas, with which acetylene cannot be used as an enricher, seemed to throw some doubt on its value for that purpose.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

SUMMER MEETING.

TORONTO, Wednesday, June 17th, 1896.

The meeting convened at 11 o'clock a.m., in the lecture room of the School of Practical Science, Queen's Park.

On motion of J. D. Barnett, seconded by A. F. McLeod, Col. Sir C. S. Gzowski took the chair.

Sir Casimir Gzowski said he was very grateful for the honor done him, but regretted that he had lost strength to an extent that prevented him from doing any mental work. His love for the Society was as strong as ever it was. (Applause). Anything that he could do for its welfare he would be only too glad to do, as he had tried to do from the very beginning. As one of the oldest engineers in Canada, his whole heart was for the success of the Society. (Applause)

Mr. Jennings, on behalf of the local committee, announced the programme of entertainment that had been provided for the delegates. By the courtesy of the Niagara Navigation Company and the Niagara Falls River and Gorge Railway Companies, delegates would be enabled to visit Niagara and see the immense hydraulic works there. The Toronto Street Railway placed cars at the disposal of the members. The bicycle works of the Lozier Company at West Toronto Junction would be visited. The mayor and city council would take the members on an excursion about the harbor The Toronto Athletic Club extended the privileges of the club to the visiting engineers. The Owen Sound Cement Co. expressed a desire to entertain any members who might visit the works, as also did the General Electric Co., and the Central Bridge Co., of Peterboro.

Prof Galbraith announced that the School of Practical Science would be open and experiments carried on in many of the departments during the visit of the society.

The Secretary said the business of the session was the discussion of the Acts of Incorporation.

The chairman, Sir C. S. Gzowski, feeling unable to preside, J. D. Barnett took the chair.

Mr. Macdougall said the members were aware that prior to the last annual meeting a draft of the proposed Acts of Parliament were prepared and submitted to the members for their consideration. These were voted upon at the last annual meeting, with the result that by a very large majority the society determined to accept those draft Acts. The original bill was in two parts, one to be passed by the Dominion Parliament and the other to be passed by each of the provincial legislatures, the object being the formation of the civil engineers into a close corporation. The Act was passed in Manitoba in March of this year, but there has not yet been time to submit it to any of the other provincial governments. The whole question of the admission of members to the profession, whether by ballot as at present, by examination, as is done by the Medical Council, or by both, as is done by the Society of Land Surveyors, was fully discussed. The many difficulties in the way of the society in securing a uniform series of Acts in the different provinces were recognized, but under the able generalship of Mr. Macdougall the society has already made great progress, and the outlook is favorable for further advances.

The evening session was devoted to an examination of the various departments in the School of Practical Science, and watching a number of experiments in strength of materials made with the various testing machines.

Thursday, June 18.

The morning session was occupied by routine business and the reading of J. D. Barnett's paper, "Pneumatic Power applied to Workshops," of which a full report appears in another column. The discussion which followed the reading of the paper is also given there.

Alan Macdougall was in the chair when the evening session opened. Resolutions were passed thanking members of the different societies and organizations in Toronto and the neighborhood of Niagara Falls for their acts of courtesy to the Society of Civil Engineers.

Prof. McLeod, of McGill University, then read a most valuable paper on the "Discharge of the St. Lawrence River," which we will present to our readers in a future issue. In the discussion which followed the reading of this paper Messrs. Stickel, Kennedy and Sproule took part, and raised a number of interesting points with regard to the estimation of river discharges by means of floats

Owing to the lateness of the hour the reading of Samuel Forter's paper on the "Storage of Water in Earthen Reservoirs" was deferred till the next meeting.

The social features of the summer meeting of the C.S.C.E. are always among its most pleasant recollections, and the 1896 meeting is no exception in that regard. On Wednesday afternoon the mayor and city council of Toronto invited the members to join in an excursion round the harbor and Island, which was very much enjoyed by those members of the association who were able to avail themselves of the opportunity of seeing one of Toronto's most popular playgrounds. The harbor improvements and the waterworks were also examined. On Thursday afternoon, the street railway took the members to High Park and to the company's power house. A visit was also made to the works of the Lozier Bicycle Manufacturing Co., at Toronto Junction.

The whole of Friday was devoted to sight seeing at Niagara. By courtesy of the Niagara Navigation Company and Niagara Falls Park and River and Gorge Railway Companies, the members were enabled to visit Niagara under the most pleasant circumstances. Boarding the steamer "Chippewa" at the Yonge street wharf, the engineers were landed at the Queenston end of the Niagara Falls Park and River Railway. From Queenston to Chippewa was a delightful run, the most magnificent scenery in the world gliding past the visitors as they were carried through fields, villages and fruit farms without the least exertion. The power-house of this company was visited and lunch taken at the Dufferin Restaurant, in full view of the falls and rapids. The party then crossed the Bridge, and after spending some time in viewing the works of the Cataract Power Company, took the Gorge railway down to Lewiston. An excellent opportunity for seeing the whirlpool and rapids below the Falls is afforded by this new line. Mayor Fleming, of Toronto, and the mayor of Niagara Falls, accompanied the members on the excursion, as did also a large number of ladies. The party returned from Lewiston to Toronto by the "Chippewa."

ELECTIONS TO THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The following members were balloted upon:

MEMBERS.

Sandford Flemming, C.M.G., Ottawa, chief engineer of Government Railways, from 1869 to 1881.

J. A. Macdonnell, Winnipeg, engaged on C.P.R. surveys north of Fort William, 1877; C.P.R. preliminary and location, Manitoba, 1880, 1881; C.P.R. construction, Manitoba, section and division engineer, 1882; Lake Superior construction, section engineer, 1888; chief engineer Manitoba Governments since 1888 to date, inclusive.

J. W. Tyrrell, Hamilton, Ont., graduated from School of Practical Science, Toronto, May, 1883, engaged by the Geological Survey of Canada, and continued with that department in the capacity of topographer and draughtsman until May, 1885, when he was engaged as topographer, hydrographer and observer with the Dominion Government expedition to Hudson Bay, and continued with said expedition—wintering in the north—until November, 1886, from which time until the spring of 1887 was engaged in preparing the maps and charts for report. From the spring of 1887 until September, 1888, employed as an assistant engineer on construction of the International Railway of Maine; the eastern extension of the C.P.R., from September, 1888, until the present time (excepting for eight months during 1893, which was spent exploring in the territory west of Hudson Bay); he has been engaged in private practice as a civil engineer and land surveyor in Hamilton, Ont. In the spring of 1889, obtained the degree of C.E. from the University of Toronto. In January, 1892, was appointed county engineer for Wentworth. During his practice in Hamilton, Mr. Tyrrell has been engaged on a number of important works, as the West Flamboro and Beverly Swamp drainage scheme, the Hamilton and Barton Incline Railway, and the location of a number of railways recently constructed or now pending.

The following names were submitted for transfer from the class of associate member to the class of member:—A. W. Campbell, of St. Thomas, Ont. Was elected an associate member of the Canadian Society of Civil Engineers, on the 22nd March, 1888. From that time to the 1st May was associated with J. A. Bell, member Canadian Society of Civil Engineers, under the name of Bell & Campbell, engineers. On the 1st May, 1891, was appointed city engineer of St. Thomas, which position has been held continuously since that time: a system of sewerage during this term, costing about $80,000, was constructed; four large highway bridges erected. Editor engineering department of *Municipal World*. C T. W. Symmes, of Santiago, Chili. In 1887 passed final examination as Dominion land surveyor, and served as leveller on the New York and Boston Rapid Transit Railway surveys; 1887 to 1890, assistant engineer on Pontiac and Renfrew Railway, and resident engineer on Baie des Chaleurs Railway, and on Great Eastern Railway. In April, 1890, elected associate member Canadian Society of Civil Engineers, and came to Chili. Employed some months in "Direccion de Obras Publicas," Santiago, and section engineer on "Talca a Constitucion" Railway till July, 1891; October, 1891, to October, 1892, section and occasionally acting chief engineer of the "Talca a Constitucion" Railway; October, 1892, to October, 1893, engineer and representative of the contractor of "Porral a Conquenes" Railway; October, 1893, to October, 1894, engineer of an extensive system of irrigation of the Haciendes of the "Compania Esplotadora de Lota i Coronel;" also engineer of the installation of a gold washing plant in the south of Chili. October, 1894, to March, 1895, locating engineer of the "Talca a Oriente" for the "Direccion de Obras Publicas;" March to August, 1895, locating engineer of the Guanillos Railway and inclined plane of three kilometers length, and 750 meters height, to transport salt and nitrate of soda from interior of Trapaca. August, 1895, to date, engineer and director for the contractor, of the construction of the "Los Vilos a Illapel i Sala Manca" Railway, estimated cost $5,000,000, including a tunnel of 1,600 meters length; elected "Socio" of the "Institute de Ingenieros de Chili," in 1893.

FOR ELECTION AS ASSOCIATE MEMBERS.

R Laird, Toronto. April, 1886, obtained a diploma of School of Practical Science, Toronto, in civil engineering, together with a course in mining engineering and assaying; 1887, certificate of provincial land surveyor, Ontario, Dec., 1887, to Jan. 15, 1890, with Canadian Pacific Railway, construction department, W. T. Jennings, chief engineer of construction on the Detroit extension and Dominion branch of the Ontario & Quebec Railway, and on the South Ontario Pacific Railway on trial lines and locations. March, 1890, to December, 1895, in city engineer department, Toronto, W. T. Jennings, city engineer, afterwards E. H. Keating, city engineer.

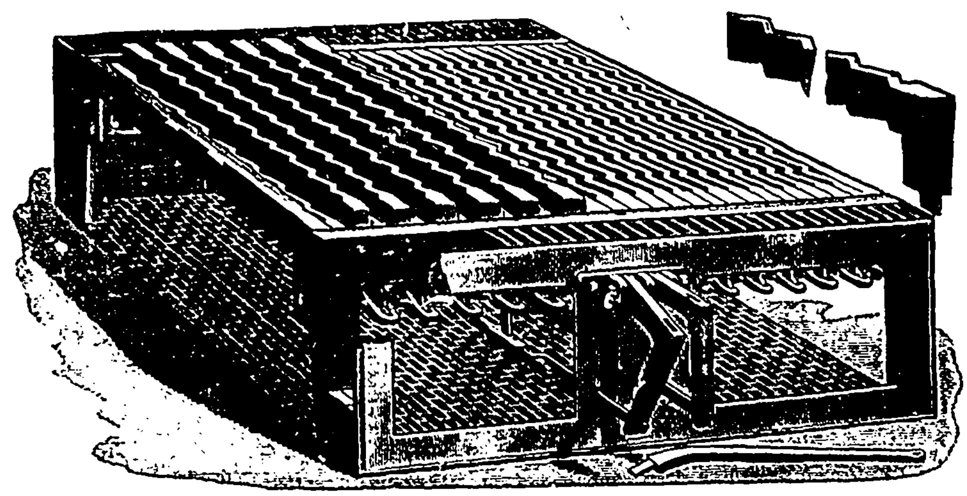
J. W. Orrock, Beauharnois, Que.; 1891-95 (four years and a half), in the office of the chief engineer of the Canadian Pacific Railway as draftsman on railway and highway bridges, masonry and wooden structures, trestling and general track requirements; 1895-96, from October, 1895, to the present time, has been employed in the office of the chief engineer of the St. Lawrence & Adirondacks Railway and South Western Railway as assistant engineer in charge of the designing and structures and bridge inspection.

FOR TRANSFER FROM THE CLASS OF STUDENT TO THE CLASS OF ASSOCIATE MEMBER.

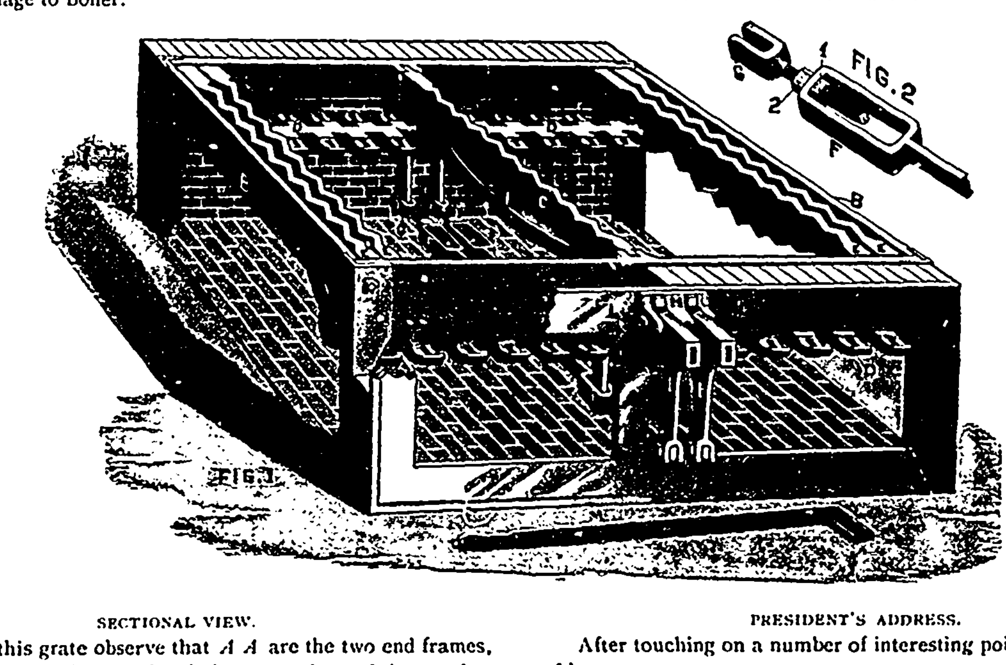
L. A. Amos, Montreal, graduated from the Royal Military College, Kingston, with honors in 1890, winning the Governor-General's silver medal. In 1891, entered the staff of engineers of the Grand Trunk Railway as rodman. In 1892 was employed as the engineer of the firm of Perrault, Mesnard & Veune, architects, Montreal, assistant in the location survey of the St. Jean de Matha Railway. In 1893, joined the firm of Cox & Amos, architects and engineers, Montreal. J. A. Duff, Toronto, 1887, degree of B.A., Toronto University, with honors in Physics; 1890, graduated School of Practical Science in Civil Engineering; 1890, admitted student Canadian Society Civil Engineers. May, 1890, to July, 1891, draughtsman Leslie Bros. Mfg. Co., Paterson, N.J.; Sept., 1891, appointed Fellow in Civil Engineering in School of Practical Science, Toronto, which position was held until vacation of 1894, when appointed lecturer in Applied Mechanics in the same institution, which position is held at the present time; Dec., 1891, appointed Principal Toronto Technical School, resigned in 1894 on being appointed lecturer School of Practical Science; July-Sept., 1892, and May-Sept., 1893, draughtsman, bridge office, Passaic Rolling Mill, Paterson, N.J., bridges and roofs.

VOLCANIC PATENT SHAKING GRATE.

Each bar of this grate is independent of the other, and has an up-and-down movement, so when operated by means of the lever, clinkers are broken and fall down into the ash pit. The castings used in them are heavy and made of good material, and they are carefully fitted and can be easily placed under any boiler. Its makers claim that it is the best constructed, most durable and eco-



nomical grate on the market; that it will outlast three to six sets of common grates, and will save from ten to twenty per cent. of fuel. You can use screenings or the poorest coal with them, for no clinker can form. To keep fire under boiler clean and in good shape, it is not necessary to open the fire doors, therefore the bottom of the boiler is not chilled by the cold draft striking it, causing loss of steam and damage to boiler.



SECTIONAL VIEW.

To set up this grate observe that *A A* are the two end frames, *B B* are the two side frames that bolt on to the end frame after the side frames are in place. *C* and *D*, castings, are to be next put in place. Next put in place two bars on each side marked *E E*. Level the bars *E E* at both ends. *F F* bolts on the front rocker. *G G*, the double nut connection, is next made When the outside bars are perfectly level the double nut connection *G G* must be made tight. Next place the bracket "*H*" on boiler front Then castings *I I* are connected to bracket "*H*" with lock pin *J*. Then attach connecting rods *K* to castings *I I*. Place balance of bars in position and key them on. The grate is now ready for use.

The Gurney Foundry Co., Lt'd, Toronto, which manufacture this grate, give these reasons for the success with which it is meeting:

"It presents a smooth level surface while at rest, which is the life of any grate. Owing to the corrugated form of the grate bar the air is delivered equally over every square inch of the grate surface, thereby causing the most perfect combustion of any grate bar made. Owing to the perpendicular shaking movement of the grate bars, the bottom of the fire is cleaned equally over the entire grate surface, both easily and quickly, without waste of fuel. Owing to the taper shape construction of the grate bars being ¾-inch at the top surface, and tapering to 3-16 inch at the bottom, thereby making a funnel shape air space between the bars, the funnel shape passage allows the air to enter under the bars freely, passing out quickly at the top surface, thereby causing a forced draft within the bars. It is the best draft grate bar in the world. It has the longest life of any grate bar now in the market, it will outlast from two to four sets of common grate bars. It is a labor and fuel saver. It increases the steaming capacity of the boiler. It will pay for itself once a year. It has no weak points in its construction."

CANADIAN ELECTRICAL ASSOCIATION.

The sixth annual convention of the above Association was opened in Council Chamber of the Board of Trade Building, Toronto, June 17th, 1896. A. B. Smith, the president, presided.

A large number of members were present representing electrical interests and ideas from all over Canada.

PRESIDENT'S ADDRESS.

After touching on a number of interesting points, the president said:

"As but a comparatively short time has elapsed since our last meeting, there is not much of actual achievement to chronicle, but there have been developments in the electrical field that indicate the possibilities of a revolution in our method of producing light by electricity. Many minds have for some time past been occupied with explorations in this promising direction. The production of light without heat has a fascination for the inventor that will probably lead to tangible results in the very near future. The ordinary developments of the science as exemplified in modern systems of power transmission, and electrical construction generally, have advanced towards perfection in as great a degree as in former years, but the field for the enterprising inventor, so far from being exhausted, appears to be growing broader and ever broader with unlimited possibilities.

"Notwithstanding the commercial depression, electrical industries in Canada may be said to be in a flourishing condition. The larger electrical manufactories are in full operation, and report a large increase in the output, and with many contracts on hand. It is likely that during the coming year their capacity will be considerably increased. The wonderful increase in the use of electricity for all purposes necessitates the installation of larger units. Dynamos that were considered colossal a few years ago are now being abandoned on account of their lack of capacity. This is leading to the equipment of the factories with more modern and powerful machinery for their production. The allied trades of the tool builder, machinist and engineer are all therefore receiving the benefit of this development of the electrical age.

"Not the least of the current developments is the remarkable increase in the number and mileage of electric railways. The electric motor, a short time ago considered as limited to urban and suburban work, is now usurping the functions of the ;am locomotive, and it is not too much to say that ere long we may expect to see it on our main lines of railway.

"In other branches of electrical work good general progress has been made in perfecting systems and methods at present in use, both electrically and mechanically. The telegraph, with its adoption of new and rapid self-recording apparatus, and the telephone, with its improvements in long distance transmission of speech, are fully keeping pace with improvements in other departments.

"The association is to be congratulated on the promising outlook. It is likely that in the immediate future, with an improvement in the financial world, and as distributing elements are eliminated, the developments will be even more rapid than in the past, and an era of greater prosperity than ever will be abundantly realized."

The secretary also read the secretary-treasurer's report as follows:

SECRETARY-TREASURER'S REPORT.

During the year covered by the report, the association has made satisfactory progress. Between 1st June, 1895, and 31st May, 1896, there were added to the membership 24 active members and four associate members. During the same period eight active and seven associate members tendered their resignations, leaving the net gain in membership 13. Since the close of the association year there have been elected 23 active members, making the present membership 194 active members and 35 associates, a total of 229. There are on the roll a considerable number of persons who, without having resigned their membership in the association, have ceased to take an active interest in its affairs, and have likewise failed to pay their membership fees. It should be understood that when a person joins the association, he thereby becomes a member, not for one year only, but until such time as he formally resigns his membership, and that until his formal resignation is received by the secretary and accepted by the executive committee, he continues to be liable for payment of the annual fee. It is perhaps due to the lack of a definite understanding on this point that the actual standing of the association, with regard to its *bona fide* membership, is at the present time somewhat uncertain. The time has arrived when definite action should be taken to put an end to present and future uncertainty with regard to this matter. It was to be expected that some of those, who at the outset became members of the organization, without being actually interested in the work which it was designed to accomplish on behalf of the electrical interests, would soon drop out. In the place of such, the association has within the past two years been receiving as members persons connected with the various departments of electrical work, and who therefore feel the benefit to be derived from connection with the organization and have a personal interest in its welfare. It thus appears that, while for a time, the additions to the membership may be, in a measure, offset by the withdrawal of members of the first mentioned class, the association is steadily gaining in character and influence.

The annual conventions, which have been extremely interesting and enjoyable from the commencement, are becoming more so year by year, in proof of which I need only point your recollection back to the delightful meeting in Ottawa last autumn, and direct your attention to the character of the programme on the present occasion. Two meetings of the executive committee have been held since the close of the Ottawa Convention, viz., on the 22nd of October, 1895, and the 16th of January, 1896. At the first of these meetings accounts in connection with the Ottawa meeting were examined and ordered to be paid, and the secretary instructed to have printed 500 copies of the revised Constitution. At the second meeting two active members were elected. Messrs. Wright, Breithaupt and the president were appointed a committee to endeavor to make arrangements for a popular scientific evening lecture in connection with the present convention. The selection of a suitable place of meeting for the convention was left in the hands of the Toronto members of the executive The sum of $25 was placed at the disposal of the Committee on Statistics. The Toronto members of the executive were appointed a committee to perfect local arrangements for the convention.

Following is a statement of the receipts and disbursements for the year:

FINANCIAL REPORT FROM 1ST JUNE, 1895, TO MAY 31ST, 1896.

Receipts.

Cash in bank June 1st, 1895	$186 77
Cash on hand June 1st, 1895	
Ninety-three active members' fees at $3	279 00
Fourteen associates at $2	28 00
Refund by Statistical Committee	23 62
	$517 39

Disbursements.

Expenses of Convention at Ottawa—	
By cash as per local committee statement	$100 00
" caretaker at Ottawa	3 00
" express charges on books to and from Ottawa	1 40
" *Can. Elec. News*, printing	72 50
" Can. Photo Eng. Co.	16 22
" A. F. Sladen, stenographer	25 80
Electrical News, for printing	7 00
Postage	35 10
Exchange on cheques	1 50
Blackhall & Co., 50 leather certificate covers	4 00
Grant to secretary	50 00
Mortimer & Co., badges, including protest charges	17 16
Grant to Statistical Committee	25 00
	$358 68
Cash in bank, May 31st, 1896	157 21
Cash on hand, May 31st, 1896	1 50
	$517 39

Receipts Since May 31st, 1896.

June 1st, 1896, cash on hand	$ 1 50
Thirty-eight active members' fees at $3.00	114 00
One " " " at 5.00	5 00
Three associate " " at 2.00	6 00
Cash for exchange on cheque	15
	$126 65

Expenditure Since May 31st, 1896.

Ribbon and pins for badges	$ 2 88
Receipt forms	40
Postage	20 78
Exchange on cheques	1 15
Envelopes	15
	$ 25 36
Deposited in bank since June 1st. 1896	95 15
Cash on hand June 17, 1896	6 14
	$126 65

Total standing to credit of association, $258.50.

Certified correct,

B. J. THROOP, } Auditors.
A. A. DION, }

The committee on statistics reported that they were making good progress in carrying out the ideas expressed in the report of last year's statistical committee as to the compilation of data relating to central stations for the supply of electric light and power. An important fact brought out was that most of the stations in Canada are operated for only a short period in the 24 hours.

The paper on "Ocean Cables" was not read, as Mr. Dwight had been unable to complete it.

The paper on "Acetylene Gas," by George Black, of Hamilton, will be found on another page.

At the morning session of the second day of the convention it was decided to hold the next meeting at Niagara Falls in June, 1897.

Committee on statistics suggested the formation of something in the nature of a bureau of mutual information, to be formed in the interests of the association, particularly to gather information regarding central stations, and to keep it on file. This would prove of value to central station men, by enabling them to base their calculations not alone on the results of their own experience, but on the combined observations of the association. The large amount of work which the maintenance of such a bureau would entail upon the secretary of the committee seemed likely to prevent the carrying out of the proposal, but the secretary of the association, C. H.

Mortimer, offered to undertake the extra work for a year without remuneration, and so the new venture was launched. If the members support the committee on statistics as they should, this will be one of the most valuable features of the association.

Jas. Milne's paper on meters, which will be found in another column, was then read and was received with a great deal of favorable comment by the members Some of those present thought that the recording motor meters were not quite so unreliable as Mr Milne believed them to be.

At the afternoon session the committee on nominations for standing committees reported as follows: Legislation—J. J. Wright, K. J Dunstan, Berkeley Powell, L B. Macfarlane, and F. H. Badger. Statistical—E. Carl Breithaupt, John Yule, and O. Higman. These nominations were followed by a unanimous election.

The election of officers for the ensuing year followed, and John Yule was elected president by acclamation, as also were L. B. Macfarlane, 1st vice-president, E. Carl Breithaupt, 2nd vice-president, and C. H. Mortimer, sec.-treas.

The following members were elected to the Executive in the order in which they are placed: J. J. Wright, A. M. Wickens, K. J. Dunstan, J. A Kammerer, Geo. Black, A. B. Smith, Ross McKenzie, John Carroll, F. C. Armstrong, C. B. Hunt.

JOHN YULE, PRESIDENT.

John Yule is manager of the Guelph Light and Power Company, a position he has held for the past 25 years, as the G. L. & P. Co. was originally the Guelph Gas Company, and on the introduction of electric lighting it went into the supply of electricity. Previous to coming to Canada, Mr. Yule, who is a Scotchman, was engaged in the gas business, first with the Dundee Gas Company, and afterwards for two years with the Dundee Municipal Gas Works.

L. B. M'FARLANE, 1ST VICE-PRESIDENT.

Mr. McFarlane entered the service of the Montreal Telegraph Company in 1865, and filled various positions, from messenger to manager, and was afterwards employed by the Western Union Telegraph Company in the Western and Southern States. In 1876 he accepted a position with the Dominion Telegraph Company as manager at Toronto, and later succeeded to the position of assistant to the managing director. On the advent of the telephone, he was appointed superintendent of that company's telephone department, and organized and put in operation telephone exchanges in all the principal cities, towns and villages in Canada. The Bell Telephone Company of Canada was incorporated in 1880, and took over from the telegraph companies, and others interested, all the telephone business then in existence in Canada. Mr. McFarlane was then appointed manager of the eastern department of that company, and has held that position for the past sixteen years. He was promoted this month to the new office of general superintendent of the whole system in Canada, which embraces the Provinces of Quebec, Ontario, Manitoba, and the North-West Territories.

E. CARL BREITHAUPT, 2ND VICE-PRESIDENT.

Mr. Breithaupt graduated from North-Western College, Illinois, in 1887, and later spent several years at John Hopkins University, Baltimore, in post graduate work in physics and electrical engineering. For several years past he has done consulting electrical engineering work in Canada; and at the present time is secretary and manager of the Berlin Gas Co., Berlin, Ont., and an electric light and power business in the towns of Berlin and Waterloo. He is also president and general manager of the Berlin and Waterloo Street Railway Co., and is identified with several railway projects in the vicinity. He was elected an associate member in the American Institute of Electrical Engineers in 1893, and elected to full membership this year.

The paper on "The Outlook for the Electric Railway," by F. C. Armstrong, was very well received by the association and a vote of thanks passed. The paper is given in full in another column. In response to a number of questions, Mr. Armstrong said that on the Galt, Preston and Hespeler Railway freight and passenger cars were handled in winter on grades of three to seven per cent., so that there could be no difficulty about laying electric lines on ordinary roadways, with only a small expense for cutting. At present a limit of profitable transmission was about ten miles from the power-house, without undue expenditure for copper, as the Hamilton, Grimsby and Beamsville. The Hamilton Radial Railway will have a limit of eleven miles at a greater expense for copper, but a saving on the cost of a polyphase apparatus otherwise necessary.

The evening of June 15th was most pleasantly spent by the members in an excursion per steamer "Greyhound" to Lorne Park. The annual banquet for members and ladies was held at the Hotel Louise, followed by a moonlight sail on Lake Ontario.

When the convention assembled on the morning of June 19th, P. G. Gossler read a paper on "Some Central Station Economics." The discussion which followed the reading of this paper was mainly on the question of belt-driven or direct-driven generators. It is sometimes found more profitable to use belts, as engines already in use may be employed, and small loads carried more economically.

A vote of thanks was tendered Geo. White-Fraser on the reading of his paper, "Power Transmission by Polyphase E.M.F.'s."

A. M. Wickens read Mr. Philip's paper on "Operating Engines without a Natural Supply of Condensing Water." As the members had not time to go into the discussion of the subject, Mr. Philips was requested to present his paper to them for discussion at the next convention.

LAKE OF THE WOODS GOLD.

When R. H. Ahn, manager of the Dominion Gold Mining and Reduction Co., paid the Montreal office of THE CANADIAN ENGINEER a visit in March, he spoke with a degree of reserve as to the prospects which the recent success of the mining enterprises there has evidently overcome. The facts, then, he thought, were insufficient to excite enthusiasm, but now encouragements come daily, and the advances made in the Lake of the Woods district are attracting prospectors from other countries. At least two English companies, who have been engaged in operations in Australia and South Africa, are sending representatives to prospect in this district, and inquiries are coming in from all parts of the world. In this district there are 50,000 square miles of gold-bearing rocks, containing three main belts of quartz, known as the Seine River, the Manitou and the Lake of the Woods. A part of the last named belt has been tentatively worked, but the other two may be said to remain untouched.

These operations, at present so limited, already show fine results. As an instance, Mr. Ahn informs us that on April 20th last he effected the purchase of the Golden Gate property. The next day he took possession of it for the owners, and at once set a gang of men to work. As a result he was able in less than a month to deposit in the bank at Rat Portage 40 ounces of 800 fine gold, worth about $750. During the next six weeks they extracted 38½ ounces of 879 fine, which Mr. Ahn displayed for our inspection in the form of a brick. These results probably cannot be matched in the past history of quartz mining, but it may happen again, and it is certain that the prospects in the Lake of the Woods district are exceedingly easy to work. All the leads known are easily accessible, mostly by water, and all of them within a very few miles of the C.P.R. track. They are easy of location, and do not need large expenditure in sinking a shaft to determine the value of a mine.

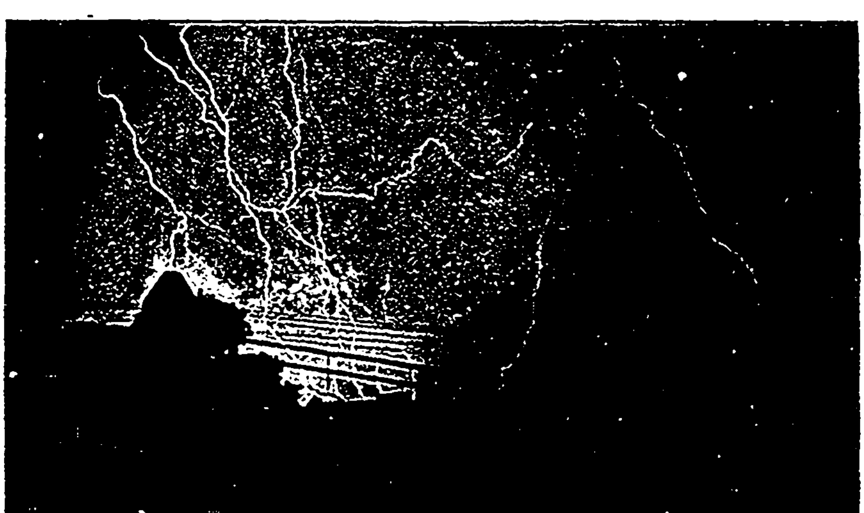
Miners in plenty can be obtained at a moderate wage, and the transport of machinery and supplies is easy. No smelting plant is necessary as the milling is free. The reduction works are in perfect working order and ready to treat any and all ore that may be brought in. At present on the Lake of the Woods there are about 300 men actively employed in working two mines. There is no reason why there should not be 2,000 mines, each employing say 50 men. There would then be 10,000 miners which would mean, with their families, 30,000 souls to supply with food and clothing.

This possibility may not be so far from realization, for the Gold Hill and the Black Jack will be worked this summer; three distinct companies have been formed to work the Eschweiler property of 1,600 acres; good work is already being done on the None Such, and many other properties are being developed and the whole district well covered by prospectors.

UPWARD BOLTS OF LIGHTNING.

Editor CANADIAN ENGINEER.

SIR,—I have pleasure in sending you a copy of a photograph taken about 8.30 p.m. during the thunderstorm which occurred in Montreal on Sunday, May 15th. You will notice there are about 20 flashes of lightning, showing more or less distinctly; three of them are shooting upwards from the earth to the sky, one near the right hand side of the picture, and the other two near the centre. Another flash darts horizontally across the picture. The whole series occurred during a period of ten minutes.



Yours truly,

JAMES HORSFALL.

1016 St. Catherine Street, Montreal.

QUESTION OF EVAPORATION.

Editor CANADIAN ENGINEER:

SIR,—Can I get through your valued columns an answer to the following question:

A brick chamber six feet square and ten feet high has hot furnace gases passing in at one side and out by an opening in the top; there is to be maintained six inches deep of water on the bottom of this chamber; size of hot gas inlet and outlet 36 inches diameter; temperature of gas 420° Fahrenheit. What quantity of water will be evaporated per hour?

ENQUIRER.

ENQUIRER.—The makers of the compressed air locomotive recently described in THE CANADIAN ENGINEER are H. K. Porter & Co., Pittsburg, Pa.

W. F. asks: "Having a water-power for which I have a purchaser, I should be glad to know what value I should put on it per horse-power?" The value of water-power depends upon its location, and also whether the site is adapted for manufacturing purposes, and how near it is to a railway or navigable water. If the individual owning it simply wished to lease the right to develop the power, it is very difficult to place a value on it, or on the contrary, if the power has already been developed, and the power can be transmitted to neighboring plants, its value will depend somewhat on the cost of steam power in the vicinity. Developed power is worth all the way from ten dollars to fifty dollars per horse-power per annum.

SOME CENTRAL STATION ECONOMIES.*

BY P. G. GOSSLER.

The difference between a modern plant which embodies all the latest ideas and one which shows a loss at every point is very wide indeed. Old plants must be replaced and the first cost must not be considered where a saving is only made at the cost of a steady loss amounting to vastly more than the interest on the original saving.

The following results are obtained from the partial reconstruction of one plant. It does not give a full idea of what will be accomplished by a complete reconstruction, inasmuch as that part so far carried out has been confined to transformer and line changes. The reconstruction affects only the alternating system of a plant which also furnishes the direct current arc and motor service. These changes include the replacing of the present single-phase generators and line shafting operating them by two-phase generators with an inherent regulation of four to five per cent., without compounding devices, the generators to be belted directly to the engines; the building of the new switch-board for two-phase currents serving light and power from the same circuit at 2,000 volts; rearranging the lines for two-phase distribution; and reducing the station load and bettering the service in general by replacing all of the old transformers on the lines by the best transformers obtainable.

To proceed with a systematic reconstruction, the first things necessary are reliable records, at least of what the plant and lines to be reconstructed consist. For the plant herein referred to it was necessary to establish pole line and circuit maps as well as transformer maps. It may be said that such a system of records in detail and kept up to date is necessary for the economical operating of an electrical lighting station. For the pole line records a card catalogue was arranged, each card having a number corresponding to a pole; in connection with this card catalogue there is a map, on which each pole is located with its number; also, for further convenience in making out reports and locating poles, each pole itself was numbered. On the card representing a particular pole all of the wires are shown in their relative positions on the pole by numbers placed over the pins to which the wires are attached, the numbers indicating the circuits of which the wires form a part. By means of this card the positions of the wires forming the different circuits were clearly shown, also what changes in the relative positions of the wires were necessary to overcome existing inductive effects. In fact, the pumping on the circuits due to mutual induction, prior to their rearrangement, when circuits supported on the same pole were running from dynamos on different engines, was so serious and caused so much fluctuation of the lights that it was necessary to rearrange the relative positions of the feeders of all the circuits to counteract these inductive effects. Very satisfactory results were obtained when the rearrangement of the wires had been carried out. Prior to this change, to overcome fluctuation, it was necessary to feed all circuits on the same pole line from one set of dynamos operated by one engine, which was very often not convenient, and only possible with a large loss in operating expenses.

In connection with this pole catalogue, circuit maps were arranged, which consisted of diagrams for each circuit, showing the streets upon which the circuit ran, and the size and length of each section of wire or wires.

At the same time transformer charts were prepared, which consisted of maps for different sections of the city covered by the

*A paper read before the Canadian Electrical Association.

different circuits. On these maps each transformer was located by a small square stamped on the map, and within this square was written the name of the customer being served from this transformer, the number of lamps installed, the revenue per year, the revenue per lamp per year, the estimated number of hours burned per lamp per day, and the probable number of lamps burning at any one time. There is also indicated on these charts the size and length of secondary wires from the transformer to the customer's cutout. All this information was found necessary for the proper "bunching" of customers on the transformers and for the loading of the transformer Wherever possible, secondary systems were established, to which several transformers were connected in parallel, in which case the size of the secondary mains between the transformers was such that the drop in these mains was small compared to the drop in the transformers themselves; in this way the transformers were made to share, more or less, the load equally between them When a secondary system of distribution was not economical, single transformers were located. In determining whether a customer was to be included in a bunch of customers all of whom were to be fed from one transformer, or whether it was more economical to place a separate transformer, it was necessary to make an approximate estimate of the cost of locating the transformer for each case. When the interest on the cost of placing a separate transformer plus the cost of maintenance of the transformer, was more than the interest upon the cost of connecting a customer to a transformer, feeding other customers, the connection in question was made to the transformer feeding the "bunch." However, even if the difference in annual cost was small in favor of a separate transformer, connection was made to the "bunch." In making these calculations, a fixed drop in the secondary mains was allowed, and the load, *i.e.*, the probable number of lamps burning at any one time, for calculating this drop was determined from the records on the transformer charts; of course, the character of the service goes a great way in making this last determination. A separate transformer was placed only when the total annual cost for the placing and maintenance of such transformer did not exceed the sum of the two following costs—the interest on the cost of placing and maintenance of wire necessary to connect the customer to the nearest "bunch" transformer, and the increased cost due to necessary increase in size of transformer. The annual cost of a transformer on the lines was considered to include the cost of the iron losses, figured as costing the electrica lighting station at an assumed rate of one-tenth (.1 cents) per lamp hour of 55 watts, a 5 per cent. interest on the cost of the transformer, and the high rate of charge of 10 per cent. depreciation

At the beginning of the reconstruction herein referred to there were 1,160 transformers on the lines, with approximately 53,000 lamps wired. There had been 473 old transformers removed, 229 new ones had been put up. The lightest load registered during the year preceding the reconstruction was 380 amperes. Ten months later, with about 8,000 more lamps wired on the service than at the time of the 380 ampere load, above referred to, the lowest load recorded was 245 amperes, or a decrease in the load line of 135 amperes, this decrease in leakage load being due to the transformer changes just mentioned. The leakage of the 229 new transformers was 19 amperes, which means that the 473 old transformers had a leakage of 154 amperes, or an average leakage of .325 amperes per transformer removed, which figure has been verified by leakage tests made on the old transformers which had been removed from the lines. Thirty-six of the 135 amperes reduction was due to the removal of the 110 old transformers, and placing the customers served from these on other old transformers, making secondary distribution systems. From this is deduced the fact that by replacing the 345 old by 187 new transformers, a saving was effected of 99 amperes. The average saving for the 187 changed is then 529 amperes per change, which, with coal at $2.75 per ton, means an annual saving of $25.58 per change in coal alone The average cost of the 187 changes, including the cost of new transformers, all extensions of wiring for secondary mains and all labor, crediting these orders with old transformers as scrap only, was approximately $65. As stated above, an annual saving per change in cost of coal would be effected of $25 58, therefore at this rate the new transformers will pay for themselves, if the saving of coal only is considered, in about two and a half years.

The reduction in leakage load so far obtained in the reconstruction under consideration has not been accompanied by any sacrifice of transformer regulation. The type of new transformer used is one giving the best all round results, that is, one in which regulation and leakage are so proportioned in its construction as not to benefit one at the expense of the other. In thickly populated or central business portions of the city, where an extensive secondary distribution is possible, and where large transformers may be connected in parallel at different points, it would be an advantage to use transformers of very small leakage current and high "all day efficiency," as in this case the transformers share the load between them, and regulation can be sacrificed to gain diminished leakage current. However, as it is only in very large cities, and only in the most thickly populated centres of these, that the secondary distribution system can be economically used, the make of transformer giving the best all round results should, in general, be selected. To further improve the regulation beyond that to be obtained by improved transformer regulation, it is intended to change the primary distribution from 1,000 to 2 000 volts, thereby decreasing the copper losses on the existing circuits to one-quarter of the present losses, and reducing the feeder drops so that good service and regulation will be obtained without the use of feeder regulators or the erection of additional copper. A source of additional improvement in regulation will be the use of generators with very close regulation. The necessity of transferring the circuits from one dynamo to another makes close inherent regulation in generators an imperative feature if satisfactory service be desired. Transformers with good regulation, feeders having small drops, and generators of close regulation, mean that the ordinary changes of load and transfers of circuits from one generator to another can be made without materially affecting the voltage on the lamps in service. When this reconstruction has been completed there will have been installed five 300 KW generators, two on one engine, two on a second engine, and one on a third engine. The two generators running from the same engine will be run in parallel when the load requires it, making the units on two of the engines 600 KW, with the advantage of having a more flexible system and a possible saving due to running a 300 KW when a 600 KW would be but partially loaded. The construction and location of the engines was such as to make it impracticable to put 600 KW generators on the two large engines, had it been so desired. It will be found that the most economical and certainly the most convenient unit of power for operation is one that has the capacity to carry the day load, the remainder of the dynamos being of a uniform type and size.

In the search for economy the lamp should come in for attention. Lamps with long life are found to be inefficient; very efficient lamps are usually short lived. Using an efficient lamp increases the earning capacity of a plant and permits of using higher candle power lamps with a proportionally less increase in cost. An increase in candle power either by high candle power incandescent lamps of high efficiency or small incandescent arc lamps, seems to be the best way to meet competition from gas.

It has been found that running a 50-volt lamp at 52 volts, or increasing the voltage four per cent., increases the candle power about nineteen per cent, while the life of the lamp is decreased about forty three per cent. Running the lamps at a pressure of 55 volts, or a ten per cent. increase of voltage, increases the candle power of the lamp about sixty-six per cent., while the life of the lamp is decreased about eighty-three per cent., from which it would seem that to a plant supplying current to a large number of incandescent lamps and furnishing renewals, running them above the rated voltage, means a large increase in the lamp renewal account, both for material and labor. Run the lamps as near their rated voltage as possible, and the lamp renewal account will be a minimum. Good regulation on the circuits goes a long way towards keeping this account down. A daily rise in voltage from three to four per cent. above normal for a short time will reduce the life of a lamp of good economy about one half.

To determine what lamp is best suited for any electric lighting station, it is necessary to know the cost of producing current per lamp hour, and having established this for any special make of lamp, the following formula will permit of a comparison of different makes of lamps and the determination of the best lamp for the conditions under which they are to run. In considering the cost of production per lamp hour in connection with the lamp question, the cost of service may be divided into three parts: A. That portion of the service per lamp hour that is practically not affected by the average efficiency and life of the lamps and such portion of the maintenance, operating and general expenses, as is practically not increased by increasing the current consumption per lamp hour. B The cost per lamp hour, coal, water, interest and depreciation on the lines, dynamos, engines, etc, and such part of the expense of the service as increases proportionately to the amount of current served per lamp hour and as the maximum station output. C. The cost of the lamp per lamp hour, and the expenses per lamp hour for replacing exhausted lamps. This is equal to the cost of one lamp, plus the cost of exchanging one exhausted lamp, divided by the average life of the lamp.

Under the first division (A) should be included the cost of fuses, meters, transformers erected, and secondary connections, line construction, maintenance, etc., and such proportion of the operating and general expenses as is not increased by increasing the current consumption per lamp hour. Under (B) should be included that portion of the cost of service per lamp hour exclusive of lamp renewals that increases proportionately to the current consumed per lamp hour. These divisions of cost should be so made that the sum of A, B and C will represent the total cost of service per lamp hour; the values of A, B and C representing the above divisions of cost having once been established for a lamp of any given efficiency and average life for any particular lighting station, the cost of service per lamp hour for this same station with any other lamp which has a current consumption different from the current consumption of the first lamp, and having an average life of "Y" hours, would be A+XB+C. — the cost of service per lamp hour, "X" representing the proportion between the current consumption of the lamps being compared, and "C" being the cost of one of the new lamps, plus the cost of replacing one exhausted lamp divided by "Y," the average hours of life of the new lamp.

This formula applies for comparing the cost of producing light with lamps having different costs, efficiency, and average lamp life, when they are to be burned in the same plant and under the same conditions of average lamp hours burned per lamp installed, and the same maximum number of lamps burning for a given number of lamps wired. Value (B) in this formula includes the coal consumption and the materials which practically vary proportionately to the watt hours' output required for providing the light. It also includes the interest and depreciation on the plant, which must be enlarged when the lamps consume large amounts of current, because the generating and supplying capacity of the plant must be proportionate to the maximum output called for by the lamps. In many plants the interest and depreciation account will form quite a considerable portion of the factor B, and as a large value to the factor "B" makes a showing against the high consumption of current per candle-power hour very bad, it would appear that any lamps installed that did not burn at the time of maximum current output from the station, could be economically used of a poorer efficiency, with longer life, than lamps which do burn at time of maximum output, because any additional demand for current on a plant that is not a call for current at the time of maximum output, does not require an increase of plant capacity. In estimating the best efficiency per candle power hour, per lamp hour, for these lamps that do not burn at the time of maximum output, the cost of interest and depreciation entering into the factor "B" in the formula (in fact all the costs that increase proportionately as the size of the plant required to serve the lights wired) should be excluded from the factor "B." The result is that lamps that do not burn at the time of maximum output can be economically used of considerably lower efficiency than lamps that do burn at that time.

Industrial Notes.

The sewage interception plant to be built in Hamilton, Ont., will cost $85,000.

The McTavish Reservoir, Montreal waterworks, will be repaired at an expense of $50,000.

The Nelson, B.C., *Miner* says that the Montague Paper Co. is building an addition to the Nantais mill.

The Tudhope Carriage Co., of Orillia, Ont., is getting out plans for a $13,000 enlargement to its premises.

Paxton, Tait & Co., Port Perry, Ont., have recently equipped a saw mill for G. G. & W. C. King, Chipman, N.B.

The Benjamin Co., manufacturer, wooden ware, Yarker, Ont., is having a siding of the N.T. & Q.R'y run to its works.

E. S. Stephenson & Co., St. John, N.B., are putting in a new 60-horse power high-speed engine for their pulverizer works.

Jas. Findlay has applied to the Victoria, B.C., city council for encouragement in establishing the manufacture of mining machinery.

R. Smith, manufacturer paper-makers' machinery, Sherbrooke, Que., is moving into new quarters in the Jenckes Manufacturing Co.'s works.

The Maritime Nail Co., St. John, N.B., has received from the works of E. Leonard & Sons an automatic cut-off engine, which they are placing in position in the factory.

Westport, Ont., has a cheese box factory, Nelson McKim, manager.

A large number of the streets in Winnipeg are to be paved with asphalt.

The town of North Sydney, N.S., will lay six miles of cast iron pipe of 4, 6, 8 and 10 inches diameter.

The Toronto Radiator Co., Ltd., will build an addition to its factory on Dufferin street, to cost $4,000.

W. E. Barnett, of Almonte, Ont., has removed the machinery to his new wood-working factory at Arnprior, Ont.

The Sims' Lumber Co., Sault Ste. Marie, Ont., has placed an order in Toronto for a large boiler and mill machinery.

Engineer Moore, of London, Ont., is preparing an estimate for the town of St. Mary's, Ont., of the cost of the proposed waterworks.

The town of Listowel, Ont., is preparing plans for an expenditure of $15,000 in waterworks improvements and a street lighting plant.

The Small & Fisher Co., Woodstock, N.B., is shipping machinery and agricultural implements to England to fill orders received.

The Russel water power at Sturgeon Falls, Ont., has been bought by United States capital, and a pulp mill will be erected this summer.

The bursting of the cylinder in the engine in Kaufman's planing mill, Berlin, Ont., recently, wrecked the engine, and a new one is being put in.

The furniture factory at Strathroy, Ont., 150 x 58 feet, is being pushed towards completion, and Smyth & Merritt expect to have it running by August 1st.

John McLaren, of Renfrew, Ont., who lately sold his roller mill in that town, is building a new one at Mile End, at the junction of the C.P.R. and C.A.R., near Montreal.

The Peterboro Bridge Co. is building a new steel bridge over the Catfish Creek at Stevens' mill, near Aylmer, Ont., and also a county bridge between Dereham and Malahide, Ont.

The Gardner Tool Co. and the city of Sherbrooke, Que., have signed the agreements made necessary by the recent vote of a bonus by the city. The new works are expected to be in operation in the fall.

The Hamilton Powder Company gives notice that it will apply to Parliament for authority to change the head office of the company from Hamilton to Montreal, to increase its capital, and to increase the amount for which the company can issue bonds.

The Toronto Brass Co., Ltd., 88 York street, Toronto, is beginning the manufacture of cabinet and builders' hardware, gas, electric and combination fixtures. A first-class plant has been put in and the manufacturing department is under the management of T. H. Stephenson, formerly manager of the Toronto Lock Co., Ltd.

W. J. Burroughes and Joseph Wright, of Toronto, organized the Master Plumbers' and Steamfitters' Association in Hamilton, Ont., recently. The officers are: Wm. Fairley, president; W. J. Walsh, vice-president; Hugh Wallace, secretary; Adam Clark, treasurer; Wm. Smith, sentinel. The association will be represented at the convention to be held in Montreal this summer.

The gravitation system of waterworks put in last year in Beamsville, Ont., having proved satisfactory, the neighboring village of Grimsby contemplates having a system of waterworks also, and the council has instructed Marshall Hopkins, C.E., of Hamilton, Ont., to report on the mountain springs available, and if sufficient water cannot be got from these to report on the cost of pumping from Lake Ontario.

At the monthly meeting of the Iron Founders' Association of Montreal, held recently, J. Best, of Warden King & Son, who was a representative at the meeting of the National Association of Iron Founders, held recently in Philadelphia, and who was elected a vice-president of that association, gave a most interesting account of the proceedings, which were of a character to benefit anyone connected with the trade.

The Babcock & Wilcox Co. have consolidated their Canadian sales department with their general sales department, at New York and given up their office in Montreal. No change will be made in the manufacturing department, and the Canadian shops will be maintained, and all boilers built here as at present. Wm. T. Bonner, resident manager for the company's Canadian business for nearly two years past, will remove to Atlanta, Ga., having been appointed manager for the company's south-eastern territory. Mr. Bonner made many good friends during his stay in Canada.

Sandon, B.C., is putting in a waterworks system.

A. West, Cole's Island, N.B., is building a saw mill.

Alma, N.S., had a boiler explosion which wrecked the carriage factory of Ross & Son, June 25th.

The Globe File Works, Port Hope, Ont., are now making fine files for use by dentists and jewelers.

The Ontario Rolling Mills, Hamilton, Ont., has closed down its nail factory till orders catch up on stock.

Kingsley Boiler Co., Lt'd, manufacturers, St. John, N.B., has sold its machinery to Waring, White & Co.

Kaslo, B C., is to have a system of waterworks put in this summer at a cost of $30,000, says the *Kootenaian*.

London, Ont., waterworks department will lay a conduit a mile long from the Colville springs to the pumping station.

Notice is given of application for letters patent to incorporate the Wrought Iron Range Company of Toronto, capital $100,000.

J. Perkins Co., Toronto, have been awarded the sub-contract for erecting tower and furnishing hydrants and valves for Petrolia, Ont.

The Truro Foundry and Machine Co. has supplied a car load of large iron girders for the People's Heat and Light Co., Halifax, N.S.

Davis & Son, boat-builders, Kingston, Ont., have called a meeting of creditors for July 15th. Liabilities about $5,000 and assets about $3,000.

The Chanteloup Mfg. Co., of Montreal, has been awarded the contract for gas and electric fixtures and counter railings for the new City Hall, Quebec.

A by-law to raise $50,000 to purchase shares in the Edmonton district railway and traffic bridge has been voted on by the ratepayers and the bridge will go on.

John Watson, box manufacturer, London, Ont., is to be compelled to pay taxes for 1895, as he did not observe the conditions on which an exemption was granted him.

The ratepayers of Tilsonburg voted on the 15th ult. on a by-law authorizing the expenditure of $8,000 for the erection of a town hall, council chamber, market building and fire hall combined.

Among the new establishments in Waterville this year is a machine shop started by R. O. Hopkinson. Besides general job work, Mr. Hopkinson manufactures a lifting jack for a Boston firm.

The Erie Iron Works Co., St. Thomas, Ont, has assigned to C. E. Armstrong. Liabilities of nearly $18,000. Assets consist of machinery, etc., $8,000: book debts, $2,000: and stock on hand, $5,000.

The following Ontario towns are considering the construction of waterworks —Arnprior, Campbellton, Cardinal, Caldwell, Cremore, Deseronto, Grimsby, Paisley, Perth, Simcoe, Smith's Falls, Thessalon, Thorold, Wallaceburg.

The Department of Public Works has awarded the contract for the construction of two steel scows to be used in connection with the steel dredge in the waters of the Maritime Provinces to the firm of Carriere, Laine & Co., of Quebec, who were the lowest tenderers.

Donald Munro, superintendent of waterworks at Woodstock, N.B., is constructing a steel bridge over the Maduxnakeag River, on abutments furnished by the town, which is to carry the water mains. Superstructure to consist of one span each, 40 feet, 57 feet 11 inches, 50 feet 5 inches.

At the annual general meeting of the shareholders of the Taylor Hydraulic Air-Compressing Company, Ltd., held at the office of the company on the 2nd inst., Messrs. Samuel Carsley, Jos. R. Fair, Robert Archer, George Durnford and Chas. Morton were elected directors for the ensuing year, and at a subsequent meeting Messrs. Samuel Carsley and Jos. R. Fair were elected president and vice-president, respectively.

The National Association of Master Plumbers of the Dominion is now in existence, having been launched at a convention of master plumbers held in Montreal recently. Delegates were present from all over the Dominion, and also three delegates from the United States Association. The following officers were elected: President, Joseph Lamarche, Montreal; vice-president, W. J. Burroughs, Toronto; vice-president for Ontario, Wm. Smith, London; for Quebec, O. Matte, Quebec city; for Nova Scotia, John Borran, Halifax; for New Brunswick, J. H. Doody, St. John; financial and recording secretary, J. W. Hughes, Montreal; treasurer, A. Fiddis, Toronto; executive committee, R. F. Elliott, Kingston; E. C. Mount, Montreal; G. A. Perrior, Halifax; Thomas Campbell, St. John.

J. R. Baird, manufacturer of electrical gas engines, is turning out a 15 horse-power engine for the Tichburn Oil Wells, at Marthaville, Ont.

Jno. Sharpe and J. A. Banfield, Toronto, are asking Ottawa city for a bonus to establish the manufacture of cash registers, computing machines, etc.

J. W. Bolet, of New York, was in Montreal recently in the interest of capitalists, who are looking into the building of the proposed Montreal-Longueuil bridge.

The master plumbers of London, Ont., held their first annual banquet recently at the Grigg House, London, the mayor and several aldermen being present. W. J. Burroughes, president of the Toronto association, and A. Fiddes and W. Mansell were present.

A bonus of $2,000 a year for ten years will be paid by St Johns, Que., to "La Societe Anonyme des Faienciers du Canada,' of France, which has bought the works of the St. Johns Stone Chinaware Company; one hundred and fifty hands are to be employed and $40,000 paid annually in wages.

The next annual convention of the Canadian Association of Stationary Engineers will be held at Kingston on Tuesday and Wednesday, the 18th and 19th of August. The local reception committee are making every preparation for the event, and between excursions and other entertainments it is expected the convention will be a great success.

Personal.

Wm. McCannon, electrician on steamer "Empire State, was drowned at Clayton, N.Y., July 4th.

J. H. Chewitt, mining engineer, Toronto, has examined a number of British Columbia properties in the last month.

City Engineer Haskins, of Hamilton, Ont., died suddenly on July 5th. Mr. Haskins had been city engineer for forty years.

F. P. Smith, representing the D'Este & Seeley Co., manufacturers of the Curtis regulators and steam traps, paid a visit to Montreal last month.

G. H. Walters, millwright, Port Hope, Ont., was killed while helping to adjust a belt-tightener in the Gillis Bros. Company's saw-mill at Braeside, Ont., June 17th.

Edmund Wragge, for thirteen years local manager of the G.T.R. at Toronto, is to retire, as the local managership has been abolished by General Manager C. M. Hayes.

Arthur L. McCollum, B.A. Sc., of Maxville, Ont., a recent graduate of McGill University, has been appointed analyst to the Dominion Coal Company, Glace Bay, Cape Breton.

D. D. Wilson, Toronto, died suddenly in Montreal, June 19h Mr. Wilson was well known as an inventor and business man. He invented and patented an electric motor and a chemical fire engine.

A. W. Campbell, C.E., late city engineer of St. Thomas, Ont., was recently entertained at a banquet given in his honor by the leading citizens of the city. The mayor of St. Thomas presented an address to Mr. Campbell.

Herbert Wallis, late mechanical superintendent of the G.T.R., was presented with an illuminated address by the locomotive engineers of Montreal, before leaving for England, where he will make his home in future.

George W. Sadler, the popular head of the well-known firm of Robin, Sadler & Howarth, is now Alderman Sadler, having been elected by a handsome majority to represent St. Antoine Ward in the Montreal city council.

Geo. Wilson, the retiring chief engineer of the St. John, N.B., Railway Company's power house, was the recipient of an address and a valuable present on severing his connection with the company. Thos. Irwin, of Montreal, succeeds Mr. Wilson.

Wm. McNichol, St. Catharines, Ont., a contractor on the Hamilton Radial Electric Railway, was accidentally killed, June 22nd, while crossing the Grand Trunk track on the Beach road, his carriage being struck by the engine of the Chicago express. Death was instantaneous.

James Sibley, son of Richard Sibley, Toronto, was awarded two first prizes at a recent exhibition of the work of the Ottawa Art School. One prize was on machine drawing. The other was on building construction, for which he received from His Excellency the Governor-General, Green's History of the English People, in five volumes.

HECTOR MACKENZIE, the founder of the Oil Well Supply Co., Petrolia, Ont., who has been prominent in the business circles of that town since 1866, where he established the firm of Draper & McKenzie, machinists, died last month at his home in Petrolia.

THOMAS AUSTIN, of Brooklyn, N.Y., is at the Balmoral Hotel, Montreal. Mr. Austin is the inventor of the "Austin Extension Heater," and visits Canada to make arrangements for the introduction of his heater on this market. His invention has met with great success in the United States, and embodies many features new to Canadians.

EDWARD LUSHER, secretary and treasurer of the Montreal Street Railway Company, died at his home in Montreal last month, at the age of seventy-one. He had been secretary and general manager of the street railway for eighteen years, and became secretary-treasurer of the company when the road was converted into an electric system.

AT the commencement exercises of the graduating class of 1896 from the Stevens Institute of Technology, Hoboken, N.J., held June 18th, 1896, the degree of doctor of engineering was conferred by the faculty and trustees of Stevens Institute upon Commodore George W. Melville, Engineer-in-Chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering. Only once before in the twenty-five years' history of the Stevens Institute has the degree of doctor of engineering been conferred, and then upon Professor R. H. Thurston, of Rhode Island, who formerly occupied the chair of Mechanical Engineering in Stevens Institute, and is now director of Sibley College, Cornell University.

Railway Matters.

SURVEYORS have been at work on the route of the Montreal, Vaudreuil and Ottawa Railway, between Rigaud and Caledonian Springs.

C. C. SMITH & Co., railway contractors, Sherbrooke, Que., have finished the Quebec Central Bridge over the St. Francis at Sherbrooke, which was washed out by the floods.

WORK is being pushed on the Dauphin Railway. The line is being located by Mr. Drury, engineer of construction; H. Urquhart, foreman of construction; R. B. Van Horne, D. A. Ross and A. C. Smith.

THE St. Lawrence and Adirondack Railway has amalgamated with the Southwestern Railway, under the name of the St. Lawrence and Adriondack Railway Company, with capital stock of $1,090,000, and head office in Montreal. The directors are Dr. W. Seward Webb, Chauncey M. Depew, Edgar Van Etten, John Jacob Astor, Charles H. Burnett and Henry L. Sprague, of New York; Martin E. McCleary, Malone; E. C. Smith, St. Albans, Vt.; and R. W. Leonard, Beauharnois, Que. The new company has decided to take over the lease made by the St. L. & A. Co., of the G T.R. Line, between Valleyfield and Beauharnois.

OFFICERS OF THE CANADIAN ASSOCIATOIN OF STATIONARY ENGINEERS.

The following officers have been elected in the different branches of the C.A S.E. for the year beginning July 1st:—

Ottawa—F. J. Merrill, president; Albert Gaul, vice-president recording secretary, F. G. Johnson; financial secretary, F. Robert treasurer, Wm. Hill; conductor, John Harris; doorkeeper, E Sutton; trustees, Wensley, Johnson and Cowan.

Montreal—President, John Murphy; 1st vice-president, J. E Huntington; 2nd vice-president, William Smyth; secretary, B Archibald York, re-elected; treasurer, Peter McNaughton; financial secretary, Harry Nuttall, re-elected; corresponding secretary, Hugh Thompson, re-elected; conductor, J. Glennon, re-elected; door-keeper, Wm. McAlpin, re-elected. Trustees, Past presidents Thos. Ryan and John J. York; John H Garth. Librarian, Past president John Robertson.

Toronto—President, J. Fox; vice-president, C. Mosely; corresponding secretary, T. Eversfield, acclamation; financial secretary, W. G. Blackgrove; treasurer and librarian, S. Thompson; conductor, T. Seaton; doorkeeper, J. Doyle; trustees, J. Huggett, E. J. Philip, G. Fowler; delegates to convention, J. Bain, J. Fox, C. Moseley, J. Huggett, A. M. Wickens; corresponding secretary, G. C. Mooring.

Kingston—President, Harvey Hopkins; vice-president, John L. Orr; secretary, John McDonald, Rockwood Asylum; treasurer, Charles Selby; conductor, Robert Bajus; doorkeeper, Ronald McDonald.

Hamilton—Past president, W. R. Cornish; president, Wm. Norris; vice-president, E. Teeter; recording secretary, Jos. Ironsides; financial secretary, A. Nash; treasurer, Wm. Nash; conductor, Wm. Jones; doorkeeper, Thos. Carter; trustees, R. Mackie, P. Stott, R. C. Pettigrew; auditors, G. Mackie, J. Ironsides and J. Wadge; delegates to convention at Kingston, Wm. Norris and G. Mackie.

Berlin—In this branch of the C.A.S.E. all the officers of last year were re-elected.

Carleton Place—President, Capt. McKay; vice-president, John McFarlane; secretary, J. D. Armstrong; financial secretary, Wm. Taylor; treasurer, H. McFadden.

Kincardine—President, D. Bennett; vice-president, J. H. Walker; secretary, Percy C. Walker; conductor, T. Hall; doorkeeper, M. Farral.

METAL IMPORTS FROM GREAT BRITAIN.

The following are the values in sterling money of the metal imports into Canada from Great Britain for May, 1895 and 1896, and the five months to May, 1895 and 1896:

	Month of May.		Five months to May.	
	1895.	1896.	1895.	1896.
Hardware and cutlery	£4,143	£6,097	£20,911	£27,493
Pig iron..................	3,118	3,179	5,871	7,780
Bar, etc..................	1,109	2,141	4,857	6,299
Railroad	23,394	9,675	26,568	22,038
Hoops, sheets, etc........	5,765	5,481	12,051	11,696
Galvanized sheets	7,357	3,006	21,243	15,672
Tin plates	16,999	13,753	48,893	56,119
Cast, wrought, etc., iron ..	5,026	6,776	15,726	21,568
Steel	6,357	10,590	19,314	36,727
Lead	2,745	1,182	6,566	5,443
Tin	1,747	1,559	7 845	7,074
Cement	4,970	3,393	6,527	10,365

ELECTRICITY AND WATER PIPES.

Editor CANADIAN ENGINEER:

SIR,—Allow me to call attention to a subject which may be of importance. Since the introduction of electricity to propel street cars in Toronto I have found leaks in underground lead pipes of a very different description to leaks or bursts found before. Formerly the pipe was split through weakness, now I find even the strongest —and in some cases pipe that is nearly new—having round holes as if a shot had gone through them.

Near and round about the hole is a white, gritty substance like ground glass, which is firmly embedded in the grain of the lead. The holes are always pointing downward and not less than about three feet apart, the pipe between being perfectly clean, sound and free from anything of a barnacle nature adhering to it. They chiefly occur in lead services that cross under the car tracks, but I have found them over a hundred yards away on streets leading north from the tracks, on a rising grade.

I believe there are many such leaks going on at present, for I find a weakness of pressure and a rushing sound on many of the house taps. But they are hard to find because the stream striking downward, it cuts a passage into the interior of the ground, and worms itself into unknown channels, seldom showing the leak on the surface.

I believe the electricity from the cars follows small streams of water or the wettest veins of the subsoil, and often strikes the lead pipes, or causes such a change in the soil by chemical action at certain points, adjoining or touching the pipe, that a hole is eaten through. If the holes, however, are eaten through by chemical action, why should they always occur on the down side?

I have questioned the gas service pipe layers, and am informed that similar defects are found in the wrought-iron pipes. The question seems to me is that in return for the privilege of electrical power, we may have the metal pipes laid under ground seriously damaged and ultimately made useless, unless changes can be made in the present system. W. M. WATSON.

THE California Gold Mining Co., Rufus H. Pope, president, has been organized to develop mineral claims in the famous Trail Creek district of British Columbia. A. W. Ross & Co., King street, Toronto, mining brokers, are placing the stock on the market. Capital, $2,500,000, in shares of $1 each.

SCHOOL OF SCIENCE GRADUATES.

The following is the list of those who have passed in the final year at the School of Practical Science, Toronto, and are entitled to the degree of Bachelor of Applied Science:

School of Practical Science Certificate —Honors—J Armstrong, W M Brodie, W H Mines, J McGowan, H L. McKinnon. Pass—E. J. Boswell, J. S Dobie, H S Hull, A F. McCallum, R. C. C Tremaine.

Thesis —Honors J S Dobie, W H. Mines, J. McGowan, H. L. McKinnon, R. C. C Tremaine Pass—J. Armstrong, E. J Boswell, W M Brodie, H S. Hull, A F McCallum.

Thermodynamics Honors—W M Brodie. Pass—H S. Hull, W H Mines, J. McGowan, J McKinnon, R. C C. Tremaine.

Hydraulics —Honors J. McGowan. Pass—J. Armstrong, J. S Dobie, W. H. Mines, E J Boswell, A F. McCallum.

Strength of Materials —Honors—J Armstrong, J. S. Dobie Pass—E. J. Boswell, A. F. McCallum

Electricity —Honors H. L McKinnon. Pass W M. Brodie, H. S. Hull, R C C. Tremaine.

With Honors—J. McGowan, H L McKinnon

THE M T Co., Kingston, Ont, is laying the keel of a barge similar to the "Minnedosa," to cost $75,000.

THE new stretch of water made navigable by the construction of the Sheik s Island dam, was opened on Dominion Day.

THE Hamilton Iron and Steel Company have tested the ore of their new iron mines opened up at Madoc, and have found it of excellent quality

THE yacht "Canada, which is to defend Canadian interests in the international races on Lake Erie in August, was built by Capt. Andrews at Oakville, Ont.

WOOD, SKINNER & Co, Newcastle, launched last month their steel steamer "Rosemount" for the M T. Co., Kingston, Ont Length, between perpendicular, 253 feet, beam, 41 feet, depth moulded, 21 feet 4 inches, and is designed to carry a large measurement of cargo on a light draught of water

AT Valleyfield, Que, the Cotton Co has commenced excavations for a large flume, which is to be put in at the end of the mill near the site of the Larkham residence. It is intended to develop about 800-horse power. What is not required for the motive power of the company s mills is to be used for generating electric power, which may be distributed to any part of the town

THE International Radial Railway Co, of Hamilton, of which Dr Burns is president, have made surveys of their projected electric road to Guelph, and announce that they expect to begin construction next autumn The line would run through Waterdown, but not touch Galt for the present, though if the road were built to Guelph, a spur would probably afterwards be run to Galt.

BANNERMAN & FINDLATER, of Ottawa, have shipped a third sectional boiler to British Columbia, the last one going to the Kootenay Mining Company's works at Rossland.

As the result of putting in the new Corliss valves on the high-pressure engine of R. & O. steamer "Montreal," the consumption was reduced from 55 to 41¼ tons per trip. The new valves put in the low-pressure cylinder this season have further reduced the consumption to 35 tons per trip.

AFTER investigation into the Point Ellice bridge accident at Victoria, B.C., the coroner s jury has rendered a verdict holding the Consolidated Railway Company directors responsible for 55 lives. The city council was declared guilty of contributory negligence, and the officials of the corporation were absolved of personal responsibility. The bridge, which was found not to have been constructed according to original specifications, was safe for ordinary traffic, and the accident would not have occurred but for the improper crowding of the cars.